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An interesting pipeline year lies ahead

Admir Celovic
Director Publications
EITEP Institute

The pipeline community do not usually think in terms of individual years - the projects are usually too long-term for that. But some individual years are special. 2020, for example, will be interesting in various respects.

On the one hand, legal disputes about specific projects are moving into the next round. Coastal GasLink, for example, continues to face problems, while Trans Mountain Tar Sands has the green light. But will it stay that way? Environmental groups and other organizations have repeatedly proven in the past that they never tire of taking legal action against pipeline projects time and time again. Other companies, such as Energy Transfer Partners, face investigations by various authorities and have to pay record fines.

Just as important, perhaps even more important, are the political obstacles that hamper various projects. Keystone XL, backed by the Trump administration, is moving forward on its long road to completion. Perhaps 2020 will be the year that decides the fate of this highly controversial pipeline.

Only the Nord Stream 2 pipeline is even more controversial, with various players facing each other as opponents. The blatant threats of the US government against participating companies have had an effect and the project has been halted for the time being. Russia is making every effort to push the project forward and digest this setback. It remains to be seen whether this will succeed, as Berlin's adherence to the project (as the most important supporter of the project) is likely to lead to serious disgruntlement with Washington.

Another major development concerns Africa. The continent is constantly being supported by China and for good reasons. Many view Africa as the next big thing in the global pipeline industry. Fossil fuels are an important export commodity and millions of people need to be supplied with water, gas and fuel. And many new pipeline projects will be necessary to achieve that. The German government for example is pushing its companies to start initiatives in this promising continent. One of these initiatives is the IDA – Infrastructure Development Africa, organized by the same company responsible for the renowned Pipeline Technology Conference (ptc). It will focus on pipelines, water and waste water solutions and harbors and logistics, because these are the most pressing issues on the continent. Make sure to check out the events homepage and to evaluate if your company could participate in the upcoming business ventures.

ptj wishes you all the best for 2020.

Yours sincerely,

Admir Celovic,
Director Publications,
EITEP Institute

THIS ISSUE'S COMPLETE CONTENT

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Over-Voltage Protection on Pipelines

Jay Warner > Dairyland Electrical Industries

Abstract

Pipelines are commonly exposed to over-voltage conditions created by AC faults, lightning and induced AC voltage from high voltage power transmission lines. To protect personnel and the pipeline from the hazardous effects of these conditions, it is critical to properly ground the pipeline and provide continuity across isolation joints for AC and lightning. In addition, structures protected by cathodic protection (CP) systems must be isolated from ground for DC current in order for the CP systems to remain effective.

Solid-state decouplers are commonly used to provide over-voltage protection and simultaneous DC isolation from ground on CP-protected structures. Proper application can ensure protection of personnel from safety hazards and equipment from permanent damage.

This paper will review the common applications for over-voltage protection on pipelines, including isolation joint protection, mitigation of induced AC voltage and protection from exposure to AC faults and lightning. A brief description of solid-state DC decoupler devices, their operation, key performance characteristics and application guidelines will be presented, as well as that for selected alternative technologies. Specific examples will be presented of damaged insulators, compromised CP systems and fire resulting from lighting and AC fault occurring on unprotected isolation joints.

INTRODUCTION

Pipelines are commonly exposed to over-voltage conditions created by AC faults, lightning and induced AC voltage from high voltage power transmission lines. To protect personnel and the pipeline from the hazardous effects of these conditions, it is critical to properly ground the pipeline and provide continuity across isolation joints for AC and lightning. In addition, structures protected by cathodic protection (CP) systems must be isolated from ground for DC current in order for the CP systems to remain effective.

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SOURCES OF OVER-VOLTAGE ON PIPELINES

The most common form of AC interference is steady state AC voltage that is induced on a pipeline due to the magnetic field associated with current flow on a nearby power line during normal operation. The level of induction is affected by many factors, including powerline load current, separation distance of each phase from the pipeline, phase transpositions, changes in pipeline distance or orientation, soil resistivity and coating quality. This induced voltage can create a shock hazard for pipeline personnel as well as create accelerated corrosion at pipe coating defects due to AC discharge.

A second method by which AC energy can be transferred to pipelines occurs during AC faults. AC faults on the powerline occur when some form of insulation breakdown has occurred and result in a very short term, high amplitude current flow. This may originate from electrical equipment (i.e., motor operated valves) shorting to the pipeline or from phase-to-ground faults. AC phase-to-ground faults are often initiated by lightning striking a powerline and causing AC current to short through the tower structure into the ground and onto a nearby buried pipeline. During such a fault, the amount of induced current onto the pipeline can also rise significantly, albeit for a short duration. Similarly, high energy electrical interference from lightning can transmit onto pipelines through AC towers and their grounding systems. The result on a coated pipeline, without mitigation, is unacceptable touch voltage and step voltage for workers, and possible pipe wall and/or coating damage and damage to isolation joints.

PROBLEMS RESULTING FROM OVER-VOLTAGE

PROBLEMS RESULTING FROM STEADY STATE INDUCED AC

The pipeline industry has acknowledged the shock hazard associated with induced AC for some time. NACE Standard Practice SP0177 [1] outlines guidance of keeping AC touch voltage limited to below 15V for human health. This level assumes values for maximum safe current and human body resistance and should be considered a guideline. European standard EN 50443:2011 specifies a maximum touch voltage of 60V [2]. AC induction can vary widely due to seasonal soil variations and power line loading. Therefore, when measuring to determine if a pipeline has safe touch potentials, voltage readings should be obtained using a data-logger over a period of time, to assure that peak potentials have been identified.

Beyond personnel safety issues, AC corrosion is also a chief concern resulting from induced AC. Even when low levels of induction are unmitigated, or when mitigation systems yield partial AC voltage reduction, the remaining value may seem insignificant, however, AC corrosion phenomena can easily occur. AC corrosion can be found when adequate AC current density exists at small coating defects. An unwanted consequence of new, high resistance coatings, AC induced current exchange between the pipeline and soil at small coating defects can achieve very high current densities – the amount of current flow per square unit of area. Industry studies point the user to concern at values approaching and exceeding 100A/m2. Note that at a more comprehensible scale, this equates to 10mA per cm2 – a value easily achieved on many pipelines. Coupons designed with a 1 cm2 area are useful in taking current density measurements to determine risk. In general, only areas with low soil resistivity typically have AC corrosion occurring at small coating defects. See NACE document 35110 [3] and EN 15280 [4] for more information on AC corrosion phenomena. AC mitigation consultants should always consider AC corrosion while performing analyses for worker safety, as it necessarily involves possible further reduction of the resulting mitigated AC voltage from that level adequate for human health issues. This in turn has effect upon the final grounding system design to achieve that criteria.

PROBLEMS RESULTING FROM AC FAULTS AND LIGHTNING

AC faults and lightning carry much greater electrical power than steady state AC interference and so have the potential to be far more damaging and hazardous. Both AC faults and lightning can cause pipeline walls to melt and damage coatings. Though they are relatively short in duration, since they can be transmitted along a pipeline for great distances, pipeline personnel can be at risk of shock even far from the location of the fault or lightning strike. AC faults, though much lower in voltage than lightning, are typically much more damaging since the duration of a typical fault is much longer - on the order of 200ms compared to less than 30s for a typical lightning strike.

ISOLATION JOINT DAMAGE

Isolation joints are commonly used to electrically isolate sections of pipe from each other to prevent unwanted flow of cathodic protection (CP) current to adjoining pipe sections which may be grounded or protected by a separate CP system. The most common types of isolation joints are bolted flange isolation joints, monolithic joints and insulated unions and fittings. These devices are very effective at insulating low voltages associated with CP systems.

However, they each have limits as to the maximum voltage which they can support before the insulating material breaks down, often referred to as the "voltage withstand". Typical levels of voltage withstand range from several hundred volts for insulated unions to a few thousand volts for bolted flange isolation joints to tens of thousands of volts for monolithic joints. Differential voltage across unprotected isolation joints due to AC faults and lightning can exceed these levels and result in arcing through or around the insulating elements. Arcing can damage and short out the joint and possibly ignite any flammable material in the pipeline.

Figure 1 shows an example of arcing damage resulting from lightning on an unprotected bolted flange isolation joint. The joint was located between a gas transmission pipeline and a storage well in rural Pennsylvania, US. Following a summer thunderstorm, the pipeline CP voltage was observed to be lower than normal and testing indicated that the flange was shorted. The arcing contaminants had created a short circuit along the path of the arc, allowing CP current to drain to ground. The joint was repaired by replacing the flange bolt insulation and adding a solid-state over-voltage protector. After the repair, the CP levels returned to normal.

In figure 2 can be seen the result of AC fault damage to a bolted flange isolation joint. Note what appears to be a weld on the face of the flange where the fault arced across the insulator. In a case such as this, the joint is either re-

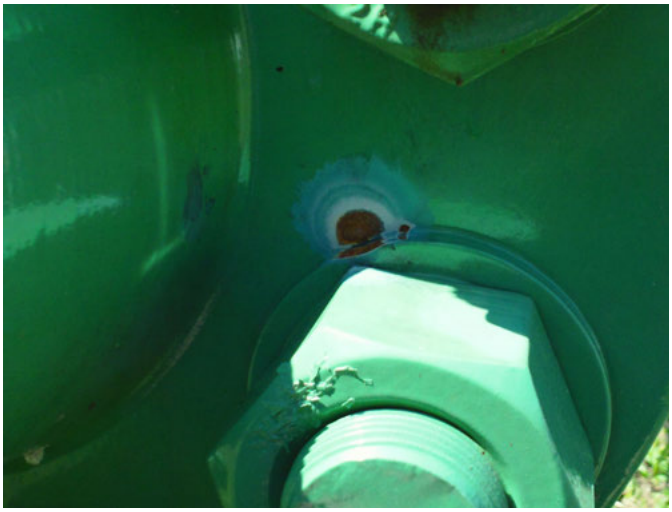

Figure 1: Lightning damage on an unprotected isolation flange

Figure 2: AC Fault damage to an unprotected isolation joint flange

Figure 3: AC fault damage on unprotected isolation unions

placed at enormous cost or left permanently shorted, thus compromising the CP protection of the entire section of pipeline.

Figure 3 shows an example of damage to isolation unions due to an AC fault at a natural gas regulator station in New York state, US. The isolation unions separated a CP-protected pipeline from grounded pressure sensing lines. The AC fault transferred to the pipeline and caused arcs across the unions which had no over-voltage protection. The arcs melted holes in the unions, causing a gas leak which was ignited by the fault current and resulted in a fire.

SYSTEM SOLUTIONS

Fortunately, the pipeline industry has developed effective solutions to mitigate these damaging effects of over-voltage. The main intent of AC mitigation systems and isolation joint protection devices is to dissipate unwanted voltage and/or minimize voltage differences at discontinuities along the pipeline resulting from AC interferences and lightning. Properly designed systems following well-established industry guidelines have proven to be highly effective at reducing safety hazards and risks to pipeline equipment [5].

AC MITIGATION SYSTEMS

The general technique for mitigating induced AC pipeline voltage is to connect the pipeline at appropriate locations to a suitably low impedance grounding system in order to collapse the voltage to a safe value. Although designed primarily to reduce pipeline voltages due to induced AC and AC faults, these grounding systems also reduce the hazards and damaging effects of lightning. The grounding system is commonly bare zinc ribbon or copper wire run in parallel with the pipeline as shown in figure 4.
The design process typically begins with software modeling by specialized consultants, inputting various factors such as soil resistivity, separation distance and voltage to arrive at a voltage map at all points along the pipeline. Then, by applying low impedance grounding points at various locations along the affected area, the AC effects under steady-state and fault conditions can be modeled, and the grounding system design can be optimized to address worker safety and AC corrosion issues. Depending on many variables such as the separation distance and geometry between the pipeline and power lines, power levels, soil resistivity, pipeline coating, etc., spacing of grounding connections may vary between a few hundred meters to several kilometers.

In order to preserve the efficiency of the CP system, properly designed AC mitigation systems include the means to isolate the pipeline from ground for DC current flow while maintaining the low impedance path for AC and lightning. International corrosion control standards call for accomplishing this through the use of DC decouplers or other devices which are described and compared in section 5 of this paper. Some of the relevant sections from these sources are listed below:

NACE SP0177, section 4.10.1
"The coordinated selection and installation of electrolytic grounding cells, solid-state DC decouplers, polarization cells ... or other devices between the affected structure and suitable grounds should be considered where arcing and induced AC potentials could develop. ... Polarization cells and solid-state DC decouplers should be considered for steady-state AC interference applications, ..." [1]

EN 15280:2013, section 9.3.1.3
"To avoid disadvantages due to direct bonding, earthing

Figure 4: AC Mitigation Grounding Wire

systems are commonly not directly bonded to the pipeline but connected via decoupling devices which provide an electrical path for the a.c. current from the pipeline to earth while simultaneously blocking d.c. current." [4]

ISO 15589-1, section 7.3.6
"If an earthing system is required, it shall be made compatible with the cathodic protection system. When allowed by regulations, this may be achieved by installing suitably rated d.c. decoupling devices in the earthing circuit." [6]

ISOLATION JOINT PROTECTION

Over voltage protection devices connected across isolation joints are designed to provide a conduction path for faults and lightning around the joint and thus limiting the voltage across the joint to safe levels. This protects the isolation joint while maintaining electrical isolation at lower voltages. In addition to protecting the joint from damage, appropriate over-voltage protection devices ensure safe touch potential across the joint in the event of an AC fault so that personnel are protected.

Several international standards address over-voltage conditions affecting safety and equipment damage at isolated joints. Some relevant sections from these sources are listed below:

U.S. Pipeline Safety Regulations. 49 CFR 192.467
(e) "An insulating device may not be installed where combustible atmosphere is anticipated unless precautions are taken to prevent arcing.
(f) Where a pipeline is located in close proximity to electric transmission tower footings ... it must be provided with protection against damage due to fault current or lightning, and protective measures must be taken at insulating devices." [7]

NACE SP0177
5.3.10. "If hazardous AC potentials are measured across an isolating joint or flange, both sides of the joint or flange shall be grounded and/or bonded across." [1]

4.9. "... a potential hazard may exist across the isolation joint and as a minimum requires fault protection." [1]

ISO 15589-1, section 7.3.3
"To avoid damage from high voltages due to lightning strikes or a.c. fault currents caused by electric power lines, protective devices shall be considered (e.g. appropriate isolating spark gap, surge protective device, and appropriate electrical earthing)." [6]

BS EN 50443:2011
10.2.2. "The interference voltage (rms value) of the pipeline system versus earth or across the insulating joints at any point normally accessible to any person shall not exceed 60 V." [2]

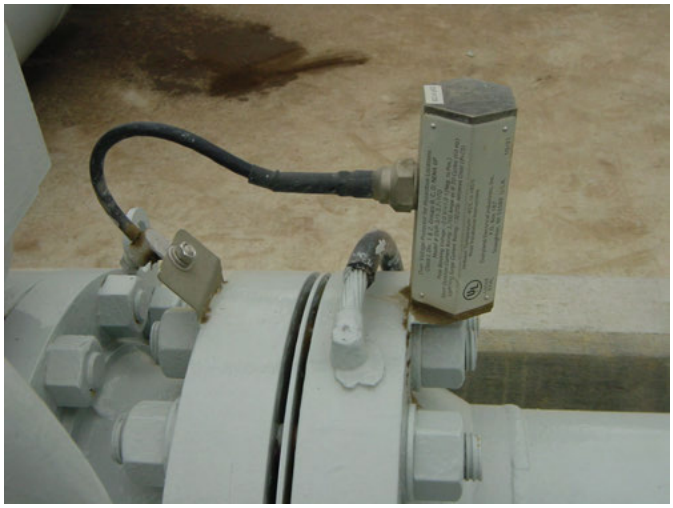

Figure 5: Solid-State Over-Voltage Protector

Figure 6: Solid-State Decoupler

D.2.2. "[Surge Protective Devices] can be used to connect the pipeline to earth or to connect the opposite sides of an insulating joint in order to reduce the amount of the voltages appearing in case of fault conditions ..." [2]

DECOUPLING TECHNOLOGIES

Numerous isolation devices are used by the cathodic protection industry as part of over-voltage protection systems. Some have very defined purposes and limitations and should be applied as specified by the manufacturer. The more commonly-used devices are described below.

