Are inaccurate records putting the safety of your pipelines at risk?

by Jason Edwards, ROSEN Group Project Manager, Lingen, Germany

Pipeline operators in general rely on robust records and inspection data so that sound integrity management decisions can be made, but how confident are you in the quality and completeness of your pipeline records?

Although many operators may have records of the original pipeline material, a complete understanding of the pipeline history in terms of modifications, repairs or replacements might not be available. Over time, confidence in historical records can easily be eroded, as operating companies are taken over, key staff or contractors change, processes evolve and paper records are lost or modified during conversion to digital formats.

In addition, variation in the quality or grade of pipe coming from different suppliers and manufacturers around the world can place extra concerns on the integrity of pipes. Errors in traceability may also result in pipes that do not meet the required grade specification being installed on networks without the installer's knowledge.

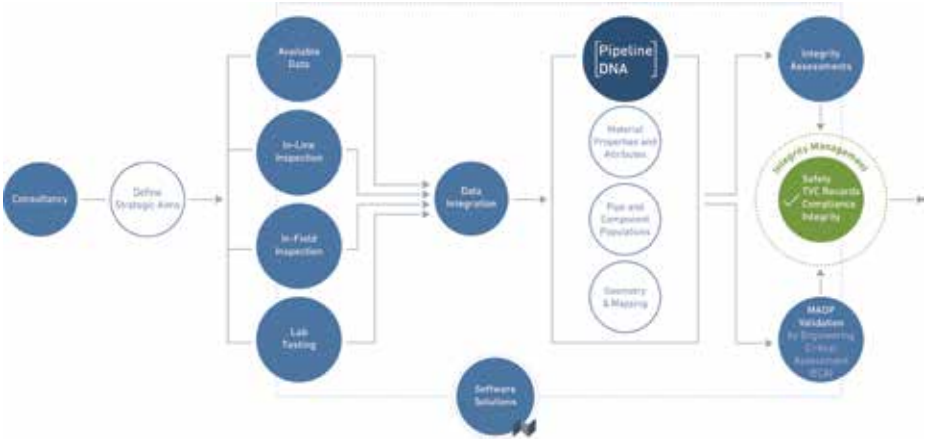
Pipeline operators have to deal with many unknowns when it comes to integrity management decisions, but with the continual change in pipeline environmental and operating conditions, Energy Transfer Director for Pipeline Safety David Johnson in Texas, US believes more emphasis is being put on integrity management systems and the need for rigorous and well documented pipeline records.

"There is an increased expectation – or again, demand – that we do better," says Mr Johnson.

"Every year, we have more pipelines delivering more energy located in closer proximity to more people. The mathematics of risk show that we have to decrease failure likelihoods to even maintain the same level of risk, as the potential consequences continually increase.

"So, we have to be better. That takes good decisions based upon deeper knowledge derived from adequate data and information."

This increase in expectation can be seen in the emergence of new regulations around the world, in particular the new US Pipeline and Hazardous Materials Safety Administration regulation in the pipeline industry, which is being introduced to extend integrity management requirements in order to address issues related to pipeline records. [1]



Material verification framework.

A major gas incident in which several people were killed and many were injured was the main catalyst for change. More than 100 homes were either destroyed or damaged, intensifying public scrutiny around gas pipelines and prompting regulations in the US to tighten.

The incident highlighted the need for robust records and data, with one of the major findings from the investigation showing the operator had an inadequate integrity management program based on incomplete and inaccurate pipeline information.

What do stricter regulations mean for operators?

The new US regulation aims to enforce operators to possess traceable, verifiable and complete (TVC) records for onshore steel transmission pipelines, for the purpose of maximum allowable operating pressure (MAOP) reconfirmation and input into integrity assessments. For operators who do not possess TVC records, the material properties and attributes (diameter, wall thickness, seam type, grade and toughness) of above and below ground line pipe and components must be verified or established.

The conventional method of determining pipe properties is to perform destructive testing on small coupons or cutouts from the pipe; however, this type of exercise is extremely costly, time-consuming, dangerous and often unviable. The regulations, therefore, allow for non-destructive methods to determine pipe properties using a statistical sampling program to verify the material properties for similar segments of pipes defined as 'populations', although this type of sampling program means major effort and cost for an operator.

