Pipeline Integrity Data: An Essential Asset

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PIPELINE INTEGRITY DATA: AN ESSENTIAL ASSET

Abstract

As we enter the third decade of the 21st Century; the Pipeline Industry worldwide, particularly in Australia, faces numerous challenges. From the Integrity perspective, ageing is undoubtedly on top of that list, and as other forms of energy become more popular and affordable, replacing hydrocarbons, capital investment and hence asset renewal become less attractive to operators. However, the supply of hydrocarbons continues to be critical to our society. As we also look at alternative forms of energy such as hydrogen possibly relying on existing assets, it becomes a more significant challenge to ensure pipelines continue to operate safely and efficiently for many years to come.

It is often the case that efforts made to address pipeline integrity threats focus on conducting inspections, followed by integrity assessments and remediation. The attention is focused on the material and its capacity to sustain pressure. The 'pipe' is often seen as the asset in question, but we forget that the data is also an integral part of the asset. There is an investment made in collecting that data, and as much as we want to increase utilisation, efficiency, and quality of physical assets, we must exercise the same discipline with the data. The data is as much an asset as the asset itself.

Introduction

Capturing and evaluating integrity data is a complex exercise that allows the operator to understand what the physical condition of the asset is at a given point in time, as well as the effectiveness of the Integrity Management Plan in assuring service life.

In the current climate, organisations need to be more innovative, but also disciplined in maximising budget allocations whilst meeting the commitments made in the Integrity Management Plan, an AS2885 requirement.

As an industry we sometimes do not fully embrace the opportunity to gather integrity data. Efforts made to collect accurate and reliable integrity data are not on the same level as, for example, those made when designing and constructing new pipelines. Stringent processes and procedures are well established for ensuring new pipelines are built to planned specifications. Close scrutiny is given to every dollar spent and numerous resources are utilised to ensure equipment is of the highest quality. In terms of day-to-day operations, capacity is always maximised so that every possible hydrocarbon molecule moves through the pipeline without interruption.

So why not also maximise the value our integrity data?

In the end, just as with new pipelines, it is about the process. We need to understand the end goal, engage the right people and communicate well to keep stakeholders accountable.

Integrity data is vital for the operator to understand the asset's physical condition, the potential for life extension, or even conversion to different services. Therefore it should be treated with as much care and disciple as the very asset itself.

The integrity data collection process consists of the following phases:

1. Plan
2. Design
3. Capture
4. Assess
5. Integrate

This paper will cover each of the above, with detail on what they involve and guidance on best practices to ensure each opportunity maximises effectiveness and value.

Plan

An Integrity Management Plan (IMP) developed in accordance with AS2885.3 is designed to target pipeline threats identified in the Safety Management Study (SMS) by conducting activities aimed at controlling, monitoring, and mitigating such threats. Some of these activities are undertaken as part of a routine maintenance plan, such as cathodic protection surveys, chemical injector checks, corrosion probe or coupon retrieval, liquid sampling, maintenance pigging, etc. Other activity types, such as inspections, are more targeted and specialised and are generally part of annual programs. These include coating defect surveys, in-line inspections and non-destructive testing.

It is critical that integrity engineers, as well as operations personnel and management, are aware of the activities and frequencies outlined in the IMP. The IMP is a document that must be followed in accordance with AS2885.3 and therefore is a regulatory obligation. But more than that, the IMP is a live guidance document designed to ensure that the pipeline's structural integrity is maintained throughout its service life. However, ever-changing conditions in the pipeline's environment and its operating parameters can affect the IMP's effectiveness, so it becomes incumbent on the operator to ensure its regularly recalibrated as needed.

IMP activities generate key inputs which, if not fed into the budget cycle promptly, an opportunity to make the appropriate corrections could be missed, possibly resulting in non-compliant parameters (such as cathodic protection potentials as required by AS2832.1), missed deadlines, critical defects not being addressed, or increased corrosion rates and pipe wall loss possibly leading to reduced service life.

A strong governance system embedded in the Pipeline Management System, whereby the organisation reviews the results from the IMP well ahead of the budget cycle, is often key to ensuring any deficiencies are addressed in time. It is also important that the appropriate resources are involved in this process. For operators with multiple pipeline systems, it becomes more critical to establish a comprehensive Pipeline Management System whereby IMP activities are planned using a risk-based approach, recognising that not all actions need to be addressed within the same budget cycle.

Some activities, particularly those with an impact to pipeline throughput (i.e. inspections, repairs) need to be carefully planned and agreed upon by the appropriate stakeholders.

