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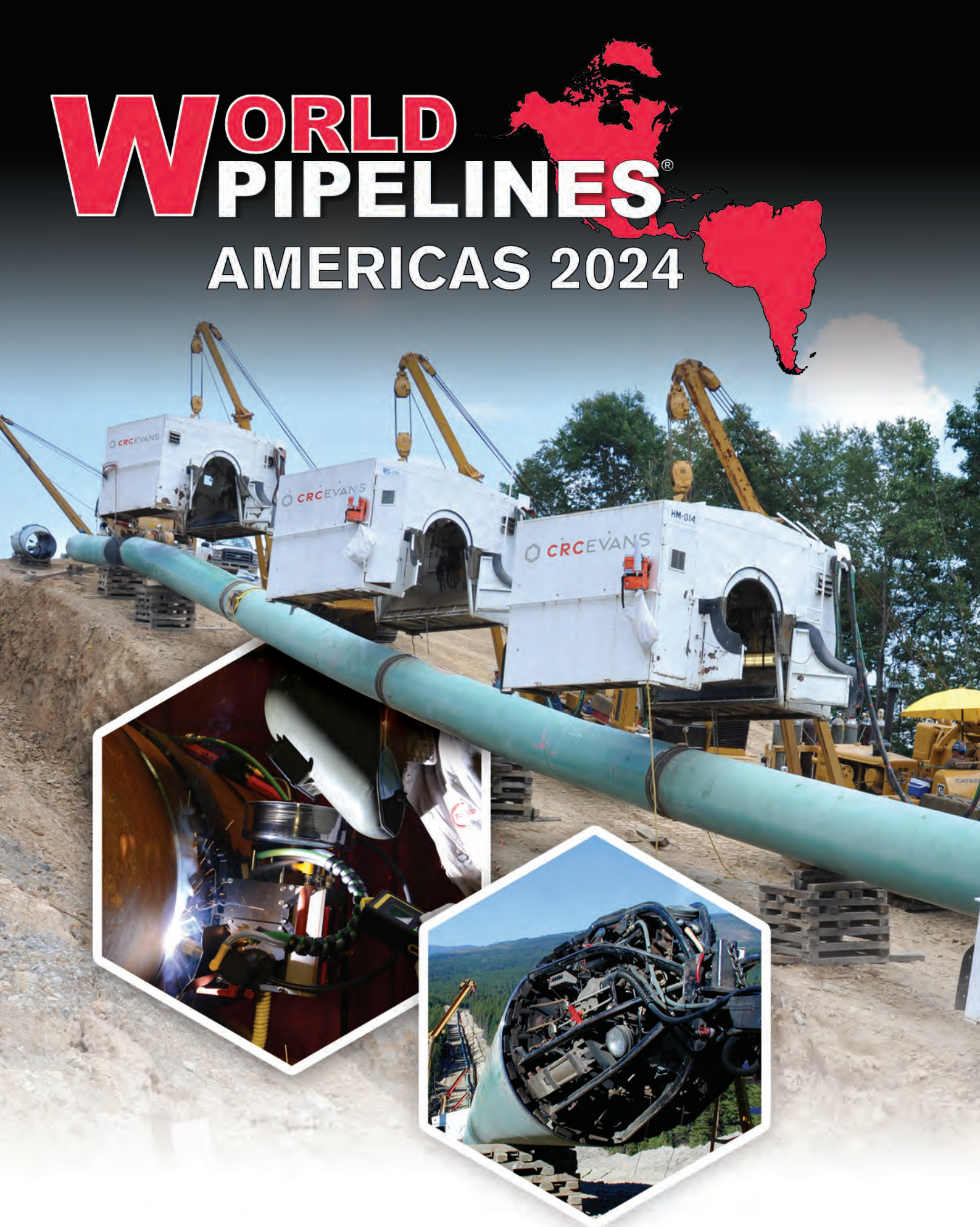
AMERICAS 2024



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ON THIS MONTH'S COVER

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GUEST COMMENT

ROBERTO CASTELLI
Chief Commercial Officer of Bonatti and President of IPLOCA

The market in the Americas currently offers wide and varied opportunities in the pipeline sector. Bonatti's perspective is that of one of the industry's leading pipeline contractors, a position we have earned through decades of constructing major projects worldwide. During these years, we have built our strengths on the expertise of our people and evolution of our equipment – our pipelayers and our mechatronic welding system, both designed and constructed in our in-house facilities – and on our field experience, which gives us a high capacity to tackle complex projects.

Our experience in the Americas began in Mexico in 2012, where we fully implemented the principles of our business model, which involves deeply integrating ourselves in the countries where we operate, behaving like a truly local company, and becoming an integral part of the local economy.

In Mexico, our experience has led us to construct over 2000 km of major gas pipelines, five compression stations, and three storage terminals, that are major infrastructures to supply the country's industrial development. Our workforce of more than 4000 people is almost entirely Mexican, and deeply committed to ensuring a very high operational level.

Thanks to these factors, we have been awarded new pipeline and relevant facilities projects, which are necessary to feed the new LNG plants being built on the Pacific coast and to bring energy where existing infrastructure cannot meet the needs of industry and population.

Specifically, I refer to projects such as the 'Mexico-Pacific' system, where we will be key players in the pipeline and compressor stations construction for the 'Gasoducto Sierra Madre', which will supply gas to the 'Saguaro Energia LNG Facility' and the 'Mayakan/ Cuxtal II' project, which will also involve us in pipeline and compression station construction.

While Mexico is well positioned to become an LNG hub for Asian markets, in Canada – where we have just completed one of the most complex sections of the Trans Mountain Expansion project with our partner Kiewit – we foresee a restart of the pipeline market in the coming years. We are closely monitoring the developments of the major pipeline projects that will enter in the execution phase in 2027.

A separate but extremely interesting chapter is the pipeline sector in Chile. This mining country is facing important environmental issues relevant to ground water consumption, which is a concern for the leading companies in the sector. We are currently involved in projects focused on transporting water from the sea to high-altitude mining areas, which (either desalinated or not), can be used for various operations instead of utilising well-extracted water. These projects are of extremely high complexity due to the particular working conditions, with steep mountains and rough terrains.

We can thus observe that the market in the Americas currently shows a high variety of opportunities that, according to the latest investment news in the gas and energy sector, are set to expand in the coming years.

I have been delighted to serve as President of the International Pipe Line Contractors Association (IPLOCA) this year. My presidency will conclude with the convention in Sorrento, Italy, from 9 - 13 September.

> "THE MARKET IN THE AMERICAS CURRENTLY SHOWS A HIGH VARIETY OF OPPORTUNITIES"

Improving safety and avoiding accidents on our sites is a top priority for our association. We rigorously collect and analyse health, safety, and environmental data to identify major causes of issues. IPLOCA members contribute to maintaining these important statistics, and we present awards for the best HSE ideas and contributions: our HSE and CSR Committee leads these efforts.

Attracting new talent is crucial in our industry. We launched an initiative to involve young professionals in our events and activities. Our workshops, such as the Novel Construction Fall session in Lisbon on 23 - 24 October, offer opportunities to learn about advances in construction technologies and workplace safety.

Each year, we recognise members' exemplary achievements with the IPLOCA Awards. This year, three awards will be presented during the Convention in Sorrento: the IPLOCA Health & Safety Award, the IPLOCA Environmental Award, and the IPLOCA Excellence in Project Execution Award.

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Annual subscription £60 UK including postage/£75 overseas (postage airmail). Special two year discounted rate: £96 UK including postage/£120 overseas (postage airmail). Claims for non receipt of issues must be made within three months of publication of the issue or they will not be honoured without charge.

Applicable only to USA & Canada:
World Pipelines (ISSN No: 1472-7390, USPS No: 020-988) is published monthly by Palladian Publications Ltd, GBR and distributed in the USA by Asendia USA, 701C Ashland Avenue, Folcroft, PA 19032. Periodicals postage paid at Philadelphia, PA & additional mailing offices. POSTMASTER: send address changes to World Pipelines, 701C Ashland Avenue, Folcroft, PA 19032.

WORLD PIPELINES®

SENIOR EDITOR Elizabeth Corner
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As we report in the news section of this special *Americas* issue, pipeline operators are increasingly betting on their natural gas pipeline infrastructure being pivotal in the supply of power to data centres. These centres, full of power-intensive computers, house the flow of information for online services, including high-traffic platforms for banking, social media and streaming services.

Data centres consume a lot of energy, and pipelines can help with this: Enbridge CEO Greg Ebel told investors during a post-earnings conference call in August that "Data centres require base load power solutions such as natural gas to meet the continuous energy demands of hyperscalers".[1]

TC Energy takes a similar view. Speaking to analysts on TC's recent quarterly conference call, Executive Vice President and Chief Operating Officer Stan Chapman said that of the more than 300 data centres proposed or under construction in the US, 60% are within 80 km of TC's natural gas system. "Data centres are now clustering where energy infrastructure is already in place, rather than prioritising proximity to telecom infrastructure".[1]

Chapman also mentioned that many data centre operators now opt to build and own their own onsite power gen facilities to meet their high electricity needs.

This trend offers a considerable opportunity for these operators to connect natural gas pipeline systems in the US, Mexico, and Canada. The world's demand for data shows no signs of slowing. The glut of AI-generated data, images and messages need to be stored somewhere. This is a sector where real estate (data centres) needs to dovetail with infrastructure (power sources).

In an article on how to invest in the data centre business, Val Cipriani (Investors' Chronicle), recognises similarities between the data centre rollout and the boom in online marketplaces in the early to mid-2000s (e.g. Amazon), which fuelled a drive to build fulfilment centres.

But Cipriani writes: "Building a warehouse and getting a data centre online are not the same thing. The latter needs land with access to fibre connection and a lot of power. The International Energy Agency estimates that global electricity demand from data centres could amount to double 2022 levels as soon as 2026".[2] Gas demand for electricity to run data centres will increase by as much as 8 billion ft^3/d by 2030, according to Chapman.

In its post-earnings call in July, Kinder Morgan said "We're having commercial discussions on over 5 billion ft^3/d of opportunities related to power demand, and that includes the 1.6 of data centre demand".[3] Where the US goes, the world follows, and similar deals are being discussed all over Latin America, and further into South America.

There is much else to be optimistic about when it comes to the future of natural gas demand in the Americas. The grid needs to keep up with a jump in manufacturing, new factories, the electrification of everything, and the gradual retirement of coal-fired power plants.

Pipelines provide the perfect partner for data centres, just as they are a great fit for carbon capture and storage, and the emerging field of hydrogen transportation. Read this special issue for updates on pipeline safety and standards in the US, pipeline risk in the Americas, pipeline logistics in the Caribbean, natural gas and hydrogen learnings in the US, and technical case studies from across the region. WP

1. https://digitalinfranetwork.com/news/data-centers-are-hungry-for-natural-gas-enbridge-tc-energy/
2. https://www.investorschronicle.co.uk/content/9c267418-1e4b-5d71-8abc-e24206cc1ef3
3. https://www.reuters.com/business/energy/kinder-morgan-misses-second-quarter-profit-estimates-2024-07-17/

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NORTH AMERICA NEWS

TC Energy eyes opportunities in North America, driven by data centre growth

Calgary-based energy firm TC Energy is seeking opportunities for growth in North America following rapid data centre growth in the continent.

First reported in Global News, the company said on 1 August that it is uniquely poised to capitalise on the expansion of data centres in North America, being built by the likes of Microsoft, Google, and AWS. Stan Chapman, Executive Vice President and COO, said that more than 300 data centres are currently in the pipeline in the US. More than 60% of these are within 80 km of TC Energy's existing natural gas pipeline.

He said: "We're seeing a shift in site preferences from regions where big telecom infrastructure is in place to regions where energy and supply infrastructure is in place."

Chapman added that a growing number of data centre operators are interested in building and owning their own on-site power, generating capacity to address electricity needs.

The company also said its footprint is not limited to the US, with Chapman suggesting that power demand in Canada could increase by one to two gigawatts by the end of the decade and hinting at potential opportunities in Mexico.

Francois Poirier, CEO at TC Energy, said: "Never have I seen such strong prospects for North American natural gas demand growth. We are seeing natural gas demand reach record highs and this is expected to grow by nearly 40 billion ft^3/d by 2035.

Earlier this month, TC Energy announced it had agreed to sell a minority stake in its Western Canadian NGTL and Foothills natural gas transmission network to a consortium of Indigenous communities for CAN$1 billion (US$720 million). The deal is said to be Canada's largest-ever Indigenous equity ownership agreement (see story below).

TC Energy has been selling off assets to help pay down its debt.

Canada's Indigenous groups to borrow CAN$1 billion for pipeline stake

A consortium of Indigenous communities in western Canada is preparing a CAN$1 billion (US$720 million) bond offering to fund the purchase of a stake in TC Energy Corp.'s natural gas pipeline system in Western Canada, according to people familiar with the matter, reports Bloomberg News.

The transaction of the pipeline stake is expected to close in 3Q24, subject to financing and official approval of the participating communities, TC Energy said.

The Alberta Indigenous Opportunities Corporation is providing a CAN$1 billion equity-loan guarantee to support the transaction, a spokesperson said.

A representative for the Indigenous consortium, which comprises 72 communities in Alberta, British Columbia and Saskatchewan, didn't respond to requests for comment.

The NGTL system and Foothills Pipeline's assets gather and transport natural gas in western Canada for exports.

Some Colonial Pipeline owners explore stake sales at US$10 billion

Some of Colonial Pipeline's owners are exploring divesting their stakes, hoping they can fetch prices that would value the largest US fuel transportation system in excess of US$10 billion, according to people familiar with the matter, cites Reuters.

Growing US energy consumption has raised demand for pipeline capacity. Any deal would test the company's value three years after a major cyberattack disrupted its operations.

Canadian pension fund Caisse de dépôt et placement du Québec (CDPQ) has begun working on the sale of its 16.6% stake in Colonial, while three co-owners that collectively account for 55.3% of the equity in Colonial are discussing whether to follow suit, the sources said.

These three parties are oil major Shell and investment firms IFM Investors and KKR the sources added. Infrastructure funds, public pension funds and sovereign wealth funds are among potential buyers, according to the sources.

A subsidiary of Koch Industries, the remaining co-owner, has indicated it plans to keep its 28.1% stake in Colonial, one of the sources said.

Colonial's pipeline system stretches over 5500 miles from Houston in Texas to New York's harbour. It moves 100 million gallons of fuel daily, including gasoline, jet fuel, diesel and heating oil, according to its website.

The pipeline offers the least expensive route to move product from low-cost production centres near the Gulf Coast to markets in the Southeast and across the Eastern Seaboard, credit rating agency Fitch said in a note last month.

A cyberhack caused a days-long shutdown of Colonial's pipeline in 2021, disrupting fuel supplies to thousands of filling stations and airports.

Colonial had failed to plan and prepare for a manual restart and shutdown operation, which exacerbated the fallout, the US Department of Transportation's Pipeline and Hazardous Materials Safety Administration found at the time.

CDPQ bought its stake in Colonial for US$850 million in 2012 from ConocoPhillips. IFM and KKR acquired their respective 15.8% and 23.4% holdings in 2007 and 2010. Shell consolidated its 16.13% into a single holding in 2019, while Koch has held its current position since 2003.

North American energy pipelines have become prized holdings in the last two years because of the growth in US energy production and difficulty of permitting and building new lines. This has led to heightened dealmaking in the sector.

NORTH AMERICA NEWS

IN BRIEF

CANADA
ATCO Ltd is planning to build a 200 km natural gas pipeline along the Yellowhead Highway west of Edmonton to support a major net-zero petrochemical project near the Alberta capital. The 200 km pipeline will support Dow's CAN$8.9 billion Path2Zero petrochemicals project.

BRAZIL
Strohm has been awarded a contract by TotalEnergies EP Brasil for the supply of TCP Flowlines for an offshore field located in the Santos Basin in the Brazilian pre-salt area.

USA
US pipeline operator Energy Transfer and fuel distributor Sunoco will form a joint venture combining their crude oil and produced water-gathering assets in the Permian Basin. It will operate more than 5000 miles of crude oil and water gathering pipelines with crude oil storage capacity exceeding 11 million bbls.

USA
Elevation Midstream, LLC, based in Denver, Colorado, has announced a merger with Platte River Holdings, a subsidiary of ARB Midstream, LLC.

CANADA
Canadian Utilities is developing a CAN$2 billion (US$1.46 billion) natural gas pipeline project in Alberta to transport natural gas to a Dow petrochemicals plant and other industrial facilities

USA
Aethon Energy Management LLC has announced the successful closing of Aethon's acquisition of Tellurian's integrated upstream assets. Aethon's footprint across its Fund II and Fund III assets in the Haynesville Shale now includes approximately 375 000 net acres with gathering and treating capacity of over 3 billion ft^3/d.

Williams to resume Louisiana natgas pipeline project

Williams got the green light to continue building its Louisiana Energy Gateway project (LEG) on Wednesday 31 July 2024, a natural gas pipeline, after a court threw out rival company, Energy Transfer's last bid to halt its construction, reports Reuters.

The two companies have been in dispute over Williams' LEG project, under construction in Texas and Louisiana, after Energy Transfer pushed back on the line for crossing its own systems.

Williams crossed the final hurdle on Wednesday, after a favourable ruling from the 30th Judicial Court of Vernon Parish, Louisiana brought an end to the crossing disputes.

"Construction can begin in earnest on the Louisiana Energy Gateway, which is expected to be in service by the second half of 2025," a Williams spokesperson said on Thursday 1 August, 2024.

The 1.8 billion ft^3/d line would feed gas from the Haynesville shale field to the US Gulf coast.

Blackcomb pipeline reaches final investment decision

WhiteWater has announced that WhiteWater, MPLX LP and Enbridge Inc. (through the WPC Joint Venture, the joint venture that owns the Whistler Pipeline), have partnered with an affiliate of Targa Resources Corp. to reach a final investment decision to move forward with the construction of the Blackcomb Pipeline. This comes after securing sufficient firm transportation agreements with predominantly investment grade shippers, including, but not limited to, Devon Energy, Corp., Diamondback Energy, Inc., Marathon Petroleum Corp., and Targa Resources Corp. I Squared owns WhiteWater's stake in Whistler.

The Blackcomb Pipeline is designed to transport up to 2.5 billion ft^3/d of natural gas through approximately 365 miles of 42 in. pipeline from the Permian Basin in West Texas to the Agua Dulce area in South Texas.

Supply for the Blackcomb Pipeline will be sourced from multiple upstream connections in the Permian Basin, including gas processing facilities in the Midland Basin and the Agua Blanca Pipeline in the Delaware Basin, a joint venture between WhiteWater and MPLX.

"We are excited to partner with Targa by leveraging Whistler's expansive footprint in Waha and Agua Dulce to develop the Blackcomb Pipeline. Blackcomb will provide much needed incremental natural gas takeaway capacity for Permian shippers," said Christer Rundlof, CEO of WhiteWater.

The Blackcomb Pipeline is a joint venture owned 70.0% by WPC, 17.5% by Targa, and 12.5% by MPLX, which is incremental to MPLX's ownership interest in WPC.

