NACE Standards on Pipeline Internal Corrosion

Oliver Moghissi
oliver.moghissi@dnv.com

What is a Standard?

ISO/IEC Guide 2

A document

established by consensus

approved by recognized body

that provides, for common and repeated use,

rules, guidelines, or characteristics for activities or their results,

aimed at achieving the optimum degree of order…

Benefits of Standards

- Pipeline operators
  - Cost reduction
  - Enhanced safety & reliability
  - Interoperability
  - Regulatory compliance
  - Reduced liability exposure

Benefits of Standards

- Vendors/Suppliers
  - Market access
  - Competitive advantage
  - Vehicle for communication/common understanding

Benefits of Standards

- Government
  - Access to technology
    - For agency and between operators
  - Lower regulatory development and enforcement costs
  - Consensus process reduces adversarial relationship

ANSI Standardization Principles

- **Transparency** – access to information; time and opportunity to comment
- **Openness** – Participation by anyone
- **Impartiality and Consensus** – No favoring of interests. Consideration of views and attempted reconciliation
- **Effectiveness and Relevance** – Address regulatory and market needs, scientific and technological developments
- **Coherence** – Avoid conflict with other international standards
- **Development Dimension** – Facilitate developing country (operator?/vendor?) participation

NACE Standard Development

- **Transparency, Openness, Impartiality, and Consensus**
  - NACE like most technical associations but unlike most trade associations
- **Effectiveness and Relevance**
  - NACE is leading resource for corrosion and materials technology
  - Uses technology to address stakeholder needs
    - Today – corrosion specialists
    - Tomorrow – all stakeholders
- **Coherence**
  - Primary consideration is complementary standards
- **Development Dimension**
  - Not deliberate

Example – SP0206 ICDA for Pipelines Carrying Normally Dry Natural Gas

- US legislation required integrity assessments
- ILI and PT impractical for many gas lines
- Focus on time-dependent threats (over static or ‘random’ led to ECDA development (no IC threat since dry gas)
- Visible pipeline failure from IC created demand for DA approach
- Development project on IC (Dusek, Moghissi, Cookingham, Norris)
  - 4 steps from ECDA
  - Quantify ‘the first sag’ in a practical way
  - CORROSION/2002 Paper #87 (completely transparent approach)
- How to standardize approach given operator, regulatory, and supplier concerns?

Example – SP0206 Standard Development

- **Effectiveness and Relevance** – Clear regulatory need addressed by technological development. In core NACE competence.
- **Impartiality and Consensus** – TG with 4 pipeline operators, 4 consultants, 1 PHMSA, 1 NTSB.
  - No IP claims, much ‘selling’ to competing service providers, challenged by scientists, pressured by operators, trust with regulators.
- **Coherence** – To be referenced by ASME B31.8S
- **Transparency** – Large and frequent email distributions and conference calls with extended group
- **Openness** – Participation by anyone
- **Development Dimension** – Struggle with ‘no threat in dry gas.’

Pipeline Internal Corrosion NACE Standards

- Assessment
  - SP0206 ICDA Methodology for Pipelines Carrying Normally Dry Natural Gas
  - SP0208 ICDA Methodology for Liquid Petroleum Pipelines
  - TG305 ICDA for Wet Gas Pipelines
  - RP0102 In-Line Inspection of Pipelines

Pipeline Internal Corrosion NACE Standards

- Monitoring and Sampling
  - RP0192 Monitoring Corrosion in Oil and Gas Production with Iron Counts
  - RP0497, Field Corrosion Evaluation Using Metallic Test Specimens
  - RP0775 Preparation, Installation, Analysis, and Interpretation of Corrosion Coupons in Oilfield Operations
  - TM0194-2004 Field Monitoring of Bacterial Growth in Oil and Gas Systems

Pipeline Internal Corrosion NACE Standards

- Corrosion Mechanisms
  - TG254 Microbiologically Influenced Internal Corrosion of Pipelines
  - TG380 Underdeposit Corrosion – Testing and Mitigation

