HARNESSING NEW TECHNOLOGY FOR SAFETY AND SUSTAINABILITY

Josh Pendleton, Skipper NDT, France, **discusses employing new technology in pipeline integrity management to ensure the continued safe and environmentally friendly delivery of energy, whilst mitigating the increasing risks of incidents to nearby environments and communities.**

In North America, there are more than 800 000 miles of gas and liquid gathering, midstream and transmission pipelines and 2.3 million miles of gas distribution pipelines that deliver energy to local and international end users. Many of these pipelines have been operating for over 50 years and will be needed for several decades with the continued demand of the energy they deliver. Pipelines are more efficient than

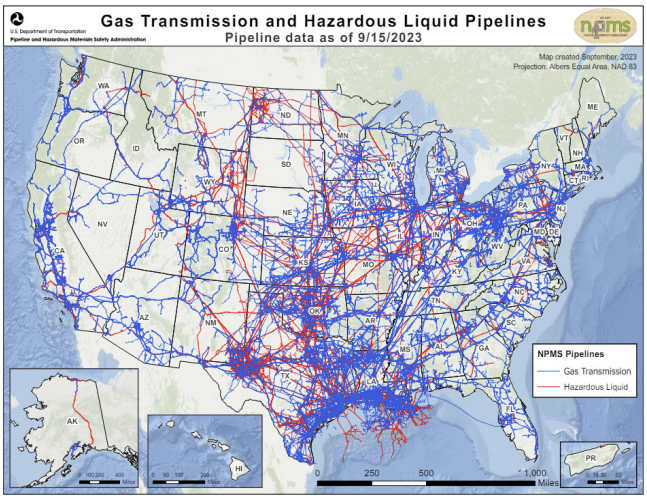

Figure 1. NPMS map of regulated pipelines in the US.

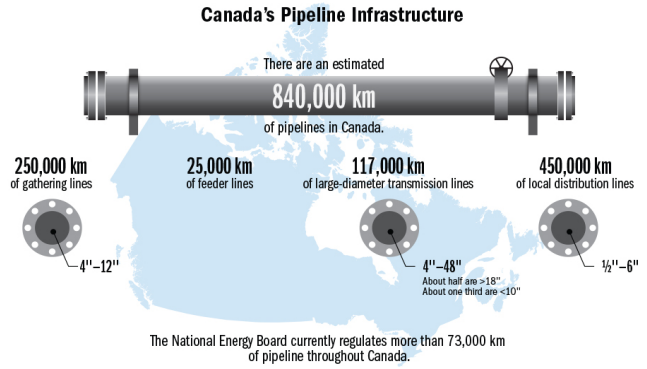

Figure 2. Summary of Canadian energy pipeline infrastructure.

other methods of energy transportation and have significantly lower environmental and safety impacts than trucking and shipping.

While pipelines play a significant role in North America's energy infrastructure, their potential for environmental impact needs to be carefully managed and mitigated through effective regulation, monitoring, and responsible operational practices. And although pipelines have clearly demonstrated that they are the safest and most reliable method of transporting energy, they can and do fail. Pipeline operators continue to look for ways to improve the safety and reliability of their assets to keep failures to a minimum. When operating safely they effectively deliver large amounts of low cost, reliable energy with low environmental and safety impacts.

The continuance of safe and reliable pipeline operations poses several challenges that pipeline operators must address and continually improve upon through the development, validation and application of new technology and engineering solutions. In concert with these challenges, operators are also charged with adapting to new regulations, public expectations and shareholder demands add complexity and pressure to maintain and improve both safety and reliability and to minimise both the likelihood and consequence of incidents.

With our ongoing reliance on pipelines for energy coupled with the complex challenges involved and potential for environmental impact operators must be constantly working to stay ahead of potential threats so that their associated consequences can be avoided or minimised. Innovation plays a large role in the improvement of pipeline integrity management and can have a significant impact both on the ongoing safe and low impact delivery of energy and minimise potential environmental impacts resulting from incidents.

Challenges

Pipeline integrity management (PIM) programmes are charged with managing and mitigating a myriad of threats and consequences. Many of these have direct ties to the environment they directly traverse and that which they can indirectly effect. As regulations and societal expectations continue to focus on improving the management of our natural environment, pipeline operators must focus on continually improving their integrity management programmes to keep pace.

While not exhaustive some of the key challenges which operators face are discussed in the following section.

- High consequence areas: Pipelines in high consequence areas (HCA) are defined for gas transmission pipelines by the proximity of population near the pipeline and for liquids transmission pipelines by the proximity of population, drinking water sources, commercially navigable waterways, and sensitive environmental areas. HCA pipelines require higher levels of inspection, monitoring and mitigation which can pose challenges for resource prioritisation, deployment and decision making.