The Blackcomb Pipeline will be constructed and operated by WhiteWater and is expected to be in service in the second half of 2026, pending the receipt of customary regulatory and other approvals.

Engie to partner with Macquarie in Mexican pipeline project

French energy company Engie has agreed to partner with Australian infrastructure investor Macquarie Asset Management to expand the Mayakan natural gas pipeline in Mexico, the two companies said in a statement on Thursday 11 July 2024, reports Reuters.

The project aims to accelerate the energy transition of the region and will reduce carbon footprint by up to 7.4 million tpy of CO_2 equivalent, the companies said.

The partnership involves Macquarie acquiring a 50% stake for US$360 million in the construction of a 700 km natural gas pipeline in the Yucatán Peninsula, according to a source with knowledge of the deal.

The enterprise value of the project will be up to US$3 billion at completion and the two companies will share the governance of the company running the asset, known as Mayakan System, the person said.

The new pipeline will double the natural gas transportation capacity for the Yucatán Peninsula and will pass through the states of Chiapas, Tabasco, Campeche and Yucatán.

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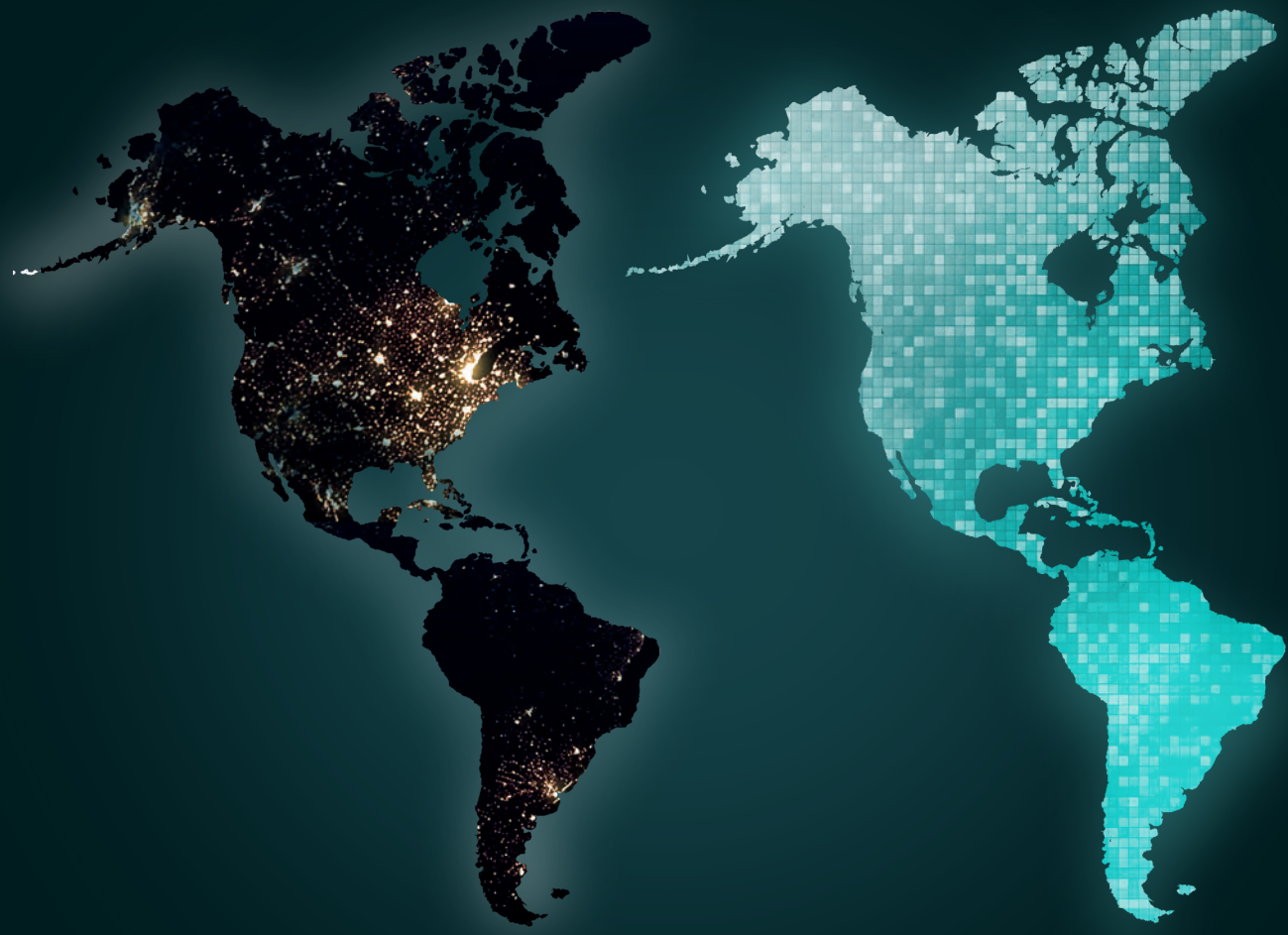

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LATIN AMERICA NEWS

BNamericas: Latin America's US$1 trillion energy project pipeline

Private and public sector companies have set aside more than US$1 trillion for energy investments in Latin America and the Caribbean, according to BNamericas data.

The figure includes US$586 billion for initiatives in the early works stage, spread among 11 705 projects, US$183 billion for those under construction (1244 projects) and US$416 billion (3389 projects) for developments already in operation.

In total, there are 16 388 energy projects in the BNamericas database – covering both the electric power and oil and gas sectors – with combined estimated capital expenditure of US$1.19 trillion.

The electric power sector accounts for around two thirds of the total forecast capex, with US$790 billion in committed investments shared among 13 439 projects. Oil and gas projects, meanwhile, are earmarked to receive US$472 billion across 2978 projects.

Around US$72 billion of capex corresponds to projects that overlap both sectors.

Mexico's state-owned electric power utility CFE is the most prolific developer with 518 projects, followed by a trio of Brazilian companies: Pacto Energía (177), Omega Desenvolvimento de Energia (139) and Voltalia Energía do Brasil (89).

Brazil is home to the largest number of developments (10 579), followed by Chile (1891), Mexico (1280), Colombia (875) and Argentina (537).

According to the BNamericas forecast tool, 294 projects are expected to advance to a new stage in 2Q24 and 179 are seen moving forward in 3Q24. Further stage changes are forecast for 496 projects in 4Q24 and 221 in 1Q25.

The biggest project, in terms of capex, is the Polo GasLub complex (ex-Comperj) in Rio de Janeiro state, which is being built at a cost of US$48 billion. Under development by Brazil's national oil company Petrobras, the initiative comprises six second-generation production units for petrochemicals, fuels and thermoplastic resins.

Second is Mexico's Olmeca refinery (ex-Dos Bocas), which belongs to national oil company Pemex. The US$18.9 billion complex will boast refinery capacity of 340 000 bpd and includes 28 km of water pipelines and 65 km of gas ducts.

It is followed by another refinery: Brazil's Abreu e Lima complex in Pernambuco state. Slated for investment of US$18.3 billion, the facility is expected to produce 230 000 bpd when it enters operation in 2028.

Next is the US$15 billion H2 Magallanes wind, hydrogen and desalination complex in Chile, the US$14 billion Saguaro Energía LNG terminal in Mexico, and the US$12.7 billion Uaru FPSO project in Guyana.

Exxon to shut two platforms in Guyana for two weeks each to connect pipeline

Exxon Mobil Corp. will shut down two offshore oil production projects in Guyana for two weeks each, between July and August 2024, to connect a natural gas pipeline, the company's country head Alistair Routledge told reporters (Reuters reports).

The 140 mile (225 km) pipeline will feed Guyana's US$1.9 billion gas-to-power project aimed at ending the country's dependence on imported fuels and at lowering energy costs for residents.

Exxon has said it will halt production to fulfill a commitment made with local authorities to have the pipeline connected by year end.

The proposed pipeline would connect offshore production vessels to a power plant and a natural gas processing facility.

Over 11 billion bbls of oil and gas have been discovered in Guyana since 2015. Guyana has plans to increase its oil production to 1.2 million bpd by 2027, but it's also looking to make the most of its gas resources. Vice President Bharrat Jagdeo has stressed the need to develop Guyana's estimated 16 trillion ft^3 of gas reserves quickly, as the world moves towards cleaner energy.

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SOUTH AMERICA NEWS

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Houston, USA
www.gastechevent.com

24 - 26 September 2024
International Pipeline Conference & Expo (IPE) 2024
Calgary, Canada
www.internationalpipelineexposition.com

20 November 2024
Global Hydrogen Conference 2024
ONLINE
www.accelevents.com/e/ghc2024

28 - 31 January 2025
Pipeline Pigging & Integrity Management Conference 2025
Houston, USA
https://ppimconference.com/

5 - 9 February 2025
77th Annual PLCA Convention
Marco Island (Florida), USA
https://www.plca.org/annual-convention-events

6 - 10 April 2025
AMPP Annual Conference + Expo 2025
Nashville, USA
https://www.ampp.org/home

5 - 8 May 2025
OTC 2025
Houston, USA
https://2025.otcnet.org/

25 - 29 May 2025
71st Annual PLCAC Convention
Banff, Canada
https://pipeline.ca/

Colombia Trasandino oil pipeline likely to stay offline through 2024

Colombia's Trasandino pipeline is forecast to remain offline until December 2024, the Chief Executive of Colombia's majority state-owned energy company Ecopetrol said on Wednesday 15 May, 2024, according to Reuters.

Earlier this month, while reporting its Q1 financial results, Ecopetrol said it had been transporting crude oil through Ecuador since November in order to combat oil theft.

Thousands of barrels of oil are stolen daily in Colombia. The crude is taken to clandestine refineries where it is converted into a bootleg fuel.

The decision to stop pumping through the pipeline followed an increase in theft, Roa said, explaining that up to 20% of oil pumped via the Trasandino, equivalent to some 3000 bpd, was being stolen.

Since Ecopetrol switched to transporting oil through Ecuador, losses have fallen to 0.3%, Roa said.

Earlier this month, Ecopetrol signed a contract with its Ecuadorean counterpart, Petroecaudor, to transport up to 22 000 bpd through the neighbouring country's pipelines.

Vallourec signs a major contract for the supply of tubes and services to Petrobras

Vallourec has secured a contract to supply Petrobras with 1800 t of premium carbon steel tubes with Glass Reinforced Epoxy liners (GRE technology), together with the associated top-of-the-range CRA (Corrosion Resistant Alloy) accessories.

These products will be used in various offshore development wells, mainly off the Brazilian coastline in the Campos pre-salt basin. This contract is in addition to the three year long-term agreement with Petrobras for the supply of OCTG tubes announced in January 2023.

The agreement between Vallourec and Petrobras also includes a wide range of services, such as stock management, rig preparation and transportation, as well as comprehensive integrated field services: receiving, inspecting and supervising pipe strings' installation.

The finished products will be manufactured at Vallourec's Brazilian plant in Barreiro (Minas Gerais).

South America leads additions to hydrogen electrolyser projects

Hydrogen electrolyser projects currently in development across the world total 1190 GW, Aurora Energy Research's latest global electrolyser database shows, with growth over the past six months slowing to 66 GW.

The regional diversity of the pipeline is increasing: South America leads additions since April 2023 at 25 GW, followed by Oceania at 20 GW, while Europe's share of projects that have advanced beyond the early planning stage1 has dropped to 46%.

Additions to the pipeline since April 2023 signal the increasing globalisation of the emerging hydrogen economy.

South America accounts for the largest share of projects added thanks to the new 25 GW Amigos del Verano project in Chile, which has already advanced beyond the early planning stage. Oceania takes second place – developers have announced 20 GW of electrolyser projects in the region since April 2023, shifting the spotlight from North America, which led additions to the previous version of the database. While Europe remains the most popular location for electrolyser projects overall, the region's share of the pipeline has fallen to 46%, from 56% in April 2023.

Anise Ganbold, Head of Research, Hydrogen, Aurora Energy Research, commented: "It is clear from the latest edition of Aurora's electrolyser database that a global shift is underway in the hydrogen market, with mega-projects exceeding 10 GW in capacity taking centre stage.

"South America's surge in project announcements over the past six months underscores this trend, marking a significant departure from Europe's traditional dominance."

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Robert H. Shelton, Vice President of the World Business Academy and CEO of H2C Safety Pipe, Inc., and Murtaza Fatakdawala, Engineer at H2 Clipper Inc. and H2C Safety Pipe, Inc., explain how historical insights from natural gas pipelines and underground storage tanks can help inform hydrogen infrastructure in the USA.

In the 1920s, America's energy landscape was heavily dominated by coal. Although natural gas was also present, it played a minimal role in America's energy mix, primarily being utilised at the time for residential heating and cooking. Although the first significant natural gas pipeline was constructed in 1891, early pipelines were generally less than 100 miles in length through the early 1930s, significantly limiting the growth of the industry. Due to transmission and distribution constraints, natural gas was used only in communities that happened to be located close to where it was produced.

Following World War II, the demand for natural gas surged, prompted in part by an expansive build-out of the pipeline network, and the opportunities opened by low-cost, reliable transmission and distribution. Whereas in 1940 there were less than 15 000 miles of natural gas transmission pipelines, by the end of the 1960s, the US had established approximately 250 000 miles of gas transmission pipelines and 600 000 miles of distribution lines.[1] This network has continued to grow, and today the natural gas network in the United States includes over 300 000 miles of transmission pipelines and well over 2 million miles of distribution and service lines. This vast


Learning from
the past, for
the future of
US pipelines

network enables natural gas to be a cornerstone of the nation's energy mix, supporting a wide range of needs from industrial processes to residential heating and cooking.

Historically, natural gas leakage from this vast network of pipelines has been somewhat dismissively accepted by the industry as an inevitable cost of doing business. Some industry experts attribute the reason for this being that because most oil and gas operators oversee many thousands of miles of pipelines, manual checks are – as one observer characterises – "impractical at best and expensive, ineffectual time sinks at worst."[2]

Other experts note that because lost gas has historically been treated as a cost of doing business that can be included in a utility's rate basis, regulated gas transmission companies have little incentive to invest capital resources to abate such losses. Even among regulators, until the last few years as worldwide concerns about methane emissions have increased, the prevailing view was that methane – the primary component of natural gas – did not pose an immediate environmental risk since unlike liquid hydrocarbons, it didn't pollute groundwater or surface waters. Accordingly, its leakage from natural gas lines was seen as a tolerable loss, economically insignificant enough not to impact the industry's bottom line substantially.

Underground storage tanks

The history of safety and environmental regulation surrounding underground storage tanks (USTs) is considerably different. In 1970, the oversight landscape began to change with the establishment of the US Environmental Protection Agency (EPA). Roughly a decade after the EPA was formed under President Nixon in the 1980s, televised reports of major gasoline leaks under some filling stations raised broad public concerns about specific challenges posed by USTs.[3] These tanks, especially those containing petroleum and hazardous substances, were identified as significant sources of environmental contamination, often leaking as they aged and, in turn, contaminating crucial groundwater supplies.

In response, the EPA implemented a more robust regulatory framework under the Resource Conservation and Recovery Act (RCRA). In 1984, Congress added Subtitle I to the Solid Waste Disposal Act to protect the public from underground storage tank petroleum releases. This legislation mandated significant upgrades of USTs and any underground pipes connecting to them and banned the installation of new, unprotected steel tanks and piping.

By 1998, the regulations mandated that all USTs had to be upgraded or replaced, or such tanks were required to be permanently decommissioned. To prevent leaks, the stringent measures mandated that owners and operators of petroleum USTs employ double-wall containment. In addition, to know when a problem was emerging, the regulations required monitoring systems to detect the release of product into the interstitial space between the inside wall of the pipe or tank, and the outside secondary containment wall.

However, natural gas pipelines were specifically exempted from these stringent measures.[4]

If we fast forward to today, what has transpired because of these decisions is significant. UST leakage is no longer a problem, and yet the EPA estimates that current leakage rates across the natural gas supply chain are 2 - 3%, and studies conducted by independent groups report considerably higher levels.[5] Detailed studies performed by the Environmental Defense Fund (EDF) show that actual methane leakage could be up to eight times greater than the EPA estimates.[6]

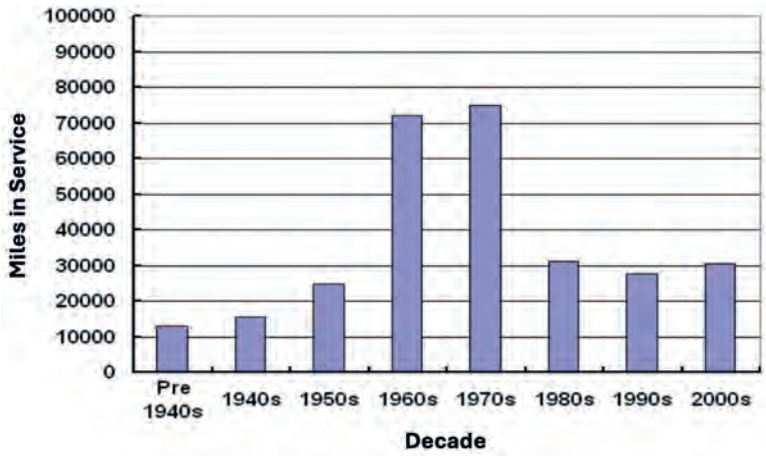

Figure 1. Miles of natural gas transmission pipeline added, by decade, in the USA. (Source: INGAA 'Integrity characteristics of vintage pipelines', October 2004, Figure 1, p.5)

Looking forward to hydrogen pipelines

McKinsey & Company forecasts that by 2050, hydrogen will eclipse natural gas in the energy mix as nations push to meet ambitious decarbonisation targets to address climate change. Yet, like the practical constraints on the natural gas industry a century ago, the absence of a widespread transmission network to provide low-cost and reliable distribution severely limits the hydrogen industry's ability to grow. Currently, there are just 2000 miles of hydrogen pipelines worldwide, with a little over 1600 miles in the US, primarily serving refineries along the Gulf Coast.

Still, just as World War II provided a catalyst for dramatic increases in natural gas use, climate change and massive government incentives are poised to press hydrogen into widespread service today. The US Department of Energy's 'Hydrogen Shot' goal of cutting the cost of clean hydrogen production to US$1/kg and the final dispensed cost of hydrogen to less than US$7/kg by 2031 would put the cost of hydrogen on parity with fossil fuel products.

Once this is the case – once the price of hydrogen from renewable sources drops to the level where it is at or below the cost of fossil fuel products – natural economic forces are primed to propel its growth. As the US$6/kg difference between the cost of production and the final dispensed cost suggests, the efficiency of hydrogen transport and distribution will play a major role in how rapidly and widespread the industry grows.

In this regard, the history of natural gas is instructive. If the transmission and distribution infrastructure develops for hydrogen to support its widespread use, the hydrogen industry will grow exponentially over the coming decades just as did natural gas between 1940 and the end of the 1960s.

The projected scale of hydrogen use and its pivotal role in achieving climate goals necessitate a thoughtful approach to the development of this emerging

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transmission and distribution infrastructure. Hydrogen carries significant safety risks due to its flammability and propensity for leakage, which is substantially greater than natural gas due to hydrogen's substantially smaller molecular size. Moreover, while hydrogen is not a greenhouse gas, it has been shown that its release into the atmosphere may be harmful because although it does not cause a warming effect on its own, hydrogen interacts with airborne molecules called hydroxyl radicals to prolong the lifetime of atmospheric methane as well as increase the production of ozone, another greenhouse gas.