Pipeline Internal Corrosion NACE Standards

- Sour service
  - MR0175/ISO 15156 Petroleum and natural gas industries—Materials for use in H2S-containing environments in oil and gas production
  - TM0177 Laboratory Testing of Metals for Resistance to Sulfide Stress Cracking and Stress Corrosion Cracking in H2S Environments
  - TM0198 Slow Strain Rate Test Method for Screening Corrosion-Resistant Alloys (CRAs) for Stress Corrosion Cracking in Sour Oilfield Service
  - TM0103 Laboratory Test Procedures for Evaluation of SOHIC Resistance of Plate Steels Used in Wet H2S Service
  - TM0284 Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen-Induced Cracking
  - TM0296 Evaluating Elastomeric Materials in Sour Liquid Environments
  - TM0187 Evaluating Elastomeric Materials in Sour Gas Environments

Pipeline Internal Corrosion NACE Standards

- Chemical Treatment
  - TM0197 Laboratory Screening Test to Determine the Ability of Scale Inhibitors to Prevent the Precipitation of Barium Sulfate and/or Strontium Sulfate from Solution (for Oil and Gas Production Systems)
  - TM0374 Laboratory Screening Tests to Determine the Ability of Scale Inhibitors to Prevent the Precipitation of Calcium Sulfate and Calcium Carbonate from Solution (for Oil and Gas Production Systems)
  - TM0397-2002 Screening Tests for Evaluating the Effectiveness of Gypsum Scale Removers
  - TM0208 Laboratory Test to Evaluate the Vapor-Inhibiting Ability of Volatile Corrosion Inhibitor Materials for Temporary Protection of Ferrous Metal Surfaces

Pipeline Internal Corrosion NACE Standards

- Coatings, Linings, and Elastomers
  - RP0304-2004, Design, Installation, and Operation of Thermoplastic Liners for Oilfield Pipelines
  - RP0491 Worksheet for the Selection of Oilfield Nonmetallic Seal Systems
  - TG 037 Pipelines, Oilfield: Thermoplastic Liners
  - TG 223 Pipelines, Steel: Standard for In Situ Internal Cleaning and Coating
  - TM0183 Evaluation of Internal Plastic Coatings for Corrosion Control of Tubular Goods in an Aqueous Flowing Environment
  - TM0384 Holiday Detection of Internal Tubular Coatings of Less Than 250 µm (10 mils) Dry-Film Thickness
  - TM0186 Holiday Detection of Internal Tubular Coatings of 250 to 760 µm (10 to 30 mils) Dry-Film Thickness
  - TM0174 Laboratory Methods for the Evaluation of Protective Coatings and Lining Materials on Metallic Substrates in Immersion Service
  - TM0298 Evaluating the Compatibility of FRP Pipe and Tubulars with Oilfield Environments
  - TM0192 Evaluating Elastomeric Materials in Carbon Dioxide Decompression Environments

Pipeline Internal Corrosion NACE Standards

- Other Corrosion Testing
  - TM0172 Determining Corrosive Properties of Cargoes in Petroleum Product Pipelines
  - TM0169 Laboratory Corrosion Testing of Metals

The Evolution of NACE Standards

- Yesterday
  - By and for corrosion specialists
  - Ad-hoc initiation and scoping
  - All the pieces exist, but could hang together better

