PIGGING PRODUCTS & SERVICES ASSOCIATION

June 2023

Pigging Industry News
the newsletter of the Pigging Products & Services Association

THE PRESIDENT'S LETTER

By Danny Molyneux, Quest Integrity, UK

Since our last Newsletter, the 35th Pipeline Pigging and Integrity Management (PPIM) Conference and Exhibition in Houston marked a welcome return to in-person events for many PPSA members. Unfortunately, commitments in Europe prevented me from attending but, by all accounts it was wonderful to see the industry reunited after a few years of disruption.

Ahead of PPIM, we held our PPSA annual general meeting. One agenda item was to reappoint our Board and I am delighted to welcome our new Directors, Neil McKnight of T.D. Williamson and Mark Olson of Entegra. Alas, while we welcome new friends, we must say goodbye to others as their colleagues Dr Mike Kirkwood and Koty Bogle depart after 4 and 2 years' good service respectively – thank you both for your efforts during this time and your continued support.

Thanks also to Rosen's Jan Frowijn for presiding this past year. I am thrilled to now take my turn at the helm and am glad to have Odd Reidar Boye of IKM Testing serving as Vice President, who is already bringing great ideas and energy to boost the benefit we bring to our members. Of course, the biggest thanks of all go to Diane Cordell for the fantastic work she does every day for PPSA.

I would like to give a huge "THANK YOU" to the sponsors and players who made our annual Golf Tournament at PPIM a great success. Through the event, we raised $4,000 to donate to Young Pipeliners International (YPI). As a YPl Fellow and former Chair, I am delighted to continue PPSA's strong support for young pipeliners, for instance by being a proud sponsor of the upcoming YPP USA Symposium on 18-19 May in Houston.

Part of the donation will fund a YPI social gathering at the upcoming Pipeline Technology Conference (PTC), which is sure to be a great event with 114 technical presentations. If you are one of the 800 attendees expected 8-11 May in Berlin, please drop by the PPSA booth to say hello.

The PPSA exists to provide benefits to its members, so please do not hesitate to contact us with any recommendations on what we can do to bring more value. Looking ahead to November and our annual Technical Seminar in my hometown of Aberdeen, I strongly encourage pipeline operators to submit papers about interesting challenges that they have faced to boost knowledge sharing and continue to push the capabilities of our industry towards zero incidents. The recent leak of reservoir fluid from a pipeline at Wytch Farm served as a reminder that infrastructure is not getting any younger, so proper pigging practices and integrity management are more important than ever.

PIGGING PRODUCTS & SERVICES ASSOCIATION

Pipeline pigging seminar
Call for Papers/Tutorials

Annual pigging seminar
14th / 15th November 2023
Aberdeen, UK

for Operators, Contractors and Engineers

www.ppsa-online.com

Industry news

Hydrogen-ready pig tracking systems

In the transition to a net zero-emission energy system, hydrogen will play a major role. Large-scale hydrogen consumption will require a well-developed hydrogen transport infrastructure. However, the properties of hydrogen present some significant challenges.

Hydrogen molecules are smaller than those of natural gas. This means bypass, where the medium passes through or around the pig opposed to being an energising force behind it is substantially more likely. The effect of this is that whatever methods the operator uses to estimate pig arrival times will need adjusting. In the worst case, the chances of a stalled pig increase – heavy wall bends at river crossings for example will require additional differential pressure, but equally if the pig sealing design is not optimum and bypass occurs, hydrogen will be far less forgiving than natural gas. One way to mitigate this risk is by using pig tracking with an Electromagnetic (EM) pig tracking system.

Hydrogen is highly flammable, easily ignited and heats up when reduced in pressure. It is also highly prone to the possibility of auto-ignition of leaks and atmospheric vents. **Online Electronics Ltd's** EM transmitters are fully ATEX, IECEx & UKEx Zone 0 certified and meet the IIC gas group requirements for hydrogen. Their design has been enhanced to ensure the electronics are not compromised by the smaller hydrogen atoms and possible explosive decompression of the seals.

Whilst the adoption of safety rated (ATEX or IECEx) EM receivers differ across varying geographies & operators, again the hydrogen molecule will play a role. Pig launcher & receiver isolation valves are the primary line of defence against the pipeline medium. Obviously, the area around a pig launcher or receiver is typically classed as Zone 1. Pipelines that are to be re-purposed having valves that were previously effective at holding & sealing against natural gas now will have a much greater foe. The use of appropriately certified EM Receivers (as well as any additional safety measures) should be considered.

Online's EM Ex receiver is hazardous area zone 0 certified and is used for locating multiple lost or stalled pigs and tracking pigs fitted with any EM pig transmitters. It can also be used to confirm a pig has left or arrived at a particular location and for general monitoring of pig movements. The enhanced sensitivity permits the location of transmitters even within very heavy walled launchers/receivers, pipeline bundles or Pipe-in-Pipe. It can also be configured in a hazardous area via Bluetooth using

the Windows or Android apps. The protection method used is Exia (intrinsically safe) which makes the unit light and very portable without the need for a separate antenna. It is certified for use worldwide and meets ATEX, UKEx and IECEx stringent requirements with no need for hot work permits and all the paperwork and time that entails, saving time and money.

Since Online's EM Transmitters and Receiver are fully ATEX, IECEx and UKEx certified and meet the IIC gas group requirements that is mandatory for hydrogen installations, no additional costly certification is required – they already meet the current and future needs of customers on their transition journey.

Online Electronics Ltd's EMRx Ex ATEX receiver ●

Naftoserwis inspects pipeline with smart ultrasonic pistons

Pipeline inspections with the use of smart ultrasonic pistons is one of Naftoserwis's core activities. They are technologically advanced inspection tools developed and fabricated by **Naftoserwis** team of engineers. Their constantly evolving technologies allow them to perform safe linear infrastructure diagnostic and uninterrupted transport of various energy utilities.

They've been trusted by the largest operators in the fuel industry. They also have experience in foreign projects, carried out in countries such as Argentina, Belgium, Ecuador, United Arab Emirates and Taiwan. In 2022, their pistons inspected about 2,000 km of pipelines. The works were carried out both in Poland and abroad. They cooperated with **Orlen, MVL Schwedt and Slovnaft**, a Slovak operator from the **MOL** capital group. They've also completed an order for the **Belgian Pipeline Organization**, an investor supplying aircraft fuel for tactical fighter bases in Belgium, Germany, the Netherlands, Luxembourg and France. This year, they're preparing for the implementation of a project in Côte d'Ivoire. They will carry out diagnostics of the technical condition of 6" and 4" pipelines as well as geometry inspection and wall thickness measurements. The on-site project will be carried out by their specialists.

The described projects are only a part of their activities. Naftoserwis, looking for new areas for research and development and being aware of the growing demand for a new type of services, decided to use its existing inspection experience. Their teams have started advanced construction work on the piston, dedicated to testing gas pipelines in terms of their readiness to inject hydrogen and hydrogen mixtures.

