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. Their long-standing competence, combined 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, making critical decisions and future business planning, 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. Moreover, we tailor these assessment reports to your specific goals, integrity management program (iMP) and requirements, ensuring you receive a service that entirely meets your needs.

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 reinsection intervals.

Finite element analysis: 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 (GIS) 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) analysis 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 (IMP).

The main objective of FFP analysis is the assessment of the integrity of pipelines that contain anomalies which may have originated during manufacturing, construction, or service. The most common anomalies which 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 analysis) with precise high-resolution ILI data enables precise anomaly assessment, reduces conservatism, and, therefore, helps to 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. This is completed using 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.
Assessment results: Level 1 to Level 3 compared to measured burst pressure

<table>
<thead>
<tr>
<th>Method/Code</th>
<th>P_{\text{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>96.6 bar (1401 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>

ANOMALIES DETECTED IN PIPELINES GROW DUE TO DIFFERENT MECHANISMS SUCH AS CORROSION GROWTH AND FATIGUE CRACK GROWTH. ANOMALIES WHICH PASS AN IMMEDIATE INTEGRITY ASSESSMENT CAN GROW TO CRITICAL SIZES DURING PIPELINE OPERATION. THE IMPACT OF CHANGE TO THESE ANOMALIES ON THE FUTURE INTEGRITY OF A PIPELINE IS ASSESSED IN A FUTURE INTEGRITY OR FATIGUE LIFE ASSESSMENT.

FUTURE INTEGRITY AND FATIGUE LIFE ASSESSMENT

Anomalies detected in pipelines are due to different mechanisms such as corrosion growth and fatigue crack growth. Anomalies which pass an immediate integrity assessment can grow to critical sizes during pipeline operation. The impact of change to these anomalies on the future integrity of a pipeline is assessed in a future integrity or fatigue life assessment.

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.

Result of a future integrity or fatigue life assessment is the estimated remaining life of the pipeline and 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 Analysis

NDT Global uses state-of-the-art computational assessment methods, so-called Level 3 assessments, including finite element analysis (FEA). These assessments provide precise 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 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. In this way, FEA 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.

Metal loss anomalies and crack-like flaws can be reliably detected and sized by high-resolution ILI robots. NDT Global’s ultrasonic geometry (UG) technology provides the detailed geometry of pipe joints (e.g. out of roundness) and deformations. Combining detailed information yields an ideal input for an accurate 3D modelling 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, providing the highest benefit to the pipeline operator.
DENT ASSESSMENT

DENT STRAIN

A dent strain assessment shows material performance in deformed zones such as a dent, allowing a better measure of the dent severity compared to simple depth criteria, traditionally used.

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 ultrasonic geometry robot offers the most accurate input information related to pipe and dent geometric shape to apply the assessment based in strain-criterion.

Using cutting-edge software, nDT Global implements a point-wise 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 detailed and accurate geometry of the deformation to estimate the levels.

Due to its use of high-resolution INS data acquisition and ability to leverage 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 discriminating field bends.

Performing Atlas INS inspections periodically, ensures the monitoring potential displacement of pipelines enabling the alignment of two inspections (odometer distance adjustment) and direct run-on-run comparison of curvatures and strain to accurately pinpoint the location of the 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 has the ability to align two inspections to detect slight changes (≥0.10%) in the strain over time, and accurately pinpoint pipeline movement locations.

PIPELINE MOVEMENT

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

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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.

Combined strain components in a deformed pipe

Pipeline strain in a pipe section

Ditch grid for deformation found by ILI (Atlas UG)
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 NDT Global’s 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 failure mechanisms, enhance integrity assessments, or while defining the best approach for a specific “challenge” not covered by common industry methodologies.

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

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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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