# Kinder Morgan Inline Inspection Process

**PHMSA Voluntary Information-Sharing System Working Group**

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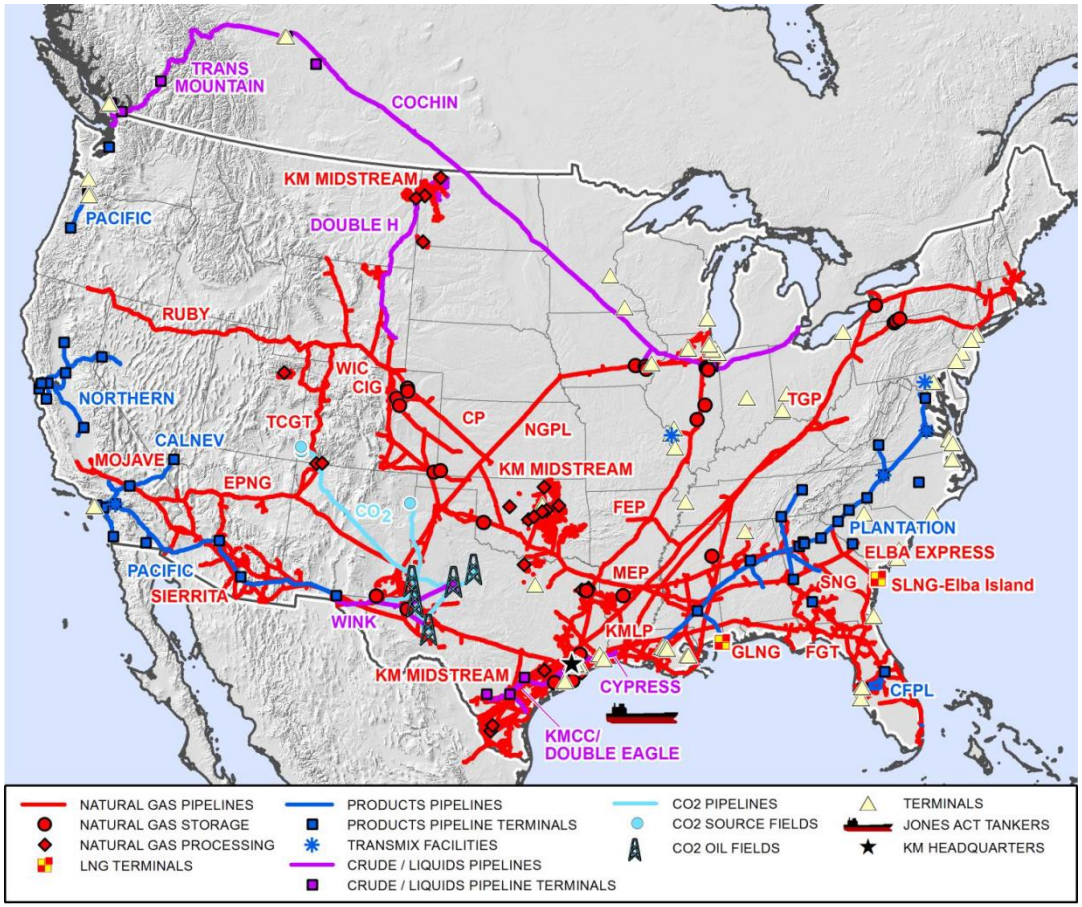
# Overview of Kinder Morgan

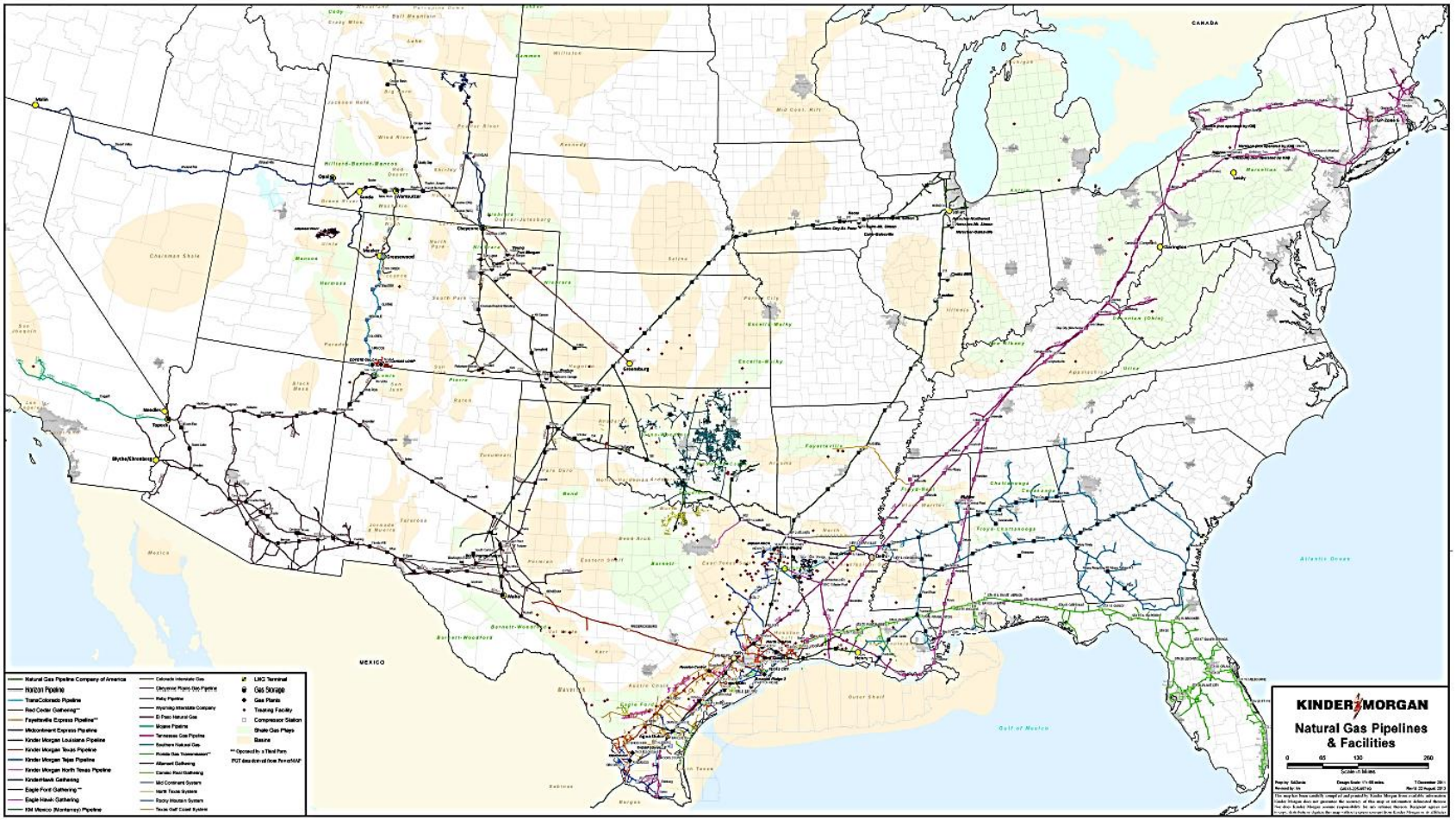
Five business units

- Natural Gas Pipelines
- Products Pipelines
- $CO_2$ Pipelines
- Terminals
- KM Canada




