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

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Process & Pipeline Services BHGE

21 November, 2018

BHGE's role in the Integrity Management Process

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

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

Threats to Integrity...

Systemic threats
... no management system to identify, quantify and manage risks

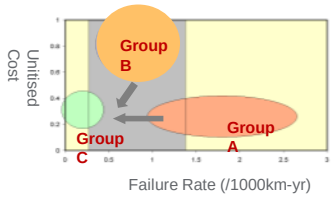
... organisational or individual resources to assess and deal with defects

Detectable threats
... 3rd party mech damage
... external corrosion
... internal corrosion
... SCC
... equipment failure
... manufacturing defect
... welding fab defect
... incorrect operation
... outside force

Integrity Management Challenge...

Benchmarking shows three types of pipeline operators

- A low cost, high failures
- B high cost, low failures
- C low cost, low failures



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

BHGE Deliverables & Solutions...

Integrity Management
... build management infrastructure

Process
/Procedures
Software
Organisation

Integrity Engineering
... provide engineering assessment

Risk assess
Planning
Defect assessment

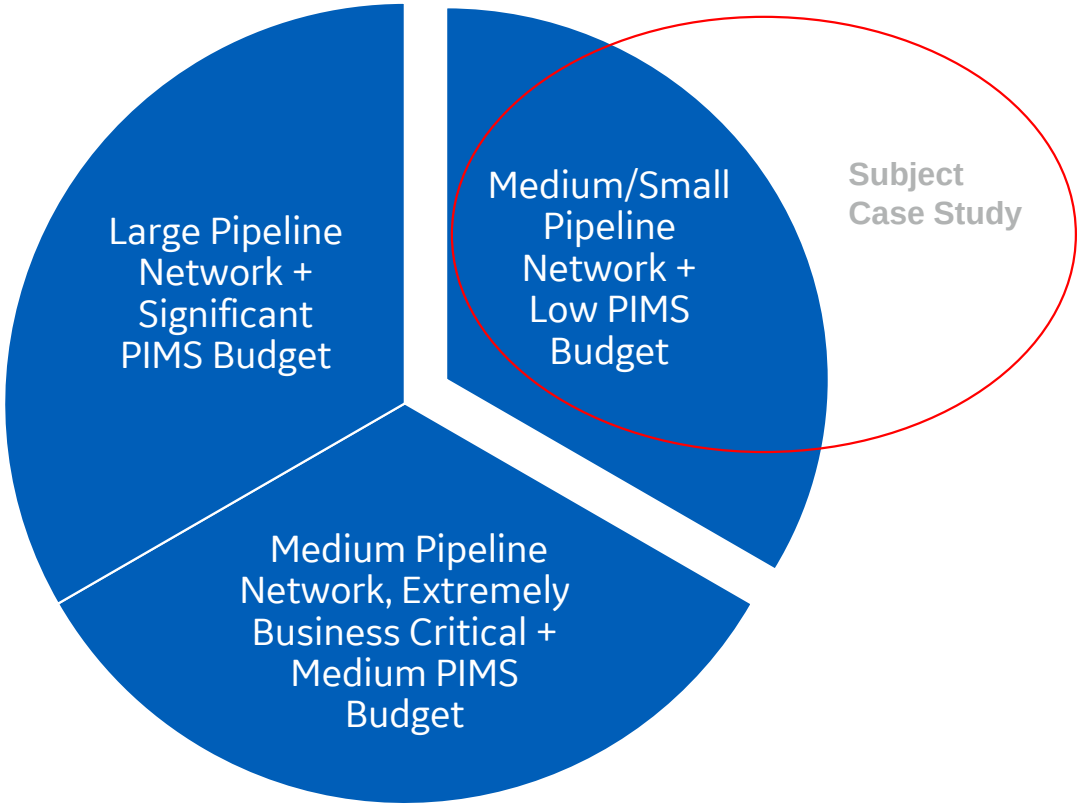
Inspection Solutions
... find defects using high technology tools

Metal loss
Dents
Cracks

2

Pipeline Operators

PIMS Implementation Scenarios



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Case Study: Medium Pipeline Network + Low PIMS Budget

