Practical implementation of a Pipeline Integrity Management System (PIMS) in Russia
Challenges and Solutions

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This presentation will review, through a client-specific case study, the issues and challenges associated with the implementation of a state-of-the-art, integrated asset and integrity management solution.

**Key topics to be covered:**

- Outline Challenges in Pipeline Integrity
- Drivers for the project
- Data integration tasks
- Risk model introduction
- Inline Inspection Data in context of the process
- The right mix: Local execution and global product reach
Integrity Management evolution

From reactive management …
…towards sophisticated proactive systems

- Light procedures
- In house Polyvalent Engineers
- Design + As-built + visual inspection + Hot spot UT inspection
- No or simple calculation tools

Detailed procedures, Standards, Regulations and Guidelines
Structured worldwide Organization and multidisciplinary engineers, QHSE, Risk, GIS, etc.
Detailed design and operation Data, Advanced Inspection, GIS, SCADA, Statistics, etc.
Advanced Software systems such as PIMS, DBMS, EDMS, GIS, SCADA

Trigger = Often Failures
Challenges
resulting threats
Position of software in the picture

Often anticipated to be replaced by math…
Legislative driver

• Amendments to the Russian Federal Law on industrial safety of hazardous production facilities (116-FZ) in March, 2013.
• Entities operating hazardous production facilities are required to implement safety management systems and ensure their functioning.

Main scope:

1. Identification, analysis and prediction of risk of accidents at hazardous production facilities and related threats;
2. Planning, implementation, and timely adjustment of measures to reduce the risk of accidents at hazardous production facilities.
• Zapsibtransgaz is located in the Tymen Region (Russia)
• Operating > 2,500 kilometer Onshore Transmission Pipelines
• Supplying Gas and Natural Gas Liquids to large petrochemical and gas processing plants

The management of the company decided to optimize costs of diagnostic and repair works by implementing a cost-effective maintenance and rehabilitation program to ensure safe operation of pipelines.
In 2012, ROSEN Integrity Solutions and Aerospace Monitoring & Technologies (AMT) started the implementation of ROSEN Asset Integrity Management Software (ROAIMS).

- Local representative and know-how about legislations and regional peculiarities
- Experts on Russian IM Standards and how to interpret them in a system
- Local Project Management
- Input for Russian Translation
- On-Site Data Collection and Integration
- Execution of risk analysis
- In-depth analysis of diagnostic data obtained from gas-and-oil pipeline surveys
- Geotechnical diagnostics
- Provision of Pipeline Integrity Management Software
- Implementation of risk assessment methodology
- Implementation of defect assessment methodology
- Configuration of data integration templates
- Installation and Training
- Localization
- Technical Support
Business requirements for Pipeline Integrity Management Software (PIMS) were described by Zapsibtransgaz within the project tender and confirmed in the project kick-off workshops.

The scope of work included the implementation of an integrated software solution including:

1. Pipeline Integrity Management System (including Asset Management, Risk Assessment, Inspection Planning, Defect Assessment, Data Alignment, etc.)
2. Integration with external EDMS/CMMS software currently present at client site.
3. Translation of Software and Manuals to Russian
4. Data Integration and Analysis (including GAP analysis)
Project description

Global Reach and strong Product Focus

Mandatory Local Execution and Expertise on Regulations
Data collection and integration

More than 10,000 documents scanned as basis for digitization towards final destination being the PIMS database (PODS datamodel).
Data collection and integration
Result data integration

- Representation of the complex branched network of pipelines (natural gas, NGL);

- Design and Operation data integration for the period of more than 30 years

- Integration of a variety of diagnostic results (e.g., the results of in-line inspection from various companies);

- Development of a corporate GIS for Zapsibtransgaz’s pipelines
Risk model outline

- **Threat Assessment:** Adjustment of threat model based on regional peculiarities (e.g. Permafrost, Geotechnical sensitive areas)

- **Diagnostic Records:** Utilization of ILI and Aboveground Surveys to adjust specific threat results

- **Consequence Assessment:** Leak and Rupture Scenarios considering Land Types, Population Density etc.
POF Process (1/3)

BPoF for the pipeline network per Threat

Severity ratio per segment

Soil PH
Soil Resistivity
Coating Type
POF Process (2/3)