KINDER MORGAN

# Kinder Morgan Natural Gas Pipelines



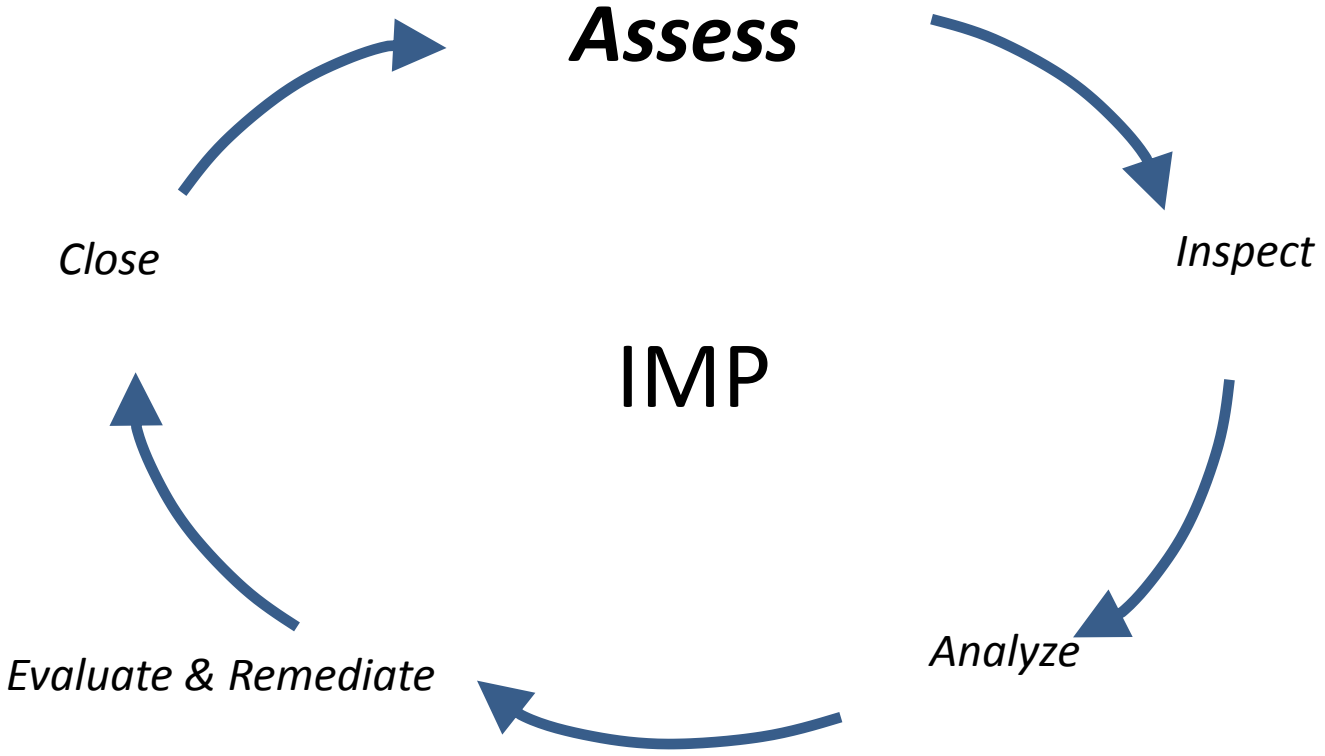
# Overview of Kinder Morgan

- Natural gas pipelines business unit
  - More than 60,000 miles of natural gas pipelines operated
  - 3,372 HCAs (2,195 miles) in 2016
  - 160 to 200 ILI segments/year typically with multiple ILI technologies (6,000-8,000 miles/year of pipeline assessed)

# Overview of Kinder Morgan

- Scope requires robust company standards and processes
  - Overarching ILI Procedure
  - ILI Service Provider Customer Profiles
  - Company Analysts Work Instructions
  - In-field anomaly assessment and response
  - Data processes

# ILI Life Cycle



# Risk Assessment

- Drives Integrity Assessment Method
- Assessment Tools
  - Internal inspection
  - Pressure test
  - Direct Assessment
  - Other
- ASME B31.8S and 49 CFR 192 Subpart O define threats and assessment tools
- ILI Tool Technology Selection
  - Guidance in Subpart O, B31.8S

# 22 Root Cause Threats

A. Time Dependent
   1) External corrosion
   2) Internal corrosion
   3) Stress-corrosion cracking

B. Stable
   1) Manufacturing-related defects
      a) Defective pipe seam
      b) Defective pipe
   2) Welding/fabrication related
      a) Defective pipe girth weld (circumferential) including branch and T joints
      b) Defective fabrication weld
      c) Wrinkle bend or buckle
      d) Stripped threads/broken pipe/coupling failure
   3) Equipment
      a) Gasket O-ring failure
      b) Control/relief equipment malfunction
      c) Seal/pump packing failure
      d) Miscellaneous

C. Time Independent
   1) Third-party/mechanical damage
      a) Damage inflicted by first, second, or third parties (instantaneous/immediate failure)
      b) Previously damaged pipe (such as dents and/or gouges) (delayed failure mode)
      c) Vandalism
   2) Incorrect operational procedure
   3) Weather-related and outside force
      a) Cold weather
      b) Lightning
      c) Heavy rains or floods
      d) Earth movements

D. Other

# Vendor Selection

- Tool
  - Technologies offered
  - Tool specifications
  - Compliance with consensus standards (API 1163, ANSI ILI-PQ)
  - Tool passage capabilities (e.g. bend radius, minimum bore for heavy-wall fittings)
  - Tool velocity ranges