Recently, a study by climate scientists from four countries and across six institutions concluded that the Global Warming Potential (GWP) of atmospheric hydrogen is between 8.8 and 14.4 times that of CO_2 over 100 years.[7] These and other studies by groups such as EDF demonstrate why serious attention must be given to reducing the leakage of hydrogen to get the full climate benefits from its usage. Here too, America's experience with USTs and natural gas pipelines can be instructive.

Learning from past mistakes and successes

While scientists today can debate the degree to which these concerns about hydrogen as an indirect greenhouse are correct, one thing seems certain. If policymakers in the past had today's understanding of environmental impacts, they certainly would have mandated more robust protections for natural gas pipelines, akin to those required both under RCRA and corresponding state regulations for USTs and underground petroleum pipelines.

It is estimated today that the cost of remediating the leakage of subterranean methane pipelines is US$1 million/mile in an unpopulated city and US$8 million/mile in a city like Boston.[8] At such high costs, in many ways, it's too late for natural gas and we are condemned to play 'whack-a-mole' as specific leaks are discovered that are simply too large to ignore.

However, the level of hydrogen infrastructure buildout today is where the natural gas industry stood in the 1920s, and thus there's a real opportunity to be proactive.

Environmental groups such as the EDF and the Sierra Club are right to demand that we should not repeat past mistakes as we plan for the extensive infrastructure necessary for hydrogen. In short, the public should demand, and regulators should require, that hydrogen pipelines follow the successful case of USTs.

Today, we possess the foresight that was absent in the past. We better understand the broad implications of our choices for future generations and the environment. By instituting rigorous safety standards now, such as requiring secondary containment around all hydrogen pipelines and storage tanks and mandating active leak monitoring and mitigation systems so that issues are addressed well before they become problems, we can establish a global standard for safe, sustainable energy distribution networks that are essential for our transition to a low-carbon future.

Such solutions are at hand. We simply need to muster the resolve to employ them.

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About the World Business Academy

The World Business Academy was founded in 1986 as a result of discussions centred on the role and responsibility of business in relation to critical environmental and social challenges. Since that time, the Academy has been a 501(c)(3) non-profit that engages the business community in better understanding and practicing the role of business as an agent for positive social transformation and solutions to humanity's largest challenges. The Academy's focus on climate change, energy security, hydrogen, and optimised corporate governance through advocacy of stakeholder capitalism, results from an analysis of the most important threats to human survival. Its 38 year track record of leadership includes the publication of cutting-edge books, articles, podcasts, and videos discussing these topics and many other issues of primary importance to the evolving role of business in society.

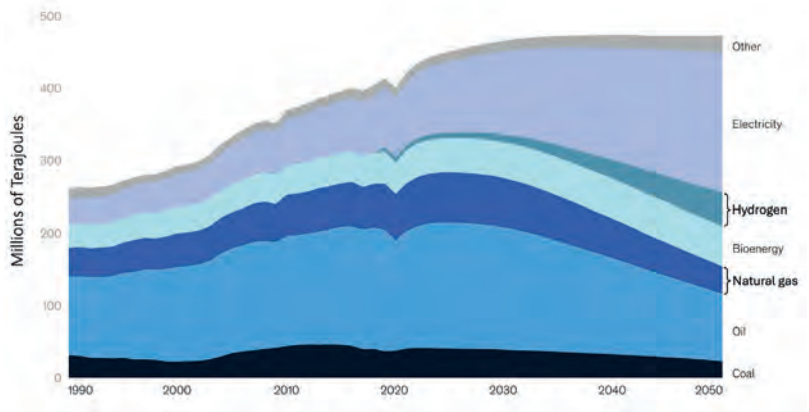

Figure 2. Final energy consumption per fuel in the USA. (Source: McKinsey & Company, 'Global Energy Perspective 2022', April 2022.)

About H2C Safety Pipe, Inc.

H2C Safety Pipe, Inc. (H2CSP) is a subsidiary of H2 Clipper, Inc., a private company focusing on hydrogen midstream solutions that was incubated through 2011 by the World Business Academy. H2CSP has developed a proprietary Safety Pipe™ technology consisting of, among other things, a hydrogen delivery line surrounded by a safety pipe to fully contain any hydrogen leakage, with a sweeper gas such as nitrogen flowing through the annular space between these pipes and one or more sensors capable of detecting even minute levels of hydrogen in the sweeper gas to provide 24/7/365 continuous monitoring of the pipeline integrity. H2CSP recently completed building and operating a prototype in Houston, Texas employing the Safety Pipe technology.

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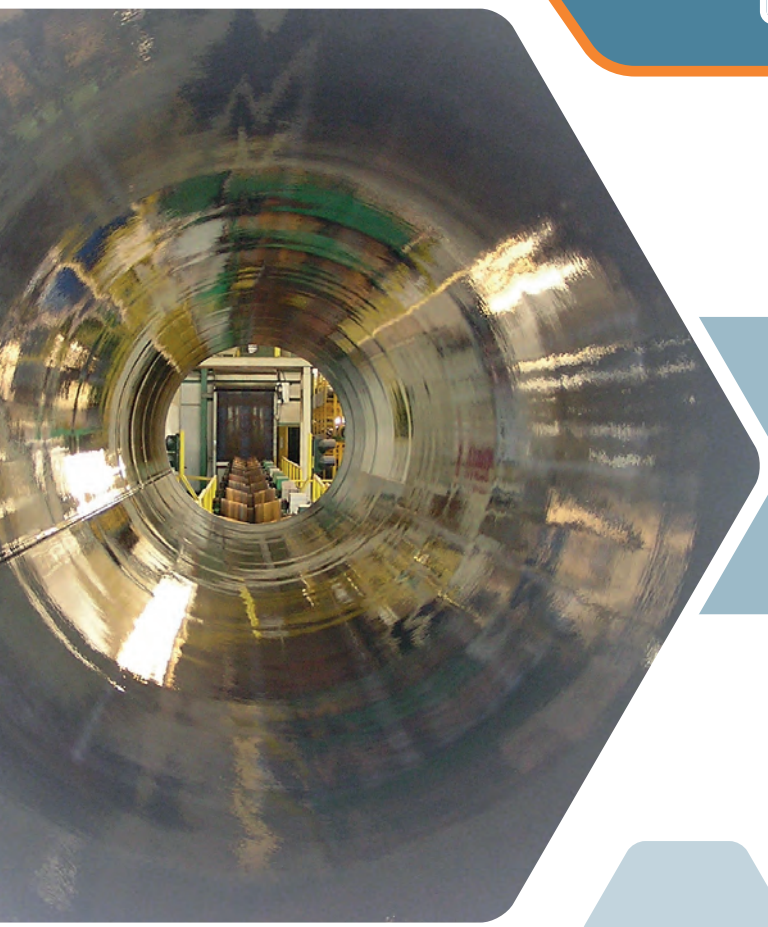

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MAKING A CASE FOR SAFETY

Tracey Murray, Dynamic Risk, Canada, discusses using the Safety Case framework in pipeline integrity management programmes, highlighting ways it can be implemented and its adoption in different regions.

The Safety Case framework emerged as a response to a catastrophic event that shook the offshore oil and gas industry to its core. In 1988, the Piper Alpha platform in the North Sea exploded, resulting in the deaths of 165 workers. The aftermath of this tragedy brought to light significant flaws in the safety and integrity management practices of the oil and gas sector. An official inquiry into the disaster recommended a new approach that emphasised systematic risk assessment and evidence-based safety arguments. This led to the development of the Safety Case framework, which has since become a critical tool for safety management in complex industrial settings.

Over time, Safety Case gained traction in Europe and Australia, becoming a standard practice in many offshore operations. However, its adoption in North America has been slower, with many operators relying on traditional safety assessments. This article explores the Safety Case framework, its unique features, and why it could play a more significant role in pipeline integrity management programmes across North America.

What is Safety Case?

Safety Case is more than just a safety assessment; it's a structured argument supported by data and evidence to prove that an operator can effectively manage and mitigate risks associated with industrial operations. Unlike traditional assessments, which often assume safety based on compliance with standards or codes, Safety Case requires operators to demonstrate safety through a comprehensive analysis of potential risks, hazards, and mitigation measures.

In the context of pipeline integrity management, Safety Case encompasses a detailed examination of all risks, specifically addressing those with low probabilities but high consequences. It involves avoidance of assumptions regarding safety and creating a living document that is continuously updated as new information becomes available. This dynamic nature allows operators to adapt to changing conditions, ensuring that safety measures remain relevant and effective.

Safety Case versus traditional pipeline integrity assessments

Traditional pipeline integrity assessments, such as Fitness for Service (FFS) and Engineering Critical Assessments (ECA), offer a static snapshot of a pipeline's condition at a specific point in time. These assessments are typically conducted periodically or in response to specific events, providing a limited view of the pipeline's overall safety. FFS assessments evaluate whether a pipeline can continue to operate safely under current conditions by examining its physical state and identifying any existing defects or signs of degradation. ECAs delve deeper into the structural integrity of the pipeline by assessing the criticality of identified flaws and predicting their impact on the pipeline's performance over time, often using advanced computational methods to model potential failure scenarios.

Figure 1. Safety Case continual improvement lifecycle diagram.

Both methodologies focus on the present condition of the pipeline, rather than continuously updating with new data and operational changes.

As such, while these and related assessments are invaluable for ensuring safety at specific intervals, they may not capture emerging risks or changes in pipeline conditions that occur between assessment intervals. This periodic nature means they can miss evolving threats or new data that may indicate deteriorating conditions, thereby providing a more limited and static view of pipeline integrity compared to the continuous, dynamic Safety Case approach.

The Safety Case framework takes a holistic and ongoing approach. It emphasises continuous monitoring and feedback, incorporating operational data, incident responses, industry data, and other relevant information to maintain an accurate assessment of risks. This continual process helps ensure that safety measures evolve, adapting to new risks and operational changes.

One key aspect of Safety Case is its focus on 'what if' scenarios. By considering low-probability, high-consequence events, Safety Case provides a more robust risk management strategy that is often lacking in traditional assessments. This approach can help operators identify potential hazards that might otherwise go unnoticed, leading to a safer operating environment.

Implementing Safety Case: challenges and opportunities

Implementing a Safety Case programme can be challenging. It requires significant resources, expertise, and coordination among various departments within an organisation. The data requirements can be challenging, and operators must have confidence that the information used to support the Safety Case can "prove the case for safety". This often involves collecting, analysing and validating disparate data sets, which can be time-consuming and resource intensive.

Despite these challenges, the benefits of Safety Case are considerable. The framework encourages operators to take a proactive approach to safety, fostering a culture of continuous improvement. By incorporating a wide range of data and feedback, Safety Case provides a comprehensive view of all risks, enabling operators to make informed decisions about safety measures.

Safety Case also promotes collaboration across the organisation. Because it involves multiple departments and mitigation activities from the procedural to the field execution level, such as integrity, risk, threat management, inline inspection, cathodic protection, even to the Management System level, the Safety Case framework fosters a team-based approach to safety. This collaboration can lead to integrated and more effective risk mitigation strategies resulting in a stronger safety culture.

Safety Case in North America: addressing regulatory requirements

In North America, regulatory requirements for pipeline safety are becoming increasingly stringent, driven by the need to prevent high-profile pipeline incidents and ensure the integrity of the infrastructure. The Pipeline and Hazardous Materials Safety Administration (PHMSA) in the United States has introduced the 'Mega Rule,' a comprehensive regulation emphasising the

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necessity for "traceable, verifiable, and complete" data to support integrity management decisions. This rule represents a significant shift towards a more rigorous regulatory framework, mandating operators to maintain high-quality data, implement robust integrity management practices and to an extent "prove safety". Similarly, in Canada, the Canadian Standards Association (CSA) has updated its Z662 standard, which now includes more stringent requirements for comprehensive risk assessments and data integrity. These updates reflect a growing recognition of the importance of thorough risk management and accurate data in ensuring pipeline safety.

Although a formal Safety Case is not explicitly considered within North American regulations, its principles are highly relevant to the current regulatory landscape. A Safety Case is a structured argument, supported by evidence, that a system is safe for a specific application in each context. By adopting a Safety Case approach, pipeline operators can demonstrate a proactive commitment to safety, aligning closely with the objectives of both the PHMSA Mega Rule and the CSA Z662 standard. This approach involves documenting and justifying safety measures through rigorous assessments, ensuring that all potential hazards are identified, analysed, and mitigated effectively.

The adoption of a Safety Case methodology can provide several benefits for operators. It allows for a systematic and comprehensive evaluation of safety risks, ensuring that all relevant data is traceable, verifiable, and complete. This aligns with the PHMSA Mega Rule's emphasis on data integrity and supports compliance with regulatory expectations. Additionally, by demonstrating a proactive and systematic approach to safety, operators can build trust with regulators, stakeholders, and the public, potentially avoiding costly penalties and reputational damage that could arise from incidents or non-compliance.

Figure 2. Seven steps to Safety Case implementation.

Furthermore, a Safety Case approach can enhance an operator's internal processes, promoting a culture of safety and continuous improvement. It encourages the integration of safety considerations into all aspects of pipeline management, from design and construction to operation and maintenance. This holistic view of safety management can lead to better decision-making, improved risk management, and ultimately, a safer pipeline network.

By adopting Safety Case, pipeline operators can not only ensure compliance with mandated regulations like the PHMSA Mega Rule and CSA Z662 updates but also demonstrate a strong commitment to safety, thereby safeguarding their operations, reputation, and the environment.

Continuous improvement

One of the key strengths of the Safety Case framework is its focus on continuous improvement. Unlike traditional assessments, which can be static, Safety Case is designed to be a living document that is regularly updated to reflect new information and operational changes. This continual process allows operators to identify and address emerging risks, ensuring that safety measures remain effective over time.

Safety Case also provides a mechanism for integrating findings from various sources, such as near-miss incidents, root cause analyses, and safety management practices. By consolidating this information, operators can identify trends and implement corrective actions to prevent future incidents. This feedback loop is essential for maintaining a robust safety culture and ensuring that safety practices remain aligned with regulatory requirements.

When Safety Case might not be ideal

While Safety Case offers significant benefits, it may not be suitable for all pipeline assets. Its complexity and resource requirements can make it challenging to implement at scale, especially for operators with limited resources or simpler operations. In such cases, operators may choose to apply Safety Case selectively, focusing on high-consequence areas or assets with elevated risks.

This targeted approach allows operators to tailor their safety management strategies to the specific needs of their assets. For example, a Safety Case might be appropriate for pipelines in densely populated areas or those with a history of incidents. However, for pipelines in low-risk areas or with simpler operating conditions, a traditional assessment approach may be sufficient.

The future of Safety Case in pipeline integrity management

The Safety Case framework represents a significant advancement in pipeline integrity management. Its comprehensive and proactive approach to safety offers operators a valuable tool for managing risks and ensuring regulatory compliance. While it can be resource-intensive and challenging to implement, its focus on continuous improvement and robust risk management makes it a compelling choice for operators seeking to enhance their safety culture.

By embracing the principles of Safety Case, pipeline operators can better safeguard their assets, employees, and the environment. This commitment to safety not only helps operators comply with regulations but also contributes to a safer and more sustainable future for the pipeline industry.

Safety first in the US

Andrew Lu, VP Safety Operations and Engineering, American Gas Association (AGA), outlines how the association works to advance pipeline safety in the USA.

Since the Shale Revolution began in earnest in 2008, North America's energy system has undergone a rapid evolution. American natural gas, once in concerningly short supply, is now the primary energy source for heating and power generation, with a further 730 000 customers and 20 700 miles of new pipelines added last year alone.

Advancing safety is the top priority for the natural gas delivery system in the US and across the globe – and by focusing on safety, we increase natural gas resiliency and reliability. In the US, the American Gas Association (AGA), is working diligently with Congress on behalf of the natural gas industry to improve pipeline safety through the upcoming reauthorisation of the Pipeline Safety Act and Pipeline and Hazardous Materials Safety Administration (PHMSA). AGA is proud to be representing more than 200 investor-owned natural gas utilities throughout the US, and is actively engaged in enhancing the safety, reliability, and sustainability of natural gas infrastructure. In testimony on the hill, conversations with lawmakers, and through the media, AGA continues to share the significant work underway in the industry to help enhance safety.

Every year, the American natural gas utility industry invests US$33 billion to advance the safety of natural gas pipeline systems. That investment is focused on maintaining and enhancing an already exemplary safety record. The progress we've made on improving safety is impressive. The progress we expect to make is even more so.

In service of this progress, our testimony to Congress highlighted several of the methods American natural gas utilities are using to make progress towards that goal and gave Congress necessary information on how they can help. One of the core components of the industry's existing safety strategy is the Pipeline Safety Management Systems (PSMS) framework, developed in collaboration with industry stakeholders

and regulatory bodies. PSMS provides a structured approach to managing safety, emphasising a culture of safety, leadership commitment, risk management, and continuous learning. Pipeline safety, worker safety, and public safety all benefit from the implementation of an effective safety management system.

A framework for improving safety

AGA and our member companies are at the forefront of voluntarily implementing PSMS, a 'Plan-Do-Check-Act' cycle that helps operators continuously and comprehensively track and improve their safety performance within 10 specific areas. This framework acts as a continuous improvement process that can be tailored to a natural gas utility's individual assets and requirements. PSMS provides a strong tool to make progress towards a goal of zero incidents.

As part of, and in line with, our efforts to enhance safety and promote PSMS, AGA is dedicated to facilitating the free flow of information and leading practices between natural gas utilities. These efforts include AGA's in-person Peer Review Program and Virtual Assessment Program which allow natural gas utilities to observe their peers, share operating practices, and identify opportunities to better serve customers and communities. Each review involves AGA staff and subject matter experts from member utilities who are dedicated to helping the host utility improve.

Investments in safety

Our member companies each have systems featuring their own unique environments and assets. A system that can provide reliable energy for home heating, industrial use and power generation for a nation of almost 340 million people is by necessity both vast and varied. The US has 2.6 million miles of natural gas pipelines made from a variety of materials and a wide range of operating pressures. All natural gas pipelines are subject to minimum federal regulations enforced by PHMSA and state regulators. Since 2012, AGA's members have developed a Commitment to Enhancing Safety and Security, which captures our commitment to implement actions voluntarily that go beyond the minimum regulations.

Our industry spends US$60 000 a minute (call it US$180 000 since you started reading this piece) on making every inch of our network as safe as possible.

The industry's investments in pipeline safety have paid off by lowering the incidence of the primary cause of industry incidents: excavation damage. Over the past two decades, significant incidents on natural gas distribution pipelines have declined 41% and serious incidents have declined nearly 47%. This improvement has saved dozens of lives and hundreds of millions of dollars over those decades. It also provided invaluable insight into what works, with states that have healthy excavation damage prevention and enforcement programmes typically experiencing lower rates of damage. Because of this, AGA supports directing PHMSA to incentivise states to adopt One Call programme leading practices, derived from the best state excavation damage programmes, and condition their grants to State One Call programmes based upon adoption of these best practices. Both the US House of Representatives Transportation and Infrastructure Committee and Energy and Commerce Committee have included this request into their respective committee-passed versions of the PHMSA reauthorisation bill – a necessary first step to a vote on this important initiative in the House of Representatives.

