Quest Integrity Group was recently contracted by the pipeline-integrity department of an offshore offloading facility to perform an ultrasonic in-line inspection of a 4 inch pipeline. By employing advanced engineering technology, the company was able to reduce the integrity department’s pipeline-integrity digs from 16 to three, saving time and money.

Quest Integrity used its InVista technology to provide both a metal-loss and geometry inspection of the pipeline, and various dents and ovalities were identified and quantified. Based upon their size, 16 of these geometric anomalies did not meet common depth-based acceptance criteria, and therefore required investigation and remediation.

The client wanted to perform an advanced assessment to investigate the lifecycle of the anomalies and establish a risk-based programme, since using depth alone is not an effective criterion for prioritising anomalies.

The solution

Quest Integrity performed remaining-life assessments on the dents and ovalities using the detailed geometry profiles that the in-line inspection (ILI) data provided. Understanding that geometry anomalies are prone to developing cracks, the probability of failure of a dent is related to the amount of time to crack formation. This time can vary widely between anomalies, and is based on the sharpness of the profile and the amount of pressure cycling that occurs.

Quest Integrity has developed a methodology for determining the stress-concentration factor using geometry ILI data and then applying the pressure-cycling information at the anomaly location to predict remaining life. This provides a more accurate anomaly prioritisation than one based upon the anomaly depth.

The results

Quest Integrity’s InVista ILI inspection identified 52 geometry anomalies including dents, double dents, and ovalities. Of these, 16 had depths greater than the conventional depth criterion of 6 per cent and would have required field investigation and remediation.

Finite-element analysis (FEA) models were created for the anomalies. Using a proprietary methodology which combines all of the component stresses, the stress-concentration factors (SCFs) were calculated for each location. The SCF measures the amount of stress magnification due to the presence of the anomaly. The magnitudes of the SCFs are driven by the sharpness of a dent or the abruptness of an ovality.

Using the operational pressure data that was provided by the client, pressure-cycling histograms were created at each anomaly location using the hydraulic modelling capabilities of Pacifica, a software program that automatically performs pressure-cycle fatigue analysis. This method accounts for the

TWO KEY BENEFITS OF USING ADVANCED TECHNOLOGY TO ASSESS PIPELINE ANOMALIES

1. Better understanding of risk: Leveraging ILI data benefited the client with fitness-for-service knowledge. In this case, the geometry profile coupled with operating pressure data predicted the life cycle of the dents and ovalities and provided a remaining-life assessment.

2. Prioritisation of anomaly investigations: The remaining-life assessment of the anomalies provided a defensible rationale for investigating the ones with shorter remaining-life predictions. This decreased the number of digs from 16 to three, providing cost and time savings to the client.
decrease in magnitude of the pressure cycles the further downstream the anomaly is from the pump station.

The remaining life of each anomaly was then estimated by multiplying the pressure histogram by the SCF, and by using an S-N fatigue-life curve to determining the number of allowed cycles. A safety factor of two was applied when converting allowed cycles into remaining life. An allowance for the damage that occurs during dent formation and subsequent re-rounding was included in the life prediction.

Only three anomalies had a calculated remaining life of less than 100 years. The client scheduled digs for these three locations and has the advanced engineering assessment documentation to support the remainder of the geometry anomalies.

Figure 3: A finite-element analysis model of a dent showing axial stress due to pressure-thrust load.