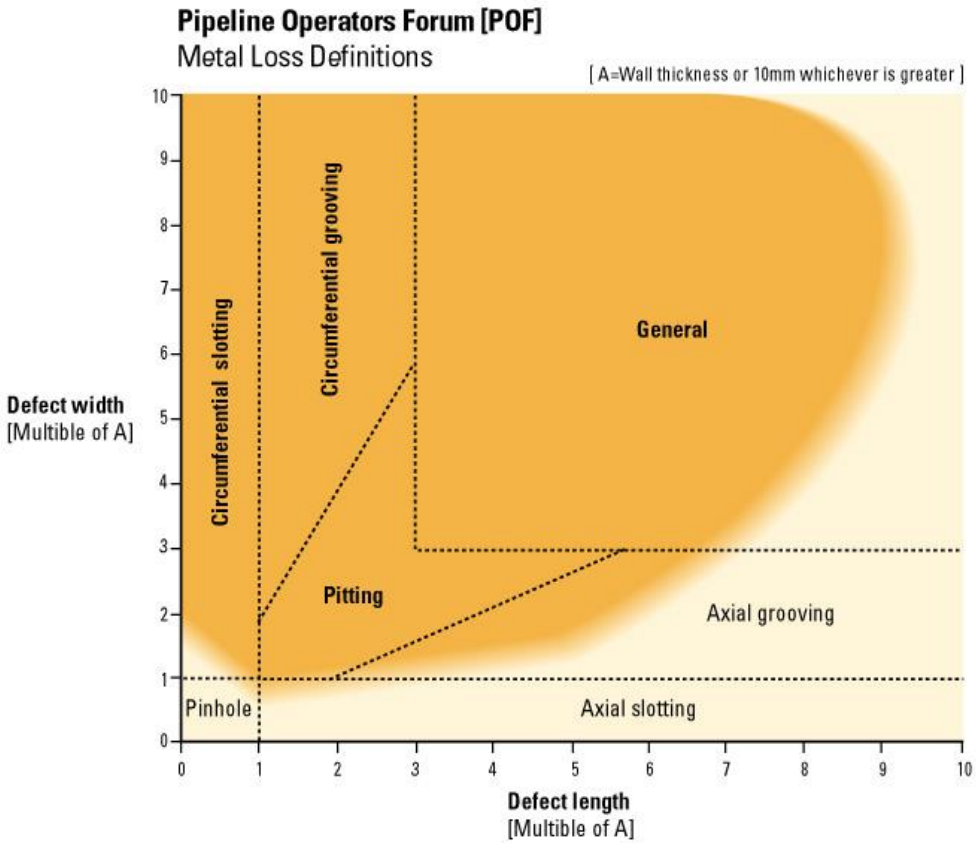
# Internal Inspection Technologies

- Cleaning tools – needed to clean the surface prior to inspection
- Gauge tools – determine if a tool can pass through the pipeline
- Geometry/caliper tools – can identify location, orientation and size of dents, deformations, and other ovality changes, as well as restrictions, bends, changes in girth welds and wall thickness and other pipeline features

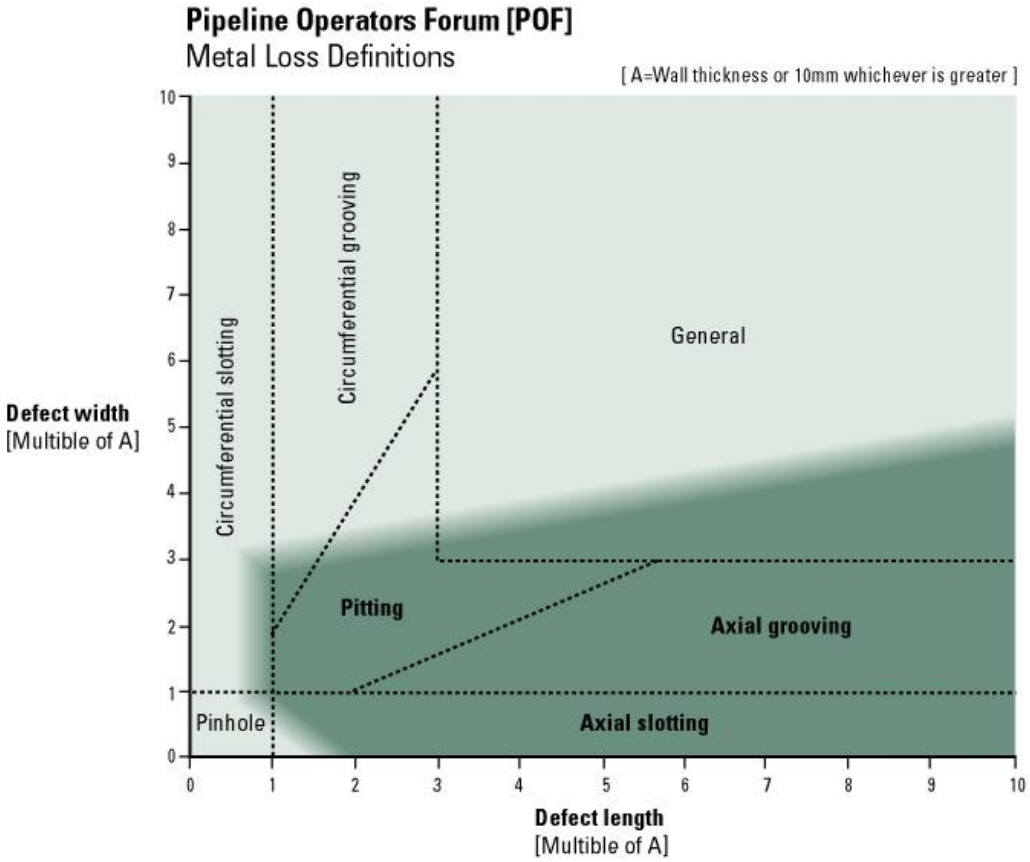
# Internal Inspection Technologies

- Metal loss tools - designed to identify metal loss, typically corrosion (internal and external)
  - Magnetic Flux Leakage (conventional MFL)
  - Compression Wave Ultrasonic (conventional UT)
- Crack tools - designed to identify linear features, typically stress-corrosion cracking or defects or corrosion in seam or girth weld
  - Electromagnetic Acoustic Transducers (EMAT)
  - Shear wave ultrasonic
  - Transverse MFL
- Inertial Mapping Unit (IMU) – designed to gather location information to precisely relocate features, can be correlated to GPS, can be used to correct mapping information and to identify pipe movement

# Corrosion and Metal Loss Characterization For MFL Tools



# Corrosion and Metal Loss Characterization For TFI Tools



# MFL Tools

# Crack Tools

# Vendor Selection

- Reporting capabilities / flexibility
  - Timing (no later than 180-days in HCAs)
  - Reporting format
  - Ability to meet company reporting requirements
  - Reliability in timing of preliminary and final reports
  - Analysis process capability, maturity, repeatability

# Vendor Selection

- Vendor performance
  - Must meet customer profile requirements
  - Tool availability
  - Flexibility in tool scheduling
  - Tool reliability (e.g. 1st-run success)

