Multiphase Flow Internal Corrosion Direct Assessment (MP-ICDA) Methodology for Pipelines

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Foreword

Scope

This standard practice outlines a methodology to assess pipeline integrity because of the threat internal corrosion in onshore and offshore pipelines and other piping systems that normally carry multiphase fluids (gas, water, and oil) termed multiphase flow internal corrosion direct assessment (MP-ICDA). Liquid separators (drips), compressing stations, vessels, and other equipment not related to pipelines are not included in this standard. This standard applies to pipelines, and piping systems both onshore and offshore, containing carbon dioxide (CO_2), hydrogen sulfide (H_2S), oxygen (O_2) and other corrosive species. Additionally, this standard applies to pipelines that continuously contain a liquid phase (water and condensate and/or oil and/or petroleum compounds), a possible solids content of various mineral scales, biofilms, or corrosion product compounds, and a continuous gas phase with fluid conditions that are not specifically covered by NACE SP0110[1] for wet gas internal corrosion direct assessment (WG-ICDA). Additionally, solids may be included as a phase by itself and may also be included in multiphase flow analysis of fluid streams.

This standard is intended for use by pipeline operators, oil/gas producers (upstream), and other pipeline industry individuals who manage pipeline integrity (both onshore and offshore) for pipelines that are normally under multiphase loading conditions and are outside the scope of NACE SP0110,[1] NACE SP0206,[2] and NACE SP0208.[3]

Rationale

The standard is being revised in accordance with AMPP's five-year review requirement. Changes in this revision include improvements on the method of evaluating the accuracy corrosion rate modeling results that are converted to wall losses with respect to the wall losses measured in the field contained in the Detailed Examination Step. It also includes guidelines that will help unify and more clearly understand the way the Detailed Examinations are reported.

The MP-ICDA methodology has been developed to meet the needs of pipeline operators and producers to assess the integrity of pipelines with respect to the internal corrosion threats posed by the fluids. MP-ICDA is a structured process that combines pre-assessment, indirect inspections, detailed examination, and post-assessment to evaluate the impact of predictable pipeline integrity threats such as internal corrosion. Specifically, the goal of MP-ICDA is to identify locations with the greatest likelihood of internal corrosion and its influencing factors, such as water content, flow regime, liquid hold-up, flow velocities, temperature and pressure changes. These locations are exposed and examined in accordance with criteria established in Section 4. The results of these examinations are used as a basis for assessing the condition and integrity of the remaining pipeline segments (those with less likelihood of corrosion). Direct assessment (DA) does not depend on the ability of a pipeline to undergo in-line inspection (ILI) by smart-pigging or pressure testing, making it most valuable to those pipelines unable to accept pigs or those that cannot be hydrostatically pressure tested. This standard is intended to provide an integrity assessment methodology for internal corrosion for pipelines where ILI cannot be performed; however, the MP-ICDA methodology may also serve, complement, or assist in those cases in which ILI was conducted or is contemplated to demonstrate the reliability of the ICDA process. It can also be used for optimizing the selection/justification, inspection frequency, or prioritization of pipelines that are subjected to ILI.

In multiphase flow systems, subregions of a pipeline that is identified within a region that are more susceptible to internal corrosion depend on the flow pattern that are defined by flow velocities, sudden changes of geometries, changes in elevation caused by the topography of the terrain, sharp elbows, expansions, changes in internal diameter and other changes that may influence the hydrodynamics of the flow. Multiphase flow and flow regimes can be determined by the use of flow models that have a hydrocarbon phase envelope (water and hydrocarbon), and the interaction between the gas and liquid phase, and allow the prediction under flowing conditions that shows local temperature, pressure, and fluid composition for a pipeline. Depending on the flow (i.e., velocity, gas/liquid quality, temperature, pressure, wall surface conditions, etc.), and specific operating conditions, the effects of flow regimes are considered. Flow regimes and flow hydrodynamic characteristics influence the threat of internal corrosion, and thus affect pipeline integrity.

The goal of MP-ICDA is to identify confirmatory or most probable locations (MPLs) along a pipeline subregion for determination of direct assessment sites. These sites are where internal corrosion damage has been identified by means of integrating available historical information in combination with the use of flow models to determine flow regimes and internal corrosion prediction models (ICPMs) that a company deems appropriate for its specific application to predict or calculate internal corrosion rates. The focus is the identification of conditions along the length of a pipeline region so