WHEN THE DATA ALIGNS

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Although massive amounts of data should make asset integrity management easier, it can also make the information difficult to make sense of and interpret. Applying practical and easily applicable solutions to data allows operators to filter out the noise, focus on what is important and facilitate decision-making. NIMA is ROSEN's cloud-based solution for integrity engineers to make informed decisions by integrating key elements to support operators' integrity management plans (IMPs).

This article shows an example and explains how data integration of key elements (such as pipeline properties, inspection data quality, reported features, integrity assessments and GIS) can be used to help manage the threat of cracking in pipelines. This article focuses on maximising value from inline inspection (ILI) utilising a crack-detection technology. It discusses how the NIMA platform can be leveraged to reduce the number of unnecessary reruns while also providing a holistic view and dynamic manipulation of datasets that can be correlated to pipeline properties, ILI results and integrity assessments.

Pipeline Integrity Framework for cracking

The Pipeline Integrity Framework for cracking provides an overview of all elements (laboratory testing, the latest ILI technology, software, consultancy and field work) and the relationships between them that are required to understand, quantify and safely manage the threat of cracking in pipelines. It is recognised that many operators will have most components of this framework already in place. The modular design enables an open discussion of what information and analysis is needed and allows the option of selecting individual elements depending on particular requirements. The framework has been developed through the consolidation of industry best practices gained through working with leading operators worldwide; it can be adjusted to meet local regulatory requirements and operators' preferences. Figure 1 shows the key elements included in the framework for cracking.

Leveraging software as part of the Pipeline Integrity Framework for cracking

The combination of a holistic view, dynamic data manipulation and an easy correlation to different datasets (pipeline properties, ILI results, integrity assessments, etc.) is essential for supporting pipeline operators with IMPs. ROSEN's software NIMA is an intuitive and reliable platform that aids integrity engineers and operators in making integrity decisions. The benefit results from visually combining many of the elements of the Pipeline Integrity Framework. NIMA really excels in supporting gate points throughout the ILI stages and in the visualisations and correlations of the final results.

One of the first elements in the Pipeline Integrity Framework is data gathering. The collected information can be easily uploaded to provide a friendly interface with the

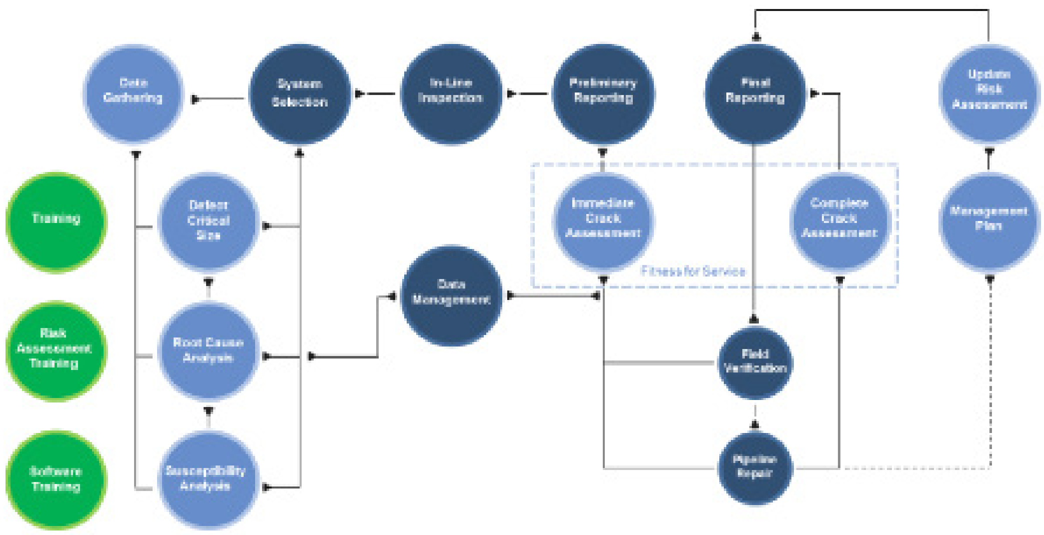

Figure 1. Elements of the Pipeline Integrity Framework for cracking.

