

# PPSA 2010 Technical Seminar- Aberdeen

## Pipeline Integrity Management

presented by Na'el Barghouti  
PII Pipeline Solutions  
a GE Oil & Gas and Al Shaheen joint venture

Engineering Consultancy  
Services for Pipeline Integrity  
Review and recommendations  
for Selected Offshore Pipelines



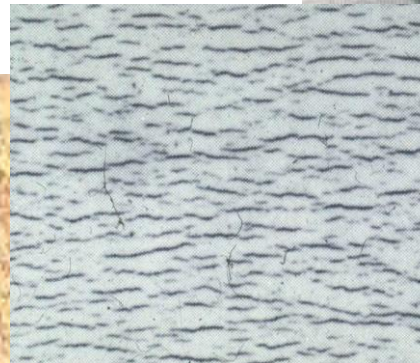
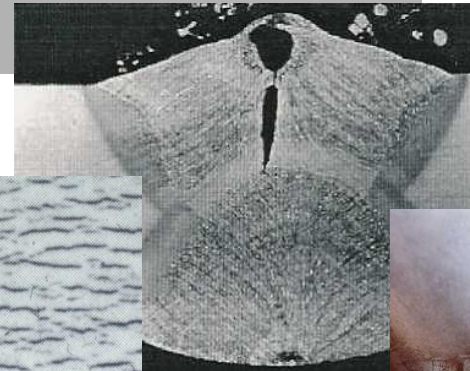
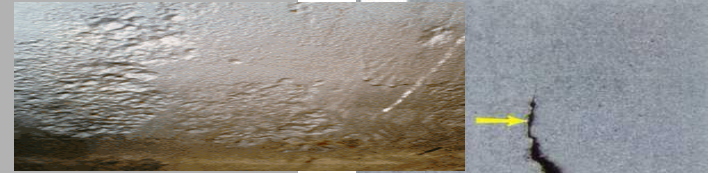
# What is pipeline integrity management?

- PIM is a subset of the Operations & Maintenance (O&M) function of Pipeline Operations
- It comprises those actions focused on preventing pipeline failures and ensuring:
  - Public and employee safety
  - Protection of the environment
  - Reliable service
- These actions generally include the following:
  - Inspection of the pipeline
  - Integrity assessment
  - Repair and remediation
  - Risk prevention and mitigation programs
  - Continual integrity assessment planning



# *In summary, we want to prevent these things ...*

- Corrosion (Internal/External)
- Mechanical Damage
- Incorrect Operations
- Loss of Ground Support
- Stress Corrosion Cracking



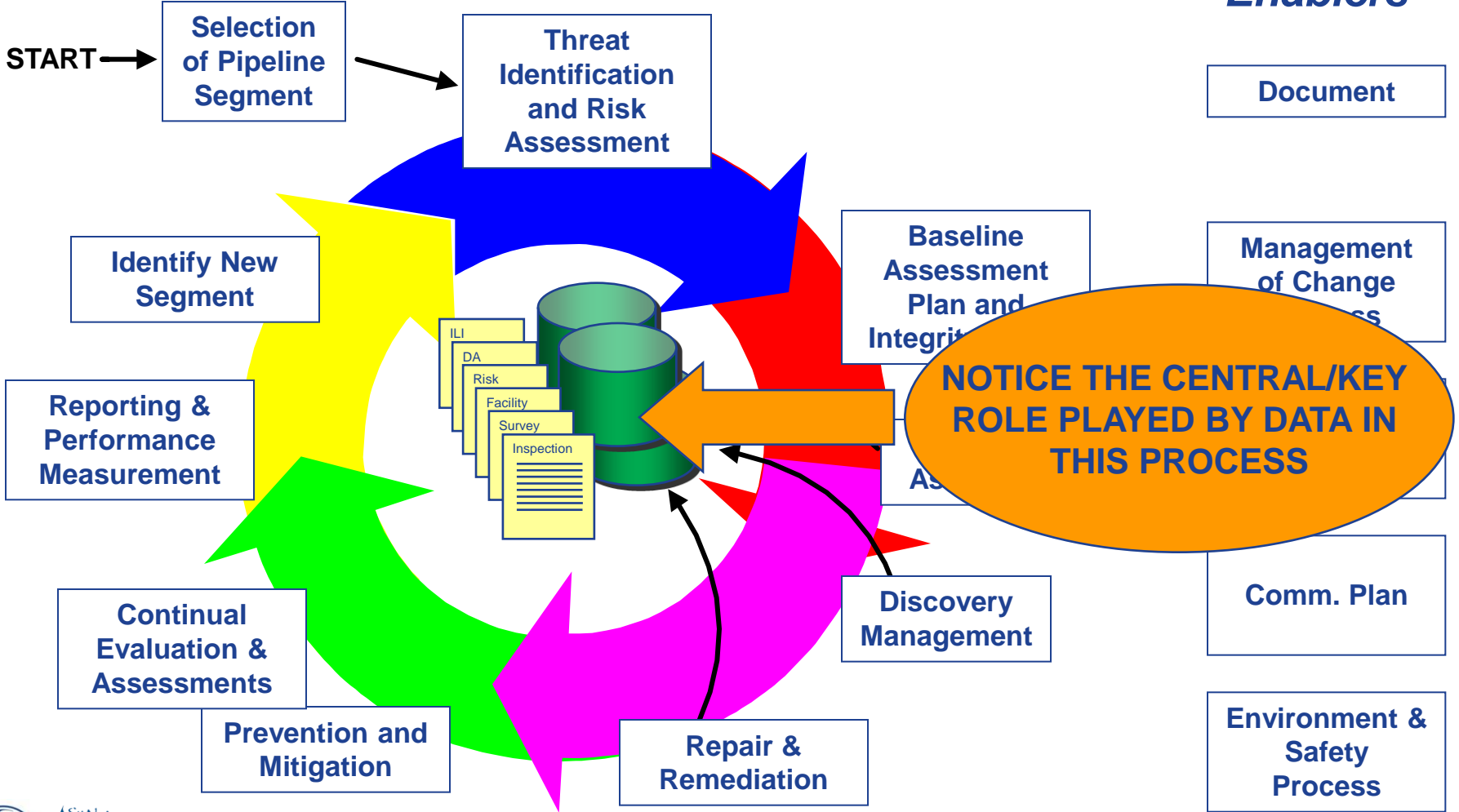
*... from causing these things*



# Pipeline Integrity Management Process

## Core Process

## Enablers



# Case Study - QP Selected Offshore Pipeline Integrity Assessment

- **Engineering Consultancy study follows the methodology laid out by QP. The overall objective of the study is to:**
  - Evaluate the condition of the 51 selected offshore pipelines
  - Establish their fitness-for-purpose and need for any remedial work
  - Determine the level of risk associated with continuing operating life
  - Identify the remedial measures and costs required to bring operation risks in line with standard industry practice levels
- **The production of individual pipeline study reports**
- **Overall Pipeline Integrity Study Report (PIR)**

