

# RECLAMATION

*Managing Water in the West*

*Corrosion Webinar Series*

## Corrosion Control System Construction Projects

**Presented by:**



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U.S. Department of the Interior  
Bureau of Reclamation

# Corrosion Control System (CCS) Construction Projects

## Webinar Objectives:

- Introduction to CCS
- Coating Specifications- key components
- Cathodic Protection System Specifications- key components
- Training for Inspectors
- Role of an Inspector (COR)
- Inspection Tools, Techniques, and Common Problem Areas



# Corrosion Control System (CCS)

A **coating** is the primary defense against corrosion.

**Cathodic protection** works with the coating to protect the structure at defects in the coating.

The most effective corrosion protection system for buried and submerged structures involves a **good bonded coating and cathodic protection.**

# What are Paints & Coatings?

- Architectural paints (latex house paints)
- Concrete sealers (basements, driveways)
- **Coatings for Corrosion Protection:**
  - Control penetration of water and ions to underlying metal surface
  - Strong adhesion to the substrate
  - Paint (coating) = binder (polymer) + pigment & filler + solvent or diluent
- Types of Protective Coatings:
  - Barrier coatings are most common
    - Ex. coal tar enamel, polyurethane, epoxy, vinyl
  - Sacrificial (zinc-rich, metallizing)
  - Inhibitive (lead, chromate)



# What is Cathodic Protection?

**Cathodic Protection (CP)** *is a technique used to control the corrosion of a metal surface by making it the cathode of an electrochemical cell*

## Galvanic Anode

- Structure directly connected to a sacrificial anode
- Current provided by natural voltage difference between metals (galvanic corrosion)

## Impressed Current

- Structure connected to anodes through rectifier
- Current supplied by rectifier



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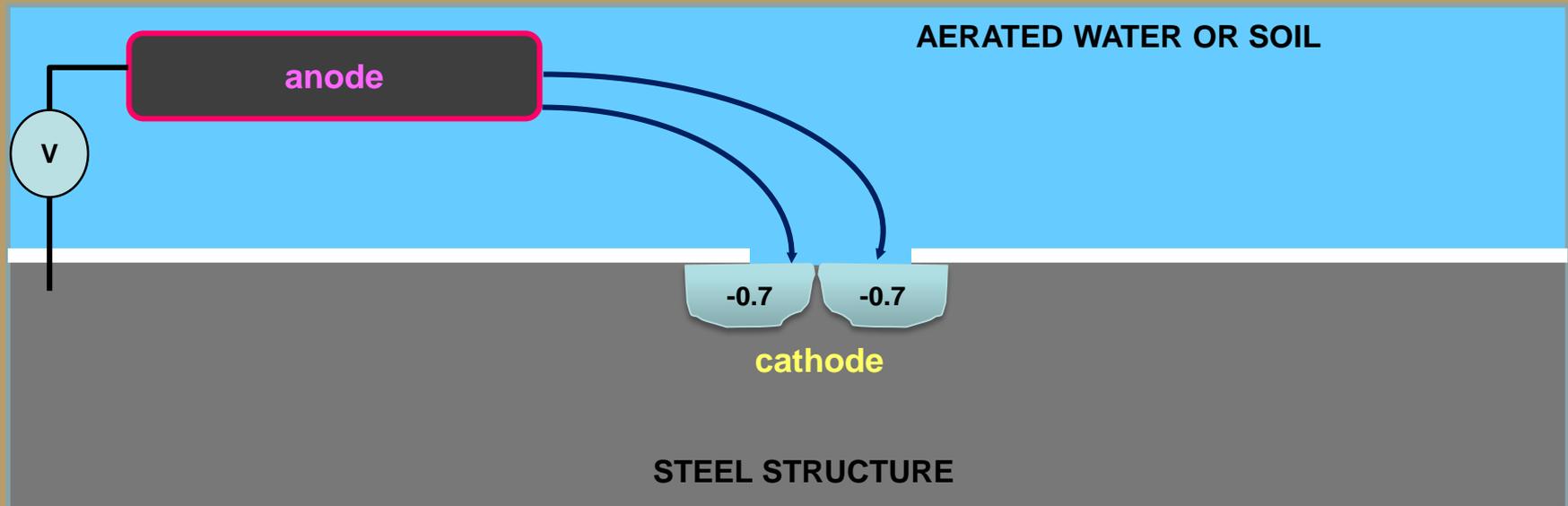
# Corrosion Control System

