



Case Study: Development of Pipeline Integrity Management System (PIMS)

Onshore Upstream & Downstream Pipelines

Yee Chin Tang, Elizabeth Hillier and Asle Venas
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- PIMS Structure
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Background

- Asset scope:
 - 12 crude oil gathering flowlines from field to central pump station (~500km)
 - >1500km long, 28” oil diameter export line
 - Short sections of subsea pipeline for tanker loading
 - Marine terminal & storage tanks
- Pipelines pass through various terrains, population densities, environmentally sensitive areas and utilities facilities.
- Multiple failures experienced historically:
 - External – corrosion at field joints
 - 3rd Party Damage
 - etc.
- No systematic Pipeline Integrity Management System in place and inspection & maintenance activities had been led by service provider.
- Upstream & Downstream are two entities and operated separately

DNV Objective and Scope of Work

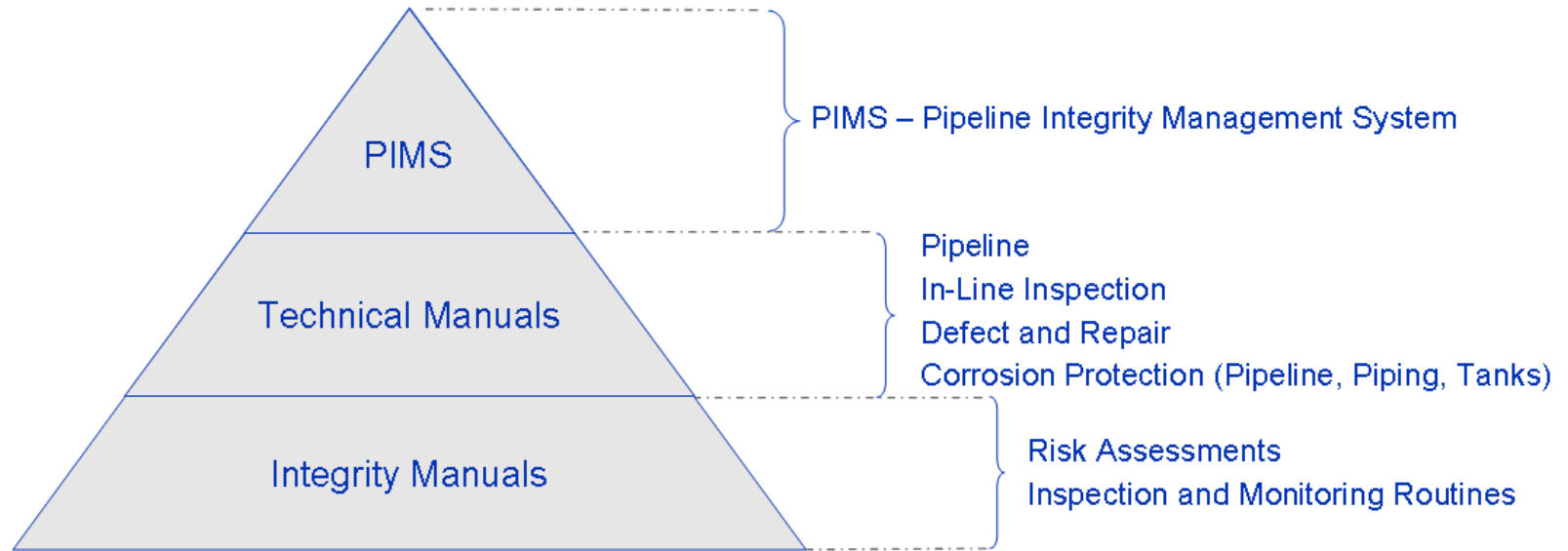
■ Objectives:

- Establish Asset Integrity Management System (AIMS) and Pipeline Integrity Management System (PIMS)
- Harmonize & Integrate integrity processes
- Establish Roles & Responsibilities
- Establish Continuous Improvement Systems
- Establish Strategies for Mitigation, Monitoring and Inspection

■ Scope of Work (Pipeline only):

- Develop a PIMS
- Develop technical manuals (corrosion protection, in-line inspection, defect assessment & repair)
- Develop risk assessment & risk based inspection (RBI) methodology
- Provide SilverPipe as Integrity Management Software Tool
- Perform the initial baseline risk assessment and produce inspection & monitoring routines
- Provide PIMS implementation training to the integrity responsible persons

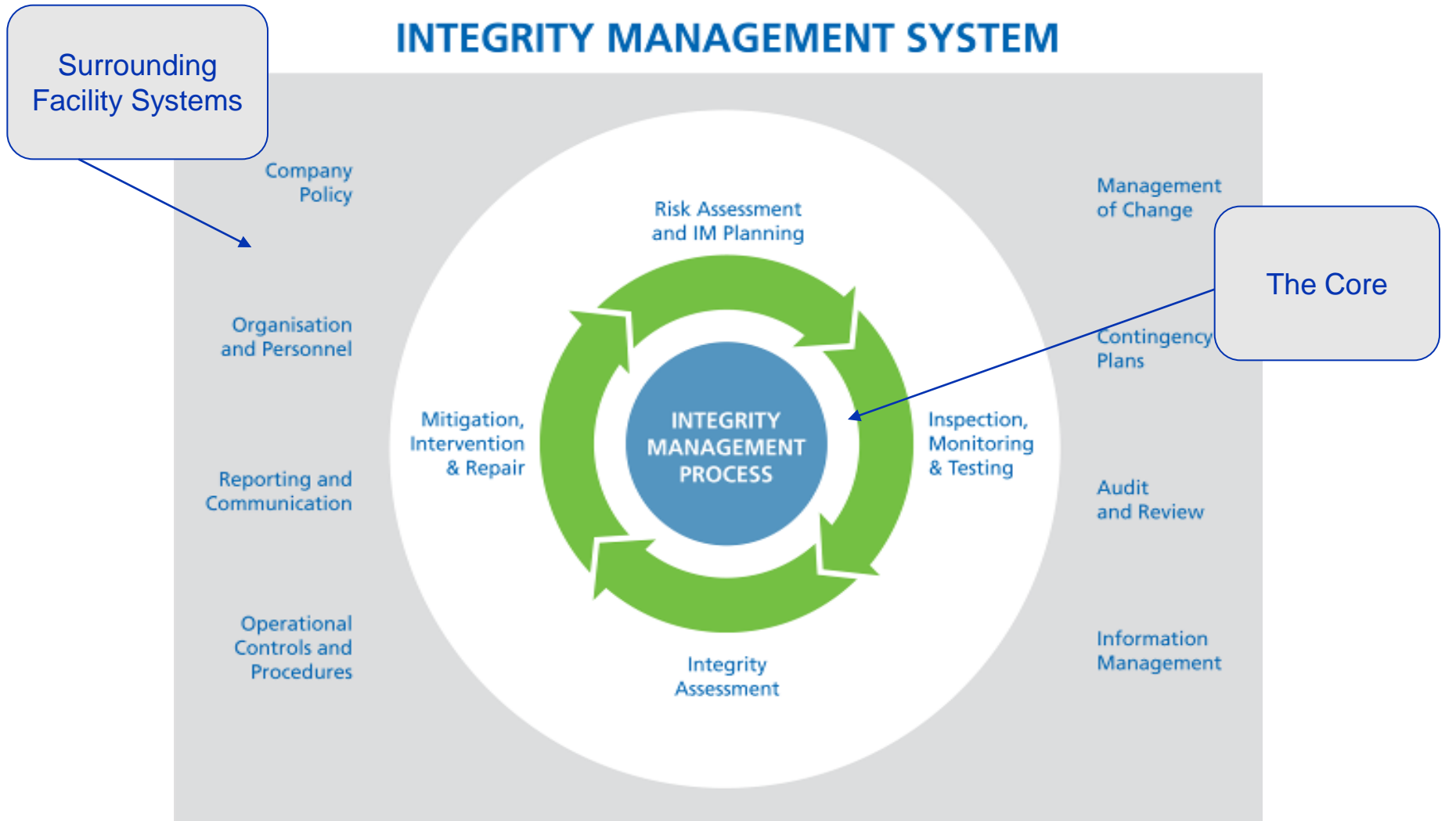
PIMS Structure



■ Core to the developed system are:

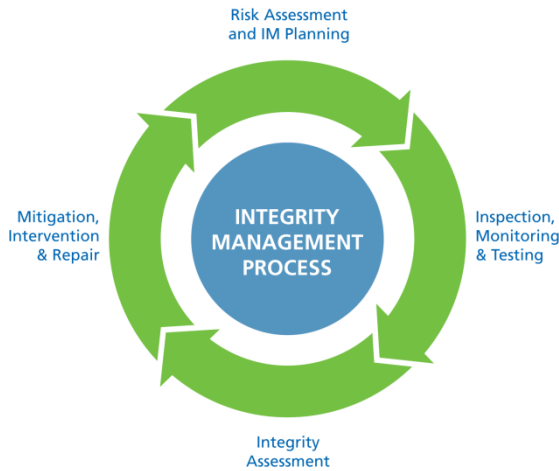
- Identified Responsible-Accountable-Consulted-Informed People for each activity
- Identified key Controlled Documents
- Clear Integrity Process Flow and Key Activities
- Managing the flow of controlled documents and information through the system
- Keep things as simple and live as possible

