Implementation of a pipeline-integrity management system for Geoplin Plinovodi, Slovenia

by Karine Kutrowski¹, Rob Bos¹, Roy van Elteren¹, Andy Glover², and Blaz Škrbec³

¹ Gasunie Engineering & Technology, Groningen, Netherlands
² Associated Technology Pipeline Ltd, Alton, UK
³ Geoplin Plinovodi d.o.o., Ljubljana, Slovenia

January, 2007

Project participants

Geoplin Plinovodi d.o.o.

Geoplin Plinovodi d.o.o. (‘Geoplin’) is the designated system operator of the natural gas transmission grid in Slovenia. As a system operator, the company is responsible for the provision of a secure, reliable, economic, and environmentally-friendly transmission of natural gas through the gas transmission grid, and therefore responsible for the design, development, and maintenance of the gas network. It is also the owner of the entire 960-km long gas transmission infrastructure in Slovenian territory.

The GET-ATP consortium

Gasunie Engineering & Technology (GET) provides services for clients worldwide to support their successful operations on the international natural gas market. GET is able to call upon the resources of its eminent parent, Nederlandse Gasunie, who owns one of the most advanced and complete natural gas transmission systems in the world. In this specific project, GET supplied knowledge and consultancy services on pipeline-integrity and project management, as the main contractor.

Associated Technology Pipeline Ltd (ATP) is a private company who has specialized in the construction of computer software for the management of oil and gas pipeline systems since 1994. Its technical experts have over 20 years’ experience, and the company has a wide circle of scientific and technical partners, in particular with Neftegazsysyema. 15 pipeline operators use ATP’s software, the most complex implementation of which covers 40,000km of pipeline.

The GET-ATP consortium was formed in 2004 after the successful implementation of a pipeline-integrity management system (PIMS) for Nederlandse Gasunie. As its share of the consortium’s activities, GET provides extensive knowledge and experience of the design, engineering, construction, and maintenance of high pressure pipeline systems, while ATP offers its technical knowledge and experience in the area of designing and developing software for the integral management of pipeline integrity. Using this co-operation agreement as a platform for a professional relationship provides pipeline operators with the most advanced PIMS available today.

PIMS philosophy

The most important objective of any pipeline operator is the preservation of the licence to operate a safe and reliable pipeline system. The philosophy of the PIMS is intended to help pipeline operators achieve this goal.
Without the correct information or tools to process information, a company cannot make sound strategic decisions on the state of any part of its pipeline network. Whether this comes down to designing maintenance schemes and inspection strategies, or demonstrating the safety and integrity of the grid, IT systems form a vital part of the overall management of the network to provide auditable results. Pipeline operators require vast amounts of data in order to manage the everyday activities related to pipeline integrity: a PIMS provides the best way to store data and solve the problem of data transparency. With this information available, the operator can then analyze the relationship between the different facts and figures, and make appropriate decisions related to pipeline inspections, repair plans, and preventive measures.

Nevertheless, having a well-designed IT system is not everything; even the best software in the hands of an inexperienced user won’t reach any goal. Therefore the PIM S philosophy is to provide much more than IT systems alone. The management system’s users will be helped and trained by experienced people, and the 40 years’ experience of Nederlandse Gasunie will be shared with clients who are willing to implement the PIM S. The PIM Slider software is thus more than just IT, particularly as it has been designed by an operator for operators.

**The PIM Slider suite**

The PIM Slider suite of software applications is a comprehensive graphical multi-user software tool that processes pipeline, population, and environmental information in an integrated manner for all phases of the pipeline integrity-management process. The tool provides vital information at the right time for business-critical decisions related to designing maintenance programmes, inspection strategies, and investment for repairs or replacements, and demonstrates the safety and integrity of the pipeline. The suite consists of the following six different modules, and operates as a fully-integrated package:

- Slider4PiMS
- PipeSafe Lite
- Risk Expert
- InPipe
- Rehabilitation Expert
- CM Expert

Since Slider4PiMS is the core element of the system, it always requires to be implemented. The other modules can be included or excluded as defined by the customer. A general description of the modules is given below.

