Direct Assessment for Unpiggable Pipelines

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Agenda

✓ **Presentation Content**

- Background
- Direct Assessment History
- External Corrosion Direct Assessment (ECDA)
- Stress Corrosion Cracking Direct Assessment (SCCDA)
- Internal Corrosion Direct Assessment (ICDA)
- Q&A

Corrosion

Corrosion is a natural process, which converts a refined metal to a more chemically-stable form, such as its oxide, hydroxide, or sulfide.

Pipeline Integrity

"Pipeline integrity is the ability of the pipeline system to operate safely and withstand the loads imposed during the pipeline lifecycle"

DNV-OS-F101

Corrpro definition:

Total integrity of a system exists when, under the operating conditions it was designed for, and taking into account the current condition of the pipeline, the predictable risk of its failure (endangering the public, property and the environment) is acceptable.

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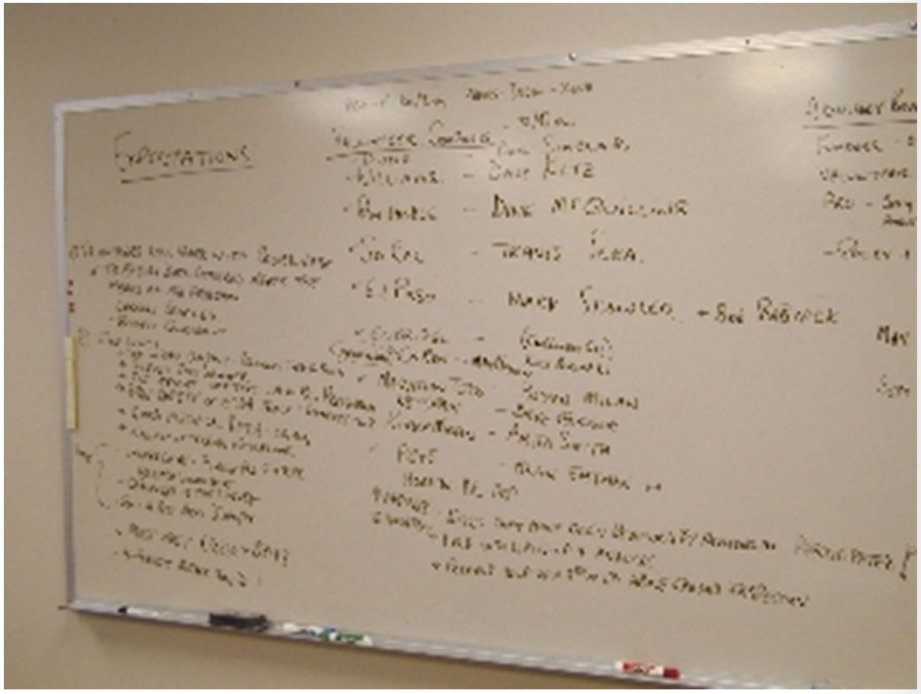
Direct Assessment History

… where it all began:

- **Battelle expert team**
- **Formed in 2000, operational through early 2002**
- **Sponsored by INGAA**
- **Led by Dr. Brian Leis**
- **Worked closely with US Department of Transportation**
- **Tasked to develop integrity assessment strategy as an alternative to ILI and hydrotesting**



Pipeline Regulations in USA

U.S. Department of Transportation

Pipeline and Hazardous Materials Safety Administration

- Regulations were initiated in 2001 for US pipeline operating companies to develop Integrity Management Programs (IMP's)
- NACE published RP 0502-2002 "Pipeline External Corrosion Direct Assessment Methodology" in 2002
- NACE and US regulations are now being adopted around the world

External Corrosion Direct Assessment (ECDA)

What is External Corrosion Direct Assessment (ECDA)?

- A structured process to improve safety and reduce the impact of external corrosion on buried pipelines
- Anticipates future pipeline defects, as well as detecting existing defects

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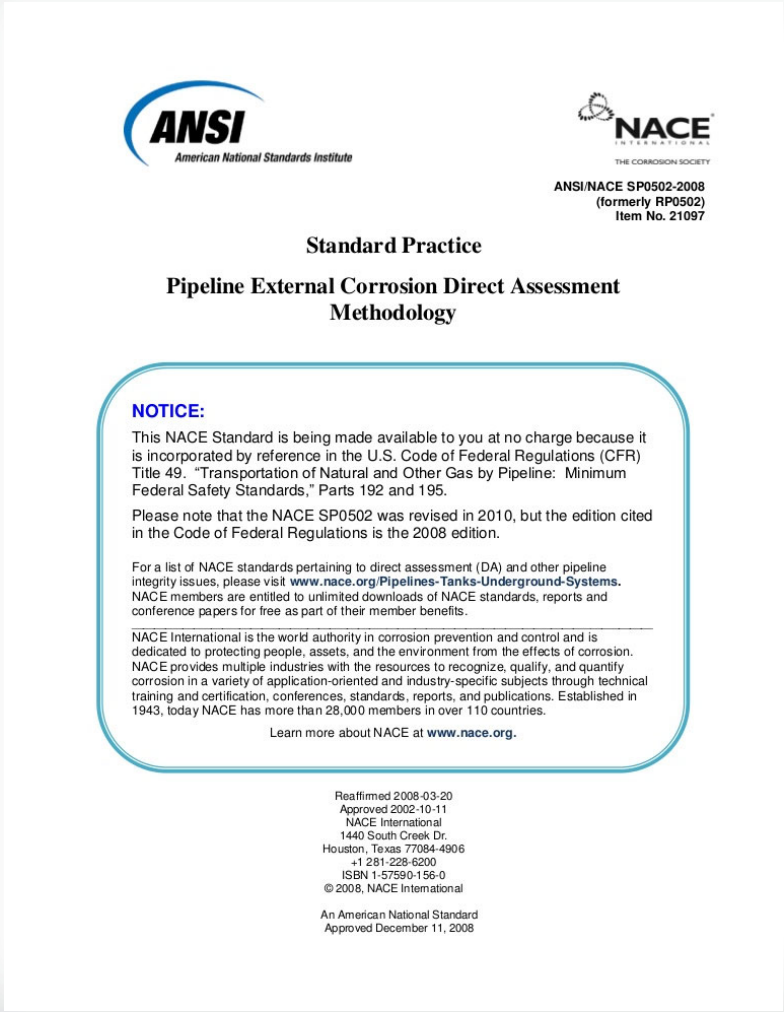
NACE Standard Practice SP0502