Reasons for change

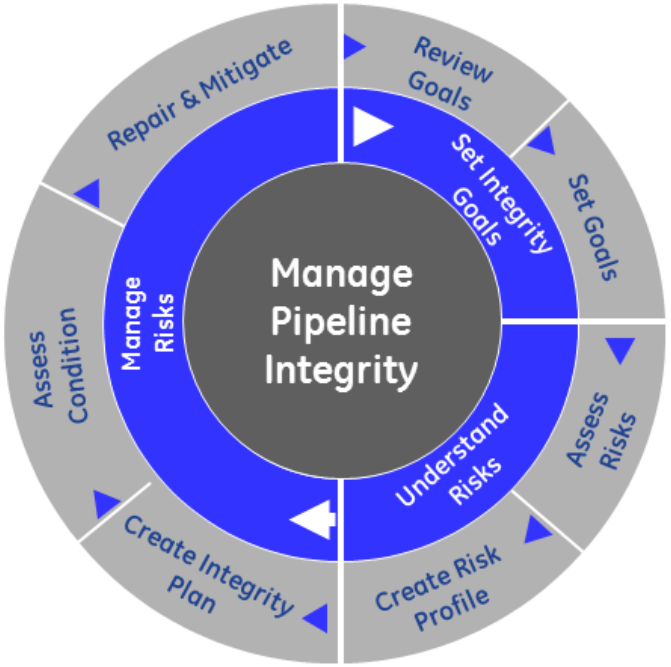
Before

- 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

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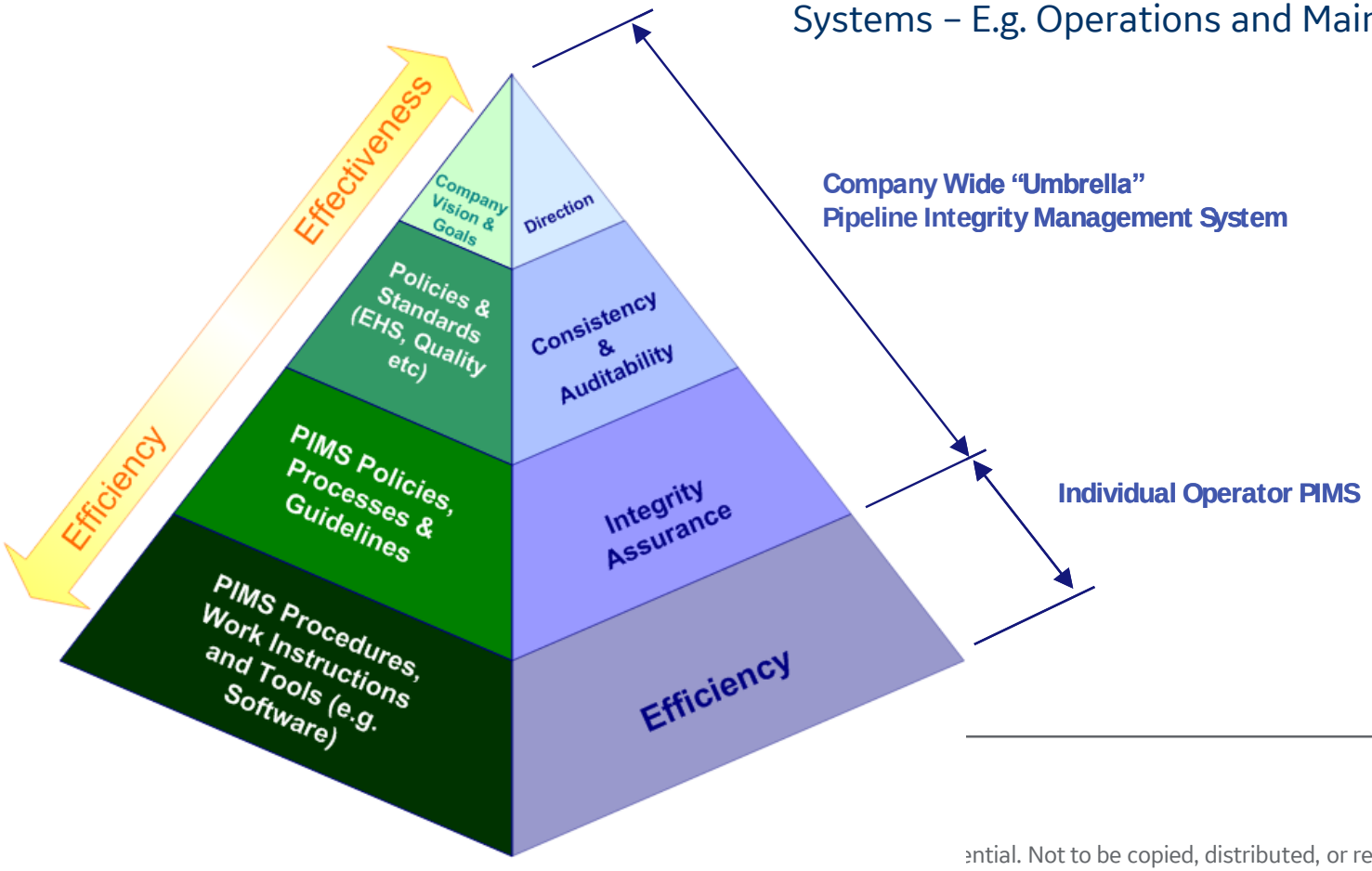
Typical PIMS Framework

