Subsea Pipeline Integrity Management
1st December 2011

Risk-based Inspection:
Managing Uncertainty in the Condition of Ageing Assets

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• What is RBI?
• Why RBI?
• How does inspection control risk?
• What is the concern for ageing pipeline assets?
What is RBI?
- Any process where the decision of what inspection to perform and how often to inspect depends on risk
- A structured approach to planning inspections (based on risk)
- “The intention of using a risk based approach is that the activities are selected and scheduled on the basis of their ability to explicitly measure and manage threats to the pipeline system and ensure that associated risks are managed to be within acceptable limits.” (DNV RP F116)
Why RBI?

- Operating pipelines presents a risk
- We cannot eliminate the risk unless we remove the hazard (i.e. don’t have the pipeline)
- We need to control the risk
- Appropriate inspection contributes to risk control
• Why RBI?
  – “General industry practice is that a risk based integrity management approach should be applied.”
  – UK PSR
  • Previously a prescriptive requirement for periodic inspection
  • Now required to identify hazards and demonstrate that risk is controlled
    – all hazards relating to the pipeline with the potential to cause a major accident have been identified;
    – the risks arising from those hazards have been evaluated;
    – the safety management system is adequate; and
    – adequate arrangements for audit and for the making of reports thereof.
Application of RBI for pipelines

- API 580 / 581
- DNV RP F116
- API 1160
- ASME B31.8S
• API 580/581:
  – RBI, but not pipelines…

• DNV RP F116, API 1160, ASME B31.8S
  – Directly relevant to pipelines
  – Pipeline integrity management
  – Cover more than just RBI
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- E.g. from DNV RP F116
• Common elements of RBI:
  – Asset identification
  – Segmentation
  – Hazard identification
  – Probability of failure
  – Consequence of failure
  – Risk assessment
  – Inspection plan
But, how does inspection control risk?
For time dependent hazards we can use inspection to:

- Monitor deterioration
- Predict future deterioration
- Plan to take action before failure

But there is uncertainty

Hence we are dealing with a probability of failure rather than a fixed, known, failure date.
• For random hazards, an incident may result in:
  – Instantaneous failure
  – Damage which may fail with time
  – Initiation of a deterioration mechanism

• Inspection cannot control the risk of instantaneous failure

• Inspection can be used to monitor for damage, or the onset of deterioration
• Probability of failure due to a hazard increases with time

**Inspection reduces uncertainty in the condition of the pipeline**
But, how does inspection control risk?
Have to take remedial action when required, otherwise:
— You will just be watching the pipeline fail....
- How often to inspect?
  - Inspect often enough that the probability of failure before the next inspection is acceptably small
  - (Need to account for the time required to assess inspection results and take remedial action)
RBI can cover different levels of approach

- Assess the risk and inspect for higher risk hazards more often.
- Set inspection intervals to keep risk at an acceptable level.

Using calculations based on reliability theory

Using guidelines developed from industry experience
• Does the RBI actually demonstrate that risk is controlled to an acceptable level?
• Or does it (only) give a structured review and identify which hazards are perceived to be of most concern?
Ageing assets

• Any thorough, structured review of:
  – Design;
  – Operating history;
  – Survey and inspection history.

• In the context of
  – Hazards
  – Failure consequence
  – Future requirements

• Will allow engineers to make sensible decision about inspection and risk mitigation
• Ageing assets

• Problems with probability:
  – Not a “casino” type question
    • The failure probability cannot be found exactly
  – Not easy to base expected incident rates on historic frequency of events
    • Most of the events we are interested are (thankfully) rare
    • Our pipelines tend to be individuals (compared with mass-produced manufactured components)
  – Many, many parameters influence failure probability and it is difficult to model them all

• Good engineering judgement, and logical, subjective assessments and decisions are therefore likely to be required.
• Ageing assets
• Sources of uncertainty
  – Condition (inspectability)
  – Design
  – Specifications and certificates (evidence)
  – Operating history (evidence)
• Ageing assets – RBI experience
• E.g. Operator with large network of offshore pipelines & assets:
  – Constructed 1960s to 80s
  – RBI study commissioned to prioritise ILI programme
• No data/evidence:
  – Design
  – Operation
  – ILI
Outcome

- Hazards:
  - Third party damage (…but not controlled by ILI)
  - Internal corrosion
- Uncertainty over condition overriding, driving high assessed failure probabilities
- Inspection priority:
  - Based on consequence
  - Or, “easiest wins”
Ageing assets – RBI experience
E.g. Operator with old, “unipiggable” subsea flowline
  – RBI to determine whether inspection needed within life
  – Quantification of pay-off between
    • Deterioration of condition, and
    • Reduction in operating pressure (depleted reservoir)
• Ageing assets – RBI experience
• E.g. Operator with new, “unipiggable” subsea flowline
  – RBI to determine whether inspection for internal corrosion needed within life (i.e. when the new has become old...)
    • Plan for re-engineering to allow ILI, unless
    • Control uncertainty over internal condition by controlling, monitoring and analysing (P, T, flow, composition).

NEED EVIDENCE
Ageing assets – RBI

Summary

Failure probability increases with time

Inspection reduces uncertainty in condition

Following inspection:

Plan for remediation, or

Justify resetting the perceived failure probability and planning reinspection

For ageing assets, uncertainty over operating history and condition can drive decisions
Thank you.

Questions?

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