The Integrity Management (IM) System



Integrity Management (IM) Process

IM-Process in a life cycle perspective:

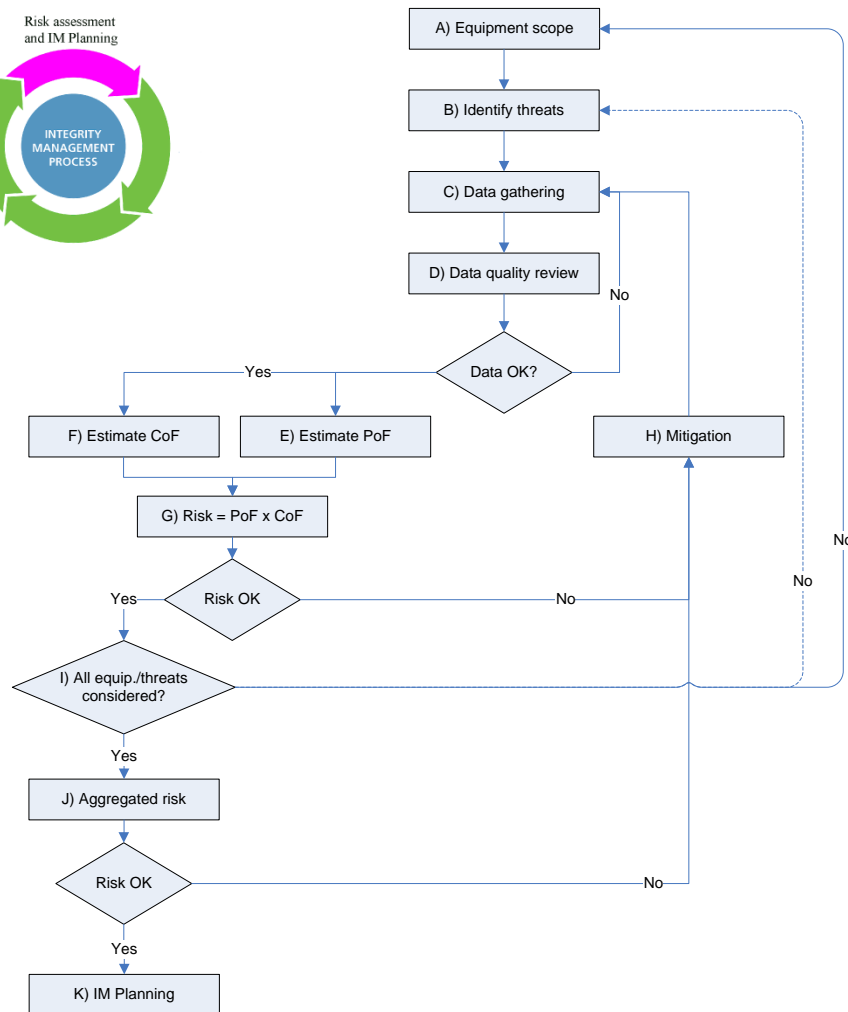


Pipeline integrity is

- *Established* during the concept, design and construction phases.
- *Transferred* from the development phase to the operations phase. This interface involves transfer of vital data and information about the system.
- *Maintained* in the operations phase.

Establish integrity	Maintain integrity	Abandonment
<p>Concept, design and construction (incl. pre-commissioning)</p>	<p>Operation (from commissioning until de-commissioning)</p>	
INTEGRITY MANAGEMENT PROCESS		
Risk Assessment and Integrity Management (IM) Planning		
	<p>Inspection, monitoring and testing</p> <p>Integrity Assessment</p> <p>Mitigation, intervention and repair</p>	

Risk assessment and IM Planning



Risk assessment and IM Planning – main tasks and link to code requirements:

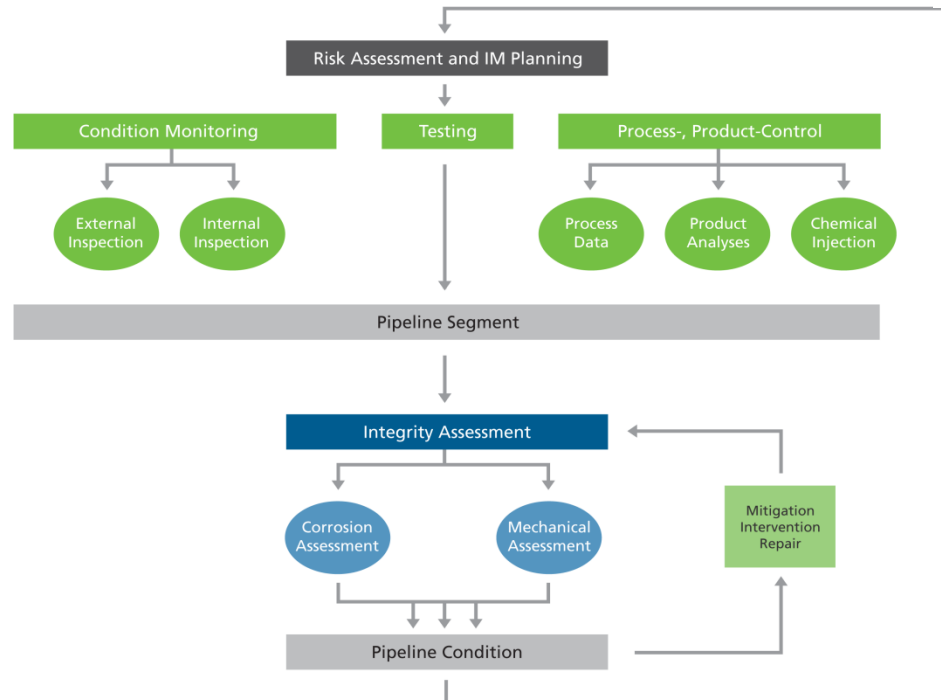
- Define equipment/item scope (i.e. all equipment/item that can lead to a failure)
- For each equipment/item, identify all threats which can lead to a failure
- For each threat; estimate risk
 - Consequence of failure (CoF)
 - Probability of failure (PoF)
- Propose plans for:
 - Inspection, monitoring and testing (IMT)
 - Mitigation, intervention and repair (MIR)
 - Integrity assessment (IA)

Integrity Assessment

Overview of damages/anomalies vs. assessment codes

Damage / anomaly	Code / Guideline	Comment
Metal loss	DNV-RP-F101	Corroded pipelines
	ASME B31.G	Including the "modified edition"
	PDAM	Summarises most common methods
Dent	DNV-OS-F101	Acceptance criteria and allowable dent depth
	DNV-RP-F113	Pipeline repair
	DNV-RP-C203	Fatigue
	EPRG / PDAM *)	
Crack	DNV-OS-F101	Detailed ECA analyses required
	DNV-RP-F113	Pipeline repair
	BS-7910	Guide on methods for assessing the acceptability of flaws in metallic structures
	PDAM	
Gouge	PDAM	
Free span	DNV-RP-F105	Free spanning pipelines
	DNV-RP-C203	Fatigue
Local buckle	DNV-OS-F101	Acceptance criteria
	DNV-RP-F113	Pipeline repair
Global buckle	DNV-RP-F110	Global buckling of Submarine Pipelines
	Germanischer Lloyd	Rules for Classification and Construction – III Offshore Technology - Part 4 – Subsea Pipelines and Risers, 1995 Edition
Exposure	DNV-RP-F107	Pipeline protection
Displacement	DNV-RP-F109	On-bottom stability
Coating damage	DNV-RP-F102	Coating repair
Anode damage	DNV-RP-F103	Cathodic protection

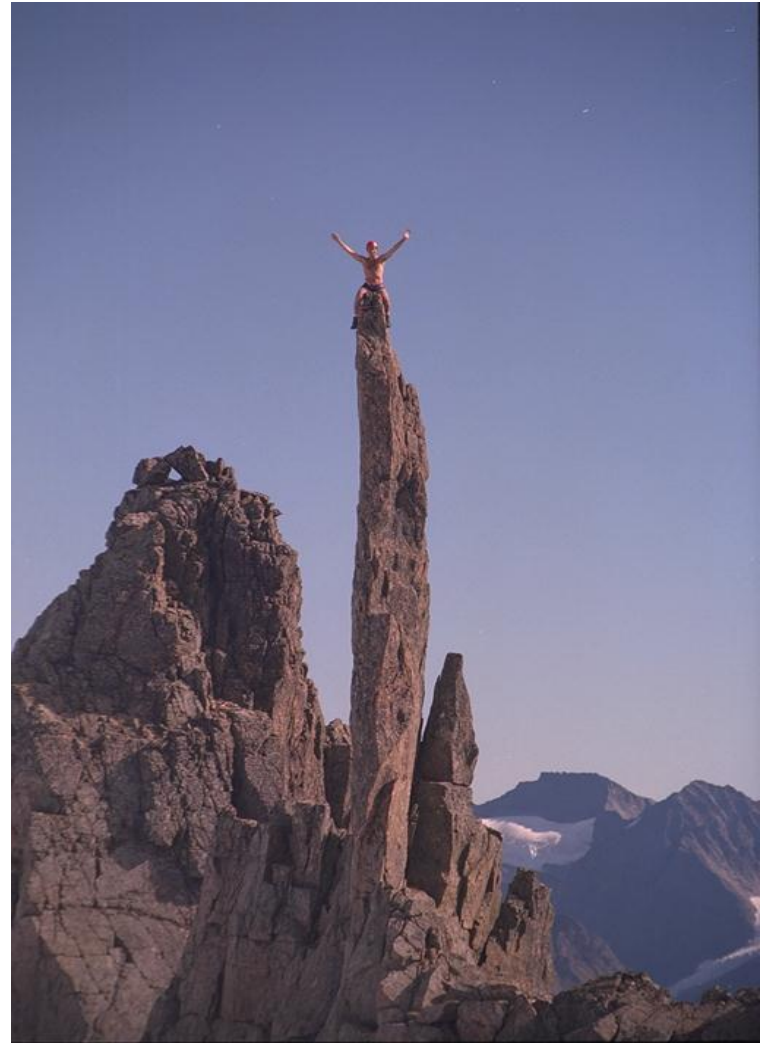
*) PDAM: Pipeline Defect Assessment Manual
EPRG: European Pipeline Resource Group