## **Other deliverables:**

- PIM document philosophy (Corporate Philosophy and Codes of Practices)
- GIS based Pipeline Management Integrity System (PIMS)



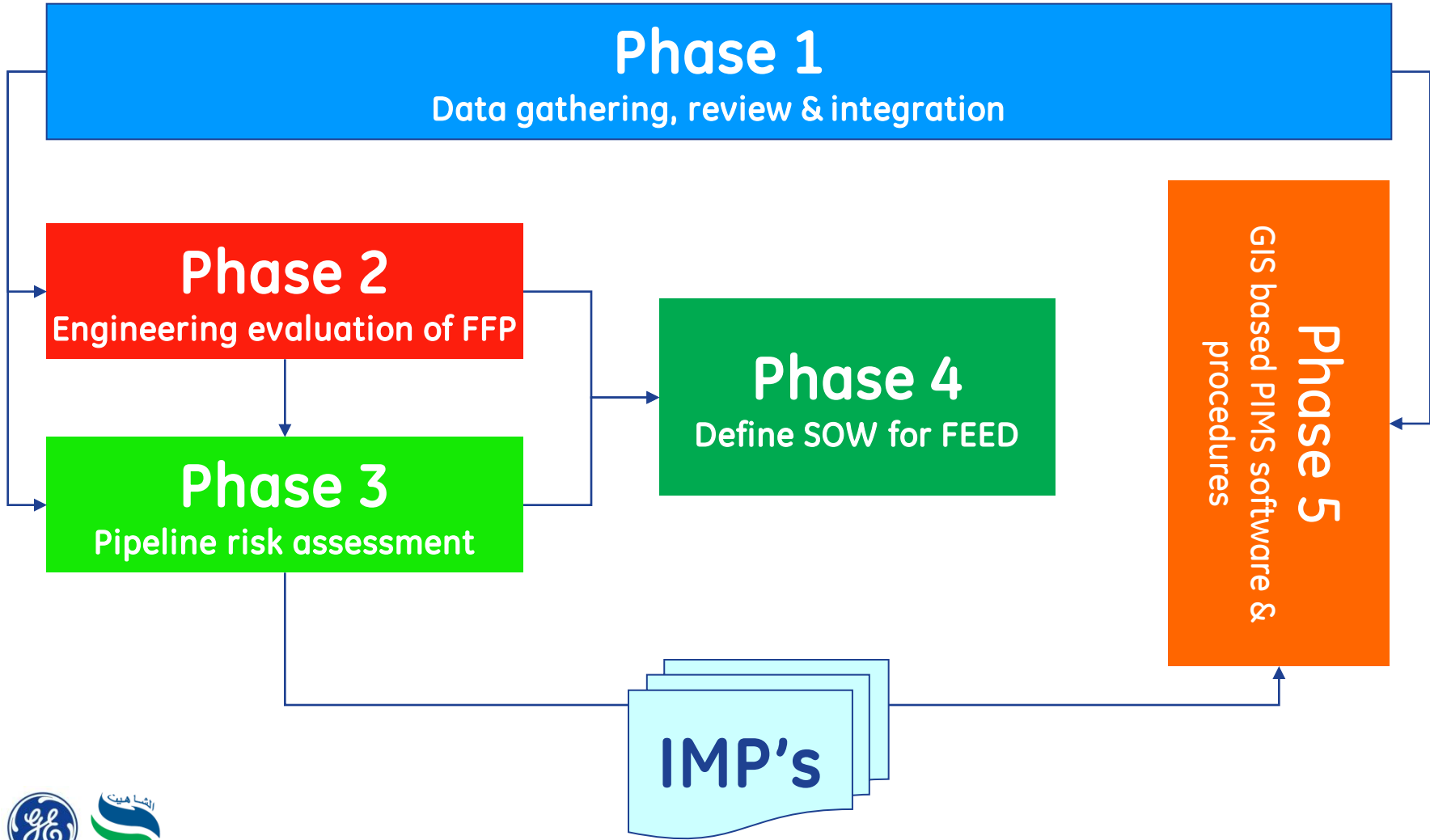
# Study approach & methodology

The work is being carried out in five phases:

- Phase 1: Data gathering, review & integration
- Phase 2: Engineering evaluation of FFP
- Phase 3: Risk assessment
- Phase 4: Define SOW for FEED
- Phase 5: Development GIS based PIMS software



