

OIL & GAS  
PIPELINE INTEGRITY MANAGEMENT PLAN FOR  
THE NATURAL GAS PIPELINE AS PER PNGRB  
GUIDELINES

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30 January 2018

**4<sup>th</sup> ICEPIM & OMIC GAS 2018**

## Process

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- Pipeline sectioning
- Threat allocation
- Probability scoring
- Consequence scoring
- Risk evaluation
- Inspection Management Plan

# Threat Allocation

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- Internal corrosion
- External corrosion
- Stress Corrosion Cracking
- Manufacturing related threats
- Welding/ fabrication related threats
- Equipment
- 3rd party damage
- Incorrect operational procedure
- Weather related and outside force
  - Weather related
  - Lightning
  - Heavy rains or Floods
  - Earth movement

# Probability Scoring – Internal Corrosion

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- Fluid Corrosivity
- Corrosion Control
- Corrosion Monitoring
- ILI Data
- Historical Performance

# Probability Scoring – External Corrosion

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- Soil Corrosivity
- Coating Specification
- Coating condition
- CP Effectiveness
- CP Interference
- ILI Data
- Historical Performance

## Probability Scoring – 3<sup>rd</sup> Party Damage

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- Burial Depth
- Excavation Activity
- Surface facilities
- Public Education
- Pipeline route conditions
- Patrol Frequency
- Communications
- Historical evidence of vandalism or terrorism
- Blasting activity
- Aerial Impact

# Probability Scoring – Earth Movement

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- Burial Depth
- Slopes
- Settlement
- Erosion
- Boulders
- Seismic Activity
- Mitigation by Design

## Probability Scoring – Flooding

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- Historical Evidence
- Drainage
- River Crossings
- Mitigation by Design
- Survey Evidence



# Probability Scoring – Material or Equipment Failure

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- Standards and Verification
- Management Processes
- Hydrotest
- Documentation

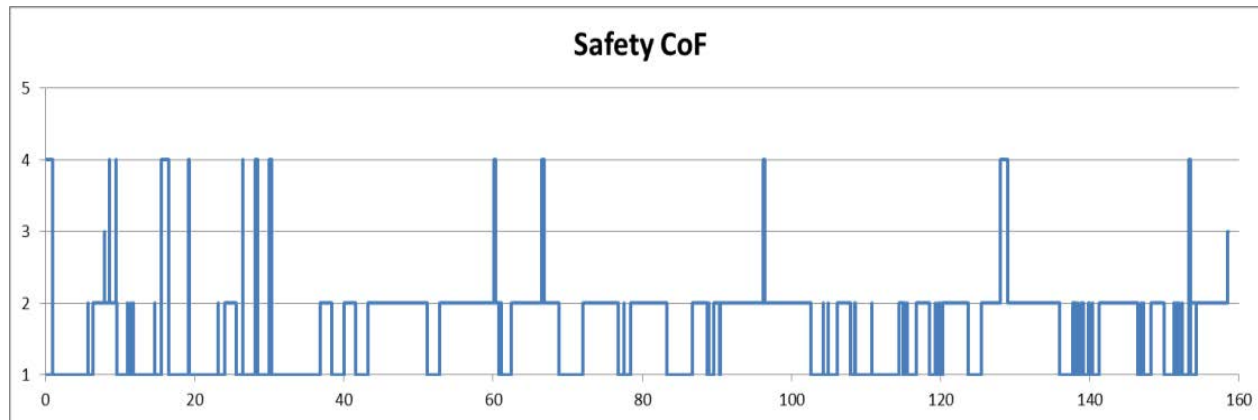
## Probability Scoring – Incorrect Operation

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- Documentation
- Audit
- Systems and Security
- Controls and Devices
- Competence and Training
- Maintenance
- Historical Performance

# Consequence Scoring

- Three types of consequence are considered
  - Safety
  - Environmental
  - Financial
- Each is assigned a score from 1 to 5 with 5 being the most severe.
- Each may vary from one pipeline section to another. And each may vary within a pipeline section, as individual factors vary.



## Consequence Scoring - Safety

- Baseline consequence score determined from proximity to high consequence areas
  - Population density
  - Schools (or other meeting places)
  - Hydrocarbon installations
  - ...