Diagnosis of the technical condition of an oil pipeline

PROTON wins second industry award

NDT Global are delighted to announce the recently launched phased array ultrasonic service, PROTON™ has won its second industry award - the 2023 Innovation Award at the 35th **International Pipeline Pigging and Integrity Management Conference.**

The PPIM Innovation Award highlights new and exciting developments in our industry and is presented to companies whose technologies have made a significant contribution to the advancement of pipeline integrity. Finalists for the award are selected by a panel comprised of thought leaders across the industry and the winner is selected by a public vote.

At NDT Global, we know pipeline operators face many challenging circumstances while maintaining the safety of their personnel, operations, and community. Understanding the truest condition of any pipeline continues to be the single most important insight an operator can have – it is only through delivering actionable insights that operators can make informed pipeline management decisions.

PROTON is a highly configurable phased array inspection platform. Multi-angle sampling allows the best depth tool tolerance available in the market by means of multiple indirect crack measurement techniques and direct crack tip measurement for critical features. The multiple angles cover a wide range of crack features such as hook cracks, lack of fusion, lack of penetration, weld anomalies, and SCC, amongst other linear indications.

Product Manager, Ryan Sikes commented, "An award of this magnitude is the result of many dedicated and passionate NDT Global colleagues who are constantly pushing the boundaries of technology and innovation. For PROTON, this is especially true of the Service Development Teams from Technology Services and Data Services. Without their expertise and passion, we never would have developed this amazing service and won this prestigious award."

Diagnostic solutions to safeguard hydrogen pipelines

Jens Voss, ROSEN Group

At the moment hydrogen and its use as an energy source in a decarbonized future is top of mind. Not surprisingly, given its properties, which allow it to be used in a variety of ways, transported over long distances and even used to store wind and solar energy. As a final charm, there is an existing pipeline network that crosses the entire European continent and can potentially be used to transport the gas.

Nonetheless there are also significant differences between hydrogen and natural gas that pose entirely new challenges to the system, especially in terms of volume, pressure, and thus maintaining the integrity and safety of pipelines. Therefore, it is important to assess the relevant threats and define an integrity management strategy. This applies to both new and repurposed lines.

Existing codes relate the effects of hydrogen on the grade of steel used. However, there are indications that the effects of hydrogen on pipelines tend to be dominated by the microstructure and chemistry of the steel. In this complex environment of hydrogen embrittlement, the industry needs practical yet safe requirements.

With this in mind, **ROSEN** is pooling together its decades of expertise in the pipeline business to support the industry as it moves toward a low-emission future.

ROSEN'S TRIAD FOR HYDROGEN

1. Hydrogen Material Testing
A solid knowledge of material properties is essential. Therefore, ROSEN's new hydrogen lab is able to perform the relevant mechanical testing of components and equipment in a high-pressure hydrogen atmosphere. The standard tests include, for example, J-R curves and FCGR testing in air and under hydrogen gas load in order to compare the effects and results in air with those under H2 conditions.

The lab is equipped with 5 autoclaves for standard K_{IH} and exposure testing. They operate in a temperature range of -20 and +200 degrees Celsius to cover the main operational envelope for pipelines. They are connected to an automatic gas mixing unit that allows flexible test gas mixing (hydrogen - H_2, methane - CH_4, carbon dioxide - CO_2, carbon monoxide – CO, and oxygen - O_2). The tensile testing machine will be equipped in a comparable way.

The leading innovator supplying cutting-edge integrity solutions. Together we can ensure sustainable decision-making. Our combination of advanced inspection systems and expert consultants delivers a comprehensive understanding of asset safety, lifetime, and performance.

Comprehensive Asset Integrity Management

www.rosen-group.com

ROSEN
empowered by technology

The testing scope is rounded off with metallographic examinations and the standard mechanical tests such as tensile and hardness testing.

2. Hydrogen Integrity Assessments
Integrity assessment is of great importance, especially in the field of future fuels. The ROSEN Integrity Framework ensures that the correlations between the materials used and the transported medium are understood. "We know the potential threats of transporting future fuels and can assess them with regard to repurposed as well as new pipelines," says Marion Erdelen-Peppler, Vice President - Hydrogen of the ROSEN Group.

The first step is to clarify and aggregate available information with respect to the effect of hydrogen on the structural integrity of steel pipelines and non-metallic pipeline materials. Subsequently a review of the available data and develop methods for the fitness for service assessment of pipelines exposed to hydrogen takes place.

3. Diagnostics: Hydrogen In-line Inspection
"Relying on the proven track record of our tool fleet, we realize successful in-line inspection is a key element to assure the integrity of hydrogen pipelines during their operation," states Marion further. "This

allows us to support our customers to prepare their natural gas networks for the accommodation of hydrogen."

The industry needs hydrogen engineering guidelines

"Close industry collaboration is incredibly important to work together to move toward a future with a high percentage of renewables in our energy mix. It is also important to maintain a close exchange within the relevant committees in order to keep the practicality of the standards in mind. With this overall package, we contribute to a secure and reliable energy supply," Marion concludes, explaining ROSEN's hydrogen strategy.

ROSEN's hydrogen laboratory is equipped with 5 autoclaves connected with an automatic gas mixing unit.
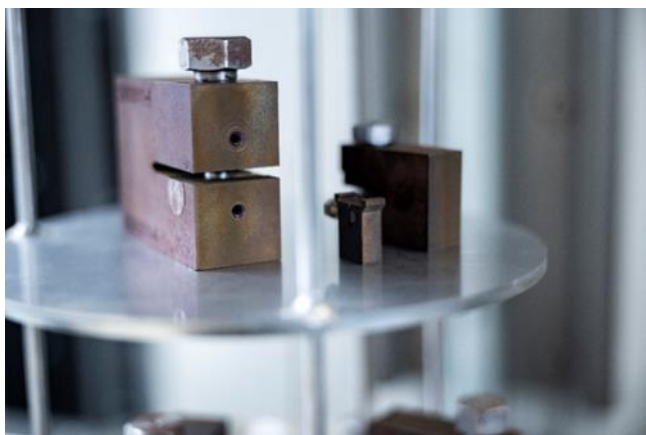
Cracking specimen in the autoclave

Cottam Brush expands its pencil brush offering

Following rigorous testing, research and investment in new technology, **Cottam Brush** are now pleased to be offering alternative manufacturing methods to produce pencil brushes for oil and gas pigging and other industries as part of our technical brush range.

Innovation is at the heart of Cottam, and with increasing energy and material costs here in the UK, our engineering team wanted to explore alternative methods of manufacturing pencil brushes that would be more cost-effective while retaining their high quality. Cottam drafted in the experts and approached the SAM (Sustainable Advanced Manufacturing) project, based at the **University of Sunderland**, to implement product development technologies. With funding support and advice from expert specialists in areas including electronics, CNC machining, and automation / robotics, Cottam invested in new machinery for their UK factory based in Hebburn, Tyne and Wear.

