STP-PT-011

INTEGRITY MANAGEMENT OF STRESS CORROSION CRACKING IN GAS PIPELINE HIGH CONSEQUENCE AREAS

ASME STANDARDS TECHNOLOGY, LLC

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FOREWORD

In response to concerns about managing the threat of stress corrosion cracking (SCC) in high-pressure gas transmission pipelines, and in the light of recently introduced legislation concerning integrity management plans focusing on high consequence areas (HCAs), a group of five major gas transmission companies initiated a joint industry project (JIP) in January 2006 to develop technical rationales to support the key processes of SCC integrity management, including hydrostatic testing, in-line inspection (ILI) and SCC direct assessment (DA). These partner companies include Spectra Energy (formerly Duke Energy Gas Transmission), El Paso Pipeline Group, Panhandle Energy, TransCanada Pipelines Ltd. and Great Lakes Gas Transmission.

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ABSTRACT

This report includes a compilation of results obtained through a series of white papers developed as part of a gas transmission company JIP addressing specific issues related to SCC in gas pipeline HCAs. This report presents the overall project approach, findings and outcomes. The overall outcome of the JIP has been the development and collation of a significant body of supporting information, made available to pipeline operators and to the pipeline industry, providing the basis for sound decision making regarding the issues to be addressed when managing the integrity of pipelines that are potentially subject to the threat of SCC. In particular, this report includes:

- A review and update of SCC experience in 130,000 miles of high-pressure gas pipelines.
- Validation of the ASME B31.8S criteria for determining segments and HCAs most likely to be susceptible to high pH SCC.
- Demonstration that the modified ASME B31.8S criteria also are applicable to near-neutral pH SCC.
- Development of guidelines and algorithms for prioritizing pipeline segments and HCAs for SCC assessment, and for selecting excavation sites most likely to show evidence of SCC.
- Development of guidance for conducting SCC hydrostatic tests.
- Development of a categorization scheme for determining crack severity and mitigation response.
- Development of a method for determining the intervals between re-tests when using hydrostatic testing, ILI or SCC DA to manage SCC.
- Provision of guidance for determining how many excavations are necessary during SCC DA.
- Development of a process for utilizing condition monitoring activities for SCC management when low levels of SCC are experienced.
- Identification of revisions to improve the existing ASME B31.8S guidance for SCC.

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1 SUMMARY

In response to concerns about managing the threat of stress corrosion cracking (SCC) in high-pressure gas transmission pipelines, and in light of recently introduced legislation concerning integrity management plans focusing on high consequence areas (HCAs), a group of five major gas transmission companies initiated a joint industry project (JIP) to develop technical rationales to support the key processes of SCC integrity management, including hydrostatic testing, in-line inspection (ILI) and SCC direct assessment (DA).

The JIP commenced in January 2006. This report summarizes the overall approach adopted during the JIP and presents the findings and outcomes obtained in a series of white papers addressing the specific issues that were identified by the JIP Steering Committee.

The overall outcome of the JIP has been the development and collation of a significant body of supporting information, made available to pipeline operators and to the pipeline industry, providing the basis for sound decision making regarding the issues to be addressed when managing the integrity of pipelines that are potentially subject to the threat of SCC. In particular, the JIP has delivered the following:

- A review and update of SCC experience in 130,000 miles of high-pressure gas pipelines, incorporating data extending over more than 50 years and including 87 in-service ruptures and leaks. This database represents a substantial proportion of the relevant operating experience in North America.
- Validation of the ASME B31.8S criteria for determining segments and HCAs most likely to be susceptible to high pH SCC, and demonstration that the modified ASME B31.8S criteria also are applicable to near-neutral pH SCC, based on the accumulated service experience.
- Development of guidelines and algorithms for prioritizing pipeline segments and HCAs for SCC assessment, and for selecting excavation sites most likely to show evidence of SCC, using the accumulated service experience and latest research information.
- Development of guidance for conducting SCC hydrostatic tests so as to deliver optimized benefits for SCC integrity management.. These test conditions may differ from those for hydrostatic tests conducted for other operational reasons.
- Development of a categorization scheme for determining crack severity and mitigation response, based on predicted failure pressure and estimated remaining life at the operating pressure. The sensitivity of crack severity to input parameters (pipeline attributes, crack growth rate and assumptions made during calculations) has been examined.
- Development of a method for determining the intervals between re-tests when using hydrostatic testing, ILI or SCC DA to manage SCC.
- Provision of guidance for determining how many excavations are necessary during SCC DA.
- Development of a process for utilizing condition monitoring activities for SCC management when low levels of SCC are experienced, consistent with the requirements of “Other Technology” for Integrity Management.
- Identification of revisions to improve the existing ASME B31.8S guidance for SCC and preparation of alternative wording for consideration and balloting by the ASME Committee.