SOLID-STATE DECOUPLERS AND OVER-VOLTAGE PROTECTORS

Solid-state over-voltage protectors use high power solid-state electronic switching components to create a switch between the two structures to be isolated. Under normal conditions, this switch remains open, maintaining DC isolation between the structures. When the differential voltage across the terminals exceeds a prescribed voltage threshold, which would occur during a fault or lightning event, the switch closes virtually instantaneously, collapsing the voltage across the terminals and electrically bonding the structures. Immediately following the over-voltage event, the device then automatically switches back into the OFF state to maintain isolation.

Solid-state decouplers, in addition to bonding structures during AC faults and lightning, provide a continuous conduction path for steady state AC to pass through the device and across the joint at all times. By shorting steady state induced AC current, a decoupler reduces AC voltage on the pipeline and prevents the AC voltage from triggering the solid-state switch. Examples of an over-voltage protector and a decoupler installed on isolation joints are shown in Figures 5 and 6.

POLARIZATION CELLS

The polarization cell is an electrochemical switch comprised of pairs of stainless steel or nickel plates immersed in a solution of potassium hydroxide. It responds to low voltage DC current by polarizing the plates and reducing the flow of DC current. It passes higher voltage DC, steady state AC, AC faults and lightning current.

Since the introduction of solid-state devices in the 1980's, polarization cells have become much less common due to their need for regular maintenance of fluid levels large package size, and the fact that when they fail, they create an open circuit, which creates a potential safety hazard.

SPARK GAP DEVICES

Spark Gap devices are commonly used to protect isolation joints from damage due to lightning. When the voltage across the terminals reaches a designated level, an arc bridges the product's two electrodes and passes current. Typically, spark gaps require several hundred volts for AC and over 1000 V for lightning for the device to go into conduction.

APPLICATION REQUIREMENTS

Decoupling products must be selected with careful examination of their electrical characteristics relative to the intended purpose in order to assure proper application.

LOW IMPEDANCE FOR AC FAULTS AND LIGHTNING

One of the most basic requirements of decoupling devices is to provide a low impedance path for AC faults and lightning. During such an event, the voltage across a solid-state device clamps at the threshold voltage, which is typically 3 volts or less. Under the most extreme AC fault conditions, the maximum voltage across the terminals is less than 10V. Under lightning surge conditions, this maximum voltage is approximately 100V. This assures that over-voltages will be clamped to low levels during faults or lightning events, providing a significant advantage for personnel safety and for applications such as isolated joint protection. In comparison, spark gaps do not provide protection until they "spark-over", which typically requires hundreds (for AC) to thousands (for lightning) of volts across their terminals, exposing personnel and equipment to this voltage until the device conducts.

SUFFICIENT DEVICE RATINGS

The typical AC fault rating for pipeline applications near HVAC towers is 5kA and levels up to 15kA are not uncommon. Most solid-state devices have the ability and ratings to handle AC fault current at these levels. Spark gaps, however, are not designed to handle such AC faults and so are typically not rated above 500A at 0.2 sec. As a result, spark gaps often fail when exposed to typical AC faults.

LOW IMPEDANCE FOR STEADY STATE AC

To be effective for use as part of AC mitigation systems, decoupling devices must be able to continuously conduct steady state induced AC. This includes devices used across isolation joints if grounding points on the opposite sides of the joint are part of the same AC mitigation system. Solid-State decouplers and polarization cells both continuously conduct steady state AC. Most solid-state decouplers introduce only a few milliohms of impedance and so do not significantly affect the pipeline voltage. Spark gaps are not designed to pass steady state AC and so cannot be used for AC mitigation applications.

LOW MAINTENANCE

Given the remote location of many pipelines, low maintenance and reliability of decoupling devices is extremely important. Since polarization cells require regular inspection to maintain liquid levels, these devices have become much less popular over recent decades. Since spark gaps often fail when exposed to AC faults, they too require frequent testing to ensure proper spark-over operation.

LOW DC LEAKAGE CURRENT

To maintain the efficiency of CP systems, it is important to minimize DC current leakage to ground through decoupling devices. Since many modern pipeline coatings provide such effective isolation, CP rectifier currents are often so low that several milliamps of DC current loss to ground through a decoupling device can negatively affect CP performance. When installed across isolation joints, spark gaps provide excellent DC isolation with no leakage current. Solid-state decouplers, when properly applied within the threshold voltage range, typically have less than 10A DC leakage.

HAZARDOUS LOCATION RATINGS

Many user sites are formally classified as hazardous locations, which are defined by international standards such as the International Electrotechnical Commission (IEC) according to the concentration of flammable gases or liquids present. Electrical devices must meet certain design and quality requirements to be used in these locations. If a site is classified or otherwise treated as a hazardous location, then an over voltage protection product having third-party certifications (UL, ATEX, IECEx) for this environment should be used.

FAIL-SAFE DESIGN

If exposed to fault current values beyond their ratings, over voltage protection devices should always fail safely and un-eventfully in the shorted mode (fail as a dead-short), bonding the two points together for safety. This assures that over-voltage conditions will be addressed – whether the product is working or failed.

Most solid-state devices are considered truly "fail-safe" and product certifications should provide verification as such. Most spark gaps have an open gap, which will always remain an open gap. If the spark gap were to fail, it would be as an open circuit. After failure, most spark gaps provide no over-voltage protection and a potential safety hazard is created, as voltage can rise to unsafe levels. Similarly, when polarization cells fail, either from fluid evaporation or tank rupture, they fail as an open circuit and cease to provide safety grounding.

CONCLUSIONS

Buried pipelines are subject to multiple threats from AC interference and lightning which affect pipeline safety and integrity. Thankfully, well-established system solutions on pipelines, including AC mitigation and isolated joint protection, exist that, when properly applied, mitigate much of the negative effects of these threats. Decoupling devices play a critical role in these mitigation solutions to isolate CP-protected pipelines from earth and other CP systems while providing bonding for AC and lightning.

However, not all DC decoupling devices are created equal. Many DC decouplers available have not been well validated by reputable third-party certification agencies to meet stated performance criteria. In addition, spark gap devices should not be used for most applications located near HVAC power lines since they will not pass low voltage steady state induced AC to earth and they are not properly rated to handle AC faults levels that are typically observed on pipelines in these locations. It is important to understand the performance strengths and limitations of the devices before application.

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References

1. Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems, SP0177, NACE International, Houston, TX, Item #21021, 2014.
2. BS EN 50443:2011, Effects of Electromagnetic Interference on Pipelines Caused by High Voltage A.C. Electric Traction Systems and/or High Voltage A.C. Power Supply Systems.
3. NACE International Publication 35110, "AC Corrosion State-of-the-Art: Corrosion Rate, Mechanism, and Mitigation Requirements," Technical Committee Report, NACE International, January 2010.
4. EN 15280:2013, Evaluation of A.C. Corrosion Likelihood of Buried Pipelines Applicable to Cathodically Protected Pripelines.
5. R.A. Gummow, A/C Interference Guideline Final Report, Canadian Energy Pipeline Association, 2014.
6. ISO 15589-1, Petroleum, Petrochemical and Natural Gas Industries – Cathodic Protection of Pipeline Systems – Part 1: On-Land Pipelines, 2015.
7. 49 CFR 192.467, External Corrosion Control: Electrical Isolation, U.S. Pipeline and Hazardous Materials Safety Administration, DOT.

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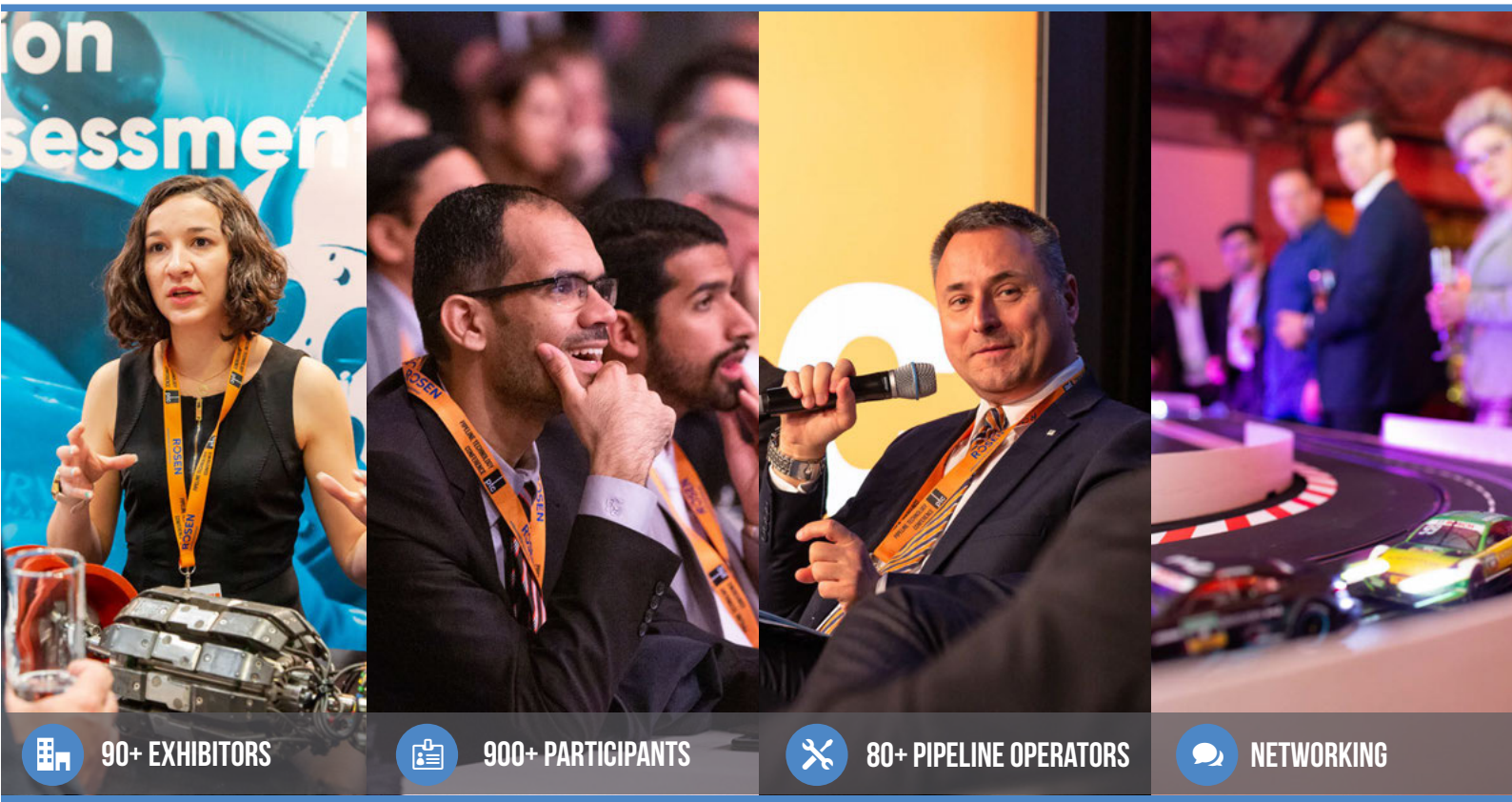

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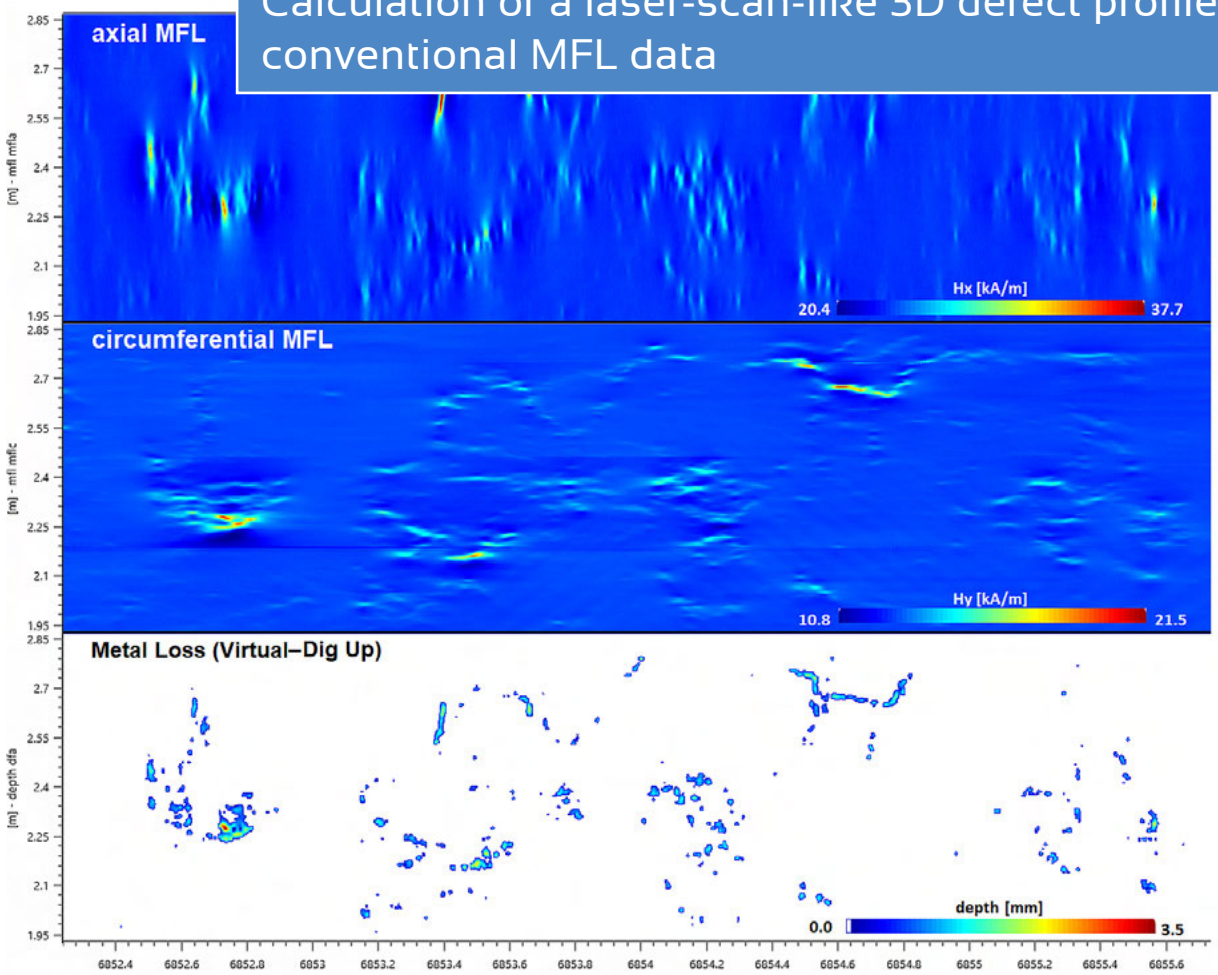
Calculation of a laser-scan-like 3D defect profile from conventional MFL data



Johannes Palmer, Andrey Danilov> ROSEN Technology & Research Center, Germany

Abstract

Calculation of a laser-scan-like 3D defect profile from conventional MFL data – For more-accurate defect assessment and prediction of safe operating pressure

Reliable pipeline safe pressure prediction is increasingly required. Complex shaped volumetric metal loss is a challenge in this regard. Methodological In-line Inspection (ILI) restrictions and principal reporting simplification reduce the precision of ILI results and output tables. Today, phenomenological Magnetic Flux Leakage (MFL) data parameterization is rearranging complex metal loss structures and often results in reduced accuracy. Nevertheless, the established maximum depth boxes do not necessarily prevent cases where MFL data interpretation is insufficiently conservative.