Cottam have extensive experience in manufacturing pencil brushes, traditionally using either bonded or soldered methods. By adopting alternative manufacturing methods into their range, they are now able to make these clusters using synthetic fill, ferrous and non-ferrous wires, as well as specialised plating's including zinc and nickel suitable for sour gas lines. Depending on the brush's intended application, we can advise on the best filament material and size to use for a truly bespoke brush.

So, what are the key benefits for their customers?
- No bonding materials required
- No restrictions on the brush material that can be used
- More design flexibility is possible
- The performance of their traditional pencil brush at a lower cost
- Locally sourced materials, manufactured at their Hebburn premises

Cottam, a brush for every industry!

Machine learning in in-line inspection: A 'revolution' going back 40 years

By Dane Burden, Senior Technical Adviser,
T.D. Williamson, USA

Could the same machine learning (ML) techniques that keep spam emails from invading your inbox, detect unusual transactions on your credit card and create Netflix recommendations also support pipeline integrity management? The answer is yes, and the fact is, while we think of ML as something new — a scientific way to get computers to recognize patterns and learn from data without being specifically programmed — the pipeline industry has been using the concepts behind it to provide insight into integrity issues for decades.

As far back as the 1980s, integrity engineers and service providers were constructing models to predict things like metal loss geometric dimensions using a combination of finite element modeling [1][2], statistical modeling and predictive functions [3]. Today, ML algorithms are used across the pipeline industry to boost operating efficiency, control costs and support integrity management. Applying ML techniques to in-line inspections (ILI) performed by intelligent pigs is improving the actionable data that pipeline operators need to keep their systems running safely.

Good Data, Better Decisions
The pipeline industry began applying formal ML techniques in the early 2000s to classify pipeline features and identify mechanical damage. Since then, the use of ML has expanded considerably: It's now being applied to improve metal-loss sizing, fitting classification and the identification of interactive threats [4]. Much of that progress goes hand in hand with the development of advanced ILI technology: ML is increasingly considered a powerful way to analyze the complex datasets produced by an electromagnetic acoustic transducer (EMAT), ultrasonic (UT) or the combination of multiple inspection technologies.

Despite how successfully ML has been deployed, it's not a silver bullet. Even when the goal seems simple — alerting people to the possibility of credit card fraud — achieving the best solutions isn't a one-and-done proposition; there's no single model that can be employed to achieve 100% accuracy. Often what is required is breaking the overall problem down into smaller subsets and developing specialized models focused on solving a specific task. These specialized models can then be ensembled together to produce a final overall prediction. This method of ensembling often outperforms a single general model.

And it all requires good data. The quantity, quality and representation of the data directly influence the performance of predictions made by any ML model.

But collecting, analyzing and labeling the critical data used to develop ML models can be difficult and time-consuming. As previously published [5], if you want to predict housing prices in Tulsa but use a model that learned from Los Angeles based data, your predictions will be grossly incorrect. The importance of quantity, quality and representation cannot be understated. This is especially true for ILI as much of the data used in model development is based upon field investigations which can be very expensive to complete.

Fortunately, it's possible to carefully select, annotate and fine-tune the available data to maximize its efficacy on ML models.

Experience Matters
At the risk of conflating man and machine, implementing an ML model to identify possible integrity threats relies on the same element used by an ILI data analyst to detect, identify and record signals recorded by ILI tools: experience based on examples and outcomes. Both analysts and ML models use their experience to identify patterns and make predictions — and the more experience they have, the better.

The experience of ML models is referred to as training data. Training data is what ML models use to develop a mathematical function that can be applied to make future predictions. The better the training data is in describing and representing a given problem, the better it will do in making a future prediction. There are several subcategories of ML, each with different ways that training data is presented and utilized. Supervised learning models use a set of data with known or desired answers referred to as labels. Labels are assigned to specific features that describe the problem and a one-to-one mapped set of inputs (features) and outputs (labels) is developed.

Input features are often engineered by subject matter experts to describe the important characteristics a model should learn. This becomes especially important when the quantity of data is not large enough for the model to learn the characteristics on its own. As mentioned earlier, this is generally the case for ILI as data labeling is often dependent on expensive field investigations. However, the beauty of these models is that they can be trained using multiple features. At **T.D. Williamson (TDW),** for example, the MDS™ platform allows subject matter experts to develop relevant, focused and valuable input features from multiple advanced technologies for a single labeled example.

Even with descriptive features or large quantities of data, the quality of labels is extremely important. If a set of perfectly descriptive features is mapped to an inaccurate label, any model will just learn to be inaccurate. Large datasets do not always mean better models; a small high-quality dataset is always

preferred over a large one riddled with inaccuracies. When both input features and labeled outputs are accurate, a model's performance is likely to be high. However, it may only be high for predictions made on data that has some correlation to the training data. Understanding the future prediction space and ensuring it is represented in the training data will lead to higher-performing models.

The quantity, quality and representation of training data are extremely important. Simply stated, the quality of the output is determined by the quality of the input. Garbage in, garbage out. Like almost everything else involved in ML, there's nothing easy about assigning performance to these models. For one thing, the quantity of the training examples should be maximized, which can mean there are only a few blind examples remaining for the actual testing. Ideally, performance metrics should be based on completely blind data unseen by the training process.

Predicting Performance
To highlight some of the nuances in assessing model performance, TDW trained a ML model using a technique called gradient boosting [6] to predict metal loss depth using a few simple features — signal amplitude, length, width and wall thickness (t). The training data set included more than 100 samples of high-quality corrosion field investigations from a single ILI of pipeline A.