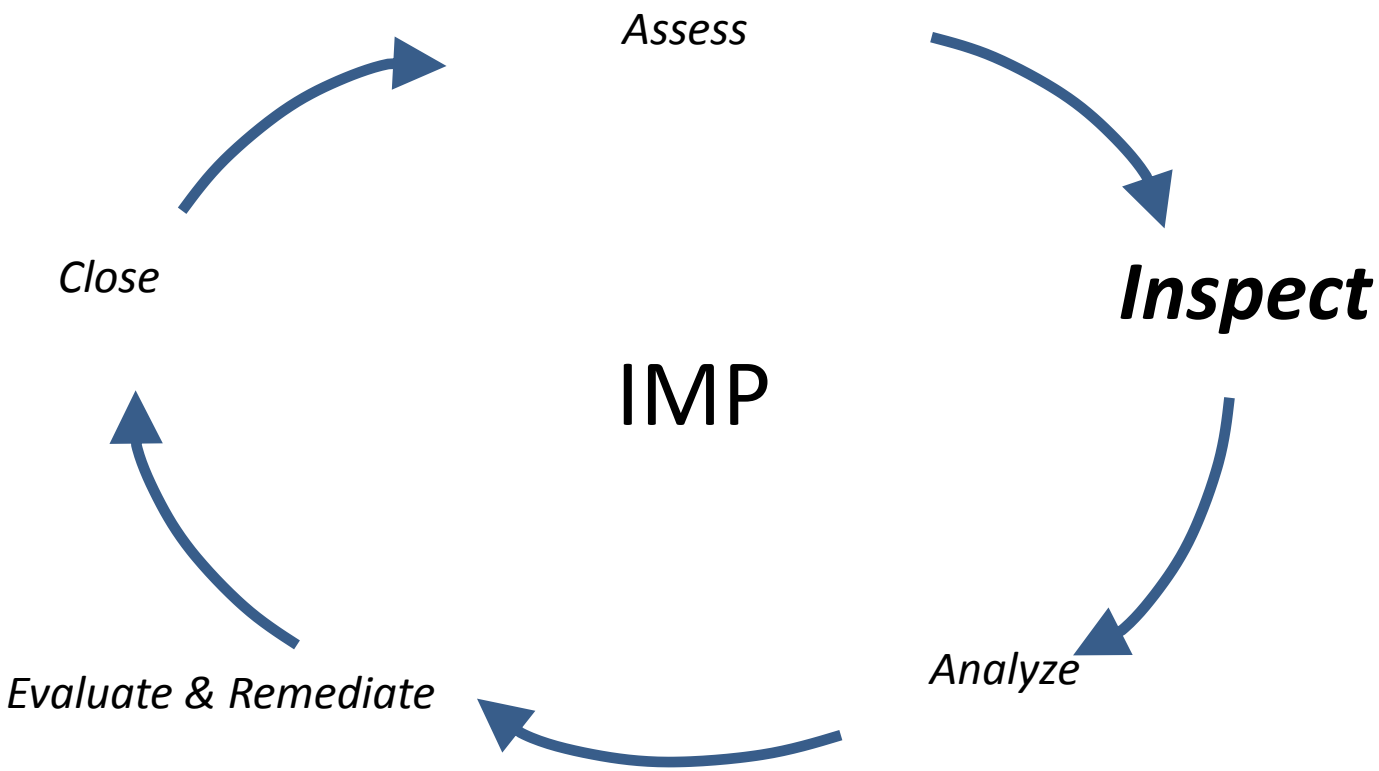
# ILI Vendor Customer Profile

- Provides for consistent results and deliverables across our system, across different tools, and multiple vendors
- Detailed analysis requirements
- Detailed reporting format requirements
- Report timing requirements

# ILI Survey Planning

- Launching, Receiving  and Handling the ILI Tool
  - Speed Control
  - Data Quality Assessment
  - EHS Considerations
  - Above Ground Markers
  - Cleaning the Pipeline

# ILI Life Cycle

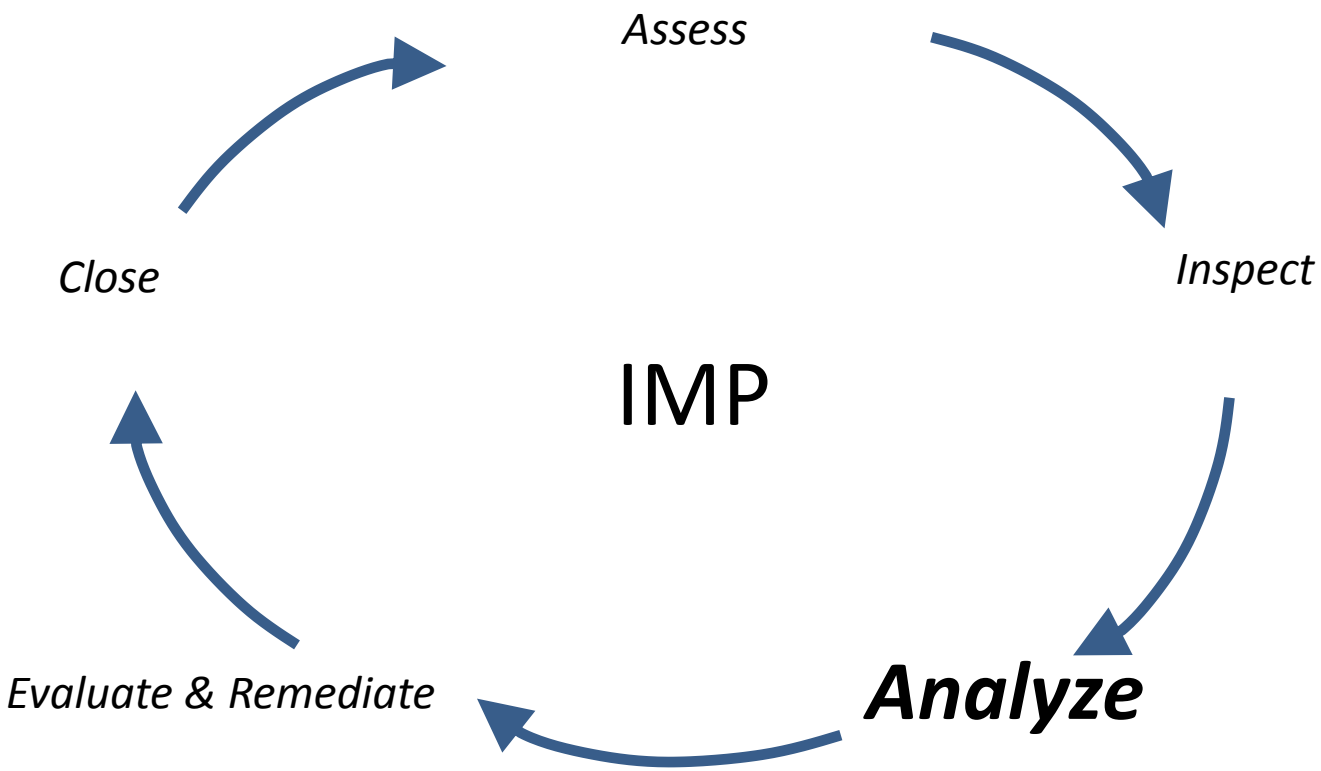


# Loading a Pig

# Data Quality Assessment Review

- Confirm data coverage
- Location of any degradation
- Quantification of degradation (e.g. can a modified specification be provided)?
- Potential cause of degradation (speed excursions in heavy-wall fittings, pipeline debris)