The presented ground-breaking MFL data evaluation technique directly calculates the accurate 3D metal loss geometry as an alternative to the currently practiced boxing. The resolution of the innovative result opens a new dimension for MFL. Auxiliary components of the typical MFL indirect interpretation method lose importance with this new system. Experience-based practices using human expertise, artificial intelligence or elaborate sizing models play a role still, but the conclusive accuracy of the calculated metal loss profile becomes significantly independent from the variability of these experience-based practices. This technology enables new services for difficult-to-access areas, areas with complex corrosion, or instances in which a laser map cannot be obtained, resulting in a more accurate, reliable and detailed corrosion growth assessment. This paper will detail concrete case examples from blind tests with high-resolution laser maps and will compare the new approach with results from the traditional MFL evaluation. Performance and reliability analyses help rationalize this innovative technique and demonstrate the contribution to more reliable management of metal loss threats. As part of describing this new evaluation technique, theoretical and practical advantages will be discussed of combining axial and transverse MFL measurements for detection and sizing of metal loss anomalies.

INTRODUCTION

In-line Inspection (ILI) result requirements continuously increase. In the case of complex metal loss, more accurate safe pressure predictions need not only more accurate maximum depth values. More detailed, more accurate and more relevant metal loss profiles are required for more precise and economically adequate predictions [Kariyawasam et al. 2019]. Established Magnetic Flux Leakage (MFL) methodological characteristics hardly follow.

The relevance of reliable and accurate safe pressure prediction increases, but MFL parameterization and result simplification introduces conservatism, which increases the number of digs too early or superfluous. Nonetheless, even this conservatism still does not completely prevent principally erroneous data interpretation caused by the ambiguity associated with the MFL method. Specifically complex corrosion is responsible for difficult data interpretation and potential threats. This situation motivates investigating the principal possibility to replace the established MFL parameterization and simplification with calculating the 3D metal loss geometry with the highest resolution.

MFL ATTRIBUTES: INDIRECTNESS AND AMBIGUITY

The MFL signals do not directly show the metal loss. A direct analytical calculation is also not possible (see below). The example (Fig.1a) shows, how different MFL field disturbances in the axial and circumferential direction are generated from the same seven ft. long complex metal loss. The established signal data interpretation of the observed signals will prefer most probable solutions. Hence, apparently dominating data structures will also dominate the metal loss interpretation.

When comparing the ILI data with the corresponding laser scan (Fig.1b), it appears typically more probable, that the axial continuity of the axial structures tends to volume loss overestimation in the circumferential and underestimation in the axial field. Obviously, both data sets in combination contain an enormous amount of detail and information. Two elementary questions arise: How precise are the ILI measurements? How sound is methodological MFL understanding?

The mathematical forward calculation from the laser scan (Fig.1b) is a complex task, but basically requires just one principal calculation step (Fig.1c). The excellent agreement between this calculation (Fig.1c) and the ILI measurements (Fig. 1a) confirms both: the understanding of MFL principles as well as the high quality of the ILI measurement. The "direct" task from 3D scan to magnetic field is straightforward attainable, the "inverse", from measurement to metal loss, is not. In academic jargon it is therefore referred to as an "incorrectly formulated task" [Militzer, Weber, 1984: 1.5.3].

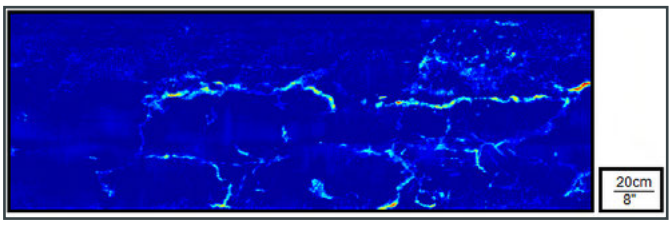


Figure 1b: External corrosion of slotting/grooving dimension under folded, disbonded coating (46% maximum depth)

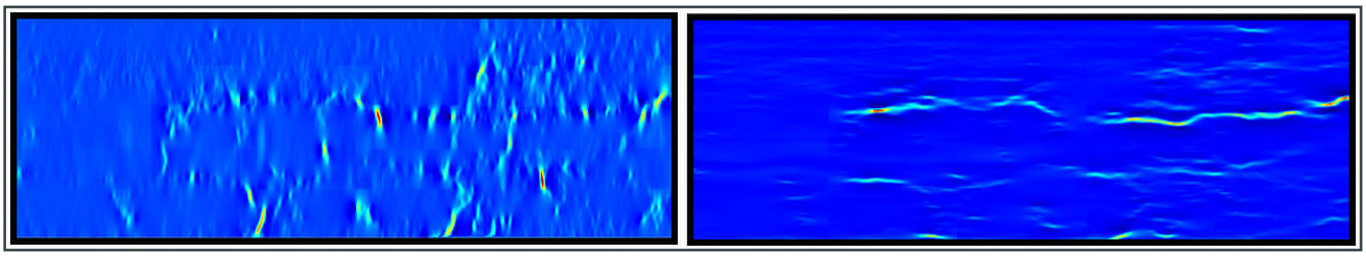


Figure 1a: ILI measured MFL signals; left axial magnetizer tool, right: circumferential megnetizer tool

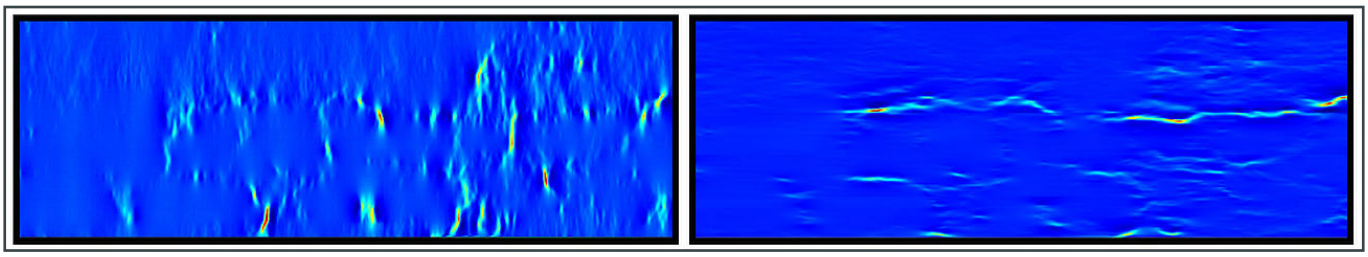


Figure 1c: Synthetically calculated magnetic field left: axially magnetized, right: circumferentially magnetized

Two different source geometries may cause the same magnetic field disturbance. Therefore, the measured field is ambiguous. In all field directions [Militzer, Weber, 1984: 5.2.1.6.1] and at different measurement heights [Militzer, Weber, 1984:1.5.2.2], no additional information is observable as long as all these measurements are outside the source itself. This is the case in ILI, since the sensors do not penetrate the wall. The ambiguity of the MFL method can be approached by knowledge databases, which store and link the source geometries with their practical occurrence probability. Since most of the pipelines and their metal loss origins and mechanisms are relatively well known, the chance of pitfalls is enormously reduced [Stuart, Clouston 2013]. Nevertheless, the most probable metal loss shape is not necessarily the correct one. Thus, the most conservative interpretation may generate false calls, eventually many. Significant efforts try reducing their number, but will never overcome inherent methodological limitations. Already the simple existence of a benefit from optimized interpretation as formulated in standards like API 1163 (e.g. 8.2.6b in [API 2013]) shows already this intrinsic vagueness, reflected in interpretational simplified boxes. Boxes are tending to over-conservatism, have often poorly defined outer limits and hence, cause low repeatability as well as ambiguous, and sometimes hidden, corrosion growth rates.

APPROACH TO OVERCOME MFL INDIRECTNESS AND AMBIGUITY

The industry result quality requirements continuously grow, hand in hand with increasing MFL measurement accuracy. Therefore, outliers become less acceptable. Contributing tool components and sizing data bases were continuously improved. Meanwhile, it is not the scattering of involved components in the MFL process chain, but the fundamental MFL sizing definitions and the MFL methodological nature itself that dominate the restrictions.

The agreement between the synthetic forward calculation (Fig.1c) and the real ILI measurement data (Fig.1a) show a level of capability, which suggests to replace the described established "interpretation" with "calculation". Calculation is simply aiming at high repeatability, comparability and accuracy.

Figure 2 shows the principal difference of the new MFL calculation approach. The complex interpretation operator Ω (Fig.2a) is experience-based and probability-driven. Ω is based on human experience, knowledge databases from verifications and synthetic calculations and machine learning. It uses human expertise and artificial intelligence to find the best sizing PIPEO.

The calculation F (Fig.2b) simply computes the difference ΔMFL of ILI measurement and refined assumption PIPEn. As long as the difference is not satisfactory, the iterative calculation continues. This process is called "Deep Field Analysis" (DFA). A typical complex assumption (Fig. 2a) may serve as start model. The success speed will depend on its quality, but the success itself does not.

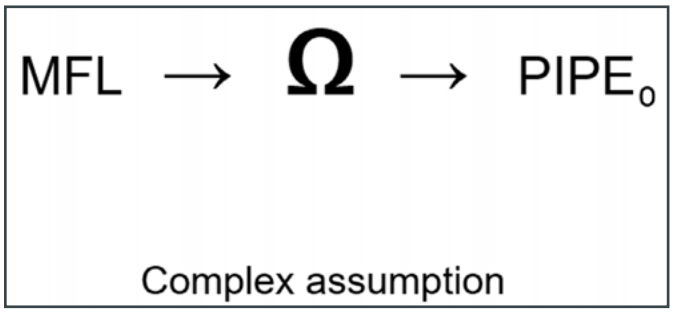


Figure 2a: Established MFL data interpretation applying knowledge based on operator Ω

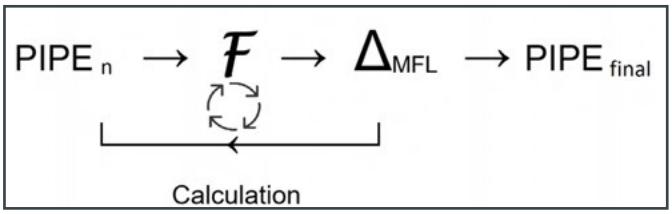


Figure 2b: MFL result calculation (Deep Field Analysis) via iteration loop to minimize ΔMFL of ILI and assumption

One of the earliest practical test examples is outlined in Figure 3a. Left hand side shows the DFA result of conventional axial MFL (MFL-A) and on the right the combination of MFL-A and circumferentially magnetized MFL (MFL-C). The two results differ significantly by metal loss volume and maximum depth.

The reason for that difference is the ambiguity described above. Even the cross-checked three components show no difference for the two different solutions, whilst the (circumferentially magnetizing) MFL-C allows for correct differentiation, as shown in Figure 3b.

The MFL-A alone will find one of the mathematically correct metal loss solutions. But only the combination of MFL-A plus MFL-C will be able to find the only real correct one. Both solutions are displayed in Figure 3c in comparison to the laser scan.

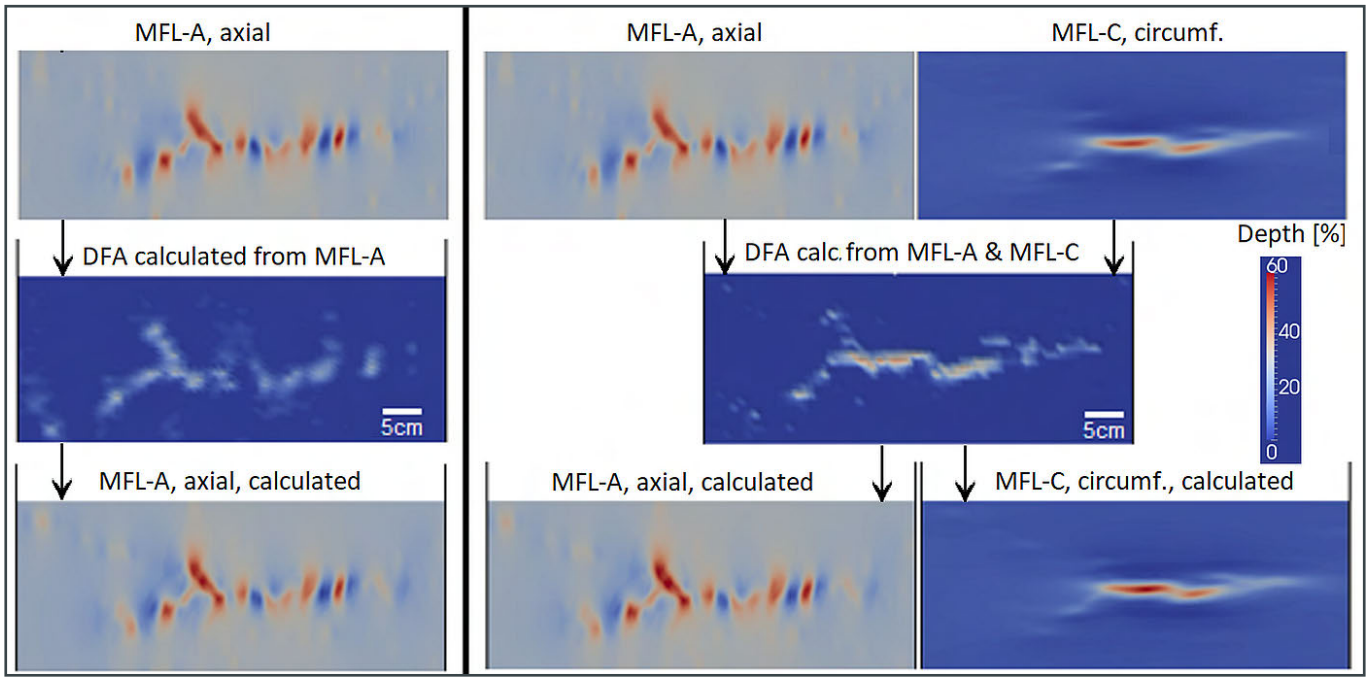


Figure 3a: Feasibility test of new MFL evaluation technique DFA on complex 2cm wide axial corrosion; test patch is 0.5m*0.2m with original 50% max. depth; comparison between stand-alone axial MFL (left) and combined axial plus circumferential MFL (right)