In response to these new requirements in the US and to address material verification around the world, new technologies capable of obtaining material properties non-destructively on the pipe surface have emerged. However, the issue remains in the number of sampling points operators must carry out to effectively verify and validate the material properties of their pipeline.

Material verification framework

In recent years, the ROSEN Group has introduced the material verification framework with the aim of supporting operators through the material verification process. ROSEN is not only working collaboratively with operators in the US to satisfy the compliance requirements of new regulations, but operators in South America, Europe and the Middle East are currently working with ROSEN to develop a robust understanding of their pipeline material in an effort improve their integrity

management systems and ultimately minimise pipeline risk.

The service provides a holistic, flexible approach to pipeline material verification, incorporating review and alignment of existing records, inline inspection (ILI) data, in situ field examinations, material testing and industry expertise to ultimately establish a complete and thorough knowledge of pipeline material properties. This forms the basis of any fitness for purpose (FFP) assessments and MAOP validation and with the aid of software solutions to help manage and integrate the data, ROSEN is able to assist operators in defining an effective integrity management program.

At the core of ROSEN's material verification service is the pipeline DNA process, which provides a comprehensive look into your pipeline's makeup or 'DNA'.

ROSEN's pipeline DNA process

The pipeline DNA process integrates multiple ILI datasets: MFL, geometry, mapping, material properties, and other pertinent information to establish 'populations' of pipes within a pipeline. Each population has a unique combination of the following characteristics:

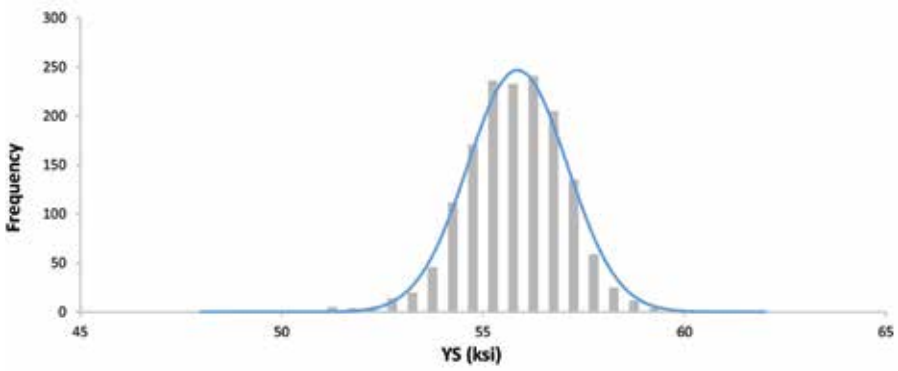
- diameter
- nominal wall thickness
- strength
- seam types.

The key to the DNA process lies within ROSEN's pipe grade sensor (PGS) technology. Traditionally, ILI has not been able to provide strength data, but with the addition of this innovative technology, material properties are now easier to obtain.

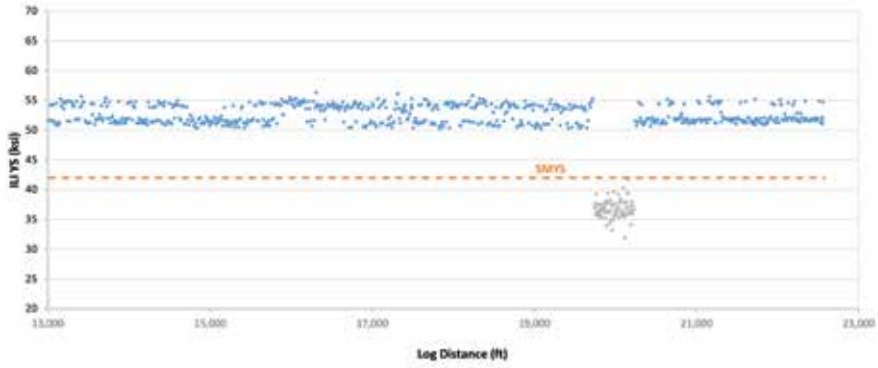
The company's PGS technology can be run in combination with the standard MFL-based ILI, which negates the need for a specific inspection run. The technology can be incorporated into the existing MFL tool set-up with no increase in tool length and data can also be collected opportunistically for use at a future date.

