

Stork Twin City Testing Corporation

PROJECT NUMBER: SOU263-01-15-91979

DATE: January 21, 2008

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VISUAL EXAMINATION

Sample Identification:

Cracked 2" diameter gas pipe section from PS07-002 Natural Gas Incident, Mitchell, South Dakota

Measurements and Visual Observations:

Overall pipe section length-	51" (Figures 1-3)
End identification-	End A adjacent most coating damage End B adjacent least coating damage
Crack location-	28" from End A (Figure 4)
Coating damage location D1-	7" from End A (Figures 5-6)
Coating damage location D2-	13+" from End A (Figures 7-8)
Coating damage location D3-	21" from End A (Figure 9)
Coating condition End B side-	42" from End A (Figure 10)
Pipe surface condition End B side-	No corrosion damage to external pipe surface of 14" section cut for tensile specimen removal. Removal of coating revealed the OD pipe surface was in pristine condition (Figure 11).
Pipe dimensions-	2.278" OD x 0.162" wall (obtained from tensile test coupon). Coating thickness measured 0.150" thick (based on overall outside diameter with sound coating (2.578") minus the measured pipe OD (2.278") divided by 2 wall thicknesses of coating.
Crack measurements-	Crack was reportedly centered on the 6:00 position of the gas line as embedded in the ground. The crack extended three quarters around the pipe circumference leaving a remaining un-cracked ligament of 1-1/2" at the 12:00 position. Maximum measured crack opening was 0.12"-0.13" at the ~6:00 position (Figure 12). Complete crack photos are provided separately under "Visual Examination Photos".
Deflection measurements-	Using a measuring tape as a straight edge, the maximum deflection measures 0.44" from the measuring tape to the bare pipe surface at the crack location (Figures 13-14). Since the straight edge was bearing on sound coating at both support points, the thickness of the coating (0.150") must be subtracted from the maximum deflection measurement of 0.44" to obtain the actual pipe deflection relative to the straight-edge support points. The actual pipe deflection therefore is 0.29".

VISUAL EXAMINATION (Cont).

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Measurements and Visual Observations: (Cont.)

Evaluation for corrosion-

No corrosion apparent on the OD pipe surface where the coating was not damaged (Figure 11). Some rusting but no significant pitting corrosion on the OD pipe surface where the coating was damaged (Figures 6,8 &12). Some rusting but no significant pitting corrosion on the ID pipe surface (Figure 15).

Evaluation of fracture-

No significant corrosion associated with the fracture (Figure 16). No necking down or stretching at the fracture edge (Figure 17). The fracture surface was cleaned with ammonium citrate solution combined with ultrasonic cleaning, but the rust could not be completely removed. The fracture surfaces will be preserved pending future SEM examination. A groove was observed adjacent to the fracture at the point of maximum crack opening. This groove is shown in Figures 17-18, and is described more completely in the **GRAIN STRUCTURE EXAMINATION**.

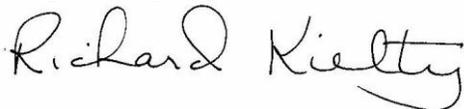
Test Equipment:

1. Olympus SZH stereomicroscope, ID Number 301-001, magnification range 3.75X-64X

Remarks:

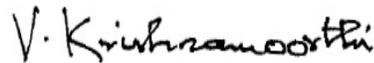
Additional photos pertaining to the visual examination are provided separately.

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Figure 1: Overall photo of the 51" long pipe section with the crack exposed (arrow).



Figure 2: Overall photo of the 51" long pipe section with the crack location rotated (arrow).