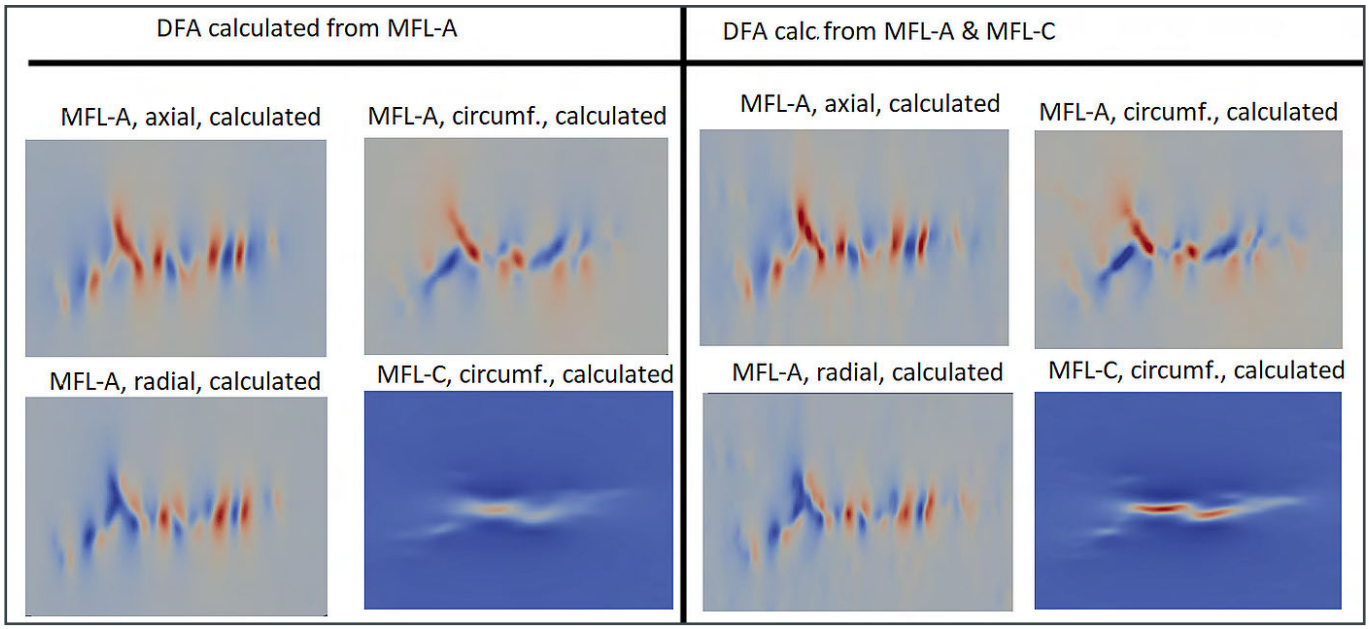


Figure 3b: Output check of all three MFL-A components and MFL-C circumferential main component

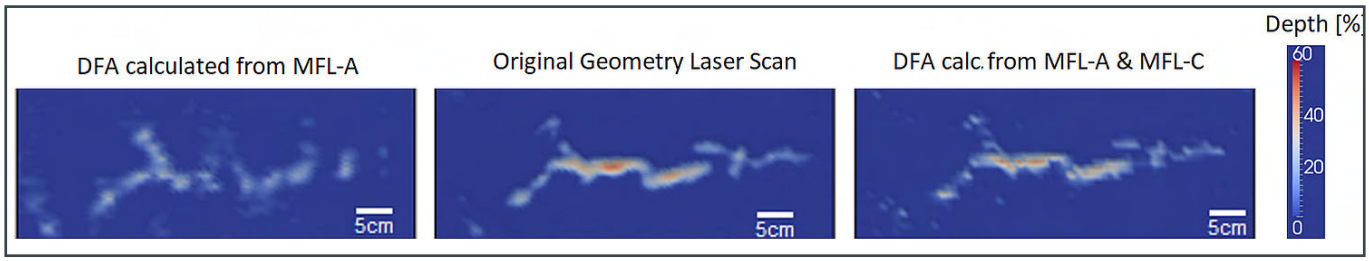


Figure 3c: Comparison of DFA models calculated from MFL-A alone (left) and MFL-A plus MFL-C (right) vs. original verification scan (center)

The concept is proven to calculate the high resolution 3D metal loss geometry from MFL-A & MFL-C data. A first prototype of a Virtual-Dig Up (VDU) User Interface was created, as visualized in Fig. 4.

External data, e.g. laser scans, can also be displayed in this frame as shown in Figure 4b. A long-term perspective could be the direct von Mises stress calculation from the 3D models, without the need of 2D profile simplification. Figure 5 provides an example in this regard.

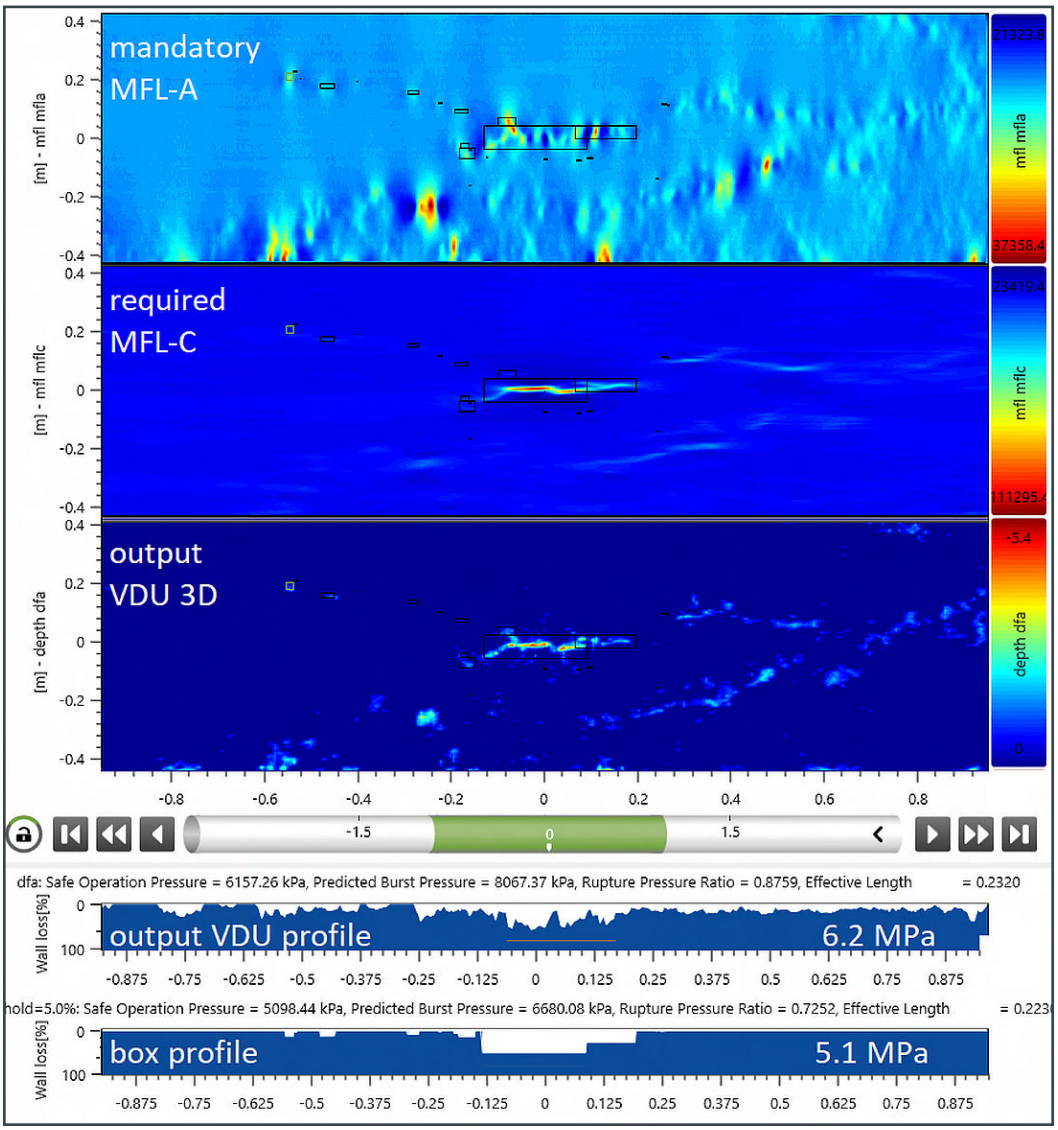


Figure 4a: Virtual-Dig Up – Graphical User Interface

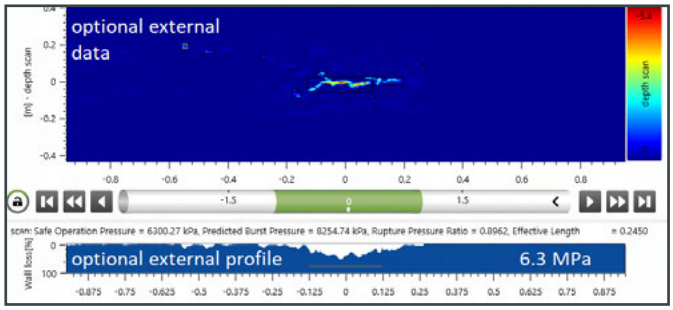


Figure 4b: Virtual-Dig Up – Graphical User Interface, Optional Data, e.g. laser scans

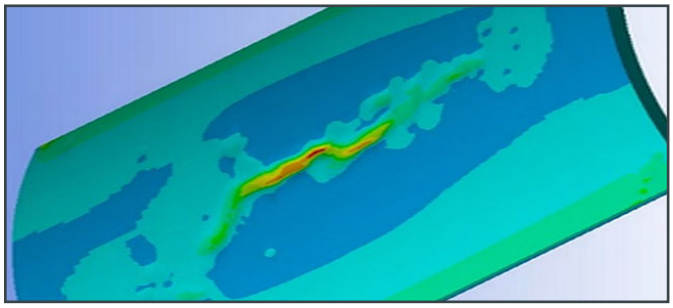


Figure 5: Long-term perspective 3D von Mises Finite Element Model stress calculation

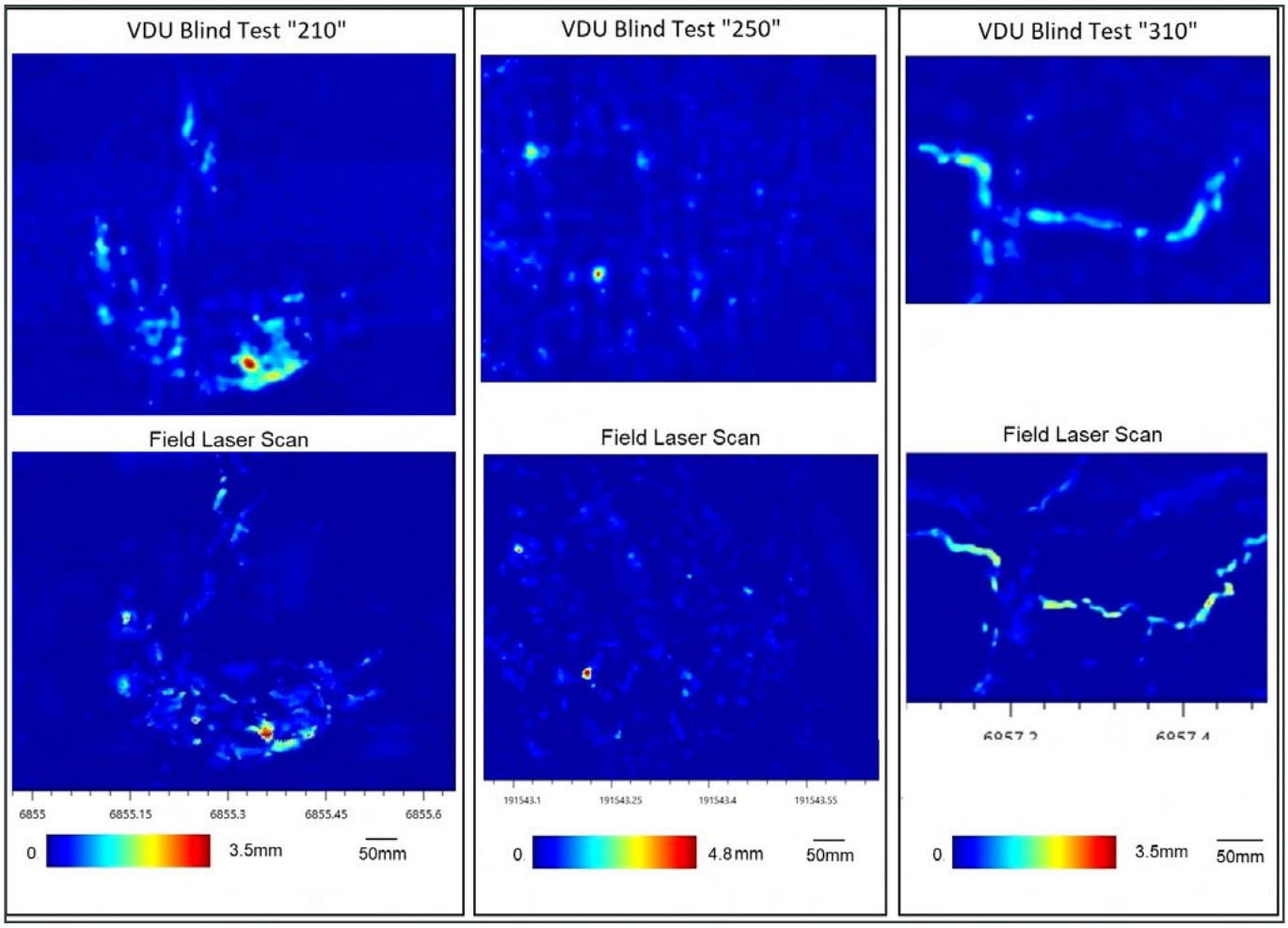


Figure 6: 3D maps of a blind test of VDU vs. high resolution laser scan maps at three locations of complex corrosion with general thinning, complex pitting partly close to pinholes, and slotting of varying directions

VIRTUAL-DIG UP BLIND TEST

Together with a North American operator with high reputation in ILI analysis, a blind test was carried through in 2018 [Danilov 2019]. Three locations covered complex corrosion with general thinning, complex pitting partly close to pinholes, and slotting of varying directions. The results are summarized here. Figure 6 shows the match of three 3D VDU results vs. laser scans and Figure 7 the corresponding comparison of the profiles with RSTRENG safe pressure predictions and maximum depth.