The table below illustrates some examples of IMP activities generated as a response to outputs from previous cycles:

Output	Response
Cathodic protection survey	Anode bed replacement
	Transformer/rectifier overhaul, replacement, new installation
	Fast-tracked coating defect survey
	Close-Interval Survey, natural-potential survey
	Test point, cross-bond installations, MIJ/IF replacement
In-line inspection data	Dig program
	Re-inspection
	Repairs
	Remaining life review
Coating defect survey	Dig up program
	Coating repairs
	Close-Interval Survey, natural-potential survey
	Fast-tracked ILI
Pipeline history (same or similar pipeline)	Dig up program
	Coating repairs
	Close-Interval Survey, natural-potential survey
	Fast-tracked ILI

In many cases, the very purpose of the response activity is to obtain more data to validate the result obtained from the IMP activity.

In the end, a multi-year plan is often developed, approved and funded for execution. A schedule should also be developed in parallel with the budget so that once funds are allocated, the program can begin without delay.

Design

Once the plan is developed, budgeted, and funded, the next step is to ensure that all the relevant stakeholders are informed about the inspection's objective, proposed timing, purpose, and requirements. Stakeholder involvement throughout the process is instrumental in identifying the best conditions to conduct the activities to ensure better data capture.

Ensuring that specific operating conditions are in place is instrumental for success, particularly when it comes to in-line inspection and non-destructive testing.

Some of the stakeholders that may need to be involved in the design process are:

- Pipeline Integrity/Engineering
- Field surveyors
- Engineering Consultants
- Inspection vendor(s)
- Construction contractors (excavation, coating removal/reinstatement, pipeline repairs)
- Pipeline operations and Control Room
- Commercial and customers
- Landholders, Cultural Heritage and other third parties
- HSE
- HR and Training
- State Regulators

Integrity management activities are often in direct conflict with operational requirements; therefore, it is crucial to identify and engage the appropriate stakeholders to ensure IMP activities are executed during a mutually acceptable operational window. For example, the ideal flow rate required for an in-line inspection may be in direct conflict with the operational/commercial requirements of the pipeline.

Capture

Once an appropriate timeframe has been identified, and with the relevant stakeholders on board, ensuring that the desired resources and conditions are in place to conduct the activity successfully becomes the next challenge for integrity engineers. In this case, ‘success’ means capturing data of the highest possible quality so that an accurate integrity assessment can be conducted.

From the list of stakeholders above, some will need to be involved throughout the entire process, whilst others may only need to be informed of progress or any changes. Developing a detailed procedure to identify these roles and responsibilities is strongly recommended, as is a requirement in AS2885.3. A key part of this process is to conduct regular planning meetings, where the various requirements are identified and tracked to ensure everything is in place prior to mobilising resources to site. Some of the items to cover during this process are listed below:

- Roles and responsibilities
- Expected feature type, required integrity assessment, possible repair methods
- Data requirements
- Required operating conditions

- Equipment, materials and consumables
- Personnel (transport, accommodation, induction and training requirements)
- Procedures, forms and templates
- Communications protocol
- Risk Assessments, JHAs and Work Permits
- Access to site, land permits, weather patterns
- Emergency Response
- Supporting equipment (i.e. excavation, sandblasting and coating, lifting, venting/flaring, welding)

Communications between field personnel and integrity engineers are of utmost importance to ensure that the required quality and completeness of the data are achieved as it is being captured. When an inspection involves pipeline excavations, establishing a well-defined sequence of events may be crucial in ensuring the correct data is collected at the right time. There are plenty of unfortunate examples where, for example, the coating is removed and grit-blasted before the NDT technician is even on-site.

Below is a high-level description of key steps in a pipeline dig up inspection:

- Pipeline location
- Girth weld location and verification
- Excavation and pipeline exposure
- Close visual inspection (pre-coating removal)
- pH and damaged coating sampling
- Cathodic protection readings, soil sampling
- Coating removal and grit-blasting
- Pipe wall inspection
- Review of data collection forms
- Integrity assessment
- Repairs and/or re-coating
- Backfilling

The value of spending time and effort developing high-quality, detailed data collection templates cannot be overstated. Ensuring that all parties involved in the capture process fully understand every data field, the methods and technology to be used, as well as data formats, units, etc is the key to avoiding re-work and making the most of the opportunity.

