

Validation of the Dry Gas Internal Corrosion Direct Assessment Methodology using In-Line Inspection

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ABSTRACT

The Internal Corrosion Direct Assessment Methodology for Pipelines Carrying Normally Dry Natural Gas (DG-ICDA) is a tool used by pipeline operators to evaluate the threat of internal corrosion and assess the pipelines integrity. This methodology may be one of the few methods available to determine the most likely locations for internal corrosion for pipelines with unique configurations or that operate at pressures that may not allow inspection by traditional In-Line Inspection (ILI) tools. This case study will provide the results of one operator's experience where DG-ICDA was utilized to assess a pipeline which was later reconfigured and inspected with ILI tools. A comparison of results and summary of learnings is provided.

Key words: Internal Corrosion Direct Assessment, DG-ICDA, Normally Dry Gas

INTRODUCTION

The process for performing Dry Gas Internal Corrosion Direct Assessment on natural gas systems that carry normally dry gas (DG-ICDA) is a relatively new development with the first NACE standard (SP0206) being published in 2006. As such there has been increasing use of the standard and improvements in its application. The authors have utilized DG-ICDA within its system to assess pipelines for the threat of internal corrosion. The use of DG-ICDA has primarily occurred on transmission level pipe, which operates over 20% Specified Minimum Yield Strength (SMYS), within our gas distribution system, which we refer to as Transmission Operated by Distribution (TOD). Being part of a distribution system, which is downstream of sources that may produce liquid water, internal corrosion has not been significant threat in our TOD system.

Internal corrosion was found however in one system, referred to as our Line 1002f West. Internal corrosion was found at a critical angle along with sediment roughly a mile from a city gate. The corrosion measured approximately 0.101" (0.257 cm) deep or 27% wall loss of nominal wall thickness. Subsequent critical angles, and sub critical angles, did not show signs of internal corrosion although indications of sediment were present. In order to validate our DG-ICDA process and to further evaluate the condition of the pipeline, it was decided to perform an in-line inspection of the system.

DG-ICDA Assessment

The DG-ICDA process used for the assessments is based on NACE SP0206¹. The pipe for this system consists of 26 inch (66 cm) grade B seamless pipe with a nominal wall thickness of 0.375 inch (0.952 cm). The pipe was installed in 1965 and 1966. The analysis of the gas exiting Red Run city gate, downstream of the M&R metering, into line 1002g showed that the gas flow velocity was 32.3 ft per second (9.8 meters per second) and a critical angle of 8.21 degrees. The indirect survey of the area between Red Run City gate and the first branch at the end of Line 1002g revealed that four critical angles existed prior to the first branch in the line, line 1002f. Refer to Figure 1. Figure 2a and 2b show a profile of the pipeline elevation for lines 1002g and 1002f West respectively. Critical angle one was created by a rolled elbow creating the riser to the filter/ separator within the city gate, the riser had been previously examined, finding no corrosion, and a permanently mounted UT sensor installed. An n=0 excavation was not required as line 1002g is flat from the regulation to the critical angle one location. Critical angle two was the drip log off the filter/ separator within the city gate, the drip log has a corrosion coupon and was not excavated during this assessment. Critical angle three (1002g Dig A) was created by a drain crossing containing a 14 degree angle and critical angle four (1002g Dig G) was a 90 degree angle created by the tie-in of line 1002g to line 1002f. Direct examinations utilizing X-ray and UT at 1002g Dig A and G did not show any indications of internal corrosion. Although corrosion was not found, the X-ray did show signs of sediment in the pipe, which were later determined to be black powder.

Additional exploratory digs were performed downstream of the 1002f input into the lines influenced by Red Run city gate to evaluate the need for a second region for gas velocities less than 16.4 ft/sec (5 meters per second). Based on learnings and research gained from "Retrograde Condensation in Natural Gas Pipelines"², it is known that liquid water will change from laminar flow to annular flow at approximately 16.4 ft/sec (5 m/s). This change to annular flow could allow water to bypass a critical angle and continue downstream until it returns to laminar flow again due to a reduction in velocity.

The first branch in the line downstream of Red Run CG is created by an in-line tee with the feeder line (line 1002g) perpendicular to the branch line (line 1002f), due to this type of branch connection, flow modeling was performed on both branches of the tee, lines 1002f East and 1002f West. Flow modeling showed a flow velocity of 13.5 ft/sec (4.11 m/s) and a critical angle of 1.23 degrees for line 1002f East. For line 1002f West flow modeling showed a flow velocity of 16.3 ft/sec (4.96 m/s) and a critical angle of 1.84 degrees for line 1002f West prior to the second branch, line 1002. After the second branch, which was constructed using a top tee which would not permit liquids to take the branch, flow modeling showed a flow velocity of 12.6 ft/sec (3.84 m/s) and a critical angle of 1.04 degrees for line 1002f West.