ANSI American National Standards Institute

NACE INTERNATIONAL THE CORROSION SOCIETY

ANSI/NACE SP0502-2008
(formerly RP0502)
Item No. 21097

Standard Practice

Pipeline External Corrosion Direct Assessment Methodology

NOTICE:

This NACE Standard is being made available to you at no charge because it is incorporated by reference in the U.S. Code of Federal Regulations (CFR) Title 49. "Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards," Parts 192 and 195.

Please note that the NACE SP0502 was revised in 2010, but the edition cited in the Code of Federal Regulations is the 2008 edition.

For a list of NACE standards pertaining to direct assessment (DA) and other pipeline integrity issues, please visit **www.nace.org/Pipelines-Tanks-Underground-Systems.** NACE members are entitled to unlimited downloads of NACE standards, reports and conference papers for free as part of their member benefits.

NACE International is the world authority in corrosion prevention and control and is dedicated to protecting people, assets, and the environment from the effects of corrosion. NACE provides multiple industries with the resources to recognize, qualify, and quantify corrosion in a variety of application-oriented and industry-specific subjects through technical training and certification, conferences, standards, reports, and publications. Established in 1943, today NACE has more than 28,000 members in over 110 countries.

Learn more about NACE at **www.nace.org.**

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An American National Standard
Approved December 11, 2008

- **NACE Standard Practice SP0502 provides a methodology for applying the ECDA process to buried onshore piping systems**
- **ECDA is a four-step process:**
  - **Pre-assessment**
  - **Indirect Inspection**
  - **Direct examination**
  - **Post Assessment**

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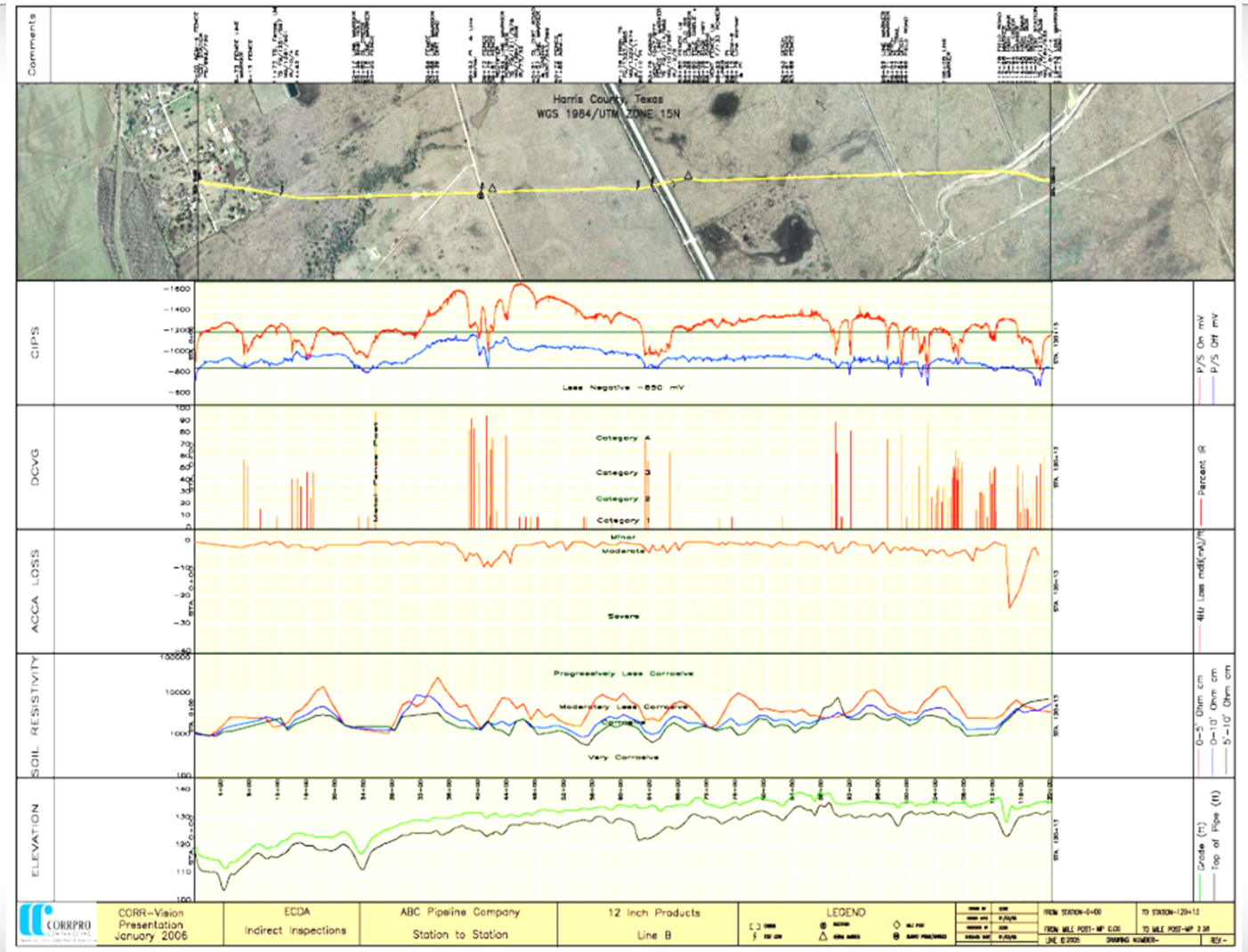
ECDA Limitations