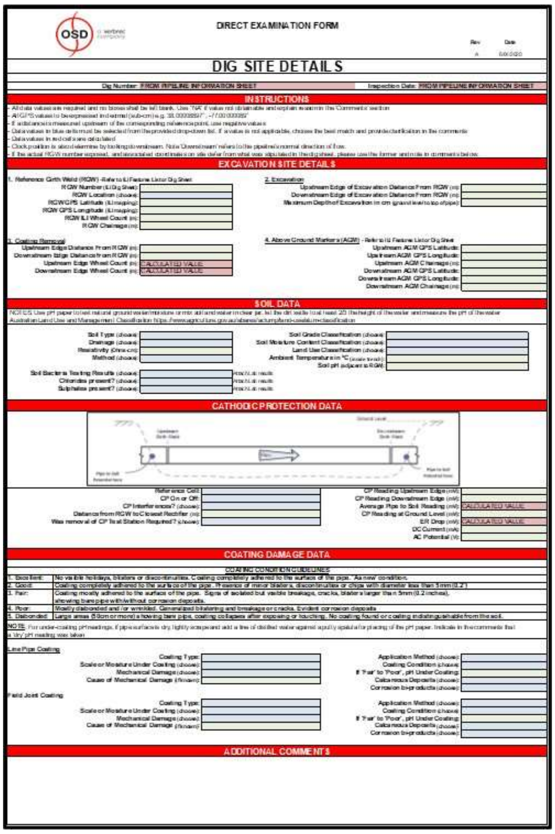

Figure 1 - Develop Detailed Data Capture Forms

Good quality photographs during each step of the process are also vital in ensuring the integrity engineer has all the information they need to understand the pipe's condition, particularly in its 'as found' state. Detailed marking of all features, including anomaly/defect dimensions, direction of flow, clock position, etc, should be required in all photographs.

The example below illustrates the benefits of proper marking and delineation of pipeline features in photographs. The image on the left is grainy, out of focus and showing no context as to its size and position. The image on the right provides an improved representation of the type and magnitude of the feature.

Figure 2 - Pipe mark-ups can make a difference

Unfortunately, the picture below is a common example of pipeline feature images obtained by field personnel.

Figure 3 - No Grainy or off-focus Pictures

Assess

An experienced integrity engineer with high-quality data in hand is in an excellent position to conduct reliable integrity and fitness for purpose assessment using the appropriate method. AS2885.3 provides useful guidance on various assessment levels and their associated conservatism. The applicability of each method is inherent to the data quality, so it is important to identify the integrity assessment method(s) to be used during the Design Phase.

Integrity assessment calculations should also be verified by an independent experienced engineer.

Integrate

Although the purpose of an integrity and fitness for service calculation is generally about the pipeline's short-term remaining strength, it is the ability to utilise the full range of data collected during the inspection what will allow the integrity engineer to also understand the possible cause for the damage, as well as identifying the best mitigation measures so that there are no more occurrences. This is the phase of the data collection cycle where the most value can be extracted out of the opportunity, but once again relying on the quality and completeness of the data collected.

The table below shows useful data sets, other than anomaly dimensions, that should be collected during a pipeline inspection, as well as their benefits:

Data Set	Benefit
Detailed coating defect data (pipe, joint, transition)	- Validate DCVG data - Align coating defect and ILI metal loss - Define levels/severity of disbondment - pH (validate effectiveness of CP) - Identify possible blistering (CP over-protection, poor installation conditions) - Effects of soil type - Identify interference (AC and/or DC)
Soil type/condition	- Effects of soil on coating - Drainage, moisture, resistivity - Bacteria and contaminants in soil
Cathodic protection potentials (at pipe level)	- Validate %IR for future CP surveys

Data Set	Benefit
	- Effects of CP on coating condition
Pipeline alignment	- Identify high/low points - Sources of soil moisture (creeks, drainage) - Evidence of soil movement
GPS coordinates (anomalies, girth welds, appurtenances)	- Validate ILI mapping tool accuracy - Validate DCVG equipment accuracy - Validate GIS alignment data - Identify pipe movement
Material Identification	- Pipe grade, SMYS - Weldability - Hard spots
Anomaly data (pre and post coating removal)	- Clock position - Distance from reference girth weld - Interaction with other anomalies/seam weld - Presence of corrosion bi-products

The list above is only a high-level guideline and is not exhaustive. The integrity engineer's responsibility is to ensure all the relevant pipeline history is well understood and evaluated during the Design Phase so that the appropriate data sets are planned for collection.

Conclusion

Pipeline surveys and inspections can be complex activities requiring interaction with and input from multiple stakeholders. The collection of data is often highly technical and requires great attention to detail to ensure reliability. Opportunities to conduct these activities can be rare and it is incumbent on the pipeline operator to maximise their value, both by identifying the right stakeholders and ensuring they all understand the purpose of the activity, as well as making sure the data parameters are appropriately identified, so that it can be better utilised throughout the asset’s ongoing integrity cycle. The time and effort spent planning and preparing for the activity will always turn into a valuable investment when compared to possible re-work or the cost of collecting unusable data.

The pipeline industry faces numerous challenges, particularly in the hydrocarbon world as alternative energy sources are further developed and established. Existing assets will continue to be needed whilst budgets and resources become more limited, resulting in the need to further maximise those rare opportunities to collect asset integrity data to ensure safe operation, extend service life, or even adapt and convert their use to support some of those very new alternatives. In the same manner as operators seek to maximise the utilisation of the asset (for example, when looking at capacity vs flow rates), we should maximise the value we get from the integrity data we take the time and effort to collect.