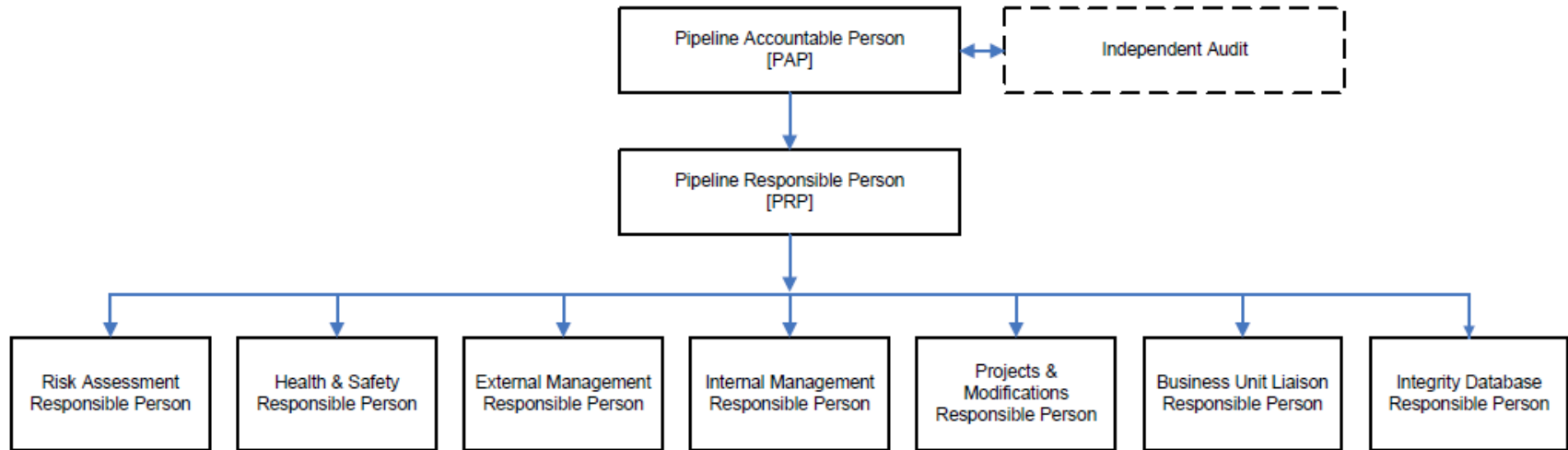
Flow diagram illustrating the different activities the integrity assessment process consists of

Risk – What is it?

- Risk (R) can be defined as a combination of
 - Probability of failure (P)
 - Consequence of failure (C)
- Risk
 $R \sim P \cdot C$
- EXAMPLE



Integrity Organisation Structure



- Integrity tasks roles & responsibilities were defined as per the RACI concept
 - **R**esponsible
 - **A**ccountable
 - **C**onsulted
 - **I**nformed

Technical Manuals

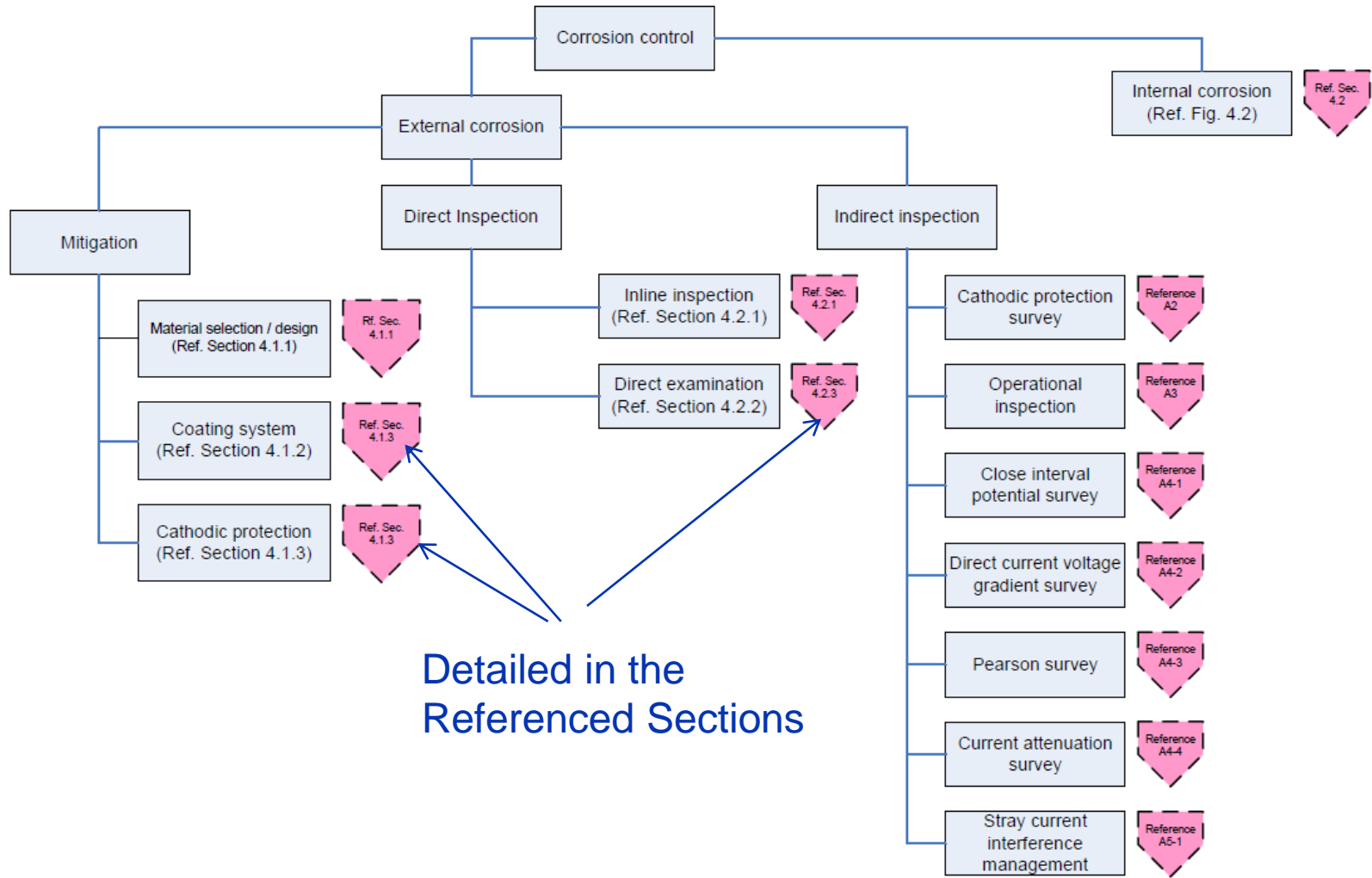
- Pipeline Manuals
- Corrosion Protection Manuals
- In-line inspection Manuals
- Defect Assessment & Repair Manuals

- Structure of Manuals:
 - Objectives and Scope Boundaries
 - Relationship to Integrity System
 - Technical Premise
 - Review of Industry Best Practice
 - COMPANY Operational Requirements & Assessment Techniques
 - Conclusion on keeping the system live

