A Case Study on Setting Up Pipeline Integrity Management System for a Medium Enterprise Operator

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Process & Pipeline Services BHGE

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BHGE’s role in the Integrity Management Process

Customer needs...
- Reputation: ...don’t harm people or environment
- Asset availability: ...maintain product throughput
- Optimise Spend: ...optimise spend & benefit

Prevent failures and optimize spend
Manage risks & Focus spend
Manage Integrity

Integrity Management Challenge...
Benchmarking shows three types of pipeline operators
- Group A: low cost, high failures
- Group B: high cost, low failures
- Group C: low cost, low failures

Threats to Integrity...
- Systemic threats: ...no management system to identify, quantify and manage risks
- Detectable threats: ...organisational or individual resources to assess and deal with defects

BHGE Deliverables & Solutions...
- Integrity Management: ...build management infrastructure
- Integrity Engineering: ...provide engineering assessment
- Inspection Solutions: ...find defects using high technology tools

Challenge.... Guide customers to the sweet spot of low cost & low failures

PIMS Management systems...
- PIMS Manuals
- PVi7 Software implementation
- Data commissioning
- Baselining integrity & risk

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Pipeline Operators

PIMS Implementation Scenarios

- Large Pipeline Network + Significant PIMS Budget
- Medium Pipeline Network, Extremely Business Critical + Medium PIMS Budget
- Medium/Small Pipeline Network + Low PIMS Budget

Subject Case Study
Case Study: Medium Pipeline Network + Low PIMS Budget

Reasons for change

Before

• Operator lacked process and tools for PIMS and maintained a prescriptive integrity management approach with people for data management, inspection strategy and performance monitoring.

• There were no formal pipeline integrity management procedures in place, with no tools available to execute engineering assessments (i.e. risk assessment) for pipelines.

After

• Successful development and deployment of PIMS

• Knowledge transfer

• Risk assessment and Integrity Management Plan

• Shift in culture
PIMS Definition*

- A framework that translates company and industry best practices into specific business processes
- Built around the plan-do-review cycle
- Achieved through full integration and alignment of all individual company management systems

*Management System Approach to Pipeline Integrity. I.Colquhoun (GE), C. Calvi (COPI), H. MacPherson (GE). IPC 2006-10531
Typical PIMS Framework

Key enablers:
- Organization
- Performance monitoring and continuous improvement
- Communication
- Management of Change Process
- Seamless Integration of PIMS with other Management Systems – E.g. Operations and Maintenance, Quality, EHS

Company Wide “Umbrella”
Pipeline Integrity Management System

Individual Operator PIMS
Building Integrity Management Infrastructure

PIMS Management System comprises...

... the **process**, workflows & integrity targets to drive Pipeline Integrity Management, via the right **people** in the right org structure using the right tools software & database **tools**.
Small Pipeline Network + Low PIMS Budget

Gap Analysis
- Review existing practices
- Capture best practices
- Identify operational constraints
- Recommend action plan to close gaps

PIMS Manual
- Manual
- Procedures
- Workflows

RACI Matrix
- Workflow analysis to prepare 1st draft of RACI matrix by contractor
- Discussion between contractor and operator
- Update by operator
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Initial Team
- To decide the scope
- To manage the project

Structure
- Decision to maintain same number of personnel
- Ad-hoc support by Contractor based on job specific contracts
- On-site presence of Contractor personnel (suggested)
- Org Chart

People

Process

Tooling – dbase, software, workbooks, etc.
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No investment on Database and Software

Option provided for On-site support

PIMS tasks executed based on Job Specific Contracts

Along with ILI

As part of PIMS Implementation Contract

KPI's

Condition and FFP Reports

Inspection Plans

Annual Risk Reports
PIMS Development & Implementation

End Objective – Best in Class

Lay the Groundwork
Evaluate current situation and develop strategy for “smart” improvements

Build the Framework
Establish PIMS - policies, procedures & tools

Deploy
Implement PIMS & establish key enabling elements – E.g. Organization & Training

Continuously Improve
Start adding proactive elements for continuous improvement
PIMS Development and Implementation

1. PIMS Gap Analysis
2. Preparation of PIMS Manual and Procedures Including:
   - Inspection and Monitoring Procedure
   - Anomaly Management Procedure
   - Prevention and Mitigation Procedure
3. PIMS Implementation
   - Risk Assessment
     - Data Collection
     - Risk Workshop
     - Identification of threats based on risk assessment
   - Integrity Management Planning
   - Performance Monitoring and Reporting
## Small Pipeline Network + Low PIMS Budget

### PIMS Implementation

#### Gap Analysis
- Review existing practices
- Capture best practices
- Identify operational constraints
- Recommend action plan to close gaps

#### PIMS Manual and Procedures
- PIMS Procedures
  - Threat Identification, RA & IMP
  - Inspection & Monitoring
  - Anomaly Management
  - Prevention & Mitigation
Small Pipeline Network + Low PIMS Budget

PIMS Implementation

Data Collection

• Documents/Data gap analysis
• Data gaps filled by:
  – Engineering judgments - discussed and agreed
  – Post workshop data collection
• Input data for risk assessment provided as part of deliverables in an organized manner

Risk Modelling Workshop

• Familiarize Operator with BHGE Risk Model
• Identify and review the threats to the pipelines
• Discuss and review the available data and address data gaps.
• Discuss and agree pipeline segmentation criteria and RAM for presentation of risk results.
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PIMS Implementation

**Risk Assessment**
- A comprehensive semi-quantitative risk assessment was performed.
- These risk results were presented in the form of a risk matrix as per operator’s RAM and definitions to identify the Risk category (High, Medium or Low).