**Slider4PiMS**

Pipeline operators require vast amounts of data in order to manage the everyday activities relating to pipeline integrity. In order for key decisions to be made effectively, the gathering and interpreting of correct data becomes an important task. The best way to solve this problem is to transfer this data to the single uniform relational database, the role for which Slider4PiMS has been designed.
One of the most powerful features of Slider4PiMS is the connection of data from different data sources. For instance, it is possible to choose a particular location on a pipeline and look at geodetic inspection data, in-line inspection diagnostics, and cathodic protection data in a single display. The operator will be able to analyse a section of this data to reveal hidden trends and make a decision based on mathematical evidence, and not just intuition and experience.

All pipeline construction information, operational data (pressure, temperature, etc.), graphic images or maps,
Call for Papers

Themeetingpointforthe internationalpipelinecommunity

Thetechnicalpapertobepresentedintheevent shouldberelatedtoanyofthefollowingsubjects:
• Automation, Supervisory Systems and Measurement
• Basis and Terminals
• Reliability and Risk Evaluation
• Corrosion
• Offshore Pipelines
• Pumping and Compressor Stations
• GIS & Mapping
• Structural Integrity and Rehabilitation
• Environmental, Operational Safety and Social Responsibility Issues
• Logistics, Operation and Maintenance
• Project, Construction and Materials
• Inspection Techniques
• Business Development and Innovative Projects
• Gas Distribution

Schedule for Submitting Papers

- Submit Abstracts March 1st, 2007
- Accept/Reject Abstracts March 20th, 2007
- Submit Final Papers June 1st, 2007
- Accept/Reject or Manuscripts to Authors for Revision August 1st, 2007
- Manuscripts Due in Final Form September 3rd, 2007

The meeting point for the international pipeline community
Av. Almirante Barroso, 52/26º floor • 20031-000 • Rio de Janeiro • RJ • Brazil
Phone: (+55 21) 2112-9000 • Fax: (+55 21) 2220-1596 • E-mail: congressos@ibp.org.br • Website: www.ibp.org.br/pipeline

Organization
Brazilian Petroleum and Gas Institute
Av. Almirante Barroso, 52/26º floor • 20031-000 • Rio de Janeiro • RJ • Brazil
Phone: (+55 21) 2112-9000 • Fax: (+55 21) 2220-1596 • E-mail: congressos@ibp.org.br • Website: www.ibp.org.br
photos, text, multimedia documents, pig run and excavation data, surveys, cost figures, object maintenance and repair, etc., can be stored in Slider4PiMS.

**PipeSafe Lite**

Because risk assessment should be part of any integrity-management program, PiM Slider includes the powerful and user-friendly module PipeSafe Lite (PSL).

PSL is the quantitative risk analysis module. It reflects the Dutch methodology for performing QRA's (quantitative risk analyses) and helps calculate, rapidly and easily, risk indicators such as location-specific risk and societal risk, as well as other intermediary calculations such as heat radiation or lethality. This module enables both the safety manager and the risk analyst to perform analyses at the required detailed level. Managers will, for example, be interested in the global performances of their operating system and will appreciate the key performance indicator function of PSL, while risk analysts will use PSL for understanding the nature and locations of risk along the pipeline. PSL also enables the user to vary the pipeline design parameters in order to examine the influence of these changes on the consequences and risks due to an adverse event on the pipeline.

**Risk Expert**

A further component of the suite of software applications, the Risk Expert module allows the user to carry out a qualitative risk assessment of the pipeline, to plan remedy actions, and to evaluate their relative costs. Risk Expert is designed to be the perfect tool for setting priorities for maintenance and inspection programs: a model is created that identifies and semi-quantifies the major threats and consequences caused by pipeline objects (crossings, defects) and its environment (soil type, population density).

With Risk Expert the operator can assign weights to groups of threats and can define a system more suitable to each level of risk, based upon their opinion, and compared against the entire pipeline. The module can graphically represent any set of technological and ecological risks (either as individual or groups of factors) for a chosen pipeline section. The graphs are automatically updated as the risk changes, making clear which factor – or groups of factors – directly influence the risk index for each pipeline section.