Map of Integrity Documentation

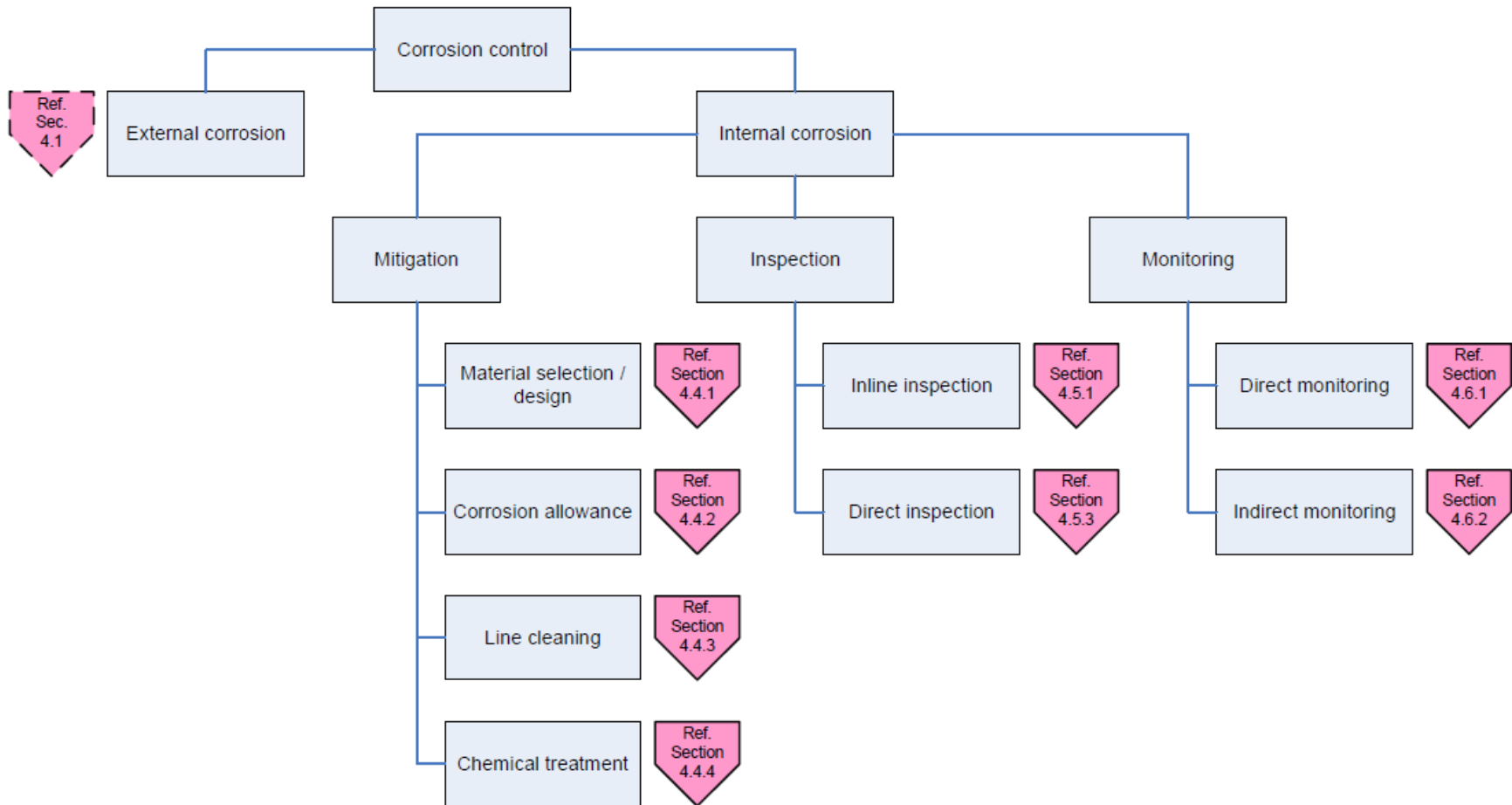
Integrity Philosophy <i>[AIMS Manual]</i>		Operating Procedures	Independent Audit <i>[Audit Manual]</i>		
Integrity Strategy <i>[AIMS Manual]</i>					
Asset Integrity Management System <i>[AIMS Manual]</i>					
Risk Assessment <i>[Technical Manuals]</i>		Risk Based Management <i>[Technical Manual]</i>	Repairs & Modifications <i>[Defect & Repair Manual]</i>		
Threat Evaluation <i>[Technical Manuals]</i>					
3 rd Party Impact	Corrosion	Physical Environment	Operational Error	Design / As-Built Flaw	
Technical Assessment <i>[Defect & Repair Manual]</i> <i>[Corrosion Protection Manual]</i> <i>[Technical Manuals]</i>	Process Monitoring <i>[Corrosion Protection Manual]</i> <i>[Technical Manuals]</i>	Visual Inspection <i>[Technical Manuals]</i>		Corrosion Inspection <i>[Corrosion Protection Manual]</i>	
		In-Line Inspection <i>[In-Line Inspection Manual]</i>		Offshore/River Inspection <i>[Pipeline Technical Manuals]</i>	

Corrosion Protection Manual: External Corrosion Mitigation & Inspection Activities



Corrosion Protection Manual :

Internal Corrosion Mitigation & Inspection Activities

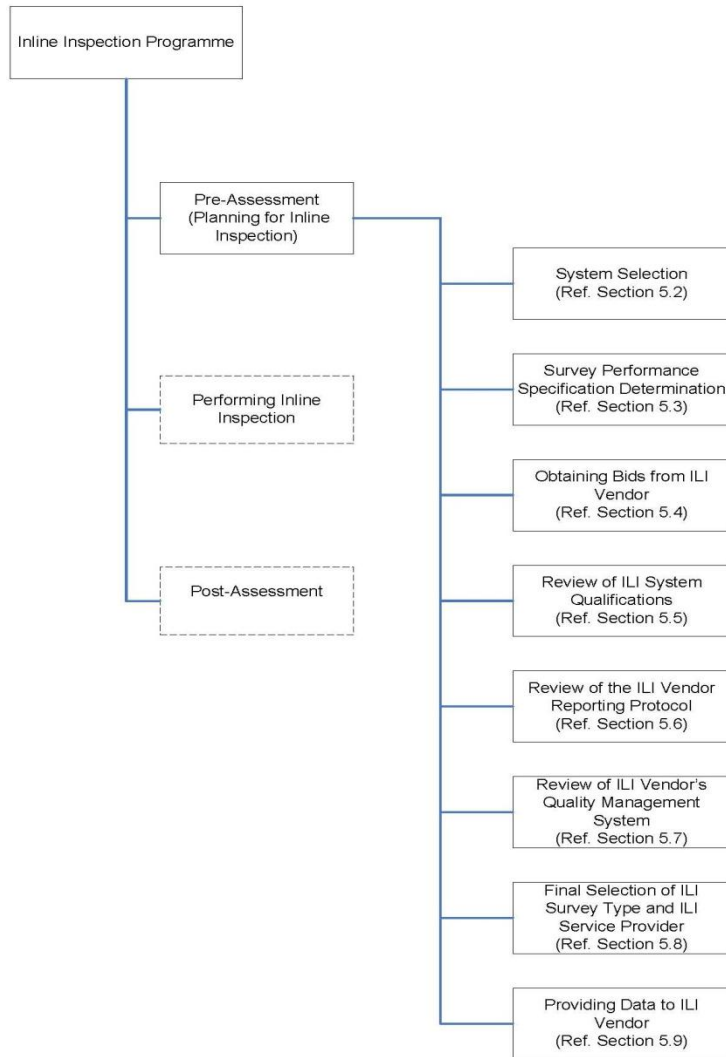


Example: Monitoring (Internal Corrosion)

Work Processes	Best Practice/ COMPANY Requirements
Monitoring (Internal Corrosion)	<p>Industry Best Practice</p> <p>Internal pipeline corrosion is typically monitored in the industry by the use of one or a combination of the following techniques;</p> <ul style="list-style-type: none"> - Direct Monitoring - Indirect Monitoring
	<p>COMPANY Requirements (Design/Operational)</p> <p>The activities below are required to be done by the COMPANY responsible person as instructed by the manual.</p> <p>Direct Monitoring</p> <p>The use and installation of direct monitoring devices should be considered during original pipeline design or where installation of a retrofit is considered necessary to monitor areas of interest. This</p> <p>Indirect Monitoring</p> <p>Product samples should be taken regularly and analysed by a qualified chemist to determine the concentrations of significant corrosive constituents in the products.</p>