Specifically the continuous general thinning and its extent was reflected well in the VDU MFL calculation result. These parts of complex corrosion are difficult to be picked up in conventional MFL interpretation, but often have significant influence on pressure calculations.Maximum depth for very small sized elements, like embedded pinholes, may show small depth underestimation as it does even for UT pitting or laser scans itself.

The typical result observed in mainly all test scenarios was confirmed as well: the robustness of this new ILI approach with regards to the application of the Effective Area Method. The safe pressure of all three types of complex metal loss varied with a deviation < 2%, whilst deviations of the established box simplifications are usually an order higher.

The MFL evaluation method presented here generates detailed three-dimensional maps of the metal geometry, which agree well with field observations. This approach is overcoming the principal methodological problem of ambiguity by using two independent magnetic field directions, which allow in principal for mathematically unique solutions. The methodological limits of the technique are then data quality or principal attributes, like the sensor to wall loss distance. This may affect, as mentioned above, small scale structures and specifically the depth of embedded small deep parts of complex corrosion. In principle, this effect can have comparable impact on high-resolution UT.

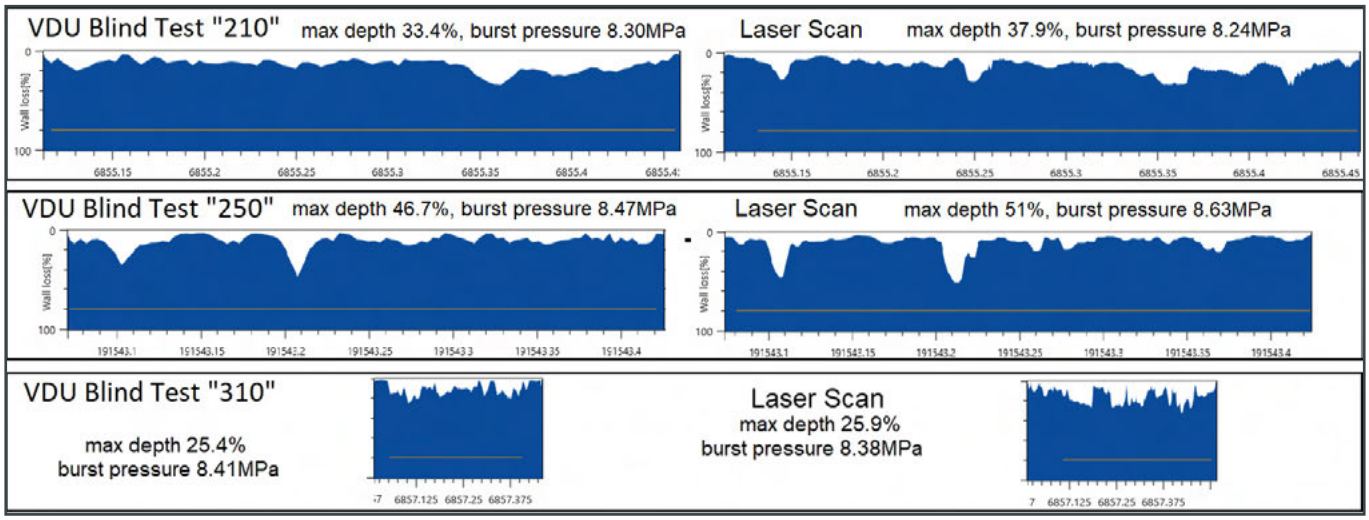


Figure 7: RSTRENG profiles of VDU blind test vs. high-resolution laser scan profiles at three locations of complex corrosion with general thinning, pitting partly close to pinholes, and varying direction slotting

The new approach is strong as it analyzes principal structures. More specifically, general thinning is well captured. These observations imply that the method works well with the robust Effective Area Method, which is by nature less sensitive against depth undulations of small lateral extent, even if affecting the maximum depth eventually.

CONCLUSIONS

CURRENT MFL OBSERVATIONS:

- The relevance of reliable and accurate ILI safe pressure prediction increases, but knowledge-based MFL parameterization reaches development limits.
- The established way of MFL data analysis is industry accepted. The approach is knowledge- and experience-based, parameterizes and simplifies the output necessarily. Together with complex corrosion, this simplification may cause difficulties, e.g. over-conservatism.
- Parameterization with boxes produces complications in pressure calculations and corrosion growth correlations.
- MFL interpretation may find the most probable or most conservative metal loss geometry, but not necessarily the correct one.

MFL DEEP FIELD ANALYSIS OBSERVATIONS:

- Changing the MFL sizing principle from knowledge-based interpretation to mathematical calculation requires 3D feature description.
- Calculation allows for high MFL result repeatability and independence from sizing model selection. Its ambiguity can be excluded by integrating two different magnetic field directions, whilst varying measurement components or sensor heights would not achieve this.
- Calculation together with two field directions allow to find the actually correct complex corrosion geometry. First blind tests confirmed this.

MFL DEEP FIELD ANALYSIS PERSPECTIVES:

- The value of the presented calculation approach is obvious, but comes along with enormous numerical efforts, which will be reduced in the next development phase.
- Artificial intelligence may increase the quality of the start model and herewith the performance. Nevertheless, the calculation will remain the final step, which guarantees the sizing result quality.
- Currently, the box sizing approach is rather tolerant with varying measurement data quality. With this new calculation, data deficits become transparent as the dominant source for individual remaining small deviations. This will help to identify and justify measurement tool improvement.
- The development of a Virtual-Dig Up service will allow for a detailed analysis of difficult-to-access areas, or areas with difficult-to-size complex corrosion and their reliable corrosion growth assessment.
- Three-dimensional metal structures per se allow the modelling of von Mises stress. Once the quality and expected errors are under control, this approach may become the basis for direct safe pressure prediction via modelling.

ACKNOWLEDGEMENTS

The authors would like to thank all the ROSEN scientists involved in this development for many years and the team for excellent technical contributions and good team work. The partnership, excellent technical support and fruitful

discussions with the North American pipeline operator were very much appreciated as well.

ABBREVIATIONS

3D three-dimensional
API American Petroleum Institute
ASME American Society of Metallurgic Engineers
DFA Deep Field Analysis
F DFA calculation operator
ILI In-line inspection
MFL Magnetic Flux Leakage
MFL-A conventional MFL with axial magnetizing direction
MFL-C transverse MFL with circum-ferential magnetizing direction
Ω MFL interpretation operator
rstreng Remaining Strength approach by Kiefner as out-lined in ASME B31G
UT ultrasonic testing
VDU Virtual-Dig Up

References

API STANDARD 1163, In-Line Inspection Systems Qualification, American Petroleum Institute, 2nd ed., 2013, The American Petroleum Institute, Washington DC
ASME B31G, Manual for Determining the Remaining Strength of Corroded Pipelines, 2012, The American Society of Mechanical Engineers, New York
DANILOV, A, Palmer, J., Schartner, A., Tse, V., Computing 3D Metal Loss from MFL ILI Data for Reliable Safe Pressure Prediction, Rio Pipeline 2019, Rio de Janeiro, Brazil, 2019
KARIYAWASAM, S., Zhang, S., Yan, J., Huang, T., Al-Amin, M., Improving Safety and Economy through a More Accurate and Precise Burst Pressure Model, APGA-EPRG-PRCI, Proceedings of the 22nd Joint Technical Meeting, Brisbane, Australia, 2019
MILITZER, H., WEBER, F.; Angewandte Geophysik-Band 1 – Gravimetrie und Magnetik; 1984; Springer; Wien, New York, Berlin
MILLER, S., CLOUSTON, S., Optimizing magnetic-flux leakage inspection sizing model performance using hi-resolution nondestructive examination data, in J.Tiratsoo (ed.), Pipeline Pigging and Integrity Technology, 4th Edition, 2013, Clarion, Houston TX

"Laser-like 3D Metal Loss Profile from MFL Data - Virtual-Dig Up breaking the boundaries

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Abstract

"For the first time in the history of mankind, there are four generations in the workforce. There are 35 million Traditionalists (Silent Gen) and 84 million Baby Boomers, the largest number of workers, which began to retire in 2010-11. There are 68 million Generation Xers and 79 million Generation Yers (Millennials as they are better known).

There will be no escaping the demographic reality that in the very near future, there will be 84 million retiring Baby Boomers, followed by 68 million Gen Xers to replace them. This will create an employee vacuum in the workforce that only the 79 million Gen Yers can fill, increasing the demand and completion for Gen Y employees, in addition to increasing the ongoing challenges of working with a multigenerational workforce."

This statement was provide by Dr. Gustavo Grodnitzky1, to a group of CEOs. I had been invited to sit in with the group and spend a half day listening to Dr. Gustavo and discussing how businesses are dealing with things like generational differences, Gen Y challenges and strengths, as well as how to recruit and retain a Gen Y workforce.

In my former career before starting my own company to address our next generation workforce skills issues, I had become very intrigued as far back as 2000 when our company was running a global survey of our operations personnel. We were trying to determine how many would be retiring by 2012, what were their likes/dislikes about their jobs, how many would be interested in moving into operational type leadership roles, etc.... Our findings were very eye opening to say the least. The biggest finding was how many stated that they were planning to leave/retire from the company by 2012/2017 - we were looking at a potential 80% loss in current operation positions by 2017. Our sr. leadership set out to start capturing the "tribal knowledge" held by this very capable workforce and we started to implement a global competency management system for all operational technician type job roles. That program was later followed by a global frontline leader competency program.

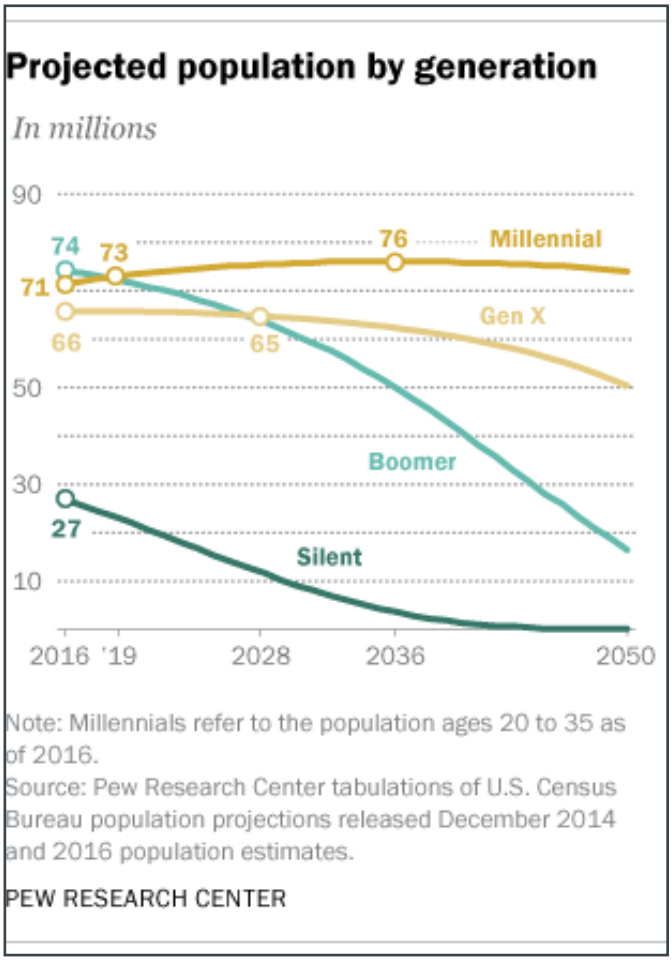

Figure 1: Project population by generation

This survey began my new career journey into better understanding and researching this workforce dilemma that was starting to unfold back in the early 2000's. If it was happening to the company I was working for at the time, then it had to be happening other companies similar to ours. What I found was that it is happening across all industries and businesses worldwide. What we're seeing for the first time is the "gap" in the human workforce. Some believe with technology and the new onset of Artificial Intelligence (AI) we won't need as many individuals to fill the vacant jobs already before us. I would agree that technology and advancements in AI will require ess people, but at the same time it will create a completely new skillset for those needed to work on and maintain the automated equipment. A recent article by Science Alert, projected that the full automated takeover of human labor jobs would not be till the year 21412.

In its March 2016 report IHS in their report for API on jobs in the Oil & Gas sector, which included the Upstream segment, Midstream for pipeline transportation, Downstream for refining and distribution, showed a projected 1.9 million jobs that will need to fill between now and the year 20353.

Last, I'll note the very recent Deloitte and Manufacturing Institutes 2018 study on lack of skilled workers to fill the needed job roles for the manufacturing industry to expand and continue to grow. They stated the following, "Deloitte expects the number of new jobs in manufacturing to accelerate and grow by 1.96 million workers by 2028. Second, the manufacturing industry could face a demographic challenge. Despite the trend of delaying retirement—according to the most recent Gallup poll, the average age of retirement is now 66 years—more than 2.6 million baby boomers are expected to retire from manufacturing jobs over the next decade. And, more than half of the open jobs in 2028 (2.4 million) could remain unfilled because of the following top reasons identified by executives:

- Shifting skill sets due to the introduction of advanced technologies
- Misperceptions of manufacturing jobs
- Retirement of baby boomers

The 2018 study shows most companies expect job categories where they have rated the current shortage "very high"—digital talent, skilled production, operational managers—to triple in terms of difficulty in filling positions in the next three years. Even at present, many of these jobs are taking longer to fill, stretching out to months of time where a company is missing key workforce to deliver open orders, expand production, or respond to customer needs4."

SO WHAT DO WE NEED TO DO IN THE MEANTIME TO FILL THE SKILLS GAPS ACROSS INDUSTRIES WHERE SAFETY AND TECHNICAL SKILLS ARE REQUIRED IN THE JOB ROLES?

I know that I'm not alone in the belief that an organization will only prosper when its employees add value. Workers who will add value to your business, do so if they are

capable, comply with prescribed action steps, respond to training, and are dependable and consistent. Needless to say that these needs are captured in the single word Competence, and that is what I want to address in this article. If a company truly wants to be a "Best-of-Class" company, then to consistently achieve profitability and stability, I believe these companies will need to invest in the competence to their frontline employees and the leaders who direct them in a structured manner.

COMPETENCE IS AN ALL-ENCOMPASSING TERM

Because competence consists of knowledge, experience and skills (performance), of which all 3 help shape the individuals attitude/behavior, among many other important traits, I want to introduce a model shared with me by Jim Wetherbee, which he created while working at NASA. I had the privilege to meet Jim Wetherbee after he came in from NASA to help our company in an investigation we were conducting from a process plant explosion that had occurred. Jim is recognized as an expert in safety culture and operational leadership and at the time he was the Director of NASAs Space Flight Operational Readiness. (Jim's job was too made sure all the astronauts behind him could demonstrate full competence before being put into space). Jim had completed 6 successful missions to space and back to earth during the shuttle program. 5 of those trips, NASA had selected him to command the space shuttle and he is the only American astronaut to have held the commander role for 5 times. Jim's level of competency is extremely high, but he would be the first to tell you that he still has to remain continually aware in every situation.

Jim developed this model after the NASA Challenger explosion in 1986 to make improvements within the NASA operational program. Jim's model as represented in Figure 5, informs us that the behaviors in the workforce are influenced by the sociotechnical structure in place. The model is represented by the four quadrants of a circle.