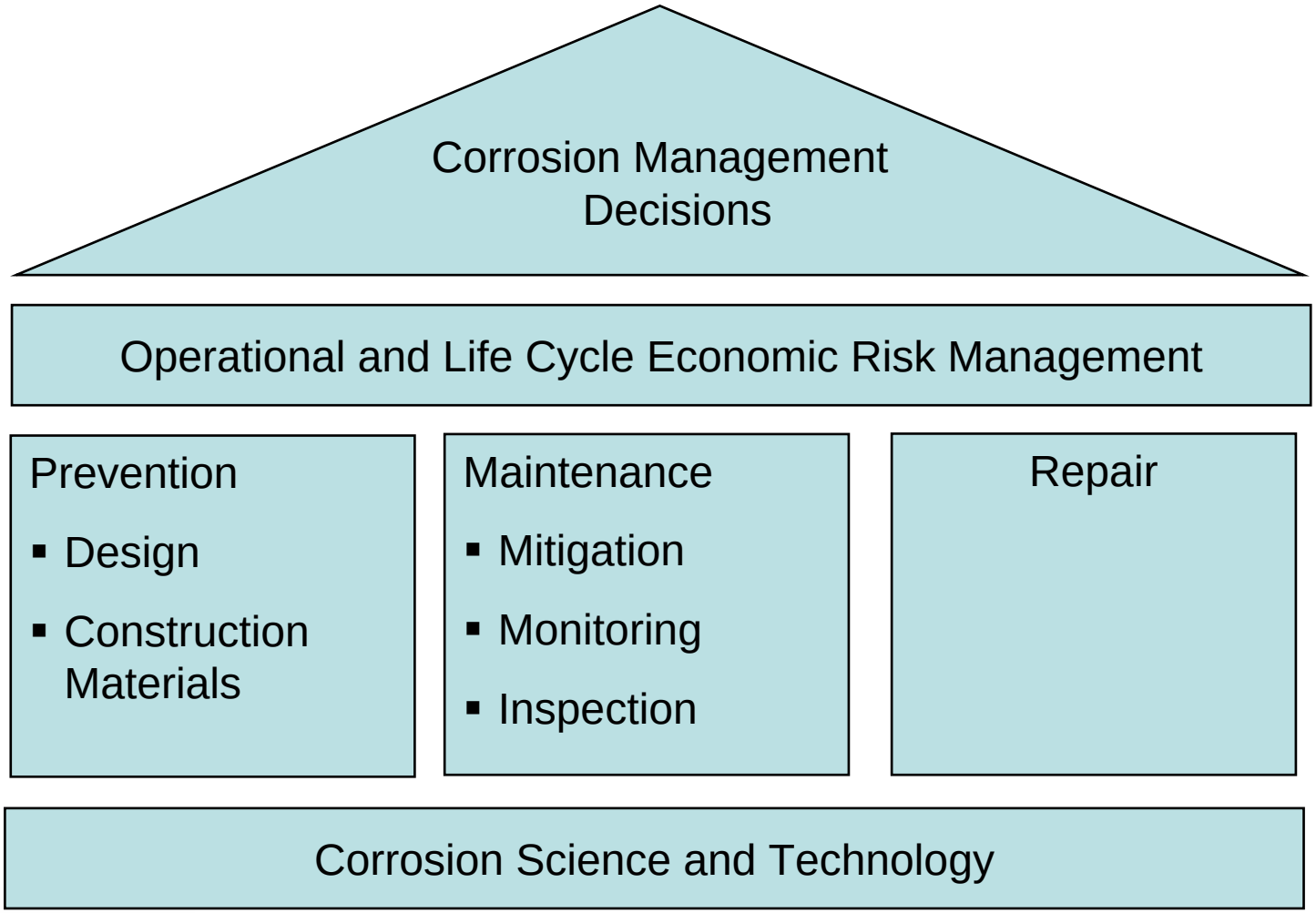
NACE #1 Strategic Goal

- NACE International will establish, promote, and maintain a comprehensive, integrated corrosion management framework.
- Goal 1 Strategic Result - An industry standard framework for increasing asset life, safe operation, and environmental responsibility
- *Comment – 'how do we use existing knowledge from NACE standards to improve corrosion decision-making?'*

Today

- SP0106 Control of Internal Corrosion in Steel Pipelines and Piping Systems
  - Pipeline design including product quality, flow, pipe configurations, dehydration, de-aeration, chemical treatment, internal coatings, & monitoring
  - Corrosion detection and Measurement including visual inspection, monitoring, sampling, ILI
  - Mitigation including line cleaning, product processing, chemical treatment, coating/lining
  - Measuring effectiveness of corrosion control including monitoring, sampling, inspection
  - Operation and maintenance of IC control systems
  - Records