**BPoF**

**Severity Ratio**

**PoF**

**ILI results**

**RPoF**
One way of applying quantitative time-dependent threat input:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Severity</th>
<th>PoF From Risk Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>If PoF &lt;1e-7</td>
<td>If PoF &gt;1e-7</td>
</tr>
<tr>
<td>Feature Density (% Area)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Corrosion</td>
<td>1</td>
<td>0.95</td>
</tr>
<tr>
<td>Segment &lt;0.1% Corroded</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Segment &lt;0.5% Corroded</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>Segment &gt;0.5% Corroded</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Estimated Repair Factor (ERF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum ERF 0.75</td>
<td>1</td>
<td>0.95</td>
</tr>
<tr>
<td>Maximum ERF 0.95</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Maximum ERF 1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>&lt;1% of Features &gt;1</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>&lt;5% of Features &gt;1</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>&gt;5% of Features &gt;1</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Maximum Feature Depth % wt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20</td>
<td>1</td>
<td>0.95</td>
</tr>
<tr>
<td>&lt;30</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>&lt;50</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>&lt;70</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>&gt;70</td>
<td>100</td>
<td>50</td>
</tr>
</tbody>
</table>

Figure 3: ILI Matrix (Corrosion)
Results Post-Processing
“ How to report the Risk results ? “

View 1 = 1-(1-Sg1) (1-Sg2) (1-Sg3)

View 2 = Maximum for pipeline

View 3 = Maximum every 3 Km

View 4 = Average for pipeline

View 5 = Sum up the segments

View n = Your own view?
CoF Categories

- Property damage and/or loss of revenue: Immediate economic impact on the company of a failure, e.g. loss of production, any contract penalties etc.

- Personnel: Impact of failure on surrounding population, e.g. injuries to people.

- Environmental: Impact on the environment, including infrastructure, e.g. pollution of aquifers, land contamination, building damage etc.

- COIM: Impact on company image, e.g. stricter governance, bad publicity, loss of market confidence etc.

- Public: Impact on company customers, public reaction, including possible litigation costs
COF Process

<table>
<thead>
<tr>
<th>Land Type</th>
<th>Population Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Receptor 1
- Leak
- Rupture

Ignition
- Cost?

No Ignition
- Cost?

Receptor 2
- Leak
- Rupture

Ignition
- Cost?

No Ignition
- Cost?

Total Cost = \( C_{R1} + C_{R2} \)

CoF value

CoF value

CoF value

CoF value

CoF value

CoF value

CoF value

CoF value

CoF value
CoF model adjusted to consider specific AMT results of spatial assessments

Results mainly from semi-automated assessments of space imagery

Classification in accordance with Russian standards
Combined Risk outcome

- PoF matrix has a PoF value for each element along a pipeline
- CoF matrix has a CoF value for each element along a pipeline
- Multiplying PoF and CoF values for each element generates risk factors.
- Risk factors may be expressed in monetary terms or as a rating on a corporate RAM.
- The result is a matrix of risk (or liability) values.

- Capability to calculate PoF, CoF and risk factors for different lengths of pipeline, e.g. 3 km long sections, the complete pipeline length, etc.
Risk reporting

### Dynamic Segments

<table>
<thead>
<tr>
<th>EC</th>
<th>EC 0005</th>
<th>EC 0006</th>
<th>EC 0007</th>
<th>EC 0008</th>
<th>EC 0009</th>
<th>EC 010</th>
<th>EC 0011</th>
<th>EC 0012</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 m</td>
<td>63.3 m</td>
<td>150 m</td>
<td>200 m</td>
<td>400 m</td>
<td>500 m</td>
<td>668.4 m</td>
<td>800 m</td>
<td>820 m</td>
</tr>
</tbody>
</table>

- [Null Value] - Asphalt - Coal tar - Coal tar - Coal tar - Coal tar - Coal tar - TPP/TPE - TPP/TPE - TPP/TPE - TPP/TPE
- Very large coat - Very large coat - Very large coat - Very large coat - No indication - No indications - No indications - No indications - No indications - No indications
- No - No - No - No - Unknown - Unknown - Unknown - Unknown - Unknown - Unknown - Unknown
- >= 90% Availability - >= 90% Availability - >= 90% Availability - <= 80% Availability - <= 60% Availability - >= 90% Availability - >= 90% Availability - >= 90% Availability - >= 90% Availability - >= 90% Availability
- 100 m shift - 100 m shift - 100 m shift - 850 mV - 850 mV - 850 mV - 850 mV - 850 mV - 850 mV - 850 mV
- 11/12/2013 12:00 AM - 11/12/2013 12:00 AM - 11/12/2013 12:00 AM - 11/12/2013 12:00 AM - 11/12/2013 12:00 AM - 11/12/2013 12:00 AM - 11/12/2013 12:00 AM - 11/12/2013 12:00 AM - 11/12/2013 12:00 AM - 11/12/2013 12:00 AM

**Roadway Condition Data**

- String: 45
- End Construction: 1
- External Corrosion: 7
- Equipment: 1

**Satellite Image**

![Satellite Image]
ROSEN performed majority of Inline Inspections on evaluated Pipeline Network. That resulting data is used for various purposes:

1) Centerline QA/QC
2) Immediate Repair Plans
3) Input to PoF evaluation
4) Corrosion Growth Assessments for long-term repair strategies
Centerline QA/QC

