Owingsville Line 15 Hard Spot Assessment Plan
June 28, 2004

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1. Overview

An in-line inspection (ILI) of Line 15 will be performed with the Tuboscope ILI Hard Spot (HS) tool as part of the remediation following the in-service break at MP 501.76 on November 1, 2003. The following assessment plan has been developed in order to methodically assess the data generated by the tool, and perform bell hole inspections of those sites that the ILI tool identifies as possibly having hard spots that could impair the serviceability of the pipeline.

2. Specific Requirements to Tool Vendor

Tuboscope will perform in-line inspection of the 30" O.D. x 0.375" W.T., API Grade X52, Owingsville Line 15 owned by Duke Energy Gas Transmission. The ILI is to be performed using the High Resolution MFL inspection tool modified with the Hard Spot (HS) Tool package. Specific requirements for performing the ILI tool run have been incorporated in the current contract (98-H-005) with Tuboscope.

3. Special Needs for ILI Execution

There are no special needs that need to be addressed prior to running the inspection tool.

4. Log Interpretation

The inspection log shall reference the following:

- Pipeline Section Surveyed
- Line Size and Number
- Survey Date
- Tuboscope Job Number
- Run Number
- Tuboscope Pipeline Inspector
- Tuboscope Survey Analyst

The inspection log shall identify each anomaly by wheel count (feet) and clock position. It shall also note the distance to the upstream and downstream girth welds.

The ILI HS tool log will provide pipe hardness values using the Brinell scale (HB). According to the vendor, all hard spots with hardness equal to or greater than 235 HB, with an accuracy tolerance of +/-50 HB will be reported. The hardness data will then be graded by the ILI contractor and reviewed by DEGT personnel according to the scale shown below:

a. Grade 3 = Hardness of 301 Brinell (HB) and above
b. Grade 2 = Hardness of 251 to 300 HB

c. Grade 1 = Hardness of 235 to 250 HB (24HRC)

Metallurgical Services personnel will then evaluate grading assessment and determine if the proposed criteria appropriately discriminates the data, and if further refinement of the criteria may be needed.

The grading criteria shown above is based on API 5L requirements and PRCI research. API 5L states that any hard spot greater than 2" in any direction and a hardness greater than or equal to Rockwell 35 HRC (327 Brinell) shall be rejected.[1] Also, the PRCI Repair Manual states that hardness properties less than Brinell 327 (Rockwell 35 HRC) can be recoated and backfilled.[2] Hardness properties of 150 to 200 HB are consistent with the normal hardness properties that are to be expected for the API Grade X52 line pipe. API 5L specifies a minimum tensile strength of 66,000 psi (131 HB) for API Grade X52. Hardness properties of Rockwell 93 (207 HB) have been documented for the pipe body, in regions away from hard spots, for A.O. Smith, API 5L Grade X52 line pipe of similar vintage.[3] This information indicates that the grading criteria shown is a conservative assessment of the ILI data. The highest grade will be associated with regions that have hardness properties, as detected by the ILI tool, that exceed API 5L requirements and industry research limits.

5. Selection and Prioritization of Dig Sites

Experience using the Tuboscope Linalog ILI HS tool in Duke's BC Pipeline system indicated that there was a high degree of correlation between ILI data for clusters of hard spots that were detected and the physical presence of a hard spot at the specified location. In comparison, the ILI data that indicated the presence of isolated hard spots were found to be less reliable based on bell hole examination results. Based on the criteria shown in Section 4, the following criteria is proposed, in the order shown, to prioritize suspected hard spot sites for bell hole inspection:

1) Waiver Site, Cluster, Grade 3
2) Waiver Site, Cluster, Grade 2
3) Waiver Site, Individual, Grade 3
4) Outside Waiver Site, Cluster, Grade 3
5) Outside Waiver Site, Cluster, Grade 2
6) Outside Waiver Site, Individual, Grade 3

The results of bell hole examinations of the hard spot anomalies will be compared to the log from the ILI HS tool run. At any time during the examination process, the results may be assessed to determine if continued investigation of hard spot anomalies from the ILI data is warranted.

6. Bell hole Examination Procedures for Hard Spots

Excavation and bell hole examination of the pipeline will be performed in accordance with company SOP and safety policy. Each task will be performed by personnel qualified for the specific tasks discussed below.

a. Prior to Excavation
    i. Pressure Reduction – The operating pressure shall be reduced to 80% of past 90 day MOP when the bell hole inspection is for the purposes of hard spot anomalies detected by ILI. If cracks or other types of defects are detected in a suspected hard spot region, Metallurgical Services shall be consulted to determine pressure reduction requirements.
    ii. Pipe-to-Soil (electrolyte) Potential Measurements – Pipe to electrolyte potential measurements are to be performed at the suspect hard spot location in accordance with SOP #2-2010 "Structure-to-Electrolyte Potential Measurements".
b. Hard Spot Evaluation Procedure After Excavation – Pipe that is exposed for the purposes of investigating ILI hard spot data should be inspected using the procedure described in this section. Inspection results are to be recorded on the appropriate company forms listed in SOP section 1-7.
    i. Excavate - Excavation shall be performed using safe digging practices in accordance with SOP 1-4010, "Excavation and Backfill".
    ii. Record Field Site Data – Record the site features in accordance with the appropriate Company forms listed in SOP section 1-7.
    iii. Coating Removal – Remove coating for a distance of 5 feet either side of the hard spot using standard company practices. Grit blasting of the surface to a commercial finish is recommended. The surface should be free of material that might interfere with the application and movement of the MT suspension or powder during inspection.
    iv. Visual Inspection – Visually inspect the pipe external surface for evidence of flat spots or any other unique features in accordance to company SOP 1-3010. Features such as a relatively flat region with rounded edges may indicate the presence of a hard spot. All relevant anomalies and defects must be documented.
    v. Magnetic Particle (MT) Inspection – Personnel performing the inspection must have current ASNT Level II qualification for MT. NDT contractors shall have the materials for performing wet MT (fluorescent and contrast) inspection prior to arrival at the inspection site. These methods are the preferred methods for MT inspection, and either method shall be acceptable. NDT contractors shall perform the specific MT method that is specified by DEGT representatives.
        1. General Instructions - Perform MT inspection over the entire exposed pipe surface in accordance with generally accepted industry standards such as ASTM E1444-01.