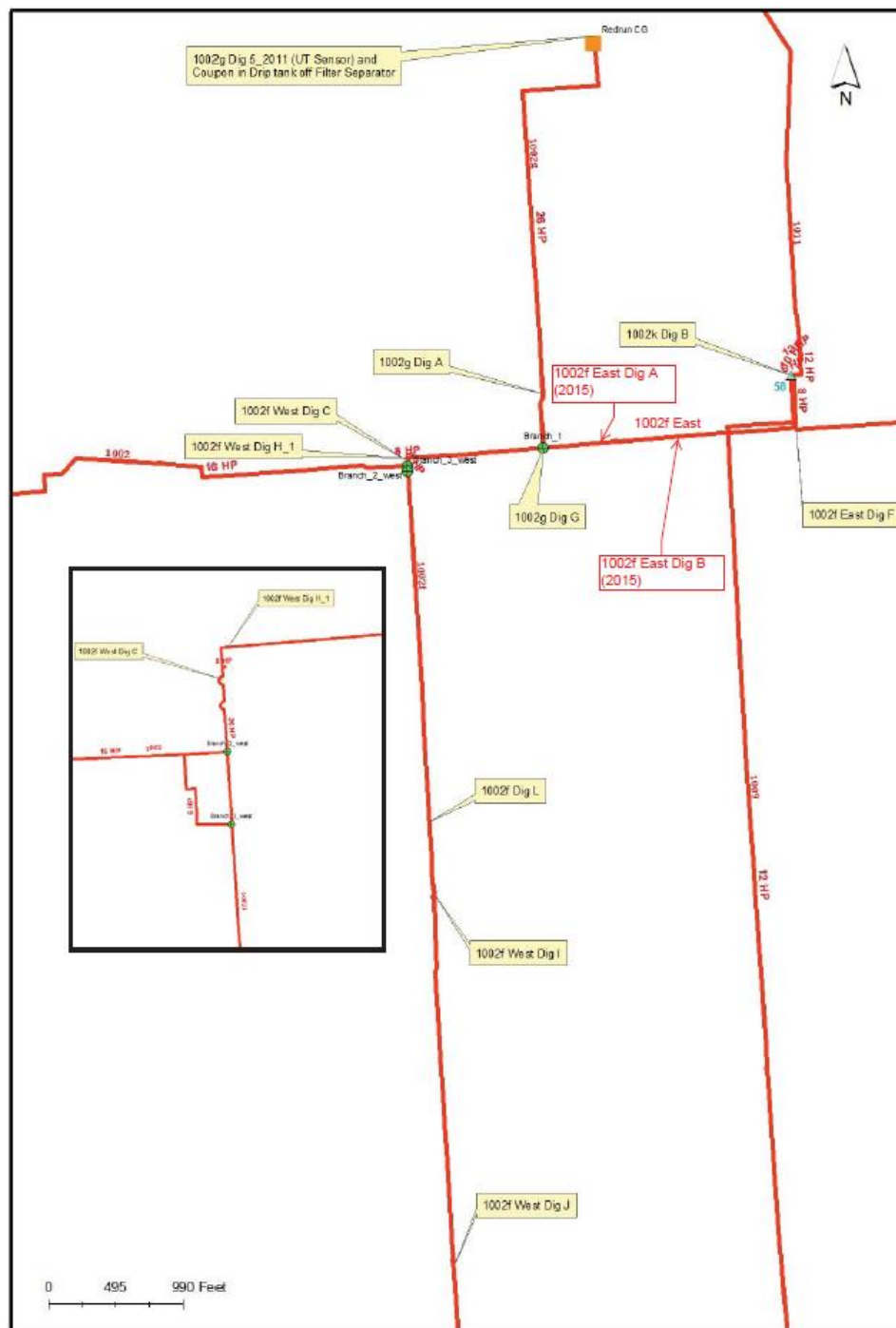


Figure 1: Pipe Schematic and Dig locations

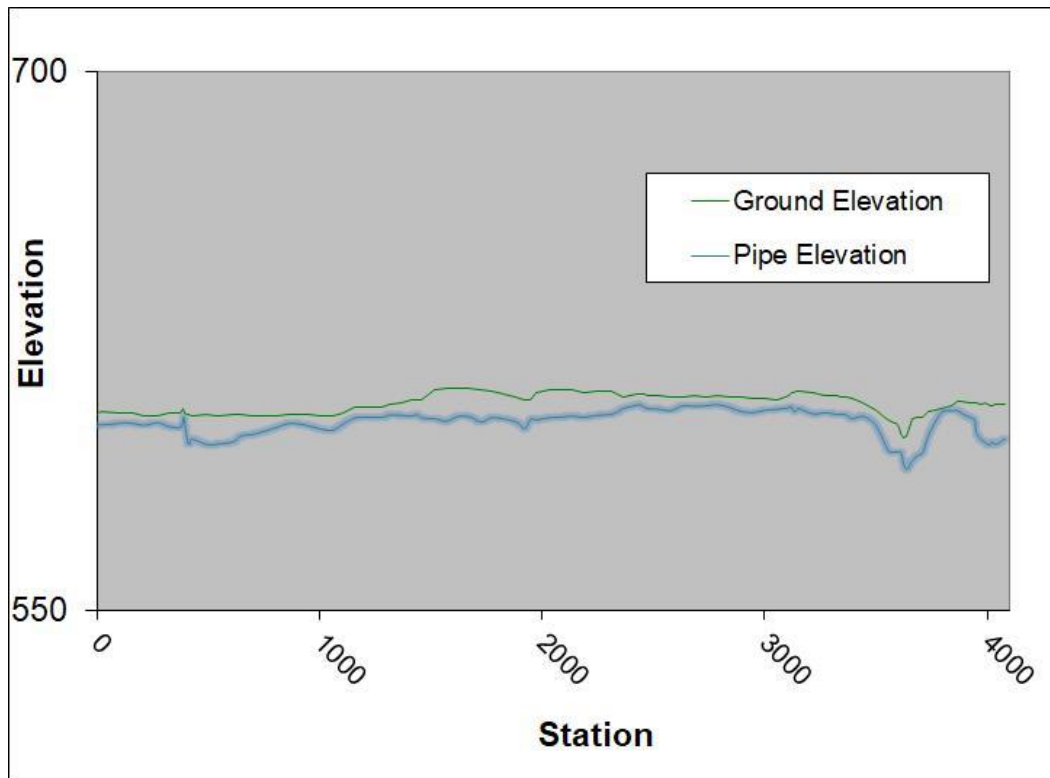


Figure 2a: Pipe 1002g Elevation Profile

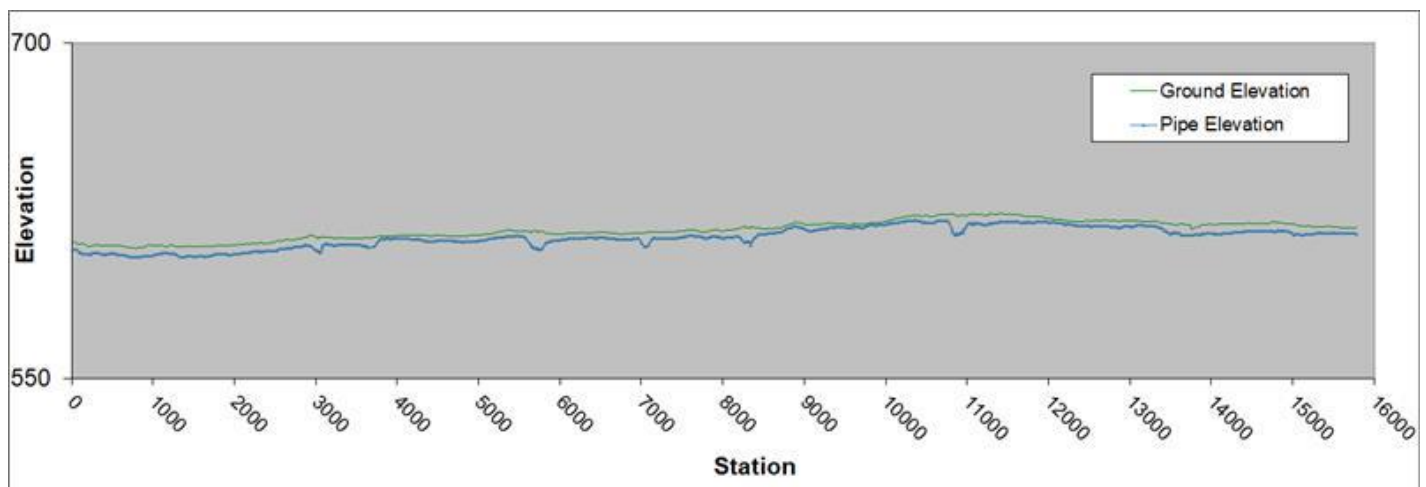


Figure 2b: Pipe 1002f West Elevation Profile

1002f East Branch

The n=0 excavation was a small rise just downstream of the branch off line 1002g for gas velocities less than 16.4 ft/sec (5 m/s) on line 1002f East (1002f Dig A inclination angle was 0.65 degrees). The critical angle one excavation for gas velocities less than 16.4 ft/sec (5 m/s) on line 1002f East (1002f East Dig B) was created by a jack bore across the roadway. The inclination angle of the pipe was measured to be 2.5 degrees. External Corrosion Direct Assessment (ECDA) 1002f Dig 6 was performed as part of the ECDA assessment and was utilized as an n=1 excavation for gas velocities less than 16.4 ft/sec (5 m/s) on line 1002f East (1002f Dig 6 inclination angle was 0.3 degrees). The