Assessment of two Business Critical Unpiggable Subsea Pipelines

Condition assessment of an unpiggable pipeline is a challenge to operators, particularly if the product passing through is corrosive. Operators are often compelled to either operate the pipeline at a pressure lower than required or risk failure.

This presentation discusses the methodology adopted to carry out a Fitness for Service (FFS) assessment and risk analysis of two business critical pipelines operated in the Asia Pacific region. These pipelines have exceeded their design lives and internal inspection was considered difficult/impractical.

This dilemma was discussed and actions were identified to ensure the future integrity of the pipelines, considering the extended service lives required.

The methodology adopted to carry out the condition assessment and risk analysis included:

a) Identification and gathering of relevant data
b) Hazard identification and analysis of all credible threats in accordance with operator's Risk Matrix
c) Corrosion analysis including:
    - Flow modelling to identify vulnerable internal corrosion locations (NACE ICDA methodology)
    - Internal corrosion rate assessment
    - External corrosion analysis using inspection data
    - Anode remnant life calculation estimation using ANSI/NACE SP-0115/ISO 15589-2 & DNV-RP-F103 recommendations.
d) Current and future integrity assessment of all potential metal loss anomalies using the guidance in the Pipeline Defect Assessment Manual (PDAM)
e) Inspection planning
f) Future recommendations

The two subject pipelines are connected to the main export lines using subsea hot-taps. Thus, these pipelines were considered difficult to inspect internally using an intelligent in-line inspection tool, as there are no pig receiving facilities available. These pipelines have been in operation since 2000 and have exceeded their design life of 15 years.

The transported multiphase fluid was found to be rich in CO_2 (2 mol% with 42% water cut), with evidence of bacterial presence at the launcher area. This resulted in 'Medium' risk of internal corrosion due to CO_2 and MIC. The anomalies reported at the riser section and rapid depletion of anodes at the subsea section resulted in 'Medium' risk of external corrosion. Risks of all other credible threats were considered 'Low'.

The corrosion model analysis was carried out for each pipeline, considering the flow characterises and pipeline profile on the seabed, thus an inhibited internal corrosion rate of ~ 0.50 mm/year was calculated. The corrosion modelling also predicted a higher than anticipated risk of internal corrosion. The pipelines' remnant life was found to have already been exceeded when considering the design pressure and the worst potential metal loss, however, at the current Maximum Allowable Operating Pressure (MAOP) the remaining life was calculated to be 2.62 years. The anodes were predicted to have a remaining life of 3.7 years.

To ensure the pipeline integrity for an additional 10 years of service, an inspection plan was prepared to examine the critical location identified to be susceptible to internal corrosion, at specified intervals. An anode rectification plan was also prepared to ensure the pipelines are externally protected as the external coating age and its condition degrades. These mitigation measures resulted in lowering the pipelines' risk profiles for the additional service life required.

The study allowed the lives of the subject pipelines to be extended safely and at an acceptable risk level. Recommendations were made to improve the corrosion management system and monitoring to minimise the risk of corrosion. This avoided replacement of the pipelines and thus resulted in substantial cost savings to the operator. With the extended service life and the current advancements in pipeline in-line inspection technologies, internal inspection of the pipelines may be possible in the future to further extend the service life.