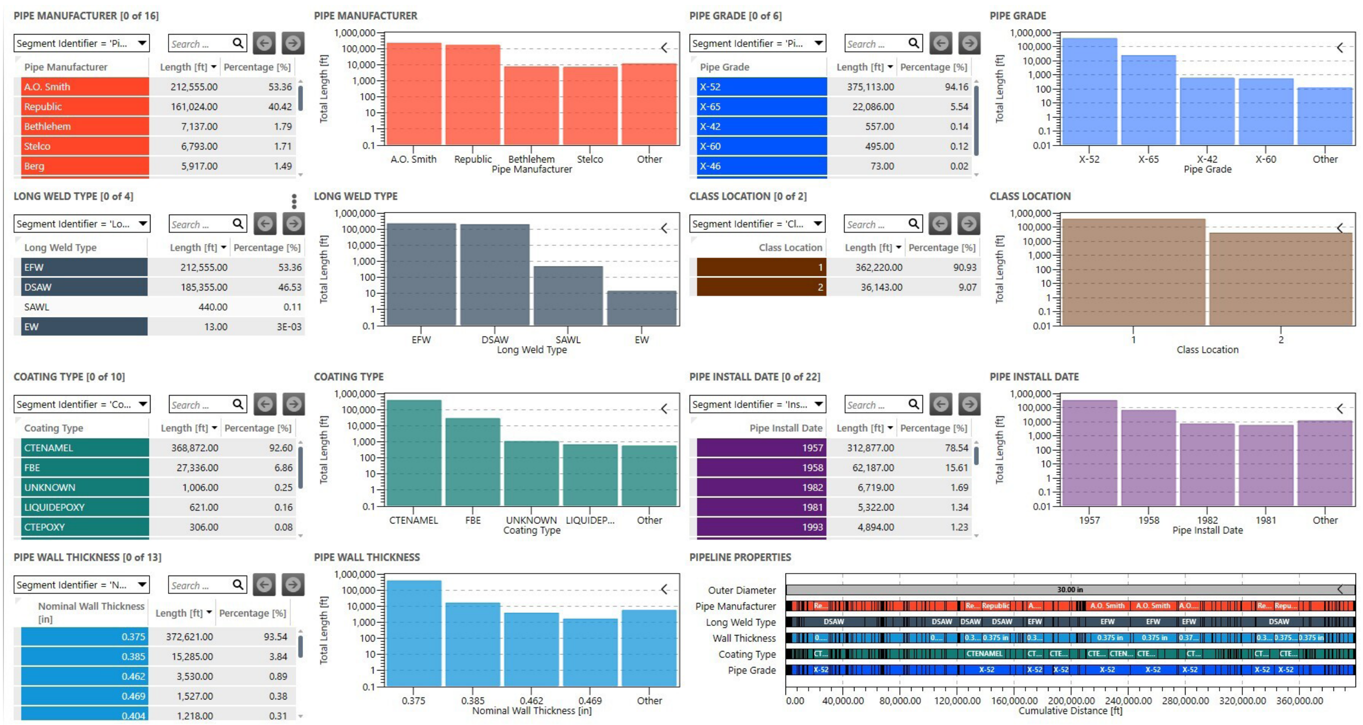

Figure 2. Pipe book information visualised.

data. One example of this feature is the visualisation of the pipeline properties. Pipe books contain vital information about a specific pipe segment. This information is most likely stored in a tabular format that may require manipulation and some effort to get a good understanding of the pipeline. Ideally, this information should be easily displayed in a few dashboards, providing the user a comprehensive overview of the entire segment.

Figure 2 shows an example of selected pipe properties for a pipeline segment. Relevant information about the pipeline is readily available. The user can effortlessly determine the main properties of the pipeline (e.g. pipe manufactures, weld types, coating types, wall thicknesses, pipe vintage, coating types, pipe grades, etc.). The plots and tables show sums of each property, and a linear view of the stacked-up information in a cumulative distance is also available. The linear information aids in identifying the changes in the pipe properties along the pipe segment overlaying with other properties.

