Detailed Outline—Cathodic Protection Technologist Course

MECHANISMS OF CORROSION

- Thermodynamics of Corrosion
  - Pourbaix Diagram
  - The Electrode Potential
    - The Electromotive Force Series
      The Nernst Equation
      Common Reference Electrodes
      Effect of Temperature on Reference Electrode Potentials
      Converting Measured Potentials between Reference Electrodes
  - The Corrosion Cell
    - Corrosion Cell Components
      Corrosion Cell Kinetics (Polarization)
  - Faraday's Law
  - Corrosion Potential
  - Factors Affecting the Operation of a Corrosion Cell
    - Depolarization of a Corrosion Cell
      Increased Polarization of a Corrosion Cell
      Circuit Resistance Changes
      Effect of Driving Voltage on a Corrosion Cell
      Effect of Time on a Corrosion Cell
      Randles Circuit Model for an Electrode Interface in a Corrosion Cell
      Types of Corrosion

CATHODIC PROTECTION THEORY

- Definition
- Criteria
  - Potential Criterion (–850 mVcse)
  - Polarization Shift Criterion (100 mV)
  - Factors affecting validity of criteria
    - Temperature
      Sulphate reducing bacteria
      AC Current density
      Type of metal
      Mixed metals
      Stress Corrosion Cracking (SCC)
- Typical Cathodic Polarization Characteristics
- Cathodic Polarization Curve
- Activation and Concentration Polarization
- Factors Affecting Polarization
  - Aeration
  - Agitation (velocity)
  - Temperature
  - pH
  - Surface Area
  - Effect of Time
- Types of Cathodic Protection Systems
  - Galvanic Anodes
    - Aluminum Anodes
      Magnesium Anodes
      Zinc Anodes
      Polarization Diagram
      Backfill
      Typical uses
  - Impressed current anodes
    - Bulk Anodes

Dimensionally Stable Anodes
Polarization Diagram
Carbon Backfill
Typical Uses
Impressed Current Power Supplies

ELECTRICAL INTERFERENCE

- Detecting Stray Current
  - Effects of Stray Current on Metallic Structures
  - Mitigation of Interference Effects from Impressed Current Cathodic Protection Systems
  - Other Sources of DC Stray Current
- AC Interference
  - Conductive Coupling Due to Faults
  - Electrostatic Coupling
  - Electromagnetic (Inductive Coupling)
- Telluric Current Interference
  - Interference Effects
  - Mitigation of Telluric Current Effects

CP DESIGN FUNDAMENTALS

- Design Objectives
- Determining Current requirement
- Current Requirement Estimating Methods
  - Minimum Voltage Drop Method
  - Polarization Test Method
  - Polarization Shift Method
- Calculation of Cathodic Protection Circuit Resistances
  - Anode Resistance
    - Calculating Pipe Resistance to Remote Earth
      Calculation of Cable and Pipe Lineal Resistances
- Calculating System Capacity and Life
- Calculation of System Life
- Calculating Number of Anodes
- Calculation of System Driving Voltage
  - Galvanic System
  - Impressed Current System
- Sample Cathodic Protection Designs
  - Galvanic System
  - Impressed Current System
- Design of Performance Monitoring Facilities
  - Typical Test Station
  - Test Arrangement at an Pipeline Crossing
  - Test Arrangement at an Underground Isolating Fitting
  - Test Arrangement at a Galvanic Anode
  - Test Arrangement at a Casing
  - Test Lead Arrangement at a Current Span Test Station
  - Coupon Test Stations
- Current Distribution
  - Attenuation
  - Effect of Coating on Current Distribution
  - Effect of Anode-to-Structure Spacing on Current Distribution
  - Effect of Structure Arrangement on Current Distribution
  - Effect of Electrolyte Resistivity Variation on Current Distribution
  - Effect of Current Distribution on Holidays on a Coated Structure

EVALUATION OF CP SYSTEM PERFORMANCE

- The Potential Measurement
    - Copper Copper Sulfate Reference Electrode
    - Buried Reference Electrode
    - Polarity Considerations
    - The Potential Measurement Circuit and Measurement Error
- Voltage Drop Errors in the Metering Circuit
- Methods of Minimizing Voltage Drop Errors in the Potential Measurement
    - Current Interruption Method
    - Step-wise Current Reduction Method for Determining the Amount of Soil IR Drop in the On-Potential
    - Reference Electrode Placement Close to the Structure
    - Using Coupons to Minimize Voltage Drop Errors in the Potential Measurement
- Measurement of the Polarization Shift
- Current Measurement
    - Using an Ammeter to Measure Current
    - Using a Shunt to Determine Magnitude
    - Zero Resistance Ammeter
    - Clamp-on Ammeter
    - Pipeline Current Measurements
- Close Interval Potential Survey
- Coating Condition Surveys
    - Voltage Gradient Method of Detecting Holidays in a Pipe Coating
    - Coating Conductance Method of Evaluating Coating Quality
- Troubleshooting Cathodic Protection Systems
    - Polarization Changes
    - Anode Polarization
    - Increased Resistance
    - Power Supply Change