Figure 1 shows the distribution of metal loss depths and a unity plot of the residual errors against depths measured in the field for pipeline A. Because the model made predictions on the data it was trained with, any assessment of future prediction performance would be extremely optimistic. This process of reviewing the residual model error may be beneficial for internal model development but should be avoided when projecting future performance.
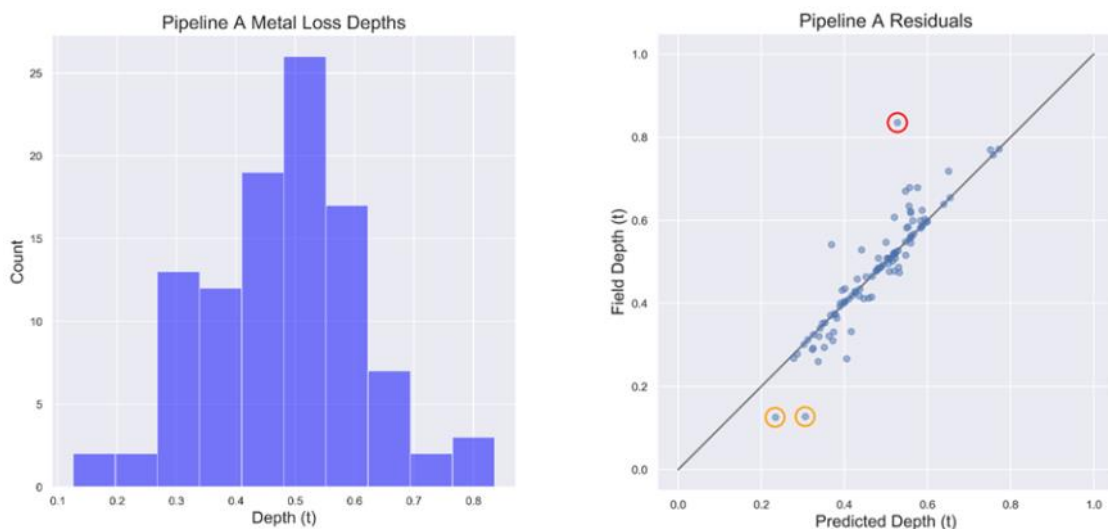
However, the assessment of residual performance highlighted some interesting outliers circled in red and orange. In one case, axial magnetic flux leakage (MFL) indicated two independent metal loss signatures that spiral magnetic flux leakage (SMFL) revealed was actually one long, connected feature. Association with the long seam and the high amplitude SMFL signal response suggested selective seam weld corrosion (SSWC), which poses a more serious integrity concern than general metal loss crossing the long seam. This feature was verified in the field as SSWC. The others were found to be mechanical damage associated with denting. Both the SSWC and mechanical damage features performed poorly as they were significantly underrepresented in our data set and our input features were chosen to describe general volumetric corrosion features, not these unique anomalies.

Blind Testing
Despite the model's good performance, we wouldn't make any assumptions about its prediction powers for the next inspection. Building confidence in a model requires testing it on a blind dataset and striving to answer "How is it going to perform on the next inspection?" For our simple example, we'll use pipeline B as our blind dataset. This pipeline has a similar number of features to pipeline A but is dissimilar in other characteristics, such as wall thickness, diameter and material type. It is important to note that none of pipeline B's features were included in the model training data and that the model only learned from pipeline A's data. Figure 2 shows the distribution of metal loss depths for pipelines A and B and a unity plot of the prediction performance against field depths for pipeline B. This time, the model overestimated metal loss depths and performed nowhere close to that of the residual errors on pipeline A. This is a clear example of how assessing model performance without a blind dataset can lead to overly optimistic performance metrics.

Figure 1: Model prediction performance is closely aligned with field results
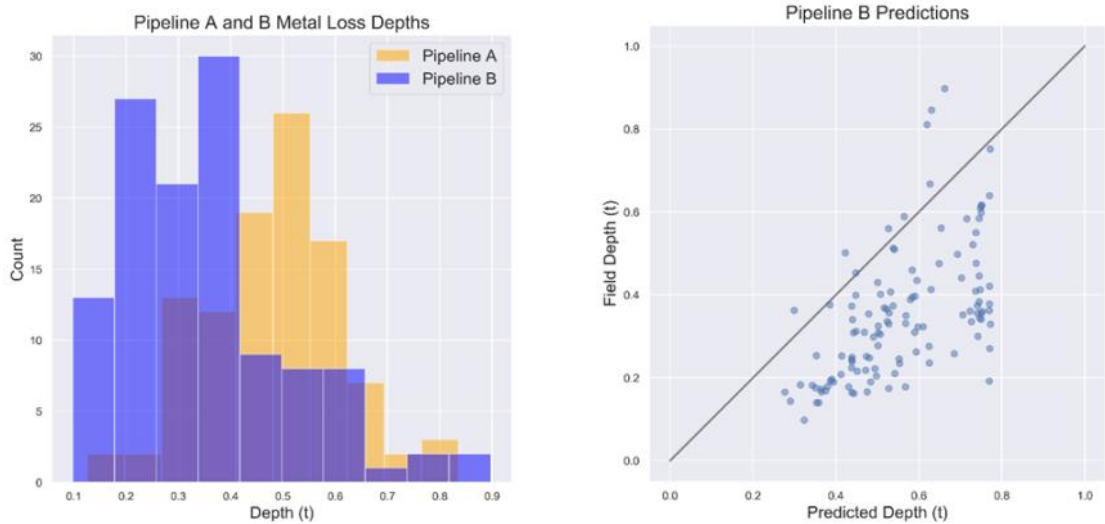
Figure 2: When the model was tested on a blind dataset, it overestimated metal loss depths, probably due to poor extrapolation from the input features it had learned

When we take a closer look at the distribution of data, pipeline A contains generally deeper metal loss samples compared to pipeline B. The model likely learned from the characteristics for deeper depth metal loss features and these poorly extrapolate to shallower depth features.

Additionally, the ILI data for pipelines A and B have different characteristics that were not accounted for in our simple set of input features. Despite the poor performance, a more accurate understanding of how the model will perform on the next inspection has been achieved.

This process of blind testing allows ILI vendors to more confidently state performance specifications which directly impacts how reported results can be used in managing pipeline integrity.

Verdict
The above example demonstrates that no two pipelines are alike, and that model development requires careful consideration of the quantity, quality and representation of training data. Collecting enough data to represent all geometries at all depths across all material types is an arduous task, made even more

difficult by the general desire of learning models to include thousands of examples in each prediction space. Curating and refining data is a never-ending process.

The good news is that the ILI industry is successfully applying learning models to solve challenging problems every day. For example, pipelines with incomplete documentation are a perfect problem for another subcategory of ML, unsupervised machine learning — that is, where the model receives input for each example and attempts to discover the structured patterns within the dataset on its own. By using the signals from patterns in permeability and bore variations created during the manufacturing process, data from high field MFL, axial low field MFL (LFM) and high resolution profilometry deformation (DEF), clusters of similar joints of pipe can be automatically identified.

TDW has also used strategically engineered features available only from MDS datasets to develop learning models that can separately classify two types of pipeline threats with small populations and unique characteristics: Selective seam weld corrosion (SSWC) [7][8][9] and dents with gouges from

coincidental corrosion [10][11]. When we applied these models to the outliers in pipeline A, they predicted a 99% probability of SSWC and correctly classified both dents as having associated gouging. By focusing the model's objective on specific anomalies, we were able to create adequate input features, which shrunk the prediction space and improved predictions. Ultimately, this work — more than 40 years in the making — has given operators a more comprehensive way to prioritize mitigation plans and manage pipeline integrity.