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

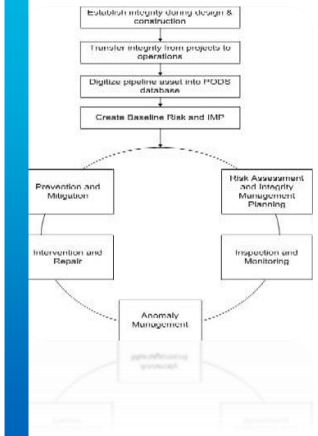


Building Integrity Management Infrastructure

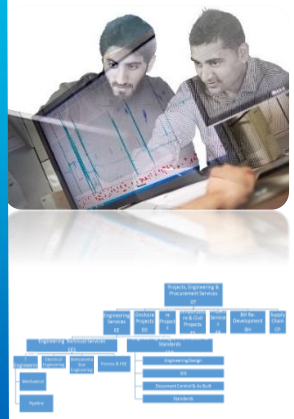
PIMS Management System comprises…

… 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*

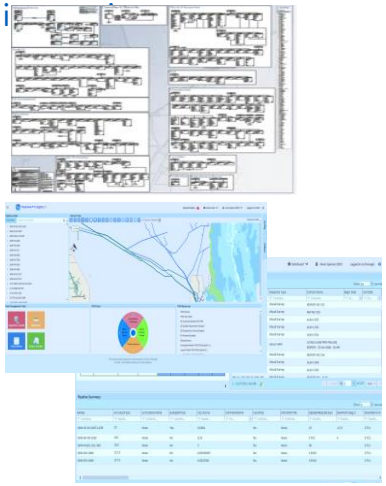
Process

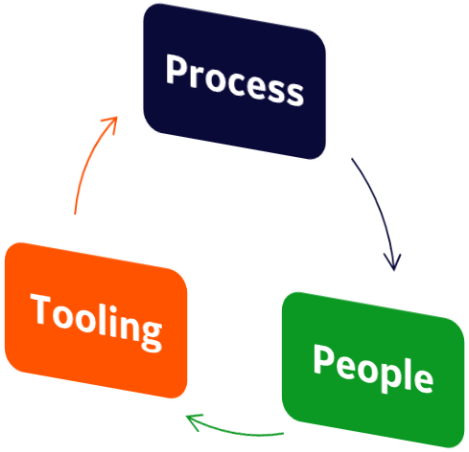


People



Tooling – dbase, software, workbooks, etc.





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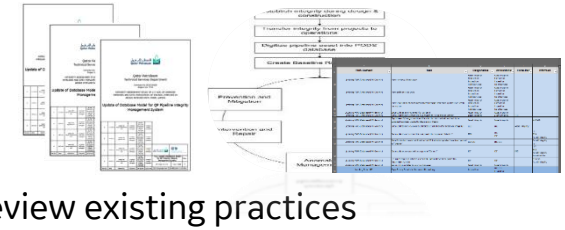
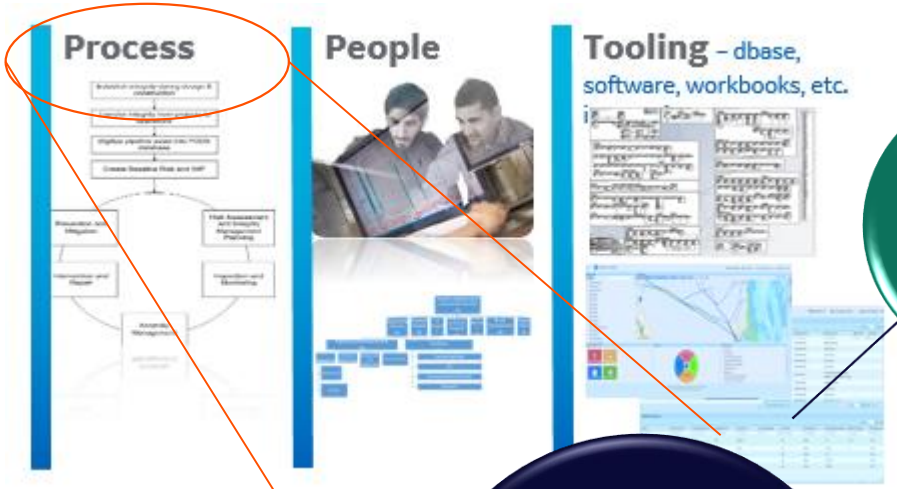
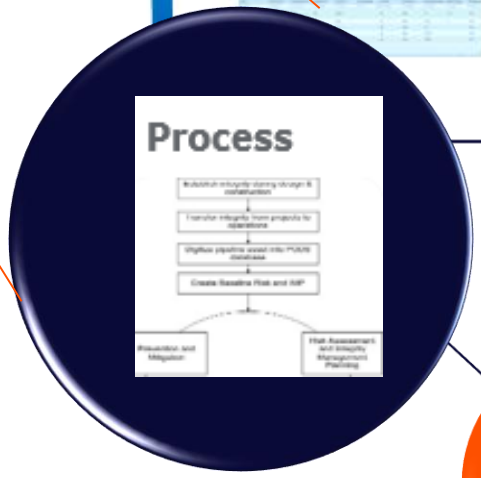