**InPipe**

InPipe is the component of PiM Slider suite that allows an operator to quickly access ILI data, browse it in a convenient form, recognize problem areas, and switch to a close-up view of selected flaws. The assessment of defects is based on the science of fracture mechanics, and the module supports calculation of the remaining strength of the pipeline as defined in various different codes. Raw data functionality also enables the automatic calculation of remaining strength using a less-conservative method, which approximates to RSTRENG calculations. This can create savings by postponing repair programs whilst maintaining the required level of safety of the pipeline contents.

The InPipe module provides the functionality that enables accurate positioning of in-line data along a three-dimensional model of the pipeline. Dynamic stretching/shrinking of the in-line data enables an optimal fit of all feature positions on the existing pipeline records (or drawings) that are held in the system. This type of data...
processing is a critical component because it accurately links the underground asset with surface objects and linear-based data sets such as survey – and CP – data. Although this process is highly automated in InPipe, it still requires expert manual input, particularly in the classification of reported defects.

Once this classification is completed, the end-user can analyze the density of defects with the help of various charts and diagrams, such as pipeline profile maps, crossings maps, electrochemical protection diagrams, and soil profiles, etc.

Rehabilitation Expert

The Rehabilitation Expert module is used to generate a preliminary repair plan for defects identified during the course of in-line inspections. The resulting reports contain a list of repairs, also indicating their urgency. This repairs list is used at the calendar scheduling stage, as it also includes the planning requirements for materials and other technical requirements for the operating company.

Defects can be assessed either by the use of the defect geometry data (as reported by the in-line inspection contractor) or by the use of the raw data from the inspection tool. The latter alternative presents the defect in a three-dimensional view, which is extremely useful when comparing the same defect at different stages of its lifetime and, in particular, the calculation of corrosion growth.

The most popular function of Rehabilitation Expert is its ability to compare pig runs made in succession. Any person involved in the process of in-line inspection data analysis knows how labor-intensive the work is to compare two sets of defects; this module is designed to ensure that this work can be done in a matter of seconds.

CM Expert

The CM Expert module enables the operator to analyze the effectiveness and the efficiency of the existing cathodic-protection system. The module can review the whole pipeline route and identify locations where particular dangerous external risks (such as aggressive environmental conditions or negative human factors) may result in pipeline corrosion. The program calculates the minimum and maximum protection potentials that are required to ensure effective corrosion protection at these points; the results of these calculations are compared to the actual protection potentials, and if they don’t match, the point is considered to be unprotected.

CM Expert also queries the databases to retrieve historical data relating to any point of the pipeline. This feature traces the development of the situation and reveals dangerous trends or – in the case of pipeline failure – it can simulate previous pipeline conditions to find the most possible cause of that particular failure. The operator is thus able to determine the protection condition of the segment as a whole. Using this data, the module allows the calculation of the optimum operation modes for cathodic-protection stations to ensure a reliable and effective protection of the pipeline segment.
For more technical articles about the pipeline industry, visit www.pipedata.net.

Fig. 4 (right, top and centre). InPipe defect distribution and B31.3 curve.

Fig. 5 (below). Anticipated repairs for a cluster of defects using Rehabilitation Expert.
THE Pipeline Piggings & Integrity Management Conference is recognized as the vanguard international forum for discussing best practices in maintenance and condition-monitoring for natural gas, crude oil, and products pipelines. Complementing the annual event held in Houston, this new event is being held in Kuala Lumpur to allow discussion of these important topics in the context of the burgeoning East Asian and Australasian industries.

As the pipeline industry's primary forum devoted exclusively to piggings for maintenance and inspection, as well as pipeline integrity evaluation and repair, this event will draw engineering management and field operating personnel from both transmission and distribution companies concerned with improved operations and integrity management.

You are invited to contribute to the proceedings of this important international forum. Attention to pipelines has never been more intense, as their criticality to infrastructure and the incidence of failure due to ageing and other factors have increased. Papers will be published in a printed volume distributed to the conference delegates and will be indexed and abstracted through important online databases such as PigSource, PipeData, Dialog, Petroleum Abstracts, and others.