## Mitigation- Coating with CP

- Coating- provides barrier and limits amount of bare steel
- CP- protects exposed steel only at defects in the coating

## Four things needed for corrosion:

- *Anode* – the corroding metal
- *Cathode* – the metal that doesn't corrode
- *Metallic Return Path* – ex. the steel pipe
- *Electrolyte* – the soil or water



# Coatings and CP Specifications

# 09 96 20 - Coatings Specification

- Coatings guide specs are available- paragraphs below are typical only and will change based on project needs

## PART 1: GENERAL

- 1.01 MEASUREMENT AND PAYMENT
- 1.02 REFERENCE STANDARDS
- 1.03 SUBMITTALS**
- 1.04 QUALIFICATIONS
- 1.05 DELIVERY, STORAGE, HANDLING
- 1.06 AMBIENT CONDITIONS
- 1.07 PROJECT CONDITIONS

## PART 2: PRODUCTS

- 2.01 MATERIALS

\* Separate spec sections for specialty coatings (ex. coatings for concrete or pipelines, vinyls, metallizing, etc.)

## PART 3: EXECUTION

- 3.01 PROTECTION OF ADJACENT SURFACES, EQUIPMENT AND NEWLY COATED SURFACES
- 3.02 REPAIR OF CONTRACTOR DAMAGED SURFACES
- 3.03 COATING OF METALWORK EMBEDDED IN CONCRETE
- 3.04 SURFACE PREPARATION
- 3.05 APPLICATION EQUIPMENT
- 3.06 COATING APPLICATION
- 3.07 FILLERS AND CAULK APPLICATION
- 3.08 CONTRACTOR FIELD QUALITY TESTING**
- 3.09 REPAIR OF DEFECTIVE OR DAMAGED COATED SURFACES
- 3.10 COATING TABULATIONS
- 3.11 COATING CATEGORIES
- 3.12 COLOR SCHEDULE

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# 09 96 20 - Coatings Specification

## 1.03 SUBMITTALS

- **RSN 09 96 20-1, Approval Data:**
  - For each brand name coating material listed in Coating Categories: Manufacturer's product data, application, and MSDS sheets.
  - For coating materials proposed as "equal" products: additionally requires specified approval data including successful similar projects, manufacturer's certifications, performance certifications
  - Paint chip samples (if matching color and gloss)
- **RSN 09 96 20-2, Final Approval Data:**
  - For each coating material: purchase order info including batch numbers
- **RSN 09 96 20-3, Certifications:**
  - Contractor's certifications for field application, hazardous material removal, and shop application
  - Manufacturer's product certifications for potable water, etc.
- **RSN 09 96 20-4, Documentation:**
  - Written evidence showing each applicator's training or experience for each coating
- **RSN 09 96 20-5, Contractor Quality Testing Data**

# 09 96 20 - Coatings Specification

## 3.08 CONTRACTOR FIELD QUALITY TESTING

- Contractor's qualified personnel shall conduct tests (often third party inspector)
- **Perform tests in the presence of the Contracting Officer's Representative (COR)**
- Key inspection points:
  - Prior to abrasive blasting
    - General condition of surface
    - Compressed air quality
  - After abrasive blasting
    - Soluble salts (chlorides)
    - Surface profile, surface comparators, and cleanliness
  - After final coat of material
    - Dry Film Thickness (DFT) → as well as after each coat
    - Discontinuity (holiday) testing
    - Adhesion
- Inspection Devices: to be furnished by the Contractor
  - Holiday tester, DFT gauge with NIST-certified calibration plates and/or plastic shims
- Contractor's reports shall include: date of work, description of areas and work performed

# 26 42 10 - Cathodic Protection Specification

- CP may have multiple spec sections depending on number and types of systems on a particular project (e.g. pipelines, tanks, and gates)
- CP does not have a guide spec- paragraphs below are typical only and will change based on design for a particular project

## PART 1: GENERAL

- 1.01 MEASUREMENT AND PAYMENT
- 1.02 DEFINITIONS
- 1.03 REFERENCE STANDARDS
- 1.04 SUBMITTALS**
- 1.05 SYSTEM DESCRIPTION
- 1.06 QUALIFICATIONS