Diagram of Corrosion Management



Tomorrow

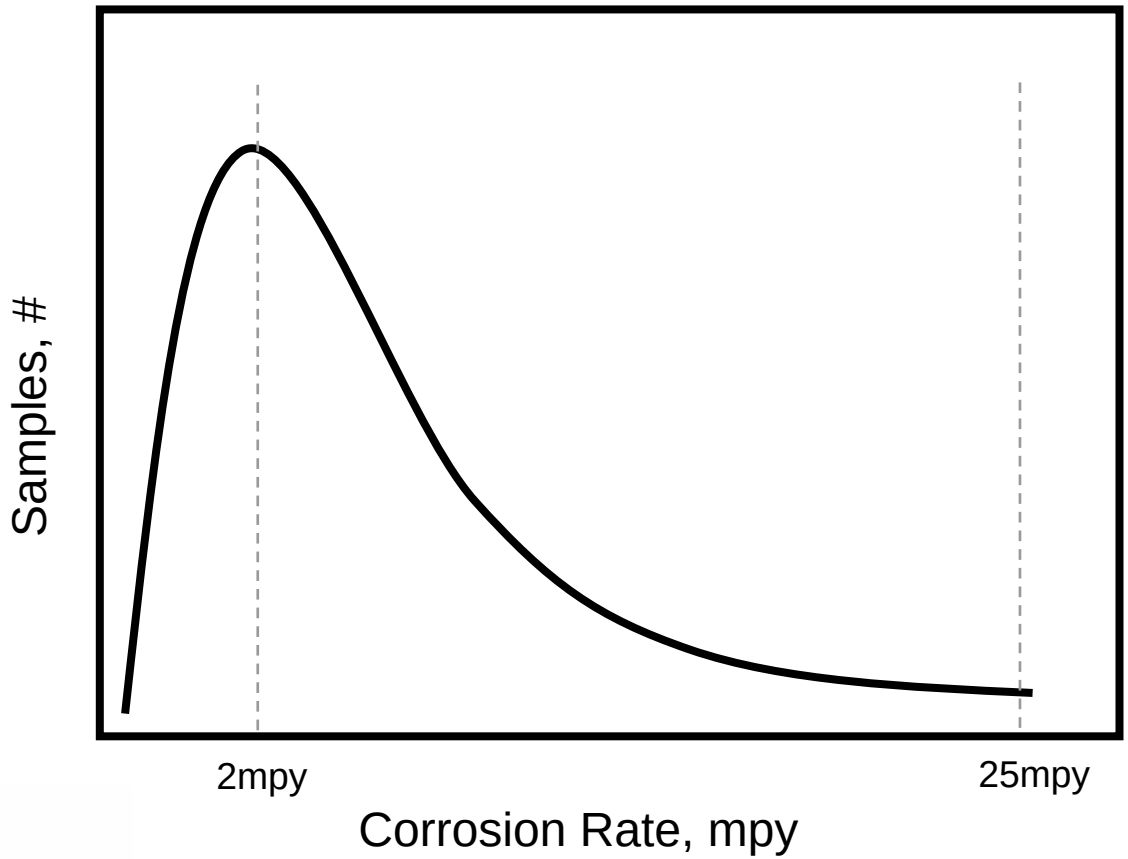
- TG 370 Pipeline Corrosion Management
  - Overarching document for all relevant NACE pipeline corrosion standards
  - Lifecycle oriented
  - Options (e.g., consider corrosion management vs. CP effectiveness criteria)

A Possible Future

- Decision making based on established risk and economic analysis principles
  - Use $$$ as basis for risk
    - Risk = P(event)*Consequence
  - Maximize return on invested maintenance dollar
    - Estimate corrosion risk for ‘do nothing’ base case and alternatives
    - Use economic analysis (anchored by safety)