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Young Pipeline Professionals Europe

Author: Sameera Naib

The Young Pipeline Professionals Europe (YPPE) is a group of highly motivated young professionals working within the pipeline industry with the aim of knowledge sharing to ensure the longevity of the industry, addressing the industry's skill shortage and foster relationships. YPPE was founded in 2018 to connect both new and experienced professionals working within the pipeline industry across the continent. We are now a group of more than 320 young pipeline professionals with a vested interest in advancing the pipeline industry to a safe and sustainable future.

What can you expect from us?

Exclusive access to our online events | Opportunity to shape your future | Large network of peers

YPPE has been active in providing several opportunities for its members to develop themselves in several aspects in their career. Discounted entry to selected pipeline conferences, invites to technical demonstrations in person or via webinar, speaking engagements and opportunity to host an event/ webinar of your work are a few of them. On top of rising costs, Europe's companies are facing another worry – the lack of skilled workers – which is becoming more prominent than ever before. It's clear that talent retention and development are critical for the ongoing success of the industry. Within this maelstrom of demand the pipeline industry needs to make its voice heard. Thankfully, the YPPE have the perfect medicine to this ailment!

Why join the YPPE?

Knowledge sharing | Leadership opportunities | Foster relationships

The group aims to build a network of likeminded young pipeline professionals to holistically develop the industry at a grassroots level. The YPPE welcomes all age groups, with those under 35 becoming associate members and those over 35 supporting members, acting as mentors to the wider group. Membership is free and includes access to a variety of events, seminars, our quarterly newsletter and even discounts to major pipeline events. We have already hosted several successful events, with more planned.

Want to register or know more? You can get in contact with us at contact@yppeurope.org and register via our new website www.yppeurope.org

PPIM Conference and Exhibition, Houston

More than 3400 people from 35 countries attended the 35th PPIM Conference and Exhibition in Houston this February. It was an amazing turnout for the first truly post-Covid edition of the conference, virtually tying the all-time record attendance.

The annual PPIM has evolved to become one of the world's two major technical forums on pipeline engineering and integrity, alongside the biennial IPC in Calgary. Ninety-four papers were presented at PPIM 2023 in a program comprising 16 different topical sessions. The 75,000 ft^2 Exhibition Hall was filled with 173 companies and organizations displaying an incredible array of tools and technologies to address every aspect of managing pipeline assets, from trenching equipment and internal cleaning to inspection data analysis and risk assessment. The displays were supported by technical experts on-hand at the booths, providing 3D, real-world exposure to the concepts and solutions presented in the many technical papers.

In a tradition that began in 2018, the opening session included presentation of the John Tiratsoo Young Achievement Award by Young Pipeliners International. YPI presents this award each year to recognize outstanding young people in the industry. This year's recipients were Cassandra Moody of Time for Change LLC and Sarah Newton of BGC Engineering. Remarkably, attendees under the age of 36 comprised almost half the crowd at PPIM – an encouraging sign for the future. Accordingly, beginning in 2024 students and job seekers who wish to attend the PPIM technical sessions will be able to do so at a very low nominal registration rate.

The 2023 event led off with two days devoted to education and training. Eight courses explored the depths of critical integrity-management activities like pigging and inspection, defect assessment and repair, testing, and risk management. More than 300 people took advantage of these learning opportunities.

PPIM 2024 is set for 12-16 February in downtown Houston. The call for papers has been issued with an abstracts deadline of 7 September of this year. ●

ARR Freeflow Private Limited develop polyurethane foam fenders

As a new start-up company Polyurethane foam fenders is one of **ARR** dream products.

About foam fenders
Foam fenders are made with highest quality closed-cell Pu foam. This resilient foam makes the fenders self-fendering with high absorption capacity.

Even if the skin was punctured, it is also unsinkable without absorbing water. With their unique laminating process, each foam core is integrated. The foam core will not rupture after long time service. It is constructed of polyurethane elastomer which is reinforced with nylon filament. The polyurethane skin is a unique elastomer specifically used for offshore applications. Its high resistance to abrasion, fatigue and ultraviolet degradation are significantly more durable. ARR retains molds for a full range of sizes, from 2" to 48" and these are custom-made to order.

Applications
This kind of fender can be used for tugs, workboats, pilot boats and is suitable for open sea terminals, gravity ports, especially for large tidal wave docks. Foam fender is also a viable option for Ship-to-Ship (STS) operations.

More features about fenders
- Great floating performance, not influenced by tidal waves
- Bright colours are available upon customer request (not all)
- No air inflation needed (as compared to pneumatic fenders)
- High energy absorption
- Reasonably resistant to acid and alkali
- Good angular performance
- Strong and safe
- Extremely long useful life ●

Effect of line pressure on inspection tool velocity

By Dr Aidan O'Donoghue, Pipeline Research Ltd

Introduction

A newly installed onshore pipeline was required to be inspected within the first 2 years of operation. Initially the line pressure was expected to be low (20 barg outlet) but after two years the pressure would increase to 50 bar with higher flow. It was essential to understand the pig velocity profile for both these cases. PIGLAB Compressible is an inhouse simulation program used to investigate the motion of pigs in gas pipelines.

Setup

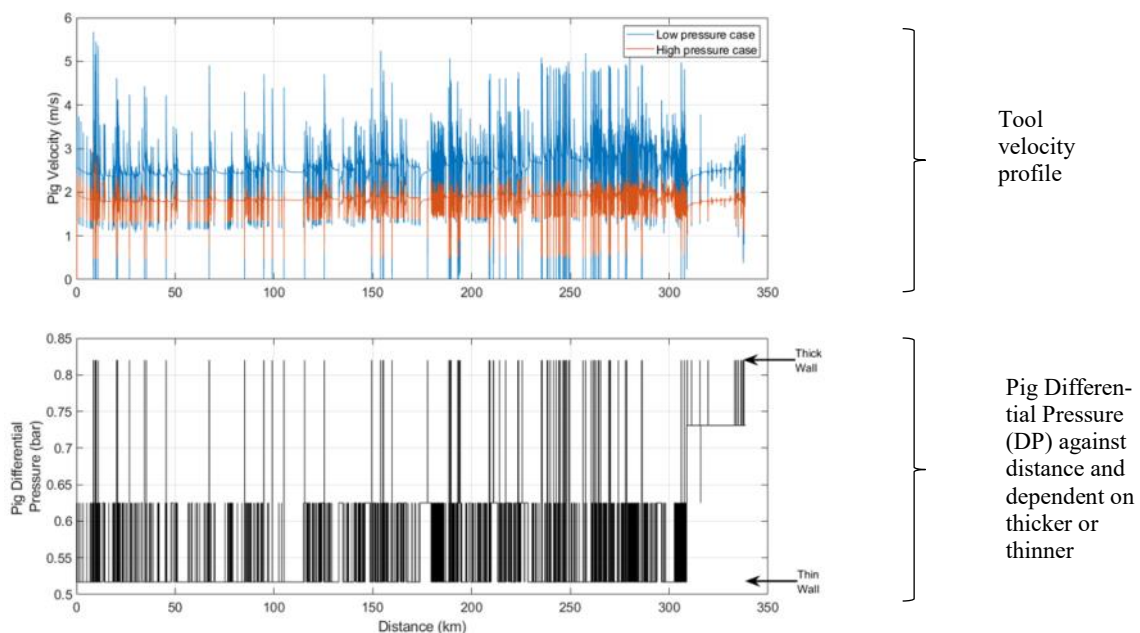The pipeline is 340 km long and involves a hilly terrain with multiple pipeline wall thickness changes due to river and road crossings. Typical pig differential pressures for the various wall thicknesses were measured in a trial at the inspection vendor. Other information such as the weight of the tool was also provided. The target was to keep the inspection pig velocity within 1 to 4 m/s ("In-specification" range).