Metallurgical Services shall be consulted if any linear indications are detected.

2. Magnetizing Procedure – For MT inspection of the pipeline using a magnetic hand yoke, a magnetic field is produced that is oriented longitudinal between the two poles. Magnetizing current can be either A.C. or half-wave rectified D.C. For detecting surface cracks, the A.C. method is preferred. Linear defects oriented transverse to the magnetic field can be detected. In order to detect defects oriented in either direction on the pipe surface, MT inspection must be performed in both the circumferential and longitudinal directions with the hand yoke. Full coverage of a region larger than the pole spread is achieved by performing MT inspection using multiple passes, with each pass overlapping the other by approximately 1" or more.
3. MT Methods – The following methods are preferred for performing MT inspection of the pipe surface for the purposes of finding surface breaking defects such as cracks, seams, and laminations open to the O.D. surface.
    a. Wet Fluorescent MT – This method uses finely divided magnetic particles suspended in a liquid medium that is applied by spraying. Water based medium is recommended. The particles fluoresce when inspected under black light. Excessive background fluorescence during inspection shall require additional surface cleaning or a change to a different medium or method. This method is preferred except in bright light conditions.
    b. Wet Non-Fluorescent MT - This method uses finely divided magnetic particles suspended in a liquid medium (water or non-oil based medium is recommended) that is applied by spraying. White contrast paint is applied to the pipe surface and the applied particles (red or black) are visible under normal lighting conditions.

The following method is acceptable for performing MT inspection, if the preferred methods are deemed not suitable due to operational and environmental conditions:

    a. Visible Dry MT – This method uses a colored powder that is selected to achieve maximum contrast to the pipe surface. A bubble blower is typically used to apply a light dust of powder to the pipe surface in the area being inspected while the current is being applied. Excessive application of

the powder should be avoided because this may mask any indication present. Excess powder can often be removed by lightly blowing the surface while performing the inspection with current being applied.

vi. Ultrasonic Wall Thickness Survey – Perform an ultrasonic wall thickness measurement survey of the suspected hard spot region. Ultrasonic measurements shall be made by personnel with previous experience taking UT measurements. For the purpose of wall-thickness measurement using ultrasonic techniques, an ASNT certification is not required. Metallurgical Services shall be consulted if lamination or wall loss is detected.

vii. Hardness Testing and Dimensional Documentation – Prior to testing, the pipe surface should be thoroughly cleaned of surface deposits and debris. Test locations should be ground to a depth of 0.010" and finish ground using a 240 grit flapper wheel. Perform hardness testing over a 2" grid using a Microdur hardness tester that has current calibration documentation. Where areas of high hardness are detected a ½" or smaller grid shall be used to determine the shape of the hard spot. Isolated high hardness readings must be verified. Further investigation of elevated hardness locations may require additional grinding to depths of approximately 0.015" to 0.020". The contractor performing the hardness testing must have a process for addressing scatter in the hardness test results. The hardness test data should be reported as an attachment to the "Pipe and Coating Inspection Report" (7T-33).

c. Hard Spot Repair Recommendations - Repair of hard spots, and other defects located during bell hole examination, will be performed in accordance with SOP 1-3010 "Pipeline Repair". **Grinding removal of cracks in hard spots is not an acceptable or approved repair process.** The available repair options are provided for each type of hard spot that would require repair.

i. Pipe with Hardness Properties Less Than 300 HB
    1. Carefully Re-Coat and Backfill.

ii. Hard Spots with Hardness between 301 and 400 HB with No Cracking Present.
    1. Replacement
    2. Pressure Containing Sleeve (Type "B" Welded Ends)
    3. Reinforcing Sleeve with Filler (Type "A" or Type "B" Non-Welded Ends)

iii. Hard Spots with Evidence of Cracking (301 and greater)
    1. Replacement
    2. Pressure Containing Sleeve (Type "B" Welded Ends)

iv. Hard Spots with Hardness Greater than 401 HB (No Cracking)
    1. Replacement
    2. Pressure Containing Sleeve (Type "B" Welded Ends)

1. API 5L, "Specification for Line Pipe", 41st Ed., April 1, 1995.

2. PRCI Report PR-218-9307, "Pipeline Repair Manual" by J.F. Kiefner, W.A. Bruce, D.R. Stephens. Page 57 and Figure 20.

3. PRCI NG-18, Report 131, "Summary of Field Failure Investigations", Field Failure No. 6, "Hydrogen Cracking in 30" x 0.375" , X52 Pipeline".