In addition, all the data displayed on the dashboard can be correlated. By clicking on any of the plots, the software will highlight the associated information. For example, by selecting the wall thickness of 0.385 in., it can easily be seen that the coating type associated with this wall thickness is either fusion-bonded epoxy (FBE) or liquid epoxy. Likewise, all other correlated properties are highlighted (Figure 3). In addition, in the linear view, the 0.385 in. segments are also exposed. Not only do the correlated information and highlighted sections help the user to draw the conclusion that these sections may be installations and/ or repair areas, but they also provide

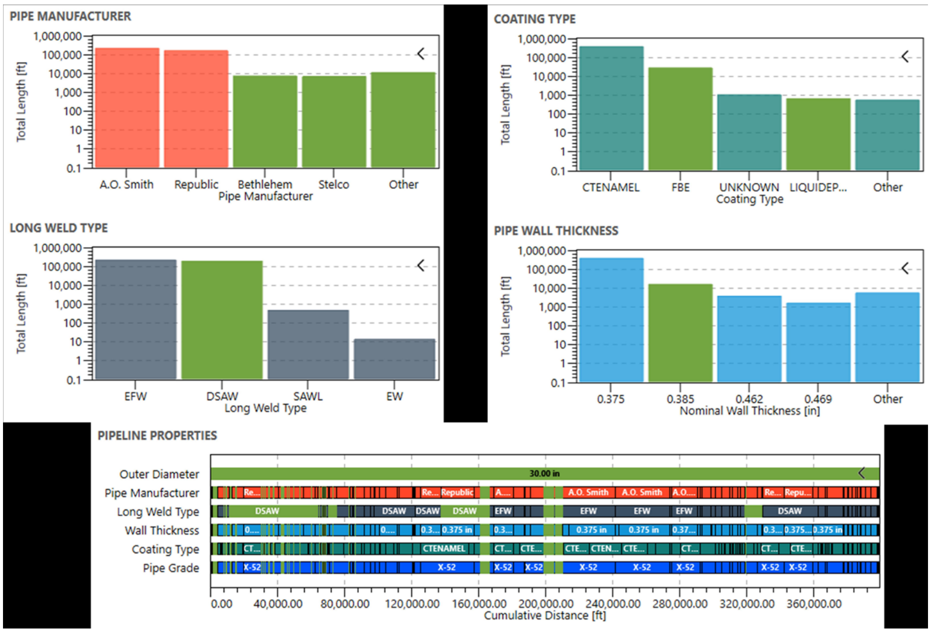

Figure 3. Correlated pipe properties.