## PART 2 PRODUCTS

- 2.01 GENERAL
- 2.02 CABLES
- 2.03 EXOTHERMIC METALLURGICAL BONDS
- 2.04 DIELECTRIC COATING FOR METALLURGICAL BONDS
- 2.05 GALVANIC ANODES
- 2.06 MECHANICAL SUPPORT BRACKETS
- 2.07 TEST STATIONS

## PART 3 EXECUTION

- 3.01 INSTALLATION
- 3.02 CONTRACTOR FIELD QUALITY TESTING**

# 26 42 10 - Cathodic Protection Specification

## 1.04 SUBMITTALS

- **RSN 26 42 10-1, Certification and Data:**
  - NACE Cathodic Protection Specialist (CP4) certification for personnel performing or directing installation and testing of cathodic protection system
  - Preconstruction drawings
  - Manufacturers' data sheets for system components
  - Interference mitigation method (where applicable)
  
- **RSN 26 42 10-2, Final Data:**
  - As-built drawings and information
  - Testing data:
    - Test equipment and methods utilized
    - Placement of reference electrode during each test
    - Results of tests conducted

# 26 42 10 - Cathodic Protection Specification

## 3.02 CONTRACTOR FIELD QUALITY TESTING\*

- A. Include energizing, adjusting, and testing the cathodic protection systems
- B. **Perform in the presence of COR**
- C. Inform COR of date, time, and tests at least 14 working days prior to testing
- D. Equipment- provided by Contractor
- E. Record and report readings with final test data submittal
- F. Conduct testing in least two testing cycles- troubleshoot, adjust, and correct problems as determined by COR
- H. Submit final data after last testing cycle when performance criteria have been met and no further adjustments are needed
- I. After reviewing the submittal, the Government may require additional testing cycles, adjustments, and re-submittal to determine if the cathodic protection system conforms to requirements

\* Testing requirements will vary based on type of system specified

# Training for Inspectors

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# Professional Certifications

- **NACE Coating Inspector Program (CIP)**
  - CIP Levels 1 and 2, Peer Review
- **SSPC Protective Coatings Inspector Program (PCI)**
  - Levels 1, 2, 3
  - Online Training Program (non-certificate)
- **NACE Cathodic Protection Program**
  - Tester (CP1), Technician (CP2), Technologist (CP3), Specialist (CP4)
  - Specification requires a CP4 oversee all cathodic protection work on a project



# On-site Safety

- Do you need site-specific Certifications?
  - Fall protection (possibly rope access)
  - Confined space, permit required
  - Lock out tag out (LOTO) (*now hazardous energy control program (HECP)*)
- Hazards and protection
  - Weather conditions, physical hazards, wildlife
  - PPE: Safety shoes, hard hat or helmet, hearing protection, gloves, safety vest, proper respiratory protection, protective suits, etc.



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# **Role of a Coatings Inspector and Key Areas for Attention**

# Inspectors on a Job Site

- **Contractor's Inspector**
  - Preferably third party inspector
  - Will perform all of the testing and reporting required by specification
  - Should be NACE or SSPC certified and have experience with the infrastructure/equipment being coated and the coating type
- **Government Inspector**
  - Typically Reclamation employee (can be TSC staff)
  - Will observe all tests performed by Contractor's Inspector
  - May also conduct their own testing
  - Should be familiar with each test required by the spec, be able to recognize “good” vs. “bad” data readings, be competent with each testing device and know how to properly calibrate it

# Coating Inspector Roles

1. Observe
2. Test to verify Contractor's results
3. Verify specification conformance

## Why use a Coating Inspector?

- Assure that you are getting a quality coating job

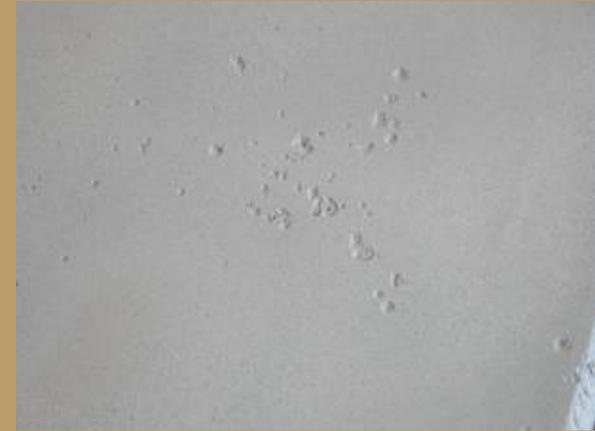
## Risks that Inspector can help mitigate:

