The right framework for SCC management

ROSEN's crack management framework has been developed from and is a culmination of years of industry research and development. In collaboration with pipeline operators, the company's experienced engineering consultants – working in integrity, risk management and stress corrosion cracking – combine with technology and data evaluation experts to provide a comprehensive crack management solution founded on best practice.

The threat from stress corrosion cracking (SCC) to pipelines worldwide increases as they age. SCC is a serious integrity threat with a history of being overlooked by pipeline operators, leading to high-consequence failures.

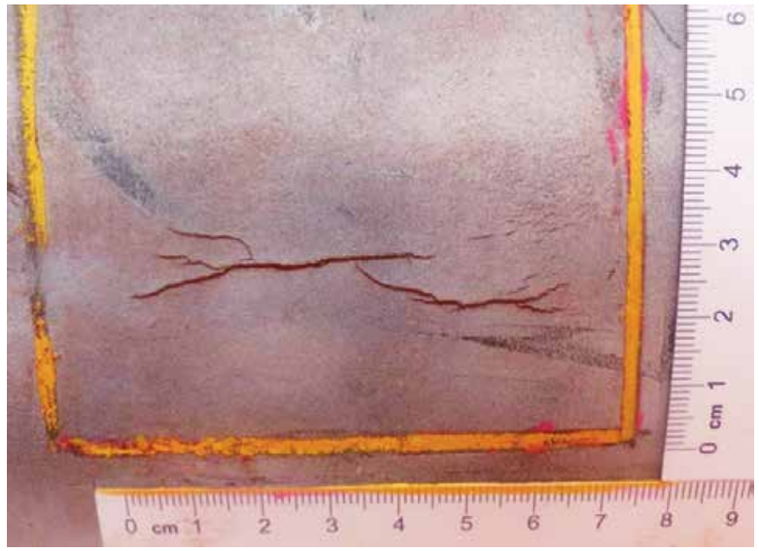
More sophisticated inspection technologies and management practices have been developed by the pipeline industry to manage this threat more reliably and cost-effectively. Hydrostatic testing and direct assessment (DA) have previously been the main management techniques, both of which have considerable drawbacks.

Hydrotesting is costly because it requires pipeline downtime and will not help the understanding of the defects that remain in the pipeline after a successful test. A range of theoretical crack sizes, which would have just survived the test, can be approximated, but the key questions on how many cracks remain in the line, their location and how fast they may be growing remain unanswered.

Stress corrosion cracking direct assessment (SCCDA) involves the quantification of the SCC threat through intensive collection and expert analysis of data related to pipeline construction, operational history and surrounding environmental conditions. This is normally combined with external non-destructive testing (NDT) at prioritised locations to validate the threat.

As expected, the success of any SCCDA approach when used as a standalone integrity management tool is solely dependent on the quality of the supporting data, and if it is limited, locating SCC could be compared to finding the proverbial needle in a haystack. Advances in ultrasonic (UT) crack inline inspection (ILI) technology and the development of electromagnetic acoustic transducer (EMAT) tools has made managing cracks easier, but even with recent developments, it is certainly not easy.

ILI should only be considered as a supporting component of an overall integrity management strategy when faced with SCC, with in-depth expertise surrounding the root cause and overall risk being just as critical – the latter requiring people and process to effectively implement.



An example of SCC.

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SCC in Australia

It seems inevitable that more Australian gas pipelines will suffer from SCC in the coming decades as their coating systems deteriorate. Most gas pipeline operators worldwide with newly discovered and long-standing SCC issues use ILI as a critical component of their crack management programs, preferring to inspect and dig over conducting costly hydrotests.

Targeted data collection at field verification locations can then be used to refine the susceptibility model along the pipeline, but ILI should not be the sole response to an SCC threat. It represents only one element among the requirements for a coordinated threat-driven response across several operational disciplines.

This process should be executed with multi-discipline expertise working alongside established procedures. ROSEN Group has visualised this concept with its crack management framework.

The framework

The crack management framework is a consolidation of current industry best practice and combines the most advanced ILI solutions with the knowledge of subject matter experts. It is a systematic approach effective in managing even the most challenging forms of SCC and can also be applied to other forms of environmental, metallurgical and fatigue-related cracking integrity threats.

The framework does not advocate throwing an expensive crack detection ILI tool into a pipeline without thought but suggests a value-adding approach to ensure that the integrity drivers for inspection are understood alongside the capabilities of the tool to detect and size the expected degradation. An operator should have answers to a range of questions about the problem before an inspection is considered.

Running an ILI tool

Most gas pipeline operators worldwide use EMAT over UT ILI technology when inspecting for SCC. Although UT crack detection technology is generally considered to have better detection and sizing capabilities, it requires a liquid couplant, meaning that in gas pipelines, it is costly and operationally challenging to execute.

