Asset Integrity Management with the methodology / tools of PIMS International
Why Pipeline Integrity Management?

Dutch Act’s on External Safety of high pressure Pipelines

1. **WION: 2008**
   1. Ground movement > 50 cm have to be reported.
   2. Pipeline operator and contractor (excavation, ram piling) have to prevent 3rd party damage by joint effort

1. **BEVB: 2011**
   1. Inspection by VROM ILT to verify risk & integrity management practice
   2. Assets & Proces descriptions (from design – abandonment). Major element: transparency in integrity management
   3. Risk based maintenance & inspection planning and above all: PDCA loop
   4. Condition report and Management review
   5. PIMS Focal Point in Company
   6. NTA 8000 code > NEN 3655 fullfills Dutch legal requirements
## PIMS International records: PIMS implementation & Risk Management Projects

<table>
<thead>
<tr>
<th>Customer</th>
<th>PM PIMS Implementation (ASME B31.8S)</th>
<th>PM PIMS Implementation NTA 8000</th>
<th>PM Risk Assessment with Bowstar Methodology / Software</th>
</tr>
</thead>
</table>
                           |                                      |                                 | 2013: Expansion current Comparison Bench Mark  
                           |                                      |                                 | 2015: NZ-Plant, Update all bowties, KPI-s retrieval with Bowstar |
| Sasol Gas (South Africa)| 2004-2005 2012 (Revitalisation)     | 2012                            | 2012: Land Pipelines                                |
| Geoplin (Slovenia)      | 2006                                 |                                 |                                                     |
| Total (TIGF, France)    | 2008                                 | 2010                            | 2010: Development Inspection Procedure               |
| PTT (Thailand)          | 2008                                 | 2009                            | 2014: LNG-plant (investment decision Ministry of Energy) |
| Total EP NL             | 2010                                 | 2009                            | 2010: Offshore pipelines                             |
| ENGIE                   | 2010                                 |                                 | 2011: Offshore Pipelines (trunk), Platforms, Risers (flexible and steel), Offshore Pipelines, Gas processing plants (NOGAT and NGT)  
                           |                                      |                                 | 2013: Fatigue Load pipelines  
                           |                                      |                                 | 2013: Wax Deposition in Oil Pipelines, Revision Permit NGT Pipeline in Environmental sensitive area (Waddenzee)  
                           |                                      |                                 | 2014: Effectiveness and efficiency of ILI pigrun for offshore interfiled pipelines, KPI-s retrieval with Bowstar (NOGAT Assets with COSO model)  
                           |                                      |                                 | 2015: Update all bowties |
| TAQA                    | 2012                                 |                                 | 2012: Gap analysis Pipeline Integrity Management manual  
                           |                                      |                                 | 2013: Gas Storage Plant Bergermeer  
                           |                                      |                                 | 2014: Fibre Cable application |
| Teijin Aramid (NL)      | 2013                                 |                                 | 2013: Validation Risk Policy                        |
| NAM, SHELL              | 2011                                 |                                 | 2011: Gab analyses PIMS Manual                      |
| NEN                     | 2010                                 |                                 | 2010: Lecturing NTA 8000 in cooperation with regulator |
| NUON                    | 2011                                 |                                 | 2011: Offshore Pipeline                             |
| BBL Company             | 2015                                 |                                 | 2015: Onshore Pipeline                              |

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Workflow PIMS (Pipeline Integrity Management System)
How our IT-solutions can assist Asset Integrity Management

Bowstar Risk Assessment

- Internal interference risk
- External interference risk
- External corrosion
- Internal corrosion

Incident & maintenance reports

New and improved mitigations

SAP, MAXIMO Maintenance Plan

Meridian

ArcGIS

Asset changes

Prioritization inspection & maintenance plan

Asset data

Asset with unacceptable risk level

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Overview PIMS Architecture

MAJOR PIMS FUNCTIONS

- Incident analyses report, required mitigating actions
- Inspection schedule (program)
- Request for repair/modification
- Inspection, maintenance and repair policy (e.g., interval change)
- Request for maintenance (e.g., tuning rectifier)
- Request for inspection & repair (e.g., repair incl. dig-up sheets)
- Adaptations inspection, maintenance and repair methods
- Optimization preventive maintenance plan (e.g., more CP, less Pig)
- Incident analyses
- Risk assessment, segmentation
- Free span calculations incl. required mitigations
- Integrity calculations incl. forecast
- CP analyses and modelling
- Defect assessment
- KPI calculations
- Alignment/cross checking all data pipeline

Pipeline & Object data (geodetic), Population density, Soil composition, Topographical data, One call data, Video data, Pigrun data, Video pipeline inspection, ROV, ROTV, AUV, and acoustic data.

Inspection, maintenance and repair policy (e.g., interval change)
Request for maintenance (e.g., tuning rectifier)
Request for repair/modification
Inspection schedule (program)
Inspection results

Pipeline incidents, Fit For Purpose, Pigrun reports, Photographs

Pipeline configuration

ArcGIS
Execution work (orders)
Document Management System

Maintenance Management
FFP declaration, compliance reports etc.