The ECDA process may not be applicable on pipelines:

- **With disbonded coating**
- **Ground surfaces such as pavement, frozen ground, and reinforced concrete**
- **Where measurements can not be done in a reasonable time frame**
- **Congested locations with adjacent buried metallic structures**

ECDA Data Presentation



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ECDA Direct Examination

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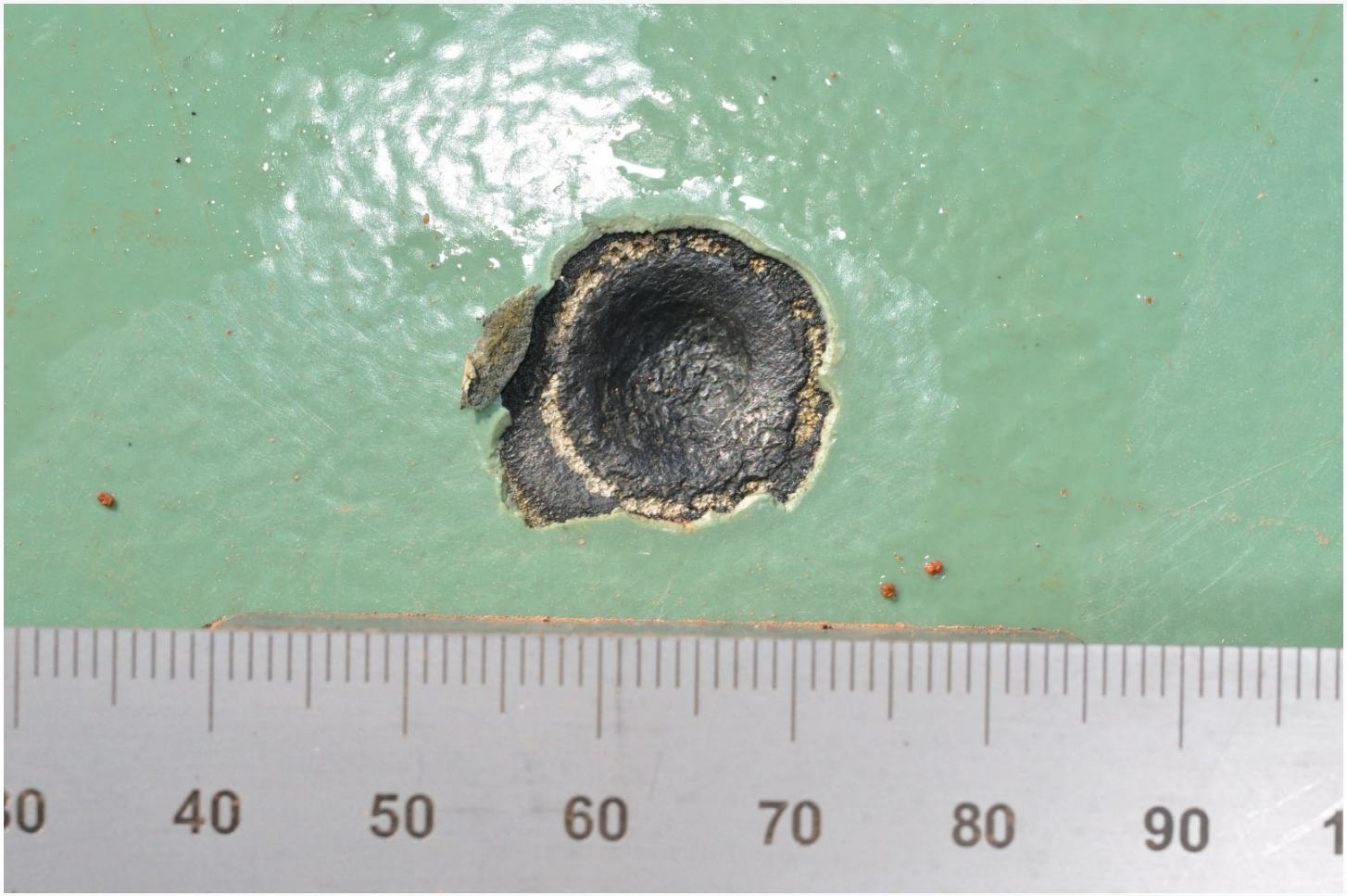
ECDA Direct Examination



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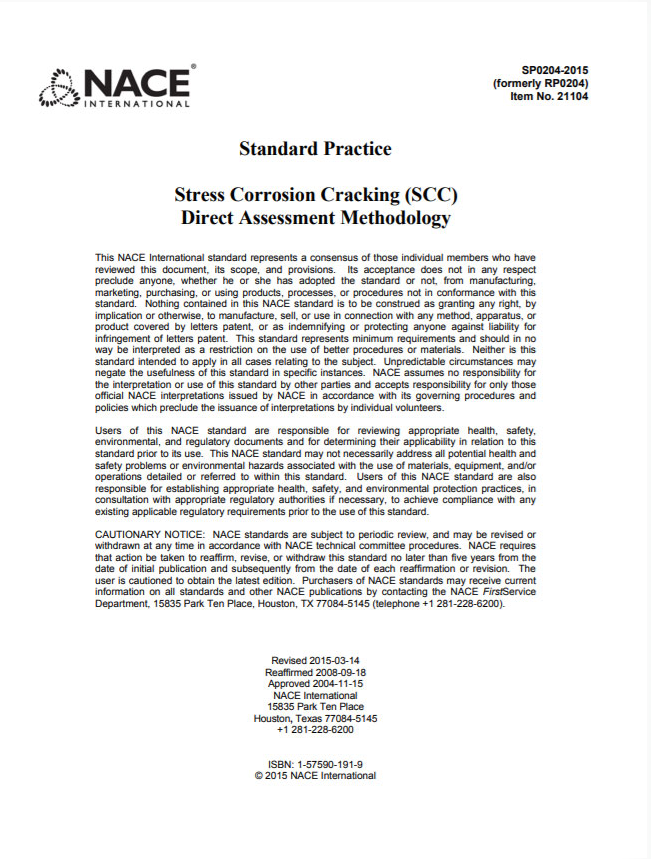
Stress Corrosion Cracking Direct Assessment (SCCDA)

