NACE CP2: Cathodic Protection 2

Course Description

Corrosion is one of the most important problems encountered by the owners and operators of underground, offshore, submerged and other metallic structures exposed to an electrolyte. If corrosion is not controlled, it can lead to large costs in repairs or facility replacement. Even greater costs can be incurred from environmental damage, injuries and fatalities.

The Cathodic Protection Technician certification indicates intermediate-level knowledge of corrosion theory and CP concepts, types of CP systems, and advanced field measurement techniques. This certification is designed for individuals with a heavy engineering/scientific background and some working knowledge of cathodic protection, or who have extensive years of field experience with some technical background.

Course Objectives

Course learning objectives

- Test and troubleshoot rectifier component parts
- Perform simulated CP related field tests (including interrupted structure-to-electrolyte potentials, current requirement, continuity, shorted road/railroad casing and, layer soil resistivity tests) and evaluate the results
- Perform tests to verify the presence of stray current interference (primarily related to underground pipelines) and recommend method(s) to mitigate the interference
- Conduct and interpret different current measurements
- Interpret voltage (IR) free readings, polarization formation and decay tests
- Maintain records, including data plotting and analysis
- Summarize induced AC voltage on pipelines and the methods of mitigation
- Purpose and uses of corrosion coupon test stations
- Depending on the jurisdiction review code CP criteria requirements related to CP

Who Should Attend?

This program is intended for personnel involved in testing the effectiveness of CP systems, troubleshooting and/or recording this data, including:

- CP field personnel
- CP Testers or
- Personnel supervising CP Testers

Course Outline

Day One

Pre test

Chapter 1—Corrosion Theory

1. **The Corrosion Cell**
   - Driving Force for Corrosion
   - Electrolyte
2. **Corrosion Rate**
   - Faraday's Law
   - Voltage Difference
   - Reference Electrodes (Half-Cells)
   - Polarization
   - Passivity
3. **Forms of Corrosion**

Chapter 2—Cathodic Protection Fundamentals

1. **Concept of Cathodic Protection**
2. **Polarization of a Structure**

3. **Current Requirement**
   - Surface Area
   - Polarization
   - Effect of Environment pH on CP Current Requirement
   - Temperature Effect on CP Current Requirement
   - Effect of Oxidizers on CP Current Requirement
   - Effect of Relative Movement Between the Structure and
   - Applied Current vs. Corrosion Rate
4. **Criteria for Cathodic Protection**
   - RP0169 Criteria
   - Basis of RP0169 Criteria
   - Polarized Potential
   - Application of Criteria
   - Other Criteria
5. **International Standard ISO 15589-1**
6. **American Water Works Association**
7. **Non-NACE International Criteria**
8. **E log I**

Day Two

Chapter 3—Cathodic Protection Systems

1. **Components of Galvanic Cathodic Protection**
   - Anodes
   - Anode Backfill
   - Wiring and Connections
2. **Components of Impressed Current Cathodic Protection**
   - Applications of Impressed Current Cathodic Protection
   - Anodes
   - Anode Backfill
   - Power Supply
   - Wiring and Connections
3. **Environmental Issues**
4. **Anode Configurations**
   - Galvanic Anodes
   - Impressed Current Anodes
5. **Experiment 3.1 Demonstrate the Use of a Sacrificial Anode to Mitigate Corrosion in a Local Action Cell**
6. **Experiment 3.2 Demonstrate the Used of an Impressed Current System to Mitigate Local Action Cell Corrosion**

Chapter 4—DC Power Sources for Cathodic Protection

1. **Transformer-Rectifier**
   - Circuit Breakers

- Transformer
- Rectifying Circuits

2. **Other Power Sources**
   - Engine Generator Sets
   - Thermoelectric Generators
   - Solar Power Supplies
   - Wind-Driven Generators
   - Batteries
   - Fuel Cells
3. **Rectifier Testing**
   - Output Problems
   - Circuit Diagrams
   - Electrical Damage
   - Efficiency Test
   - Filters
   - Detection of Cable Breaks
   - Testing Transformers