The natural gas industry is grounded in innovation. We've asked Congress to support pipeline technology alternatives that weren't available when existing regulations were written. From drones to satellite leak detection, we have tools and options today that were unavailable two decades ago. America's natural gas delivery system would benefit from improvements to PHMSA's process to identify and deploy technology alternatives that, if utilised, will meet the intent of existing pipeline safety regulations and provide an equal or greater level of pipeline safety.

Unfortunately, not all damage is accidental. Natural gas utilities are experiencing an uptick in criminal attacks to property, equipment and facilities, up to and including gunshots and IEDs intended to damage facilities and equipment necessary for safe delivery of natural gas. Vandalism is a true risk to public safety and threatens a utility's ability to deliver natural gas to thousands of homes, hospitals, schools, government and military facilities, and other critical infrastructure customers. To address this, Congress is considering increasing criminal penalties on bad actors in the US who intentionally damage, destroy, or otherwise impair pipelines and pipeline facilities.

Looking to the future

As we look forward to the future needs of the system, it's also clear that hydrogen is likely to play a role in gas system decarbonisation. AGA member companies like Hawai'i Gas are already out in front, leading by example, with the fuel blend used by Hawai'i Gas containing approximately 15% hydrogen. In the past, hydrogen was a significant component of the fuel used across much of the US in the form of manufactured Town Gas. However, today's pipeline network has come a long way since Town Gas was phased out more than half a century ago. By advancing research around hydrogen-natural gas blending and studying natural gas distribution systems worldwide that already use significant amounts of hydrogen, we can pursue decarbonisation without compromising on safety.

Collecting and sharing institutional knowledge, whether from studies or individual experience, is tremendously valuable to furthering the safety, reliability, and affordability of natural gas worldwide. We asked Congress to authorise a Voluntary Information-sharing System (VIS) that can engage stakeholders, collect and share best practices and lessons learned, and promote pipeline safety by encouraging information sharing and facilitating understanding and management of pipeline risks.

Our final priority wasn't about the content of PHMSA reauthorisation, but rather how it's reauthorised. Recently, PHMSA has been reauthorised every three years with Congress using it as an opportunity to incorporate new and updated regulations. With a technical topic of this magnitude and importance, three years simply is not enough time for all the necessary preparation and planning. As such, our final request for Congress is a return to PHMSA Pipeline Safety reauthorisations for a period of at least four years.

It's worth remembering that these reforms are important not for their own sake, but for the cause of advancing pipeline safety. We share the same goal as safety advocates, the public, pipeline sector industry partners and Congress: ensuring that America's pipeline system remains the safest, most secure, and most reliable system in the world.

Anchal Liddar, American Petroleum Institute (API), USA, outlines the new API RP 1185 standard, for enhancing public engagement in US pipeline activities.

USA: setting a new standard for pipeline public engagement

In today's energy landscape, pipelines are vital for transporting vast quantities of oil, natural gas and petroleum products across the country, and supporting the successful implementation of these projects requires building public trust. Incorporating genuine, two-way community engagement is essential for fostering this trust, as it helps identify and address potential issues early, tailoring solutions to meet specific community needs. This open communication is especially valuable for both new and existing pipeline projects, as it leads to safer and more reliable construction and operations that align with the industry's commitment to a zero-incident safety culture while embracing its responsibility for environmental stewardship.

With these goals in mind, the American Petroleum Institute recently published API Recommended Practice 1185 (RP 1185), Pipeline Public Engagement, 1st Edition. This new standard provides comprehensive guidelines for enhancing public engagement throughout the entire pipeline lifecycle, from early siting conversations through construction, operations, and, potentially, abandonment. The document builds on API RP (RP 1173, Pipeline), Pipeline Safety Management Systems, which provides a framework for developing and implementing robust safety management systems that continually improve pipeline safety by expounding on stakeholder engagement guidance and detailing a mechanism for soliciting and incorporating public feedback.

The publication of RP 1185 is the result of a collaborative effort involving representatives from the oil and natural gas industry, government agencies at the federal, state and local levels, including Tribal governments, community leaders and public interest groups. This collective approach underscores the industry's commitment to open, respectful and inclusive dialogue with all communities impacted by pipeline operations, thereby linking effective community engagement to enhanced pipeline safety.

The case for RP 1185

Engaging non-industry stakeholders yields multiple benefits for both pipeline operators and the communities they serve. Regular and open communication helps build and maintain strong relationships with local communities, which is crucial for gaining public support and fostering a cooperative environment. When communities feel informed and respected, they are more likely to support pipeline projects and collaborate on safety measures. Additionally, effective engagement allows pipeline operators to identify and address safety concerns raised by the community, contributing to incident prevention and safe and efficient pipeline operations.

While the pipeline industry has long engaged community and public stakeholders, RP 1185 codified these good practices and goes further by incorporating more meaningful and inclusive dialogues. For instance, traditional approaches typically involved disseminating information to the public without adequate opportunities for feedback. This led to gaps in understanding and missed opportunities to address community concerns proactively. The document provides a process-based approach to sharing pertinent information with relevant stakeholders to respond to their concerns while maintaining limitations on certain confidential or security-sensitive information.

RP 1185 was developed to bridge these gaps, providing guidelines that facilitate two-way conversations and help develop greater transparency and trust. The new standard recognises the importance of involving a wide array of stakeholders, helping to ensure that evolving cultural and social considerations are integrated into engagement strategies.

Additionally, the new standard proactively engages communities that have been historically underrepresented in such dialogues, customising resources to address disparities and differences among stakeholders. In this way, it aims to achieve meaningful participation and interaction, developing trust that aims to prevent potential issues from escalating.

Figure 1. Stakeholder contributes feedback during community engagement meeting with pipeline operator.

A principled approach

RP 1185 is built on six core principles designed to ensure effective and meaningful stakeholder engagement:

- Openness and transparency: Emphasises the importance of sharing truthful, timely and relevant information, along with a willingness to listen and learn.
- Respect: Encourages considering and respecting other views by listening to questions, understanding concerns and stakeholders to share their perspectives.
- Reciprocity: Focuses on achieving mutual benefits and shared responsibilities in communication. It involves listening and being responsive to inquiries.
- Inclusiveness: A deliberate effort is made to reach out to diverse groups and all those interested in the subject or proposed action.
- Accessibility: Commits to providing various methods and opportunities for all stakeholders to participate.
- Equity: Ensures that all stakeholders are afforded an opportunity for meaningful engagement and that their input informs decision-making processes.

By adhering to these principles, pipeline operators can create a structured and effective engagement process that benefits all parties involved. This comprehensive approach enhances public trust while contributing to the identification and mitigation of potential risks.

Long-term engagement

Effective stakeholder engagement involves a systematic process that incorporates genuine interactions throughout a pipeline's lifecycle. RP 1185 outlines six key elements for effective public engagement:

- Commit and align: Operators must demonstrate a top-down commitment to stakeholder engagement through leadership and organisational alignment. This involves setting clear goals and ensuring buy-in from all levels of the organisation.

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- Identify, understand and confirm: This step involves identifying key stakeholders, understanding their concerns and confirming their needs.
- Plan and prepare: Effective engagement requires operators to develop detailed engagement plans that outline the methods and channels of communication.
- Share information: Providing stakeholders with accurate and timely information includes sharing information about pipeline operations and their potential impact on the community.
- Ask, listen and respond: Engagement is a two-way process that involves actively seeking stakeholder input. This helps build trust and integrate stakeholder feedback into decision-making processes.
- Monitor, evaluate, and adjust: Operators should continuously monitor and evaluate their engagement activities to assess their effectiveness, revising their strategies as necessary to improve outcomes.

Integrating with Pipeline Safety Management Systems (PSMS)

RP 1185 integrates seamlessly with existing Pipeline Safety Management Systems (PSMS) as outlined in RP 1173, 1st edition, by incorporating the Plan-Do-Check-Act (PDCA) cycle of continuous improvement. The document also intentionally incorporated two foundational aspects of RP 1173: flexibility and scalability. Flexibility facilitates the incorporation of existing company programmes and procedures to address the number and variety of stakeholders across unique operating environments, while scalability applies RP 1185's guidelines to companies of all sizes and complexities. As mentioned, it also builds off the stakeholder engagement guidance established in RP 1173. By implementing RP 1185 guidelines, operators can ensure that their safety management systems include effective communication and active community involvement, thereby enhancing the overall effectiveness of the safety management systems as it addresses community concerns proactively.

Furthermore, RP 1185 expands upon the goals of API RP 1162, Public Awareness Programs for Pipeline Operators, first published in 2003 and most recently revised in 2022, which focuses on public awareness and education. While RP 1162 aims to inform the public about pipeline safety, RP 1185 takes this a step further by promoting two-way engagement, building trust and collaboration between pipeline operators and the communities they serve. This leads to safer and more effective pipeline operations.

Figure 2. First responder and contractor discuss pipeline implementation with local correspondent.

Implementing RP 1185

RP 1185 is applicable to gas and liquids transmission lines regulated by the US Department of Transportation, as well as certain regulated gathering lines; it does not include gas distribution pipelines. It covers the lifecycle of a pipeline, from preconstruction, siting and design through operation and abandonment. With the collaborative foundation of RP 1185 firmly established, companies have begun turning their focus to implementation. This begins with a comprehensive internal evaluation and alignment of existing practices with the standard's requirements (implementation will look different for each company, depending on their size and operations). Leadership buy-in is essential; a top-down approach helps foster a culture of engagement, which is critical for success. Additional steps include conducting gap analyses and educating personnel about the standard's foundation of openness, transparency and inclusiveness.

To assist companies and educate stakeholders on this process, API provides a variety of resources, including guidance briefs and training materials, hosted on the RP's implementation website. Implementation resources include fact sheets, tactical how-to booklets, and flexible and scalable briefs, along with step-based guidance following the PDCA process. Moving forward, an implementation team is also planning in-person workshops and virtual webinars to support operator's journeys and foster implementation maturity.

The Plan-Do-Check-Act (PDCA) cycle

Implementing RP 1185 is never a one-and-done proposition. Rather, it is an ongoing journey, one that follows RP 1173's Plan-Do-Check-Act (PDCA) cycle to continually improve and evolve with community expectations.

As its name suggests, PDCA promotes continuous efficiency and improvement as a company progresses through (and around) the cycle. When it comes to RP 1185 and its engagement activities, the PDCA cycle is applied throughout a pipeline's lifecycle and involves the planning, executing, monitoring and revising of engagement activities.

Building trust, enhancing safety

RP 1185 represents a significant advancement in pipeline safety and community engagement by promoting proactive, inclusive and collaborative dialogue. By fostering transparent and genuine interactions, it builds trust and strengthens relationships between pipeline operators and stakeholders, thereby contributing to safer and more reliable pipeline operations.

While the publication of RP 1185 is a key step forward, it marks the beginning of a longer journey. As companies adopt and enhance their public engagement programmes, the document will play a key role in advancing the long-term sustainability and acceptance of pipeline projects, supporting both energy security and environmental stewardship.

STRONG GROWTH IN THE CARIBBEAN

John Clouston, ASCO Logistics, Trinidad, outlines the company's work in the Caribbean region, where the material management and logistics sector plays an important part in local growth.

For more than a hundred years, the oil and gas industry has been a significant contributor to the economy of Trinidad and Tobago. Now, more recently with the discovering of significant oil reserves in Guyana and Suriname, the global focus on the Caribbean region as a producer of oil and gas has escalated considerably.

To support that future growth, the material management and logistics sector has also continued to evolve, investing

Figure 1. Pipeyard supervisor Damian Hagley.

in and advancing its service offering to meet operator client requirements.

The criticality of having access to a safe, efficient and reliable supply base and logistics services cannot be overestimated. Managing the energy supply chain is a complex and challenging business with failures coming at a potentially heavy cost and disruption to exploration, drilling or production resulting in anything from subsea pipeline failure and associated environmental implications to delays, lost time or shutdown.

Building a presence in the Caribbean

ASCO, a provider of end-to-end logistics, has had a presence in the Caribbean since the turn of the millennium, levelling its global expertise to deliver its fully integrated logistics service to numerous global operators including bpTT Centrica, Shell, Total Energies and Woodside. It has now expanded its presence in the Caribbean, operating a client base for Total Energies at Kuldipsingh Port in Paramaribo, Suriname.

The main services offered here include logistics, warehousing and inventory, bulk and MGO and marine services.

The company built its first shore base and managed pipe yard facility in 2001 and now operates from three bases in Trinidad - Chaguaramas, La Brea and Galeota Point. It has also recently operated from a third party shore base with 4 acre pipe yard in Paramaribo, Suriname, and has options to resume operations there in 2025 in response to the ramping up of activity related to the new finds. A number of further pipe yard facility options are being evaluated.

Making investments in the region

Earlier this year, ASCO secured a five year contract with bp Trinidad and Tobago (bpTT), its largest hydrocarbon producer, accounting for more than half of the country's production. The contract will see it provide supply base and pipeyard management services to the operator's 16 offshore platforms from Galeota Point and to its drilling rig from La Brea.

Figure 2. Granwood pipeyard in Chagaruamas, Trinidad.

To support this, ASCO is making a significant investment in a new pipeyard in La Brea, including in equipment and infrastructure, to deliver its services to the highest international standards. This includes approximately four acres of laydown storage, pipe washing, tallying and inspection facilities.

This latest award renews the relationship with bpTT which ASCO first worked with in 2001, when it supported around 23 offshore platforms and three drilling rigs.

This new contract builds on ASCO's expertise and in-country experience which has developed from working with many global operators for almost quarter of a century delivering full pipe storage and management services and sub-contracted inspection services from the Trinidad bases and from Guyana and Suriname.

The contract and planned scale up of activity and ongoing investment reaffirm ASCO's commitment to the region. In 2019, it created a purpose built pipeyard specifically for Shell in Chaguaramas, Trinidad. Built in just 14 weeks, the 5.7 acre yard included six offices, a double washbay for pipe washing and inspection with secondary emergency power support from an 80KVA generator. It also has CCTV coverage across all areas, on-site 24/7 security, enclosed by 6 ft fencing.

Local logistics

Materials management for the pipeyards includes storage of tubulars, tracking and tallying, pipewashing and inspection services and preservation services. Yards also include an undercover area to protect chrome pipes from corrosion by the elements.

Pipes arrive in the region from various locations including Brazil and Gulf of Mexico. First inspections are carried out by a surveyor when the vessels docks, with the pipe bundles being checked for damage prior to them being downloaded. After unloading they are transported to the relevant yard where they are unbundled, racked and inspected ready for shipping offshore.

Once in the yard, third party inspectors carry out thorough inspections to check for any dents on the pipes, damaged threads, integral soundness of casing strings, completeness of protectors or any other indications of damage.

From then on, pipes undergo regular inspection and ongoing maintenance, including doping the thread and rabbiting the pipes, according to every operator's prescribed maintenance programme.

Liaison with teams across every base and with the clients to coordinate activity to meet required needs is crucial. Through working closely with drilling teams on the various assets, client and contractor build three or six month forecasts of pipe needs to ensure the correct pipes get a final inspection and are ready and accessible for transport when required.

Safety and environment

New technologies are also adding value to pipeyard services. Plans are currently in place to introduce

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Figure 3. Pipes storage at Granwood pipeyard in Chagaruamas, Trinidad.

bar-coding technology for pipes later this year which will enhance overall tracking and tracing of joints.

Other recent site enhancements include permanent sling racks assuring lifting gear is stored compliantly and is accessible ready for use.

In its operations across the globe, ASCO's overriding obsessions are safety excellence, service excellence and sustainability. The layout of pipeyards is designed in such a way as to allow suitable access to pipe storage areas within a safe working environment. Numbered signage on racks ensures easy and correct identification and location of stored materials. Undercover areas are provided to protect chrome piping from corrosion. Yards are well-maintained with regular yard and rack inspections carried out to ensure everything is in good order at all times.

A safety culture is embedded across every sphere of ASCO activity. To reinforce its local commitment to safety, ASCO participates in the Trinidad and Tobago Safe to Work (SOW) accreditation standard. ASCO's safety performance is also endorsed by clients and in 2021, the company was named Q1 Goal Zero Hero by Shell.

ASCO is also committed to environmental excellence. Interceptors are designed to prevent pollution and protect the environment, capturing oil, grease, fuel or contamination from tubulars which are being prepared for, or returned from, offshore.

Trinidad's ground water regulations prohibit discharge of hydrocarbon pollutants such as oils, greases and fuels into the ground or into watercourses and oil separators or tanks fitted to surface water drainage separate and store pollutants until removal by ASCO's specialist contractor partner for waste management.

Commitment to the local workforce

A clear focus of ASCO's presence in the Caribbean region has been its commitment to developing and upskilling local talent and to using local services and personnel to meet and exceed local content requirements. This commitment comes with an assurance to international operators that their global standards of work will be met by skilled and highly qualified local teams. Benefits to the local community include the creation of direct and indirect jobs.

The local team now comprises 100% local personnel and headcount is set to grow by 30% to support the new bpTT contract win. Equally supportive of diversity and inclusion, ASCO Trinidad and Tobago is a female-led team, with two-thirds of its management team being talented Trinidadian women.

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SIMULATING GAS IN THE AMERICAS

Bob Truman, Business Development Director (Gas) and Rodrigo Salgado, Sales Engineer (Latin America), Atmos International, discuss minimising pipeline risks in the Americas with online (real-time) gas simulation.

The gas industry is expanding, fueling industry, power plants, domestic homes, vehicles and electrical power stations. The Americas is one of the biggest producers of natural gas in the world, with the US experiencing astronomical growth as a gas supplier in the past eight years (Figure 1) owing to the ongoing expansion and addition of gas pipeline projects to the country's gas transmission network, such as the Louisiana Energy Access, Matterhorn Express and Mountain Valley pipelines.[1,2,3] Similarly, in Latin America the Texas-Tuxpan pipeline was recently completed and Argentina and Brazil are currently investing in the expansion of their existing gas transmission network.[4,5,6]

Gas transmission networks in the Americas will become increasingly more complex as new pipelines are developed to support growing global energy demand. Now more than ever, operators will need a complete view of pipeline activities to overcome the risks associated with gas transportation. Below are some of the main risks and how the installation of pipeline simulation software can provide support.

