Wet Gas Internal Corrosion Direct Assessment (WG-ICDA) Methodology for Pipelines

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Foreword

This standard practice outlines a methodology to assess pipeline integrity because of the threat of internal corrosion for onshore and offshore pipelines and other piping systems that normally carry water-saturated or undersaturated natural and/or raw gas with condensed water, or with water and liquid hydrocarbons, termed wet gas internal corrosion direct assessment (WG-ICDA).

This standard is intended for use by gas pipeline operators/gas producers and others who manage gas pipeline integrity (both onshore and offshore) in which pipelines and piping systems are normally or periodically under wet loading conditions and are beyond the application of NACE SP0206 and NACE SP0208. The original conceptual basis for addressing wet gas pipelines commenced in 2004 with two publications.

The WG-ICDA methodology has been developed to meet the needs of gas pipeline operator/gas producers to assess the integrity of pipelines and piping systems with respect to internal corrosion. WG-ICDA is a structured process that combines pre-assessment, indirect inspection, detailed examination, and post-assessment steps to evaluate the effect of predictable pipeline integrity threats such as internal corrosion. Specifically, the goal of WG-ICDA is to identify the most probable locations (MPLs) with the greatest likelihood of internal corrosion. These locations are exposed and examined in accordance with criteria established in Section 4. The results of these detailed examinations are used as a basis for assessing the current condition and integrity of the remainder of the pipeline segment (with less likelihood of corrosion). WG-ICDA does not depend on the ability of a pipeline to undergo in-line inspection (ILI) or pressure testing, making it particularly valuable for those pipeline segments that are unable to accept inline inspection tools or that cannot be hydrostatically or pneumatically tested. This standard is intended to be a stand-alone, pipeline integrity validation assessment methodology for internal corrosion, but not for environmentally assisted cracking (EAC), in lieu of ILI analyses; however, the WG-ICDA methodology may also serve or assist those cases in which ILI may have been performed or is contemplated to demonstrate the reliability of the WG-ICDA process. It may also be used for optimizing the selection/justification or prioritization of pipelines that are identified for an ILI. The Multiphase Flow – Internal Corrosion Direct Assessment (MP-ICDA) Standard Practice, NACE SP0116, has a very similar structure and documentation as this Standard Practice. The major distinction between this SP and SP0116 is that the latter, in addition to what is in SP0110, also includes the presence of a hydrocarbon liquid (oil) phase, free water, and solids. WG-ICDA may also be used in conjunction with ILI tools. In this approach, the indirect inspection step may be replaced or may be complemented with ILI data. NACE SP0113 describes integration of ILI and ICDA through the 5-M methodology approach.

In wet gas systems, subregions of a pipeline that are identified within a region and may be more susceptible to internal corrosion depend on the local subregional flow patterns as defined by flow velocities, sudden changes of pipeline geometries, changes in elevation that may be caused by the topography of the terrain, sharp elbows, expansions, contractions, changes in internal diameter and other changes that influence the hydrodynamics of the flow. Multiphase flow and flow regimes can be determined by the use of field-proven flow models. The flow model must have a thermodynamic calculations ability to determine the two-phase hydrocarbon phase envelope and water dew point curves (for gas, water, and liquid hydrocarbon), and the interaction between the gas and liquid phase, and allow the prediction under flowing conditions that show local temperature, pressure, and fluid composition for a discrete pipeline subregion.

Depending on the flow characteristics (i.e., velocity, gas/liquid quality, temperature, pressure, wall surface conditions, etc.), and specific operating conditions, the effects of flow regimes must be considered. Flow regimes and fluid hydrodynamic flow characteristics influence the threat of internal corrosion and thus affect pipeline integrity.

The goal of the WG-ICDA is to identify confirmatory or MPLs along a WG-ICDA pipeline region or subregion to determine the position of assessment sites. These assessment sites are selected where internal corrosion damage has the highest likelihood that has been identified by means of integrating available historical information in combination with the use of flow models to determine: liquid holdups, flow regimes (e.g., stratified, slug, annular, or annular/mist but other flow regimes may also exist and must be considered) and predict or calculate internal corrosion rates by means of internal corrosion prediction models (ICPMs) where a pipeline operator/gas producer or its Subject Matter Expert (SME) deems appropriate for its specific application to predict or calculate internal corrosion rates and subsequently wall loss as required by this Standard Practice. The end-user is also directed to consider selecting models using NACE Publication 21410 if required. The essential focus is the computational discrimination of conditions along the length of a WG-ICDA region so that possible local WG-ICDA pipeline subregion integrity threats are identified for prioritized damage assessment and mitigation.

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 of 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.

Referenced Standards and Other Consensus Documents

Unless specifically dated, the latest edition, revision, or amendment of the documents listed in the table below shall apply.