Pipeline Corrosion is Not Average

- P(event) defined by distribution



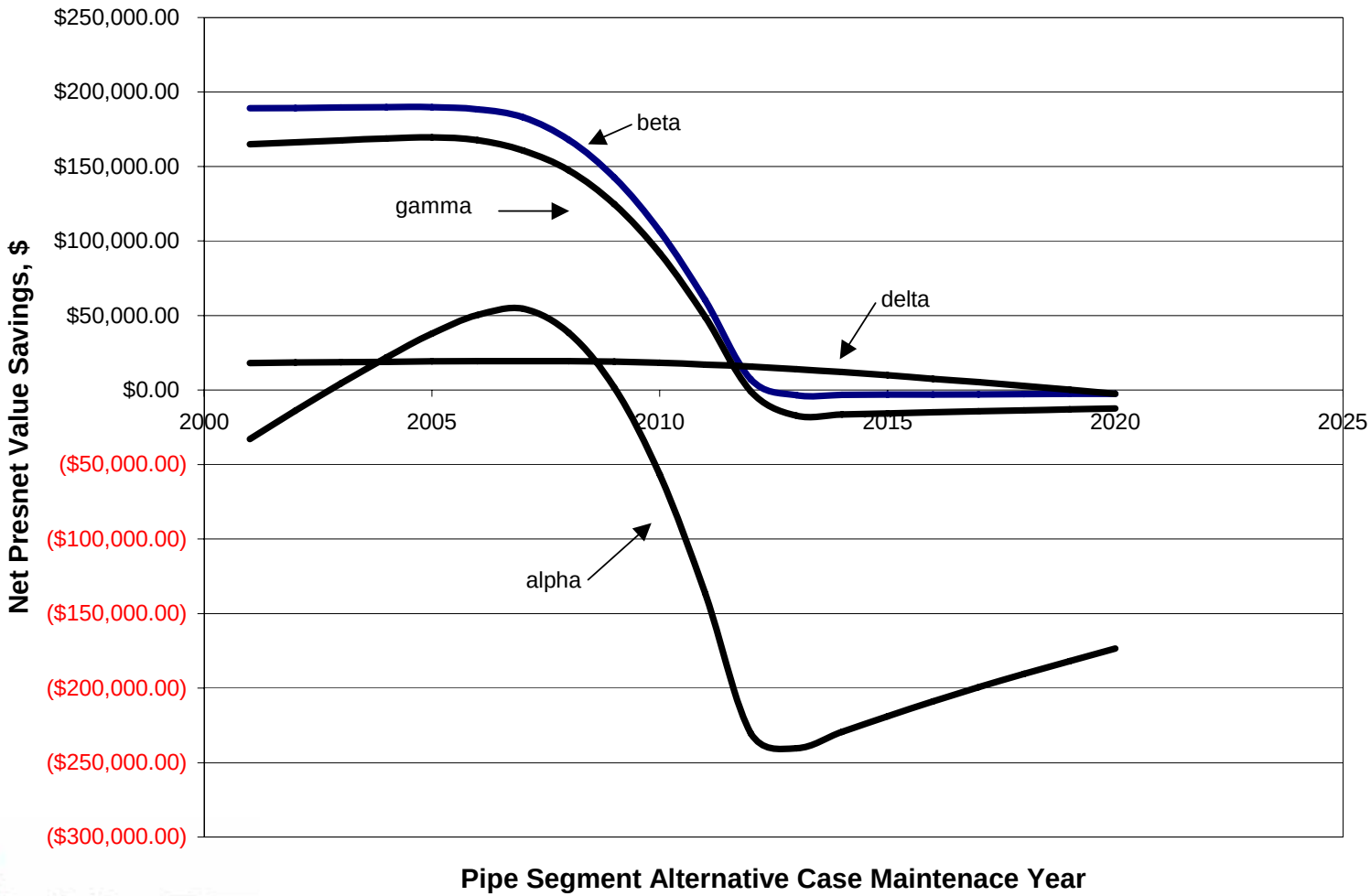
Example* – Liner Installation

- Protect pipeline from internal corrosion
- Estimate corrosion rates (and distributions)
- Estimate cost and effectiveness of liner installation

*Mauney, Moghissi, Sridhar

Liner Installation

Net Present Value versus Pipe Segment Maintenance Year



Summary

- NACE standards provide comprehensive information on pipeline internal corrosion
- NACE standard development process meets goals of stakeholders in pipeline integrity
- NACE is developing standards to provide better guidance on corrosion management