

**List and Abstract of Intellectual Property Contents**

GRI-02/0087

**Direct Assessment Overview for Pipeline Integrity.**

Gas Technology Institute, Des Plaines, IL

**Abstract:**

A significant amount of natural gas transmission pipelines can not accommodate in-line inspection (ILI) tools, nor can they be taken out of service to be pressure tested to find time dependent defects. Direct Assessment provides a means for assessing the integrity of such lines. Direct Assessment is a process through which an operator is able to integrate their knowledge of the physical characteristics and operating history of a pipeline, with the results of diagnostic testing performed on the pipeline system, to determine the state of integrity of the pipeline. The process is further validated by directly examining the pipeline to verify that the conditions predicted by the integration of the knowledge and diagnostic testing results are what are actually found upon examination. Direct Assessment methodologies for external corrosion, internal corrosion, and stress corrosion cracking are summarized. Numerous companies, organizations, government agencies, and individuals have contributed to the ongoing development of the Direct Assessment methodology, resulting in the revision of industry standards, the publication of numerous research reports, studies of the validity of the process, and recommendations for further research and standards development. Appendices containing presentations from industry meetings comprise a major portion of the report.

GRI-04/0093.1

**Comparisons of Pipeline Integrity-Assessment Methods.**

Kiefner & Associates, Inc., Worthington, OH

**Abstract:**

This project developed a comparison of three pipeline integrity-assessment methods: hydrostatic testing, in-line inspection, and direct assessment. Pipeline operators may use any one or a combination of these methods to assess the integrity of a pipeline after a period of service in which it is perceived that the pipeline may have suffered deterioration from corrosion or fatigue or some other phenomenon. The purpose of this report is to compare the attributes of the three methods so that pipeline operators will be better able to choose a method or combination of methods that is best suited for particular situations.

GRI-00/0231

**Direct Assessment and Validation.**

Battelle Memorial Institute, Columbus, OH; CC Technologies, Dublin, OH; Paragon Engineering Services, Houston, TX

**Abstract:**

This report summarizes the underlying principles and current status of the Direct Assessment process for assessing the effect of external corrosion on the integrity of natural gas pipelines. Direct assessment is a process of verifying the integrity of a pipeline using data from above-ground measurements (indirect examinations), selected excavations (direct examinations), the pipeline's characteristics, and the pipeline's operating history. The report contains information on 1) pipeline corrosion damage; 2) methods of measuring the effectiveness of the corrosion protection system; 3) the elements and proper use of the direct assessment process, including checks and balances built into the method; and 4) the ongoing development of the method, including its calibration and verification against in-line inspection results. Integration of indirect and direct examinations is the strength of the Direct Assessment method. Statistical analyses are being done to ensure the process provides a similar level of confidence in a pipeline's integrity as that obtained with a hydrotest or in-line inspection.

GRI-00/0228

**Cost of Periodically Assuring Pipeline Integrity in High Consequence Areas by In-Line Inspection, Pressure Testing and Direct Assessment.**

University of Illinois at Chicago, Energy Resources Center, Chicago, IL

**Abstract:**

The Office of Pipeline Safety has proposed requiring integrity management plans which would require natural gas transmission operators to periodically pig and/or hydrostatically test 100 percent of their pipeline systems that fall into High Consequence Areas (HCA). A spreadsheet estimation tool was developed to generate an industry picture of the cost to implement this proposed ruling over the next fifteen years. This report summarizes the assumptions, the mean and variations, and the calculation rules used. Costs for each pipeline testing and monitoring technology were identified, based on the assignment of uncertainty ranges to key variables. The specific goal of the iterative process used was to estimate probability distributions for the project's total 15 year cost using a specific monitoring scenario, with inputs provided by the Interstate Natural Gas Association of America (INGAA). For this specific scenario, the mean 15 year total cost is \$288 million with a standard deviation of \$53 million. This analysis tool can be used by industry to estimate costs of various monitoring and testing scenarios for discussion and planning.

GRI-02/0141

**Development of External Corrosion Direct Assessment Methodology.**

Battelle Memorial Institute, Columbus, OH

**Abstract:**

This report outlines a group effort by pipeline companies, industry organizations, regulatory groups, service providers, and technology development companies to support the development of the External Corrosion Direct Assessment (ECDA) methodology as a standardized testing method for assessing external corrosion in gas transmission pipelines. ECDA, as documented in the National Association of Corrosion Engineers (NACE) International Standard Recommended Practice TG-041 "Pipeline External Corrosion Direct Assessment Methodology", is a four-step process. ECDA requires integration of information on a pipeline's physical characteristics, operating history, and prior inspections (a pre-assessment step) with data from multiple field examinations (an indirect inspection step) and pipe surface evaluations (a direct examination step) to provide a more comprehensive integrity evaluation (a post-assessment step). A comparison of integrity evaluations made by pressure testing, in-line inspection, and ECDA is presented. Data collection efforts used to develop and validate the process are discussed, as are analyses of the data and modifications to the proposed methodology that were made based on the findings of this project.

GRI-02/0139

**Direct Assessment--External Corrosion. Integration and Spatial Normalization of the Data.**

Baseline Technologies Inc., Calgary, AB

**Abstract:**

External corrosion direct assessment (ECDA) is a structured process that is intended to improve safety by assessing and reducing the impact of external corrosion on pipeline integrity. The process follows four defined steps: pre-assessment, indirect (above ground) inspections, direct examinations, and post assessment. As part of the development and validation of the ECDA process, the objective of this project was to perform quality assurance of data sets submitted by volunteer pipeline operators, as it relates to spatial integration of the data, and to spatially integrate the data to support subsequent statistical analysis. Summaries of the various data elements and of each company's data sets are provided. Several factors impaired both the ability to tightly integrate the various datasets and the

general quality of the data in this first round of ECDA validation. The data tended to be inconsistent in structure and limited in content, partially due to the use of pre-existing data. As various elements of survey data are standardized and documented within the industry, it is anticipated that spatial normalization and correlation of the various data sets can be achieved in future phases of validation.