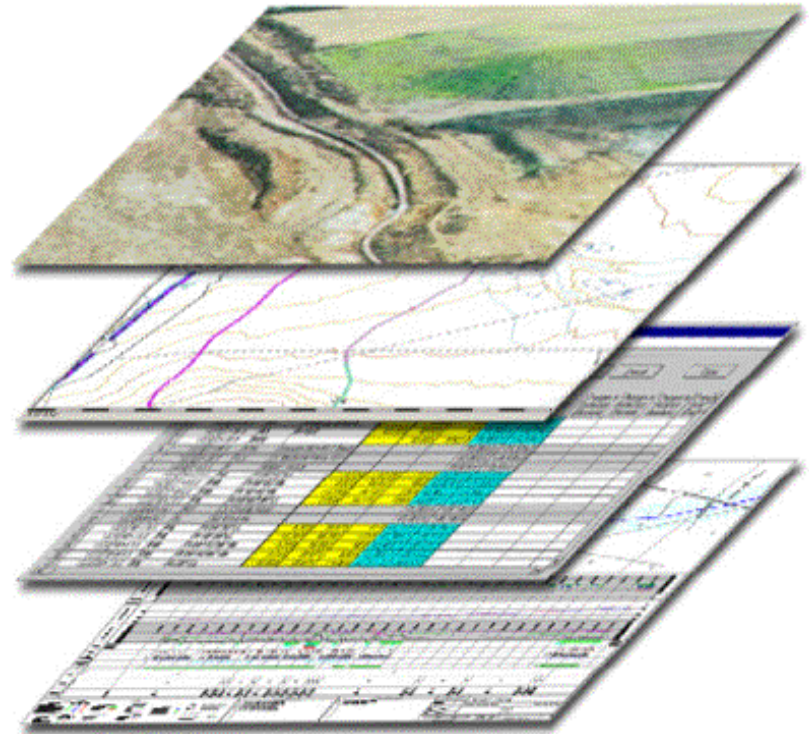
# Study approach & methodology





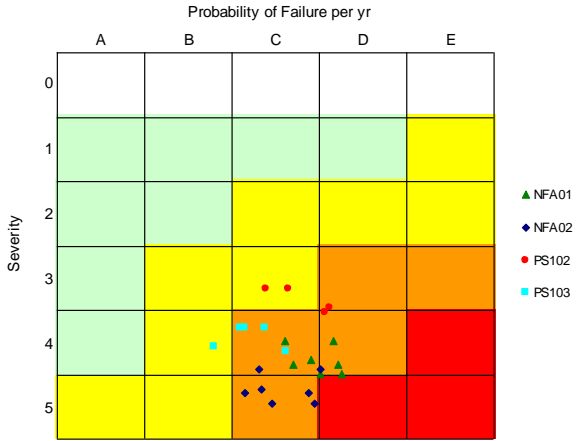
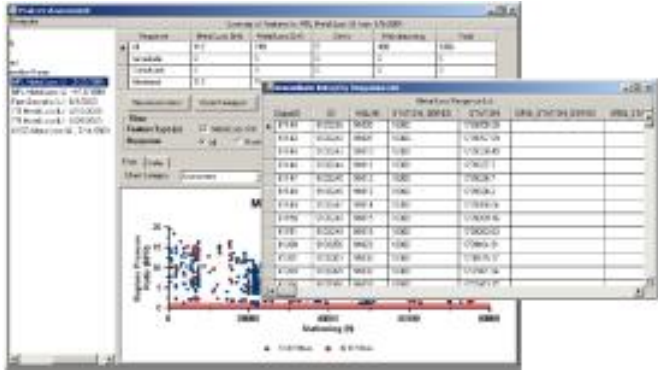
# Volume of data...

- More than 5 GB of data gathered, checked & loaded including:
  - Alignment sheets for 51 pipelines (total of 965 km)
  - Centerlines set up
  - Survey results imported:
    - 107 ROV reports
    - 85 external UT reports
    - 9 ILI reports
  - Data elements for more than 90 attributes entered for multiple line segments (~40,000 individual entries)



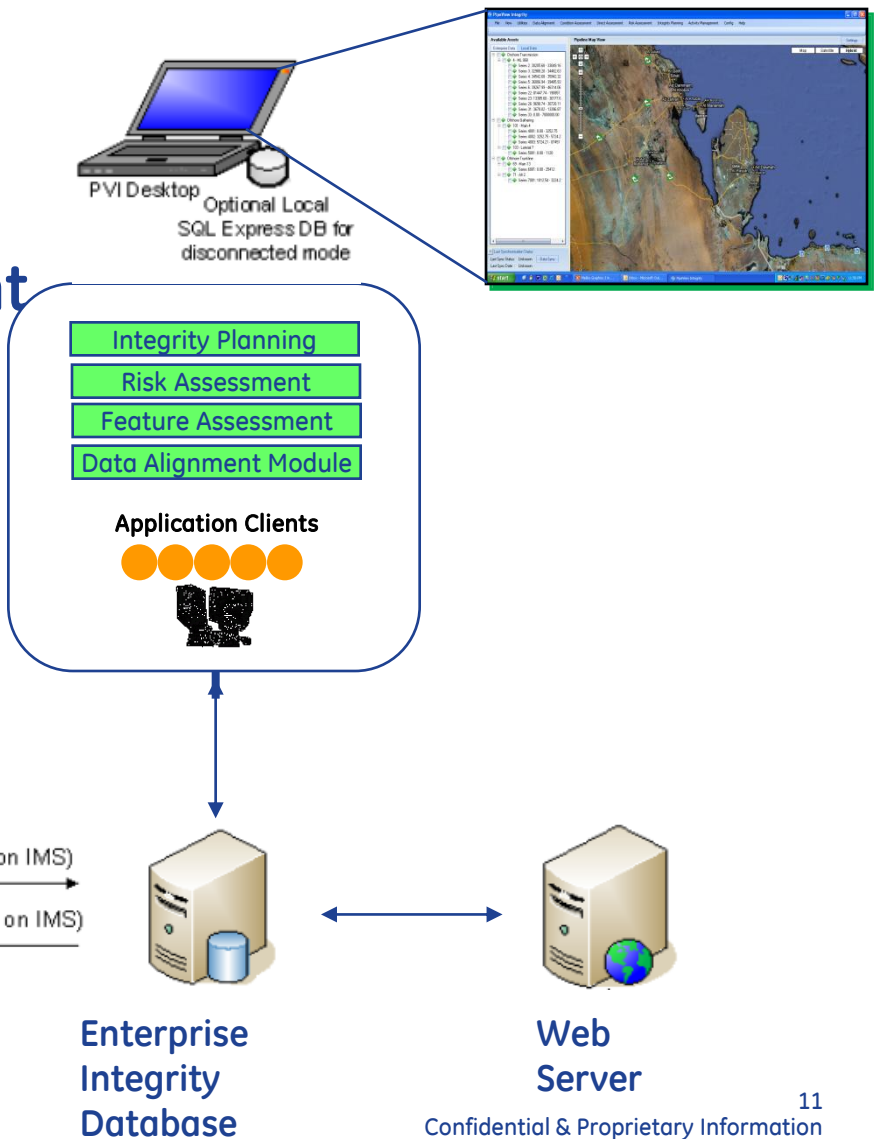
# Engineering evaluation

- Evaluation of the severity of over:
  - 600,000 ILI anomalies
  - 4,600 pipeline spans
  - 500 crossings
  - 100 stabilizations
  - 600 anodes (CP)
- Written deliverables...more than
  - 350 reports prepared
  - 250 risk profiles (before & after remediation)
  - 51 IMP's developed
- Identified & provided cost estimate for:
  - Over 800 remediation activities

