OVERVIEW

INTEGRITY INTELLIGENCE IS OUR PHILOSOPHY

Our dedicated in-house teams have extensive experience working with integrity assessment methods and an intimate working knowledge of ultrasonic inspection data. Combining their long-standing competence with the accuracy of our inspection robots ensures a precise and reliable integrity assessment of your pipeline.

An accurate, up-to-date insight into the structural integrity of a pipeline delivers a reliable basis for prioritizing maintenance tasks and making critical decisions while optimizing operational costs. Following an ultrasonic inline inspection using state-of-the-art inspection robots, our analysts perform a detailed assessment of your pipeline’s integrity.

Using specialized software and algorithms, we meticulously analyze data covering metal loss, cracks, geometric faults and other irregularities, completing an in-depth assessment. We tailor these reports to your specific goals and integrity management program.

THE NEXT LEVEL OF ASSESSMENT

Fitness-for-purpose assessment: Achieve the most comprehensive overview of the integrity of your pipeline under current and future operating conditions

Immediate integrity assessment: Easily translate results from an inline inspection into mitigation and repair needs

Feature growth assessment: Compare features across multiple inspection runs which accurately measures growth of features over time

Future and fatigue life assessment: Gain insight into the remaining life of your pipeline and determine ideal reinspection intervals

Finite element assessment: Receive the most accurate estimate of failure pressures

Pipeline movement: Prioritize repairs appropriately with insight into ‘potential to fail’ areas due to external forces

Dent assessment: Get the most accurate input related to pipe dents and localized strain

ACCURATE INSPECTION DATA IS FUNDAMENTAL

NDT Global provides:

- Ultrasonic metal loss inspections that offer quantitative wall thickness measurements with pinhole and pitting resolution
- High-resolution crack inspections which deliver precise crack assessments to include full wall thickness depths
- Advanced crack technology (Eclipse UCx) which accurately identifies and sizes tilted and skewed cracks at the seam and in the pipe body
- Data that can be exported to your geographic information system to enable at-a-glance visualization
- Integrity assessments that enable visualization of current pipeline performance and identify potential problems for future decision making
- Insight at an early stage means better planning and prioritization of maintenance

Example of accurate corrosion growth assessment

Example of FEA analysis
Fitness-for-purpose (FFP) assessment is an engineering study by which the capacity of a pipeline is determined under current and future operating conditions. FFP is one of the fundamental tools of an integrity management program.

FFP assessment is used to assess the integrity of pipelines that contain anomalies. The most common anomalies that affect the current and future capacity of pipelines include metal loss, geometric anomalies or deformations, laminations, cracks and crack-like anomalies, all of which are detectable with ultrasonic inline inspection (ILI) robots.

Anomalies are assessed according to accepted codes, standards, or recommended practices. Combining the most advanced assessment methods (e.g. finite element assessment or FEA) with precise high-resolution ILI data enables precise anomaly assessment and reduces conservatism and, therefore, helps avoid unnecessary repairs or pressure restrictions.

Once anomalies are detected and sized, their mechanical effect must be determined by calculating the remaining resistance of the pipeline. Analytical methods that determine whether the affected pipeline can acceptably remain in service.

Results are expressed in terms of failure pressure, safe pressure or stress level. The different evaluation methods are described in industry standards.

The assessment results are documented in a technical report that describes the evaluation parameters, the type and dimensions of the analyzed anomalies, methodologies used, results, conclusions and recommendations.
FUTURE INTEGRITY AND FATIGUE LIFE ASSESSMENT

Mechanisms such as corrosion growth and fatigue crack growth, may pass an immediate integrity assessment, yet then grow to critical mass during pipeline operations. NDT Global compares the results of consecutive inspections to determine corrosion or fatigue growth, assessing the impact of change through future integrity or fatigue life assessments.

Crucial input for a future integrity assessment is the rate at which anomalies deteriorate. Corrosion growth rates are ideally determined by comparing results of consecutive inspections.

Fatigue crack growth strongly depends on cyclic variations in the operating pressure. Fatigue crack growth rates are calculated from pressure variations recorded over a sufficient time or can be estimated based on assumed load cycles. Pressure cycling can also lead to fatigue failure of dents.

NDT Global will use the results of a future integrity or fatigue life assessment to predict the estimated remaining life of the pipeline and deliver specific corresponding repair dates for all anomalies. This is an important input for future maintenance and repair strategies and optimization of re-inspection intervals.

FINITE ELEMENT ASSESSMENT

NDT Global uses state-of-the-art computational Level 3 assessment methods, so-called Level 3 assessments, including FEA. These assessments provide precise and accurate predictions of the failure pressure of anomalies.

Conventional assessment methods are widely used and accepted, despite their well-known conservative results leading to decreased throughput and unnecessary pipeline repairs. Although these methodologies have been refined, assessing the severity of defects by simplified rectangular boxes (peak depth, maximum length) or depth profiles yields too-conservative predictions for the maximum allowable safe working pressure.

FEA is based on the actual 3D geometry of the damaged pipe (anomaly + pipe joint) and can account for specific material properties, if available. This reduces the degree of conservatism and helps avoid costly excavations and repairs in difficult-to-access locations.

FEA is also well suited to assess combined anomalies (e.g. dents with cracks or dents with metal loss) which is not possible with standard assessment methods.

NDT Global’s high-resolution inline inspection robots accurately and reliably detect and size metal loss anomalies and crack-like flaws, and our ultrasonic geometry (UG) technology provides detailed geometry and deformations of pipe joints (e.g. out of roundness) and deformations. Combining such detailed information yields an ideal input for an accurate 3D modeling and FEA assessment.