Poor surface prep or coating application by contractor →

Reduced coating service life or premature coating failure →

*Poor protection of the structure*

# Critical Stages of a Coatings Inspection



Surface cleanliness and profile

Soluble salt testing



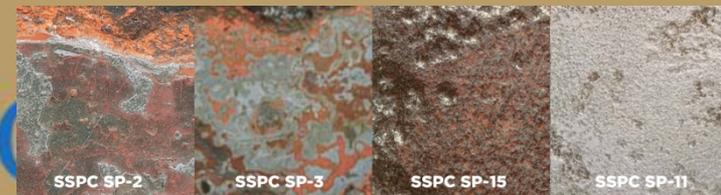
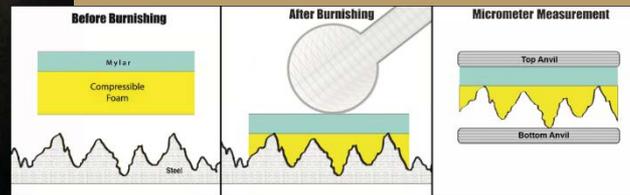
Check for thin spots, stripe coat, filled crevices

DFT after each coat

Holiday Testing

# Inspection Testing and Tools- Surface Prep

- Protect adjacent surfaces and equipment
- Grind sharp edges, irregular surfaces, and pits
- Surface cleanliness
  - Free of blast media
  - Rust or other visible contaminants
  - Soluble salt contamination (ex. chlorides)
- Surface profile
  - Should meet spec for chosen coating product
  - Use replica tape



# Inspection Testing and Tools- Application

- **Environmental Testing**
  - Ambient and surface temperature, relative humidity, dew point, and wind speed
- **Dry Film Thickness (DFT)**
  - Should meet spec for chosen coating product
  - Measure after each coat
  - Focus on difficult areas to coat
- **Stripe Coat / Filler**
  - Contractor should stripe coat on edges, corners, other difficult areas- confirm DFT
  - Filler materials should be used on rivets, seams, skip welds, irregular surfaces, pits, and crevices
- **Also – recoat windows, coating defects, amine blush, off-ratio application, contaminants, etc.**



# Inspection Testing and Tools- Final Inspection

- **DFT**
  - Pay special attention to difficult to coat areas
- **Holiday testing**
- **Visual inspection of final product**
  - Check for runs, sags, pin holes, defects, blisters
- **Adhesion**
  - Pull-off or cross-hatch adhesion testing can confirm suspected problems
- **Ensure coating is not put into immersion service until fully cured (unless an underwater cure coating)**



# Role of a CP Inspector and Key Areas for Attention

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# Cathodic Protection Inspector Roles

- Reclamation's CP Inspector is typically the project COR.
- Role is:
  1. Observe installation and testing
  2. Verify that only approved materials are installed (ex. cable)
  3. Approve any troubleshooting that is required, or defer approval to TSC CP staff
- CP inspector does not typically perform testing themselves; they observe the contractor hired to energize and test a system. Results are then submitted to TSC by the contractor.
- Benefit of a knowledgeable inspector:
  - ✓ Assurance that you are getting a quality product
  - ✓ Assurance that CP system is adequately protecting your structure

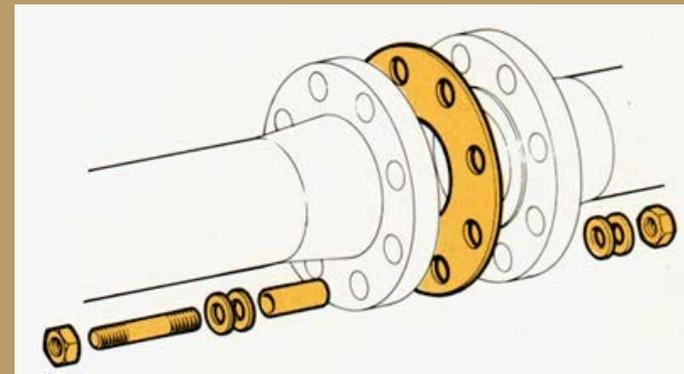
# Inspection/Testing Tools

- **Copper/Copper Sulfate ( $\text{Cu}/\text{CuSO}_4$  or CSE) Reference Electrode**
  - Solution mixed with distilled water; should always be solid crystals in solution
  - Field electrode should be calibrated to “stable” electrode—no more than  $\pm 5\text{mV}$  difference
- **Portable Voltmeter:**
  - Minimum input impedance of  $10\text{ M}\Omega$
  - Capable of measuring DC voltages between  $\pm 0.1$  millivolt to  $\pm 100$  volts
- **Current Interrupter:**
  - Must interrupt all rectifiers on a pipeline to get a true  $V_{\text{OFF}}$ ... this often means more than one interrupter is needed for testing



