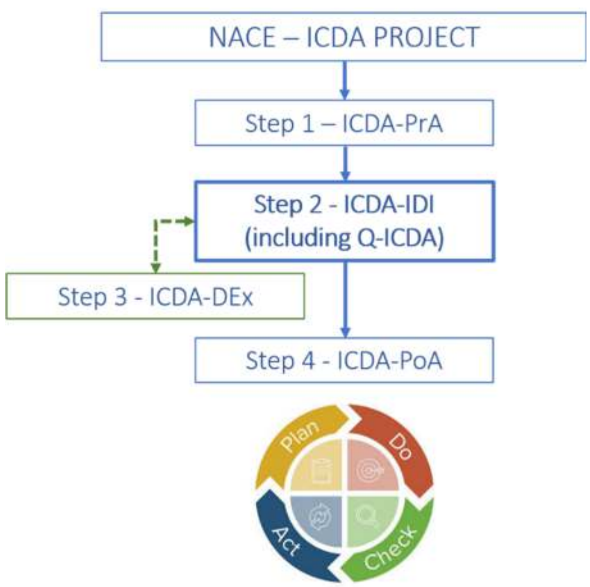
# Smart-Project Management Inc.
# Q-ICDA Corrosion Profiling within NACE – ICDA Projects

## NACE – ICDA Project Structure

The series of NACE – ICDA standard methodologies have been developed to meet the needs of pipeline operators and oil and gas producing companies to assess the integrity of pipelines with respect to internal corrosion:

- Multi-Phase Gathering - MP - ICDA - SP0116-2016;
- Wet-Gas Gathering - WG - ICDA - SP0110-2018;
- Dry-Gas - DG - ICDA - SP0206-2016; and,
- Petroleum Liquids / Crude Oil - LP - ICDA - SP0208-2008.




NACE - ICDA is a structured process that combines four structured project execution steps;

1) pre-assessment (PrA);
2) indirect inspection (IDI);
3) detailed examination (DEx); and,
4) post-assessment (PoA).

Specifically, the goal of NACE – ICDA methods is to identify locations along a pipeline structure with the greatest likelihood of internal corrosion; the most probable locations (MPL). The results of a detailed examination of the most probable locations by either exposure of the pipeline, or by means of an in-line inspection project are applied as the basis for assessing the condition and integrity of the remainder of the pipeline exhibiting a lower likelihood of corrosion damage.

ICDA methods do not necessarily depend on the ability of a pipeline to undergo in-line inspection (ILI) or pressure testing, making it most valuable to those pipeline segments unable to accept pigs or that cannot be hydrostatically tested. ICDA standards are in intended to be a stand-alone assessment methodology for internal corrosion in lieu of ILI analyses; however, ICDA methods may also serve or assist those cases in which ILI may have been performed or is contemplated to demonstrate the reliability of the ICDA process for the specific pipeline system. ICDA projects are also useful for optimizing the selection / justification or prioritization of pipelines that are considered as ILI candidates.

ICDA standard methods identify subregions of a pipeline that are within a larger region considered susceptible to internal corrosion based upon consideration of the fluid flow patterns that are defined by flow velocities, sudden changes of pipeline geometries, and / or changes in elevation caused by the topography of the terrain, sharp elbows, expansions, changes in internal diameter and other changes that influence the hydrodynamics of the flow.

Multiphase flow and flow regimes can be determined using flow models, where the qualifying flow model method applied has the thermodynamic calculation modules necessary to determine the multiphase envelope (gas, water and liquid hydrocarbon), and the interaction between the gas and liquid phase, and offers characterization of temperature, pressure, and fluid compositional profiles 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 must be considered. Flow regimes and flow hydrodynamic characteristics influence the potential severity of the internal corrosion reactions and, and therefore are important considerations when evaluating the integrity of a pipeline structure.

ICDA identifies confirmatory or most probable locations (MPLs) along a defined pipeline region to determine the position of assessment sites. These MPL 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 holdup fractions, flow pattern 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 industry standard internal corrosion rate prediction models.

## FOUR-STEP ICDA PROJECT EXECUTION

ICDA methods emphasize the identification of potential corrosion damage distribution by characterizing the potential corrosion rates and extent of expected damage at the most probable locations (MPL). The implementation of ICDA projects follow a well defined Four-Step Process;

**Step 1—Pre-assessment (PrA):** The pre-assessment (PrA) step includes the collection and organization of all historic and current operating data about the pipeline relevant to assessment of internal corrosion. This includes determining whether ICDA is feasible and defining the pipeline segment to be assessed. This step includes identification of functional regions within the pipeline segment based on input, withdrawal, and other parameters, and establishes the strategy for constructing appropriate flow modes to best represent the potential vulnerability to internal corrosion deterioration mechanisms.

The types of data collected are typically available in design and construction records (e.g., topography, routes, material, design pressures, temperatures, and microstructures), operating and maintenance histories, flow rates, alignment sheets, corrosion survey records, gas and liquid analysis reports, and inspection reports from prior integrity evaluations and/or maintenance actions.

**Step 2—Indirect Inspection (IDI):** The indirect inspection (IDI) step includes the use of the Q-ICDA engineering assessment method for prediction and prioritization of overall corrosion severity at different locations along a pipeline segment to undergo detailed examination (MPL assessment sites). This step also includes definition of the ICDA vulnerable subregions as a function of flow regimes through multiphase flow modeling, determination of corrosion rates and expected over-life cumulative metal loss within each NACE-ICDA subregion.

Calculations are performed within Q-ICDA using proprietary flow models to determine flow regimes and liquid holdup to quantify corrosion rates, with consideration of operating and maintenance history of the pipeline throughout defined over-life operating eras (periods).

The integration of results from both flow models and corrosion rate models within Q-ICDA are analyzed and used to select the MPL's within a region based on susceptibility to internal corrosion, which may then be defined as assessment sites for direct examination within NACE – ICDA – Direct Examination (DEx) stage of the project.

**Step 3—Direct Examination (DEx)**: The direct examination (DEx) step includes performing all actions to allow for detailed examination of assessment sites prioritized to have the highest corrosion severity along the pipeline by application of Q-ICDA within the IDI project stage. The pipe examination strategy must be sufficient to determine the existence, extent, and severity of corrosion at the MPL assessment sites. Detailed examination of the internal surface of a pipe may involve non-destructive examination (NDE) methods sufficient to identify and characterize internal defects or wall losses.

Additional data and information gathered using various methods such as guided wave testing (GWT), automated ultrasonic testing (AUT), manual ultrasonic testing (UT), in-line inspection data, and installation of internal corrosion monitoring devices may be incorporated and used to further evaluate the most damaged locations for detailed examination, and as a strategy for evaluating the effectiveness of mitigation strategies within the post assessment stage.

**Step 4—Post-assessment (PoA):** The post-assessment (PoA) step is an analysis of data collected from the previous three steps to assess the effectiveness of the ICDA method; design and modify mitigation strategies; establish corrosion control and maintenance strategies; and determine integrity reassessment intervals for the pipeline(s) studied. Results of the ICDA results are extrapolated to other pipelines sharing strong historical sibling association, and to pipelines considered less likely to exhibit corrosion damage relative to the pipeline(s) prioritized and examined within the ICDA project.

By considering the direct examination of the MPL assessment locations, the ICDA - PoA method creates a prioritized hierarchy of mitigation options for the pipelines studied, and for all associated pipelines within the system. The PoA stage is an opportunity to communicate the findings to the field, operations team / chemical teams to facilitate workshops that consider their system knowledge, and operating experience to create the most effective strategy for each pipeline within an associated connected network.