Day Three

Chapter 5—Safety

1. **Introduction**
2. **Electrical**
3. **Electrical Equipment (Rectifiers)**
   - Electrical Equipment (Rectifier) Case
   - Cathodic Protection Rectifiers
4. **Lock Out / Tag Out**
5. **Electrical Hazardous Areas**
6. **Explosions or Ignitions**
7. **Cathodic Protection Surveys**
8. **Induced AC Voltages**
9. **Excavations**
10. **Hazardous Material**
11. **Material Safety Data Sheets (MSDS)**
12. **Reaction Products**
13. **Other General Precautions**

Chapter 6—Field Measurements

1. **General**
2. **Measurement of Cathodic Protection Effectiveness**
3. **Structure-to-Electrolyte Potentials**
   - The Potential Measurement Circuit and Measurement Error
   - Voltage Drop Errors in the Potential Measurement Due to
   - Current in the Pipeline

4. **IR Drop Error Determination and Correction**
   - Current Interruption
   - Reference Electrode Near the Structure
   - External CP Coupons
   - Reference Electrode at Remote Earth
   - Stepwise Current Reduction Method
5. **Surface Potential Surveys**
   - Close Interval Potential Survey
   - Analysis of Surface Potential Surveys

Day Four

6. **Current Measurement**
   - Using an Ammeter to Measure Current
   - Using a Shunt to Determine Current Magnitude
   - Zero Resistance Ammeter
   - Clamp-On Ammeter
   - Pipeline Current Measurements
   - Earth Current Measurements
   - Non-Cathodically Protected Structures
7. **Surface Coating Evaluation Techniques on Buried Pipelines**
   - Pearson Survey
   - Direct Current Voltage Gradient (DCVG) Survey
   - Pipeline Current Mapping
   - Coating Resistance Calculations
8. **Current Requirement Tests**
9. **Electrical Isolation**
   - Indication of Problems
   - Locating the Problem
   - Testing Above Grade Isolating Flange/Unions
   - Structure-to-Electrolyte Potential for Isolation Testing
   - Interrupted Structure-to-Electrolyte Potential to Test Isolation
   - DC Line Current to Test Isolation
   - Fixed Cell to Moving Ground for Continuity Test
   - Current Response
10. **Casings**
    - Indication of Problems
    - Locating the Problem
11. **Soil Resistivity Testing**
    - Purposes
    - Measurement Techniques
12. **Measuring pH**
13. **Concrete Structures**
14. **Direct Inspection**
15. **Leak Frequency**
16. **In-Line Inspection**

Day Five

Chapter 7—Stray Current and CP Interference

1. **Stray Current**
2. **Dynamic Currents**
   - Sources of Dynamic Stray Currents
   - Detecting Dynamic Stray Currents
1. **Static (Steady State) Currents**
2. **Cathodic Interference**
   - Anodic Interference
   - Detection of Static Interference Currents
3. **Sample Field Data**
   - Structure-to-Electrolyte Potentials
   - Current Measurements
4. **Resolving Interference Problems**
   - Installation of Metallic Bonds to Control Interference
5. **Controlling Stray Current Through Cathodic Protection**
6. **Coating**
7. **AC Testing and Mitigation**
   - Introduction
   - Electrostatic or Capacitive Coupling
   - Electromagnetic Induction
   - Resistance or Conductive Coupling
   - AC Voltage on Pipelines
   - Measurement of AC Voltage to Ground
   - Mitigation of AC Interference

Chapter 8—Monitoring and Records

1. **Major Objectives of a Cathodic Protection System**
2. **Monitoring**
3. **Detailed Field Survey**
   - Pre-Survey Planning
   - Survey Methods
   - Routine Reading
   - Inspection Intervals
   - Records
4. **Useful Information**

Post Test

Duration

Five days: 08:00am until 03:30pm daily