Gap Analysis

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

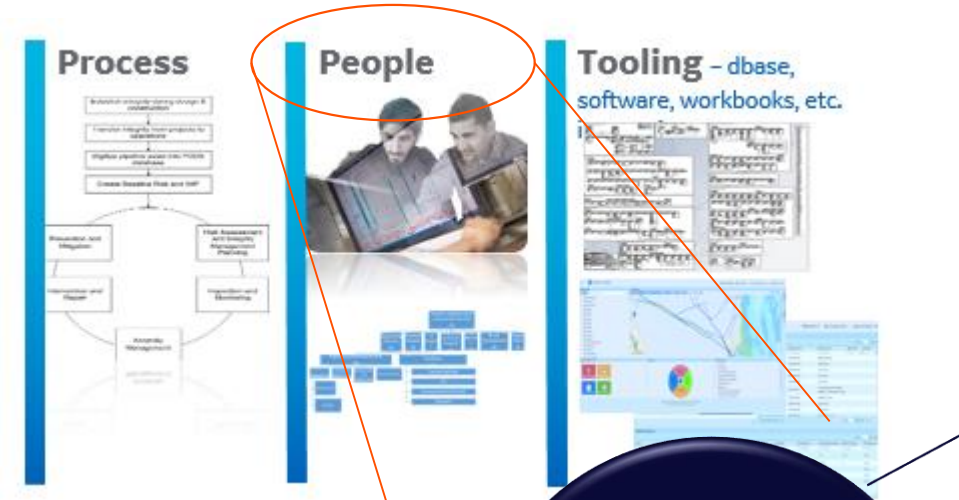
PIMS Manual

- Manual
- Procedures
- Workflows

RACI Matrix

- Workflow analysis to prepare 1st draft of RACI matrix by contractor
- Discussion between contractor and operator
- Update by operator

Small Pipeline Network + Low PIMS Budget



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

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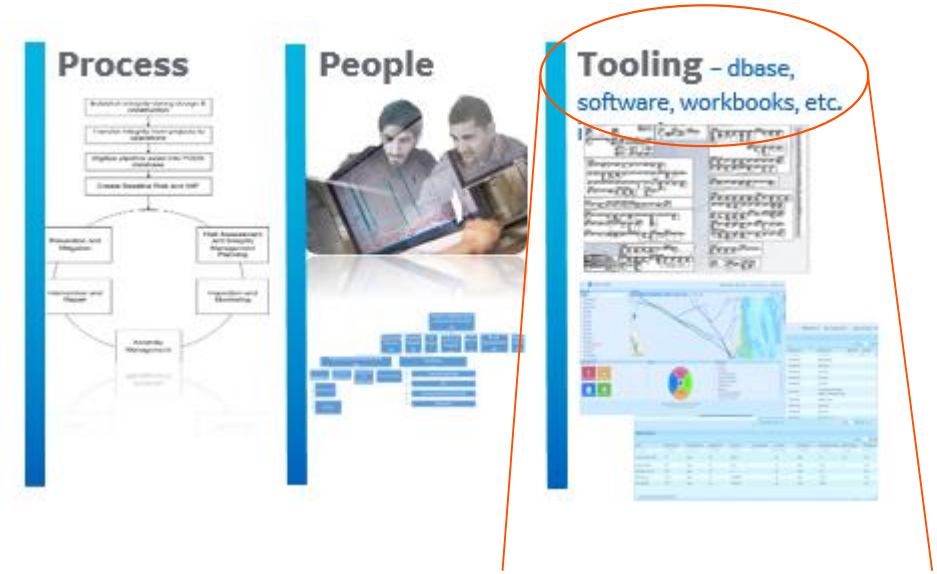


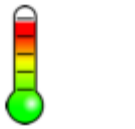
PIMS database

Option provided for On-site support

?