SCCDA Indirect Inspection Tools

- Pipe locate and depth-of-cover – AC Current Attenuation (PCM)
- Pipe elevation (sub-meter or sub-foot GPS) for slope magnitude (steep, gentle, flat) and locations on slopes (bottom or top)
- Environment – soil characteristics, drainage and soil resistivity
- Coating defects (DCVG) and cathodic protection deficiencies (CIS)
- In-line inspection information for stress risers (mechanical damage) and appurtenances (bends, river weights, attachments) – ILI may also provide much of above information (GPS, elevation and defects associated with SCC)



NACE INTERNATIONAL

SP0204-2015
(formerly RP0204)
Item No. 21104

Standard Practice

Stress Corrosion Cracking (SCC)
Direct Assessment Methodology

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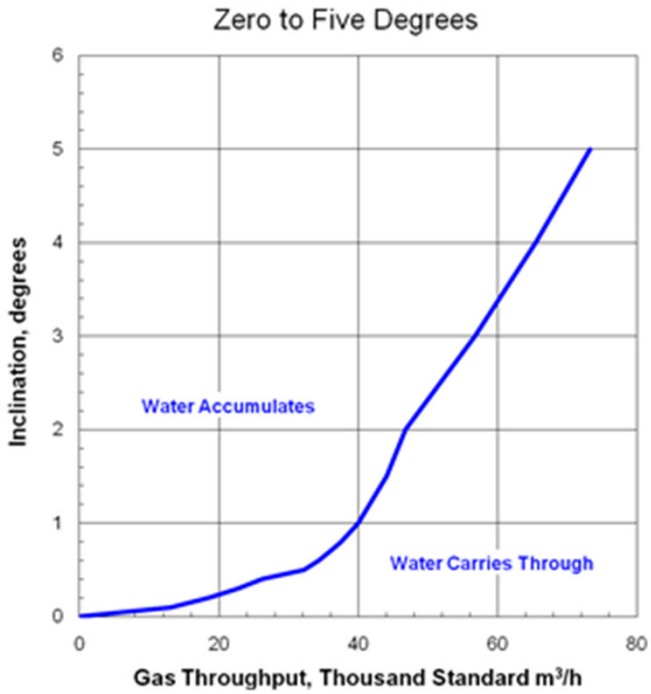
Stress Corrosion Cracking Direct Assessment (SCCDA)

Internal Corrosion Direct Assessment (ICDA)

What is Internal Corrosion Direct Assessment (ICDA)?

- A structured process to improve safety and reduce the impact of internal corrosion on buried pipelines
- Anticipates future pipeline defects, as well as detecting existing defects



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Internal Corrosion Direct Assessment (ICDA)

ICDA Indirect Tools

- NACE SP0110-2010 (WG-ICDA)

  Wet Gas Internal Corrosion Direct Assessment Methodology for Pipelines

- NACE SP0116-2016 (MP-ICDA)

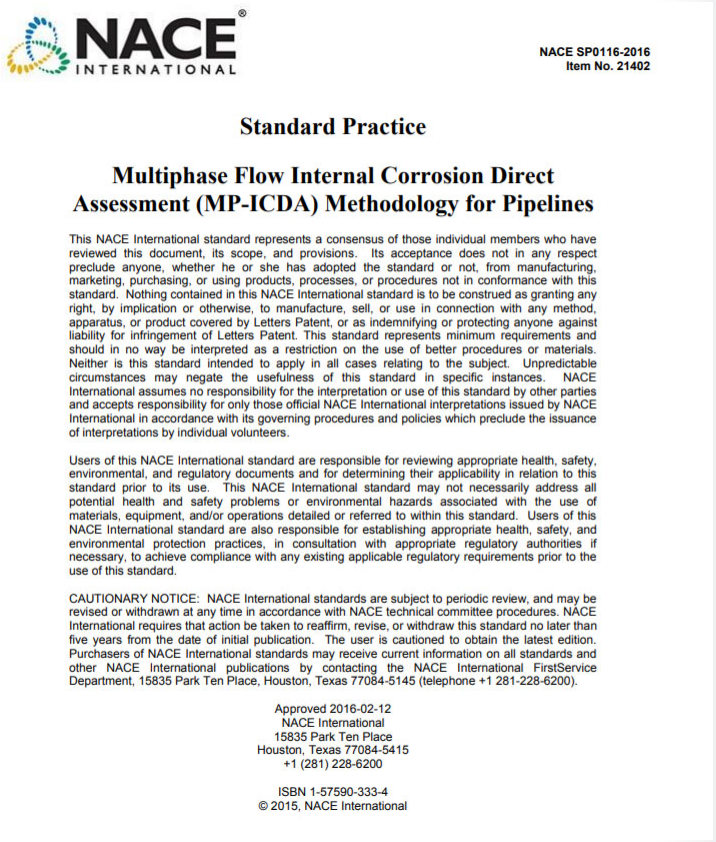
  Multiphase Flow Internal Corrosion Direct Assessment Methodology for Pipelines

- NACE SP0206-2016 (DG-ICDA)

  Internal Corrosion Direct Assessment Methodology for Pipelines Carrying Normally Dry Natural Gas

- NACE SP0208-2006

  Internal Corrosion Direct Assessment Methodology for Liquid Petroleum Pipelines



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NACE SP0116-2016
Item No. 21402

Standard Practice

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

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Internal Corrosion Direct Assessment (ICDA) (§192.927)