<b>HCA Type</b>	<b>Safety CoF</b>
Population Density : Very High (as per ASME Location Class 4)	5
Population Density : High (as per ASME Location Class 3)	4
Population Density : Medium (as per ASME Location Class 2)	3
Population Density : Low (as per ASME Location Class 1)	2
Population Density : Very Low or None	1
School	5
Hydrocarbon Installation	5
Other (General)	3

## Consequence Scoring - Environment

- Baseline consequence score determined from terrain type

<b>Terrain Type</b>	<b>Environmental CoF</b>
Forest	4
Jungle	4
Plains/Savannah	3
Grassland	3
Farmland (Intensive)	4
Farmland (Non-intensive)	3
Desert	2
Swamp	3
Wetland (seasonal)	4
Wetland (permanent)	4
Mountain	2
Lake	5
Other (General)	3

## Consequence Scoring – Financial

<b>Description</b>	<b>Financial CoF</b>
Extensive damage – Substantial or total loss of operation (costs in excess of US\$10,000,000).	5
Major – Partial operation loss (2 weeks shutdown, costs up to US\$10,000,000).	4
Local damage – Partial shutdown (can be restarted but costs up to US\$500,000).	3
Minor damage – Brief disruption (costs less than US\$100,000).	2
Slight damage - No disruption to operation (costs less than US\$10,000).	1

# Risk Assessment

- Consequence of failure

- Safety
- Environmental
- Financial

- Probability of failure

- Internal corrosion
- External corrosion
- 3<sup>rd</sup> party damage
- Earth movement
- Flooding
- Material failure
- Equipment failure
- Incorrect operation
- Other

<b>E</b>	Medium	High	Very High	Very High	Very High
<b>D</b>	Medium	High	High	Very High	Very High
<b>C</b>	Low	Medium	High	High	Very High
<b>B</b>	Low	Medium	Medium	High	High
<b>A</b>	Low	Low	Low	Medium	Medium
<b>Consequence/ Probability</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>

## IMP Overview

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- Review threats and specific means of mitigation
  - Specific mechanisms of corrosion etc.
  - Specific locations along pipeline
- Derive detailed inspection plans, linked to the risk profile from RBI
  - Written Schemes of Examination
- Develop schemes for monitoring performance
  - Key Performance Indicators



# Internal Corrosion

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- **Inspection Type**

- ILI or ICDA
- Direct Examination Dig Survey
- LRUT Inspection of crossings

- **Monitoring**

- Process Parameters
- Product Specifications
- Chemical Injection
- Gas Sampling
- Corrosion Coupons
- Corrosion Probes
- Maintenance pigging

# External Corrosion

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## ■ Inspection Type

- ILI or ECDA
- Direct Examination Dig Survey
- LRUT Inspection of crossings
- Pipe to Soil Potential (PSP) monitoring
- Close Interval Protection Survey (CIPS)
- Direct Current Voltage Gradient Survey (DCVG)
- Stray Current Interference Survey
- Cased Crossing Inspection

## 3<sup>rd</sup> Party Damage

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- **Inspection Type**

- Aerial GVI Survey
- Patrol/Line Walk
- Pipeline Survey

- **Monitoring Type**

- Pipeline Intrusion Detection System
- Community Telephone contact system
- Public Awareness events
- Monitoring of blasting activities
- Population Density Survey

## Earth Movement

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- Instability of slopes, settlement or erosion of soil, seismic activity, etc.
  - Survey to confirm depth of cover etc.
  - Check approach to river crossings to mitigate the threat of upheaval at bends
  - Implement recommendations from survey (reactive)
  - Intelligent pigging to confirm side strains if ground movement observed (reactive)
  - **Inspection Type**
    - Pipeline Survey

# Flooding

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- Localised or widespread flooding
  - Check river crossings to look for signs of damage to banks
  - River survey to check profile and top of pipe level
  - Implement recommendations from survey (reactive)
  
- **Inspection Type**
  - River Survey
  - Post monsoon GVI
  - Pipeline Survey

## Material or Equipment Failure

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- Design errors
  - insufficient design to allow pipeline to operate safely under the expected operating condition and service life.
- Fabrication errors
  - Poor procedures and poor QA/QC activities during fabrication.
- Installation errors
  - Improper transportation and handling such as accidental impact, inadequate support could lead to coating damage, dents, introduction of localised stress.
  
- Relatively little that can mitigate risk during operation
  - Function testing of equipment such as valves

## Incorrect Operation

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- Includes pipeline design & operation aspects, physical environment aspects and human aspects
- Main mitigating actions are to ensure that
  - operating procedures are appropriate and up to date (HAZOP, auditing etc.)
  - operators have the required training
- **Inspection Type**
  - Process Parameter
  - Function testing of valves and protective devices
  - Review/Update Hazop
  - Review training of operators
  - Review security of control room
  - Third Party Independent Audit

# Thank You

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