No investment on Database and Software

PIMS tasks executed based on Job Specific Contracts



KPI's

Along with ILI

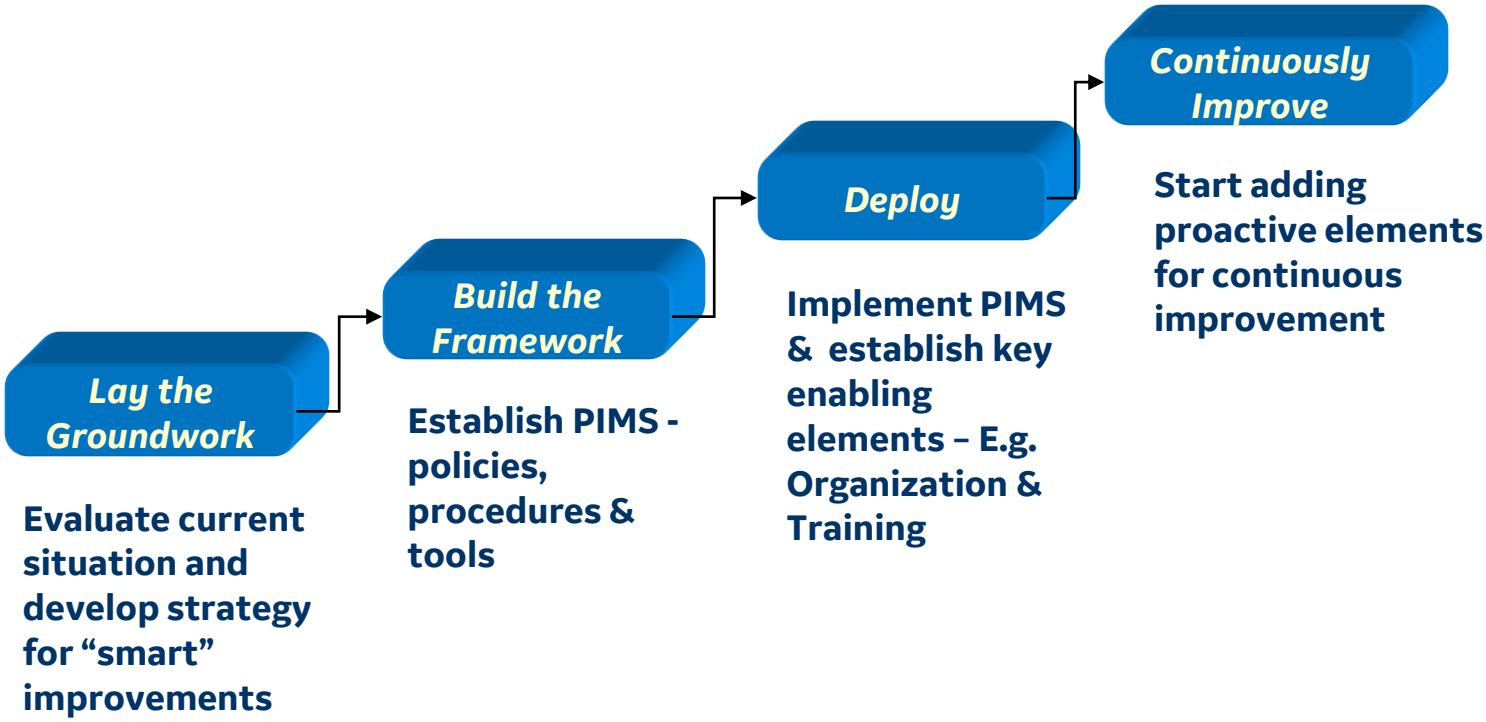
Condition and FFP Reports

As part of PIMS Implementation Contract

Inspection Plans

Annual Risk Reports

PIMS Development & Implementation



End Objective – Best in Class

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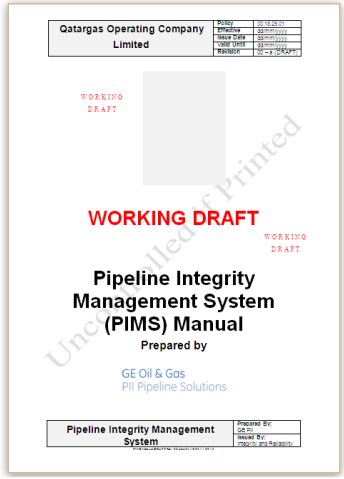
PIMS Development and Implementation



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

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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

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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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Pipeline Integrity Management Process

Core Process Elements

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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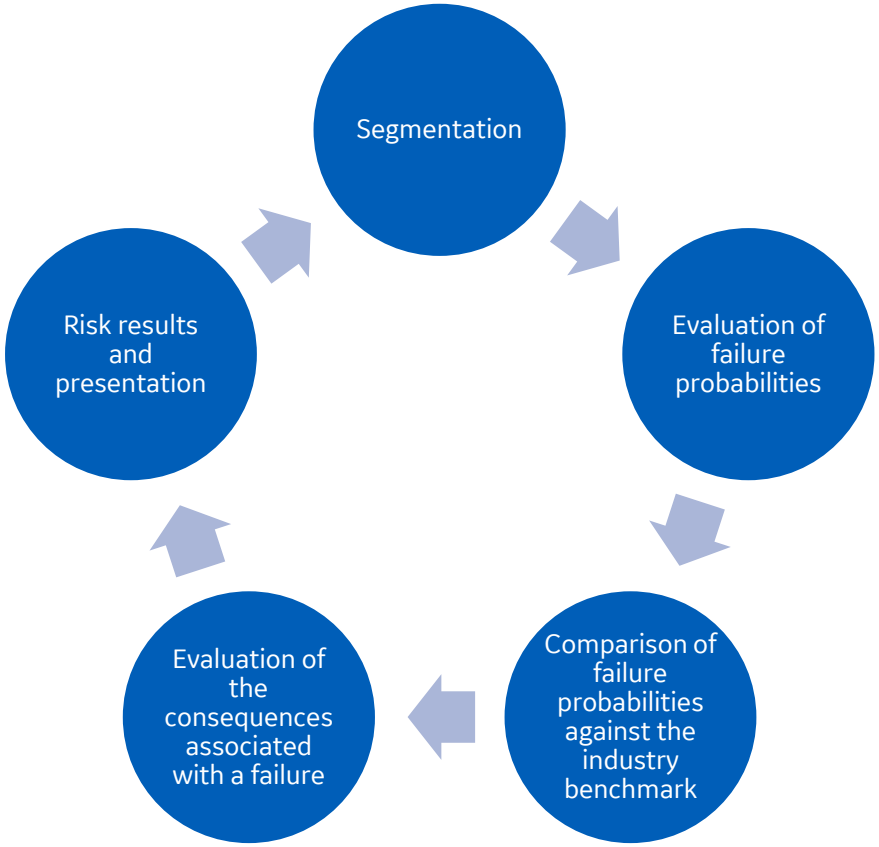
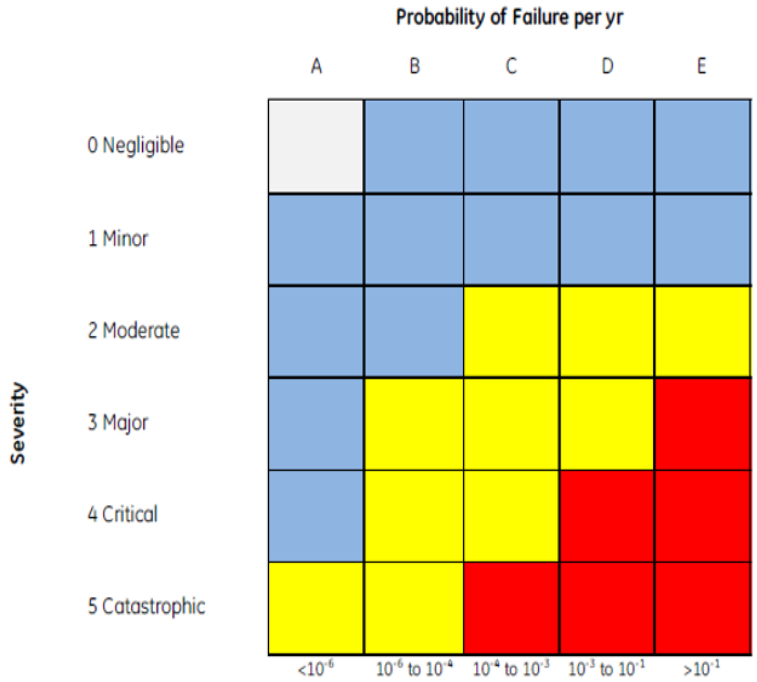
Quantitative Risk Assessment (QRA)