The increasing cost of operating gas transmission and distribution systems

In addition to global challenges such as rising labour and material costs, a range of Americas specific factors are contributing towards the increasing cost of operating gas pipelines. For example, in the US a large amount of gas pipeline infrastructure is ageing

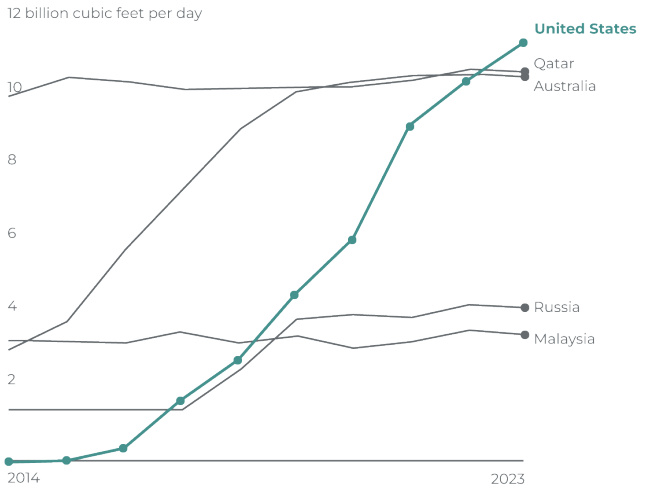

Figure 1. Top exporters of LNG. Data represents the annual average of LNG exports by country.[7]

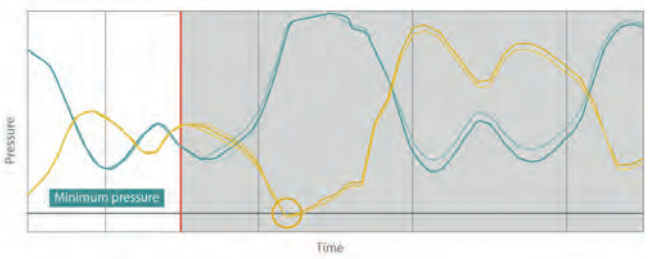

Figure 2. Trending data from a live pipeline's recent activity (light background), along with the look-ahead's prediction of a future scenario. The circled area signposts a potential minimum pressure violation that can be prevented by taking actions early.

Figure 3. An example in Brazil of proposed flow and pressure set points recommended by simulation tools.

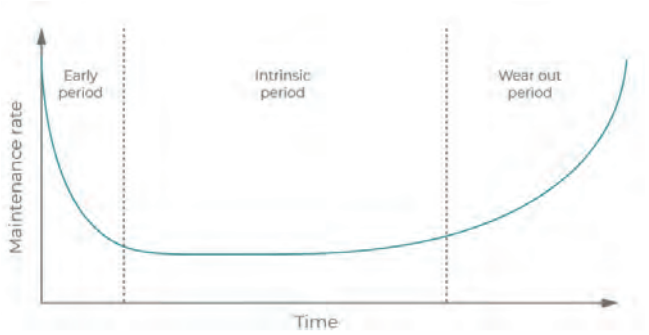

Figure 4. A visualisation of the bathtub curve, as used to define the reliability of a product.

and stringent regulatory requirements require companies to make substantial investment in their repair if they pose a risk to the surrounding area.[8] In Latin America, currency volatility continues to affect the cost of imported materials, resulting in increased operational costs.[9]

To keep gas pipeline companies' costs down, simulation software can help reliably meet gas contract requirements of pipeline customers. It reduces costs for gas pipeline operators by informing the control room of the best course of action when it comes to planned and unplanned operating events in gas transmission and distribution networks.

Cross-border pipelines

To support multiple countries in the region, there are many cross-border pipelines in the Americas. The Tennessee Gas Pipeline (TGP) covering Canada, the US and Mexico; the Los Ramones pipeline between the US and Mexico; and the Southern Cone gas pipeline connecting Argentina, Bolivia and Brazil are some notable examples of border crossing pipelines in the Americas. With plans to develop more in the future, it's important for pipeline companies to consider the challenges associated with border crossing gas pipelines, such as navigating the different regulations and rulings of each country which a pipeline route passes through.[10]

Each country has its own regulatory body, pipeline construction and customer requirements, which will affect the operating requirements of the pipeline. The maximum allowable operating pressure (MAOP) and lowest allowable operating pressure (LAOP) can differ between countries, for example the United States' is dictated by the Pipeline and Hazardous Materials Safety Administration (PHMSA) while Canada is bound by the Canada Energy Regulator (CER).

Simulation software can factor the differing requirements into a cross border pipeline model, providing under and over pressure alarming in each country. Forecast models can also provide an early warning if a pressure violation is anticipated in the future (Figure 2).

Managing risks

Gas pipelines are typically operated in an imbalanced condition, so they rarely reach a steady state. Customer requirements and the operational integrity of a gas pipeline also need to be met so LAOPs and MAOPs are in place to manage risks.

Simulation tools with machine learning capability can make recommendations that reduce the risk of operating a gas pipeline outside allowable limits (Figure 3).

Ageing infrastructure

Over half of natural gas transmission pipelines in the US were built before 1970 and can be classified as "ageing".[11] Similarly, Latin American countries like Argentina have a substantial but ageing gas transmission network.[12]

The challenge with ageing infrastructure is that the pipeline reaches a 'wear out period', increasing operational costs and volatility and a higher risk of hazardous leakage events (Figure 4).

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The corrosion caused by ageing infrastructure is unavoidable, however pipeline simulation tools – especially those with machine learning built in – can automatically generate an optimal and actionable operational plan each day including set points for flow, pressure and equipment and ensuring the smartest use of a gas pipeline network and creating less risk of accelerating pipeline ageing.

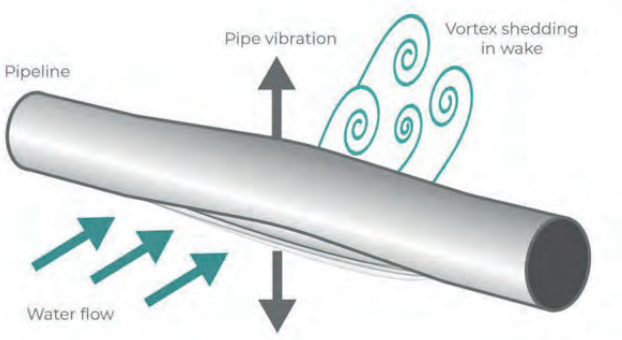

Figure 5. Riverbed scour exposes pipelines to the elements and the fast-flowing water can cause vibrations that weaken pipeline integrity, also known as vortex induced vibration.

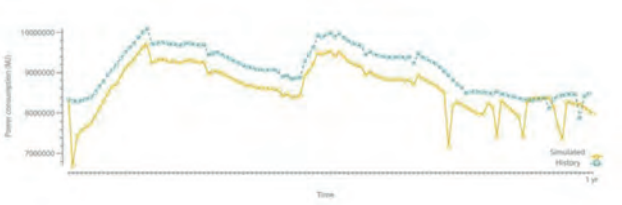

Figure 6. Calculated compressor power consumption (yellow) compared with historical data (green).

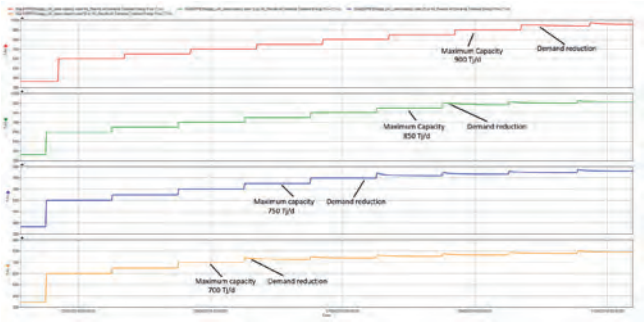

Figure 7. Hydrogen blend maximum capacity calculated by Atmos SIM (red 0%, green 10%, blue 25% and orange 50% hydrogen) in an example pipeline network.

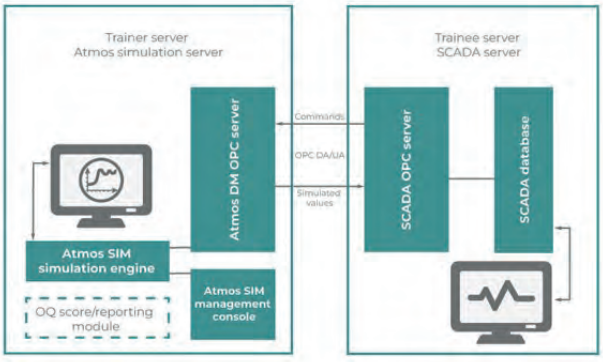

Figure 8. Example training system architecture.

Leaks and explosions

Gas pipelines across the world are at risk of leakage and explosions, but there are some factors unique to the Americas that make the region more at risk. For example, a significant portion of pipelines in the Americas are ageing, but there are also factors relating to external damage that impact the region. Clashes with indigenous communities over pipeline routes have historically resulted in pipeline vandalism, which can impact pipeline integrity and create a heightened risk of leakage.[13]

Similarly, gas pipelines with sections running offshore require additional care to safeguard against the marine environment. Trinidad and Tobago's cross-island pipeline, sections of the Los Ramones pipeline in Mexico and many routes in Brazil have offshore sections. Failure to protect offshore gas pipelines can accelerate corrosion and be susceptible to other harsh environmental forces that can lead to a catastrophic leak event that not only results in product loss, but endangers the environment and marine life in the surrounding area.

The topography of the Americas is also highly variable. Latin America alone is made up of mountains and highlands, river basins and coastal plains. Extreme geographic variation presents a risk of geohazards, such as landslides, laharas and volcanic eruptions impacting pipelines in the vicinity of mountains or riverbed scour and underground erosion affecting pipelines (Figure 5).

Pipeline simulation tools can equip a leak detection module that provides fast, sensitive and reliable leak detection. Utilising a sequential probability ratio test (SPRT), it's possible for simulation tools to provide leak detection by calculating the ratio of leak probability over no-leak probability, which are then tested against threshold values to provide reliable leak warnings and alarms.[15] For gas transmission networks in the Americas which are already at high risk of leakage and explosions, pairing leak detection with simulation software is vital.

Managing the complexity of gas networks

When gas networks in the Americas can contain multiple compressor stations and many delivery points, determining the best course of action can be difficult for pipeline operators when multiple changes occur simultaneously on the system.

Simulation software can provide a detailed model of the network, with machine learning even being capable of presenting where energy savings are possible. Figure 6 presents an example of a 548 mile gas transmission pipeline across three countries where an energy saving of 5% is achievable, resulting in a saving of US$5 million/yr.

Greenhouse gas emission reduction

To reduce greenhouse gas emissions, a solution being explored is the introduction of hydrogen into the gas stream. Hydrogen doesn't generate greenhouse gas emissions and countries across the region are exploring hydrogen as part of their energy transitions. For example, Canada has a hydrogen strategy in place to position itself as a global leader in hydrogen production and export,[16] Mexico's National Institute of Electricity and Clean

Energy (INEEL) is researching hydrogen projects and Chile has plans to become a green hydrogen exporter.[17]

Pipeline operators in the Americas will have to account for hydrogen's differences to other natural gases when it's introduced into the gas stream. Simulation software can help operators model the behaviour of various hydrogen blends as well as managing the network's capacity (Figure 7) and tracking gas quality.

Operator training

With everything that needs to be considered in the safe and efficient operation of a pipeline today and with the rapid growth in new pipeline facilities, proper operator training is now more important than ever. Simulation software can be adopted to mimic the operator's SCADA interface (Figure 8), allowing the operator to experience operating a gas pipeline with a digital simulation and actual SCADA interface. This experience can prove invaluable in making sure that the operator knows how to react to changing pipeline conditions and prevent potential loss of life and facilities.

Gas simulation is key to keeping control of transmission networks in the Americas

Whether it's managing ageing pipeline networks or incorporating new pipelines, safe and efficient gas pipeline operations should always be the highest priority. A range of challenges continue to face gas pipeline operators in the Americas but the installation of a simulation software solution can alleviate operators' concerns. WP

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In praise of returning to your roots

In Tulsa, USA, Dick Williamson repurposes a building for new business, and helps revitalise a historic neighbourhood.

For Richard B. (Dick) Williamson, the historic 89 000 ft^2, 12 building campus he purchased early this year in Tulsa, Oklahoma, USA, isn't just the new home of his company, R.B. Williamson Energy Advisors (RBWEA). The old Tulsa Operations facility is also a link to his family history, and to his own.

Built in 1947 on Latimer Street – now part of a flourishing arts district and hub of Latino life in the city – Tulsa Operations was the original manufacturing plant for the pipeline services and equipment company founded in 1920 by Williamson's grandfather, Truman Dale Williamson Sr. It's where some of the industry's most innovative technology got its start, including the T.D. Williamson (TDW) STOPPLE plugging machine.

Next door was the Hill Co., where the tapping machine was invented. Although that facility has been physically connected to Tulsa Operations for some time, it is still referred to as the 'Hill Co.

Figure 1. Tulsa operations shipping and receiving in the 1940s.

building'. (TDW acquired the HILLCO tapping machine license in 1949. They modified the machine design and began marketing the WMSON-HILLCO tapping machine later that year.)

Tulsa Operations is also one of many places where Dick Williamson – a pioneering and much-honoured figure in the energy business – cut his teeth after joining TDW as a young engineer in 1971. He would spend decades overseeing advances in pipeline integrity before starting RBWEA in 2023 to address what he describes as "the growing technical and regulatory compliance needs of the pipeline and energy industry."

The stars aligned

TDW sold the Tulsa Operations complex in 1981 and it went through multiple ownership and tenants over the next 40 years. When it came on the market again in 2023, it seemed like fate: RBWEA needed more space to support the increasing scope and technical content of its consulting and related technical services business, and Williamson quickly realised that, with some renovation and repurposing, the Tulsa Operations building would fit the bill. He seized the opportunity for RBWEA and its advisors to revitalise a location where, he said, a tradition of innovation and service was born.

Figure 2. Flag ceremony at Tulsa Operations, June 2024.

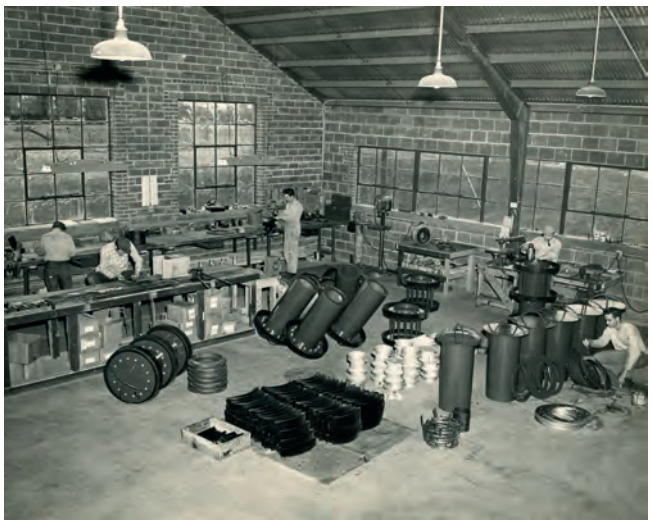

Figure 3. Tulsa Operations assembly shop in the 1940s.

Eventually, the space will include a conference area that companies and industry organisations can rent and where RBWEA advisors will host specialised training on topics such as the Mega Rule and best practices for pipeline purging. A pipeline museum is also in the planning stages; when completed, it will be the 24th petroleum museum in the US but only the second dedicated primarily to pipeline operations.

"It was like the stars had aligned," RBWEA Business Development Manager Emily Williamson Perkins said. "RBWEA was looking for a certain kind of facility to support its growth, and a personally significant building came on the market.

"In many ways, Dick is returning to his roots," Perkins added. "But he's doing so with a forward-looking attitude." That means building on the core business values that are the indelible legacy of his grandparents – Truman Sr. and Edna Williamson – who believed in serving customers well, caring for employees and engaging with others to address critical community needs.

"Those core business values were sustained for more than 100 years and continue to guide the RBWEA team on their journey of service," Dick Williamson said.

It also means focusing on the new and emerging challenges facing the energy industry.

Not really a newcomer

Of course, when you've been in the business for 50 years like Williamson has, you've seen a lot of 'new challenges'. In that, he's not alone. Each of the RBWEA advisors has weathered the volatility of the industry. They honed their skills from the shop floor to the field, from corporate offices to international conferences. All told, the group of eight has more than 200 years' cumulative experience in pipeline safety, operations, maintenance, code compliance and strategic planning. Their work, Williamson said, has "prepared them to help the industry improve upon what it has done well and to seek solutions to matters that have heretofore not been addressed."

In other words, RBWEA may be relatively young but it's a newcomer in name only.

Since the company started, the advisors' attention has been on everything from how emerging products such as hydrogen and ammonia will affect pipeline integrity, to preparing customers to comply with the shifting regulatory landscape. That last point is especially important as operators are increasingly required to demonstrate they are meeting safety objectives through engineering assessments and data-driven approaches.

"Regulatory bodies are moving from prescriptive to performance-based regulations", Robert Bockmeulen, RBWEA advisor said. "As regulations on safety, emissions and environmental impact become stricter, operators need to adopt new technologies and practices to ensure they're meeting all standards.

"At the same time, increased public concern about pipeline safety and environmental impact puts pressure on operators to demonstrate a strong commitment to both," he added.

In an ever-changing business climate, Bockmeulen said, operators need advisors who can navigate complexity. They have to be able to translate technical solutions into real-world business benefits like increased efficiency and cost reduction, and they have to understand the regulatory landscape.

Those are the qualities RBWEA brings to the table, Bockmeulen added.

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Preservation and revitalisation

Well before the ink was dry on the Tulsa Operations contract, Williamson and his team had begun envisioning how the restored and renovated facility would look and function. The goal was to bring the building up to modern codes while preserving as much history as possible. Some of the conservation work was actually done for them: Perkins said the west side of the facility, including Truman Dale Williamson's former office and a small boardroom, had been virtually untouched over the years and remain in nearly pristine condition.

Figure 4. Truman Dale Williamson Sr in the early years at Tulsa Operations.

Figure 5. Dick and Emily on Flag Day 2024.

Figure 6. Tulsa Operations Flag day open house, June 2024. BBQ was served in the original shipping and receiving building.

"It really is like the facility was waiting for Dick to come back to it," Perkins said.

Other features, like a 'secret entrance' at the front of the building, just needed a touch-up before being ready to put back into service. Elsewhere, renovations have helped restore Tulsa Operations to its former glory.

Williamson's vision didn't begin and end with cosmetic or structural changes, however. He hopes that breathing new life into Tulsa Operations will also contribute to the continuing resurgence of the nearby historic Kendall-Whittier neighbourhood.

Founded in the early 1900s, Kendall-Whittier played a key role in Tulsa's development. The University of Tulsa established itself there, and the area was a prominent stop on Route 66. However, in the 1960s the construction of an interstate highway divided the neighbourhood, displacing residents and impacting businesses. Ageing infrastructure and zoning changes further contributed to decline.

Recently, though, Kendall-Whittier has been experiencing a comeback and is now recognised as an official Tulsa cultural district.

One concern, however, is that the area in general is prone to flooding. Following his family's tradition of community engagement, Williamson hired a hydrologist to build the models for a retention pond on the Tulsa Operations grounds. (Retention ponds limit how much water saturates the ground in an area by gradually introducing the water collected from rainfall into the water table.) The expectation is that the pond will not only protect the facility but will also reduce the risk to adjacent residential and industrial neighbourhoods.

"Though our primary focus for revitalisation has been on the Tulsa Operations facility, our intent is to expand the scope of revitalisation and help create a diverse community of organisations committed to the renewal of the area," Williamson said. "Reaching that goal will require us to engage the people and business owners around us as well as the city of Tulsa and its educational and social services organisations."