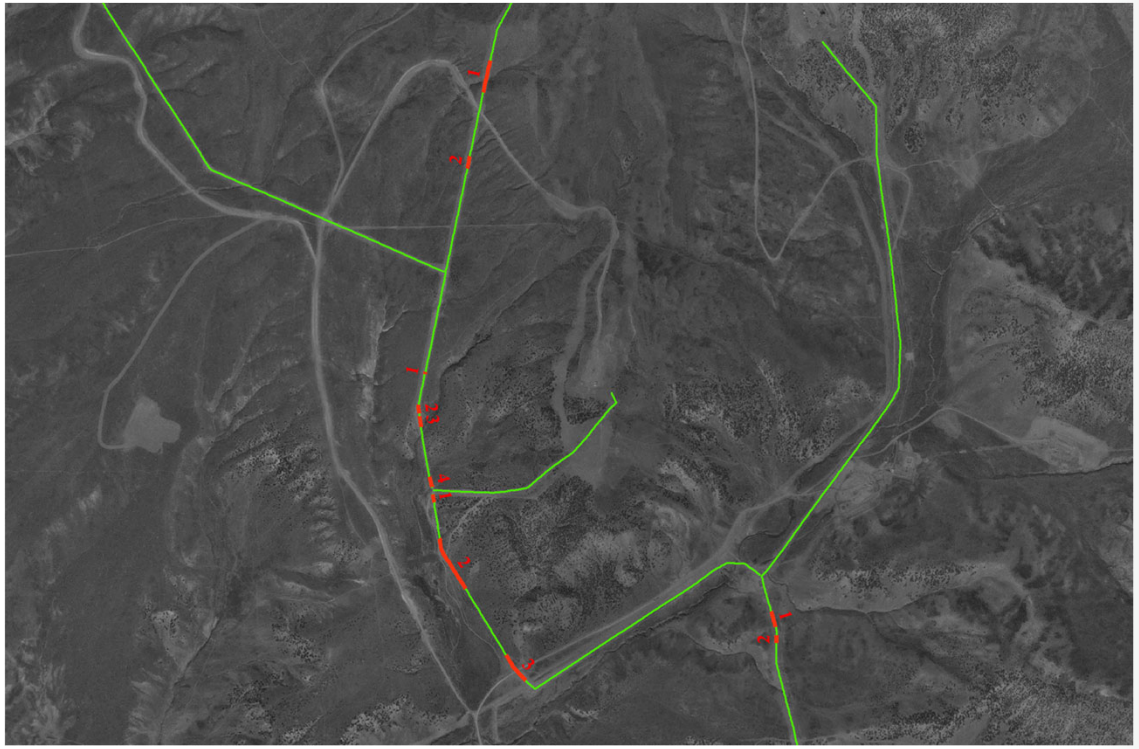
- Identify Areas Where Water or Other Electrolyte may Accumulate Inside Pipeline
- Focuses Direct Examination Where Internal Corrosion Most Likely
- Four Step Process
  - Pre-Assessment
  - ICDA Region Identification
  - Identify Excavation Locations and Perform Direct Examinations
  - Post Assessment
- In Addition, Rule Requires ICDA Plan to Include:
  - Criteria for Making Key Decisions for Each Step of Process
  - Provisions for More Restrictive Criteria for First Use
  - Provision for Analysis of Entire Pipeline, Except Remediation Limited to Covered Segments

ICDA Step 1 – Pre-Assessment

- Gather and Integrate Data and Information to:
  - Evaluate Feasibility of ICDA for Covered Segment
  - Support Use of Model to Determine Where Electrolyte may Accumulate
  - Identify ICDA Regions
  - Identify Areas Where Liquids may be Entrained
- Data and Information to Include:
  - All Data Elements of B31.8S Appendix A2 (physical and historical operating data)
  - Information for Model (gas input and withdrawal points, low points, elevation profile, etc.)
  - Operating Data Regarding Historic Upsets
  - Scraper or ILI Use