Results of Level 3 assessments, based on a non-linear FEA have shown the most accurate estimation of the pipeline failure pressure.

Extrapolated repair dates

<table>
<thead>
<tr>
<th>Method/Code</th>
<th>$P_{fail}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASME B31G</td>
<td>69.7 bar (1011 psi)</td>
</tr>
<tr>
<td>ASME modified B31G</td>
<td>85.6 bar (1242 psi)</td>
</tr>
<tr>
<td>DNV-RP-F101 Part B Single Defect</td>
<td>58.6 bar (851 psi)</td>
</tr>
<tr>
<td>RSTRENG Effective Area</td>
<td>95.4 bar (1384 psi)</td>
</tr>
<tr>
<td>DNV-RP-F101 Part B Complex Defect</td>
<td>115.5 bar (1675 psi)</td>
</tr>
<tr>
<td>Non-linear FEA</td>
<td>132 bar (1914 psi)</td>
</tr>
<tr>
<td>Measured burst pressure</td>
<td>136 bar (1972 psi)</td>
</tr>
</tbody>
</table>

Assessment results: Level 1 to Level 3 compared to measured burst pressure.
A dent strain assessment shows material performance in deformed zones such as a dent, allowing a better measure of the dent severity compared to the traditionally used, simple depth criteria.

The strain at the dent peak, which is affected by the overall distribution and shape of the deformation, is considered a measure of the material performance. The data collected by NDT Global’s robot offers the most accurate input information related to pipe and dent geometric shape to apply the assessment based on strain-criterion.

Using cutting-edge software, NDT Global implements a pointwise method of calculating strain by calculating the membrane and bending strains in the longitudinal and circumferential directions. Using the recorded geometric shape of the pipeline, we deliver the calculated inner and outer strains on a point-by-point basis. Taking advantage of Atlas UG’s axial resolution and overlapped sensors, we use a very detailed and accurate geometry of the deformation to estimate the levels.

Displacement caused by natural phenomena such as ground movement and elevation changes, compromises a pipeline’s integrity. Excessive tensile strain can cause a direct rupture of a pipeline, while excessive compressive strain can cause local wrinkling, and often buckling. Such deformations ultimately cause pipeline failures that result in lost product and environmental damage.

Due to its use of high-resolution INS data acquisition and leveraging of leading-edge software products, NDT Global’s Atlas INS is the most reliable means of measuring changes in the shape of a pipeline caused by external forces. With a single Atlas INS inspection, a potential high-strain area can be located, delineating field bends.

Performing Atlas INS inspections periodically protects against potential pipeline displacement, and the alignment of two inspections (odometer distance adjustment) and direct run-on-run comparison of curvatures and strain enables accurately pinpointing the location of such displacement.

The pipeline displacement between the two INS inspections is obtained by comparing the vertical and horizontal strain at the same points on the pipe.

NDT Global aligns two inspections to detect slight changes (≥0.10 %) in the strain over time, and accurately pinpoint pipeline movement locations.

PIPELINE MOVEMENT

**PIPELINE STRAIN COMPARISON**

**DENT ASSESSMENT**

**DENT STRAIN**

**DENT PROFILE CHARACTERIZATION**

API 1183 geometry characterization for dent assessment relies on the accurate acquisition of the axial and traverse profiles from ILI data.

The inherent sensor calibration in mechanical calipers and noise in the data (due to vibration or tool decentralization) needs to be filtered out before the profiles are extracted. The most challenging part of this process is the use of different smoothing techniques to correct the data, while preserving the original shape of the profile and the depth of the dent.

Taking advantage of the direct measurement method offered by the Atlas UG, each ultrasonic beam travels through the same medium properties to reach the internal wall of the pipeline. Every ultrasonic sensor working as one allows the faithful reconstruction of the internal shape of the pipeline. A true axial and circumferential profile of any dent can be directly extracted from the Atlas UG data without the risk of altering the dent profile due to smoothing techniques.

**PIPELINE MOVEMENT**

**PIPELINE STRAIN COMPARISON**

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Pipeline inspection is the cornerstone of any pipeline integrity management program. Delivering first-class customer and consulting services is embedded in NDT Global’s core values and culture.

Using high-resolution data collected by ILI robots, NDT Global delivers the best of integrity services and data analysis to pipeline operators. The effective use of data is key for operators worldwide when trying to understand specific mechanisms, enhance integrity assessments, while defining the best approach for a specific challenge not addressed by common industry methodologies.

Our team of experts will find a solution and the best fit for any integrity management program (IMP).

**EXAMPLES**

- Integrity assessments and models considering robot sizing tolerances, statistical tolerances and physical limitations
- Re-analysis of historic inspection runs using today’s data-processing and analysis methodologies to determine more accurate results on specific pipeline threats
- Custom case studies, e.g. determining growth rate and impact of hydro testing
- Assistance in managing historic data results and aligning them into a more useable analytics database for better pipeline insights
- Custom applications using high-resolution feature profiles

- Specialized analysis task groups for specific challenges or custom studies, such as pattern analysis for a custom threat, for example deformations with stress risers, selective seam corrosion, or complex geometry self-consolidating concrete
- Advanced data analysis including in-depth signal interpretation for features below reporting thresholds
- Integration of data from multiple sources, including third party results and custom spreadsheets that are fed information directly into NDT Global’s analysis software
- Providing tailored solutions for specific challenges
Please note: Robot and performance specifications depend on inspection and pipeline conditions. Please contact your local NDT Global representative for further information. NDT Global reserves the right to introduce modifications and changes without prior notice.

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