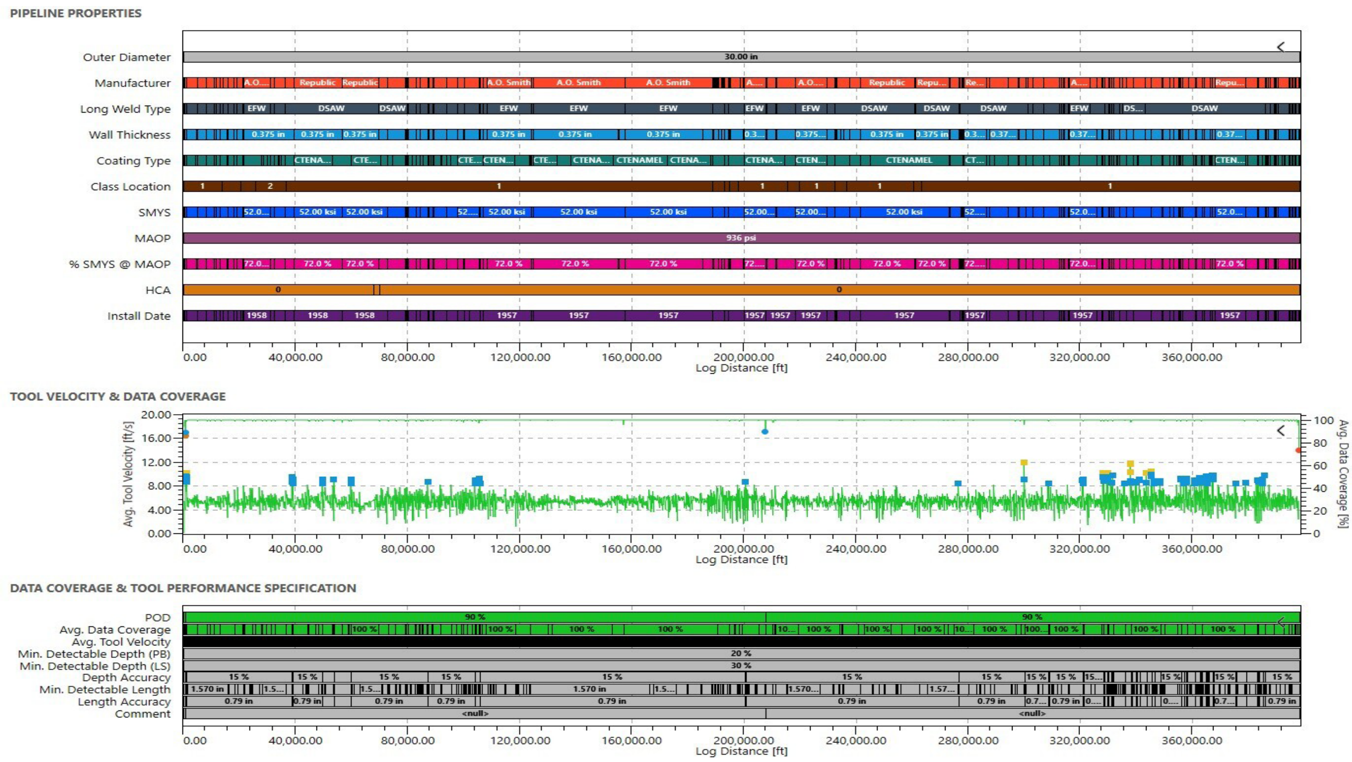

Figure 4. Pipe properties overlaid with DQA.

the visual locations of the selected sections along the pipeline.

All the relevant information gathered at this initial stage can be overlaid with the other stages of the inspection or assessment.

ILI reporting stages

Typically, the crack detection ILI is comprised of three reporting stages: preliminary site survey report, data quality report (DQR) or data quality assessment (DQA), and final reporting.

Intended to attest to the tool's functionality, the site survey report is provided within a few days after the run. The second stage (DQA/DQA) dives into the quality of the recorded data (data coverage, probability of detection, tool velocity, etc.).

Historically, crack technology DQRs were delivered to operators in a written format, documenting high-level inspection details such as launcher and receiver information, data coverage, tool velocity and more. While this document did provide a concise summary, operators encountered issues in correlating locations of potentially degraded data and overspeed areas as well as defining how the overall data quality would impact run acceptance and integrity decisions.

To gain an understanding of inspection quality, the evaluation team began providing DQA in a tabular format. The DQA delivered in Microsoft Excel format allows the data coverage and pertinent tool performance specification to be presented for each segment or joint. The benefits of the tabular report and segmented information include the ability to identify locations where probability of detection (POD) and tool sizing tolerances may be impacted. However, some data manipulation may still be required to correlate with the pipeline details (e.g. long-seam type, wall thickness, coating type, etc.).

When degraded data is observed, several aspects of the inspection can be reviewed to aid the decision-making regarding the acceptance of the survey. Some of the questions that ROSEN's integrity experts may discuss with operators include:

- Are the locations of degraded data in areas susceptible to cracking (e.g. stress-corrosion cracking)?
- If there is sensor lift-off, what may be causing it?
- Are there clear patterns in the data coverage that indicate debris being dragged through the line?
- Is overspeed being caused by changes in wall thickness/installation areas or by failure to control the pressure during the run?
- Does decreased coverage coincide with repaired sections of pipe that may not be susceptible to cracking (e.g. newly installed areas coated with fusion-bonded epoxy)?