AMPP/NACE/SSPC, www.ampp.org:	
NACE SP0113	Pipeline Integrity Management: Methods Selection and Implementation
NACE SP0204	Stress Corrosion Cracking (SCC) Direct Assessment Methodology
NACE SP0206	Internal Corrosion Direct Assessment Methodology for Pipelines Carrying Normally Dry Natural Gas (DG-ICDA)
NACE SP0208	Internal Corrosion Direct Assessment Methodology for Liquid Petroleum Pipelines
NACE SP0210	Pipeline External Corrosion Confirmatory Direct Assessment
NACE SP0116	Multiphase Flow – Internal Corrosion Direct Assessment
NACE SP0502	Pipeline External Corrosion Direct Assessment Methodology
NACE TR3T199	Techniques for Monitoring Corrosion and Related Parameters in Field Applications
NACE TR31414	Field Monitoring of Corrosion Rates in Oil and Gas Production Environments Using Electrochemical Techniques
NACE Publication 21410	Selection of Pipeline Flow and Internal Corrosion Models

NACE Publication 21413	Prediction of Internal Corrosion in Oilfield Systems from System Conditions
ANSI/NACE MR0175/ISO 15156	Petroleum and Natural Gas Industries—Materials for Use in H_2S-containing Environments in Oil and Gas Production

American Petroleum Institute (API), www.api.org:

ANSI/API 1160	Managing System Integrity for Hazardous Liquid Pipelines
ANSI/API 579-1/ASME FFS-1	Fitness-for-Service
ANSI/API Spec 5L	Specification for Line Pipe

American Society of Mechanical Engineers (ASME), www.asme.org:

ANSI/ASME B31.8	Gas Transmission and Distribution Piping Systems
ANSI/ASME B31.8S	Managing System Integrity of Gas Pipelines
ANSI/ASME B31G	Manual for Determining the Remaining Strength of Corroded Pipelines: Supplement to ASME B31 Code for Pressure Piping

ASTM International, www.astm.org:

ANSI/ASTM G170	Standard Guide for Evaluating and Qualifying Oilfield and Refinery Corrosion Inhibitors in the Laboratory
ANSI/ASTM G184	Standard Practice for Evaluating and Qualifying Oil Field and Refinery Corrosion Inhibitors Using Rotating Cage
ANSI/ASTM G185	Standard Practice for Evaluating and Qualifying Oil Field and Refinery Corrosion Inhibitors Using the Rotating Cylinder Electrode
ASTM G16	Standard Guide for Applying Statistics to Analysis of Corrosion Data
ASTM G202	Standard Test Method for Using Atmospheric Pressure Rotating Cage
ASTM G208	Standard Practice for Evaluating and Qualifying Oilfield and Refinery Corrosion Inhibitors Using Jet Impingement Apparatus

British Standards Institution (BSI), www.bsigroup.com:

BS 7910	Guide to methods for assessing the acceptability of flaws in metallic structures

Canadian Standards Association (CSA), www.csagroup.org:

CSA Z245.1	Steel Pipe
CSA Z662	Oil and Gas Pipeline Systems

Det Norske Veritas (DNV), www.dnv.org:	
DNV-RP-F101	Corroded Pipelines

> In AMPP standards, the terms shall and must are used to state requirements and are considered mandatory. The term should is used to state something that is recommended, but is not considered mandatory. The term may is used to state something considered optional.

Section 1: Scope

1.1 Introduction

1.1.1 This standard describes the AMPP internal corrosion direct assessment (ICDA) process for wet natural and/or raw gas pipeline and piping systems (i.e., WG-ICDA). It is intended to serve as a guide for applying the WG-ICDA process to onshore and offshore natural and/or raw gas pipeline and piping systems that:

a) Contain or will contain (as a function of operating temperature and pressure) saturated wet gas as demonstrated on a water dew point curve for that specific gas composition after verifying both the gas moisture content and its associated water holding capacity; or,
b) Contain free water; or,
c) Operate below the water dew point or a gas pipeline which transitions through its water dew point; or,
d) Are not covered by dry gas internal corrosion direct assessment (DG-ICDA),
e) Are not covered by liquid petroleum internal corrosion direct assessment (liquid ICDA); and,
f) Meet the feasibility requirements described in Paragraph 3.4 of this standard.

1.1.2 The four primary purposes of the WG-ICDA process are to (1) assess the integrity of a pipeline because of internal corrosion in wet gas flow pipelines (2) identify the susceptible locations in onshore and offshore pipelines where internal corrosion is likely to occur (3) establish the type (mechanism) of corrosion threats and (4) determine the frequency of pipeline integrity assessment.

1.1.3 The WG-ICDA method assesses the internal corrosion severities and how the internal corrosion severity is distributed along the subregion. The methodology includes methods of examination available to a pipeline/piping operator/gas producer to determine the occurrence, extent, severity, rate, and mechanism of internal corrosion.

1.1.4 WG-ICDA also provides a framework for the use of multiphase (solids, wet gas, water, and condensate) flow modeling results (e.g., flow velocities, temperature, and pressure profiles, liquid hold-up, and flow patterns) in understanding the fluid hydrodynamics of the flow along this pipeline segment and aids in understanding how these variables can affect internal corrosion.

1.1.5 One significant benefit of the WG-ICDA process for gas pipelines is that an assessment can be performed on a pipeline system for which alternative methods (e.g., ILI, hydrostatic testing) may be impractical. Where practical, WG-ICDA may be used in conjunction with ILI (see NACE SP0113 for details).

1.1.6 The WG-ICDA process has limitations, and not all pipelines can be successfully assessed with WG-ICDA. These limitations are dependent on the specifics derived from the feasibility assessment of each pipeline segment and shall be identified in the pre-assessment step.