



# INTELLIGENT PIPELINE INTEGRITY MANAGEMENT

MANAGING THE TECHNICAL INTEGRITY OF A PIPELINE WITH AN “OUT OF THE BOX” GIS- AND GEODATA-BASED PIMS

The requirements on Geographic Information Systems (GIS) have originally been focused on data capturing and mapping functionalities. Current analyses state clearly, that 80% of all technical business processes are related to geospatial questions. That's why an intelligent Pipeline Integrity Management System (PIMS) is more than reasonable for pipeline operators. This article shall introduce a GIS and geodata-based PIMS making use of already existing GIS and expert data.

The technical integrity can be shown by collecting all essential influences on the system for each pipe segment. All this information will be evaluated using a standardised concept. An analysis of reliability is performed applying the criterion of failure probabilities in the technical condition analysis (TCA). That's how pipeline operators are able to detect weaknesses of a line or loop and also to take action in order to ensure its proper condition. As a result, already existing GIS systems with existing objects and objects from a newly developed database can be used for the assessment. The data model is available “out of the box” and can be configured and enhanced if necessary. The collected data can be transferred to the PIMS via standard Interfaces, e.g. CSV, XML or any other kind of format. In the PIMS the data can be analysed and presented. Failure probabilities or renovation actions can be managed with these analyses and with parameter studies. Finally, as a state of the art PIMS, it is not bound to one special Geographic Information System like ESRI's Arc GIS, GE Smallworld GIS, Bentley Microstation or

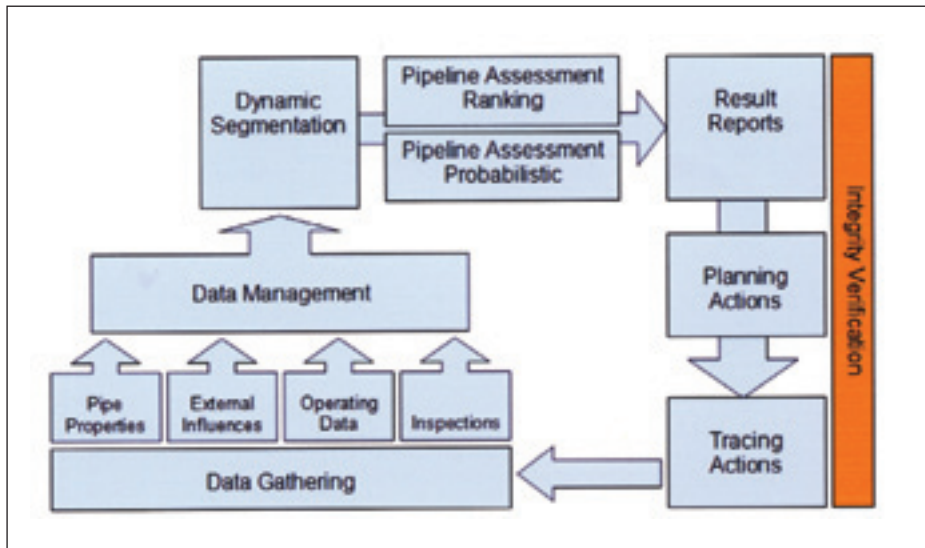


Figure 1. Data cycle used for the assessment

Intergraph. Using IT standards such as Oracle, Java or XML, it is platform neutral. In all the software is a very elaborate solution which focuses on pipeline integrity using already given data.

### Integrity of a pipeline

The integrity of a pipeline is defined as follows: Warranty of a comprehensive structural integrity and operational reliability according to specifications while yielding optimal cost effectiveness. Gas companies are obliged to keep their pipelines and facilities in correct and sound condition according to governmental safety regulations. This guarantees the necessary standard of stability and secures the utility or gas supply at any time.

The pipeline has to comply with the requirements of technical integrity and the operation, including maintenance. It has to be performed in an economically, quality-safe, environmental-friendly way and has to comply with the obligations. Process integrity guarantees that the operational environ-

ment meets the corresponding requirements. If significant features show that the integrity according to specifications is questioned, this has to be pursued. Reactions can be the following:

#### 1. Need for action

Experience of the personnel or the body of regulations necessitate immediate action (e.g. impact of third parties with significant damage to the pipeline or unclear communication in certain special cases).

#### 2. No need for action

An impairment of the pipeline is, indeed, identifiable, but the experience of the operating personnel can safely assess it (e.g. slight displacement of a pipeline under a surface load).