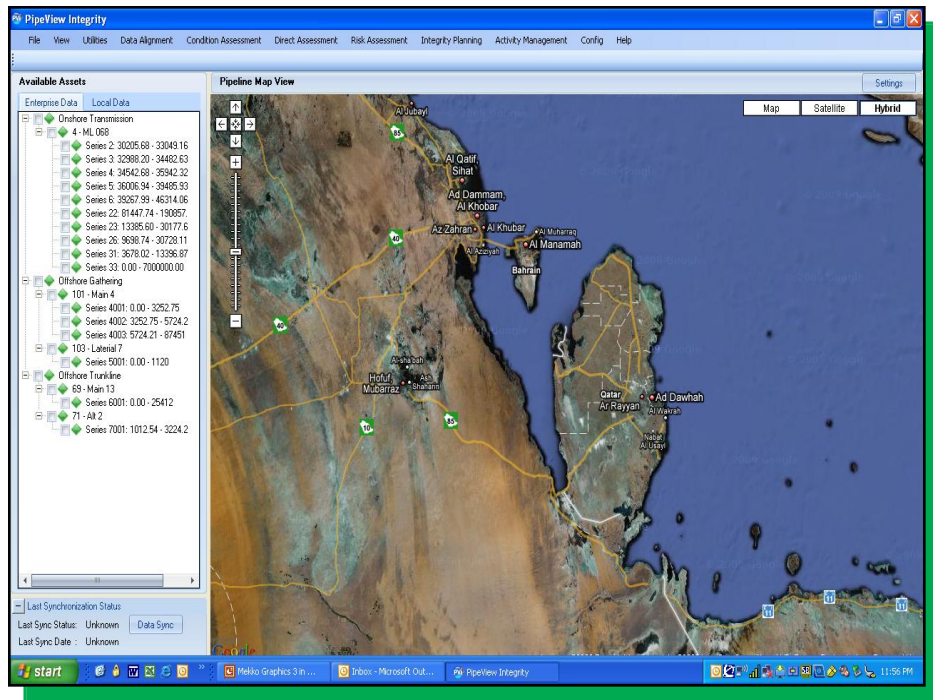


# Supply of GIS Based PIMS System

- GIS Facility Data Management system (based on ESRI's ArcGIS)
- Web Access Software
- Pipeline Integrity Management Software
  - Risk Assessment module
  - Data Alignment module
  - Feature Assessment Module
  - Integrity Planning Module



# Integrity Management Software



## ➤ Data Alignment Module

- Load and align various data sets to enhance analysis and visualization of pipeline data

## ➤ ILI Feature Assessment

- Perform in-depth feature analysis for an understanding of current and future condition

## ➤ Risk Assessment

- Accurately rank and forecast risk for cost-effective, long-term pipeline management

## ➤ Integrity Planning

- Automatically and / or manually generate scenarios consisting of proposed mitigation actions. Compare between various scenarios based on risk reductions, costs and KPI performance

# Data Alignment

- Tools to load & align data various data types and formats – in-line & above-ground inspections – for subsequent analysis & visualization
- Align new data to centerline or other inspection data
- Automatically or interactively establish matches or common features
- Immediate feedback of alignment based on user-established tolerances
- Graphic and tabular interface to target & align data

**Top Window: FacilityData**

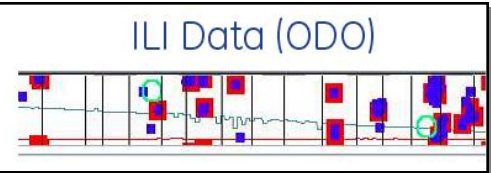
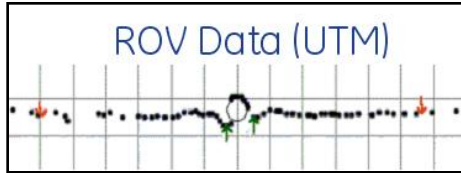
Target: FacilityData, Contract Name = FacilityData / Contract ID = -1

Matched	Position	MatchID	ID	Feature	Series_Value
<input type="checkbox"/>			(646d6d0-1170)	ICE - Valve	26
<input type="checkbox"/>		1	(90d6e82-5d10-4)	ICE - Tee	33
<input type="checkbox"/>		2	(40413c24-cd62-4)	ICE - Valve	33
<input type="checkbox"/>		3	(c327496e-9cb3-4)	ICE - Tee	33
<input type="checkbox"/>		4	(fefa7b8-345e-4)	ICE - Valve	33
<input type="checkbox"/>			(934cc9d6-c629)	External Corrosi	33
<input type="checkbox"/>			(b79550d0-e5e3)	External Corrosi	33
<input type="checkbox"/>			(729d632e-0ff6)	External Corrosi	33
<input type="checkbox"/>			(357d411d-471)	External Corrosi	33
<input type="checkbox"/>			(e8752948-a93)	External Corrosi	33
<input type="checkbox"/>			(847ead855-5e0)	Metal Loss	33
<input type="checkbox"/>			(7c6b1b4e-d3e)	Metal Loss	33
<input type="checkbox"/>			(2d62230-8ec)	Metal Loss	33
<input type="checkbox"/>			(6ce15e60-4e1)	Metal Loss	33
<input type="checkbox"/>			(aa9fec9c-700b)	Metal Loss	33
<input type="checkbox"/>			(ec1c289c-1481)	Metal Loss	33
<input type="checkbox"/>			(0cd17b9-36b8)	Metal Loss	33
<input type="checkbox"/>			(010b8b8f-5617)	Metal Loss	33
<input type="checkbox"/>			(a4143d66-5d13)	Metal Loss	33
<input type="checkbox"/>			(c1a76cc0-3888)	External Corrosi	33