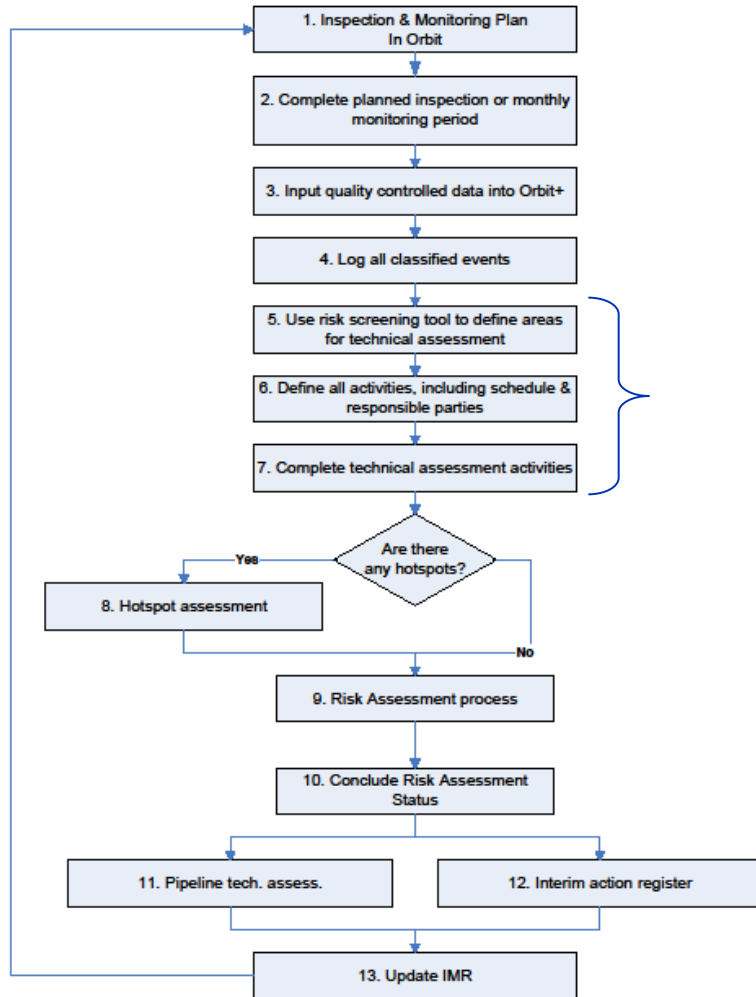
In-Line Inspection Manual:

Inline Inspection Programme – Pre Assessment

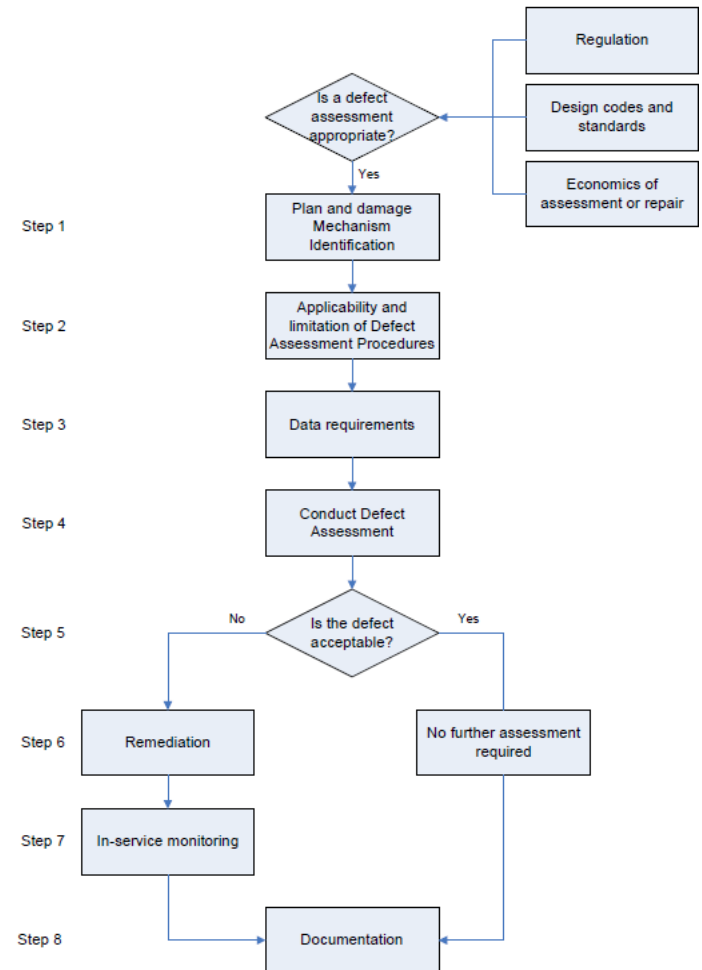


Process Step	Key Actions
System Selection	<ul style="list-style-type: none"> • Determining Inline Inspection Goals and Objectives • Determining Physical & operational characteristic e.g. pipe design, type of fluid • Collection of ILI tool specification e.g. operational limitation, historical success rate of survey technique

Defect Assessment & Repair Manual : Pipeline Defect Assessment



GENERAL PIPELINE DEFECT ASSESSMENT



Integrity Manuals

- Risk Assessment Manual
 - Structure
 1. Objectives and Scope Boundaries
 2. Relationship to Integrity System
 3. Risk Assessment
 4. COMPANY Risk Assessment Process
 5. Baseline Risk Assessment Results

- Inspection & Monitoring Routine User Manual
 - Structure
 1. Objectives and Scope Boundaries
 2. Relationship to Integrity System
 3. Integrity Actions Planning
 4. User Guide To COMPANY Integrity Actions Planning

Risk Management – Risk Assessment

- A **Risk Assessment** is a structured process through which all the credible **Threats** to the pipeline are examined and a consistent evaluation of the Risk of the associated **Failure Event** is completed.
- Once a consistent Risk Level is evaluated for the pipeline asset, the decision has to be made as to what to do to manage the risk.

Risk Assessment is a Decision Support Tool



Threat Evaluation

3 rd Party Impact	Corrosion	Physical Environment	As-Built Flaws	Improper Operation
<p>Description</p> <p>The threat of 3rd party accidental or deliberate impact on the pipeline is an event-based scenario. This means that there is a large uncertainty in predicting occurrence with time</p>	<p>Description</p> <p>Buried and submerged pipelines are exposed to both internal and external corrosive environments.</p>	<p>Description</p> <p>The pipeline should be adequately designed to meet the requirements of the operating environment. The operating environment implies both internal flow regime and external physical environment.</p>	<p>Description</p> <p>Design and Manufacturing flaws may be flaws in the fabrication of the steel itself, out of specification material properties, a flaw in the construction process or it may be a problem in the coating or CP system.</p>	<p>Description</p> <p>Operational misuse arises as a failure event through incorrect operating procedures or a failure to follow the correct procedure by company personnel.</p>
<p>Sources</p> <ul style="list-style-type: none"> • Construction • Vandalism • Transport link • Anchor • Ship Sinking • Fishing 	<p>Sources</p> <ul style="list-style-type: none"> • CO₂ • H₂S • MIC • General External • Hydrogen Cracking • Process Related 	<p>Sources</p> <ul style="list-style-type: none"> • Storm • Fire • Seismic • Subsidence • Landslide • Hydrodynamic (offshore) 	<p>Sources</p> <ul style="list-style-type: none"> • Seam Weld (fabrication) • Coating / CP (fabrication) • Out-of-Spec Material • Girth Weld (construction) • Dents / Gouges (construction) 	<p>Sources</p> <ul style="list-style-type: none"> • Operator Error • Incorrect Procedures • Poor Management of Change • Insufficient Training & Competence
<p>Mitigations</p> <p>Depth of Burial</p> <p>Physical barriers</p> <p>Visibility and maintenance of the Pipeline Right-Of-Way (ROW)</p> <p>Public Awareness</p> <p>Regular Surveys</p>	<p>Mitigations</p> <p><u>Internal</u></p> <p>Process Control</p> <p>Corrosion Inhibition</p> <p>Regular Cleaning Pigging</p> <p><u>External</u></p> <p>Cathodic Protection</p> <p>Coating</p>	<p>Mitigations</p> <p>Depth of Burial</p> <p>Physical barriers</p> <p>Maintenance of the Pipeline Right-Of-Way</p> <p>Proper Design</p>	<p>Mitigations</p> <p>Fabrication Specifications</p> <p>Construction Specifications</p> <p>Independent Verification</p> <p>Independent Audit</p> <p>Pressure Hydrotest</p>	<p>Mitigations</p> <p>Robust operating procedures</p> <p>Adequate training and employment selection</p> <p>Independent Audit</p>

Probability Assessment- PoF Assessment Sheet

Risk Model

- Combines Matrix Model with Indexing Model
- Uses COMPANY Corporate Risk Matrix
- Index Model used to provide consistency of assessment
- Uses quantitative input data to arrive at a semi-quantitative risk assessment
- Index Scores are not explicitly linked to Risk Level to preserve Engineering Control