#### 2. Application of assessment procedures

If, on one hand, the distinctive features found cannot be identified as not critical by the experience of the operating

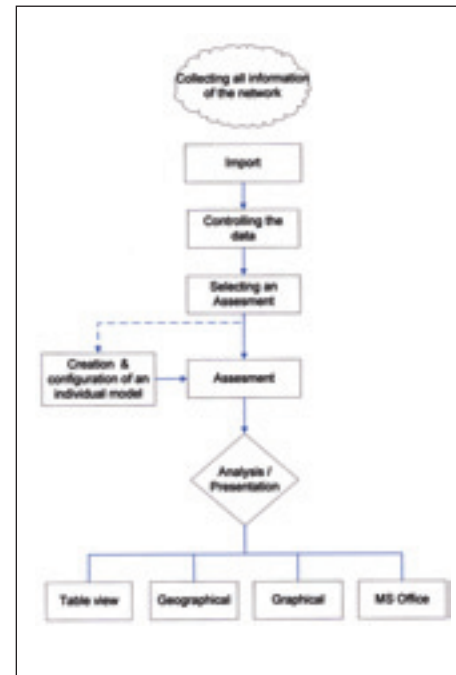


Figure 3. Standard workflow with trascue.PIMS

personnel, and, on the other hand, the taking of measures would imply economic disadvantage, it is recommended to apply recognised assessment procedures, which show the technical or operational safety or question it.

### PIMS & TCA: A General Overview

The driving goal for the technical integrity of a pipeline is that all security relevant processes are examined holistic and organised in a PIMS. The technical integrity can be shown by collecting all essential influences on the system for each pipe segment. All this information will be evaluated using a standardised concept. An analysis of reliability is performed applying the criterion of failure probabilities in the TCA. That's how pipeline operators are able to detect weaknesses of a line or loop.

A PIMS enables pipeline operators to design and integrate specific business processes. Integrity Management allows different departments and people to work on the safety of a pipeline. Costs and efforts can be shared throughout the cycle.

### Data gathering for the assessment

Data gathering is of course a must before performing a technical condition analysis or calculating the failure probability. This might be realized using a directive for data gathering to ensure that the data is correct. For optimization of orientation and display, it is also possible to integrate land register data or other backgrounds via e.g. Web Map Services.

The advantage of using a GIS is that it is cost effective and additional data from other systems can also be connected to the pipeline such as cathodic protection data or

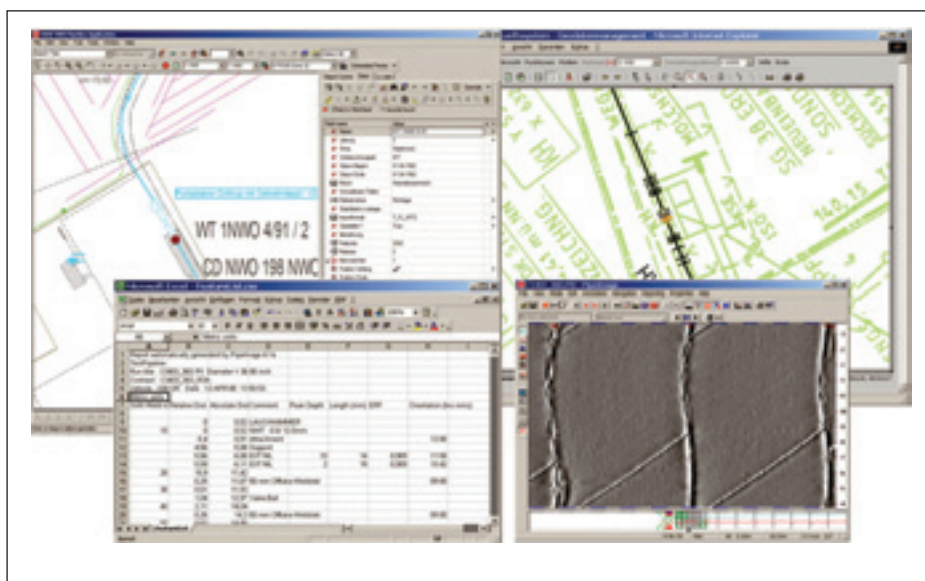


Figure 2. Integration of inline inspection data into a GIS.