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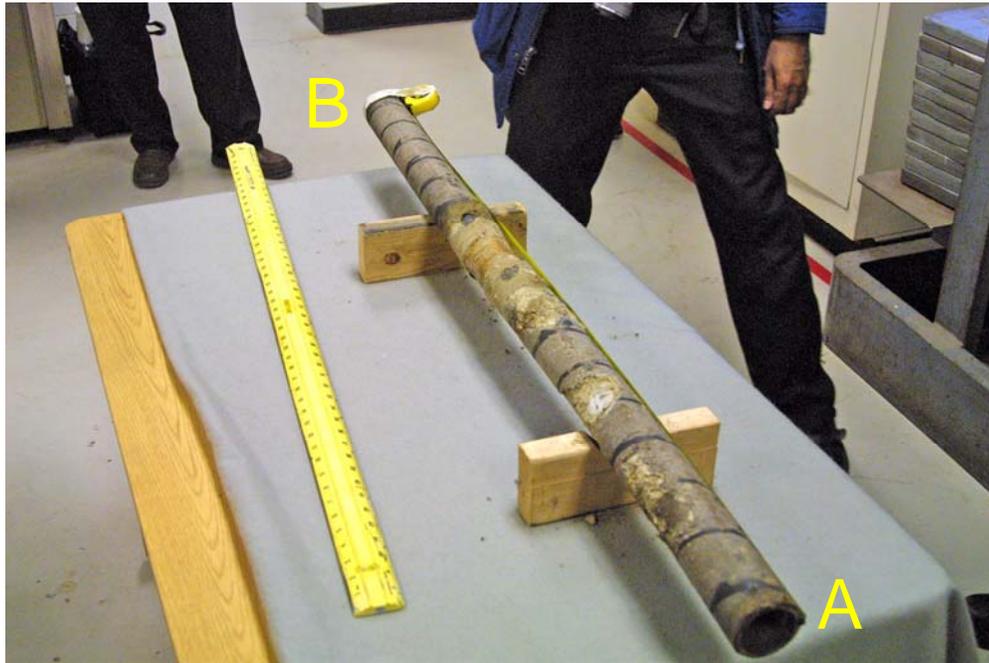


Figure 3: Table set-up for examining the pipe section. The ends are identified as A and B as shown.



Figure 4: Location of crack 28" from End A.

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Figure 5: Coating damage 7" from End A (Location D1).



Figure 6: Coating damage and underlying pipe surface 7" from End A (Location D1) after removal of some coating for visual examination.

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Figure 7: Coating damage 13+" from End A (Location D2).



Figure 8: Coating damage and underlying pipe surface 13+" from End A (Location D2) after removal of some coating for visual examination.

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Figure 9: Coating damage 21" from End A (Location D3). Photo reversed for continuity.



Figure 10: Coating condition 42" from End A showing no apparent damage this point and beyond.

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Figure 11: Section of pipe adjacent End B after removal of the coating. Note the pipe OD surface is in pristine condition with no observable corrosion.



Figure 12: Point of maximum crack opening (6:00 position). Measurements can be made by referring to crack calibration photo provided separately under “Visual Examination Photos”.

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Figure 13: Isometric view of the pipe deflection with the crack down (6:00 position).



Figure 14: Close-up view of the pipe deflection with the crack down (6:00 position). The maximum deflection measures 0.44" from the measuring tape to the bare pipe surface at the crack location.

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Figure 15: Typical ID surface of pipe after removal of some of the rust. Note the lack of any significant pitting corrosion.



Figure 16: Failed end of the gas pipe section after separation of crack surfaces. Note the two pie-shaped sections cut and mounted for grain structure examination. Also note the lack of any significant pitting corrosion associated with the fracture.