It's a big job, but Williamson believes his team is up to the task.

Coming home

Before renovations began on Tulsa Operations, Williamson, Perkins and the architectural team spent countless hours onsite. Some days turned into an impromptu treasure hunt, like when they came upon the old flagpole that had marked the facility's entrance for nearly two decades. It had been a gift to Truman Dale Williamson Sr. from 'the whole gang' on his birthday in 1962. Though the original flag was long gone, Bockmeulen arranged to have it replaced by one flown over the US capitol building. A local Boy Scout troop raised the new flag on the reinstalled flagpole on 14 June – Flag Day in the US – and the date of an open house welcoming hundreds of people to the repurposed facility. Among the crowd were many TDW retirees who had long called Tulsa Operations home.

For Dick Williamson, this is a full-circle moment, a return to his roots. More than that, it's the start of a new future.

modern pipeline monitoring

Ehsan Jalilian, HiFi Engineering, Canada, presents distributed fibre optic sensing use cases for pipeline integrity management, with some case studies from North America.

Distributed fibre optic sensing (DFOS) is best known for its traditional role in leak detection, with first-generation, backscatter-based technologies like distributed acoustic sensing (DAS) and distributed temperature sensing (DTS) having their roots in external leak detection almost two decades ago. While the ubiquitous nature of telecom fibre made early versions of DAS and DTS logical candidates for pipeline monitoring projects, the inherent limitations of the host telecom fibre itself act to restrict the utility and breadth of application of these systems.

In recent years, the continuous evolution of sensor design and system architecture has dramatically improved fidelity and enabled integrated measurement of acoustics, temperature, and strain/vibration over long distances with minimal performance degradation, resulting in next-generation, high-fidelity DFOS systems, such as Hifi's High Fidelity Distributed Sensing (HDS™), with enhanced performance in leak detection and expanded operational applicability. High-fidelity DFOS systems play an expanded role in pipeline leak detection with the ability to not only better detect, but also better differentiate event characteristics allowing for greater precision (i.e. the ability to detect pinhole leaks at low pressures) as well as superior accuracy (specifically the virtual elimination of false positives). Moreover, high-fidelity DFOS systems such as HDS leverage next-generation fibre optics and advanced machine learning (ML) tools to provide a pipeline monitoring platform that transcends traditional leak detection.

Specifically engineered for sensing, Hifi's next-generation HDS fibre optic sensors continuously capture acoustic, strain and vibration, and thermal data generated by a wide range of

activities occurring on, in or near the pipeline while leveraging the power of ML tools such as sequential neural networks to dive deep into the data to identify events of interest. The result is a comprehensive monitoring solution with capabilities that extend well beyond the traditional role in advanced leak detection. Combining these powerful technologies in a single system provides operators with unparalleled real-time monitoring capabilities while also delivering a host of predictive insights to support proactive integrity management. Among its transformative applications, pig tracking and accurate estimations of flow, pressure, and density are of high value to pipeline operators.

The high sensitivity and light-speed transmission capabilities of Hifi's HDS, when combined with advanced ML strategies, offer a wide range of applications. These include advanced leak detection to pinhole levels, pipeline insulation mapping, ground disturbance and intrusion detection, pig detection, tracking, and analysis, and distributed strain analysis for preventative integrity management. The technology can also be used for geotechnical investigations, including the analysis of the impacts of earthquakes, landslides and other ground movements.

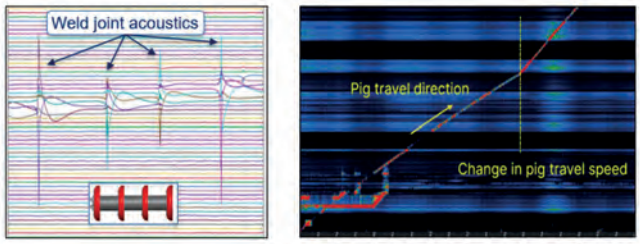


Figure 1. Use of DFOS (a) acoustic and (b) strain measurements for pig tracking and analysis.

Figure 2. Deployment types of fibre optic cable.

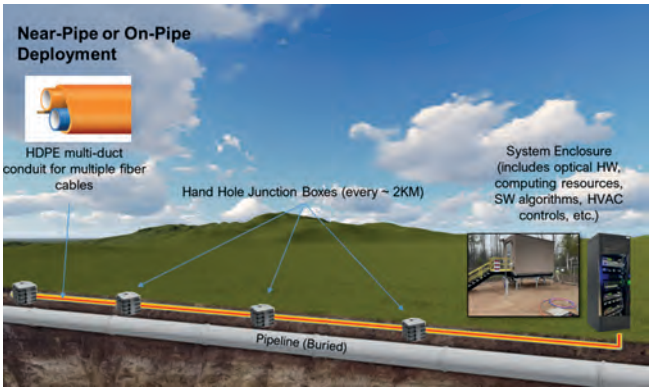


Figure 3. Typical DFOS system architecture schematic showing main system components: sensing and/or telecom fibre, periodic junction boxes, and system enclosures where all electro-optical components are housed.

Pigging applications

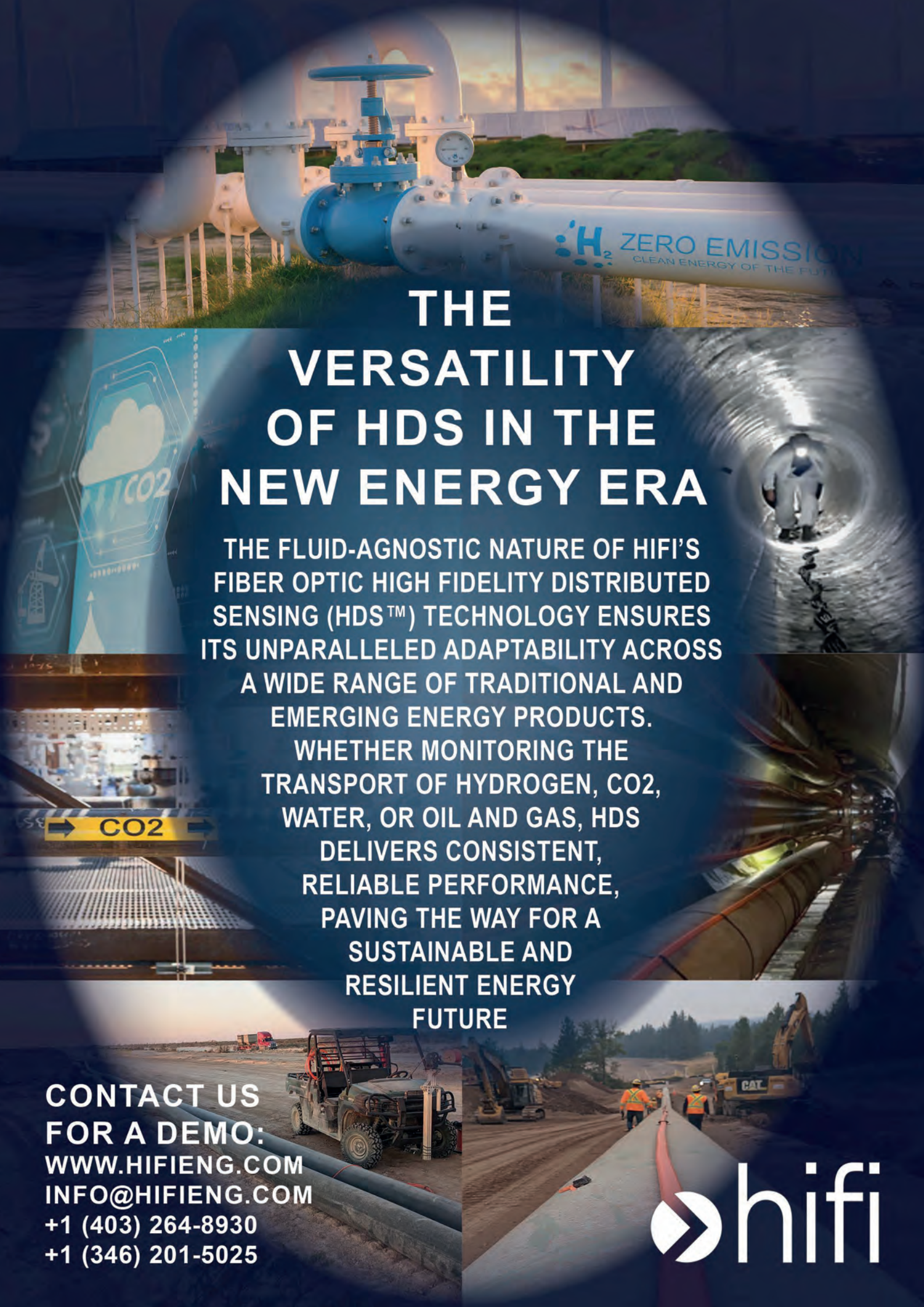
Operators have been quick to seize on the recent rapid advancements in high fidelity DFOS capabilities, to detect, track and analyse pipeline inspection gauges (pigs), which has continued to push the technology into new applications to expand its operational utility and value-in-use.

One primary application of DFOS that appears to have considerable direct financial value for pipeline operators is the tracking of inline inspection (ILI) pigging tools. Pigs generate vibrations and acoustics when travelling through the pipe (for instance, when contacting weld joints – Figure 1), and these signatures are generally quite pronounced in the context of fibre optic sensitivity, allowing advanced systems to detect pigs from thousands of metres away. High fidelity DFOS systems such as Hifi's HDS are well-suited to do double-duty as pig tracking and analysis platforms, enabling operators to efficiently monitor pig location, speed, status (i.e. stopped vs. moving) without the need for costly third party services. Most importantly, applications like pig tracking and analysis are enabled by customised algorithms that can be initialised remotely (i.e. via software updates) without any need for new equipment or system hardware. The result is a highly versatile tool that brings considerable real value at minimal cost.

System design and deployment

The fibre optic sensor is a cornerstone of modern pipeline monitoring, providing high fidelity distributed sensing that leverages patented sensing fibre architecture to overcome early generation limitations. Hifi's HDS platform represents the cutting edge of this evolution, introducing a host of new capabilities and benefits. The fibre optic cable can be deployed in various ways depending on the specific project needs, with the fibre being injected into a conduit deployed either directly onto the pipe, near the pipe, or inside the pipe depending on the project needs and accommodations (Figure 2).

The HDS architecture capitalises on wavelength selective reflective elements known as Fibre Bragg Gratings (FBGs) to dramatically improve and control the returned light of specific wavelengths while preserving fidelity over long distances. FBGs are inscribed onto the fibre optic cable's core, creating variations in the refractive index for individual wavelengths of light. It's possible to control the reflectivity of each FBG, making them ideal for high fidelity distributed fibre optic sensing applications, where having sufficient optical reflections is a key component of sensing.



THE VERSATILITY OF HDS IN THE NEW ENERGY ERA

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A key benefit of high fidelity DFOS systems is their ability to support monitoring over very long distances with little degradation in performance, resulting in attractive per-metre economics for longer deployments.

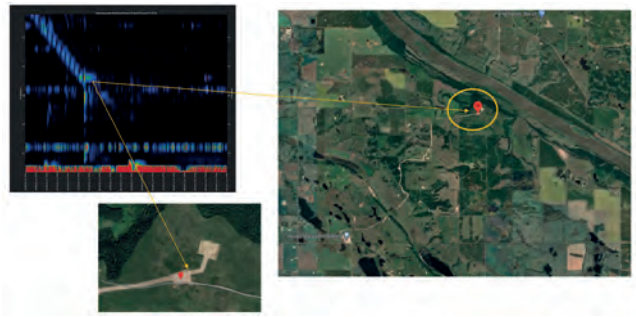

Figure 4. Last pig location sensed by the fibre and map location.

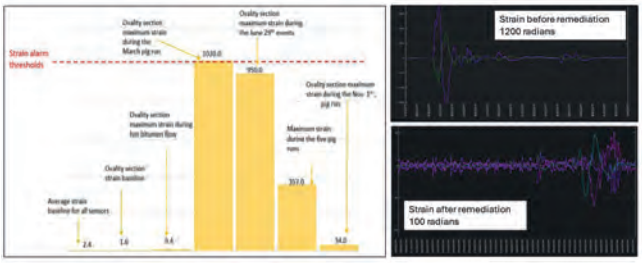

Figure 5. DFOS strain measurements used to validate effectiveness of pipeline ovality remediation efforts.

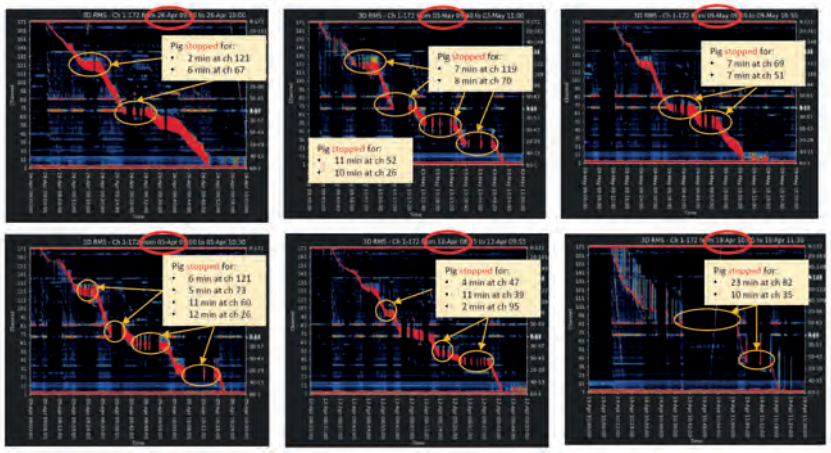

Figure 6. Pig signature and pig stoppages.

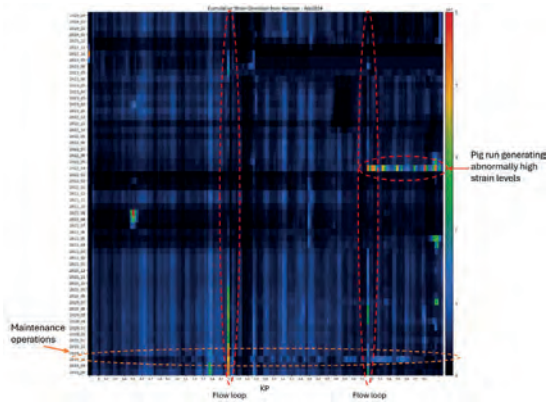

Figure 7. Accumulated strain levels during pig runs vs. time and space.

Case studies

Hifi has several case studies that exemplify the effectiveness and versatility of the HDS system. These instances range from tracking pipeline pigs to monitoring pipeline integrity during remediation efforts. They illustrate how high fidelity DFOS such as HDS can provide critical real-time data, guiding effective decision making and enhancing operational efficiency.

Husky Midstream

Husky Midstream's gauge tool pig investigation case study offers a prime demonstration of our advanced functionality in addressing critical use cases. In November 2022, Hifi's fibre monitoring system identified a pig in a Husky pipeline, clocking the pig's speed at 0.94 m/sec. While traversing the pipe, the pig stopped moving at one location and did not generate any additional movement related signatures. Husky was very interested in identifying the location of the pig in order to facilitate the retrieval operation. The HDS system data allowed the team to surmise the specific Kilometre Post (KP) as the pig's location, a hypothesis that guided the successful recovery operation. This case underscored the critical need for accurate fibre channel to KP/GPS coordinate mapping in such scenarios.

Suncor

Complex integrity digs often represent the only viable means of validating pipeline remediation efforts, and in some cases (like river crossings or high consequence areas) even this expensive solution isn't viable. For these situations, HDS provides a cost-effective means of condition assessment that may be crucial for effective risk analysis, once again delivered remotely via customised software tools.

The Suncor remediation case study showcases the versatility and utility of an existing HDS system in managing pipeline integrity. During the construction phase, ovality concerns arose and remediation efforts were required. HDS was instrumental in measuring strain levels in the host pipe across successive caliper pig runs. Figure 5 illustrates the use of an existing HDS system to monitor the progress of ovality remediation efforts on this pipe section. HDS was used to measure strain levels in the host pipe during successive caliper pig runs, allowing the constructor to assess whether their efforts to address the ovality issue were achieving the desired result. As can be seen in the figure, HDS measurements clearly indicate a reduction in observed strain values attributable to the remediation efforts, with residual values approaching the pre-event levels.

An operator monitoring pipe strain levels

In a case study conducted with another pipeline operator, pig runs were compared, revealing high acoustic levels but not significant strain levels compared to ambient strain. The duration of the pig runs for the specific pipe section being monitored varied from 24 - 93 mins across different dates.

Notably, flow changes with significant strain levels were observed, especially when the pig stopped at a location for

several minutes, causing an increase in cumulative strain levels as shown on Figure 6. For instance, on 30 May, a pig run was monitored lasting in total 84 mins. The pig was detected to have stopped at various locations, leading to increases in strain levels. A colourmap plot was utilised to display the normalised average strain levels accumulated during the pig runs at each sensing zone, as well as where higher pig-induced strain levels were experienced.

Additionally, the average accumulated strain levels at each sensing zone during the pig run were analysed and compared against baseline strain levels from a high strain reference point and the normalised average of strain levels over five years of monitoring, as shown in Figure 7. The flow loop locations marked on the graph are expected to have higher strain levels, but the emergence of a high strain zone during an April 2022 pig run was flagged for additional analysis by the operator.

These insights enable the operator to monitor the pipe strain levels and determine if a particular pipe section is experiencing excessive strain levels compared to its previous temporal baseline, or in comparison with the other locations along the pipe.

Grasping the potential of the technology

Our case studies demonstrate the effectiveness and versatility of Hifi's HDS system. These instances range from tracking pipeline pigs to monitoring pipeline integrity during remediation efforts, providing critical real-time data that guides effective decision making and enhances operational efficiency.

This technology holds the potential to cut expenses and streamline pig detection and tracking, contributing to improved pipeline integrity management. It's another step forward in Hifi's commitment to advance preventative asset management and deliver high-quality, cost-effective solutions for our clients. Hifi is planning to release its Advanced Pig Analytics (APA) platform in the near future, which among other enhancements, will provide minute by minute pig location updates, as well as the ability to track a pig outside the monitoring zone covered with DFOS.

As operators continue to explore and understand the capabilities of DFOS, they are pushing this technology into new and exciting domains. One of the emerging frontiers is distributed flow and pressure monitoring. With advancements in high fidelity DFOS technology such as Hifi's High Fidelity Distributed Sensing and its expanded use in pipeline monitoring, the ability to measure flow and pressure changes across vast pipeline networks is becoming a reality. This could revolutionise pipeline management, allowing operators to identify and respond to changes in flow and pressure in real-time, leading to improved safety, efficiency, and operational effectiveness. The future of high fidelity DFOS technology is promising, and we look forward to seeing it shape the landscape of pipeline monitoring and integrity management.

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EXTENDING PIPELINE PRODUCTIVITY

Jim Bramlett, Commercial Manager – Americas, Tracerco, outlines how to extend the lifespan of pipeline assets through proactive maintenance.

We all want value for money regardless of the nature of any investment we make. Whether it's everyday items such as clothing and groceries or larger expenses like a vehicle or home, ensuring we get as much out of it as possible is at the forefront of our minds.