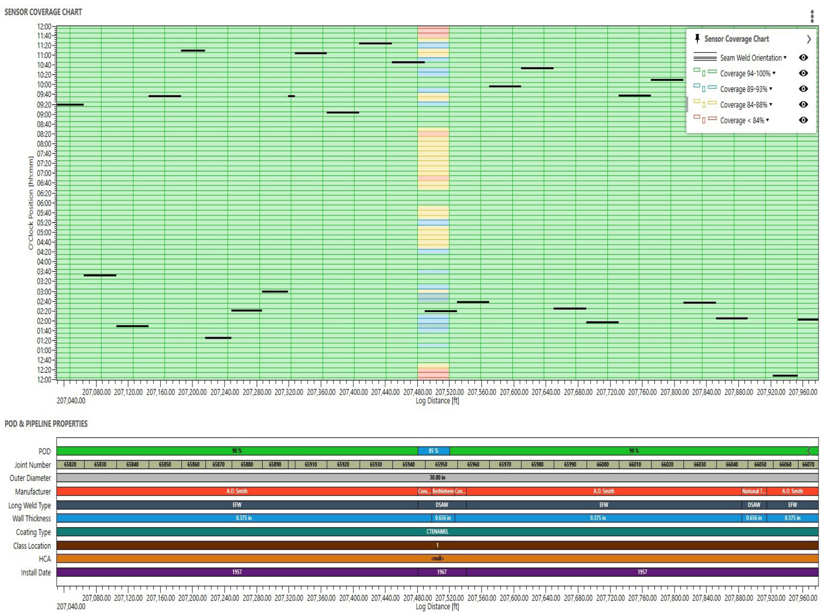

Figure 5. **Sensor coverage around the pipe circumference correlated to pipeline properties.**

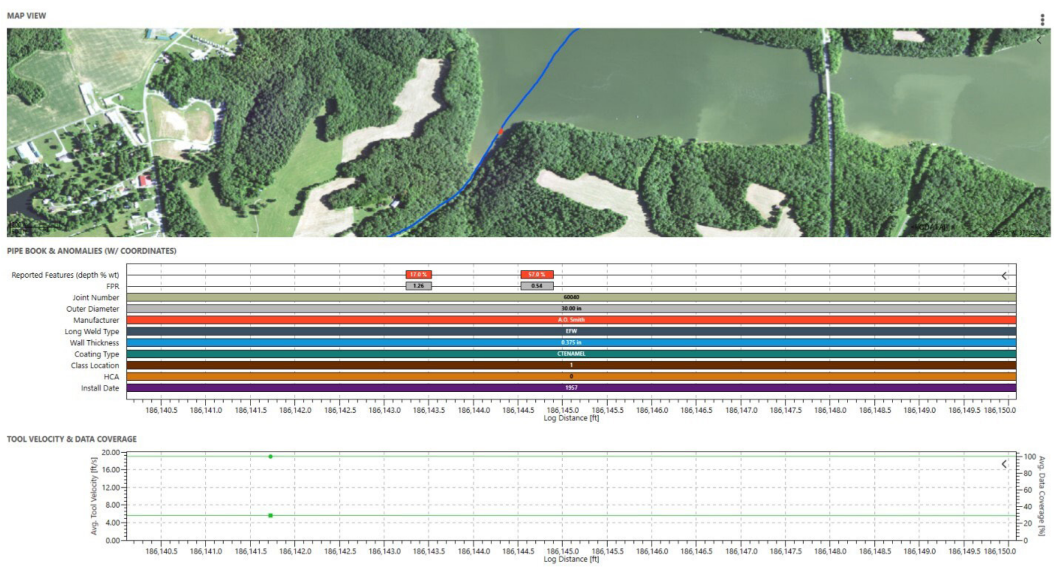

Figure 6. **Reported features distribution overlaid with pipe properties and DQA.**

- Do all high-consequence areas (HCA) have acceptable coverage?