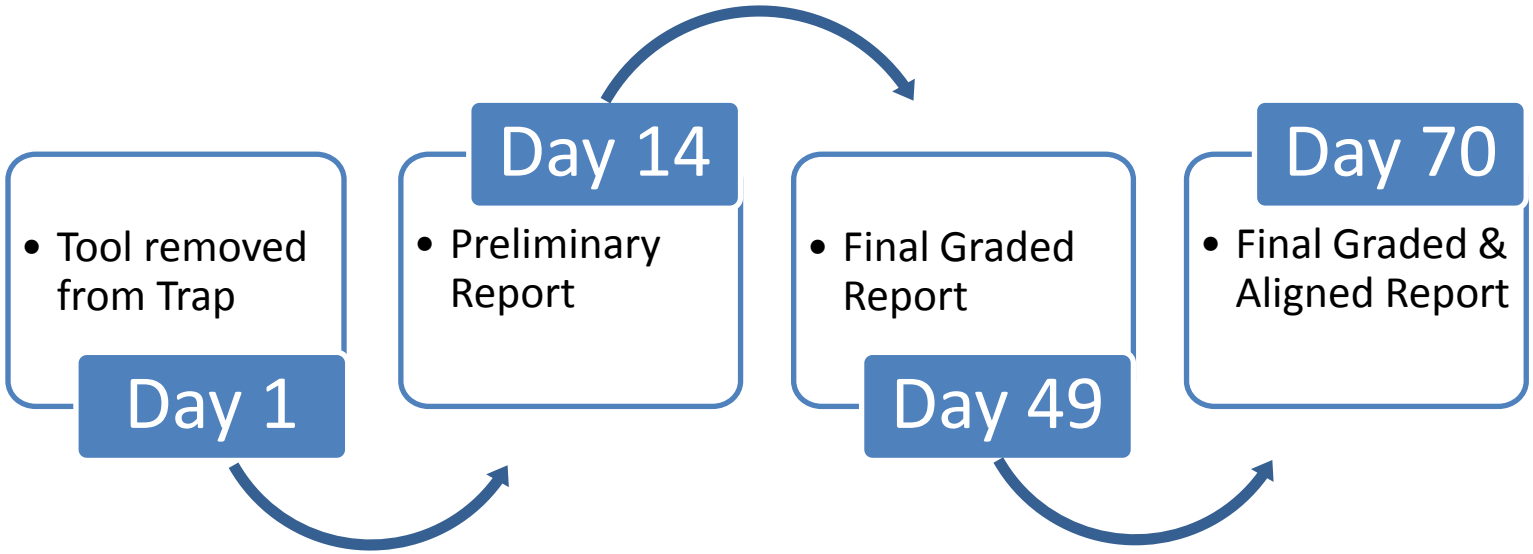
# ILI Life Cycle



# ILI Reporting

- Preliminary report
- Final Report
- Data alignment with pipeline attributes

# ILI Reporting Process (typical)



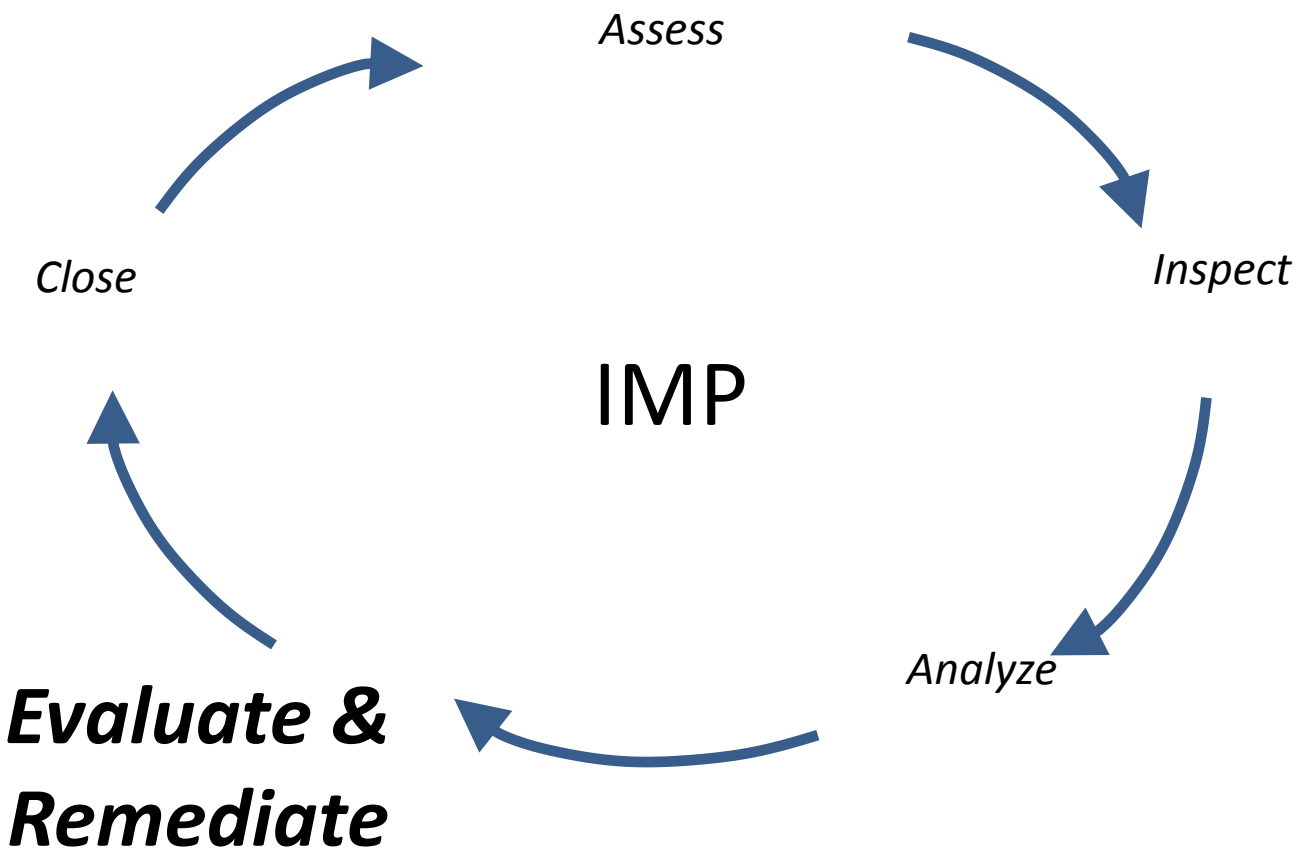
# Anomaly Response

- Identification of immediate, scheduled or monitored anomalies
- Conservative response criteria (FPR, Depth-based)
- Consideration of tool tolerance and metal loss growth information

# NDE Service Providers

- Selection and Training of NDE Personnel
  - Operator Qualification of NDE personnel
  - Training on company specific procedures
  - Knowledge testing
  - Standardized NDE personnel Field Audits