**Bottom Window: ML068 Metal Loss**

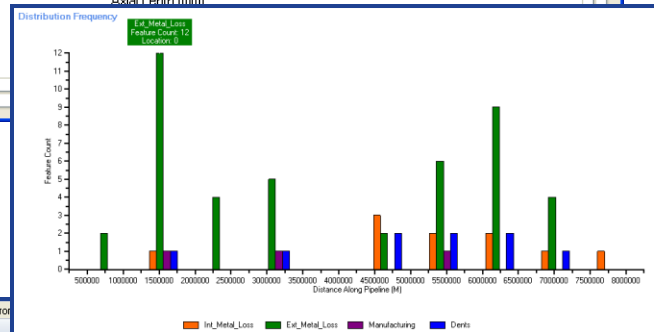
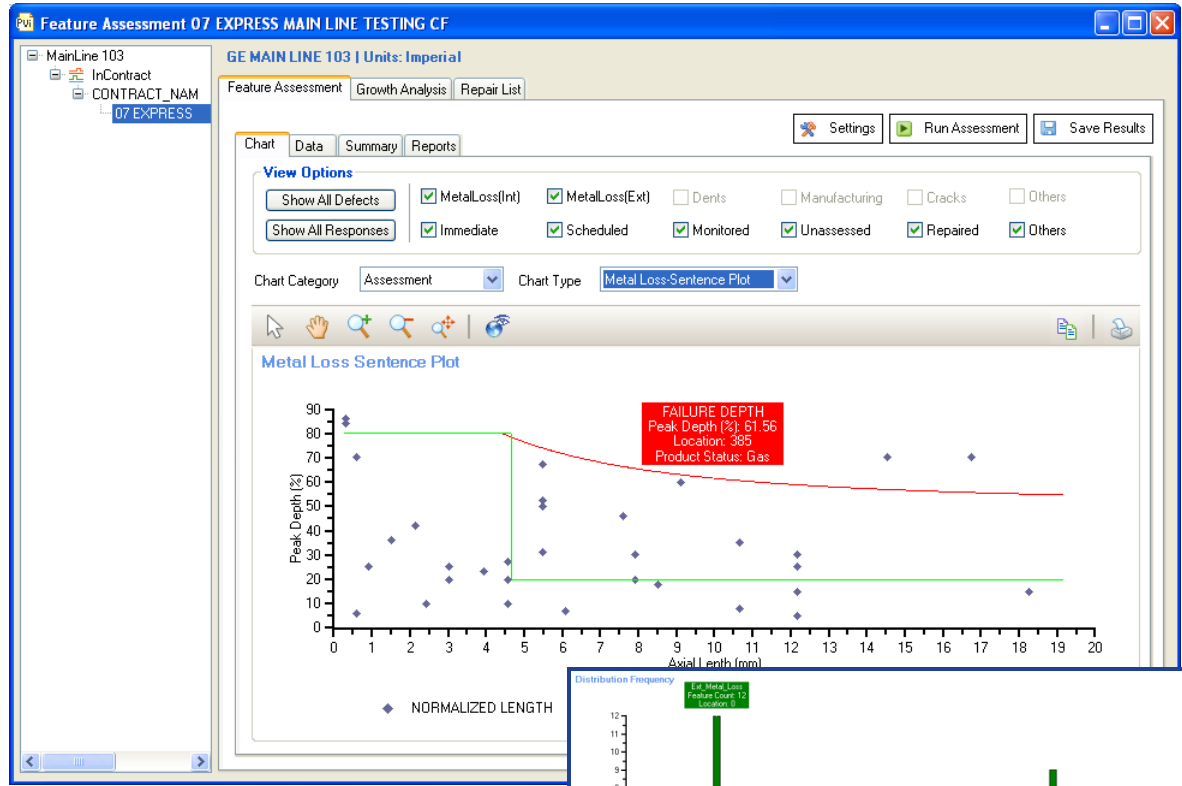
Target: FacilityData, Contract ID = -1 / Contract Name = FacilityData

MatchID	ID	Feature	Series_Value
1	9	ValveFacility	ML068-316
2	143	Wall Thickness	ML068-316
3	54	Teefacility	ML068-316
4	10	ValveFacility	ML068-316
5	55	Teefacility	ML068-316
6	56	Teefacility	ML068-316
7	52	Teefacility	ML068-316
8	147	Wall Thickness	ML068-316
9	15	WeldFacility	ML068-316
10	61	WeldFacility	ML068-316
11	1	ValveFacility	ML068-316
12	148	Wall Thickness	ML068-316
13	82	WeldFacility	ML068-316
14	25	WeldFacility	ML068-316
15	17	WeldFacility	ML068-316
16	74	WeldFacility	ML068-316
17	49	WeldFacility	ML068-316
18	44	WeldFacility	ML068-316
19	63	Teefacility	ML068-316



# Feature Assessment

- Analyze and prioritize data for more effective prioritization and management of repairs
- Engineering critical analysis of feature data
  - Probability of Exceedance
  - Deterministic: (B31G, modified B31G, DNV)
  - Corrosion growth
- Configurable repair criteria including
  - API 1160
  - B31.8S
- Repair management



Response	Metal Loss (Int)	Metal Loss (Ext)	Dents	Manufacturing	Dents
All	10	44	9	0	3
Immediate	1	10	0	0	1
Scheduled	5	18	0	0	0
Monitored	4	16	9	0	0
No Action Required	0	0	0	0	2
Unassessed	0	0	0	0	0