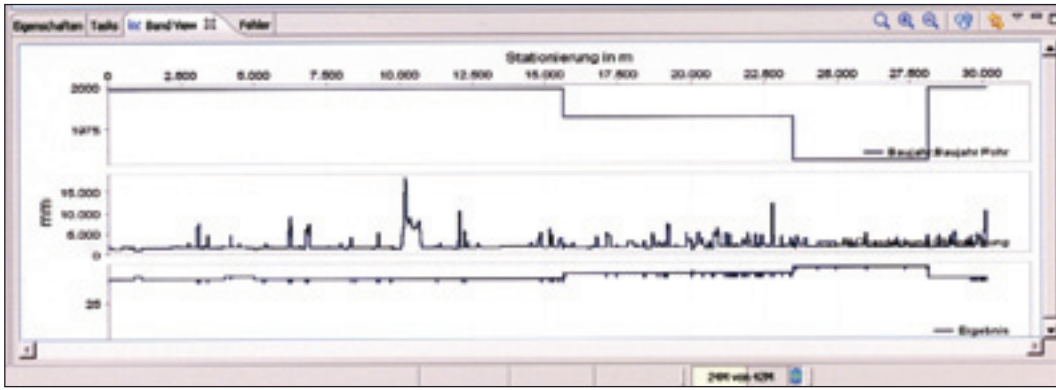


Figure 4. Band View with construction year, depth of cover and assessment result

pressure changes. Plus the geographic background like cadastral data is at hand. In the context of the implementation of CAD and GIS in the mid 90s, most companies are owners of detailed as built documentation of their network. Operating data like pressure or pressure change can be handled via SCADA integration, external influences like land use can be captured easily to each existing GIS, if not available yet.

As one very important aspect in such a PIMS framework, the integration of inline inspection (ILI) and cathodic protection (CP) data is essential. Important modules in state of the art PIMS are spatial enabled add-ons for the handling of such data. The big advantage of this approach is the data storage in a one central database. This offers the opportunity to access the information company wide over the Integrity Management System but also via GIS, the

Intranet or the Internet.

When all needed data are gathered, the PIMS will pick up the information. In the next step dynamic segments will be generated. The software will calculate the length of the segments using specific pipeline properties. This is realised with an XML-output, which basically connects the database or GIS to the PIMS.

**Standard workflow of a PIMS**

The standard workflow of the PIMS is modularly structured into the steps in Figure 3.

**Import of the geodata from GIS to PIMS**

The PIMS is managing all relevant pipeline resp. network data in a command structure. The base is one (original) pipeline and versions of this pipeline with multiple

alternatives as copies from this original. Every copy version can be used for copying, editing or deleting this alternative. This is implemented especially in the context of calculating assessments with different parameters for the same pipeline. The default data import is based on the XML standard. But specific imports from other platforms or systems can be implemented quickly due to the open and modular architecture of the PIMS. An import wizard is assisting the operator during the data import to the PIMS.

**Selecting and running an Assessment**

There are several ways to run an assessment on the calculated segments. One option is a ranking. The principle behind it is to grade the pipeline according to its condition.

All tools for the analysis and presentation are based on the result file, which is created automatically by the PIMS after each assessment in the form of a table view. Each result file will reflect the condition at a specific time under specific conditions. This is very important in the context of an internal or external revision demand.

The band view is linked with a table-based view, so the operator of the PIMS can jump between both views in both directions by one mouse click.

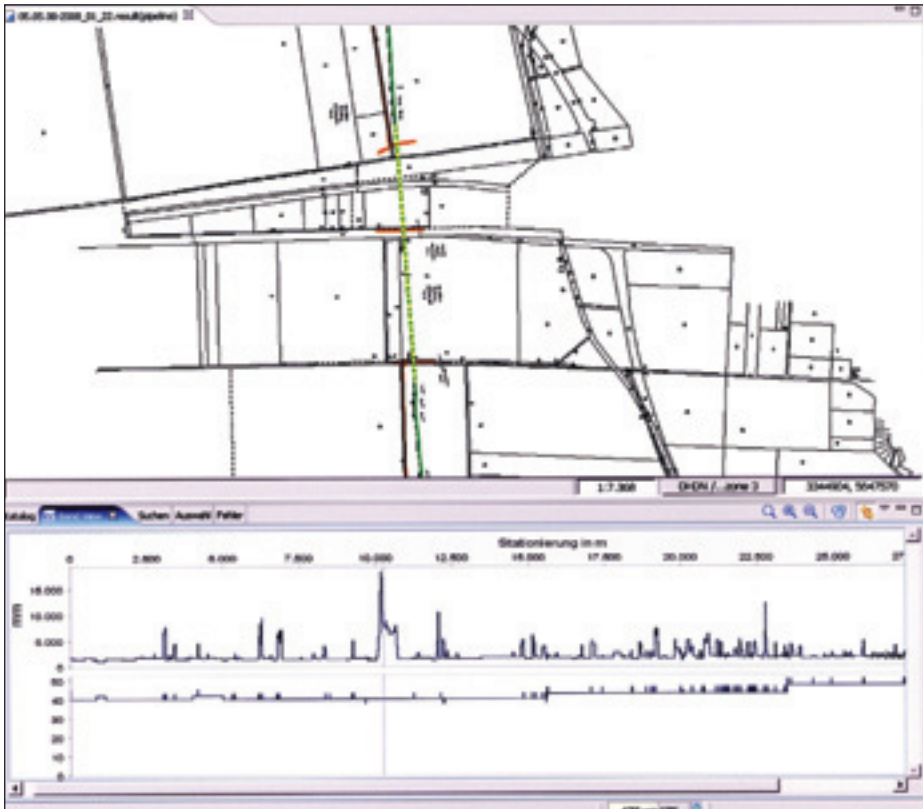


Figure 5. Screenshot showing assessment results in Band View and also Geographical View presenting critical parts of the pipeline using depth of cover data.