Number	Risk Factor Question	Result	Weighting	Type of Factor	Factor Scoring	Weighted Score	Result Basis / Study Reference
A.01	Significant Corrosion in Section?	Yes	20%	Likelihood	1	20	
A.02	Any manufacturing or historical dents/buckles?	Yes	10%	Likelihood	1	10	
A.03	Remaining Pressure Utilization Sufficient?	No	10%	Likelihood	1	10	
A.04	Pipeline Impact Coating Present?	No	5%	Likelihood	1	5	
A.05	Pipeline Burial Depth Adequate?	No	20%	Likelihood	1	20	
A.06	Susceptible to Upheaval Buckling?	Yes	10%	Likelihood	1	10	
A.07	Presence of warning tape or mesh?	No	5%	Likelihood	1	5	
A.08	Presence of a physical barrier to impact?	No	10%	Likelihood	1	10	
A.09	Clear, well maintained and marked Pipeline Right of Way (ROW)?	No	10%	Likelihood	1	10	
Cumulative Score						100	
B - Physical Environment Aspects							
Number	Risk Factor Question	Result	Weighting	Type of Factor	Factor Scoring	Weighted Score	Result Basis / Study Reference
B.01	Is the pipeline in a scour zone? i.e. reduced burial depth	Yes	40%	Likelihood	1	40	
B.02	Is the pipeline in a zone of potential permanent ground deformation? E.g. landslide or earthquake	Yes	50%	Likelihood	1	50	
B.03	Is the pipeline in a region where environmental forces can disrupt or obscure the Pipeline Right of Way?	Yes	10%	Likelihood	1	10	
Cumulative Score						100	
C - Human Environment Aspects							
Number	Risk Factor Question	Result	Weighting	Type of Factor	Factor Scoring	Weighted Score	Result Basis / Study Reference
C.01	Construction Activity Near Pipeline ROW?	Yes	20%	Likelihood	1	20	
C.02	Other Utilities proximity to Pipeline ROW?	Yes	20%	Likelihood	1	20	
C.03	General Human Transit Activity Near Pipeline?	High	20%	Likelihood	1	20	
C.04	General Human Residential Activity Near Pipeline?	High	20%	Likelihood	1	20	
C.05	Transportation or Utility Crossings in Section?	Yes	20%	Likelihood	1	20	
Cumulative Score						100	
D - Ad-Hoc Aspects							
Number	Risk Factor Question	Result	Weighting	Type of Factor	Factor Scoring	Weighted Score	Result Basis / Study Reference
D.01	Active One Call System in Use?	Yes	25%	Likelihood	1	25	
D.02	Public Education and Awareness in Use?	Yes	25%	Likelihood	1	25	
D.03	Regular and Effective Ground and Air Patrols?	Yes	25%	Likelihood	1	25	
D.04	Public Planning Approval Process and Pipeline ROW lodged with Planning Authority?	Yes	25%	Likelihood	1	25	
Cumulative Score						100	

Consequence Determination

- Sectioning based on
 - High Consequence Area (HCA)
 - Terrain Type
 - Highly Sensitive Areas

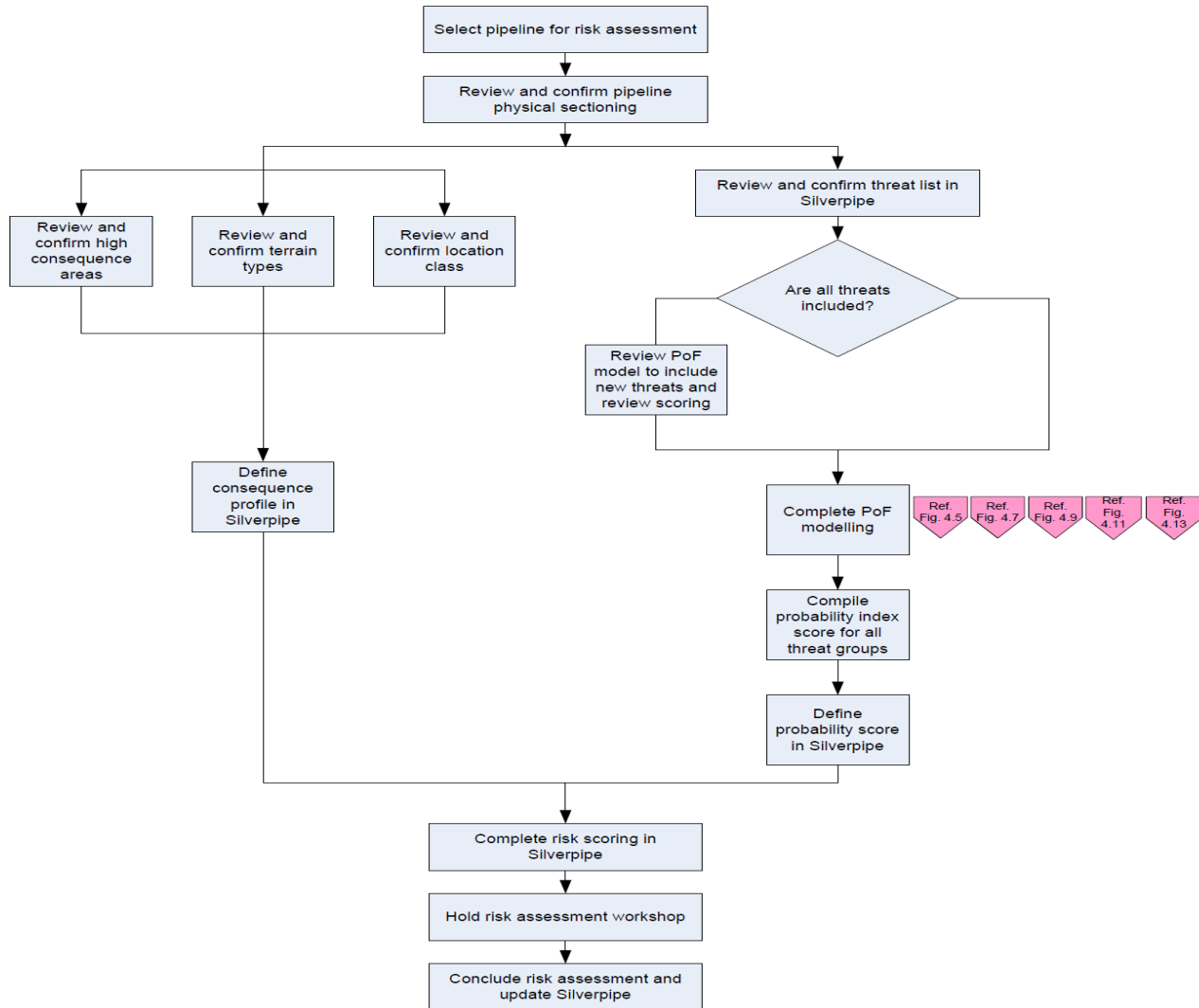
- Highest CoF for section prevails

HCA Category	Consequence Score	Terrain Type	Consequence Score	Highly Sensitive Areas CoF = 4
Cat 1 <= 46 buildings within 1 mile	1	Desert	1	A waterway where commercial navigation exist
Cat 2 >46, <100 buildings within 1 mile	2	Grassland	2	
Cat 3 >100 buildings within 1 mile	3	Mountains	2	High Polulation Area >50,000 people or >1000 people per square mile
Cat 4 Where multi-story buildings are prevalent, heavy/dense traffic, numerous utility underground	4	Farmland	3	
		Wetland	4	Unusually Sensitive area, i.e. drinking water source, treatment plants, area containing endangered species, area close to other pipelines, power lines etc.
		Forest/Jungle	4	
		Urban Areas	4	
		Rivers	5	
		Lakes/Sea	5	