- Upper left: Leadership Expectations
- Lower left: Leadership Behaviors

Together the upper and lower left quadrants represent the social side of operating behavior in the workforce. The other quadrants are:

- Upper right: Operational Systems
- Lower right: Operational Practices

Using different words, we could say that organizational policy has a social side and a technical side. Together the upper and lower right quadrants represent the technical side of operating behavior in the workforce. As to workforce behavior, the same Operational System may end up being subjected to non-identical Operational Practices. In other words, what Leaders or Management want done is not always what the workforce will do.

The quadrants can also be viewed as Upper Left and Upper Right representing Organizational Policy whereas Lower Left and Lower Right represent Organizational Practices. Again, different workforce members may subject the system to widely differing practices. What individuals do or how they act is a personal behavioral choice. Their choices and actions may or may not harmonize with company policy and the actions expected by the company.

Organizational Policy shapes leadership expectations both from the top down and from the bottom up. Verbalized expectations are called Organizational Policies. As mentioned earlier, organizational policies form the upper half of the circle in Figure for both the Social and Technical sides. So when upper management sets leadership expectations based on the operational systems they've put in place, the competency (or lack thereof) and behavior of the operational leaders on the front lines greatly influences the workforce to follow operational practices.

Leadership behavior is closely observed by the workforce. Hypocrisy in leadership cannot be hidden. A single act of hypocrisy will instantly destroy a thousand acts of team-building and displays of equitable or professional conduct. Hypocrisy in leaders can cause irreparable harm to organizations. So the first key step for an organization is to invest in your frontline leadership.

KEY MANAGEMENT ACTIONS NEEDED TO HELP ASSURE WE HAVE A CAPABLE NEXT GENERATION WORKFORCE

Although we influence our workforce in many ways, there are essential actions that need to be emphasized. Management must:

- Demonstrate interest in, listen to their frontline, and coach, develop and assess their frontline leaders.
- Give skillful feedback and recognition for good practices, personal contributions, and commitment.
- Build shared expectations and hold each other accountable.
- Keep their promises.

Management and the workforce can ascertain whether an organization is healthy by assessing and measuring key competencies. Jim Wetherbee in his book, Controlling Risk6 defines 5 key competencies that all frontline leaders working in hazardous environments must demonstrate. An organization must verify their frontline leadership can demonstrate these 5 competencies and support their development when gaps are identified if that organization wants to remain healthy. Here is Jim's list of the 5 competencies that frontline leaders need to demonstrate:

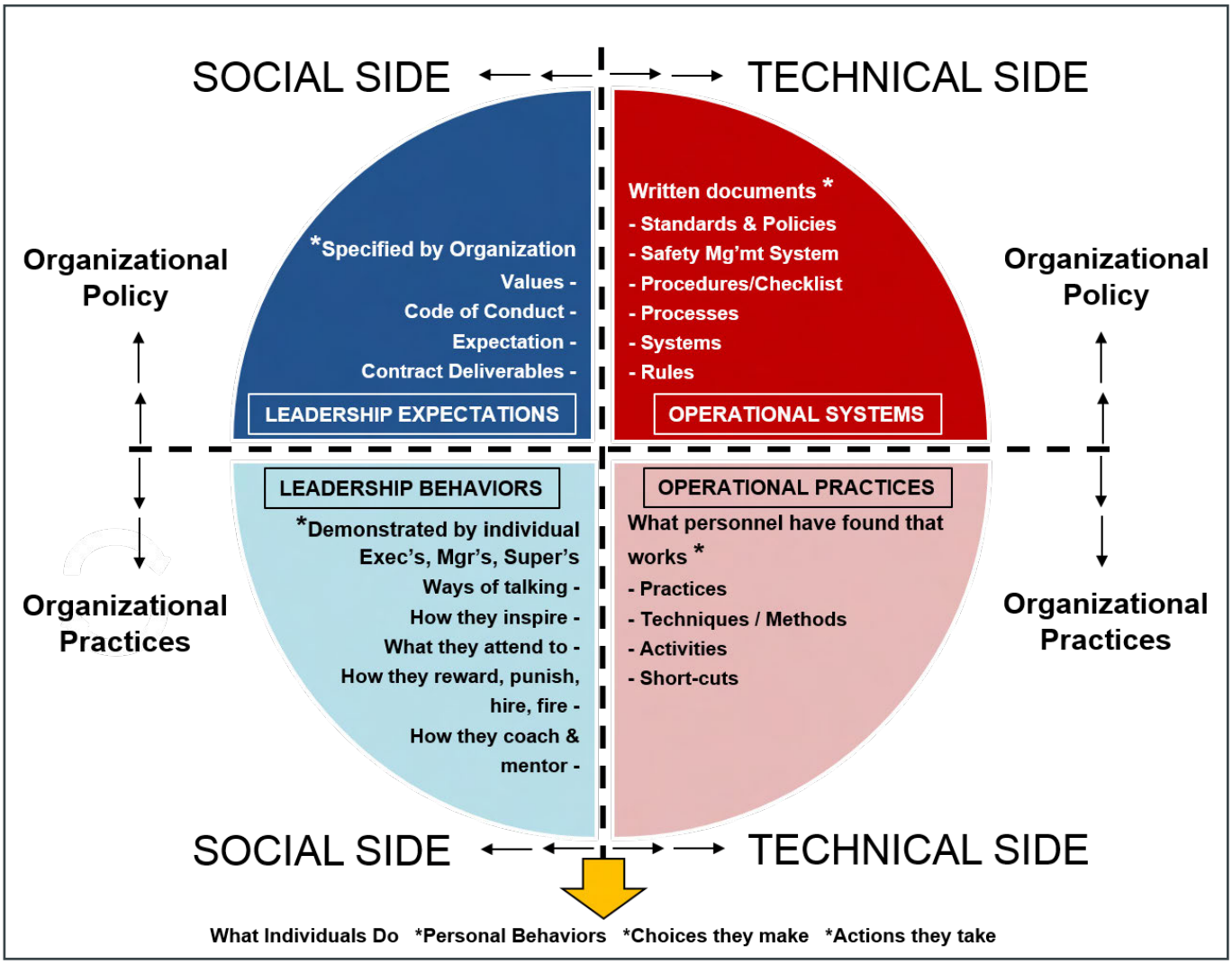

Figure 2: Jim Wetherbee's representation of what influences workforce behavior

1. INFORMED. Leaders listen to their workforce and know what's going on. Communications in an informed setting are two-way, and people report freely on errors and near-misses. All parties and job functions are confident that this information sharing will not lead to recrimination but will, instead, be used to improve safety
2. MINDFUL. There is a "smart awareness" about potential failures. People think about what might go wrong and what should be done to prevent it.
3. LEARNING. People examine and learn from internal and external incidents. Assumptions are challenged; procedures are constantly validated. Issues are resolved and action steps taken and acted upon.
4. FAIR. People accept and agree on accountability and consequences. Everyone is treated equally and consistently. Failures are opportunities to improve. Blame is reserved for truly culpable behavior.
5. RESPECTFUL. People are involved and encouraged to participate. Their ideas are sought out and considered. People are willing to listen and defer to those who have knowledge and expertise.

As you think more deeply about the meaning of Jim's model, you begin to realize the significance of what it conveys regarding an organizations Risk Management Plan. Jim states the following:
"The framework of policies, rules, and standards of practice are intended to give employees direction. These are company-wide standards, basic operating principles, and local rules, work practices and procedures. Leaders are responsible for ensuring this structure of guidance is correct, published, accessible, and understood. Leaders must know that people are not accountable unless they have accepted their responsibilities after fully understanding what they are being asked to do.

We also realize that leaders specify practices. Here, 'specify' means that leaders clearly set expectations to follow the guidance, including what practices are to be used.

Practices are the ways of working, including the methods for making decisions or performing tasks. Employees are expected to conform to the standards and principles and comply with the policies and rules. Before employees implement what seems to be a feasible shortcut or 'work-around', they must obtain buy-in from the leaders.

Employees must understand and accept accountability by committing to perform. If the needed accountability is not accepted, the leader should not expect performance. When organizations fail, this is often the omitted step; the leaders may provide the policies and rules, but then will fail to set expectations to follow certain practices. Some managers/leaders compound the problem by not testing for understanding or not asking for commitment; leaders must verify that the expected practices are actually being followed and agreed-upon actions are being performed in the workplace."

SO, WHY IS COMPETENCY MANAGEMENT NEEDED IN AMERICAN INDUSTRIES? ALSO WHY ISN'T TRAINING A PERSON ENOUGH ANYMORE?

A significant contribution to my understanding of competence is made by the U.K.'s Office of Rail Regulation (ORR)7 which serves as an independent safety and economic regulator in Britain for its rail industry. The experts at ORR best define competence as "the ability to undertake responsibilities and to perform activities to a recognized standard on a regular basis." The ORR go on to say that "Competence is a true composite, a combination of practical action, thinking skills, knowledge, understanding and experience. Competence may include a willingness to undertake work activities in accordance with agreed standards, rules and procedures."

Again paraphrasing ORR, "competence depends on the context and the environment in which the activity is performed, and also on the working culture of the organization. In the typical work environment, the standard of competence is the standard of work expected to satisfy several requirements, including business objectives and health and safety requirements. The context, the environment and culture, are particularly relevant during a person's development program before their first competence assessment, and when seeking to address any subsequent sub-standard performance. Developing competence will not in itself guarantee safety, but it will improve the predictability of good performance." I've underlined that last sentence because I think it is extremely important for organizational managers to understand this. What the ORR group has stated and what others working in occupational workforce competency management know is that confirming the competence of your workforce will not completely prevent incidents from ever happening in your workplace or facility again, but investing in your workforce to ensure their competent performance goes a long way toward a safer and more reliable workplace that keeps your workflow processes moving.

Hopefully by this point, you've picked up that "just training" the workforce is no longer the answer for organizations. The reason I'm making the case that "Training" alone is not enough for today's American workforce and their frontline leaders is primarily due to the that we're losing our diminishing and retiring current capable workforce. Our next generation operational leaders and their workforce will need much more than training to help carry these organizations forward. Over the last 25 plus years, industrialized nations like the U.K., Europe, and Australia for example, moved to competency management structures to maintain the skills needed to safety and reliably run their operations. In Figure 3 I've outlined the key principles needed within the structure of a competency management system. The main purpose of training a new hire is to transfer "knowledge" and hopefully some "understanding" to the individual, but that is only the first step in the new hires journey to being a competent worker. You must then provide that individual with on the job "experiences" to help increase their knowledge and understanding, all the while getting hands on time under the supervision of a trusted and competent person. As they gain more experience, learn to follow the company's practices, policies and procedures, they begin to develop the needed "skill/performance" required to work unsupervised. This is the point where their knowledge and performance is ready to be assessed in the workplace by trained and qualified assessors following a preset standard for that job role. The assessor's role is to collected evidence that will match up against the knowledge and performance requirements of the job standard. If it doesn't match up, then you can clearly see a skills gap and can then address it directly in the workplace.

In Figure 3 I've drawn a Venn diagram to demonstrate what I've been describing. When John Venn invented his diagrams in the 1880s, he did so to teach elementary set theory, as well as illustrate simple set relationships in probability, logic, statistics, etc. So at the risk of being redundant, I want to make sure we understand the model together. Every human starts off their life being taught/given knowledge about something. A mother without any real formal training teaches her child how to speak a language, be it English, French, or Spanish for example. How does she do that? Through teaching the child with repetition to learn and understand how to pronounce 'apple' first and then by showing the child

an apple and letting it hold and/or eat the apple. She then gives the child more and more experiences to use the word apple in a sentence along with other words and over time the child is able to be observed skillfully speaking about

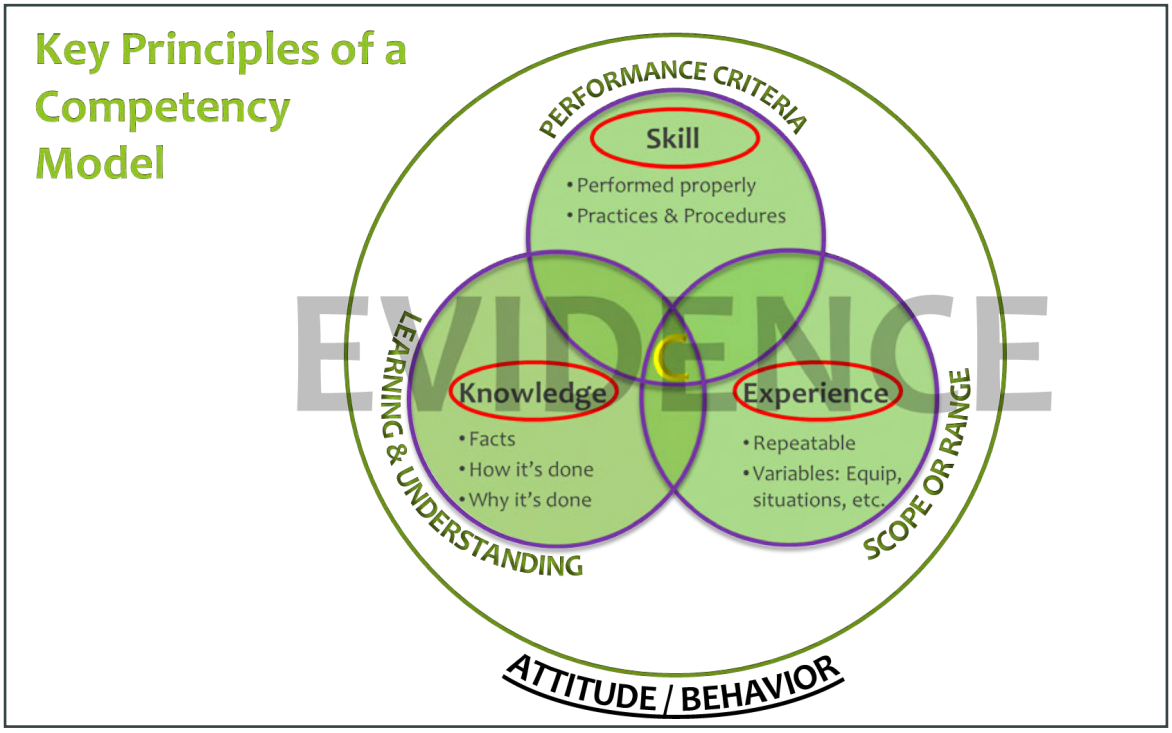

Figure 3: Venn Diagram of the key principles needed in a competency model

apples while showing others about the apple in their hand. In this simple example we can see how the skills development in the child has influenced its behavior as it displays how proud it is to show others how well they can pronounce and explain about the apples. The mother is very proud as well, but not for herself, but rather for seeing how fast her child is growing and learning.

Knowledge + Experience + Performance = Competency, and as the individual develops their capability, it helps shape their attitude and/or behaviors in the workplace.