We want to ensure we'll get a good return either financially or through value. For example, you want to make sure you are on top of the air conditioner in your home being serviced regularly, so that if the worst does happen in the heat of summer the damage – physical and financial – won't be so bad. The same goes for your car and everything that goes with making sure it continues to run as you need it.

On a bigger scale, the same rule should apply to offshore assets and the accompanying infrastructure. Across the Gulf of Mexico, for example, we have seen a marked increase in the number of companies whose assets are coming to the end of their permits looking to extend their productivity.

Managing ageing assets

In recent months, Tracerco has secured a million dollar contract in the region which will see its state-of-the-art Discovery™ technology deployed to safeguard production processing and implement necessary corrective measures.

As assets age over time, oilfield professionals face the challenge of ensuring efficient production and maintaining pipeline integrity, and subsea inspection of these pipelines and risers has often posed difficulties in cases where traditional pigging methods are not feasible or considered too risky.

Tracerco's technology has been specifically designed for both flow assurance and integrity experts looking at subsea pipelines that cannot be inspected using traditional methods. With 65 years' of subsea experience going into Discovery, clients can visualise and measure flow assurance and integrity issues all in the same project, without interruption to production or any coating removal.

To date Discovery has provided real-time critical insights for many of the world's deepwater infield flowlines, and most recently has been utilised by a trio of leading US energy companies, all of whom operate different flowline and riser pipes on multiple platforms in the Gulf.

Contracts such as these enable Tracerco to get standardisation as we work with these operators to maintain pipeline integrity, assure flow and extend the lifespan of their assets. Discovery can obtain real-time, highly accurate data via a non-intrusive approach, meaning there is no need for any downtime. This allows owner/operators to gain enhanced understanding of a pipeline, all whilst being fully operational.

As well as this, the output – high-resolution tomographic images of the pipe wall thickness and contents – helps operators refine and improve the efficiency of existing pipeline models and can also help companies plan for life extension, a major factor in the GoM project. In fact, our biggest efforts and pushes right now in North America are all centred around life extension work.

Life extension work

Organisations must apply to the Bureau of Safety and Environmental Enforcement (BSEE) for a life extension permit, which is only approved for well maintained platforms with proven integrity of all components. And that's the catch.

The older assets get, and the closer towards the end of their permit they get, the more organisations need to be thinking about how to best protect their interests. With many only having a BSEE permit for 20 - 25 years, a decision needs to be made towards the end of that platform's lifecycle: either decommission and remove the asset, or apply for a permit extension to extend the asset's life.

But in order to do that, you have to prove that the condition of the asset is within standards and still in good shape.

In financial terms it is a wise investment. Take an asset that costs US$5 billion to get operational in the first place, for example. That will be paid off over the course of the permit, meaning that the longer it can – safely – be operated, the higher the profit margin on everything they can recover after the original permit.

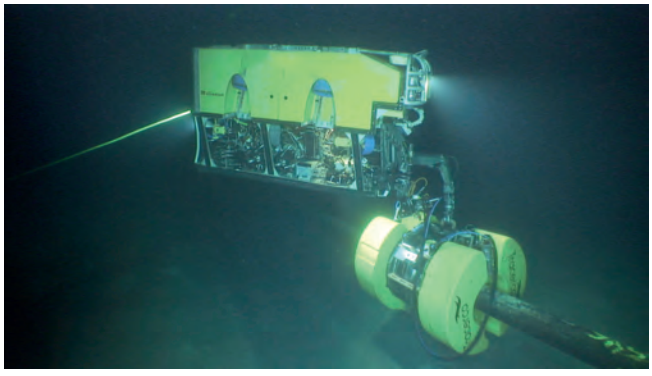

Figure 1. Tracerco Discovery™ technology on an ROV.

However, while many will want to extend the lifespan of those assets, instead of waiting until that 20/25 year period is up, companies need to be looking at everything as early as possible and ensure they are carrying out predictive maintenance years ahead of their current licence period coming to an end. They should also be planning the life extension process and obtaining all inspection data about two years in advance. This doesn't just apply to the Gulf of Mexico, though, these same principals should be applied in places such as Trinidad and other Caribbean countries.

Predictive maintenance

Platform owners and operators need to be proactive rather than reactive. It's similar to owning a car. You know that every 7000 miles or so, you should probably change the oil in your vehicle. That's predictive maintenance. You don't wait until you hear a knocking noise to take action. You know that by that stage you have created all kinds of issues that are going to be much more expensive to repair. If only you had not ignored the knocking. If only you had acted sooner. It's about avoiding the 'if only'.

When it comes to making decisions that will have a lasting impact on operations, having all the information at your fingertips is important. An added value of Tracerco's technology is that it not only provides essential pipeline integrity data but can also provide invaluable insights regarding flow assurance data. With its flow assurance services for subsea pipelines capable of sourcing the location, extent and nature of blockages or restrictions in subsea pipelines without interrupting or halting production completely, the benefits are clear to see.

Diagnosing the problem

Back offshore, the approach to this will depend on different companies and their own philosophies. Some will be what we call early engagers, who are familiar with technologies and throw all the resources they can to get it right the first time. And then there are others who are a bit more gung-ho and eager to try to figure it out themselves. They'll throw everything they can from their in-house knowledge base, and only once they realise it doesn't work do they start reaching out – by which time they've caused some irreparable damage or at the very least exacerbated the problem.

Blockages could be caused by multiple issues such as changes in the well dynamic. It could be a change in pressure, a change in fluid composition, or they may be producing more water. As well as issues occurring through the production process, they could also arise due to corporate strategy. If regular maintenance pig runs or chemical treatments are not carried out pipes can eventually block off over time and it inevitably catches up with the company with significant loss of production.

We encounter several situations like this through the year, and that's just the ones we are aware of. There are bound to be more out there we do not know about.

That is why it is critical that businesses invest in predictive maintenance. We are fortunate that we have the technology that can go out there and help them with that. We can identify deposition build up issues well before they become a critical issue.

Committing budget up-front on predictive maintenance can be far more cost-effective than dealing with the issue after it has happened. Spending money on the front-end avoids spending 10 times that on the back end due to lost production.

For example, if you have a pipeline that's producing 4000 bpd, a quick run of the numbers looking at 4000 x the price of oil x the minimum couple of weeks downtime due to a blockage: the figure starts getting significant very quickly. In relation to the cost of predictive maintenance, it's a drop in the ocean.

We have had customers in the past who have experienced total blockages and now engage in predictive maintenance because of the cost implications. By looking to alleviate the issue before it even exists can help save owners and operators significant sums.

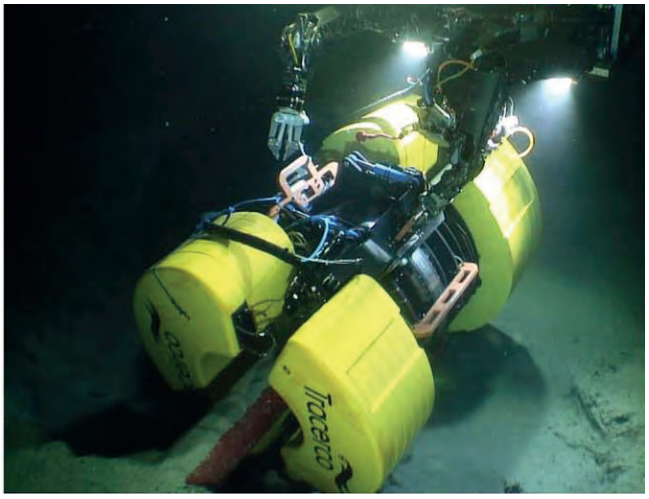

Figure 2. Tracerco's Discovery technology on a pipe.

It's relatively straightforward and fast to go out and carry out a predictive maintenance operation to ensure you don't have anything unexpected in the line that's going cause you a problem later. Companies can do that while still producing oil and not impacting the already-existing costs.

Working with clients holistically

We have been in situations previously where we have had members of our flow assurance team in-field and they have been able to find issues clients were not aware of, or at least not aware of the extent of the problem. When we identify the problem, companies see the value of the technology and engage in long-term agreements.

For example, we have a major operator in the Gulf of Mexico right now, for who we carried out inspections and, in doing so, found issues they were not aware of from a flow assurance standpoint. Although we were conducting an integrity-focused project, Discovery has found flow assurance issues and they've been able to go in and correct online.

While the bulk of what we do with Discovery is asset integrity, during those projects we have found quite a few flow assurance issues and have been able to bring that to clients' attention, which is a major value add of getting both the integrity and flow assurance data all in the same scan.

And it is bringing that added value to owner operators in the Gulf of Mexico – and beyond – that helps place Tracerco as a key partner when it comes to ensuring asset life extension becomes a reality.

Q & A WITH:

Jim Campbell, Operations Manager, Tinker & Rasor, USA, answers some questions about corrosion mitigation and holiday detection technology.

Can you provide a brief overview of Tinker & Rasor's history and how the company has evolved in the corrosion mitigation industry?
The company was founded in 1948 by Leo Tinker and John Rasor. In 2019, Tinker & Rasor (T&R) became a Texas Corporation, an electronics firm that successfully designs, develops, and manufactures holiday detectors and a sizeable line of cathodic protection instrumentation. Products are 100% made in America and are sold worldwide.

What were some of the key milestones in Tinker & Rasor's journey that have significantly contributed to the pipeline sector?
In 1961, T&R purchased the Detectron pipe and cable locators, which are used to 'sweep' right-of-ways for buried foreign objects before excavation begins.

How has the company maintained its position and reputation in the industry over the years?
For 76 years, T&R has focused on three key areas: providing the best customer service in the industry, delivering top-quality products, and offering rapid custom component manufacturing in hours instead of weeks.

What are the primary products that Tinker & Rasor manufactures for the midstream market and can you elaborate on any recent technological advancements or new products that Tinker & Rasor has introduced for holiday detection?
For 76 years, we have been manufacturing holiday detectors, high voltage meters and testing electrodes for operators. T&R was the first manufacturer to incorporate a safety switch into the handle of our holiday detector which shuts the unit off when released. Our custom-made LiFePO4 batteries reduce the weight of our holiday detector by 3 lb while maintaining enough power for a full day's work. We also produce a split-box-locator for marking and clearing rights-of-way of pipelines and foreign structures. The addition of our Test Stations in 2002 and out RF-IT to test above ground pipe insulators and flange bolts have been a fantastic success and complements the pipeline portion of our business.

What core values drive Tinker & Rasor as a company? Can you share some insights into the company culture at Tinker & Rasor and how it supports innovation and customer satisfaction?
Honour: our word is our bond. And quality, which is evident in our people and products. We are also dedicated to our employees, our industry, and its members.

Figure 1. **Model APS Holiday Detector Kit for pipeline coating inspection.**

Figure 2. **Tinker & Rasor cathodic protection equipment, reference electrodes and test station line, perfect for protecting/testing buried pipelines and tanks.**

Figure 3. **Tinker & Rasor locating instruments for locating pipe, right-of-way searches and tracking pigs/finding leaks.**

How does Tinker & Rasor anticipate and respond to the changing regulations and technological trends in the pipeline industry?
We listen to our customers and stay updated with industry changes through various media channels, both traditional and new. Staying connected allows us to quickly adapt and navigate the evolving environment.

What do you see as the biggest challenges facing the pipeline sector in North America today, and how is Tinker & Rasor addressing these challenges?
The greatest challenge will be the workforce and the lack of new/younger employees. While this affects manufacturers like T&R differently than our customers, the need to focus on the upcoming workforce is imperative to our survival.

How has Tinker & Rasor adapted its products and services to meet the specific needs of the North American pipeline market?
Global pipeline personnel require a rugged, reliable detector designed to withstand the challenges of working in the field, and T&R's products have proven to be the toughest most dependable equipment in even the harshest conditions around the world.

Can you discuss any partnerships or collaborations Tinker & Rasor has with other companies or organisations within the North American oil and gas pipeline sector?
T&R has been proudly collaborating with AMPP, previously known as NACE International, since 1950.

What role do you see Tinker & Rasor playing in the development and maintenance of pipeline infrastructure in North America over the next decade?
We are currently advancing the utilisation of our equipment through the integration of other manufacturers' robotics, aiming to elevate operator safety within elevated work environments.

How does Tinker & Rasor engage with its customers to understand their needs and challenges?
Our team travels globally to collaborate with clients, improving efficiency and ensuring safe work environments. Effective communication is essential for our customer service.

Can you provide examples of how Tinker & Rasor has helped a specific client overcome a significant challenge in corrosion mitigation?
A prominent producer is currently engaged in the initiative to entirely remove scaffolding to address safety concerns. Through collaboration with robotics manufacturers, they have endeavoured to engineer tethered robots capable of conducting blasting, painting, and inspection activities while keeping all personnel stationed on the ground. T&R holds a distinctive position to supply instrumentation and tailor the components of these systems to specific requirements.

Texas pipeline scores the GOOD kind of ZERO

Holly Tyler, Specialty Polymer Coatings (SPC), a division of Carboline, explains the significance of performing a rare whole-length DCVG test on a new Texas pipeline.

Shortly after a 535 mile natural gas pipeline that crosses Texas, USA, was completed in 2022, its owners ordered a direct current voltage gradient (DCVG) test for its whole length. While this is rare, rarer still was the result of the test.

Building and protecting the pipeline

The pipeline begins its run from a sun-scorched patch of the Permian Basin called Waha. A few miles eastward, it branches off: a smaller lateral pipe runs north to supply customers in the Midland Basin, while the mainline continues south and then southeast through more rocky desert before arcing toward its terminus near Corpus Christi, Texas, USA.

The primary construction challenge was creating the trench into which the pipeline would be installed. The general contractor had their work cut out for them: of the pipeline's 535 miles of total length, about 80% of it – over 420 miles –travels through solid rock.

This unforgiving environment demanded enhanced protection for the pipeline exterior.

Mill-applied fusion-bonded epoxy (FBE) protects the pipeline sections. But because this protection does not meet abrasion-resistant overcoat (ARO) criteria on its own, it was supplemented with a powder additive that enhanced its physical properties.

Ordinarily, ARO-rated protection is intermittent along a pipeline length, corresponding to locations where the risk of damage from abrasive force is elevated. However, the whole of this pipeline's length is protected in this way. That's rare, partly because it is not strictly necessary, and partly because it adds to the cost to build.

But the investors fronting the cash to build the pipeline insisted on this higher-performance protection to secure their investment. They adopted a similar approach to integrity testing after construction was completed.

As for the pipeline's 2000+ weld joints, a single-coat, two-in-one liquid epoxy material that provides both corrosion and ARO-verified abrasion protection was applied. The coating subcontractor utilised automated spray equipment for fast, consistent, repeatable coating application.

Two characteristics of the specified liquid epoxy are noteworthy. First, SP-2888, manufactured by British Columbia-based Specialty Polymer Coatings, a division of Carboline, is the only liquid epoxy available that meets ARO benchmarks when applied in just a single coat. Second, the formula cures around 50% faster than most competing liquid epoxies for weld joint protection.

These factors combine for a generally faster, smoother application in which coating crews follow immediately behind welders and apply the product without doubling back for a second coat. Faster construction translates to trenches being closed sooner, and pipelines entering revenue service faster.

A rare whole-length DCVG test

Myriad non-destructive testing methods assess the integrity of buried pipelines, and some – like DCVG tests – are regarded as more accurate and comprehensive than others.

In a DCVG test, current is run between two points on a pipeline and the difference between the starting voltage at one end and the final voltage at the other is recorded. A difference from one end to another means current is bleeding off somewhere, indicating a defect either of the pipeline itself or its exterior protective coating.

These defects come in many forms:

- Damage to pipe sections during installation, such as when laid into a trench, pulled through a bore hole, or during backfilling.
- A bad weld.
- Damage to the FBE pipeline coating prior to section installation.
- Damage to, or holidays in, a liquid protective coating film.

The use of ultrasonic equipment and a deeper dive into the electrical current data helps inspectors understand the nature, location, and severity of defects.

New pipeline leak detection and repair rules from the US Pipeline and Hazardous Material Safety Administration aim to make surveys of regulated distribution lines more comprehensive and establish definite timelines for the timely repair of any leaks.

Integrity assessments such as DCVG tests play key roles in complying with these new rules, but this pipeline's ownership group stepped beyond even these new requirements in another act of stewardship over their investment. They ordered a comprehensive engineering report on the integrity of the pipeline immediately after it was completed, including DCVG testing for its entire 535 mile length.

This testing and the compilation of the exhaustive engineering report that accompanies it is very expensive. It is partly due to this cost that pipeline owners or operators only elect to conduct them bit by bit over time according to applicable state or federal rules.

Still, the ownership group ordered an inspection and report for the entirety of the pipeline right away to build rock-solid confidence among investors that a payoff was assured.

Those investors must have been happy with the results: DCVG testing of the pipeline revealed, in general, excellent workmanship in the construction and installation of the pipeline. A few anomalies were observed based on voltage data from the tests, and these were traced to defects in the FBE coating of the pipeline exterior.

As for the weld joints protected by the SP-2888 liquid epoxy, testing showed no loss of voltage at any of the 2000+ joints. That means the two-in-one, ARO-rated, one-coat liquid epoxy performs as intended – a credit to its formulation and to the coating subcontractor's application team.

Integral to future plans

This pipeline was built to meet growing demand among Gulf Coast buyers for gas drawn out of the Permian Basin.

Those market signals were strong enough that the investor group responsible for building the pipeline remained comfortable in going the extra mile – twice – by insisting on enhanced abrasion protection and ordering the comprehensive integrity testing and report.

Strong enough, too, that a new joint venture was announced in March 2024, declaring that the pipeline would be an integral component of plans to further expand natural gas transmission capacity in the region.

ONLY AS RELIABLE AS YOUR DATA

François Lachance, Product Manager - Software, Creaform, highlights the importance of having complete confidence in the data used to develop risk-based assessment models, particularly when calculating corrosion rate and thickness loss.

As an asset owner, would you rather have three data sets you are 100% confident in or a thousand points you cannot trust? This question refers to the integrity assessment of plants, refineries, or pipelines, where thickness loss measurements are collected every one to two years.

When asset owners lack trust in their data, they are constantly grappling with uncertainty. They remain oblivious to the potential acceleration of the corrosion mechanism. They are forced to rely on predictive models that incorporate aberrant data, leading to maintenance decisions and inspection schedules that may not be optimal.

In risk-based inspection (RBI) and asset integrity management, aberrant data can skew risk assessments, leading to either overly optimistic or overly conservative evaluations of the risk posed by corrosion. This will result in unnecessary or inadequate maintenance of critical assets, which either increases costs or heightens the risk of equipment failure and accidents.

In the context of limited resources, not prioritising the proper repairs of critical assets can have significant consequences, often referred to as the opportunity cost. Fires, explosions, and toxic releases, as well as fines, penalties, and legal liabilities, are all potential outcomes of not allocating resources to the most critical repairs. Delaying critical repairs can also lead to more severe damage over time, resulting in higher long-term repair costs when assets become irreparable and require complete replacement.

Consequently, asset owners must prioritise the proper repairs of critical assets. To do so, they need accurate data and human-independent measurements that they can fully trust. If you are navigating the uncertainty of countless untrustworthy data points, this article will guide you toward reliable solutions.