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

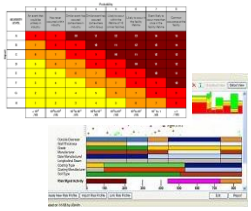
- Keep people & environment safe
- Increase asset availability
- Maintain reputation

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

Probability of Failure (Loss of Containment)

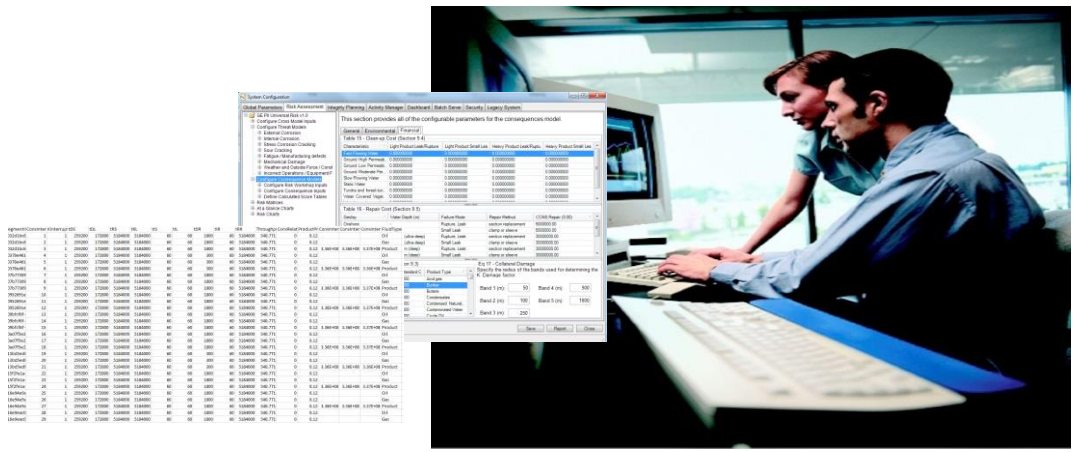
- •External Corrosion
- •Internal Corrosion
- •Stress Corrosion Cracking
- Sour Cracking
- Fatigue/Manufacturing defects
- Mechanical damage
  - •Weather and outside force/Construction defects
  - •Equipment failure and Incorrect operations

Determination of Failure Consequences

- Heath and Safety
- Environment
- Financial

Failure Modes

- Small Leak
- Large Leak
- Rupture



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Risk Service

Challenge

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

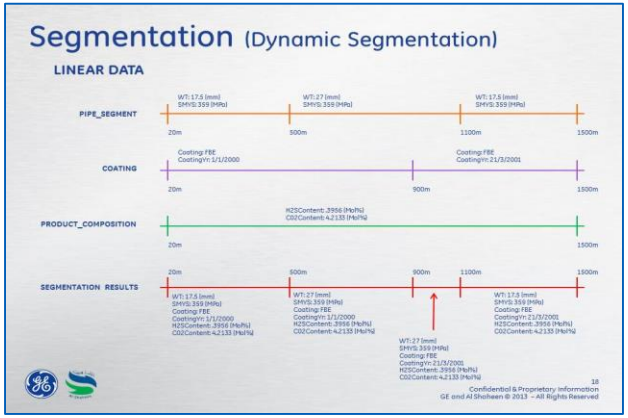
Solution

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

Outcome

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

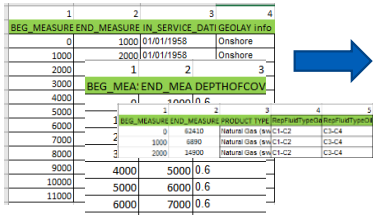
...An Excel macro which copies data from the input data table into risk calculation spreadsheets and then copies results into risk reports