**Geographic View**

So far there has been no connection between the results or diagrams and the context of geography. This has been made possible with the introduced approach of a PIMS. It is possible to show the diagrams of the results plus the geography like cadastral data. If this is existent it should be included to support the view. The PIMS operator can use thematic mapping functions to present critical segments on the pipeline. For this thematic mapping all input- and the result data can be used as well. The Geographical View and Band View are linked, so the spatial context in each view is always analogue. Additionally the geographic context makes it easier to compare results.

**Tracking the measures**

The software enables companies to plan and control measures for renewals and constructions. This knowledge can be used to interpret the assessment results. The results are displayed together with the measures.

There are several possibilities to keep the data up to date and to share the work between departments. A mobile system, for example, can be used to reduce the effort because the data input is handled in the

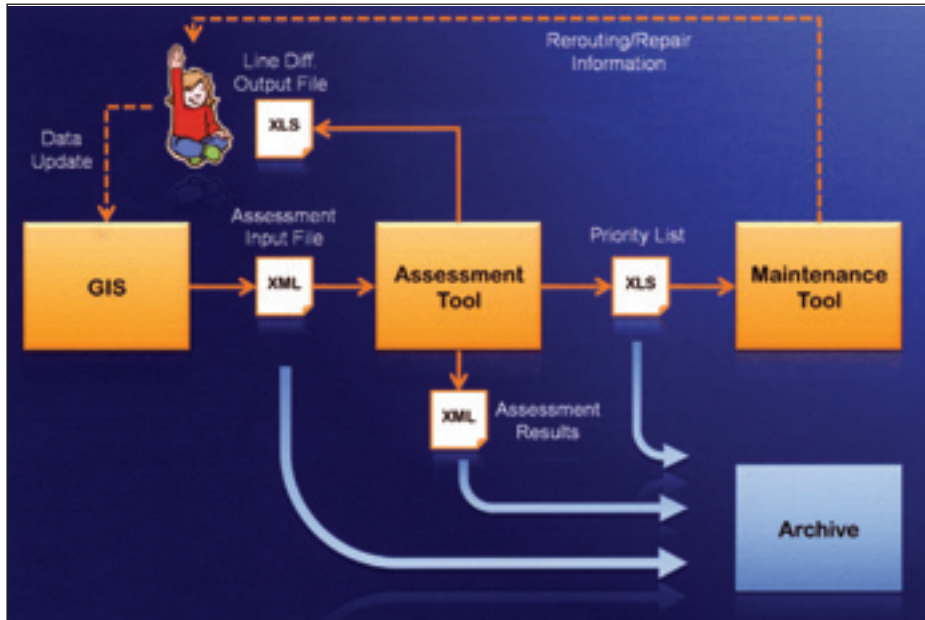


Figure 6. The complete data flow between the GIS and PIMS

field. The PIMS is able to save all results in a file format, which is used for all implemented assessment modules in the same way. In this context the result-file will contain the results of the assessment as well as all data that has been used for the assessment. With this functionality a utility company will fit every requirement which is linked to internal or external revision demands. The result files are separated from the core database and can be used as an argument to bring forward evidence.

### Conclusion

Each pipeline has to comply with the requirements of technical integrity and the operation, including the maintenance, has to be performed in an economic, quality-safe, eco-friendly way and has to comply with obligations. Process integrity guarantees that the operational environment meets corresponding requirements of quality.

The technical integrity of a pipeline, which means the proper and technically safe

condition, requires knowledge about the pipeline and maintenance. The conditions change continuously due to corrosion or third-party-impact. To organise processes that support the safety it is necessary to implement a PIMS. Using a GIS and geodata powered PIMS, the integrity of the pipeline system is provided. That's how pipeline operators are able to detect weaknesses on a line or loop and also to take action in order to ensure the safety.

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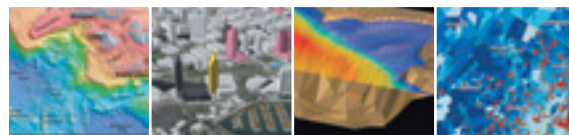
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