# Risk Assessment

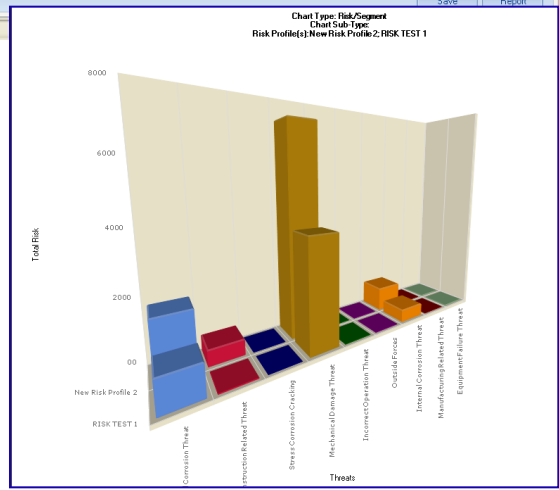
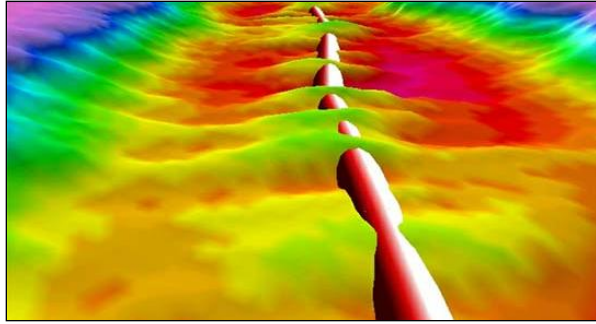
- Generate a risk profile including histogram of risk algorithm results and condition assessment results
- Perform threat screening
- Perform a data gap analysis with ability to directly edit pipeline data
- View and compare multiple risk results
- Generate output in charts and customizable reports

**Risk Model**

Selected	Contract Name	Type	Start date	End date	LINE_LOOP	OPERATING_COMPANY	SYSTEM
<input checked="" type="checkbox"/>	ML-068 Metal Loss	ILI - Metal Loss I	09/01/2007	09/01/2009	MAIN LINE 068	IMS Transm	IMS Transm
<input type="checkbox"/>	Test MFL Activity	ILI - Metal Loss I	07/03/2006	07/14/2006	MAIN LINE 068	IMS Transm	IMS Transm
<input checked="" type="checkbox"/>	Test Inspection Ac	ECCA - Close Int	05/30/2006	06/24/2006	MAIN LINE 068	IMS Transm	IMS Transm
<input type="checkbox"/>	ML-068 Caliper	ECCA - Close Int	07/01/2007	07/01/2011	MAIN LINE 068	IMS Transm	IMS Transm

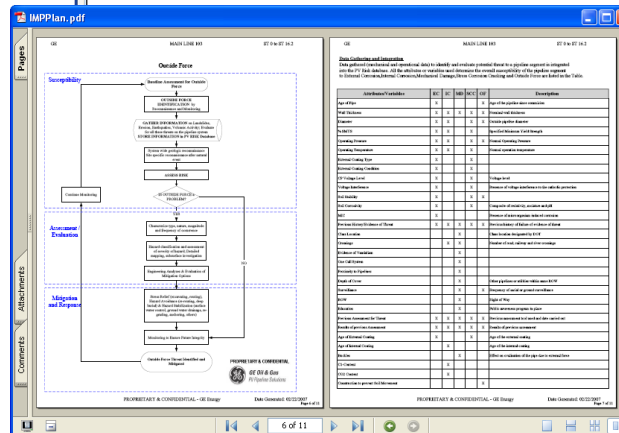
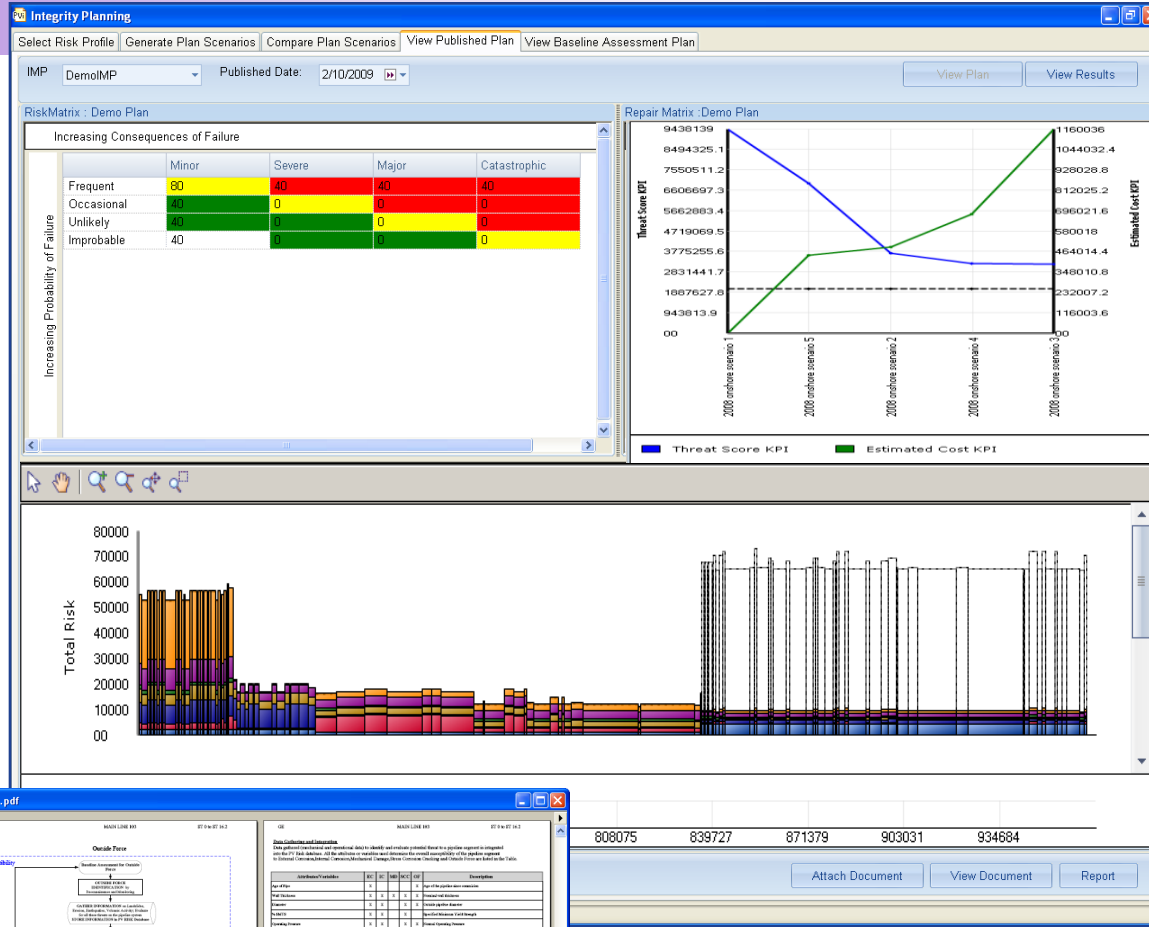
**Legend for Data Gap Analysis**

