Learning from incidents

AWARENESS ALERT

Pipeline Failure in Houma to Houston Crude pipeline System

Shell Supply & Distribution – North America **April 2011**

What happened

On November 16th, 2010, Shell Pipeline Company's Houma-Houston crude oil pipeline ruptured 10 miles downstream of Sulphur pump station near Vinton, Louisiana. The impacted section was shut down immediately by the control center and then isolated in approximately 5 minutes. In total, 1030 bbls of oil were released in a remote area near the Intercoastal Canal (no release to water).

The failed line pipe was 22" OD x 0.312" WT, API 5L, Grade X52, double submerged arc welded (DSAW) seam, constructed in 1952 with a coal tar coating. Excavation revealed a 35-inch long "fish mouth" failure at the 6 o'clock position (see inset). The failure was at a slight field bend (underbend) and not in the long seam. Evidence of external corrosion was visible in failed area (corrosion depth measured ~0.10", or ~30% of the original WT).

There was no evidence of a pressure excursion or upset conditions prior to the failure. Pressure at the leak location was 694 psig at time of the failure (established Maximum Operating Pressure of this segment is 1050 psig). There were no injuries and no impact to wildlife as a result of the release or follow-up response activities.

Why it happened

Based on field observations and laboratory analysis, it was determined that the failure was caused by combination of the following factors:

- Coal tar coating was disbonded at the field bend
- Shielding from the Cathodic Protection (CP) system caused by the disbonded coating allowed corrosion to develop
- The elongated corrosion feature made the location susceptible to fatigue cracking (stress concentration). This may have been enhanced by the extrados of the field bend which can act as a stress riser and is prone to residual stresses.
- Pressure cycling caused long term fatigue loading
- Orientation and shape of the features were likely not accurately sized by conventional Magnetic Flux Leakage (MFL) inline inspection; No feature in the failed joint was reported by the MFL smart pig vendor who conducted an ILI assessment in 2007.

Lessons learned

- The combination of multiple factors represented a previously **undetected threat** to the Houma-Houston pipeline.
- The unique features found at the excavated rupture location, in combination with review of the MFL data, showed that the particular inspection technology used in 2007 was not optimal to detect and size this specific geometry of anomaly.
- Despite that operational pressure fluctuations at the failure location were not considered "aggressive", it appeared that this particular type of corrosion feature in the extrados of a field bend was susceptible to fatigue cracking. Corrosion on the actual fatigue crack surface indicated that the fatigue process had been occurring over an extended period of time.
- As a result of the historic construction practices of making field bends, the coal tar coating could have sustained damage causing disbondment and subsequent shielding from the CP system. This condition can lead to active corrosion over time, even when CP potentials are adequate.

Recommendations

- For liquid pipelines of similar age, service, and coating type, alternative in-line inspection (ILI) methods should be used that can better detect and size longitudinal corrosion features of significant length. These methods include magnetic Transverse Flux Inspection (TFI) and possibly Ultrasonic wall thickness measurement tools.
- A review of historic ILI results at field bends, combined with coating defect / cathodic protection demand measurements through Direct Current Voltage Gradient (DCVG) or Cathodic Protection Current Mapping (CPCM) should be performed to identify locations possibly susceptible to shielding and unmitigated/active corrosion.
- Enhanced data integration techniques should be developed and utilized to align multiple data sets that could indicate potential injurious conditions. Data integration is a key component in both integrity assessment (smart pigs) and risk assessment but can be improved and expanded to make even more effective.
- Consider an exercise for systems under significant pressure fluctuations to generate a lifetime assessment quantifying the (corrosion) anomaly size versus the fatigue life and combine that information with the ILI tool performance and reporting requirements.

Goal Zero: Zero injuries, Zero fatalities

- Work with Operations and Scheduling teams to create increased awareness of the effects of pressure fluctuations, and utilize procedures and technology to minimize pressure fluctuations in liquid pipelines where possible.

Further information
For additional info, contact Eelco Jorritsma or Peyton Ross.