Answering these questions, as well as understanding other integrity concerns, often facilitates the decision-making process during the DQA acceptance stage. For that reason, data integration is extremely important.

In the same way as the pipe books, the DQAs can be easily integrated and visualised using appropriate software. All line-specific information can be loaded into a project file, and the synchronised data can be displayed simultaneously, facilitating answers to many of the aforementioned questions.

An example of a DQA overlaid with a pipe book is shown in Figure 4. The top of Figure 4 shows the pipe properties along the log distance of the line segment. The second and third charts on the lower part of the image represent information from the DQA (tool velocity, data coverage and tool performance specification). All plots are synchronised, and as the user zooms in on a specific area of interest, the corresponding data quality along with the POD and tool performance specification is readily available.

If further inquiry of the data is needed, additional plots can be created to facilitate DQA acceptance decisions. For this specific case, the major concern was crack-like defects in the long seam. The DQA shows excellent results (99.97% of the pipeline with a POD of 90%, and for 98.8% of the run, the tool average velocity was below 8.2 ft/sec.). However, if there is a need to better understand the segment with reduced POD (e.g. a log distance of ~208 000 ft), it can be shown that the average POD for the segment is 85% – but the long seams of the affected joints are located within areas where the data coverage is above 94% (Figure 5).

Another common diagnostic plot is tool velocity versus wall thickness. Changes in the wall thickness may influence tool speed, and such plots may explain momentary tool stops and/or short-peaked overspeeds.

The ILI final stage (analysis of the data to produce the final report) is only initiated if the first two stages have provided acceptable results. At this final stage, the recorded signals are 'translated' into callouts (reported features).

Post-inspection consulting may be useful for operators. Supplementary support ranges from burst pressure calculations and dig prioritisation to a full fitness-for-