...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

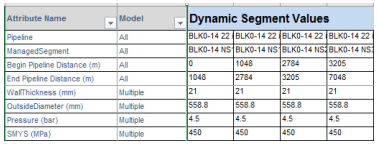
Solution for Medium Pipeline Network + Low PIMS Budget

Risk Service



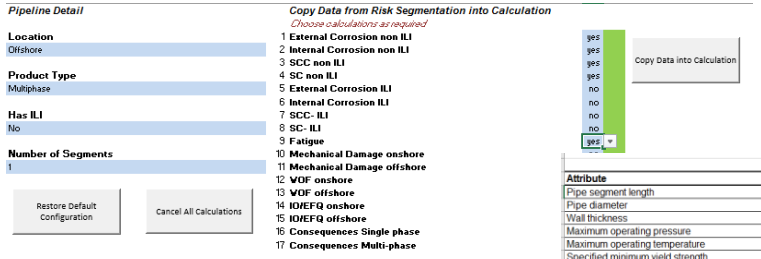
	1	2	3	4
	BEG_MEASURE	END_MEASURE	IN_SERVICE_DATI	GEOLAY Info
0	0	1000	01/01/1958	Onshore
1000	1000	2000	01/01/1958	Onshore
2000	1	2		3
3000	BEG_MEA	END_MEA	DEPTHOFCOV	
4000	0	1000	0.6	
5000	1	2	3	4
6000	BEG_MEASURE	END_MEASURE	PRODUCT_TYPE	RiserFluidTypeGa
7000	0	824	Natural Gas (sv	C1-C2
8000	1000	6890	Natural Gas (sv	C1-C2
9000	2000	14900	Natural Gas (sv	C1-C2
10000	4000	5000	0.6	
11000	5000	6000	0.6	
	6000	7000	0.6	

Data loading templates



Attribute Name	Model	Dynamic Segment Values			
Pipeline	All	BLK0-14 22	BLK0-14 22	BLK0-14 22	BLK0-14 22
ManagedSegment	All	BLK0-14 NS	BLK0-14 NS	BLK0-14 NS	BLK0-14 NS
Begin Pipeline Distance (m)	All	0	1048	2784	3205
End Pipeline Distance (m)	All	1048	2784	3205	7048
WallThickness (mm)	Multiple	21	21	21	21
OutsideDiameter (mm)	Multiple	558.8	558.8	558.8	558.8
Pressure (bar)	Multiple	4.5	4.5	4.5	4.5
SMYS (MPa)	Multiple	450	450	450	450

Dynamically segmented input table



Pipeline Detail

Location
Offshore

Product Type
Multiphase

Has ILI
No

Number of Segments
1

Restore Default Configuration | Cancel All Calculations

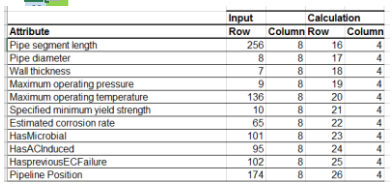
Copy Data from Risk Segmentation into Calculation
Choose calculations as required

1 **External Corrosion non ILI**
2 **Internal Corrosion non ILI**
3 **SCC non ILI**
4 **SC non ILI**
5 **External Corrosion ILI**
6 **Internal Corrosion ILI**
7 **SCC- ILI**
8 **SC- ILI**
9 **Fatigue**
10 **Mechanical Damage onshore**
11 **Mechanical Damage offshore**
12 **WOF onshore**
13 **WOF offshore**
14 **IO/EFQ onshore**
15 **IO/EFQ offshore**
16 **Consequences Single phase**
17 **Consequences Multi-phase**

yes yes yes yes no no no yes

Copy Data into Calculation

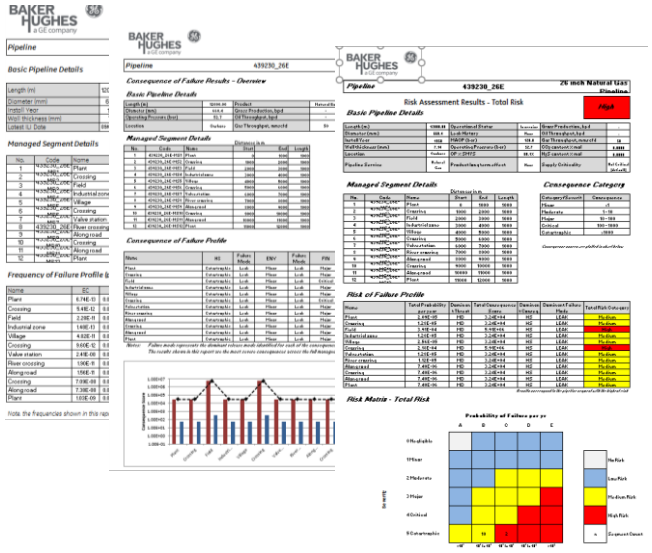
Macro to copy input table values into probability and consequence calculation sheets