**Integrity Management Plan**
- Mitigation measures for the dominant threats that drive risk were identified and used to re-calculate risk.
- Post mitigation risk results were presented in the operator’s risk matrix to show the residual risk following mitigation actions.

**Performance & Monitoring Reporting Guideline**
- Evaluation of the on-going effectiveness and suitability of the PIMS by monitoring results and trends for KPI’s
- Proactively implement improvements.
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Diagram:
- Operator PIMS Supervisor
- Contractor (Satellite Offices)
- Integrity Team (On-Site)
- Operator
- Consultants
- Risk Assessment
- IS consultancy (Call-off)
- Specialized Trainings
- PIMS Activities
- Anomaly Register
- KPI Reporting
- Integrity Team
- Review Risk Assessment
- Action assessment findings

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Pipeline Integrity Management Process

Core Process Elements
- Risk Assessment and IM Planning
- Prevention & Mitigation
- Inspection & Monitoring
- Intervention & Repair
- Anomaly Management

Enabling Process Elements
- Company Policies & Strategies
- Organization
- Operational Controls & Procedures
- Contingency Planning
- Documentation & Data Management
- Performance Management
- Quality Assurance
- Communication
- Management of Change

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Quantitative Risk Assessment (QRA)

- Segmentation
- Evaluation of failure probabilities
- Comparison of failure probabilities against the industry benchmark
- Evaluation of the consequences associated with a failure
- Risk results and presentation

Probability of Failure per yr

<table>
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<tr>
<th>Severity</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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<td>&lt;10^-6</td>
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<tr>
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<tr>
<td>3 Major</td>
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<td>&lt;10^1</td>
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<tr>
<td>5 Catastrophic</td>
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<td>&gt;10^1</td>
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</tbody>
</table>

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Quantitative Risk model...

... the risk model that forms the core is integrity management functionality is quantitative... it provides the benefits of quantitative risk using the same lower data intensity of semi-quantitative models.

**Risk drivers**
- Keep people & environment safe
- Increase asset availability
- Maintain reputation

**Key question**
- Where & what risks to focus?
- What’s my safety $ exposure & environment?
- Will my spend reduce risk to an acceptable level?

**Quantitative?**
- Most models are semi-quantitative
- Quantitative models costly & data intensive

**PVi7 risk model**
- Output has absolute meaning & tangibility
- Compare risk across pipelines, systems & threats
- Map H&S, finance & environment to common scale

... Semi-Quantitative: models can answer the questions of where do I spend and how

... Quantitative: models are needed to answer how much should I spend, am I spending too much? Am I spending enough

... PVi7 is quantitative: the model provides the benefits of quantitative risk without needing the data intensity and cost of typical quantitative models
Risk assessment and integrity management planning

Quantitative Risk Assessment

Failure Modes
- Small Leak
- Large Leak
- Rupture

Determination of Failure Consequences
- Health and Safety
- Environment
- Financial

Probability of Failure (Loss of Containment)
- External Corrosion
- Internal Corrosion
- Stress Corrosion Cracking
- Sour Cracking
- Fatigue/Manufacturing defects
- Mechanical damage
- Weather and outside force/Construction defects
- Equipment failure and Incorrect operations
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Risk Service

- Risk assessment required as part of PIMS
- No budget for Software investment

Challenge

Solution

- Build & implement excel based risk assessment tool
- Gather, convert & load data into templates
- Segment the pipeline based on data

- Quantitative risk assessment conducted
- Risk based Integrity Management Plan with minimal investment

Outcome

• Risk assessment required as part of PIMS
• No budget for Software investment

Challenge whilst execution:
To sandwich all the linear data to create segments

... Data collection templates linked to an input data table enabling dynamic segmentation

...An Excel macro which copies data from the input data table into risk calculation spreadsheets and then copies results into risk reports

...Over 60 metadata tables (maps) referencing input data table fields to attributes used in risk calculations and results to reports

... Risk, Probability and Consequences reports

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Solution for Medium Pipeline Network + Low PIMS Budget

Risk Service

Data loading templates
Dynamically segmented input table
Probability, Consequence and Risk reports

Macro to copy input table values into probability and consequence calculation sheets
Maps, referencing input table fields to attributes used in calculation

Probability and consequence calculation sheets, following the latest version of TRM

Copy Data from Risk Segmentation into Calculation
1. External Corrosion
2. Internal Corrosion
3. SCC
4. AOS
5. External Corrosion BI
6. Internal Corrosion BI
7. SCC BI
8. AOS BI
9. Fatigue
10. Mechanical Damage
11. Mechanical Damage offshore
12. WFE offshore
13. WEP offshore
14. SEIS offshore
15. Risk Single phase
16. Risk Multi-phase

Report maps

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Risk Workshop

- Use of required data
- Interpretation of risk results

Risk model explained

Interviews with site personnel

Engineering judgments

Default values

- Where the data gaps were still open after steps above

Review and confirmation

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Risk Results Before (a) and after Mitigation (b)

- The threat that was found dominant was Weather and Outside Force in both offshore risers.
- The next threat in the pipeline was failure due to Incorrect Operations in start safety zone, main line and end safety zone.
- Mechanical Damage threat in the pipeline was driven by anchor handling.
- Internal Corrosion threat in the pipeline was demonstrated to be low.
Small Pipeline Network + Low PIMS Budget

Conclusion

Pipeline integrity management system was implemented successfully with safety, quality and efficiency within the available resources.

Advantages over Typical PIMS supported by Database and Enterprise Software

• Low cost and staffing levels
• Risk assessment workshop instead of detailed software
• Stepwise approach to PIMS development made it easier for operator to adopt
• The decision to implement the developed PIMS with the support of consultant through a senior integrity engineer absorbed the initial surge of workload and roadblocks.