Sensitivity analysis

The gas properties and operating data for the two cases were provided by the operator. This included the inlet flow and temperature for the year 1 case (20 barg outlet pressure) and the year 2 case (50 barg outlet pressure). The analysis aimed to determine when the pigs were less than 1 m/s and greater than 4 m/s ("Out-of-specification").

Output

The pig velocity profile for the low and high pressures cases was calculated using PIGLAB Compressible: -

Tool velocity profile

Pig Differential Pressure (DP) against distance and dependent on thicker or thinner

The pig travels at out-of-specification velocity for a total of 15 km in the low pressure case (blue plot) and only 1.2 km in the high pressure case (red plot). At high pressure, the tool is never above 4 m/s.

Commentary

The analysis allowed the client to understand the percentage of the line that would be within velocity specification for the inspection and to determine the optimum timing for the pipeline base line survey. Further sensitivities were performed using the PIGLAB Compressible model to examine temperature changes, flow disruptions and contingency measures. ●

Self-propelled intelligent inspector completes baseline inspection

IP PIPELINE TECHNOLOGY's self-propelled intelligent inspector has successfully completed the baseline inspection for Natural Gas Pipeline project. Covering a total of 1,253 kilometers of pipeline in the Shandong and Jiangsu sections, this innovative technology has provided a crucial guarantee for the pipeline's safe and efficient operation.

Item	Pipeline Section	Scope of Work	OD	Length
1	Anping-Taian	Intelligent Caliper + IMU + Camera	1219mm	325.8Km
2	Lianyungang-Taixin	Intelligent Caliper + IMU + Camera	1219mm	461Km
3	Taixin-Linyi	Intelligent Caliper + IMU + Camera	1219mm	261Km
4	Tianchang-Hefei	Intelligent Caliper + IMU + Camera	914mm	206Km
5	Total			1253.8Km

2022 Natural gas pipeline intelligent inspection project breakdown
Note: Each long section is divided into several small sections

In the baseline inspection of the new pipeline, the self-propelled intelligent inspector offers several advantages over traditional intelligent calipers:

First, it can crawl independently inside the pipeline, eliminating the need for compressed air, nitrogen, or pressurized water as a power source. This not only saves costs but also makes it easier to inspect large-diameter and long-distance pipelines.


Self-propelled caliper

Additionally, its autonomous crawling ability makes it more convenient to deploy immediately after the section is pressure tested and dewatered, without the need to wait for the installation of launcher, receiver, and main valves.

The self-propelled inspector is also equipped with a high-performance power control system that enables it to autonomously crawl uphill and downhill, ensuring consistent inspection speeds and high-quality data. Compared to traditional

inspection methods that rely on compressed air, nitrogen, or pressurized water as a power source, the self-propelled inspector is less prone to blockages and has lower risks.
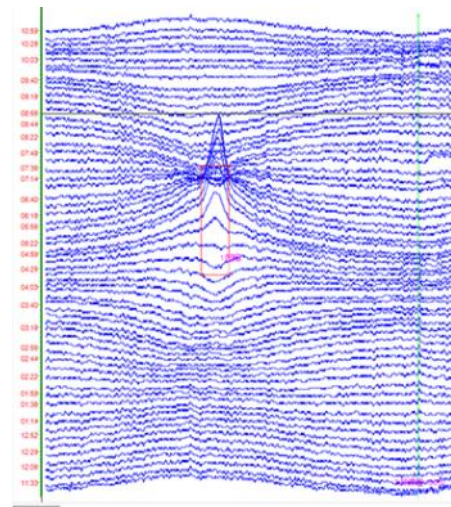
Data of dent

Photo of excavation

"We are pleased to announce the successful completion of the baseline inspection in the Shandong and Jiangsu sections of natural gas pipeline," said the spokesperson of IP PIPELINE TECHNOLOGY. "Our self-propelled intelligent inspector is the result of years of research and development, and we are confident that it will continue to play an important role in pipeline inspection and maintenance in the future."

The self-propelled intelligent inspector's success in this project demonstrates its effectiveness in providing efficient and reliable pipeline inspection. As a result, it is expected to be a game-changer in the pipeline industry, offering better quality data and more stable inspection speeds while also reducing costs and risks. ●

History of the first Kaliper (ILI) tool

By: Larry D. Payne, LP Services, LLC

In July 1969, **T.D. Williamson, Inc. (TDW)** was visited by the General Manager of **Lakehead Pipeline Company.** This was a Canadian based company that operated a 34" crude oil line coming out of Canada, running through Northern Minnesota, through Wisconsin, to a refinery in Northern Illinois. He met with Burt VerNooy and Larry Payne. Prior to this meeting Burt asked Larry to cut a 36" spherical pig in half, which was not easy. This was to be used to demonstrate a flexible cup that later was to be used on the first ILI tool. In this meeting, the General Manager explained that they were concerned this pipeline contained a significant flaw in the form of dent or buckle in the section running through Wisconsin. The reason for thinking this was that the cleaning pigs were being received in a damaged condition.

At this time, Burt VerNooy was the "Director of Research" and Larry Payne was "Research Designer". Also, at that time Burt had over 50 patents, Larry had only been employed by TDW for 5 months and coming from the aerospace industry could not spell pig and had no patents. TDW was offered $25,000 to develop a tool that would find, size, and locate this flaw. They accepted the challenge and Burt and Larry's first thoughts were that the tool must be flexible enough to traverse a major restriction in the pipeline. They also thought that when traversing this restriction, the tool would experience a drive pressure increase. Therefore, their first design was for a tool that would traverse a 30% reduction and record a pressure increase on an off the shelf chart recorder. Knowing the flow rate and the chart advancement speed, they thought they could locate the restriction. They designed an instrument that held 63 feet of pressure sensitive paper chart and a piston that would push a stylus across the paper making a mark on the chart that was moving 4" of chart per hour. The pig in this crude oil was moving at approximately 3 mph. That would have been about 4000' of pipeline per inch of chart. Burt mostly designed the tool and Larry made the production drawings per his sketches, had the pieces built and assembled the tool. Larry then headed to Minnesota to test run this prototype in a test section running to Superior, Wisconsin. The tool came in at pump station in Superior and looked OK, Larry opened the instrument, removed the chart that was full of vertical recordings, indicating he was getting pressure increases throughout the pig run and the battery life was gone. When he received the flow rates to determine location of any recording, he found the flow rates changed continuously throughout the run. Based on this information, he would have been lucky to locate a reduction within five miles!