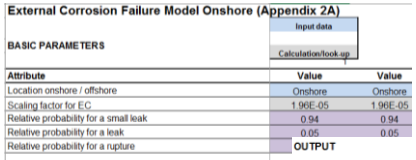


Attribute	Input Row	Input Column	Calculation Row	Calculation Column
Pipe segment length	256	8	16	4
Pipe diameter	8	8	17	4
Wall thickness	7	8	18	4
Maximum operating pressure	9	8	19	4
Maximum operating temperature	136	8	20	4
Specified minimum yield strength	10	8	21	4
Estimated corrosion rate	65	8	22	4
HasMicrobial	101	8	23	4
HasACInduced	95	8	24	4
HaspreviousECFailure	102	8	25	4
Pipeline Position	174	8	26	4

Maps, referencing input table fields to attributes used in calculation

Probability, Consequence and Risk reports





External Corrosion Failure Model Onshore (Appendix 2A)

Input data | Calculation/look-up

BASIC PARAMETERS

Attribute	Value	Value
Location onshore / offshore	Onshore	Onshore
Scaling factor for EC	1.96E-05	1.96E-05
Relative probability for a small leak	0.94	0.94
Relative probability for a leak	0.05	0.05
Relative probability for a rupture		

OUTPUT

INPUT

Attribute
Pipe segment length
Pipe diameter
Wall thickness

Attribute	Value	Value
Failure rate for external corrosion	1.21E-04	6.06E-05
Failure rate for external corrosion (small leak)	1.14E-04	5.70E-05
Failure rate for external corrosion (leak)	6.06E-06	3.03E-06
Failure rate for external corrosion (rupture)	1.21E-06	6.06E-07
Failure probability for external corrosion	1.21E-04	6.06E-05
Failure probability for external corrosion (small leak)	1.14E-04	5.70E-05
Failure probability for external corrosion (leak)	6.06E-06	3.03E-06
Failure probability for external corrosion (rupture)	1.21E-06	6.06E-07
	0.06858	0.06858

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

Report maps

Attribute	Row	Column	Report Ro	Report Co
TOTAL_REL_TIME_R	87	3	3	161
VOLUME_RELEASE_R operating	88	3	3	164
Environmental Flammable area Max	89	3	3	19
Environmental Flammable area Sum	90	3	3	22
Environmental Toxic area	91	3	3	25
Financial Hazard area	92	3	3	90
H&S Flammable area Max	93	3	3	93
H&S Flammable area Sum	94	3	3	96
H&S Toxic area	95	3	3	99

Risk Workshop

Code and standard requirements

Risk model explained

- Use of required data
- Interpretation of risk results

Interviews with site personnel

Engineering judgments

Default values

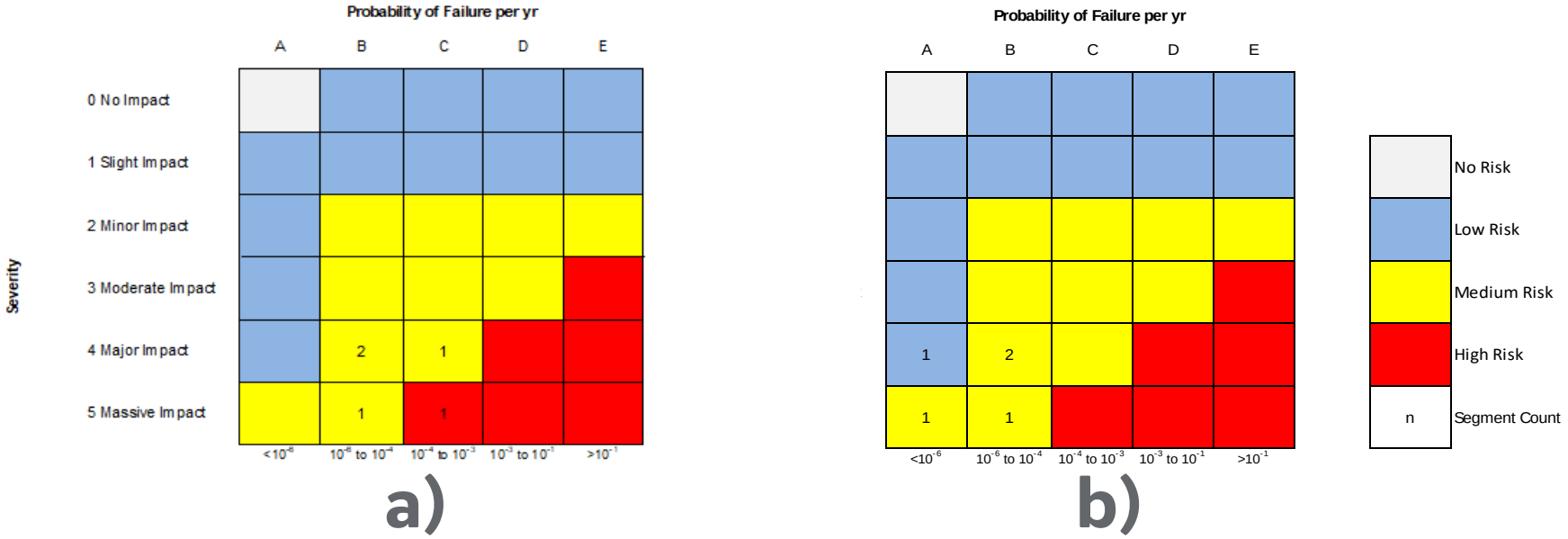
- Where the data gaps were still open after steps above

Review and confirmation

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

example

- 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.



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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.


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