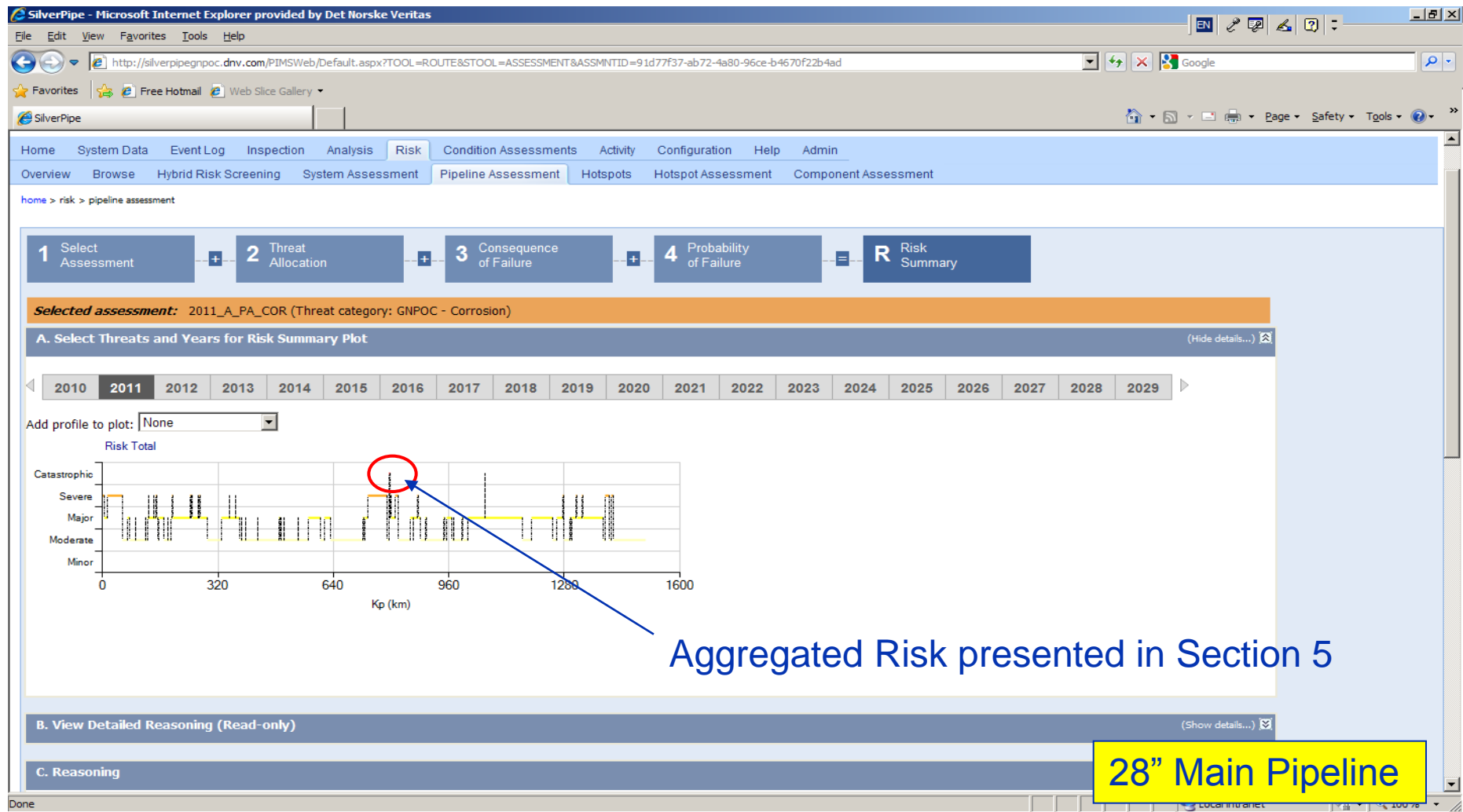
Risk Matrix

5	Major	Major	Severe	Catastrophic	Catastrophic
4	Major	Major	Severe	Severe	Catastrophic
3	Moderate	Moderate	Major	Severe	Severe
2	Minor	Moderate	Moderate	Major	Major
1	Minor	Minor	Moderate	Major	Major
Consequence/ Likelihood	1	2	3	4	5

Risk Assessment Process Flow



Baseline Risk Assessment in SilverPipe – Risk Summary



Aggregated Risk presented in Section 5

28" Main Pipeline

Inspection & Monitoring Routine User Manual

- Risk-Based Inspection Method
- Integrity Action based on Risk Category

5	Major	Major	Severe	Catastrophic	Catastrophic
4	Major	Major	Severe	Severe	Catastrophic
3	Moderate	Moderate	Major	Severe	Severe
2	Minor	Moderate	Moderate	Major	Major
1	Minor	Minor	Moderate	Major	Major
Consequence/ Likelihood	1	2	3	4	5

Risk Category	Integrity Action
Catastrophic	<p>Repair options to be considered as an immediate requirement, with mobilisation of repair team as soon as practically possible (within 1 month). Inspection team to be on site to monitor development of threat on a very frequent basis, as appropriate.</p> <p>Evaluation and Justification to be clearly presented as to why the line can continue to operate.</p>
Severe	<p>Mitigation options to be considered in addition to increasing the inspection and monitoring requirements.</p> <p>Where detected as a Hotspot, consideration for further inspection using detailed investigation to be completed as soon as practically possible, where repair or mitigation is not completed. Evaluation to be completed as to whether line can continue to operate during inspection.</p>
Major	<p>A change to the Inspection and Monitoring Routine frequency, to increase the inspection and monitoring requirements for the pipeline is required. Sources of mitigation should be identified and applied where practicable to reduce the risk to Moderate.</p> <p>Where detected as a Hotspot, consideration should be given to for further inspection using detailed investigation to be completed as soon as practically possible. Evaluation to be completed as to whether line can continue to operate during inspection, although anticipated that line can continue to operate.</p> <p>Change to scheduled Inspection and Monitoring Routine should be made, to monitor the Hotspot area with an increased frequency for two further inspection cycles, if repair or mitigation is not deemed appropriate to ensure risk development does not continue.</p>
Moderate	<p>Risks are generally understood and adequately characterised by the current inspection and monitoring routine. No anticipated change in the Inspection and Monitoring Routine. No reduction in Inspection and Monitoring Routine is deemed appropriate.</p> <p>Where detected as a Hotspot, consideration should be given to an increase in inspection and monitoring efforts in this area for a single cycle of inspection to ensure that Hotspot area does not develop.</p> <p>Where practicable, sources of mitigation may be employed to reduce the risk to a Minor category.</p>
Minor	<p>Generally the Inspection and Monitoring Routine is deemed more than adequate to characterise the risk to the pipeline system. Where multiple integrity cycles have been seen to demonstrate a consistent minor risk rating, consideration can be made to reduce the Inspection and Monitoring requirements for the system.</p> <p>Where detected as a Hotspot, generally a Minor risk will not require any further mitigating actions or examination. Hotspot can be closed and logged as Event on the pipeline within SilverPipe.</p>

Example Inspection & Monitoring for Corrosion Threat (1)

Inspection Type	Threats Covered	Risk Category	Frequency	Comments
ILI (Refer to Doc 2.1, In-line-inspection manual for operational requirement and assessment technique)	Internal/ External Corrosion/ Manufacturing Flaws	N/A General Notes		ILI is the most preferable method. Consideration should be given to make pipeline piggable. Unpiggable pipelines, use Direct Inspection
		Catastrophic	Maximum inspection intervals to be determined based on the degradation rates and/ or condition assessment	Repairs to be completed within 1 month or as soon as practically possible. Evaluation and Justification to be clearly presented as to why the pipeline can continue to operate at current existing operational parameters.
		Severe	2 yearly	Or inspection interval of half of remaining life whichever is smaller. Verification Digs as per ILI manual.
		Major	4 yearly	Or inspection interval determined through A.8.5 of the Corrosion Protection Manual (Doc.2.6) Verification Digs as per ILI manual.
		Moderate	6 yearly	Verification Digs as per ILI manual.
		Minor	12 yearly	Verification Digs as per ILI manual.

ILI can also detect DFI flaws

Inspection & Monitoring for Corrosion Threat (cont')

<p>Direct Inspection</p> <p>As alternative to ILI for non-piggable pipeline, or verification of ILI results</p> <p>Gauge and UT measurement</p>	<p>Internal/ External Corrosion / Manufacturing Flaws</p>	All	Annual	<p>Minimum of 2 digs.</p> <p>For verification digs after an ILI run, please refer to the Corrosion Protection Manual (Doc.2.6).</p>
		General Notes		<p>Direct inspection can be time consuming and costly. For non-piggable pipeline (alternative to ILI), please follow the followings as [er ros]:</p>
		Catastrophic		<p>Repairs to be completed within 1 month or as soon as practically possible.</p> <p>Evaluation and Justification to be clearly presented as to why the line can continue to operate.</p> <p>Make line piggable as soon as practically possible.</p>
		Severe	2 yearly	<p>Or inspection interval of half of remaining life as minimum.</p> <p>At least 10 locations (length dependent) covering sample of low points, welded joints, areas susceptible to stray current interference, etc.</p> <p>For locations susceptible to internal corrosion, same locations are to be inspected again during future inspection.</p> <p>For locations susceptible to external corrosion, locations have not been inspected are to be identified and selected for future inspection</p>
		Major	4 yearly	<p>Or inspection interval of half of remaining life as minimum.</p> <p>At least 10 locations (length dependent) covering sample of low points, welded joints, areas susceptible to stray current interference, etc.</p> <p>For locations susceptible to internal corrosion, same locations are to be inspected again during future inspections to determine the degradation rates.</p> <p>For locations susceptible to external corrosion, locations have not been inspected are to be identified and selected for future inspection</p>
		Moderate	6 yearly	<p>At least 5 locations (length dependent) covering sample of low points, welded joints, areas susceptible to stray current interference, etc.</p> <p>For locations susceptible to internal corrosion, same locations are to be inspected again during future inspections to determine degradation rates.</p> <p>For locations susceptible to external corrosion, locations have not been inspected are to be identified and selected for future inspection</p>
		Minor	12 yearly	<p>At least 5 locations (length dependent) covering sample of low points, welded joints, areas susceptible to stray current interference.</p> <p>For locations susceptible to internal corrosion, same locations are to be inspected again during future inspection.</p> <p>For locations susceptible to external corrosion, locations have not been inspected are to be identified and selected for future inspection</p>

Inspection & Monitoring User Manual Key Performance Indicators


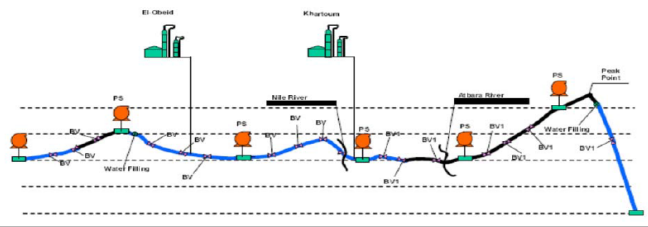
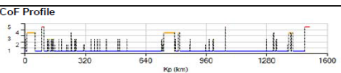
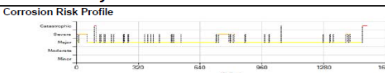
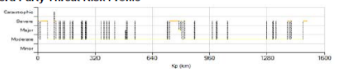
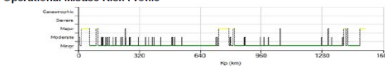
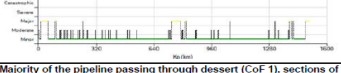
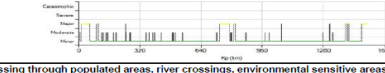
- Purpose: To ensure that the integrity management system remains relevant, efficient, and up-to date at all times, its performance will be monitored and assessed on a regular basis.
- KPIs are performance measure aimed at all aspects of the integrity management process.
- Characteristics:
 - Measurement of Plan vs Actual
 - Indication of effectiveness of preventive measure
 - Leading & Lagging
 - Monitor Monthly, quarter, yearly