Then appeared a new hire, Bob Kendall. He looked at what they were doing and recommended they use an Odometer roller equipped with magnets to trip a reed switch that would send a signal to a stepper motor that would make to paper chart proportional to the pipeline length. Larry designed the mechanisms and an odometer wheel that was *near* exactly 2' circumference. One magnet installed in a wheel, positioned to trip a reed switch would give a pulse every two feet. That produced 2000 pulses per inch of chart which equated to 2000' of pipeline per inch of chart. If they put two magnets in odometer wheel, the chart scale would be 1000' of pipeline per inch and so on. Since the instrument would only hold 63' of chart, the pig run distance determined the chart scale.

They added all the distance recording mechanisms, increased the spring pressure to reduce the vertical line movement, and off to Clearbrook Larry went. They also added a spring-loaded cam roller that would make noises so the pig could be more easily tracked. Larry tracked the pig over 200 miles and pulled the pig out at Superior again. This time he had a good chart length chart for distance, fewer vertical random restriction indications, but this told him nothing as to what may have caused them.

Back to Tulsa and back to the drawing board. They felt they had the distance location method figured out, but the sizing of restriction design needed to be fixed. Burt and Larry started designing a mechanical finger mechanism that would record the downward movements of multiple fingers installed inside the rear cup. So now they were measuring distance traveled with odometer rollers advancing the chart at a certain scale proportional to the pipeline length, and sizing the reduction based on the mechanical movement of fingers located inside the rear cup.

So off to Superior, Wisconsin for another run. The tool recorded a full-length chart showing a 4" plus reduction about halfway down the pipeline. Larry started the analysis by comparing known things recorded on the chart (pipe wall changes, valves, bends, etc) to the pipeline strip map distances to determine the actual chart length scale within a given area. He recalled locating the reduction from a valve about five miles away. He notified the customer of what he found and the following week met them at the dig site. It was in the middle of a field covered with about two feet of snow. There was no reason to have a 4" reduction in middle of a field. They start digging with a Trackhoe. The tolerance was plus or minus 50 feet. They dug up, exposed, about 50' to the south and nothing, they then started digging 50' to the north, Larry was feverously going through his location calculation again when he heard the Trackhoe hit something. As he walked up to the dig site, he heard the Dig Forman say, "They found it". The pipe was resting on a rock ledge and when the pipe was back filled with dirt and loaded with crude oil, the pipe had buckled causing a 4" reduction. Larry called the office with excitement to report the success. That occurred in December 1969, about 6 months from when they started this project.   ●

Morken Group's inspection of 12" gas pipeline with MFL Introscope technology from an offshore platform

Natural gas production in Ecuador comes from the Amistad field, located in the Gulf of Guayaquil, Pacific Ocean, from where around 28 million cubic feet are produced per day.

This production is transported through a 12" diameter gas pipeline with a total length of 70 kilometers, which starts from an offshore gas collection and compression platform and culminates in an onshore gas dehydration plant located in the town of Bajo Alto.

As part of the mechanical integrity plan for this 12" OD gas pipeline, and in compliance with current international regulations, its inspection is contemplated every 5 years to determine the possibility of future anomalies and to know the evolution of those anomalies determined in ILI inspections executed in previous years (2012 and 2017).

Given this, the operator needs to carry out an inspection of the gas pipeline with a technology that can provide better inspection performance than those obtained in previous runs, due to the high speeds recorded in those runs and the difficulty in controlling said parameter, taking into account the strict commitments that the operator of the gas pipeline has with the thermoelectric plant that supplies one of the main cities of the country, due to the daily production volumes that this demand.

Accordingly, the operational margins of pressure and flow in the pipeline are limited, limiting the possibility of modifying the current operating parameters in order to reduce the transit speeds of the inspection tools and with them obtain inspection data from good quality that allow to validate or re-determine characteristics and dimensions of previously detected anomalies but with greater reliability and precision, especially in the internal wall of the duct, where it was possible to detect more severe anomalies in the runs of previous years.

The solution:
Morken Group proposed the use of an innovative technology in inspection tools, based on the principle of Magnetic Flux Leakage, (MFL), which is equipped with an additional inspection module, called Introscope®, capable of providing together to the high resolution MFL module, more accurate and reliable results than any other MFL High Resolution (HR) tool on the international market. The Morken Group MFL HR tool with Introscope® module provides a resolution of 2.4 mm and anomaly detection and sizing accuracies in the tube body and weld beads of +/- 0.1t (t: wall thickness of the tube) with a probability of detection of 90%.

Morken Group's MFL HR tool with Introscope® module

In addition, this tool incorporates a contactless, lowflow, increased passability and high temperature design capable of greatly reducing the risks inherent in failed, invalid runs and/or tool jams in the duct; as well as not damaging internal coatings, reducing friction, negotiating greater mechanical restrictions and not being affected by temperatures of up to 100°C.

Results and benefits:
Morken Group carried out successfully the inspection runs with the MFL HR tool with the Introscope® module through the 70 km length that makes up the 12" gas pipeline. Thanks to the study of previous runs with other tools and the lowflow design of the proposed tool, it was possible to effectively control the characteristic "stop and go" effect in gas pipelines, there was no damage or affectation to the tool sensors and the managed to collect 100% of the length of the pipeline. This was reflected in the high quality of the information collected and in the clarity of the characteristics and anomalies detected, exceedingly meeting the client's expectations.

With these results, the client was able to have greater certainty of the type and dimensions of the detected anomalies, with which, in turn, he was able to better discriminate the severity of these anomalies and reconsider a more assertive and reliable integrity plan.

Among the benefits achieved with these inspection runs were:
- More accurate and reliable sensing and sizing data.
- Validation and effective re-determination of anomalies with respect to previous runs.
- Rethinking of a more assertive and reliable integrity plan.
- Low risk of clogging or flow interruption.
- No disturbance of the operational conditions of the pipeline.
- Zero incidents against environmental preservation.
- Less execution times. ●

Apache Pipeline Products: Accurately and reliably detecting your cleaning pigs

At **Apache Pipeline Products** , they know that knowledge is power. That is why they want to make pipeline operators always know when the pig has passed a critical point in the pipeline. To achieve that, they designed the pigPRO™ Series, a patented line of intrusive pig passage indicators that reliably detect the precise location of a cleaning pig as it travels within the pipeline network. The pigPRO™ indicator is most commonly installed on pig launchers and receivers, as well as other key locations along the pipeline.