The unique patented technology is based on the interrogation of signals from eddy current sensors to define yield strength (YS) and ultimate tensile strength for each individual pipe length, using algorithms developed through pull tests and a significant amount of supporting material test data.

Analysis of the strength data is the most crucial part to identifying the populations. The strength data from a single population of pipes is described by a normal distribution, if the pipes are made by the same pipe manufacturer, using consistent process control.



YS of pipes from a single population described by a normal distribution.



Plot of YS vs distance showing different pipe classes (populations) of pipes.

By analysing the strength distributions and combining it with other known pipeline characteristics like wall thickness, diameter, seam type and pipe joint length, it is then possible to define individual populations of pipe. Once these populations are defined, each can be assigned a grade in line with API 5L specification for the line pipe.

An integral part of the wider material verification process is the interrogation of existing pipeline records to validate and align the ILI data. Pipeline route information, construction history and material records are analysed by ROSEN's integrity engineers and technical specialists to produce a detailed and accurate picture of a client's pipeline DNA.

Once a complete picture of the pipeline is obtained, non-destructive field verification can be implemented to fill any gaps in the pipeline knowledge. ROSEN performs industry accepted in situ non-destructive strength determination and hardness testing as well as chemical analysis, in situ metallography and ultrasonic wall thickness measurements.

These non-destructive strength determination techniques provide validation of the ILI measurements and can measure strength with a tighter tolerance and confidence than ILI, providing more accurate inputs into the DNA process. A targeted verification program is then developed in collaboration with the operator until a robust understanding of the attributes of a pipeline is achieved.

Benefits of the pipeline DNA process

Material properties

When material properties are unknown, the material verification process can obtain, validate and verify material properties such as diameter, wall thickness, strength and seam type. This can be particularly useful for pipeline sections in inaccessible locations where excavation is not possible.

A case study was presented at the 2018 International Pipeline Conference on a pipeline with its earliest construction dating back to 1928. [2] Due to the number of modifications over the long history of the pipeline, the operator had missing grade data and incomplete hydrotest records for several sections along the length of the pipeline.

Because of the long history and complexity

of this pipeline, addressing these gaps in data was a significant challenge. Through the pipeline DNA process ROSEN identified 72 different populations and provided a first assessment of grade for every pipe. Given the number of populations and the amount of missing records, the DNA process provided input into defining a clear and confident material verification strategy for their records.

Populations that differ from the design basis

Identifying unknown populations of pipe with strength characteristics below the design specified minimum yield strength (SMYS) of the pipeline is crucial for safe current operation. In 2017, ROSEN's pipeline DNA process identified a population of pipe that was not known to the operator, as seen in Figure 3. The operator's records indicated that the section was designated as grade X42 pipe, however in situ non-destructive testing confirmed that the population was in fact lower than the design SMYS.

Without the application of PGS technology, this section of pipe would have remained unknown. Sections of the pipe were then removed in a replacement program.

Unknown pipeline modifications and records

Pipeline modifications and/or crossings (rivers, roads and bridges) where a different population of pipe from the standard main population has been used are a common occurrence in pipelines. However, maintaining complete and accurate records of this over the lifetime of a pipeline can be difficult.