In addition to the main information on defect location and sizes ILI delivers:

- Listing of installations (valves, tees, taps, …)
- Wall thickness changes
- Casings
- Accurate XY(Z) location of all references

That information is used to QA/QC antiquated as-build information.
Immediate repairs

Custom logic for repair prioritization
Immediate repairs

“Straightforward Rules“

e.g. B31G; RStreng calculation of safe maximum pressure based on dimensions of corrosion

“Decision Tree“

e.g. cfr 49 – 192 or 195 complex decision tree with different consequences (remediation schedule) understanding of multiple threads and environmental factors (HCA)
## Prioritization rules (sample)

<table>
<thead>
<tr>
<th>Priority</th>
<th>Target Anomaly Type</th>
<th>Query Definition</th>
<th>Query Details</th>
<th>Repair Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Metal Loss</td>
<td>Metal Loss &gt; 70 %</td>
<td>Depth &gt;70% and HCA = YES</td>
<td>Immediate Repair</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>o'clock ≥08:00 and ≥04:00 and event DENT-DWML, DENT-DWGC, IDAN-DWML, IDAN-DWGC and HCA=YES and STR=YES</td>
<td>Immediate Repair</td>
</tr>
<tr>
<td>HCA Condition</td>
<td>Dent</td>
<td>Top Side Dent within 5ft of any metal loss, cracking or a stress riser</td>
<td>o'clock ≥08:00 and ≥04:00 and event IDAN-DENT and ID-Reduction ≥6% and HCA=YES</td>
<td>Immediate Repair</td>
</tr>
<tr>
<td>3</td>
<td>Dent</td>
<td>Top Side Dent with a Depth &gt; 6%</td>
<td></td>
<td>Immediate Repair</td>
</tr>
<tr>
<td>HCA Condition</td>
<td>Gouge/ Groove</td>
<td>Gouge or Groove &gt; 12.5% NWT</td>
<td>Depth ≥12.5 % and event MELO-MEDA or MELO-GOU</td>
<td>Scheduled</td>
</tr>
<tr>
<td>14</td>
<td>Crack</td>
<td>Potential crack</td>
<td>event like <em>CRACK</em></td>
<td>Scheduled</td>
</tr>
<tr>
<td>Other</td>
<td>Metal Loss</td>
<td>Metal Loss within 100 ft from a CP reading that is ≥ -850 mV</td>
<td>event like <strong>MELO</strong> and CP_UP=YES</td>
<td>Scheduled</td>
</tr>
</tbody>
</table>
corrosion growth

- Girthweld matching as basis for ILI comparison
- Feature matching
- Statistical calculation of growth rates (conservative - no signal matching)
- Result utilization to calculate “safe remaining life”
Proper data exchange process with established CMMS Software:

- Synchronization of Asset Register and creation of “links”
- Creation of Notifications / Work Orders from PIMS to CMMS
- Retrieving information when Work Order is executed (e.g. Defect repaired > remove from Immediate Repair list)
- Utilization of standardized methods such as MS Biztalk
## Prerequisites and challenges to success

<table>
<thead>
<tr>
<th>Prerequisites</th>
<th>Challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Global Supplier</strong></td>
<td><strong>Localization / Translation</strong></td>
</tr>
<tr>
<td>• Product designed for generic PIMS subjects</td>
<td>• Variance in unit systems</td>
</tr>
<tr>
<td>• Roadmap aligned to globally accepted standards and guidelines</td>
<td>• Global varieties in data input formats</td>
</tr>
<tr>
<td>• Strong background in local legislations</td>
<td>• Background know-how in local legislations</td>
</tr>
<tr>
<td>• Native speaking resources</td>
<td><strong>Local Experts</strong></td>
</tr>
<tr>
<td>• Support and data integration resources</td>
<td>• Formalization of customer requirements in supplier format</td>
</tr>
<tr>
<td><strong>Local Experts</strong></td>
<td>• Being the “middle man”</td>
</tr>
<tr>
<td>• Strong background in local legislations</td>
<td>• Risk model adjustments to regional demands</td>
</tr>
<tr>
<td>• Native speaking resources</td>
<td><strong>Done!</strong></td>
</tr>
</tbody>
</table>
conclusion

• Clear trend that Countries ask their Operators to formalize PIMS approaches by releasing own regulations

• Efforts and expert knowledge required to properly reflect local peculiarities

• Establishing a proper risk model requires a good mix of international expertise / proven models with knowledge about the specific network

• Utilization of Inline Inspection results into the process goes beyond immediate repair planning – it’s the most valuable input data in the entire IM chain!

• Software must be designed to allow proper reflection of PIM System requirements (algorithms, data, processes, other 3rd Party products)
THANK YOU FOR JOINING THIS PRESENTATION.