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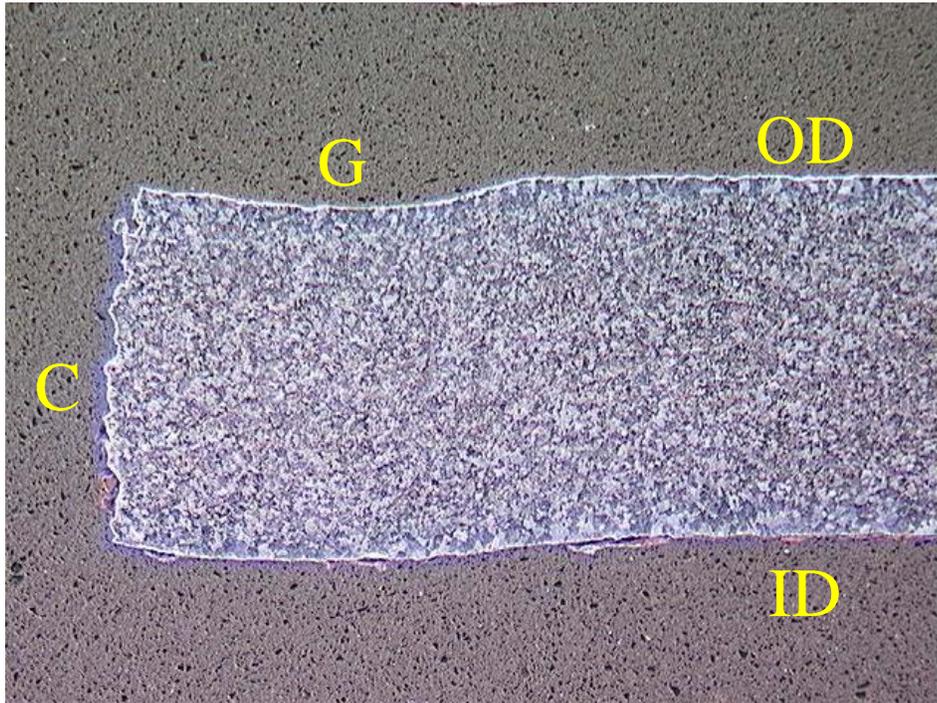


Figure 17: Cross section of pipe wall thickness through the groove (G) adjacent to the crack surface (C). The outside diameter (OD) and inside diameter (ID) of the pipe section are as shown. Mag. 11.8X

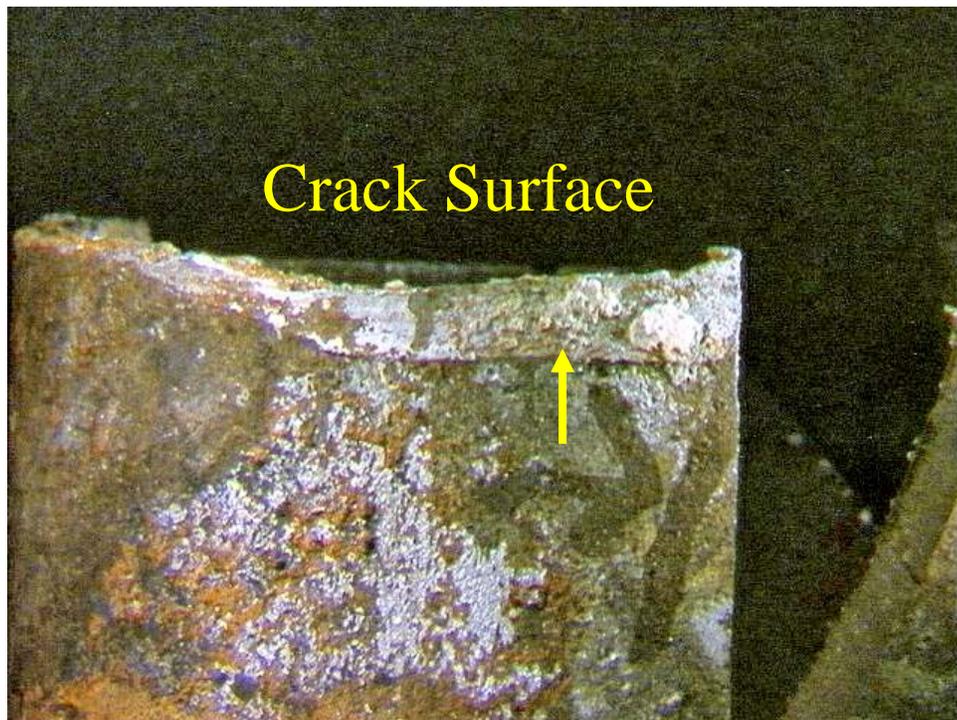


Figure 18: Close-up photo of the groove (arrow) adjacent to the crack surface at the point of maximum crack opening. Magnification 2.8X