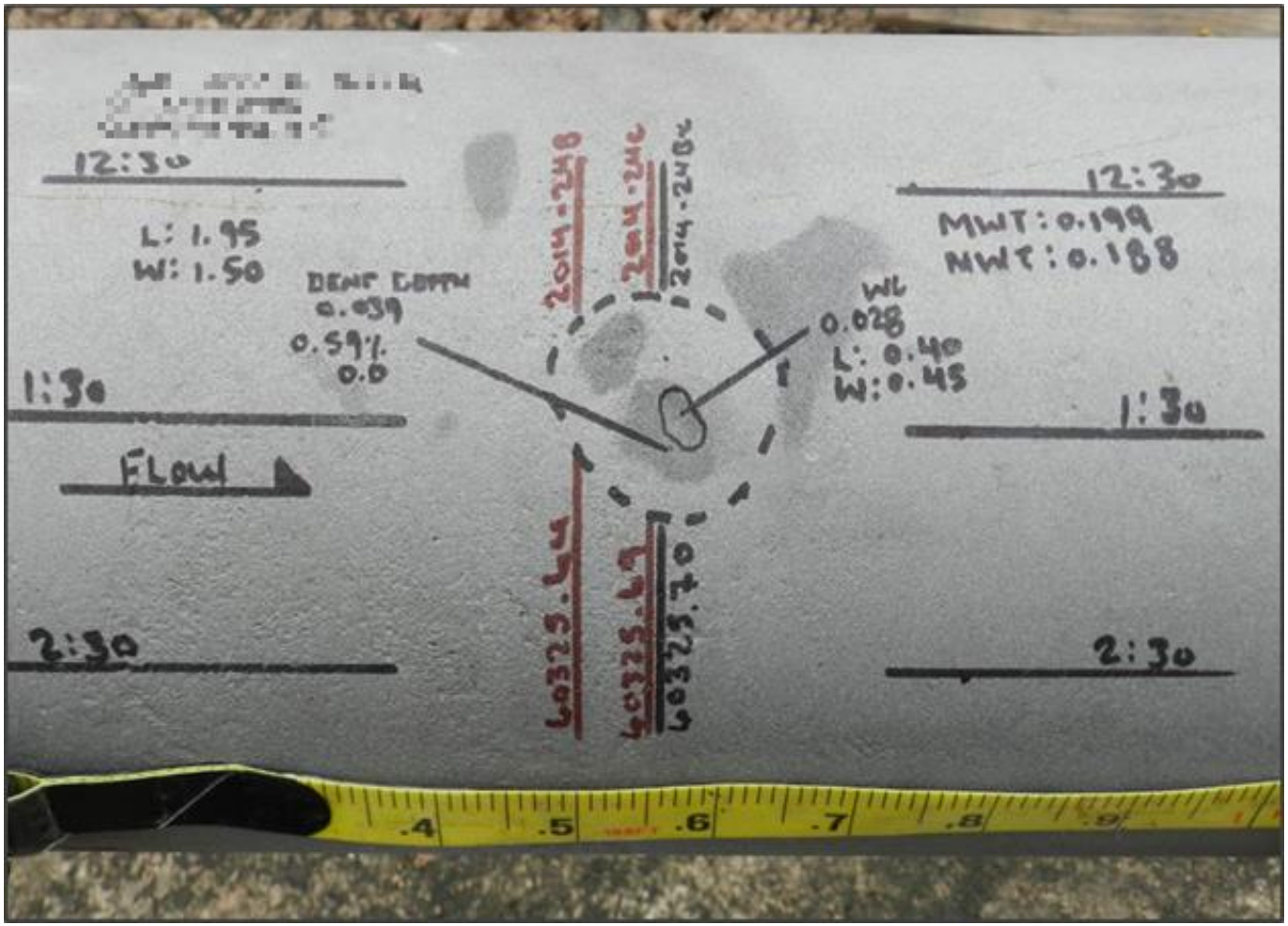
# ILI Life Cycle



# Field Anomaly Evaluation

- Robust Procedures
- Use of advanced technologies
- Conservative response criteria

# Field Anomaly Documentation



# Field Documentation Review Highlights

- Electronic Reporting Tool
- Draft form is sent by NDE technician to the vendor's QA/QC for review, then sent back to KM for QA/QC review, then back to Vendor to update and back to KM to finalize
- Confirmation of proper remediation
- Data is available in a database and GIS

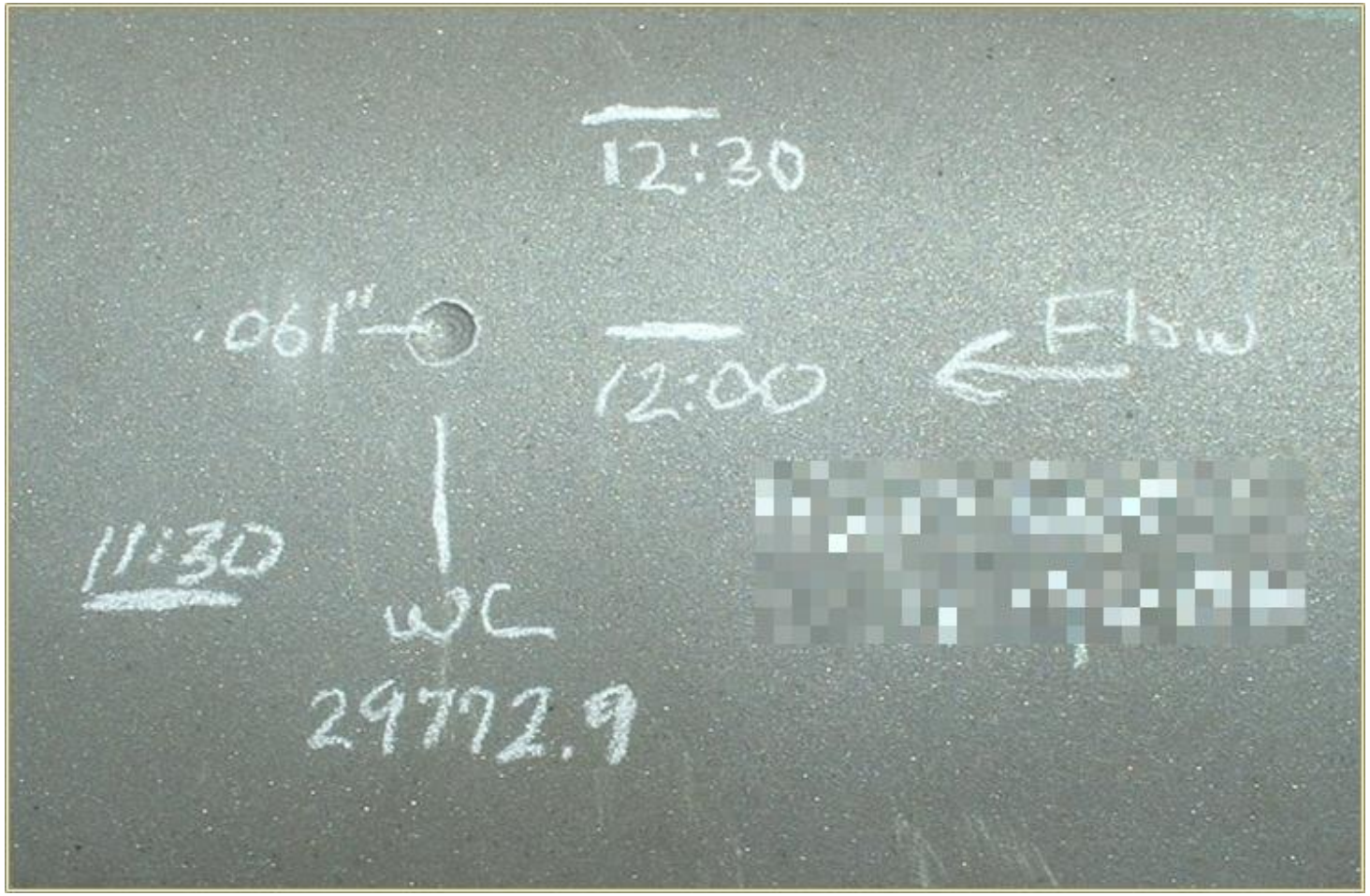
# Root Cause Analysis

- The data collected at each dig is designed to provide sufficient information to determine the root cause of the anomaly, for example:
  - Pipe-to-soil potentials (both AC and DC) at anomaly
  - Examination of coating prior to removal
  - Soil resistivity at pipe depth
  - pH under coating
  - Magnetic particle inspection
  - X-ray (for internal indications)

# Root Cause Analysis

- The root cause of the anomaly is identified, for example:
  - External corrosion – shielding coating
  - External corrosion – AC stray current
  - Metal loss – manufacturing defect
  - Internal corrosion
  - Near-neutral pH or high-pH SCC

