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QUARTERLY REPORT

Guidelines for the Identification of Stress Corrosion Cracking Sites and the Estimation of Re-Inspection Intervals for Stress Corrosion Cracking Direct Assessment

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Project Background

The objective of this project is to develop a set of quantitative guidelines for predicting where and when Stress Corrosion Cracking (SCC) might be an integrity threat for gas and liquid hydrocarbon pipelines. These objectives will be achieved over 24 months through the following tasks:

- Task 1: Data Collection – Data will be collected from the literature, company or field records, pipeline operators, and regulators;
- Task 2: Data Analysis – Analysis of field and laboratory data to derive relationships describing susceptibility to SCC, crack initiation, crack growth and dormancy, and crack growth to failure;
- Task 3: Documentation – Document the results of the data analysis task;
- Task 4: Technology Transfer – Disseminate the results of this work to the industry; and
- Task 5: Administration and Reporting – Direct and document the research and report on project progress and results.

Technical Status

Progress in the quarter was made on a number of the scheduled tasks. In particular, progress was made on Task 1: Data Collection and Task 2: Data Analysis.

Task 1: Data Collection

Sub-task 1.1 Data Collection from Literature

Data collection from the literature is virtually complete, with a total of 100-200 papers, articles, reports, and conference presentations obtained to date. A final search of the literature will be performed in the next quarter to ensure that all relevant literature data have been collected.

Sub-task 1.2 Data Collection from Pipeline Operators

The format of the questionnaire for pipeline operators has been finalized. The initial questionnaire will be in the form of an Excel spreadsheet comprising three sheets. The first page will provide some background to the questionnaire and give instructions and guidance as to how it should be completed. The data collection exercise is intended to benefit not only this project, but also other current and future SCC projects. This sharing of data and streamlining of the data collection exercise was requested by pipeline operators in order to minimize the amount of effort on their part. In turn, this coordination of efforts should result in a more-extensive and more-complete data set being collected.

Briefly, the pipeline operators will be asked to discretize their systems into "segments." There is no prescribed definition of a segment, but as guidance we are suggesting that a segment should be no larger than a valve section. Because coating type will be an important parameter in discriminating between the occurrences of SCC, we require that the entire length of line in the segment have the same coating (short repair sections can be ignored). Therefore, if more than one coating type is present in a particular valve section, then a number of segments will need to

be defined for that section. Additional segments should be defined if the operator knows of a particular parameter or feature that leads to a higher incidence of SCC (e.g., a particular type of girth weld coating).

Based on the response to the questionnaire, some pipeline operators may be approached for additional information. Those companies will be operators with extensive databases or other information deemed of interest to this and other projects.

Sub-task 1.3 Data Collection: Foreign SCC Mitigation Practices

After some effort, contact has been established with an expert in Russia who has access to extensive SCC records from that country and other former Soviet Union countries. Although the information has not yet been delivered, it is understood that the information includes: pipeline records (length of line, number of SCC failures, severity of other SCC indications, soils information, steel data, etc.), as well as a textbook describing Russian experience with SCC.

Figure 1: Image of Wrinkled Tape Coating.

Figure 2: Image of SCC Colony.

Task 2: Data Analysis

Analysis of the data has been proceeding simultaneously with data collection.

Sub-task 2 Data Analysis: Categorizing Data

This sub-task involves identifying which one (or more) of the four stages of SCC to which the information belongs. The four stages considered in this project are: susceptibility, initiation, crack growth and dormancy, and crack growth to failure.

Sub-task 2.1 Data Analysis: Pipeline Susceptibility to SCC

The R&D literature contains a number of studies that relate to the susceptibility of pipelines to SCC. There is relatively little information about the effect of materials properties on susceptibility (as known from the field observation of the susceptibility of a wide range of grades and pipe manufacturers), but there is some information about the effects of coatings properties on SCC susceptibility. There is also some information on the effects of surface preparation.

Sub-task 2.2 Data Analysis: Initiation

There is extensive information about the effect of stress level (both the maximum stress and the magnitude of stress fluctuations) on the initiation of high-pH SCC. There is less information on the effect of stress levels on the initiation of near-neutral pH SCC and, as yet, no threshold stress has been identified for this form of cracking.

Sub-task 2.3 Data Analysis: Crack Growth and Dormancy

There are a number of recent publications (in the past 2-3 years) dealing with the factors that cause SCC cracks to either continue to grow once initiated or to decelerate and become dormant. Much of this effort has been focused on near-neutral pH SCC.

Sub-task 2.4 Data Analysis: Crack Growth to Failure

Models have been developed for predicting the growth rate of both high-pH and near-neutral pH SCC. These models are appropriate for the growth of cracks beyond a depth of 10-20% through-wall. The models for high-pH SCC are based on the identified SCC mechanism, involving the periodic rupture of a crack-tip film, crack growth by dissolution of the metal, and cessation of growth due to repassivation of the crack tip. This sequence of events is repeated, resulting in continued crack growth. Near-neutral pH SCC, on the other hand, is believed to follow a corrosion-fatigue type mechanism, in which cyclic loading promotes crack advance.

Plans for Future Activity

The following activities are anticipated for the next milestone period:

Technical Progress

Complete the data collection survey and canvass PRCI member companies. Continue with literature review and begin model development. Currently available literature will be reviewed and additional information collected. The basis for the SCC model will be started to be formulated.

Obtain and translate Russian pipeline data.

Meeting and Presentations

None planned.

Tests and Demonstrations

No tests or demonstrations are planned for the next reporting period.