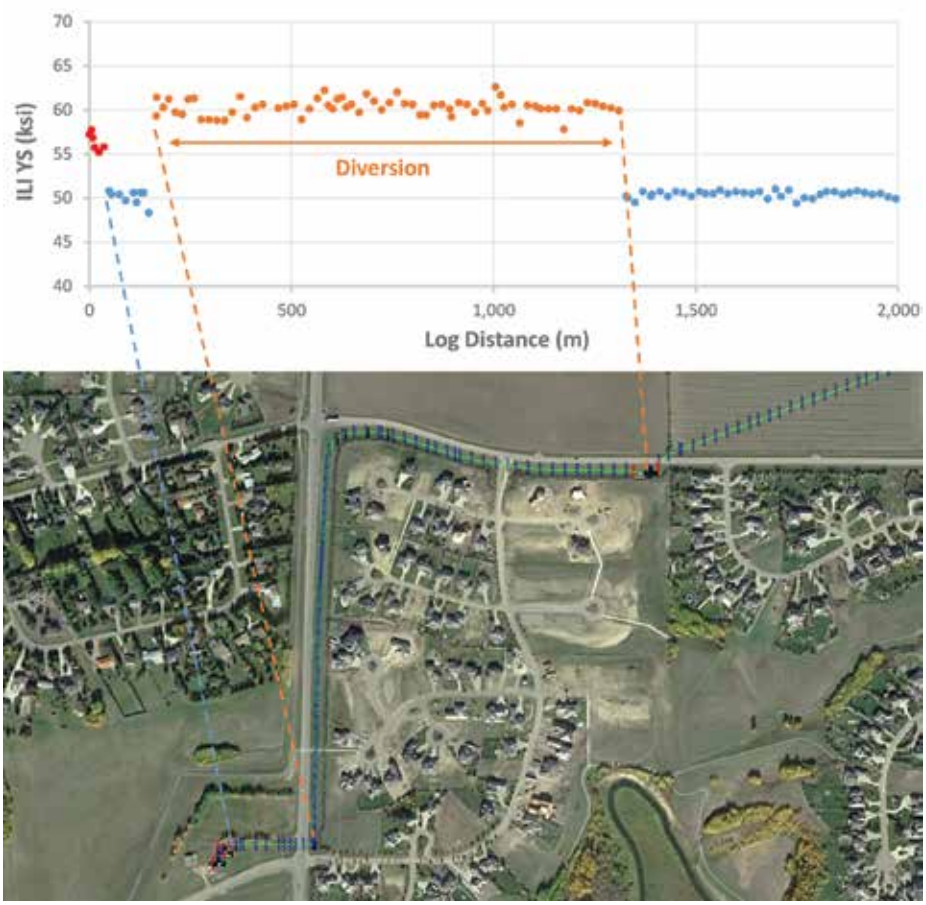
Through the use of mapping data, combined with analysis of the PGS strength data, it was possible to identify unexpected populations and, in some cases, align with existing records. One assessment identified an unexpected population under a river crossing.

As a result of this assessment, the operator was able to find records and match them with the population for the river crossing. Another assessment identified a pipeline alteration due to a new housing development.

The operator had discrepancies in their pipeline records and ROSEN's DNA process was used to realign pipeline route information and re-establish material properties.

Combining information

One of the key benefits of the pipeline DNA process is in the support it provides for FFP assessments and MAOP validation. Being able to define strength grades for individual populations as well as determine strength values for each individual pipe joint, provides an extra level of detail and confidence in these assessments.



Data integration process – route analysis.

The impact of the DNA process on FFP assessments was presented in a case study at the 2018 Pipeline Pigging and Integrity Management Conference and Exhibition in Houston, US. [3] The study showed ROSEN's DNA process provided essential data input for the FFP process, which negated the need to use overly conservative assumptions.

The immediate and future repair strategy was targeted on the pipe joints that had a potential higher risk of failure. In the US, regulations are driving operators to re-establish material property documentation and develop TVC records, which has stemmed from an increased risk of pipeline failure due to a lack of accurate pipeline material knowledge and a demand from the industry regulator to do better.

Though prescriptive regulation is not in place in all countries, ROSEN is now seeing other regions across the globe start to follow the lead of the US industry and recognise the importance of a robust knowledge of pipeline material properties in ensuring the safety of their pipelines.

In the last few years, technology has emerged to address this area of risk that was previously prohibitive to address in terms of both complexity and cost. Through a combined solution of new ILI technology and non-destructive in situ techniques, all the necessary tools and processes are now in place and available to operators.

The onus is now on operators to proactively improve their integrity management systems and processes, of which a robust pipeline material database is fundamental. Only then, when the fundamental basis is as accurate and reliable as possible, can we make informed integrity management decisions. **P**

References

[1] Federal Register of Rules and Regulation Vol. 84 No. 190, PHMSA 49 CFR Parts 191 & 192 Amdt nos 191-26, 192-125, pg 52180.

[2] S. Slater, T. Eiken, M. Ginten, K. Dwyer, O. Burkinshaw; An integrated approach for the verification of pipeline material using the latest state-of-the-art technologies IPC 2018, Calgary, Alberta, Canada.

[3] S. Slater, Oscar Martinez & Jaime Cervantes; State-of-the art ILI Services to Support Fitness-For Service Assessments, PPIM 2018, Houston, US.