# Induced AC Corrosion



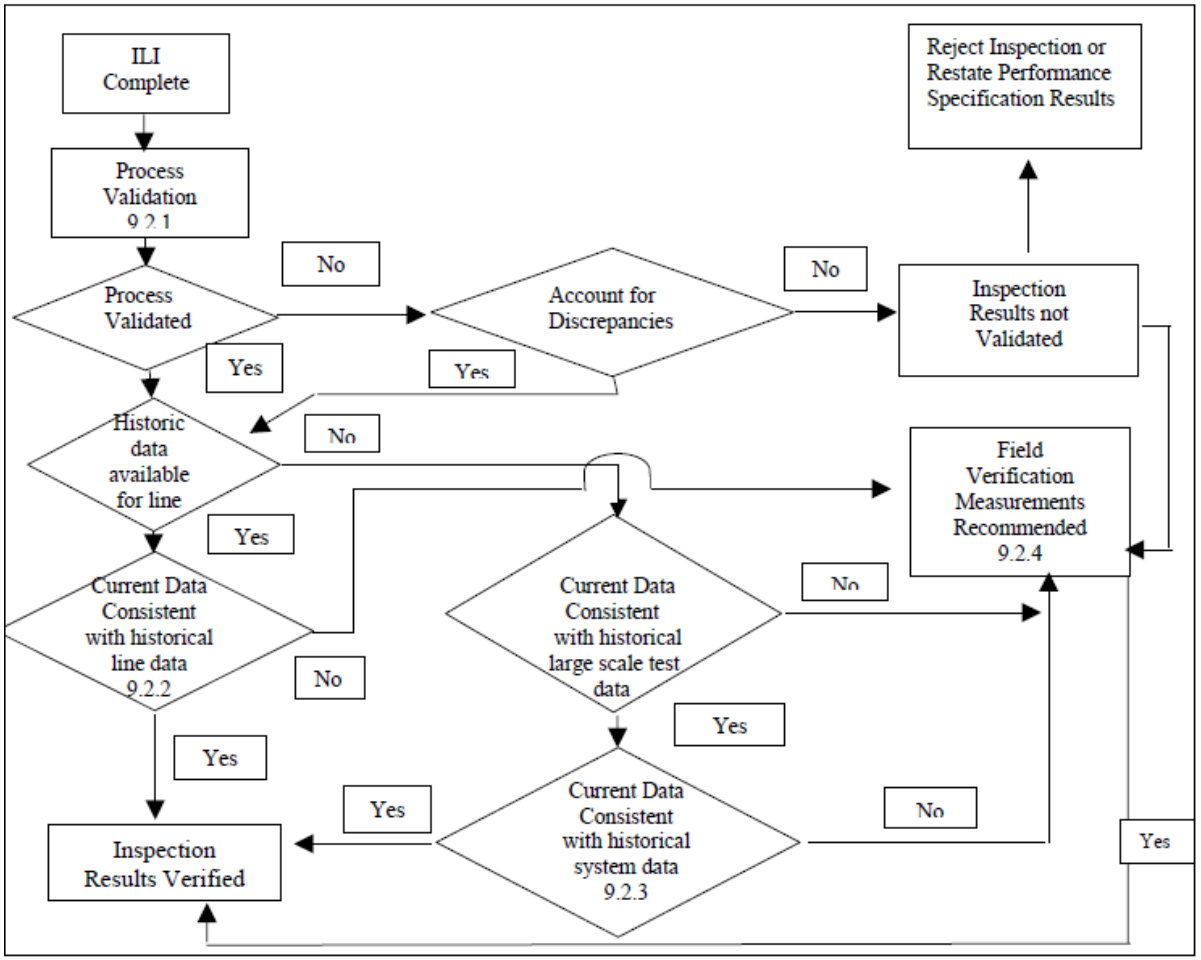
# Review of NDE Performance Metrics

- Minimum Annual Review
- More frequent review if needed (identification of concerns by company QA personnel)
- Weighted report quality by vendor and technician
- Timing

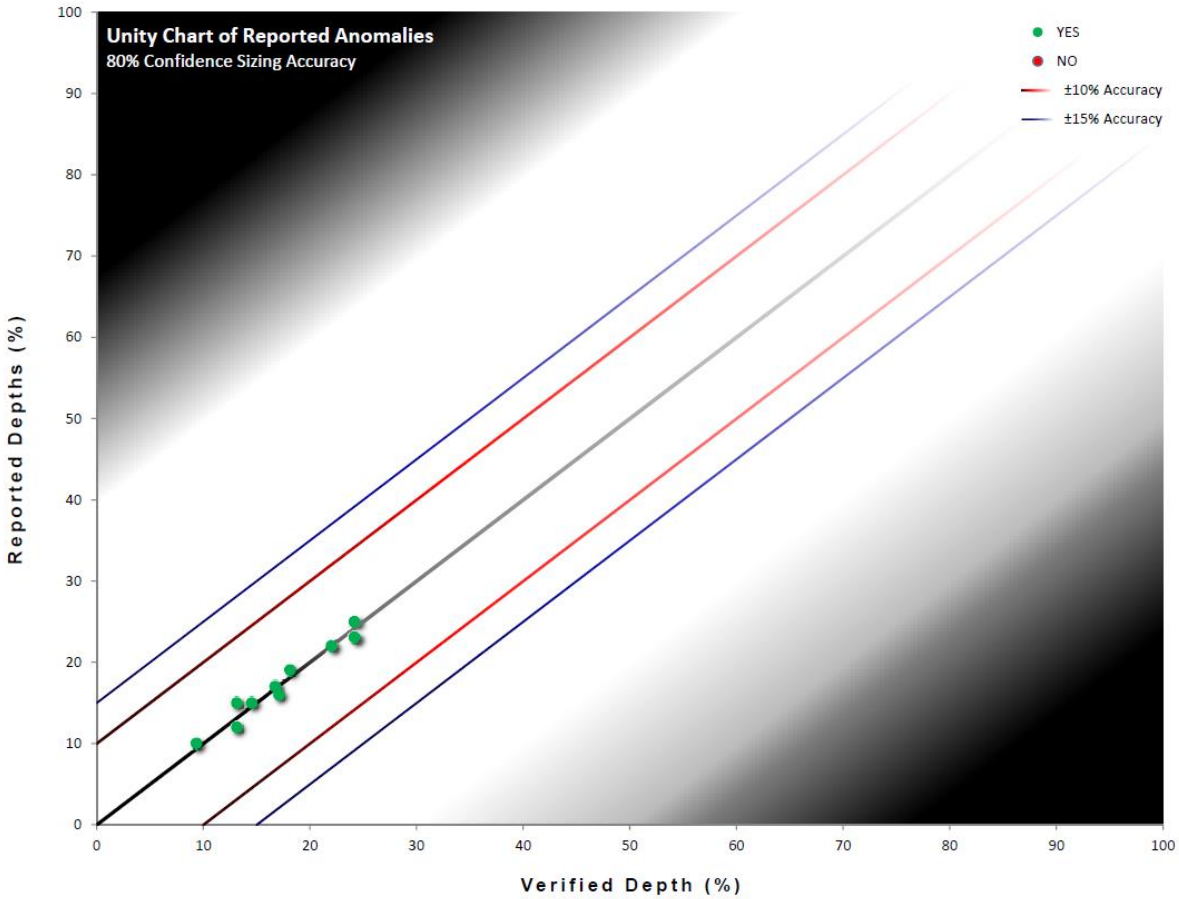
# Validation of Results

- API 1163-based Process
  - Systems Qualification Process
  - In-line Inspection System Selection
  - Qualification of Performance Specifications
  - System Operational Validation
  - System Results Verification
  - Reporting Requirements
  - Quality Management System