2 BACKGROUND AND OBJECTIVES

As pipeline companies prepare integrity management plans for SCC, they are faced with the challenge of complying with the regulatory requirements of US Federal Regulation 49 CFR Part 192 Subpart O and, at the same time, minimizing the risk of failures due to SCC. In some cases, the required procedures may not be optimally effective to reduce such risks and, as such, they may divert resources from more effective procedures. In other cases, it is not obvious what specific procedures would be most cost effective for the industry to employ to comply with the regulations. Some of the most important questions relate to the most effective way to deal with a large number of high-consequence areas (HCAs), and determining appropriate procedures and re-test intervals for hydrostatic testing, in-line inspection (ILI) or SCC direct assessment (SCC DA).

While it is recognized that each pipeline company must have individual integrity management plans that are tailored to the specific characteristics and history of the pipeline system, a common approach to some of the key issues would be beneficial in dealing with the regulatory agencies, as well as providing guidance for developing an effective integrity management plan. Such an approach would draw upon the key processes of integrity management outlined in ASME B31.8S, including:

- Defining the basis for SCC susceptibility
- Prioritizing HCA segments susceptible to SCC
- Selecting the appropriate assessment method and assessment location for each segment
- Defining mitigation of SCC when found (including assessing the severity of the SCC)
- Determination of and basis for reassessment interval
- Determination of additional preventive and mitigative measures.

In response to these issues, five major gas transmission companies initiated a joint industry project (JIP) to develop a common approach to managing stress corrosion cracking in HCAs for natural gas transmission. The five companies are:

- Spectra Energy (formerly Duke Energy Gas Transmission)
- El Paso Pipeline Group
- Panhandle Energy
- TransCanada Pipelines Ltd.
- Great Lakes Gas Transmission.

The overall aim of the JIP has been to develop the technical rationale to support each of the key processes identified above. Emphasis has been placed on the need for operators to show consistency in their technical approach to SCC management, particularly regarding the development of compliant solutions for HCAs where SCC is a threat of concern. Technical consistency does not imply a uniform response, but rather a consistent framework enabling each operator the flexibility to adopt an approach tailored to the attributes and SCC history of each line. The rationale has been based, to the extent possible, on scientific knowledge of SCC, analytical models of behavior of pipe containing stress-corrosion cracks and field experience from as many companies as possible.

It has been intended from the outset that the rationale will be made available for use by operators in establishing their respective plans for managing SCC in HCAs. It has also been intended that the JIP will develop any materials required to support the technical rationale, such as modifications to completed recommended practices and standards.

3 APPROACH

The JIP commenced in January 2006 and has been managed by BIZTEK Consulting, Inc. (Dr. Raymond Fessler), with Dr. David Batte (Macaw Engineering Ltd.) and Mr. Mark Hereth (PPIC) as technical advisers and project team members. The project has consisted of the following tasks.

- Task 1. In consultation with the JIP Steering Committee, establish which issues should be addressed and whether the technical rationale is already strong enough or whether more data or analyses are needed. For those answers for which there is insufficient technical justification, determine what additional data or analyses are needed and possible, and whether the participants can provide any necessary additional field data.
- Task 2. Prepare a "white paper" addressing each identified issue, including, where necessary, analysis of additional field data or construction/refinement of predictive models. Each white paper is thoroughly discussed and finalized in conjunction with the JIP Steering Committee.
- Task 3. Present the provisional outcomes of the JIP at meetings with industry experts (operators and technical consultants) to provide detailed technical scrutiny of the findings and their implications and build a broader consensus across the industry.
- Task 4. Present the provisional outcomes of the JIP at meetings with DOT/OPS/PHMSA to provide updates and understanding of the findings and their implications for the integrity management of gas pipelines.
- Task 5. Identify needs or opportunities for modifying and improving the existing guidance and legislation and develop technology packages to support changes.

4 TASK 1 - CLARIFICATION OF ISSUES

The initial discussions with the JIP Steering Committee identified seven questions that are faced by operators seeking to implement sound SCC management practices in line with integrity management regulations. These questions were of particular concern because, in each case, the existing regulations and guidance leave the decision on precisely how to proceed at the discretion of the operator. The seven questions are set out below, and their significance in the context of the integrity management process is illustrated schematically in Figure 1:

Question 1: On what basis should HCAs and segments be defined as SCC-susceptible?

Question 2: How should SCC-susceptible HCAs and segments be prioritized for assessment?

Question 3: Where hydrostatic testing, SCC DA or crack detection ILI have been chosen as the assessment methods, what are the appropriate re-test intervals?

Question 4: What is the appropriate procedure for hydrostatic testing?

Question 5: When using SCC DA, where is the best place to dig and how many digs should be conducted? (This question was subsequently divided into two parts.)

Question 6: How should crack severity be defined, and how should severity determine what kinds of remedial actions are appropriate?

Question 7: What additional preventive and mitigative measures are appropriate for SCC condition monitoring, and how can they be used to enhance confidence in the management of SCC?

A further question concerning the performance of ILI tools for detecting and sizing SCC was deferred pending future developments in ILI technology.