- Area not covered by Risk Process setup
- Missing Value
- Default Value from Risk Expression



# Integrity Planning

- PipeView Integrity provides the ability to generate integrity plans
- Create an auditable documented process for integrity management that is compliant with regulations
- Ensure company standards are achieved by incorporating the client's guidelines on best-practices for mitigation and remediation
- Calculate the most cost-effective mitigation strategies for the client's pipelines





# 51 Integrity Management Plans (Example)

## 1. FFP Evaluation

Document No: GENOF-7-17-009  
Pipeline Integrity Review

Pipeline Code/Name: \_\_\_\_\_

Overall Risk Category: **Significant**

CTR 5-65 Engineering Evaluation for Fitness-For-Purpose

Engineering Evaluation Report D-65-W1

Item	Findings	Remarks
1.1.1.1.1.1	2008	
1.1.1.1.1.2	2008	
1.1.1.1.1.3	2008	
1.1.1.1.1.4	2008	
1.1.1.1.1.5	2008	
1.1.1.1.1.6	2008	
1.1.1.1.1.7	2008	
1.1.1.1.1.8	2008	
1.1.1.1.1.9	2008	
1.1.1.1.1.10	2008	
1.1.1.1.1.11	2008	
1.1.1.1.1.12	2008	
1.1.1.1.1.13	2008	
1.1.1.1.1.14	2008	
1.1.1.1.1.15	2008	
1.1.1.1.1.16	2008	
1.1.1.1.1.17	2008	
1.1.1.1.1.18	2008	
1.1.1.1.1.19	2008	
1.1.1.1.1.20	2008	
1.1.1.1.1.21	2008	
1.1.1.1.1.22	2008	
1.1.1.1.1.23	2008	
1.1.1.1.1.24	2008	
1.1.1.1.1.25	2008	
1.1.1.1.1.26	2008	
1.1.1.1.1.27	2008	
1.1.1.1.1.28	2008	
1.1.1.1.1.29	2008	
1.1.1.1.1.30	2008	
1.1.1.1.1.31	2008	
1.1.1.1.1.32	2008	
1.1.1.1.1.33	2008	
1.1.1.1.1.34	2008	
1.1.1.1.1.35	2008	
1.1.1.1.1.36	2008	
1.1.1.1.1.37	2008	
1.1.1.1.1.38	2008	
1.1.1.1.1.39	2008	
1.1.1.1.1.40	2008	
1.1.1.1.1.41	2008	
1.1.1.1.1.42	2008	
1.1.1.1.1.43	2008	
1.1.1.1.1.44	2008	
1.1.1.1.1.45	2008	
1.1.1.1.1.46	2008	
1.1.1.1.1.47	2008	
1.1.1.1.1.48	2008	
1.1.1.1.1.49	2008	
1.1.1.1.1.50	2008	

Note: PS203 Idle since 1998

External Corrosion Review Report D-65-W2

Section of the pipeline	Length, m	Dominant Threat	Risk Category
Start River	40	External Corrosion	Significant
Start to Mid Section	500	Internal Corrosion	Medium
Mid Section	38,775	Weather and Outside Force	Medium
End to Mid Section	500	External Corrosion	Medium
End River	40	External Corrosion	Medium

Internal Corrosion Review Report D-65-W3

Internal Corrosion Risk: The line operates dry so it is concluded that the system is stable and no corrosion activity is expected. Under worst-case conditions an average corrosion rate of 0.1 mm/yr (0.004 in/yr) is predicted.

## 2. Threat identification & risk profile

## 3. Recommended remediation activities

Document No: GENOF-7-17-009  
Pipeline Integrity Review

Pipeline Code/Name: \_\_\_\_\_

Overall Risk Category: **Significant**

CTR 5-65 Engineering Evaluation for Fitness-For-Purpose

Engineering Evaluation Report D-65-W1

Item	Findings	Remarks
1.1.1.1.1.1	2008	
1.1.1.1.1.2	2008	
1.1.1.1.1.3	2008	
1.1.1.1.1.4	2008	
1.1.1.1.1.5	2008	
1.1.1.1.1.6	2008	
1.1.1.1.1.7	2008	
1.1.1.1.1.8	2008	
1.1.1.1.1.9	2008	
1.1.1.1.1.10	2008	
1.1.1.1.1.11	2008	
1.1.1.1.1.12	2008	
1.1.1.1.1.13	2008	
1.1.1.1.1.14	2008	
1.1.1.1.1.15	2008	
1.1.1.1.1.16	2008	
1.1.1.1.1.17	2008	
1.1.1.1.1.18	2008	
1.1.1.1.1.19	2008	
1.1.1.1.1.20	2008	
1.1.1.1.1.21	2008	
1.1.1.1.1.22	2008	
1.1.1.1.1.23	2008	
1.1.1.1.1.24	2008	
1.1.1.1.1.25	2008	
1.1.1.1.1.26	2008	
1.1.1.1.1.27	2008	
1.1.1.1.1.28	2008	
1.1.1.1.1.29	2008	
1.1.1.1.1.30	2008	
1.1.1.1.1.31	2008	
1.1.1.1.1.32	2008	
1.1.1.1.1.33	2008	
1.1.1.1.1.34	2008	
1.1.1.1.1.35	2008	
1.1.1.1.1.36	2008	
1.1.1.1.1.37	2008	
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1.1.1.1.1.39	2008	
1.1.1.1.1.40	2008	
1.1.1.1.1.41	2008	
1.1.1.1.1.42	2008	
1.1.1.1.1.43	2008	
1.1.1.1.1.44	2008	
1.1.1.1.1.45	2008	
1.1.1.1.1.46	2008	
1.1.1.1.1.47	2008	
1.1.1.1.1.48	2008	
1.1.1.1.1.49	2008	
1.1.1.1.1.50	2008	