# API 1163 System Verification Process



# Unity Plot

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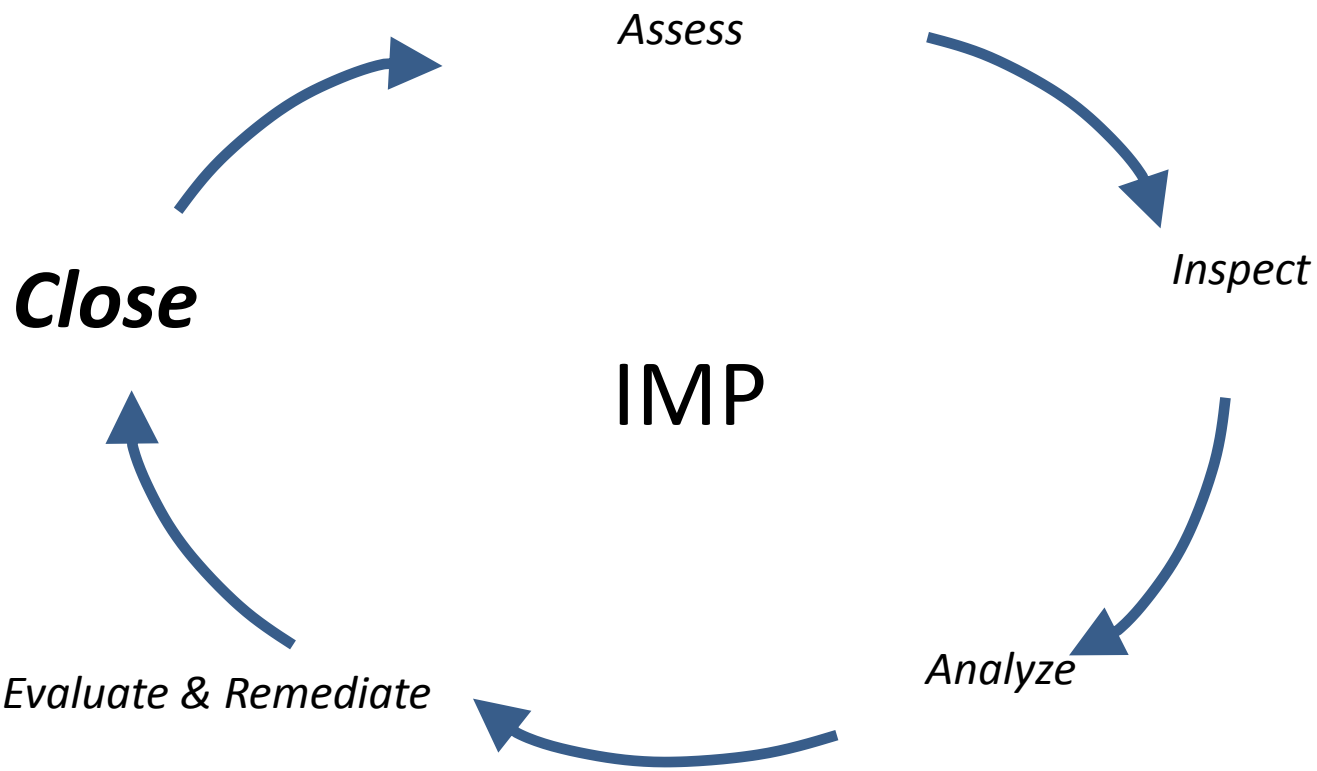
# ILI Life Cycle



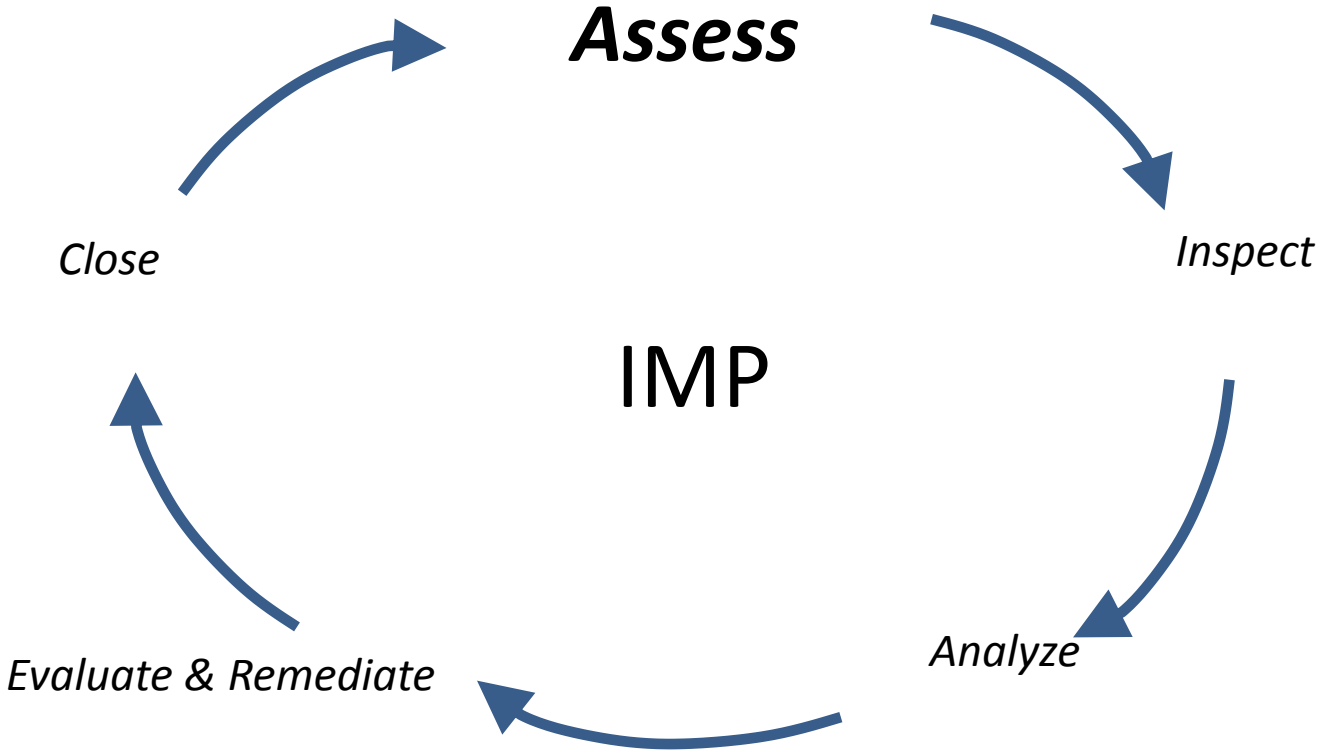
# Project Closure

- Closure report documenting completion of required anomaly digs

# Data Process

- ILI data goes into KM's GIS system
- Centerline updated by data from IMU
- Data is leveraged by additional processes
  - Cathodic protection assessments
  - Shorted casing reviews
  - Internal corrosion monitoring and mitigation program
  - Results from data collection during anomaly digs are query-able

# ILI Life Cycle



# IM Cycle

- Calculate reassessment interval
- Evaluate P&M measures
- Review threats

# Process Improvement

- Annual Vendor Metrics Reviews
  - Report Timing
  - Report Quality
  - Data Accuracy
  - Following Customer Profiles