Quarterly Report – Public Page

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Contract Number: DTPH56-06-T-000020

Prepared for: DOT/PHMSA and GTI SMP (Sustaining Membership Program)

Project Title: Phase Sensitive Methods to Detect Cathodic Disbondment

Prepared by: Gas Technology Institute

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Objective and Public Abstract

The proposed work is to develop a phase sensitive technology that could detect coating disbondment on steel pipe from above ground, thus locating potential corrosion failure points. The system would consist of two components, a stationary signal generator that is attached to a test point and a detector that is carried along the pipeline. Sinusoidal or pulse excitation signals may be used. A wireless link between the generator and the detector provides accurate synchronization. An abrupt change of signal phase is expected at the disbondment.

There is currently no method to detect or locate a disbonded coating from above ground. Existing pipeline potential gradient surveys, both DC and AC voltage, make use of only amplitude data. While amplitude methods can detect an active holiday (break) in the coating, a disbonded coating can shield active corrosion from both detection and cathodic protection. Stated another way, the space between a disbonded coating and the pipe can house an active corrosion cell. Until there is an actual holiday in the coating, the corrosion cell cannot be detected with current technology. A holiday will allow increased cathodic protection current to flow to the pipe in the immediate vicinity of the holiday, but may not reach the extremities of a large disbondment.

A disbonded coating can contain an active corrosion cell that is undetectable until serious damage has occurred to the pipe wall. There is no exterior method that can reliably detect disbonded coating at this time. The coating effectively "shields" areas of active corrosion within the disbondment from DC or AC voltage gradient surveys. Internal methods, such as magnetic flux leakage (MFL) pigging may detect wall thinning but will not differentiate causes. MFL pigging is expensive and may not be possible on lines with bends or diameter changes. The proposed work is to provide a completely new method for surveying pipelines.

The object of the proposed work is to develop a technology that could detect coating disbondment on steel pipe from above ground, thus identifying potential corrosion locations before the pipeline fails. The deliverable would be prototypes of two components, a stationary signal generator and a hand carried detector. The signal generator would be attached to the pipeline at a test station. The

hand-held device would be carried along the pipeline to acquire signal phase and amplitude measurements from the pipeline.

Progress to Date

In Quarter 1, an advisory group was formed from members of GTI's Sustaining Membership Program (SMP) Technical Guidance Committee (TGC.) The group was sent a survey form with the following questions:

1. How many miles of coated steel pipe are in your system?
2. How many new miles of coated steel are installed every year?
3. What type of coated steel do you have the most of?
4. What type of coated steel has the most failures?
5. How is your steel cathodically protected?
6. Would your company be interested in hosting a test?
7. Does your company have conventional surveys of coated steel pipelines scheduled in the next two years?

A state of art assessment document was drafted and circulated to the advisory group. GTI determined there is currently no method to detect or locate a disbonded coating from above ground. Existing pipeline potential gradient surveys, both DC and AC voltage, make use of only amplitude data. While amplitude methods can detect an active holiday (break) in the coating, a disbonded coating can shield active corrosion from both detection and cathodic protection. Stated another way, the space between a disbonded coating and the pipe can house an active corrosion cell. Until there is an actual holiday in the coating, the corrosion cell cannot be detected with current technology. A holiday will allow increased cathodic protection current to flow to the pipe in the immediate vicinity of the holiday, but may not reach the extremities of a large disbondment. Internal methods, such as magnetic flux leakage (MFL) pigging may detect wall thinning but will not differentiate causes. MFL pigging is expensive and may not be possible on lines with bends or diameter changes. As part of the assessment, a patent research was performed, and no technologies relating to Phase Sensitive Methods to Detect Cathodic Disbondment were found. There are, however, other technologies that detect cathodic disbondment by other means.

In Quarter 2, GTI received four survey responses from SMP TGC members in different parts of the country:

A	B	C	D	Company / Question
9300	440	7343	5640	Miles of coated steel in service
30	0.6	20	25	New miles per year
CTE	XTC	CTE	CTE	Prevalent type of coated pipe
CTE	XTC	FBE	FBE	Highest coating failure type
B	A	B	I	Is CP Anodic, Impressed, or Both
yes	no	no	yes	Willing to host field test
yes	yes	yes	yes	Are surveys scheduled in 2007-2008
			CTE	Coal Tar Enamel
			XTC	X-Tru Coat or "yellow jacket"
			FBE	Fusion Bonded Epoxy

Table 1 – Survey Results

A draft test plan was created based on the survey results and sent to the advisors for review. The purpose of the test plan is to define a reasonable subset of coated steel pipe types that can be used to verify the operation of a prototype cathodic disbondment detector. Once approved, GTI will fabricate a representative set of test samples and conditions.

GTI researched relevant transmission line theory, scenarios, and engineering calculations that will be used during the research project including:

- A Buried Coated Metal Pipe as a Transmission Line
- Electrical Properties of Transmission Lines
  - Capacitance
  - Resistance
  - Inductance
  - Conductivity
- Derived Properties of Transmission Lines
  - Characteristic Impedance
  - Propagation Constant
- Applicable Partial Differential Equation and Their Solutions
  - Partial Differential Equations of a Uniform Transmission Line
  - When driven by a sinusoidal wave of known frequency
  - Phase Shift
  - Attenuation
- Reflections on a Transmision Line when Impedance Changes (Characteristics of the Reflected Wave)
- Case of an Air-filled Disbondment
- Case of a Broken Coating

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