We hope you will take advantage of this high-quality professional opportunity and send your proposal for a presentation at the conference. Proposals should include an abstract accompanied by the author's complete contact information and affiliation to:

John Tirittoo
Editor, Global Pipeline Monthly
PO Box 21, Beaconsfield HP9 1NS, UK
tel. +44 (0)1494 675139
fax +44 (0)1494 670155
e-mail jtitirtoo@pipemag.com

Abstracts deadline 15 January, 2007
Final paper/presentation deadline 26 March, 2007

Note: We do not necessarily require a formal written paper. However, we do require that presentations be simply documented with copies of all slides, handouts, etc. Often a printed copy of a PowerPoint file will serve this purpose, if the slides contain a suitable amount of detail.
For more technical articles about the pipeline industry, visit www.pipedata.net.

PIMS implementation

On 1 March, 2006, Geoplin published the following invitation to tender: “The supply and integration of a computer software package for storage, management and processing of sources related to transmission system for the whole transmission grid”. The company’s gas pipeline network (Fig.7), to which this project refers, incorporates the following:

- 960km of gas transmission pipelines
- more than 200 meter-regulation stations
- two compressor units
- operating pressure up to 67 bar
- dispatcher centre with remote grid control
- 24/7 monitoring and operation of the gas grid.

The GET-ATP consortium submitted a quotation on 16 June, 2006, and the project was awarded to GET (on behalf of the consortium) on 30 June. The unofficial start of the project was on 4 July, and a one-week training programme completed the project on 14 December, 2006.

Implementation project and planning

The consortium met the requirements of the tender with the PiMSlider suite, for which the six modules were extended with some custom components, described below. The project was divided into three phases, shown in Fig.8.

The geographical spread of the team members (Slovenia, Netherlands, and UK) meant that special attention had to be paid to the assignment of resources in order to cope...
with the narrow timeframe. Six project sessions of 2-5 days were spent in Slovenia gathering the information, data, functional requirements, and management approval. On top of this, Geoplin itself spent considerable time and effort gathering the data, although this is normal practice even with new pipelines.

Data digitizing and software coding was carried out in by ATP. A team of around ten people was assigned to this task, which took about three months to complete.

The development of the functional specifications, together with the definition of custom components for the PipeSafe Lite, InPipe, and Rehabilitation Expert modules was carried out by GET in the Netherlands.

Finally, Geoplin’s PiMS users received a one-week training programme to complete the project.

Custom components

In order to take account of all Geoplin’s requirements, such as the mandatory differences or the specific company policy requirements, some extra functionality was been implemented, summarized below.

<table>
<thead>
<tr>
<th>Module</th>
<th>Custom components</th>
</tr>
</thead>
<tbody>
<tr>
<td>PipeSafe Lite</td>
<td>Requirement to perform calculations with a failure frequency due to ground movement. In the original version of PSL only third-party interference and corrosion were proposed.</td>
</tr>
<tr>
<td>InPipe and Rehabilitation Expert</td>
<td>Extension of the functionality of the dig-up sheet with geographical information and feature descriptions.</td>
</tr>
</tbody>
</table>

**Conclusion**

The collaboration between Geoplin Plinovodi, Gasunie Engineering & Technology, and Associated Technology Pipeline Ltd was not only a success as regards the sharing of knowledge and experience, but has also been very fruitful in terms of results. The PiM Slider suite was not only implemented on time, but rapidly became operational. The software will undeniably reinforce the position of Geoplin as a recognized safe, reliable, and prudent gas pipeline operator.

**Acknowledgements**

The authors of this paper would like to express their gratitude to their colleagues in the research, safety, integrity, and operational departments of both GET and Geoplin Plinovodi who have been involved in this project, not only for the work they have carried out but also for contributing to the successful collaboration between the three companies. ATP is in particular acknowledged for the very high quality of the software it has developed.

**Bibliography**

3. [www.geoplin-plinovodi.si](http://www.geoplin-plinovodi.si)
4. [www.nvnederlandsegasunie.nl](http://www.nvnederlandsegasunie.nl) and [www.getgasunie.nl](http://www.getgasunie.nl)
5. [www.atpuk.co.uk](http://www.atpuk.co.uk) and [www.pipeline-integrity-management-system.com](http://www.pipeline-integrity-management-system.com)