Appropriate Corporate & Legal reports

QRA-tool (Carola in NL)

One call system (and pipelines)

PIMS database

Video data

Pigrun data

Video pipeline inspection
Inspection results
ROV, ROTV, AUV, and acoustic data
Tally list and raw data

© PIMS International
PIMS International owns a great collection of templates to facilitate the development of your asset-specific bowtie diagram.
What is the difference between Integrity and Risk?
What is the difference between Integrity and Risk?

And how the bowtie fits into this definition.
What is the difference between Integrity and Risk?

Management of threats

Management of consequences

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Roadmap to a successful risk assessment with Bowstar

1. Used by key players in the industry,
2. Lots of templates from these key players that simplify your risk assessment and guarantees optimal results,
3. Maximum support by the very user friendly software package,
4. The results are automatically transported to the:
   1. Risk Register of Bowstar to control the risk mitigation program,
   2. GIS-environment of Bowstar to find the high risk sections of the linear assets by dynamic segmentation (e.g. pipelines, high voltage power lines, dikes, railroads, water supply etc.).
5. Full integration with Microsoft Office:
   1. Generation of detailed Diagram Report in MS Word, using a company specific template,
   2. MS Excel up- and download of the diagram, analyses results etc.,
   3. Clipboard function to copy diagram, results, graphs etc. to your own text file.
6. Professional software package. Compatible with Windows, OSX, Linux etc. developed in C-Sharp
It all starts with the setup of the basic bowtie diagram.

Threats that can result in the unwanted event incl. percentage contribution (total = 100%)

<table>
<thead>
<tr>
<th>Threat Description</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>[T1] - External Interference New</td>
<td>30%</td>
</tr>
<tr>
<td>[T2] - Operation outside specs</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>[T3] - External corrosion</td>
<td>20%</td>
</tr>
<tr>
<td>[T4] - Internal corrosion</td>
<td>40%</td>
</tr>
</tbody>
</table>

Hazard: High pressure

(Loss of containment)

Consequences that can result from the unwanted event incl. ranking risk issues

<table>
<thead>
<tr>
<th>Consequence Description</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>[C1] - Gas emission, environmental damage</td>
<td>B1 B2 B3 B4</td>
</tr>
<tr>
<td>[C2] - Flash fire- Jet fire</td>
<td>B3 B4 B1 B4</td>
</tr>
</tbody>
</table>

Unwanted event

Ranking risk matrix:
1. People
2. Assets
3. Environment
4. Reputation

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The next step is the inventory of all threats (escalations) for all life cycles

First the preventive threats & mitigations

Threat that can result in the unwanted event incl. percentage contribution (total = 100%)

Life cycle barrier incl. percentage of total life cycle barriers (total all life cycle barriers = 100%)

Actual effectiveness life cycle barrier

Hazard: High pressure (Loss of containment)

Unwanted event

Escalation factor incl. percentage contribution to life cycle, mostly > 1 (total = 100%)

Mitigating measures incl costs:
- Green: implemented, no improvement possible
- Blue: implemented, can be improved
- Red: new mitigation, not implemented

Effectiveness mitigations:
1. Potential
2. Actual

Hidden consequences incl. hidden life cycle barriers

Mitigating measures incl costs:
- Green: implemented, no improvement possible
- Blue: implemented, can be improved
- Red: new mitigation, not implemented

Threat incl. hidden life cycle barriers

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Bowtie diagram development
And next the repressive escalations & mitigations for each life cycle

Life cycle barrier incl. percentage of total life cycle barriers (total all life cycle barriers = 100%)

Consequences that can result from the unwanted event incl. Risk ranking

Hazard: High pressure (Loss of containment)

Mitigating measures incl costs:
Green: implemented, no improvement possible
Blue: implemented, can be improved
Red: new mitigation, not implemented

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Once developed the analytical functions of Bowstar will give you a clear view on your (potential) risk management performance!
The condensed bowtie diagram delivers all information on actual and potential mitigation performance.

Hazard: High pressure
(Loss of containment)

Maximum summed barrier value of all life cycles that can be achieved by the implementation of all improvements

Current contribution threat to unwanted event

Potential contribution threat to unwanted event

Consequences that can result from the unwanted event incl. Risk ranking

Unwanted event

Actual summed barrier value of all life cycles

© PIMS International
Full understanding and monitoring of your risk mitigation is provided by the Risk Register.
KPI-s: mitigation & life cycle performance are generated automatically
The methodology of Bowstar: life cycle risk assessment incl. costs of mitigations

Advantages of the Bowstar approach of bowtie-analyses:

1. Highly structured threat inventory with a strong focus on each individual life cycle,
2. Finding the right balance between investment and operational costs,
3. Supports economic evaluation of all mitigations (new and existing) and as a result: the definition of the most efficient Mitigation Plan,
4. Justifies investment decisions by quantification and visualization of the effect of (new) mitigations in the risk matrix,
5. Enables balancing between preventive and repressive mitigations to find the most effective solution in managing the risk,
6. Reflects a very practical understanding of the actual and potential integrity level of the assets.
Bowstar GIS Functions
Presentation pipeline and other objects / polygons on the map

TPI-activities (blue and red polygons)

Wind turbines

More detail, map with several pipelines (blue / yellow)

MAP- and/or satellite background

Detailed info on pipe joint that has been selected

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Flexible Map-layer selection and settings

(incl. detailed information of selected objects)
Map layer examples: Line & point crossings, flexible threshold
Overview of all relevant pipeline parameters incl. dynamic segmentation based on this data implemented in a flexible threat model (e.g. Bowtie)
All windows interconnected!

Bowstar-GIS window
Selected segment
Individual threat contributions
Bowstar-Pipeline Plot window
Bowstar-Risk window

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Search and plot!
Flexible interface / user settings!
Interface Bowstar – Bowstar GIS, options menu: Export function

Options

- Configuration
- Diagram Font
- Save Diagram image to EMF file
- Renumber IDs of the Risk Register

Export diagram to MS Excel
- Export Hazards to MS Excel
- Export Diagram to Bowstar GIS

Import diagram from MS Excel
- Import All Hazards from MS Excel
- Import One Hazard from MS Excel

Export Diagram to Bowstar GIS

Select item in the list for exporting and press the 'Export' button.

- All
  - Busleiding
    - Lek
  - Oefening
    - Lek

Threat based

XML files for the Bowstar GIS will be created in the next folder:

C:\Bowstar\Demo Pipeline

Export
Cancel

© PIMS International
Import Bowstar file in Bowstar GIS – Risk module
Bowtie presentation in Bowstar GIS (90 degree rotation)
Risk ranking and dynamic segmentation with the Bowstar GIS – Risk module

The risk model from Bowstar bowtie is downloaded as a threat scheme in the Bowstar GIS Risk module. Additional algorithms are added in order to translate the generic risk analysis to a threat profile along the pipeline route on the basis of all relevant parameters. The Bowstar GIS module will calculate the overall threat level of the pipeline (left picture) next to the threat profile of the pipeline (right picture):

Remark: If requested, any risk scheme (independent of the bowtie scheme) can be added to the Bowstar GIS Risk module to enable dynamic segmentation of the pipelines.
Align the pigrun data in Bowstar GIS – Risk module

Opening CSV file with pigrun data, retrieved from pigrun-contractor
Align the pigrun data in Bowstar GIS – Risk module

Bowstar GIS view → upper picture = pigrun data incl. welds; lower picture = pipeline joints from as built
Align the pigrun data in Bowstar GIS – Risk module

Bowstar GIS function → matching joints, fine tuning and approval by hand
Align the pigrun data in Bowstar GIS – Risk module

Bowstar GIS function → example: pigrun data is missing a weld, see next picture
Align the pigrun data in Bowstar GIS – Risk module

Pigrun data is missing a weld, correction by: 1) selecting a weld-point from the pigrun data
Align the pigrun data in Bowstar GIS – Risk module

Pigrun data is missing a weld, correction by: 2) drag weld-point to the correct position
Align the pigrun data in Bowstar GIS – Risk module

Pigrun data is missing a weld, correction by: 3) Bowstar executes automatic re-ordering of the welds
Align the pigrun data in Bowstar GIS – Risk module

Bowstar GIS function → 2nd example: pigrun data is missing a weld, short section needs positioning by the selecting the right weld-point
Align the pigrun data in Bowstar GIS – Risk module

Bowstar GIS function → 2nd example: pigrun data is missing a weld, Bowstar executes automatic repositioning
Align the pigrun data in Bowstar GIS – Risk module

Bowstar GIS function → once all welds are right positioned the corrected pigrun file is transferred to the Bowstar database
Finally the features that have been reported are shown on the map including all pipe details and relevant feature parameters (geometry, safe pressure etc).
Pigrun analyses and corrosion growth modelling

Automatical classification defects according to POF-specifications (= Pipeline Operator Forum).

Defect assessment on the basis of the ASME B31G and/or other models such as BG, Rstrength

Enables forecast of corrosion growth and remaining strength on the basis of a user defined algorithm (see for example corrosion growth depth / length in mm/yr).

The white marked field in the table shows the date that the remaining strength doesn’t meet the code requirements (ASME B31G) and needs a repair. The blue line indicates the remaining strength of the selected corrosion defect after 5 years.
Finally the Dig-up sheet can be generated by the Bowstar Dig-up module
Our customers and publications
Contact us

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Newsletter
Stay informed about our current news and events. Subscribe here to our newsletter.

Latest news
Bowstar Bowtie and GIS functionalities: the perfect combination!
Questions?