The system is fitted with an intruding plunger, physically penetrating the pipe bore. When a cleaning pig passes, it actuates the plunger, which activates either a visual or electrical indicator, or both. The instant that the indicator is displayed, the pipeline cleaner's precise location is revealed. The pigPRO™ Series can be easily installed to meet your operational needs.

Apache's pigPRO™ Series Models:
Series 53 is a combination visual and electrical indicator with manual and automatic reset. Offering both visual and electrical indicator capabilities and manual and automatic reset features, the Series 53 is the most versatile member of Apache's pigPRO™ Series. It includes a thread mounting nipple, standard lower housing with fluorocarbon O-Rings, hemispherical plunger with a flag assembly and weather sealed & explosion proof limit switch. The switch employed on this model is NEMA rated, UL listed and CSA certified to suit most applications.

Series 55 is an electrical indicator with automatic reset. With its optional manual and automatic reset capabilities, the Series 55 is a highly sought after member of Apache's pigPRO™ Series. It includes a thread mounting nipple, standard lower housing with fluorocarbon O-Rings, hemispherical plunger, and weather sealed & explosion proof limit switch. The switch employed on this model is NEMA rated, UL listed, and CSA certified to suit most applications.

Series 57 is the most popular pigPRO™ Series, with a visual flag indicator with manual reset. The base model Series 57 includes a thread mounting nipple, standard lower housing with fluorocarbon O-Rings, hemispherical plunger with a flag assembly.

Series 67 is a visual flag indicator with manual reset and comes standard with an isolation ball valve. The Series 67 adds safety and servicing options to their existing line of intrusive pig passage indicators. Incorporating a customized ball valve with an extended lower housing into the design of their Series

67 pigPRO™ allows for a safe and simple isolation of the pig passage indicator from pipeline pressure for inspection, maintenance or repair. Complete removal and re-installation on any pressurized line is easy using the Extraction Kit and does not require specialized hot tap professionals or equipment. The extraction kit contains a pressure relief tool and a custom-built extraction cap and jack tube specifically designed for the Series 67 pigPRO™. Other items include O-Rings, fasteners, lubricant, and hex key wrenches. All of this is provided in a protective industrial case. (Extraction Kit sold separately). The integral isolation feature of the Series 67 means the cost, time and safety concerns of de-pressurizing and draining a line are eliminated. Now the pig passage indicator can be isolated, removed, repaired, and reinstalled while the pipeline is flowing and pressurized. Preventative maintenance, inspection or repair are easily accomplished without specialized equipment or crews.

Series 67 Flanged incorporates a customized flanged isolation valve with an extended lower housing into the design of their Series 67. Allowing a safe and simple isolation of the pig passage indicator from pipeline pressure for inspection, maintenance or repair. ●

3X Engineering's Mechanical protection of gas risers, Qatar

Overview
The aim of the job, performed in October 2022 by **3X ENGINEERING (3X)** was to protect (mechanical protection + impact resistance) 19 gas risers (from 8" to 20" OD) on their splash zones and thus prevent further deterioration of the risers. The risers were in Offshore Qatar. They were straight line risers with a maximum operating temperature of 70°C, with a calculated pressure of 60 bars. It was decided to protect the risers areas using 3X composite solution REINFORCEKiT® 4D.

Scope of work
According to ISO 24.817 standard and 3X calculations, it was decided to apply 6 layers of REINFORCEKiT® 4D (using R3X95 resin) on each riser to protect them from impacts and corrosion issues. Surface preparations were completed using sandblasting to remove coating and create a good surface roughness (superior to 60μm Rz) and ensure a good bonding between the steel pipes and the composite solution. Then hygrometric conditions were checked and the whole prepared surfaces were cleaned with air blower. The composite applications were then completed following the main stages mentioned below (the procedure was the same for the 19 risers):

1/ One layer of R3X95 resin was firstly applied on the prepared surface to ensure the good impregnation of the first tape layer.

2/ Composite wrapping was then completed using Kevlar® tape impregnated with R3X95 resin. Six layers were applied on each riser with a repair length between 7220mm and 9200mm. A total of over 175m repair length using REINFORCEKiT® 4D product was installed on the 19 risers.

3/ Last layer of R3X95 resin was applied all over the wrappings as finalization stage and id plate was installed for traceability.

4/ Eight hours after, coating was applied on the composite protection.

Results

Samples of resin were taken during each tape impregnation for quality control and hardness measurements were performed and validated on site and in 3X offices. The 19 risers are now protected with REINFORCEKiT® 4D from impacts and corrosion issues that could affect their mechanical resistance. The design life for each riser for this composite protection is 20 years. ●

Industry leading technology brings natural gas closer to Kilroot

Industry leading technology from engineering specialist **STATS Group** (STATS) has been deployed in Northern Ireland while vital work is underway converting a coal-fired power station to gas. The Kilroot power station, located on the shores of Belfast Lough, once supplied one-third of Northern Ireland's electricity but faced closure next year because it could not meet low-carbon environmental standards. Power station owners **EPUK Investments** committed to a major project which would transform Kilroot into a more environmentally friendly energy producer, securing its future and jobs, while also strengthening Northern Ireland's energy security.

A crucial stage of the project required **Mutual Energy**, the owner and operator of major natural gas pipelines across Scotland and Northern Ireland, to tap into its Belfast Gas Transmission Pipeline (BGTP) to tie-in a new line and block valve arrangement to provide a gas supply to Kilroot. But the BGT pipeline supplies gas to thousands of homes and businesses all across Northern Ireland, and it was inconceivable that the supply could be turned off while the pipeline tie-in work was carried out.

The solution was to deploy STATS' BISEP pipeline sealing technology in two locations, which allowed a leak-tight isolation to be installed while a live gas feed to Belfast consumers continued through an integrated bypass without interruption.

Mutual Energy Project Engineer, Marcus McFarlane, said: "We needed to introduce a gas supply to Kilroot power station from Belfast's main gas pipeline but without causing any disruption to domestic and business users in Belfast and further afield. "The only option was to create a bypass while the pipeline was still 'live' and for that we needed the latest technology available and STATS' BISEP system came into its own.

"It is the first time this technology has been used in this way on a UK onshore gas transmission system and it brought a number of considerable benefits, mainly reducing the number of interactions needed with this strategic pipeline, and therefore greatly reducing the risk and the time needed to complete the job."

STATS has an international reputation for providing leak-tight pipeline isolation and intervention tools to the oil and gas sector and is broadening its scope into renewable energies including CCUS and hydrogen.

Aiden Hardy, STATS Group's Regional Business Development Manager said: "We are delighted with how the job has been executed with both our tools providing leak-tight, monitored isolations allowing the site works to be undertaken in the safest manner possible, which is exactly what the BISEP is designed to do.

STATS Groups' BISEP, Belfast, Northern Ireland ●