GRI-04/0093.2

**External Corrosion Direct Assessment Validation.**

Kiefner & Associates, Inc., Worthington, OH; Advantica, Houston, TX

**Abstract:**

The pipeline industry has come to accept and rely on the results of in-line inspection (ILI) and pressure testing to ensure the integrity of pipelines. Unfortunately not all pipelines are equipped to accommodate ILI tools, and due to the inconvenience and expense of conducting pressure testing, External Corrosion Direct Assessment (ECDA) has been given serious consideration as an alternative or complementary approach. However, the ECDA process is relatively new and the method has been treated with skepticism in some quarters, leading to the need for additional research. Previous attempts to demonstrate the ECDA process and evaluate its effectiveness have produced varied results. This document presents results, obtained using Structural Reliability Analysis (SRA), of comparing the reliability levels of pipeline segments that had been subjected to both ILI and ECDA. Five companies contributed pipeline inspection data to the study. SRA is a reliability-based approach built on probability theory and structural mechanics principles. The methodology is well suited to comparing results obtained from one technique with those obtained using another technique.

GRI-04/0093.4

**External Corrosion Direct Assessment Validation.**

Kiefner & Associates, Inc., Worthington, OH; Battelle Memorial Institute, Columbus, OH

**Abstract:**

This report covers the evaluation and analyses of ten External Corrosion Direct Assessment (ECDA) projects conducted by nine natural gas pipeline operators. The objective of the work was validation of the ECDA methods proposed in NACE RP 0502 as an integrity assessment method that could be used in place of, or along with, pressure testing and in-line inspection. Results indicate the process described in the current edition of NACE RP 0502 provides a methodology that can effectively locate pipeline coating anomalies. It is emphasized that these ECDA projects represent one of the first series of applications of the ECDA process, taking advantage of pre-existing projects. Since the projects were implemented on a limited scale, they should be considered a learning experience for the operators and others considering ECDA for integrity assessment. The ECDA process will continue to evolve and improve with additional experience.

GRI-04/0093.6

**Practical Guidelines for Conducting an External Corrosion Direct Assessment (ECDA) Program.**

Kiefner & Associates, Inc., Worthington, OH; Corpro Companies, Inc., Houston, TX

**Abstract:**

The purpose of integrity assessments of gas transmission or liquids pipelines is to minimize hazards to the general public, minimize pipeline leaks and spills, ensure continuous operations of the pipelines, optimize expenditures for reducing risk, and satisfying governmental regulatory requirements. The purpose of this document is to provide a bridge to help pipeline professionals follow NACE RP 0502-2002 (Standard Recommended Practice Pipeline External Corrosion Direct Assessment Methodology) and conduct pipeline integrity assessments for their pipeline systems. This document presents the four-step ECDA process, with an

appropriate level of details to facilitate pipeline professionals in conducting integrity assessments using the ECDA process. Numerous figures and tables are presented to emphasize salient points related to integrity assessments for pipelines, using the ECDA process. Attachments include a questionnaire for collecting relevant data as part of the pre-assessment step and a worksheet to be used during direct examinations.

GRI-02/0057

**Internal Corrosion Direct Assessment of Gas Transmission Pipelines--Methodology.**

Southwest Research Institute, San Antonio, TX; CC Technologies, Dublin, OH; ScandPower, Inc., Houston, TX; Gas Technology Institute, Des Plaines, IL; El Paso Pipeline Group, Houston, TX

**Abstract:**

An internal corrosion assessment methodology for gas transmission systems was developed and is termed "Internal Corrosion Direct Assessment" (ICDA). The basis behind ICDA is that detailed examination of locations along a pipeline where an electrolyte such as water would first accumulate provides information about the remaining length of pipe. The primary goal of the approach is to determine if internal corrosion is likely or unlikely to exist in a chosen length of pipe. Locations most likely to accumulate electrolyte are predicted using the results of pipeline multi-phase flow modeling. If the locations along a length of pipe most likely to accumulate electrolyte have not corroded, then other locations less likely to accumulate electrolyte may be considered free from corrosion and not require further examination. The ICDA method as described in this report can be used to focus the assessment of internal corrosion in pipelines and help ensure pipeline integrity. The method is applicable for gas transmission lines that normally carry dry gas but may suffer from short term upsets of wet gas or liquid water (or other electrolyte).

GRI-04/0093.3

**Internal Corrosion Direct Assessment of Gas Transmission and Storage Lines.**

Kiefner & Associates, Inc., Worthington, OH; Southwest Research Institute, San Antonio, TX

**Abstract:**

Internal corrosion is difficult to detect because pipe interiors are not easily accessible. Tools for performing detailed examination of interior pipe corrosion require excavation and are not economical to perform on the entire pipeline. Therefore, it is necessary to identify likely locations of internal corrosion in pipelines, in order that detailed examination can be used more effectively. An Internal Corrosion Direct Assessment (ICDA) method has been previously developed. The method consists of four iterative steps, and it is presently applicable to dry gas pipelines. This project validated the ICDA method for dry gas lines, using in-line inspection data from four pipelines, although some uncertainties remain. An example wet gas ICDA method shows promise, but needs to be further developed and validated.