Complex corrosion mechanism

The rate of thickness loss due to corrosion can vary depending on several factors, including the material, the corrosive environment, and the presence of protective measures. In some cases, the corrosion rate can be constant over time,

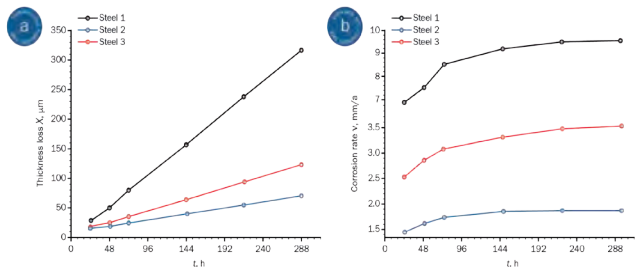

Figure 1. Typical representations of thickness loss and corrosion rate evolution of different metals through time.

$$t = \frac{PD}{2(SE + PY)} \qquad t_{min} = t + CA \qquad t_{nom} = \frac{t_{min}}{0.875}$$

Figure 2. Pipe wall thickness calculation as per ASME B31.3.

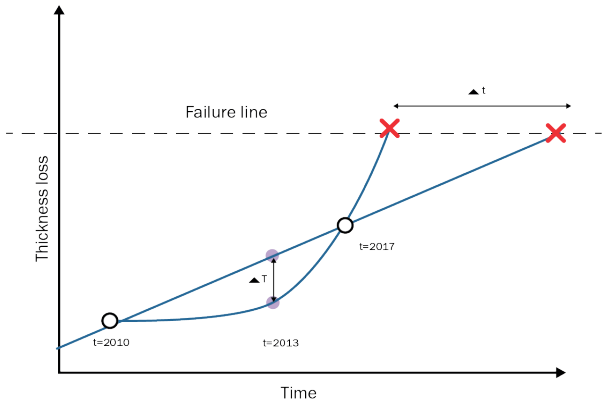

Figure 3. Impact of the thickness measurement variation on the failure projection timeline.

Figure 4. Obtaining superior 3D data is crucial when inspecting complex geometries.

leading to linear thickness loss. However, in most cases, the corrosion rate accelerates over time, leading to exponential or non-linear thickness loss.

The actual corrosion kinetics is a complex mechanism that generally does not fit perfectly into linear or exponential models. Therefore, it is important to conduct regular inspections and use traceable techniques to accurately assess the corrosion rate and predict thickness loss over time.

Advanced predictive maintenance

Asset integrity predictive models are used to forecast the breaking points of physical assets. These models leverage data trends, engineering principles, and statistical methods to predict when an asset might fail or require maintenance.

These models allow asset owners to prioritise maintenance based on corrosion rates. Basically, the steeper the slope, the higher the priority for repair. The slopes vary depending on the corrosion mechanism.

By accurately predicting breaking points, organisations can optimise maintenance schedules, reduce downtime, and improve safety.

Critical thickness

The American Petroleum Institute (API) provides guidelines and standards for inspecting, maintaining, and repairing refinery equipment to ensure safe operation and prevent failures due to corrosion or other degradation mechanisms.

The concept of critical thickness or minimum required thickness (MRT) is an important aspect of these standards. It refers to the minimum thickness a component must maintain to ensure its structural integrity and safe operation under the expected operating conditions, including pressure, temperature, and corrosive environment.

For example, API 510, which covers pressure vessel inspection, repair, alteration, and rerating, specifies the minimum thickness for pressure vessel components based on calculations that consider factors such as corrosion rates, design conditions, and material properties.

Similarly, API 570, which applies to piping inspection, repair, alteration, and rerating, also specifies minimum thickness requirements for piping systems, considering factors such as design pressure, corrosion allowance, and material properties.

The American Society of Mechanical Engineers (ASME) has also developed the ASME B31.3 code to provide guidelines and rules that ensure the safety of piping systems throughout their lifecycle by addressing aspects such as piping inspection, testing, and maintenance.

When the thickness reaches the API critical level or MRT, it is a clear signal that immediate action is required to maintain the infrastructure's safety, operational integrity, and compliance.

Impact of aberrant data in thickness loss calculation

Accurate data is crucial for calculating corrosion rate. The presence of an outlier among data points can significantly affect the slope of a curve fitted through these points, causing it to either increase or decrease depending on the outlier's position. The outlier can skew the fitted curve away from

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the overall trend, distorting the data analysis and conclusions drawn from the curve.

Concretely, including aberrant data can lead to incorrect calculations of thickness loss, resulting in either underestimation or overestimation of the actual material loss. This can skew the assessment of the component's integrity. Underestimating thickness loss due to aberrant data can lead to a false sense of security, potentially allowing the component to operate under unsafe conditions. This increases the risk of failure, which can have severe safety implications. In parallel, overestimating thickness loss might result in unnecessary shutdowns, repairs, or replacements, leading to operational inefficiencies and increased costs.

Overall, inaccurate thickness loss calculations can complicate maintenance and repair planning, making it difficult to prioritise actions and allocate resources effectively. Relying on aberrant data for thickness loss calculations can also lead to non-compliance with industry standards and regulatory requirements, resulting in penalties, fines, or legal issues. Finally, stakeholders, including operators, regulators, and insurers, may lose confidence in the integrity management programme if aberrant data is not identified and addressed appropriately.

To mitigate these issues, it is crucial to use technology that generates reliable, accurate, and traceable data independent of human influence.

Trust in accurate, traceable, and human-independent data

3D scanners bundled with NDT software platform VXintegrity form the only technique available on the market that offers metrology-grade accuracy, traceable data over time, and human-independent results that eliminate measurement variations and doubt linked to aberrant data.

Unbeatable accuracy

3D scanners are tridimensional measurement instruments that capture countless data on surface damage and bring this information into the digital world for in-depth analysis. Once corroded surfaces are digitalised, VXintegrity's algorithm simulates a virtual pit gauge that measures extraction, as with the manual tool, but with higher accuracy and 100% surface inspection coverage.

Figure 5. Accurate results and in-depth analyses directly onsite helps to establish valid diagnoses and orient repair decisions.

Over the years, the virtual pit gauge has democratised 3D scanning for surface damage assessment. It has become a standard for sophisticated pipeline integrity assessment, delivering consistently more accurate results than conservative manual calculation methods.

Infinitely traceable data

Tracking damages through time requires a traceable monitoring solution where data can be stored. With the integrity assessment power of 3D scanning and VXIntegrity, NDT technicians can acquire large amounts of high-accuracy data and save them to conduct in-depth assessments of corroded areas.

Asset owners can then use the 3D scan data to document, follow, and compare corrosion and damages over time. By establishing trends, they can prioritise the sequence of repairs and allocate the necessary resources to high-priority damages rather than less critical concerns.

Many users, same result

Many programmes have documented the issues related to manual inspection in the past, highlighting that the variation in performance between operators performing manual acquisitions has an overriding impact on inspection results, significantly surpassing any benefits derived from improved procedures or training.

Consequently, the most efficient way to improve result repeatability is to remove human bias from the surface acquisition as much as possible. Doing so ensures that the digitalised surface is always the same regardless of the technician's experience level, and 100% of the damaged areas are measured. 3D scanning, unlike manual techniques, provides 100% surface inspection coverage and 100% human-independent results, leaving no room for subjective interpretations.

In short, the data acquired with 3D scanning and analysed with VXintegrity is accurate, traceable, and independent of the technician's skills, ensuring reliable damage evolution and analysis over the years.

Accurate, traceable, and user-independent data

Risk-based assessment models can only be as reliable as the data they are based on. And because data is collected only every one to two years, they must be overly reliable to maintain asset integrity over the long term. Over a span of 30 years, any inaccuracies or human errors can corrupt the database entirely, making it untrustworthy for maintenance and prioritisation decisions.

Asset owners must start to have complete confidence in the data used to develop their predictive models. They must rely on accurate, traceable, and human-independent data sources to ensure the effectiveness and reliability of their models. Only then can they ensure that resources are allocated to the most critical needs, balancing short-term constraints with long-term operational and safety objectives, thus maintaining pipeline integrity and public safety and preventing disasters.

A breath of fresh air for oxygen corrosion control

Sutton Garlick, ChampionX, USA, looks at the increasing problem of oxygen corrosion in midstream pipelines and its implications, providing a case study on the development of a new technology solution for a pipeline operator working in the Permian Basin.

The ingress of oxygen, and the highly damaging corrosion which results, can have a critical impact on the continuing integrity of existing midstream oil and gas pipelines.

This is not a new problem but an issue which operators have had to deal with for many years. However, a combination of increasingly ageing assets and the development of more sophisticated technologies that analyse and monitor problem areas, has brought the visibility of oxygen levels in pipelines to the forefront.

Solutions to mitigate oxygen corrosion can fall short of being efficient and effective enough to truly address the problem, a situation of growing concern to operators and producers around the world.

What are some of the problems caused by oxygen ingress?

The presence of even small amounts of oxygen can create major problems, which pose a severe threat to the integrity of oil and gas pipelines. It can lead to a sharp increase in corrosion rates and metal loss in pipeline infrastructure by impeding the application of a film of chemical corrosion inhibitor on assets. This increases the corrosion rate of steel and causes accelerated pitting and under-deposit corrosion.

Oxygen contamination in sweet and sour systems can progress to oxygen-induced corrosion and may cause high general and pitting corrosion rates and failures. In carbon dioxide-dominated corrosion, the presence of oxygen also means additional electrochemical reactions can occur. If oxygen continues to ingress

into the fluids in sweet systems, it can result in the formation of iron oxide, iron hydroxides and iron carbonite precipitation.

In sour systems, oxygen and hydrogen sulfide can also react to form elemental sulfurs and iron sulfides. These can have serious consequences in natural gas streams, causing localised corrosion and increasing the corrosivity of the gas, making corrosion inhibition challenging.

In worst-case scenarios, oxygen-induced corrosion can lead to complete pipeline compromise and failure with potentially catastrophic consequences.

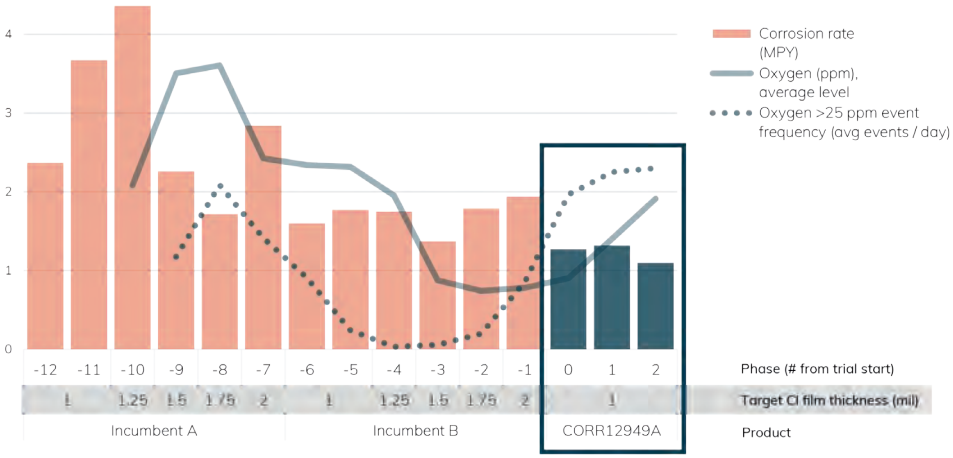

Figure 1. Even with elevated oxygen levels, CORR12949A reduced the corrosion rate month-over-month in a recent field trial.

Figure 2. The presence of even small amounts of oxygen can increase the corrosion rate of steel and causes pitting and under-deposit corrosion, which pose a severe threat to the integrity of oil and gas pipelines.

Can oxygen ingress be prevented before it causes problems?

It can be difficult to eliminate oxygen from systems, however technologies such as catalytic oxidation and the use of solid bed towers can be used, along with engineering controls, to reduce oxygen ingress. For example, solid beds and catalytic oxidation are best suited for large-scale oxygen removal, while mechanical blanketing methods, such as vacuum deaeration, reverse osmosis and the use of chemicals is utilised where oxygen is present in parts per billion (ppb) or parts per million (ppm) levels.

Oxygen ingress can arise in various locations and it's through these points of entry that corrosion events occur. This includes the vapour space in tanks, custody transfers, injection pumps, vapour recovery systems, operating pumps with faulty seals, pipelines that have not been properly purged of oxygen during commissioning operations, gas lift operations, methanol use and pigging operations.

What are some of the solutions historically used to combat oxygen corrosion?

Many operators use chemical control for mitigating oxygen corrosion, and oxygen scavengers and corrosion inhibitors are often seen as the most economical way to inhibit oxygen-induced corrosion.

Existing corrosion inhibitors will function, to a limited degree, with lower levels of oxygen. However, the majority of corrosion inhibitors, while protecting against carbon dioxide and hydrogen sulfide (H_2S), don't provide the level of protection or deposit the film that's required to protect against the high levels of oxygen being seen in some pipelines today. The presence of oxygen in a system, therefore, can quickly lead to exposed pipe wall surface.

Many operators opt to use chemical oxygen scavengers, which reduce oxygen levels, but at a high cost of operation-compromising efficiencies. Also, these types of products often require higher concentrations for treatment and may react best under specific conditions, such as high temperatures. In addition, they are not suitable for sour gas systems and treatment in hydrocarbon fluids. That means oxygen scavengers can be more suited to water treatment than oil and gas multiphase and gas pipelines.

How did you approach the problem?

Some operators working in the Permian Basin reported failures in their assets. In working with them to identify why these failures were occurring, it became evident that there was a commonality across the assets, which was identified as corrosion primarily caused by oxygen exposure.

While oxygen corrosion was not a new problem, the operators struggled to identify a treatment currently available on the market that could effectively cope with the high levels of oxygen now being experienced. ChampionX was asked to develop a new

internal corrosion inhibition technology to help mitigate the level of risk during oxygen events.

In response, a ChampionX team, led by our midstream director of RD&E, developed CORR12949A as a solution for this specific problem. This solution helps clients to create a safer environment and sustain their production by increasing the useful life of their assets.

CORR12949A went through a series of intensive laboratory trials before being field trialed in collaboration with a midstream operator in the Permian Basin.

The technology creates a long-standing barrier, which is resistant to oxygen corrosion and protects the pipeline wall. It lays down a solid film on the pipe wall, which protects against oxygen, hydrogen sulfide and carbon dioxide in the environment.

The new solution, which can be used in sweet or sour fluids, has been proven to be very effective where higher concentrations of oxygen are present in the system. It gives excellent corrosion inhibition in both sweet and sour conditions and is suitable for batch or continuous applications. Even with elevated oxygen levels, CORR12949A delivered consistent improvement on every metric during trials.

We see this as being a real gamechanger for the industry, designed specifically to tackle the high levels of oxygen which have proven to be such a worrying problem across the midstream sector and oil and gas industry abroad.

How important is RD&E and innovation for the future of the industry?

Our role, as a service company, is to be a problem solver for operator issues arising now and in the future.

Oxygen ingress and corrosion is only one of the ever-increasing challenges faced by the oil and gas industry seeking to continue to derive maximum extraction of hydrocarbons from existing infrastructure in a way that is safe, economically viable and environmentally acceptable.

The development of new chemical technologies is increasingly important to the oil and gas industry as operators realise the benefits they can deliver through efficiencies impacting performance. By actively targeting specific challenges, such as oxygen corrosion, substantial gains can be made for operators.

This is absolutely crucial in ensuring the longevity and integrity of oil and gas infrastructure. The deployment of these technologies, which are developed to address specific problems that arise particularly as assets age, increases flow assurance while minimising risk. They are also delivering sustainable solutions by helping maintain existing pipelines and equipment to ensure they remain efficient and continue to contribute to global energy demands.

We have a strong safety culture and are committed to improving the lives of those living in the communities in which we operate, and mitigating risk by improving safety is integral to that commitment.

Developing new technology for oxygen corrosion control in gas gathering pipelines

The challenge

A Permian Basin midstream operator was facing frequent oxygen ingress in a natural gas gathering pipeline. The oxygen contamination had increased corrosion rates in tandem with water and acid gases, like carbon dioxide and hydrogen sulfide, causing corrosion rates to exceed the operator's corrosion KPI. This posed an unacceptable risk of costly asset integrity failures and safety incidents.

Figure 3. The development of new chemical technologies is increasingly important to the sector as operators realise the benefits they can deliver to performance.

ChampionX was approached and asked to use its expertise to create a new oxygen corrosion inhibitor which would resolve the issues.

Some of the key points taken into account included:

- A corrosion rate that averaged 2.3 mpy (mils per year).
- The average pipeline oxygen concentration at ppm levels.
- Frequent oxygen ingress events, peaking at hundreds of ppm.
- Condensate in pig returns from solids.
- Elevated safety concerns from a history of pipeline failure risk.

The solution

ChampionX developed CORR12949A, a new chemical technology which can be used in sweet or sour fluids (multiphase and wet

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gas) that contact oxygen, with the particular advantage that the solution can be effective even when higher concentrations of oxygen are present in the system.

Laboratory testing

To test the effectiveness of the new product, laboratory evaluations were performed, along with third-party testing, using standard corrosion evaluation tools. This was then followed by a field trial, working in collaboration with the operator.

CORR12949A laboratory testing included rotating cylinder electrode (RCE), rotating cylinder autoclave (RCA) and top-of-line (TOL) corrosion assessments.

A series of tests were also carried out to gauge how the chemical would react in pipeline conditions. The tests were conducted to represent realistic pipeline scenarios where water can separate out due to low velocity of fluids. Temperature, pressure, and flow parameters were set to represent the environment of liquid transport pipelines and 100% brine was utilised to represent a worst-case scenario.

The tests were conducted at a low pH of 4.5 to 6.5, which is a normal range for pipelines. The inhibitor was added at 200 ppm to the test fluids after an initial two hours of pre-corrosion for a total duration of 18 hours.

Injection of a continuous purge of oxygen representing the continuous flow of oxygen in a pipeline also formed part of the tests. This was deliberately a very aggressive scenario, however, the chemistry provided adequate percent protection in these testing conditions.

Field trial

The field trial was conducted in a 9 mile long, 16 in. diameter pipeline with oxygen analysers installed to allow direct, inline measurements of oxygen levels.

In each phase of the trial, a one mil film batch of corrosion inhibitor was applied, then the new oxygen corrosion inhibitor chemistry was applied continuously. Coupons remained in the system for 28 - 40 days until the end of the phase, at which point they were removed and analysed for corrosion rate. Key metrics were selected to track internal corrosion in a challenging oxygenated environment. These included:

- Coupon corrosion rates in mpy.
- Visual presence of solids in pig return condensate.
- Average in-line oxygen levels in each phase.
- Number of discrete oxygen ingress events (starting when oxygen levels rose above 25 ppm and ending when levels returned below 1 ppm).

Results

Even with elevated oxygen levels, CORR12949A delivered consistent improvement on every metric. The corrosion rate was reduced month-over-month and condensate clarity was improved in consecutive pig runs, indicating reduced corrosion, corrosion byproducts, and solids.

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