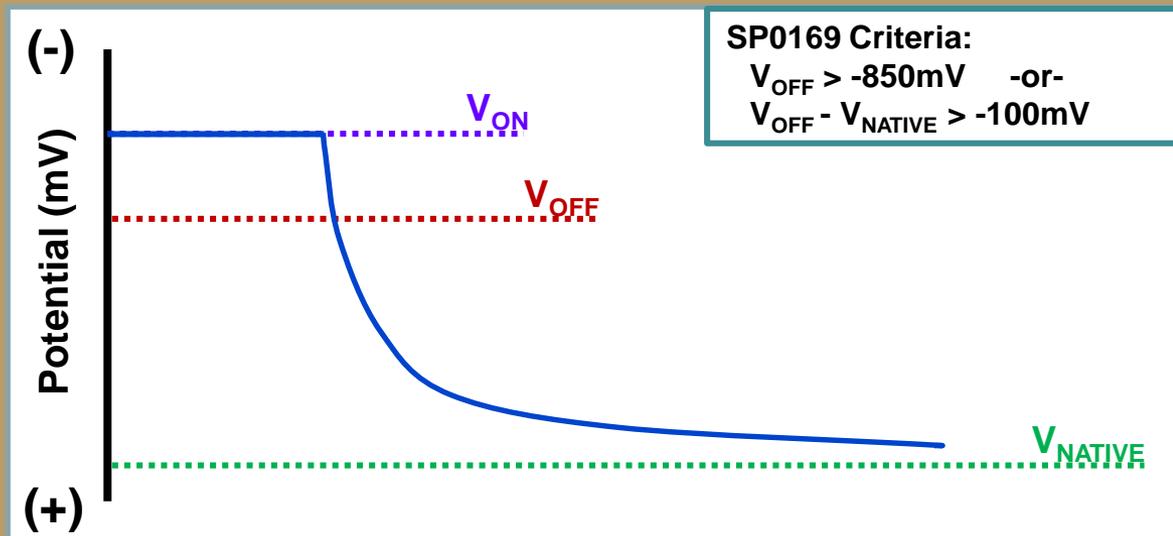
# Areas for Attention- Installation

- **Metallurgical Bonds**
  - “hammer test”
- **Electrical Continuity**
  - across a pipe flange or joint
  - performed between test stations to ensure continuity of an entire pipe section
  - should be performed between anode and structure, ex. direct mount galvanic anode, to ensure good weld
- **Electrical Isolation**
  - typically performed across a joint or flange on a pipeline



# Areas for Attention- Energizing and Testing

- Polarized Potential- “Instant OFF”
  - Should meet NACE criteria for pipe material. Ex. Steel:
    - $-850 \text{ mV}_{\text{CSE}}$  or more negative
    - minimum  $100 \text{ mV}_{\text{CSE}}$  negative shift from native potential
    - Reclamation recommends no more negative than  $-1100 \text{ mV}_{\text{CSE}}$
- Current output from each anode
- Rectifier settings
- Any adjustments made to system



# TSC- Sponsored Training

- **Coating and Corrosion School**
  - 3-days in Denver with lectures and hands-on training in Coatings and Corrosion Labs
- **Corrosion Webinar Series**
  - Twice per year, Feb-March and June-July
  - Email Jessica Torrey ([jtorrey@usbr.gov](mailto:jtorrey@usbr.gov)) to receive email notices
  - 7 webinars now available:
    - Intro to Corrosion
    - Corrosivity Testing and Intro to Corrosion Mitigation
    - Testing Cathodic Protection Systems
    - Corrosion Mitigation for Gates
    - Coatings Maintenance Assessments
    - Cathodic Protection 101
    - CCS Construction Projects
- **TSC Training Website**
  - <http://intra.usbr.gov/tsc/training/training.html>
  - Lists dates of upcoming TSC training and has links to slides and videos of all Corrosion Webinars

# Thank you for your attention! Questions?



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