- Geohazards: Managing pipelines operating in areas susceptible to geohazard threats is a formidable task which is compounded by several factors:
  - Changes in the frequency and intensity of significant weather events are affecting buried pipeline environments in new ways and rapidly.
  - There are limited options to pipeline operators for direct measurement of below ground pipeline locations.
  - They can be co-located within an HCA.

  The inherent complexities of subterranean environments demand innovative solutions and advanced technologies to ensure proactive monitoring and effective risk mitigation strategies.

- Water crossings: Water crossings are typically active hazards particularly during flooding events. Recent changes in weather have resulted in an increase of extreme events with heavy rainfall, overland flooding, and coastal flooding. These events have a direct impact on pipelines that cross them. Riverbed scour, bank erosion and river avulsion can lead to significant pipeline failures. As with geohazards, water crossings are also often co-located within HCAs.

- New construction: The construction of new pipelines continues to be a formidable challenge, characterised by high costs, regulatory hurdles and often faces concern

from the public. The intricate interplay of diverse stakeholders, including regulatory bodies and public interest groups, further complicates the endeavour, which leads to fewer new projects being planned and approved and the rising importance of finding improvements in managing ageing pipelines. When possible, there are often legacy assets (below and above ground) that need to be properly accounted for in construction planning to prevent costly unplanned interruptions during construction.

- Decommissioned and abandoned assets: In addition to the challenges with operating pipelines, legacy assets, notably decommissioned and abandoned pipelines, and wells, can serve as potential conduits for sub-surface water erosion and methane or CO_2 leaks.

Solutions

Meeting these challenges requires integrity management programmes that:

- Address all potential threats and consequences to their pipeline assets.
- Understand and control the probability of failure and potential consequences.
- Have complete, accurate and current data about the health of the assets being managed.
- Address all regulatory and operational requirements, including HCAs.
- Can adapt and address rapid changes due to environmental events and their effects (flooding, heavy rainfall, geohazards, erosion, etc).

Beyond the establishment of a robust integrity management structure and analysis methodology the data to support it is the most critical component of any PIM plan. Understanding pipeline integrity threats and consequences is impossible to achieve without having the necessary data to characterise the pipeline and surrounding environment. This data includes pipeline operational data, maintenance data, inspection data, patrol data, design data, operational history, and incident history.

The completeness, quality and currentness of this data poses a significant challenge for operators to manage. Operators face the opposing challenges of very large amounts of new data (inline inspection (ILI) for example) to be integrated with older datasets (historic ILI, historic excavations, and repairs, etc.) or situations where current data can be difficult to gather at a level of completeness and quality suitable for decision making. To reiterate this point, collecting accurate and complete data is essential.

With reference to the challenges listed in the section above some of the specific data required are as follows:

- High consequence areas: Pipelines within HCAs must have accurate and current data as to the exact XYZ location of the pipeline, in addition to current operating data, inspection data and patrol data as well as data on any potential change to the conditions of the pipeline and surrounding environment.

- Geohazards: Pipelines traversing areas with the presence of geohazards must also have accurate and current data as to the exact XYZ location of the pipeline in addition to ongoing monitoring of the surrounding environment (soil, rainfall, erosion, etc.). Having current, and frequent high-quality data as to the exact location and geometry of the pipeline, along with regular bending strain analysis enables the operator to understand change and the rate of change to the pipeline in geohazard areas so that appropriate mitigation can be applied.

- Water crossings: Pipelines crossing dynamic water bodies rely on accurate and current data as to the exact XYZ location of the pipeline in addition to information about the water body itself (riverbed, level, flow, bank changes, etc). Having the ability to collect XYZ data regularly and accurately for the pipeline allows the operator to track and analyse trends in changes to key factors and predict issues before they cause harm.

- New construction: Many new construction projects are considered as brownfield projects which have the potential to be impacted by existing, legacy assets with poor records or no records at all. These assets are often below ground and when encountered unexpectedly during construction can cause costly delays and change orders. Pre-project data collection can mitigate this challenge and allow construction teams to plan accordingly.

- Decommissioned and abandoned assets: Decommissioned and abandoned assets are challenging to both owners and regulatory bodies. Having technology that can efficiently and effectively locate and map these assets is the initial step in the process of assuring they are properly decommissioned and pose no ongoing safety or environmental hazard.

Accurate pipeline position data can be difficult and costly to collect in all these situations and locations, however the rise of drone-based, non-intrusive systems for locating and mapping underground assets and de-commissioned infrastructure offer operators innovative and cost-effective solutions to tackle these challenges reliably and accurately. These technologies enable continuous enhancement of integrity management programmes, thereby ensuring the protection throughput of critical economic infrastructure as well as the ongoing safety of the environment and people.

Conclusion

By integrating new technologies with comprehensive pipeline integrity management programmes, pipeline operators can consistently enhance their capacity to tackle growing challenges from environmental factors and stakeholders. This approach ensures the continual safety and reliability of our crucial energy transportation infrastructure.