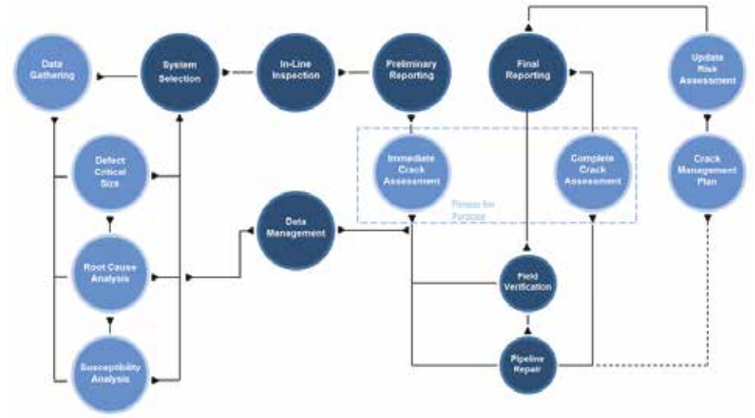
Acoustic-based crack detection technologies rely on the detection of planar reflectors in the pipeline, but cracking is not the only phenomenon that will generate these reflections. Sharp-edged corrosion (commonly found with certain types of SCC) and geometrical irregularities such as the weld cap profile can also generate similar signal patterns.

A common result is that an unmanageable number of features are reported from an investigation standpoint, making it difficult for the operator to make decisions on the next steps. The challenge therefore must be to improve probability of identification (POI) of 'real cracks'.

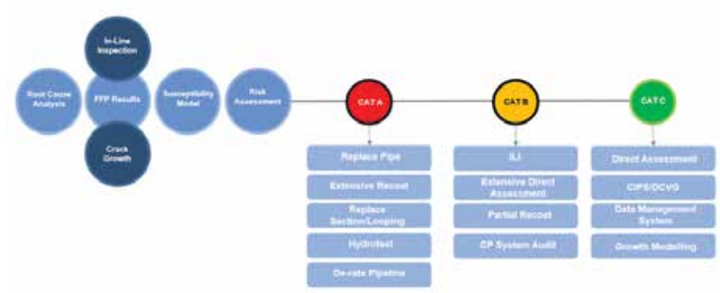
According to ROSEN, close cooperation between integrity engineers and data evaluation experts is needed at this stage and, using the results of a susceptibility analysis, engineers can target sections of the pipeline that should be focused on from an evaluation perspective. A great advantage of running EMAT is that it provides information on coating condition and the location of different types of coating, which can be used to identify areas of poor coating where SCC is more likely to be present; this data can be used to drive the susceptibility analysis.

To complement this process, it is critical to have good in-field results, necessitating close cooperation between ILI vendor and client. Once an the vendor has a good understanding of what the tool is seeing and the corresponding feature is found in-field, signatures in the wider ILI data population can be benchmarked and POI further increased.

The framework allows this process to happen with its preliminary reporting of the ILI results followed by field verification and repair before the final ILI report is delivered. Choosing which features to go and dig first should be driven by a prioritisation approach considering theoretical



ROSEN's Crack Management Framework.



The typical components of a crack management plan.

defect criticality (i.e. a fracture mechanics-based assessment) as well as evaluation confidence in the feature.

The feature population can therefore be 'binned' and a range of sites sitting in each bin investigated – each refining the understanding of the threat in the line.

ROSEN's experience is that the above phase is often skipped or substantially curtailed, leaving the integrity engineer no choice but to assess and sentence reported anomalies. This approach often originates from historical experience of running metal loss inspection technologies where both the technology itself and the associated integrity assessment activities result in binary choices. This does not hold true when faced with a cracking threat.

Putting it all together

A framework brings together experts in SCC, pipe manufacturing, fracture mechanics, inspection systems, inspection data evaluation, non-destructive examination, data analysis, fatigue, and risk and stress analysis.

It is modular, allowing clients to pick and choose the elements they can complete themselves and those they require support with.

Boasting a long-term track record working with leading pipeline operators and regulators worldwide to provide crack assessment services, ROSEN has the inspection technology and breadth of engineering expertise to deliver the entire framework.

The pipeline industry has come a long way when it comes to managing SCC. New ILI technologies and assessment methods have been developed to identify SCC and quantify the threat it poses.

More important is the understanding of that factors lead to SCC, allowing for a proactive mindset to be adopted and mitigation actions to be taken before SCC can develop into something that could cause pipeline failure.

ROSEN's crack management framework allows operators to adopt a proactive mindset in a systematic manner, combining the best technology with subject matter experts to ensure SCC is safely and reliably managed. **P**