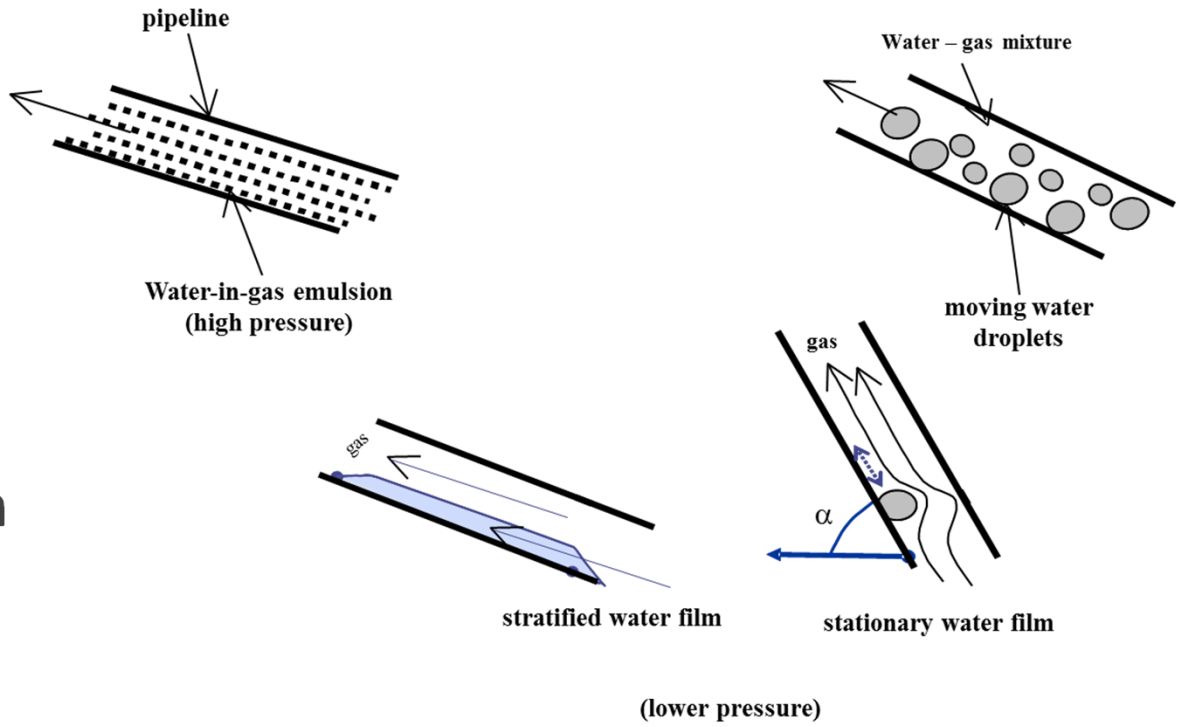
ICDA Step 2 – Region Identification

- Region Extends From Where Liquid May Enter and Encompasses Area Along Pipeline Where Internal Corrosion May Occur
- Region May Encompass More Than One Covered Segment
- Must Use GRI 02/0057 Model to Identify Regions (unless operator demonstrates another model equivalent)



ICDA Step 3 – Flow Simulations

- Develop Digital Elevation Model
- Assess Inclination Angle and Identify Critical Elevation Changes
- Identify Areas with Water Hold-Up
- Evaluate Water Residence Times



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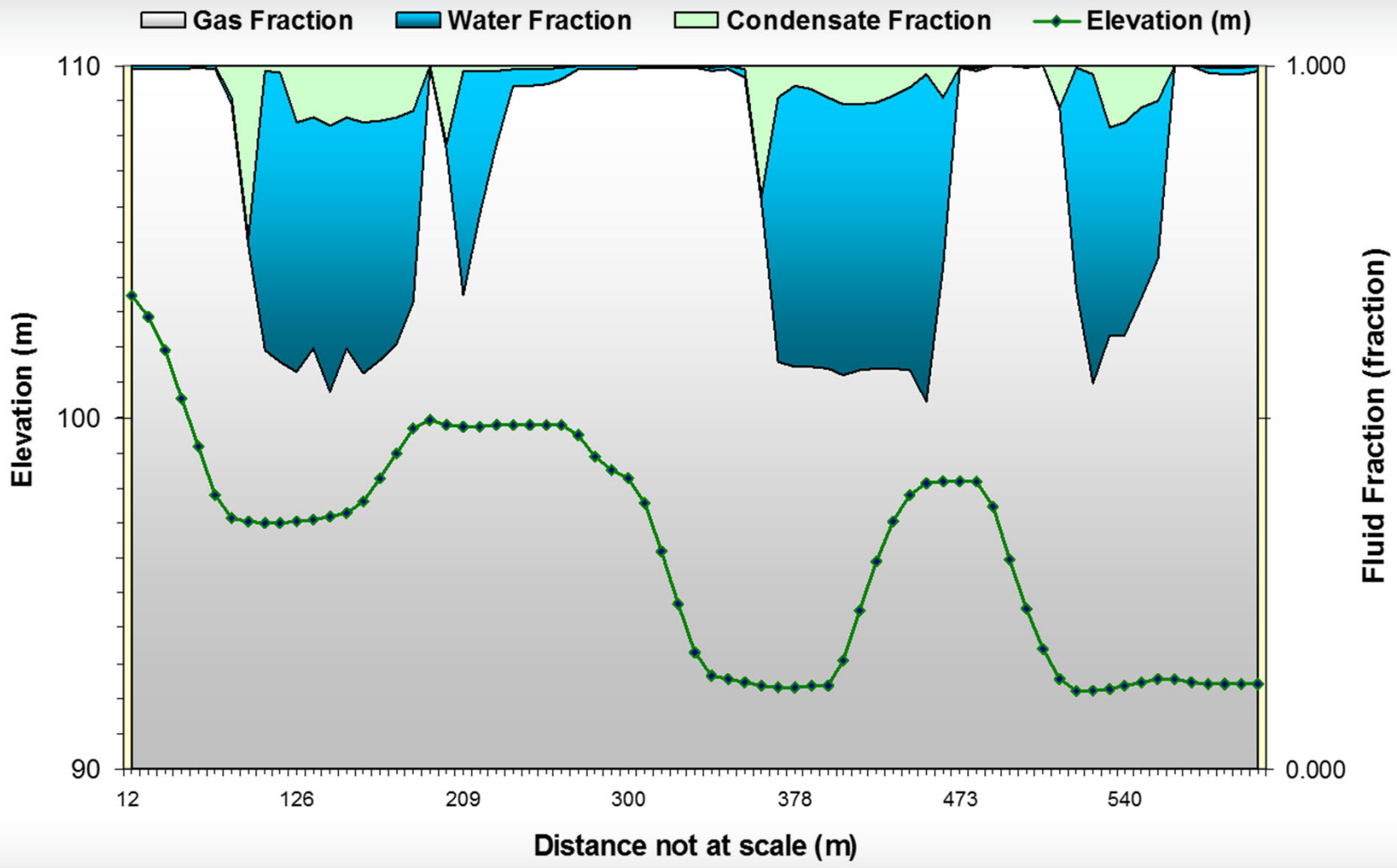
ICDA Step 3 – Dynamic Analysis