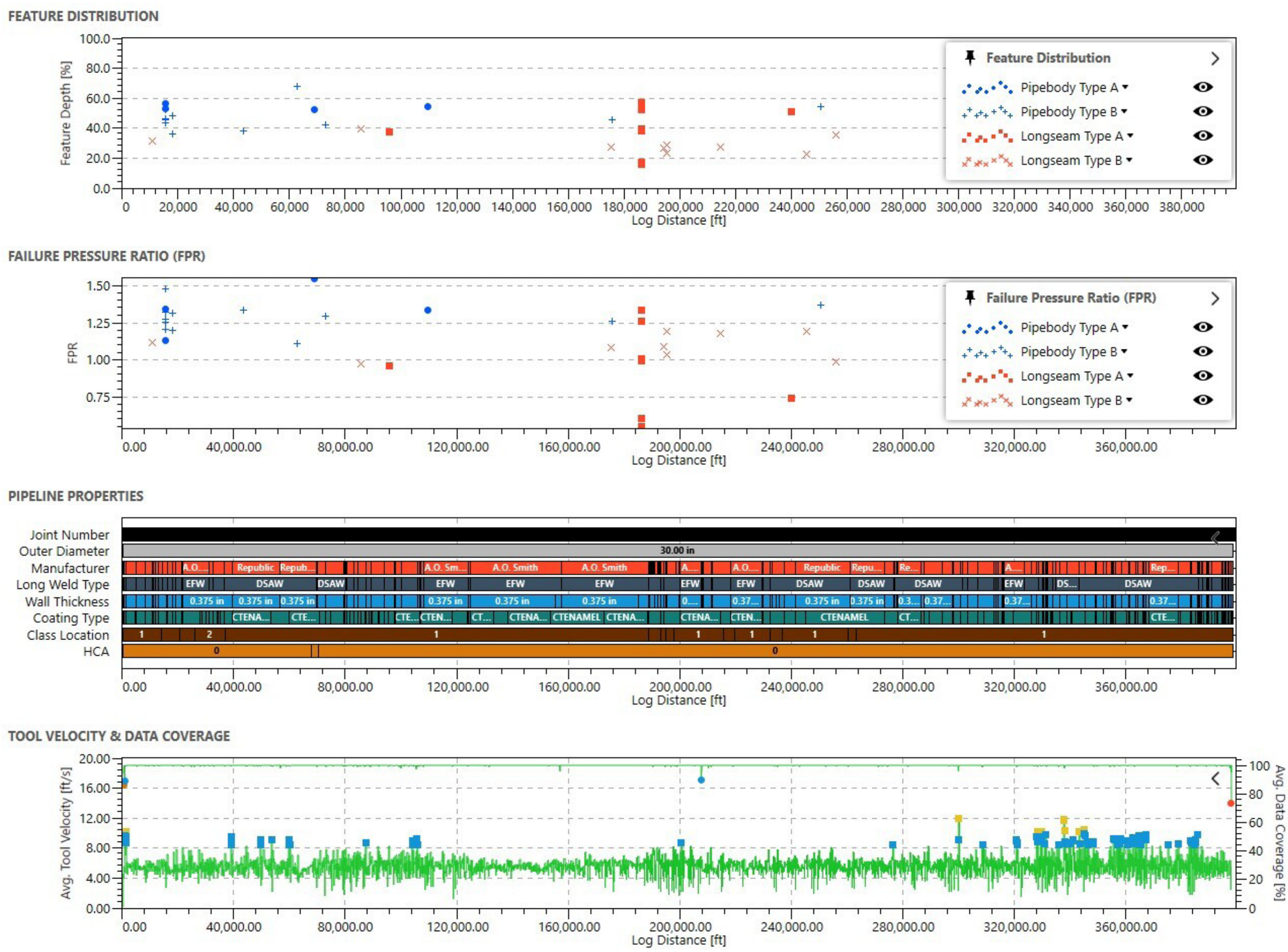

Figure 7. Reported features distribution overlaid with pipe properties and DQA.

service assessment. Additional services that may be beneficial for operators to obtain support with include feature response methodology based on the API RP 1176 approach, identification of pipes to cut out and test, metallography and the development of long-term management plans.

Software can also be used to overlay ILI results with integrity assessment and pipeline details. At the final stage, everything is compiled in order to facilitate informed integrity decisions. With a few dashboards, reported features can also be correlated to the pipe details, data quality, failure pressure ratio and POD. It is even possible to display geographical locations (map view).

The first two plots in Figure 7 illustrate the reported feature distribution (pipe body and long seam) for two confidence levels (high – Type A and lower – Type B) along the pipeline and corresponding failure pressure ratios (FPR). The plots are all synchronised to indicate pipeline properties at that location (including correlation to operators' joint numbers) and whether that area has been impacted by reduced coverage or overspeed.

Figure 6 shows a map view of the pipeline centreline highlighting the geographical location of two selected long-seam features. The chart also provides the tool technology's estimated depth sizing and calculated FPRs, as well as the correlated pipe book details. The two selected features are located in the same joint in a riverbank. The user can simply select any of the reported features to assess pertinent details of the selected area.

In this specific instance, the operator's main concern was possible crack-like defects in the long seam. Being able to overlay the survey data with pipe properties at the DQA stage can help alleviate concerns about data degradation in certain areas and reduce the number of unnecessary and disruptive reruns. This is one example of how the provided pipe book data can be used to facilitate approval of the ILI survey. In addition, the ability to provide an easy and dynamic way to manipulate all the available data (pipe books, ILI results and integrity calculations) provides the user with the necessary elements to make informed integrity decisions. Good software is so versatile that other datasets (e.g. previous ILIs, field verifications, repair areas, etc.) can be easily integrated to further enhance IMPs.

NIMA: supporting your asset integrity management decisions

The combination of digitised historical data and modern high-tech inspection systems means that vast quantities of data are now likely to be available for any pipeline. This data can help in managing complex threats such as stress-corrosion cracking, but only if we can create meaningful information by smart and efficient alignments, visualisations and analyses. One answer to these challenges is software that is specifically designed for this task, has the capability to handle large datasets, ensures repeatability and traceability, and can be adapted to suit particular situations. We experience these challenges working with hundreds of operators and have developed NIMA to help deliver solutions – and to help our clients make the right decisions.