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Is Your Pipeline at Risk?

Small-Bore Connection Pipeline Fatigue Failures due to Vibration

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Vibration analysis may not be your first thought when investigating the cause of a pipeline failure, but vibration has recently caused fatigue damage and failures of small-bore piping connections in multiple oil and gas pipelines. Small-bore connections, where a relatively heavy-gauge nipple or valve is connected to a small-diameter pipe connected to the main line, are particularly susceptible to fatigue failure from vibration, when they bend back and forth repeatedly (such as when vibrating) until they begin to crack and eventually fail. In most cases, these failures are unexpected, carry significant safety risks, and may initially be incorrectly attributed to some kind of trauma to the pipe.

By proactively integrating vibration analyses into their integrity management programs, utilities can minimize the need for urgent maintenance and unscheduled downtime. Predictive maintenance plans that include vibration analyses can also help utilities more cost-effectively address the pipeline connections that have the highest risk of fatigue failure. Performing a vibration assessment at the same time as other pipeline integrity works may be a small additional cost that leads to large long-term savings.

A Cumulative Problem

While pipeline vibration was not a primary concern when many oil and gas facilities were built, engineers now know that excess vibration can be a significant contributor to pipe damage, especially in aging infrastructure. Additionally, increased vibration levels can be evidence of possible changes in boundary or operating conditions. Both may contribute to the accumulation of fatigue damage and lead to failures where small-bore piping connects to larger pipelines. These failures are especially problematic for natural gas pipelines that can develop gas leaks and pose other health and safety hazards.

Some pipeline operators may be unaware that heavy pipelines can be damaged by vibrating small-bore connections. While it is true that these pipelines will not likely break due to overload, unwanted repetitive movements can cause significant structural damage, particularly in older pipes since fatigue damage is cumulative. This is not to say all small-bore connection failures happen slowly. Exponent recently investigated a small-bore connection that experienced fatigue failure one week after being replaced. Small changes to the mass and length of the small-bore connection during replacement were found to be responsible for quickly causing catastrophic levels of vibration due to resonance.

Incorporating Existing Guidance

Pipeline operators will benefit from becoming familiar with vibration guidelines from the Gas Machinery Research Council (GMRC), Pipeline Research Council International (PRCI), and the Energy Institute (EI). These guidelines provide methods to measure and assess the relative risk of pipeline connections that experience vibration. Because federal regulations for pipeline integrity management do not specifically reference

testing pipeline and small-bore connections for susceptibility to vibration, some operators are unaware of these valuable guidelines.

Our team at Exponent frequently partners with utilities to evaluate pipeline risk for vibration damage and provide recommendations for connections that may need vibration mitigation, reinforcement, or ongoing assessment. Many operators choose to include these vibration analyses in their broader plans to comply with federal rules for integrity management. Having experts perform vibration testing concurrently with corrosion testing, pressure testing, etc. can help utilities and other pipeline installations consolidate upfront evaluation costs and prioritize their predictive maintenance budgets.

How Exponent Can Help

Exponent's multi-disciplinary team of mechanical, thermal, and acoustical engineers has partnered with multiple utilities to build integrity management systems from the ground up. We can help utilities perform prevention planning and conduct failure analyses related to fatigue failure from pipeline vibration and other causes.

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