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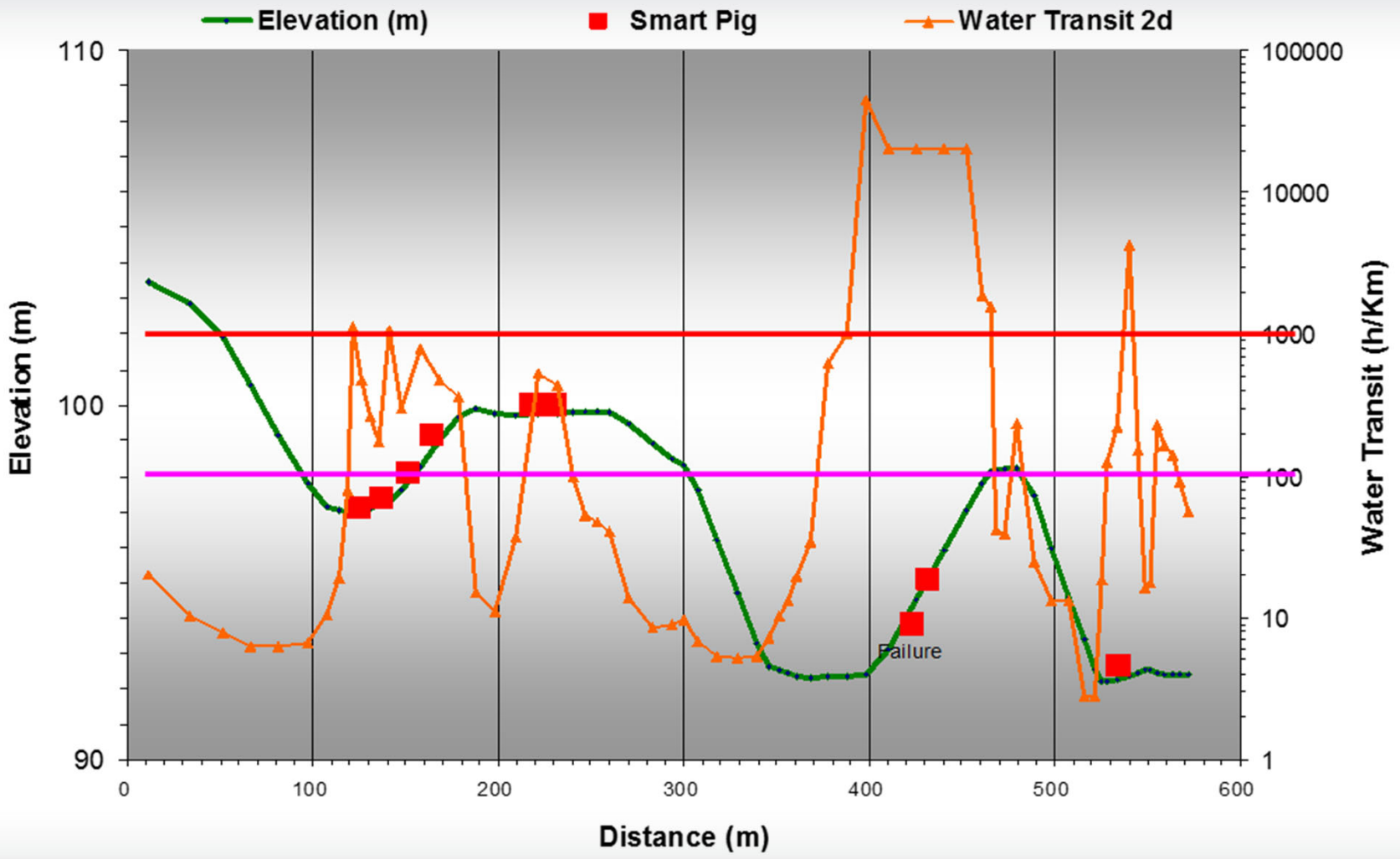
ICDA Step 3 – Identify Transit Profile



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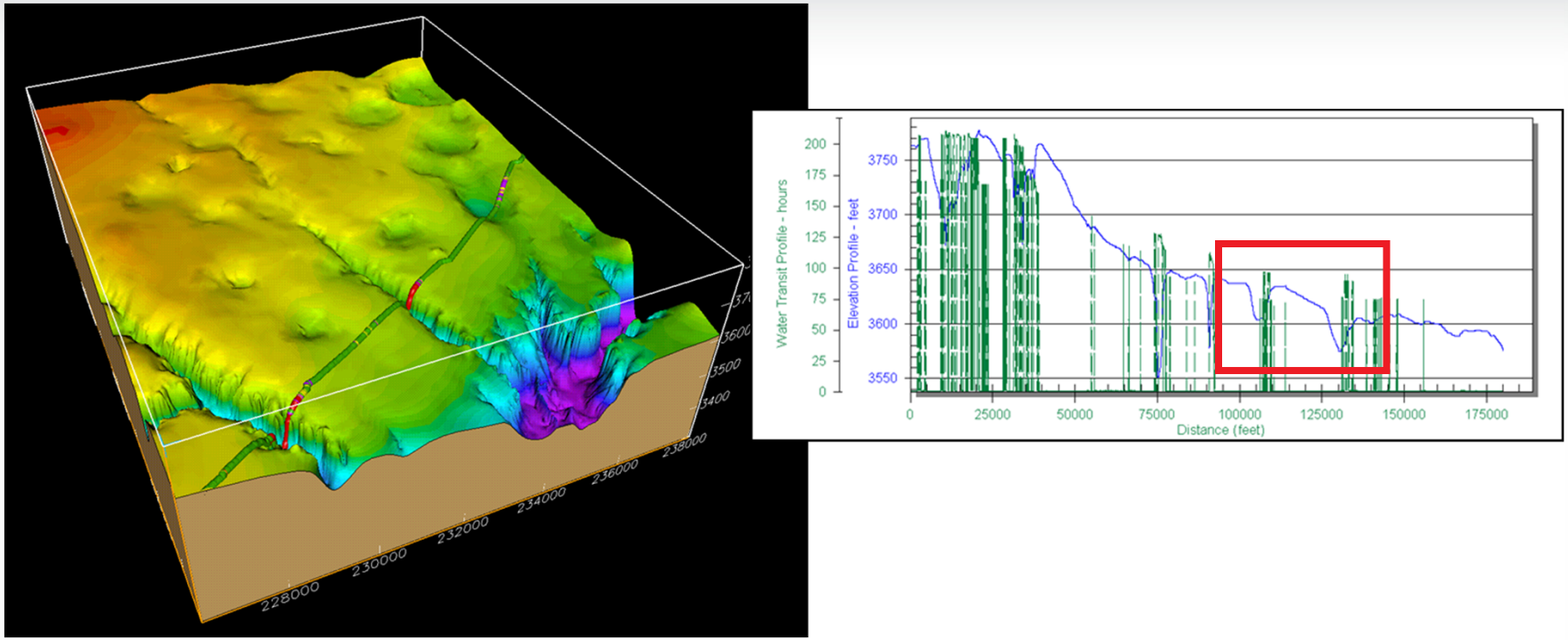
ICDA Step 3 – Identify Excavation Locations