KPIs Example – Corrosion (1 of 5)

Threat	Leading/Lagging	Performance	Measurement scoring guidance		Remarks
Corrosion	Leading	Compliance with inspection plans (Including ILI, direct inspection, all CP inspections, CVI for flanges & fittings)	Excellent	≥95% completed on time	
			Fair	≥80% completed within 1 month of due date ≥80% completed on time for inspection with interval of 2 weeks or less	
			Below Average	≥60% completed within 1 month of due date ≥60% completed on time for inspection with interval of 2 weeks or less	
			Poor	≤60% completed	
	Leading	ILI Data collection	Excellent	100% data collected	
			Fair	>80% data collected	
			Below Average	Between 50-80% of data collected	
			Poor	<50% data collected	
			Not Required	This KPI is not required to be measured during the months where ILI is not carried out.	
	Corrosion	Leading	ILI results compare with verification digs	Excellent	All verification dig completed and ILI and verification dig results within 10% of each other.
Fair				All verification dig completed and ILI and verification dig results within 20% of each other.	
Below Average				All verification dig completed and ILI and verification dig results >20% of each other.	
Poor				No verification dig completed or No match between ILI results and verification digs	
Not Required				This KPI is not required to be measured during the months where ILI is not carried out.	

Sample IMR – 1

(Inspection/Maintenance Routine work sheet)

 IMR # 28M 28" Main Trunkline – 28"- Crude Oil - Central Processing Unit to - [REDACTED] Terminal																			
Document Owner	Pipeline Responsible Person																		
Issue Date	Valid till Date																		
Pipeline Details and Safe Operating Limits																			
Battery Limits [REDACTED] e																			
Process Description [REDACTED] Components included in System: Total of 309 components, see attached sheet																			
Pipeline Outer Diameter	711.2 mm	MAOP	97.24 bar																
Pipeline Wall Thickness	10.72 / 16.36mm	Max. Surge Pressure	HOLD																
Total Pipeline Length	1507.799 km	Max. Operating Temp.	70°C																
Pipeline Material	X65	Design %CO2 Limit	HOLD % (tolerances)																
Pipeline SMYS	448 Mpa	Design %H2S Limit	HOLD % (tolerances)																
Coating	2.5mm 3PP & 0.35mm FBE	Design %BS&W Limit	HOLD % (tolerances)																
Construction Year	1999	Design %Water Cut Limit	HOLD % (tolerances)																
Total Pipeline Length	1507.799 km																		
<table border="1"> <thead> <tr> <th>PS No.</th> <th>CPF/PS #1</th> <th>PS #2</th> <th>PS #3</th> <th>PS #4</th> <th>PS #5</th> <th>PS #6</th> <th>Terminal</th> </tr> </thead> <tbody> <tr> <td>Distance:</td> <td>0.00 km</td> <td>236.1 km</td> <td>547.6 km</td> <td>819.3 km</td> <td>1085.7 km</td> <td>1311.8 km</td> <td>1505 km</td> </tr> </tbody> </table> 				PS No.	CPF/PS #1	PS #2	PS #3	PS #4	PS #5	PS #6	Terminal	Distance:	0.00 km	236.1 km	547.6 km	819.3 km	1085.7 km	1311.8 km	1505 km
PS No.	CPF/PS #1	PS #2	PS #3	PS #4	PS #5	PS #6	Terminal												
Distance:	0.00 km	236.1 km	547.6 km	819.3 km	1085.7 km	1311.8 km	1505 km												
Risk Profile & Summary																			
 CoF Profile		 Corrosion Risk Profile																	
 3rd Party Threat Risk Profile		 Operational Misuse Risk Profile																	
 DFI Threat Risk Profile		 Physical Environment Risk Profile																	
<p>Majority of the pipeline passing through dessert (CoF 1), sections of the pipeline passing through populated areas, river crossings, environmental sensitive areas and highly sensitive areas (utility facilities, military base). Pipeline going through elevation as per sketch above. Sections of the pipeline have 'Catastrophic' risk under the corrosion and 3rd party threats. External corrosion occurs at the joint weld (fied joint coating issue), and internal corrosion occurs as isolated metal loss areas. External corrosion are more serious (ER>1). 3rd party risk is 'catastrophic' due to high population & high CoF (environmental sensitive) in that particular area.</p>																			

Title

Responsible Person & Validity

Pipeline Details and Safe Operating Limits

Pipeline Sketch

Risk Profile & Summary

Sample IMR – 2 Inspection

Inspection Routine						
Survey Type	Frequency	Comments	Threats Covered	Section Applicable	Risk	Next Due Date
ILI	2 yearly	Follow on survey to be undertaken using UT technology	Corrosion, DFI flaws,	All	Catastrophic	2012
Direct Examination – DIG Survey	Min. 2 per Year	Program to be developed to confirm all defects with ERF>1 as identified by 2010 MFL survey	External/Internal Corrosion	Corrosion Engineer to select 2 areas	Catastrophic	2011
CP Functional Inspection -Power source Stns -Drainage Stns	Monthly	Check that the operation and condition of the transformer-rectifier unit is satisfactory, record output voltage & current. Measure drain-point potential and the current.	External Corrosion	All	Catastrophic	Monthly
CP Functional Inspection -Test Stns -Connection Cables -Isolation Devices -Safety & Protection devices	Annually	off potentials. Measure current flow of connection cables. Check electrical discontinuity of the resistance bonds/ isolation devices. Measure settings and function of safety and protection devices.	External Corrosion	All	Catastrophic	Asap if not been done previously
Cathodic Protection Survey	2 monthly	Refer to Appendix 2 of Corrosion Protection Manual (Doc. 2.6)	External Corrosion	All	Catastrophic	2 Monthly
CIPS & DCVG	Annually	Pearson or Current Attenuation Survey can be used as alternative where appropriate (see Corrosion Protection Manual Doc 2.6)	External Corrosion	'Catastrophic' Risk Sections	Catastrophic	1 year from last inspection
CIPS & DCVG	3 Yearly	Pearson or Current Attenuation Survey can be used as alternative where appropriate (see Corrosion Protection Manual Doc 2.6)	External Corrosion	'Major' & 'Severe' Risk Sections	Severe	3 years from last inspection
Vantage Point GVI Survey	2 weeks	Alternate week from aerial survey	Accidental Impact, Environmental	All Vantage points	Catastrophic	End of even number week
Aerial GVI Survey	2 weeks	Alternate week from vantage survey	Accidental Impact, Environmental	All along pipeline Area around	Catastrophic	End of odd number week
Public Awareness meeting / Notification	Annual		Accidental Impact, Environmental	'Catastrophic' Risk Sections	Catastrophic	1 year from the last campaign
Public Awareness meeting / Notification	Annual		Accidental Impact, Environmental	All remaining sections	Severe	2 years from the last campaign

Sample IMR – 3 Monitoring

Monitoring Plan						
Type	Parameter	Frequency		Target Value	Tolerances	Comments/ Out of Spec Actions
Process Parameters	Pressure	Daily	Max, Ave, Min			Trended to KPIs
	Temperature	Daily	Max, Ave, Min			Trended to KPIs
	Flow Rate	Daily	Max, Ave, Min			Trended to KPIs
	BS&W	Daily	Max, Ave, Min			Trended to KPIs
Product Specification	CO2 Content	Daily		As per export specification		Trended to KPIs
	H2S Content	Daily		As per export specification		Trended to KPIs
	O2 Content	Daily		As per export specification		Trended to KPIs
Chemical Injection	Biocide	No injection				NB.Assumed product is treated at
	Corrosion Inhibitor	No injection				NB.Assumed product is treated at entrance to the Main export line.
	Wax Inhibitor	No injection				Assumed controlled elevated temperature to prevent wax.
Liquid Sampling	Sulphur Compounds	6-monthly		As per export specification		Trended to KPIs
	Iron Content	6-monthly		As per export specification		Trended to KPIs
	Chloride Content	6-monthly		As per export specification		Trended to KPIs
	pH	Monthly		As per export specification		Trended to KPIs
	S.R.B.	Annually		As per export specification		Trended to KPIs
	Remaining Inhibitor	Annually		As per export specification		Trended to KPIs
Cleaning Pigging	Cleaning Pigging	every 10 days		Not Applicable	Not Applicable	Trended to KPIs
Operations	Plant Trips	Monthly				Events and reasons for events recorded in SilverPipe.

Conclusions – Key benefits

- Developed an integrity philosophy designed to meet regulatory and corporate integrity requirements.
- Highlighted the important a series of *controlled documents* required to present an auditable and controlled integrity process
- A fit-for-purpose integrity *organization*, including defined roles and responsibilities, to deliver the requirements of the integrity philosophy
- Developed core working processes which are required to meet the integrity objectives set out in the company integrity philosophy.

Safeguarding life, property and the environment

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