Risk Matrix

Probability of Failure per yr

Severity	A	B	C	D	E
0 Negligible	Green	Green	Green	Green	Green
1 Minor	Green	Yellow	Yellow	Yellow	Yellow
2 Moderate	Green	Yellow	Orange	Orange	Orange
3 Major	Green	Yellow	Orange	Red	Red
4 Critical	Green	Yellow	Orange	Red	Red
5 Catastrophic	Green	Yellow	Orange	Red	Red

Legend:

- Green: Negligible Risk
- Yellow: Low Risk
- Orange: Medium Risk
- Red: Significant Risk
- Dark Red: High Risk

Comments: High Inland section and start river have the highest risks and the dominant threats are from WOC and EC respectively. ROW/CP information is 7 years old so a new ROW/CP survey is now due. In-situ inspection, coating and cathodic protection works.

Document No: GENOF-7-17-009  
Pipeline Integrity Review

Pipeline Code/Name: \_\_\_\_\_

Overall Risk Category: **Significant**

CTR 5-65 Engineering Evaluation for Fitness-For-Purpose

Engineering Evaluation Report D-65-W1

It is understood that the intention is to return this pipeline to service. The following statement can be made regarding the fitness-for-purpose of the pipeline based on the FFP engineering evaluation of the reported anomalies and of the current status in the pipeline it is concluded that this pipeline is currently fit for purpose for operation at the stated MOP. To safeguard the future integrity of the pipeline the following recommendations should be conducted as indicated.

Recommendations

Action	Required Activity/ Proposed Schedule	Remark	Ref
Remote Conductivity (RC) survey	The RCV is overdue. Introduce with urgency.	Recommended interval for RCV survey is 7 years.	153,601,608
Inspect 7 start river 100' RCV control	Auto-CP shut.	RCV of 700amps should be conducted at a maximum interval of 7 years. i.e. the next survey is now due.	153,601,608
Inspect 7 conductivity section	100'	The frequency of conducting RCV in this section is not clear for current operating conditions to be investigated.	153,601,608
Investigate Critical Signs	40'	Introduce with urgency.	153,601,608
Inspect and Review Start section	2	Introduce with urgency.	153,601,608
Investigate Anomalous Readings	0'	See Table C (08), follow with RCV and re-inspection.	153,601,608
Investigate Areas of Possible Pipeline Movement, Sliding or Seismic Crack Change	None reported.	Not applicable.	153,601,608
Investigate Areas of Possible Pipeline Corrosion	None reported.	Not applicable.	153,601,608
External Corrosion Control program (Start river)	None reported.	Not applicable.	153,601,608
Re-inspection of the CP system	Not applicable.	Not applicable.	100
Re-inspection of CP survey	Before the end of 2011.	CP survey intervals should not exceed 7 years. A River should be cleared/CP reviewed and re-surveyed and should be conducted where possible.	100
External Corrosion Control program (Start river)	Facilitate inspection of the river by erecting scaffolding or similar structure.	Confirm accessibility.	100
River inspection activities	Before installing the river survey.	Confirm accessibility.	100
River survey activities	None.	None.	100
River pipeline electric isolation	Confirm electric isolation between the pipeline and the isolated structure. If CP continuity is confirmed CP should attempt to remove isolation. If CP continuity is not confirmed CP should attempt to remove isolation. If CP continuity is not confirmed CP should attempt to remove isolation. If CP continuity is not confirmed CP should attempt to remove isolation.	To be conducted annually as a minimum.	100



# Pipeline Life Extension

- Notional design life is 25 years
- 38 pipelines have exceeded 25 years design life
- Main concerns (of this study) to remaining useful life are time dependent threats:

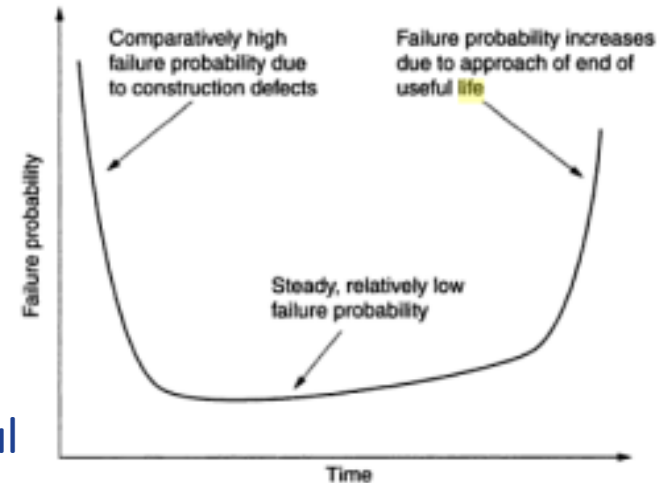


FIGURE 3.3 Bathtub curve of pipe performance with age.

Mitigated/Monitored by ...

- |                            |        |                                    |
|----------------------------|--------|------------------------------------|
| • Internal corrosion       | —————> | ILI/auto UT/inhibition/sampling    |
| • External corrosion rehab | —————> | CP surveys/anode retrofits/coating |
| • Stability                | —————> | Repair anomalous spans, crossings  |
| • Sour cracking            | —————> | Control internal corrosion risk    |

- As long as pipelines are regularly monitored for all relevant threats, maintained & remediated as required they can continue to be operated beyond design life indefinitely until economically unviable
- Life extension relies more and more heavily on effective use of increasing volumes of data as the life extension process matures.