- Identify Two Locations Within Each ICDA Region
  - One at Low Point Nearest Beginning
  - A Second Location Further Downstream Near the End of ICDA Region

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ICDA Step 3 – Perform Direct Examinations

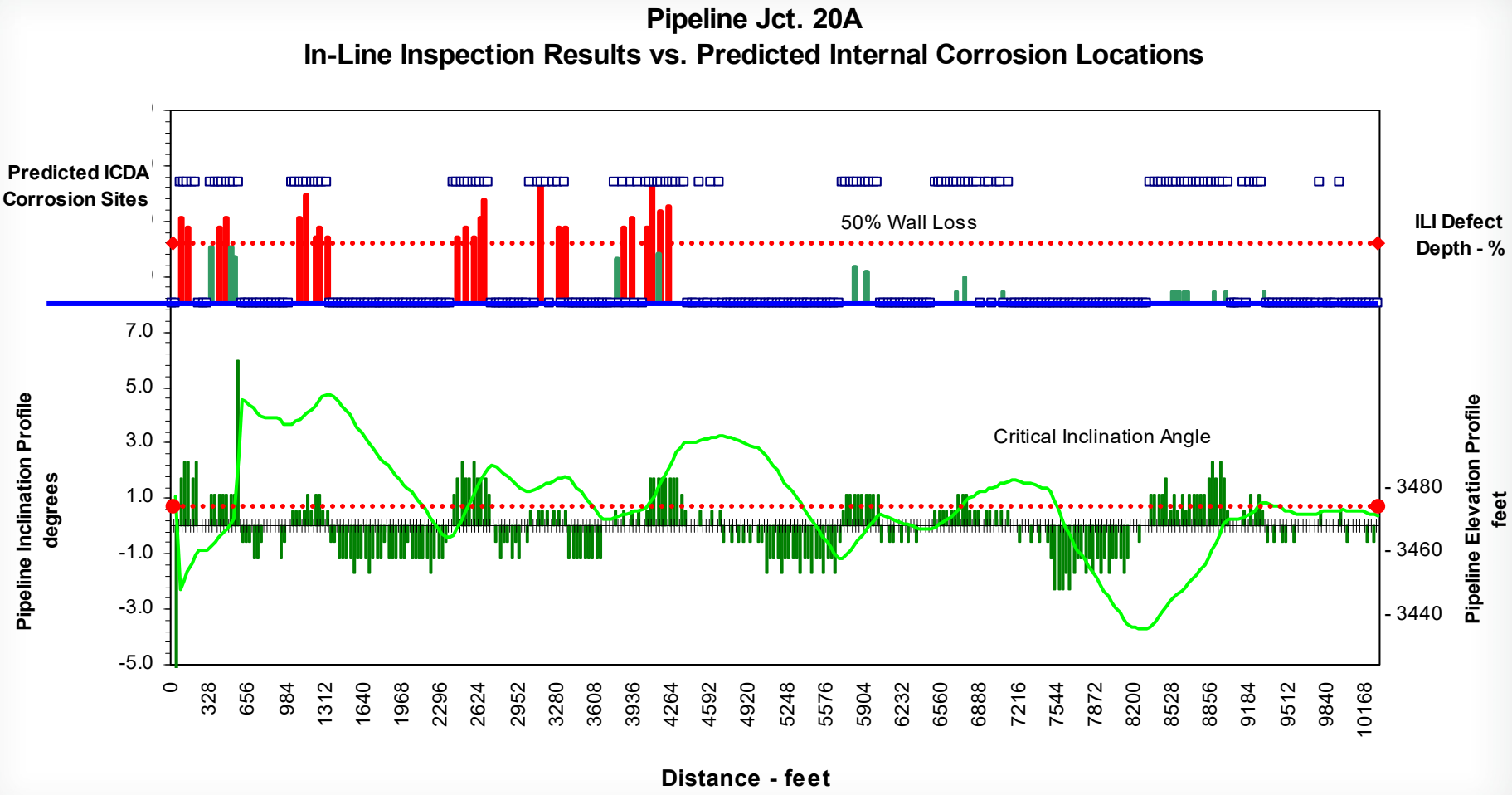
- Dig All Locations Identified and Perform Direct Examination (ultrasonic, radiography or other)
- If Corrosion is Found, Must:
  - Evaluate Severity and Remediate
  - Either Perform Additional Digs or Use Another Assessment Method in Region
  - Evaluate Potential for Internal Corrosion in Covered and Non-Covered Segments with Similar Characteristics and Remediate as Needed

ICDA Step 4 – Post-Assessment

0-5 Low risk 6-10 Moderate risk 11-15 High risk 16-25 Unacceptable	Minor injury, insignificant property or equipment damage 1	Non-reportable injury, minor loss of process or slight property damage 2	Reportable injury, moderate loss of process, limited property damage 3	Major injury, single fatality, critical process loss, critical property damage 4	Multiple fatalities, catastrophic business loss 5
5 Near certain	5	10	15	20	25
4 Probable	4	8	12	16	20
3 Possible	3	6	9	12	15
2 Unlikely	2	4	6	8	10
1 Remote	1	2	3	4	5

- Evaluate Effectiveness of ICDA Method
- Detailed Route Cause Analysis
- Update Pipeline Risk Assessment
- Adjust Inspection Strategy
- Continue to Monitor Each Segment Where Internal Corrosion Identified
  - UT Sensors or Electronic Probes
  - Analysis of Liquids
- Determine Reinspection Interval

ICDA Step 4 – Post-Assessment



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Thank You

Thank you for your participation!