Noel Burch8, who worked with the Gordon Training Institute in the 1970s, developed a model he called the Four Stages of Learning. It later became known as the Four Stages of Competence. Here is a listing of the four stages:

- Unconscious incompetence (You are unaware that you lack a skill)
- Conscious incompetence (You are aware that you lack a skill)
- Conscious competence (You are actively working at a skill, but it still requires thought)
- Unconscious competence (You are so skilled that you no longer have to think about it)

Burch points out the common misconceptions that training, knowledge, experience, or behavior alone equate to competence; they decidedly do not. Likewise, competency cannot be assessed by a written test. Good competence management is demonstrated when the following seven points can be affirmed in an organization:

- Senior Leadership recognizes that training alone isn't the complete answer, and they invest in establishing competence management frameworks across their organizations.
- Clearly-defined job descriptions, role statements, and competency profiles are in place for each job function.
- Competency standards exist for job roles that define the knowledge and performance required in the job role or job function.
- A fair assessment process to the competency standard is used by trained and qualified assessors. These assessments measure knowledge and performance of the individual as defined in those standards. Personal opinions are not part of the assessment.
- Assessors understand the legal impact of conducting, recording, and documenting an assessment summary.
- Knowing how to provide feedback of the assessment outcome is required to increase accountability and trust.
- Career development, progression, and pay can be tied to proven competency. Workplace assessments are never to be a one-off event, but rather, they follow the individual throughout their career.

WORKPLACE ASSESSMENT - WHAT GOOD LOOKS LIKE

I want to touch slightly on workplace competency assessments. The real issue facing companies hiring a next

generation workforce that lacks proven skills in their job role is the risk of injury/fatality, environment damage, damage to equipment etc. causing lost products/production in real time. The reason we're even talking about this issue is because as I've previously mentioned, our more competent, aged workforces are exiting their companies and leaving a massive skills gap.

There was a time when new hires could stand beside individuals who knew what to do and how to do it. Today, they mostly stand alone, working and doing their best, but with very little help. No one is there to provide the guidance and training needed for safe and reliable work. I want to note here that the majority of the time your next generation workforce is getting it right more than they are getting it wrong while having to figure it out as they go, and yet most organizations never stop to recognize these workers until there is an "event" and then it's to blame them.

As we've stated previously, for any formal assessment of individuals in their workplace, each job role must have competency standards that are clearly-written. That is, the knowledge and performance requirements of the operations are described in detail for the worker. Those standards should be provided and explained to the workers up front: this is what you need to know and here's what your need to do. There should be a listing of the types of evidence an individual could provide their assessor to help prove their competence in their role, prior to the assessor conducting the actual workplace assessment.

Those who conduct workplace assessments of the worker's knowledge and performance must be skilled and competent in the job role functions they will assess, as well as trained and qualified in the competencies of a workplace assessor. The assessor's job is to remain neutral throughout the full assessment and defer judgment until all the evidence can be reviewed and measured to the competency standard.

For companies who will implement a competency management system, I recommend that companies look initially to hire trained and qualified assessors for each role discipline to help establish the baseline on where the workforce is currently at when you start the program. Once management understands where their safety-critical capability gaps are, they can then focus on specific training to help close those gaps, and then re-assess those individuals to prove knowledge and performance can match up to the full requirements of the competency standard. Once a company's competency management system is in place, management should carefully select key individuals and have them trained and qualified as internal assessors so they can conduct on ongoing assessments independently. I can't stress enough how important independent assessment is to the integrity of your competency program.

Formal assessments by trained and qualified job-role assessors provide a collection of evidences to measure an individual's competence against a required standard. In high-hazard industries, meeting your standard of safety is at the top of the list of the competence measures.

CONCLUSION AND TAKE AWAYS

I'll end how I started off, talking about how businesses can't escape the workforce skills gap demographic. Dr. Gustavo's research1 on millennials, (Dr. Gustavo defines Millennials as being born between 1982 and 2000, making them 19-37 years of age in 2019.) entering the workforce led to some key findings on how to attract and retain this next generation.

If you were to run an exercise on the numbers of your current millennial workforce and the numbers you expect to hire by 2020, what is the differential between those two numbers? Dr. Gustavo's emphasis is that millennials are becoming the largest generation in the national workforce - in 2015 (35%), this year (2019) they will be between 41%-42%, by 2020 they will be 49%, and by 2025, they will be 68%. Dr. Gustavo says that this data creates the following issues:

- The magnitude of the numbers themselves means if you are not on par with these national numbers, you are behind this inescapable demographic curve. There is no escaping demographics.
- You have to consider the increased acceleration of their presence and influence in the workforce. Because of these numbers, they will have an oversized influence in the workforce, as Boomers did two generations before them (Gen Xers are between Boomers and Millennials).
- This is why we are experiencing a war for talent across *all* industries. Every company in every industry is fighting for the same pool of talent.
- If your company is behind this demographic curve, it will be very difficult for it to survive without the right percentage of millennials because you just won't be able to find people for your future workforce. If owners think, "I'll just retire and/or sell my company before this is an issue." I would say to those owners:

  - Too late. This is already an issue.
  - Do you think any potential buyer for your company isn't going to look at the generational make up of your workforce? You may be able to sell your company, but it will be at a fraction of whatever multiple you think it is worth.

So what is your company doing about this workforce issue? Dr. Gustavo notes 5 key factors to recruiting and retaining your next generation workforce:

1. Time - vacation, holidays, sick days. Look at how other companies are being creative with "time." PTO - Paid time off for personal time, but set ceiling or allow comp. time cap. LWOP - Leave without Pay, again set cap. DTO - Discretionary Time Off tied to performance, studies show they take less time off.
2. Flexibility - having a flex schedule, 4-day work week, Job sharing, Self-manage teams, Self-directed teams. Accountability precedes Flexibility - have to measure performance with matrix/reward.
3. Growth - Interesting to learn, Relaxed/Friendly culture, Idea sharing, Career advancement, take on responsibility. No longer have a "corporate ladder" - to millennials that is tall and narrow and only one person at a time gets to climb up it. Consider a "corporate lattice" - this is wide and accessible to all and allows for cross-training with no promotions, staying at same pay until competency is proven and opportunity is created to move up.
4. Relationships - Great boss/supervisors, Take interest in the ENTIRE world, Provide and REQUEST feedback, Be a friend at work, Opportunities for socialization, Social networking. *Money is a threshold, not a cost. Competency bosses will keep you next generation in place. Millennials are not job hoppers, they are boss shoppers.
5. Cause - Changing the world, Changing human experience in the world, Being a part of something bigger than themselves, Having a sense of purpose. Millennials want to work for companies that have meaning and big picture purpose to make the world a better place.

Now ask your management team what is being done to: 1) capture your organizations "tribal knowledge" in a structured way and 2) develop the competency needed to keep our employees safe and our operations reliable? 3) to create a culture that allows you to recruit and retain your next generation workforce. If the management team doesn't have a solid answer to those three questions, then I would recommend you find a company that specializes in safety and technical workplace competency management for your frontline leaders and the workforce they lead, as well as a cultural change specialist to help your company with the core topics in this article.

We recognize that in American industrial jobs, on the job training has been effective in the past, mainly due to management maintaining stricter control, guidance, testing, and observations before a new worker was allowed to work unsupervised. In the past, even after the new workers were working independently as it were, they still had many more senior craftsmen and operations personnel around them in the workplace. Co-workers helped prevent them from making mistakes, or blundering into violations which could have led to disaster within the facility, warehouse, or factory. Today, those senior craftsmen and operations personnel are fewer and management is stretching them much further, to the point where our "Next Generation Workforce" no longer has that person close by as they work or operate independently. As a consequence, there is nobody available to stop them or question their next step. No worker-colleague is there to make sure they're actions harmonize with the company's practices and procedures at all times. In the last decade we've seen a rise in incidents in the workplace where safety and technical skills are required; I attribute it to our new workforces not being held accountable by their frontline leaders and those leaders not checking that proper practices and procedures are being followed. At the same time, these new frontline leaders are struggling to establish a true culture of safety where our next generation workers feel free to speak up as they are not provided the support they need from their management.

About 25 years ago the majority of the world's industrial countries moved to competency management whenever safety and technical skills were needed to conduct work. In America, we still mainly just "train" our workers and send them out into our facilities, warehouses, and factories. We assume we've done all that is needed for them to be successful in their job roles. I hope you'll take another look at your next generation workforce and the leaders who manage them for you.

Resolve to make an investment into their skills and capability going forward. I believe the ROI surprise you.

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References

1. Dr. Gustavo Grodnitzk - https://drgustavo.com, used with permission.
2. Mike McRae, Science Alert, Jun 3, 2017 Experts Think This Is How Long We Have Before AI Takes All of Our Jobs.
3. IHS Global Inc., March 2016, Minority and Female Employment in the Oil & Natural Gas and Petrochemical Industries, 2015-2035
4. Deloitte / MFI, November 2018, The jobs are here, but where are the people?, Key findings on the skills gap and future of work study.
5. Sociotechnical Model created by Jim Wetherbee; NASA 5 time space shuttle commander, Director of space flight operational readiness, used with permission.
6. Controlling Risk in a dangerous world: Capt. Jim Wetherbee, USN, (RET), Morgan James Publishers, Copyright 2017.
7. U.K.'s Office of Rail Regulation (ORR); Developing and Maintaining Staff Competence, Published by the U.K. Health and Safety Executive, 2002.
8. Noel Burch; Gordon Training Institute 1970s, 4 Stages of Learning Model. www.gordontraining.com/free-workplace-articles/learning-a-new.

PIPELINE PEOPLE

Steffen Paeper > Senior Offshore Commissioning Engineer

With our new series Pipeline People, we would like to introduce you to some of our pipeline experts: informal and up close. The first one is our long-time and valued companion, Steffen Paeper.

Steffen Paeper, a graduate of the Karlsruhe Institute of Technology (KIT), has been a true pipeliner practically since the beginning of his professional career in 2003. He started with the well-known service provider ROSEN, where he worked as a manager for 9 years. Since then, he has worked on major pipeline projects like Nord Stream, the Trans Mountain Expansion Project and South Stream as engineer and manager. In addition, Steffen Paeper is involved with the Pipeline Technology Journal as a member of the editorial board and with the Pipeline Technology Conference as a member of the advisory board.

Q1: Steffen, you worked as an offshore engineer for South Stream for five years. How did you come to be part of this ambitious project?

I had been working on Nord Stream 1 (Russia and Germany) and TransMountain (Canada) before I was recruited for the South Stream Project which turned into the TurkStream Project.

Q2: What were your main tasks at the South Stream Project and what did you like best afterwards?

I was mainly involved in offshore pre-commissioning and onshore asset integrity. This included acting as subject matter expert for pigging aspects of TurkStream's dry pre-commissioning as well as leading the asset integrity team of the TurkStream landfall in Russia and Turkey as well as the central control room and backup control room.
Onshore asset integrity provided a great opportunity for definining operational processes and preparing the company's transition from construction to operation. Dry pre-commissioning of TurkStream was a great success which could change the way the industry puts pipelines into service.

Q3: The project is nearly completed. Do you feel more happy or more sad about the projects finalization?

Completing offshore and onshore construction has been a major achievement and I am happy to be a part of it. The project started as South Stream and transitioned to Turk Stream. There was never a dull moment on this journey. TurkStream had a great team composition. These days, it is sad to see project members departing. I will also miss representing TurkStream at the Pipeline Technology Conference (PTC) with all its remarkable moments. However, the PTC is a fantastic community and I want to stay connected to this group.

Q4: What are you doing when you are not at work?

In general, I enjoy working out and eating healthy as well as traveling, water sports, and taking photos.

Q5: What are you going to do after the project is done?

My father and I own an old sailboat. It is said if one maintains a sailboat one will not need another hobby. Hence, I will help him preparing the boat for the 2020 season. However, I will be available for new opportunities and look forward to supporting other operators.

Q6: As a 007 fan, a very important date for you is the upcoming Movie „James Bond - No Time To Die". So who is the best Bond for you? Sean Connery, Daniel Craig, Pierce Brosnan or Roger Moore? Or perhaps somebody else? And why?

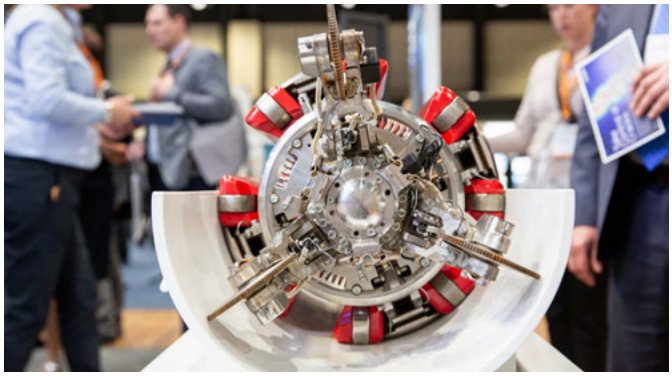
The best Bond featuring a pipeline should be Diamonds are forever with Sean Connery. He accidently participated in dry pre-commissioning of an onshore pipeline and exited that pipeline with a spotlessly clean white shirt and tuxedo. However, I also like Daniel Craig and hope the next Bond (No Time to Die) features a pipeline again.

900+ PARTICIPANTS

90+ EXHIBITORS

50+ DIFFERENT NATIONS

The pipeline world as guest in Berlin: Pipeline operators from all over the world take part in Europe's leading industry event: the 15th Pipeline Technology Conference and Exhibition (ptc) in Berlin.



The leading European event for the pipeline industry is now taking place for the 15th time, this time from 30 March to 2 April 2020 in Berlin's Estrel Congress Center. The ptc provides the international pipeline industry with a platform to discuss technical challenges and solutions and to discuss the future of the entire industry. Europe's most important pipeline event is growing from year to year: "For 2020, too, we as organisers expect growth of between 15 and 20% compared to the previous year," says Dr. Klaus Ritter, President of the EITEP Institute.

For them, there is a series of high-ranking plenary sessions and panel discussions, all of which deal with topics of interest to operators worldwide. This includes classic topics such as "Safety" as well as current challenges in the areas of "Qualification & Recruitment", "Difficult to Inspect Pipelines", "Illegal Tapping" and "Climate Adaption". Important future topics such as hydrogen transport and Power-to-X are also included in the programme.

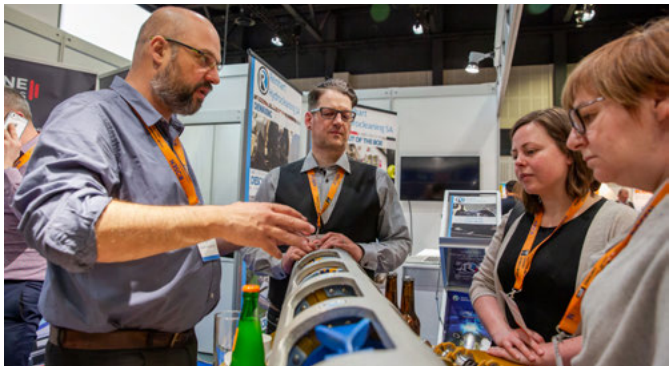
Another unique selling point of the ptc is its internationality: "About two thirds of the participants come from abroad. Last year, we saw the greatest growth from Latin America and Eastern Europe, a large proportion of which were

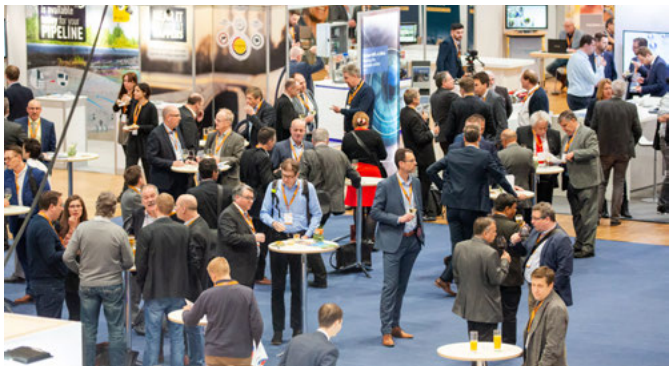
pipeline operators," says Dennis Fandrich, Chairman of the Pipeline Technology Conference. This makes ptc the most international event of its kind in the world.

The conference will be accompanied by a trade exhibition at which leading technology and service providers and pipeline operators will be able to present their innovative pipe solutions. The suppliers will be present throughout the entire lifecycle of the pipeline. With more than 90 exhibitors, a new record is also expected in this area in 2020. The conference and the trade exhibition will be complemented by thematically oriented one-day seminars, workshops and operator discussion rounds in which participants will be able to delve deeper into various topics.

As every year, the conference papers will be made available to the specialist public via the freely accessible "Pipeline Open Knowledge Base":

https://www.pipeline-conference.com/abstracts.



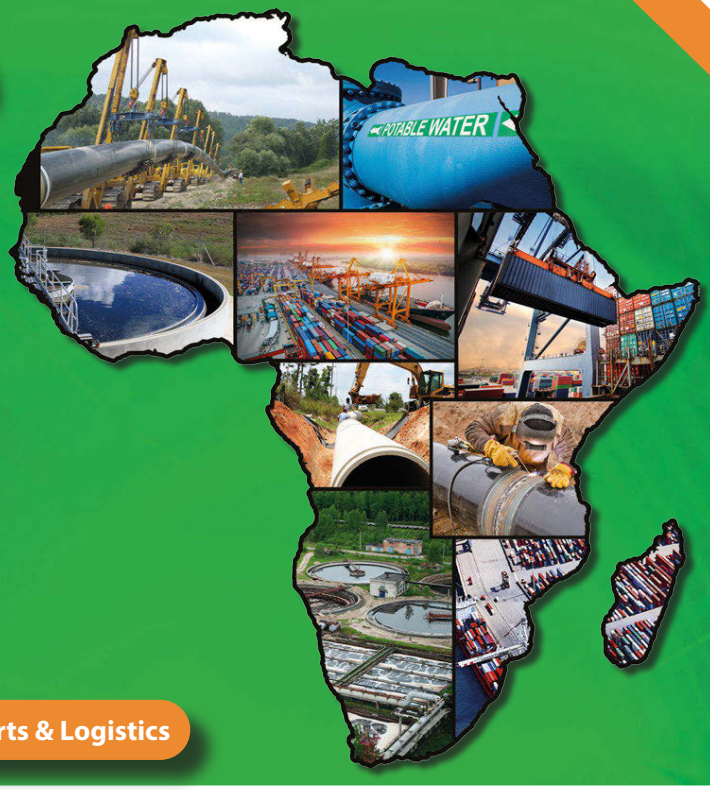


80+ Pipeline Operators

IDA INFRASTRUCTURE DEVELOPMENT AFRICA

IDA 2020

Regional Focus 2020:
Preparations for Reconstruction Libya



1st Announcement &
Call for Papers

10-12 November 2020 Tunis, Tunisia

International Conference and Exhibition for the Development of the African Infrastructure Market

Key Topics 2020: Water & Waste Water, Oil & Gas, Ports & Logistics

an ITIDA event
ITIDA

Partners
EITEP Euro Institute for Information and Technology Transfer
TEAM ENVIRONMENTAL INFRASTRUCTURE ACADEMY

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EUROPEAN/AFRICAN INTERNATIONAL TRANSFER CENTRE FOR INFRASTRUCTURE DEVELOPMENT IN AFRICA (ITIDA) FOUNDED

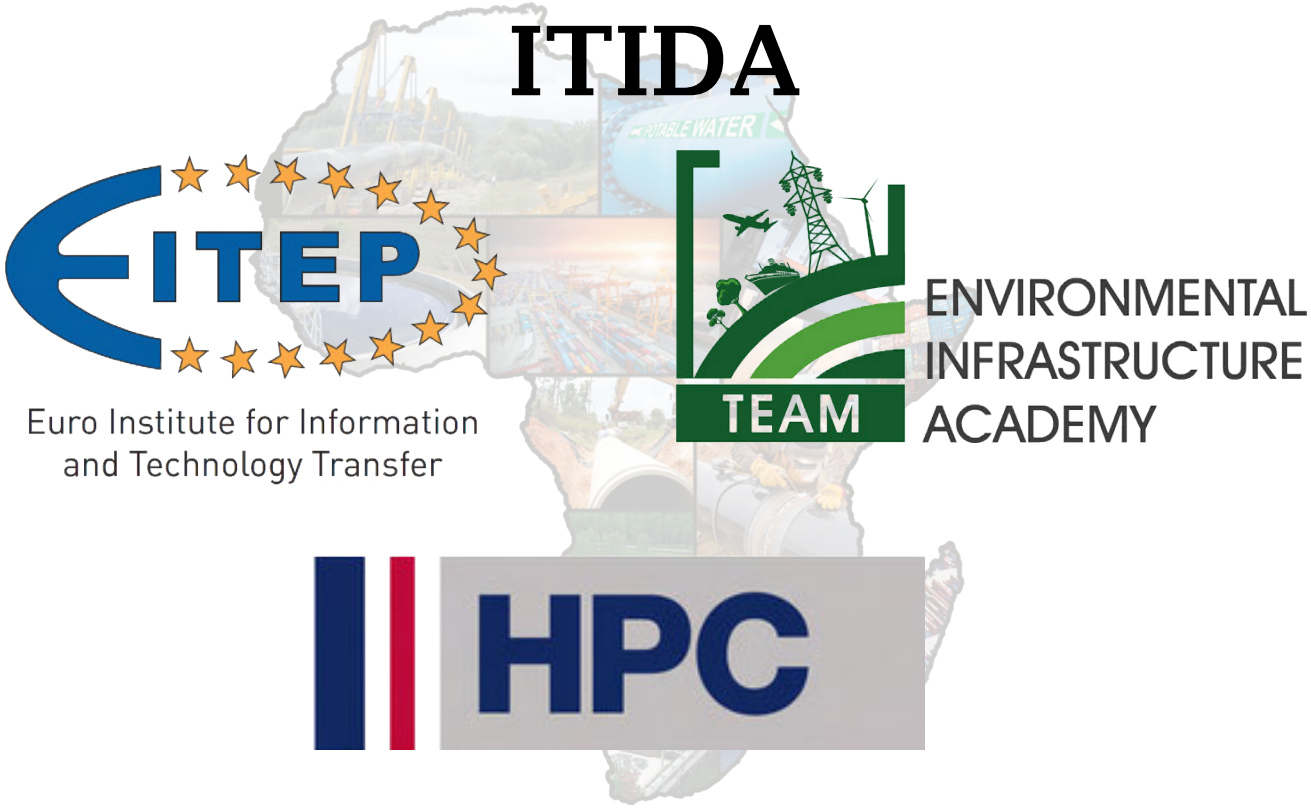
THE CENTER AIMS TO TRANSFER TECHNOLOGY AND KNOW-HOW FROM EUROPEAN INSTITUTIONS TO AFRICA

The European governments are currently pushing their companies and institutions to increase their involvement in Africa. From the Governments point of view, Africa offers many business opportunities.

ITIDA is a major initiative that supports this development by enabling the systematic transfer of technology and know-how between Europe / the industrialized countries and Africa. It provides a framework that enables companies to apply their expertise, which is already renowned in most parts of the world, in Africa as well.

At the same time, it offers African authorities, state-owned enterprises and private companies access to important know-how and technologies from all over the world. In this way, the initiative should contribute to the improvement of the economic circumstances and thus to the overall situation.

The International Transfer Centre for Infrastructure Development in Africa (ITIDA) is operated by several institutions with a similar interest: to improve the infrastructure in Africa with the expertise of European companies. Originally, the initiative was created by two cooperating institutions:



The three institutions of ITIDA: The EITEP Institute, TEAM Academy & Hamburg Port Consulting (HPC)

The Euro Institute for Information and Technology Transfer in Environmental Protection, EITEP Institute is Europe's largest networker in terms of oil, gas and water pipelines. TEAM Academy (Training and Education in Africa and Middle East) is a group of German companies dealing with the construction, operation, maintenance and repair of water supply and sanitation infrastructure. Together they have already won another important partner for the initiative: Hamburg Port Consulting (HPC), which brings enormous expertise regarding worldwide port, logistics and transportation routes.

Together, these three institutions are currently preparing their first major project in Africa. It is an international conference& exhibition named Infrastructure Development in Africa (IDA). The event will take place in November 2020 in Tunis, Tunisia. It marks one of the highlights ITIDA has planned for 2020. Fixed topics during the event:

- Supply / Disposal Solutions for Water, Waste Water & Gas
- Production / Treatment Solutions for Water & Waste Water
- Transport and Logistic Solutions for Ports
- Pipeline Solutions for Oil, Gas, Petrochemicals and other Products

Furthermore, the organizers are eager to increase the scope of the first IDA. Partners are welcome for following areas: power supply regional and international; urban traffic development, cross-region road, rail and air transport; telecommunications.

ITIDA's administration and seminar building in Tunis

One of the topics of IDA: supply, disposal and treatment solutions for water and waste water (including training measures)

Logistics and transport services of ports are further focus of IDA

One of the topics is oil, gas and water pipelines

Although the Infrastructure Development in Africa (IDA) is without doubt an integral part of the ITIDA agenda, it is by far not the only attractive activity. The following additional steps are currently in planning, showing the full scope of this ambitious and promising project:

- Advisory services for cities and federal states, drawing on the expertise of German institutions
- Creation of international electronic journals and newsletters covering all aforementioned topics
- Establishing a job and trainee platform for access to the European and African job markets
- Train-the-Trainer-Activities
- Establishment of drinking- and waste water treatment plant neighborhoods
- Etc.

All ITIDA players have many years of experience in international economic cooperation. Success in this work also requires cooperation with other initiatives.

> *We seek coordination with the goals set by African institutions and initiatives*
> *Dr. Klaus Ritter, President of EITEP*

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Association

IAOT - International Association of Oil Transporters
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www.iaot.eu/

DVGW - German Technical and Scientific Association for Gas and Water
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Automation

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BIL - Federal German Construction Enquiry Portal
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Pipesurvey International
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PPSA - Pigging Products and Services Association
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Romstar
Malaysia
www.romstargroup.com

Rosen
Switzerland
www.rosen-group.com

Inspection 1/2

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Applus RTD
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EMPIT
Germany
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Integrity Management

Metegrity
Canada
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Pipeline Innovations
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Leak Detection 1/2

Asel-Tech
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GOTTSBERG Leak Detection
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MSA
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Leak Detection 2/2

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Pergam Suisse
Switzerland
www.pergam-suisse.ch

PSI Software
Germany
www.psioilandgas.com

sebaKMT
Germany
www.sebakmt.com

SolAres (Solgeo / Aresys)
Italy
www.solaresweb.com

VEGASE
France
www.vegase.fr

Monitoring

Airborne Technologies
Austria
www.airbornetechnologies.at

Krohne Messtechnik
Germany
www.krohne.com

PHOENIX CONTACT
Germany
www.phoenixcontact.de/prozess

SolSpec
United States
www.solspec.solutions

Operators 1/2

Transneft
Russia
www.en.transneft.ru/

Operators 2/2

TRAPIL
France
www.trapil.com/en/

Qualification & Recruitment

YPPE - Young Pipeline Professionals Europe
International

Pump and Compressor Stations

TNO
The Netherlands
www.pulsim.tno.nl

Repair

CITADEL TECHNOLOGIES
United States
www.cittech.com

Clock Spring NRI
United States
www.clockspring.com

RAM-100
United States
www.ram100intl.com

T.D. Williamson
United States
www.tdwilliamson.com

Research & Development

Pipeline Transport Institute (PTI LLC)
Russia
www.en.niitn.transneft.ru

Safety 1/2

DEHN & SÖHNE
Germany
www.dehn-international.com/en

Safety 2/2

HIMA
Germany
www.hima.de

Signage

Franken Plastik
Germany
www.frankenplastik.de/en

Surface Preparation

MONTI - Werkzeuge GmbH
Germany
www.monti.de

Trenchless Technologies

Bohrtec
Germany
www.bohrtec.com

GSTT - German Society for Trenchless Technology
Germany
www.gstt.de

Rädlinger Primus Line
Germany
www.primusline.com

Valves & Fittings

AUMA
Germany
www.auma.com

Zwick Armaturen
Germany
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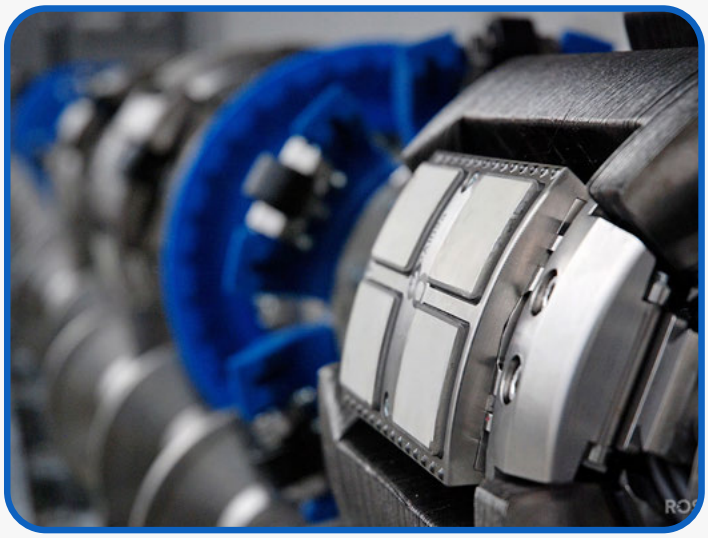

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UESI Pipelines 2020 Conference	9 - 12 August 2020	San Antonio, USA
IPC - International Pipeline Conference	28 September - 2 October 2020	Calgary, Canada
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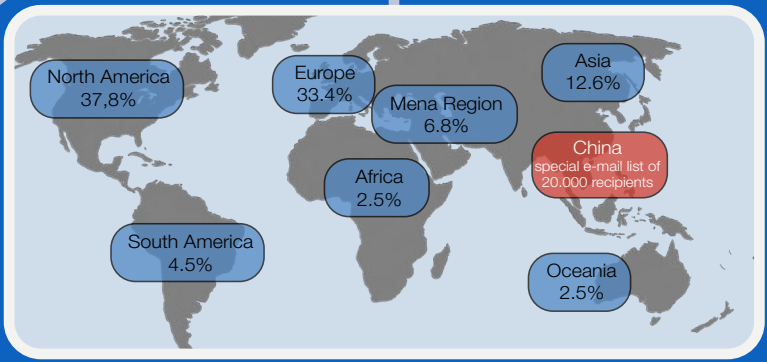

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