



Florida Department of  
**TRANSPORTATION**

# **Corrosion and Materials Durability**

## **Materials & Maintenance Meeting**

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**State Materials Office (SMO)**

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# OFFICE OF MATERAILS MISSION

- Maintenance of Existing Cathodic Protection (CP) Systems
  - Performed by consultants and SMO personnel.
  - Consultant funding provided by the Districts.
  - Need is determined through inspection of existing systems.
- Upgrade/Replacement of CP Systems (Maintenance Activity)
  - Performed by consultants and SMO personnel.
  - Design of the system usually done in-house
  - Consultant funding provided by the Districts.
  - Notice of need varies from quick response to multi-year planning.

# OFFICE OF MATERAILS MISSION

- Forensic Inspection of Structure with Non-Destructive Evaluation
  - Ground penetrating radar (GPR).
  - Ultrasonic.
  - Rebar locators.
  - Surface resistivity.
- Developmental Research
  - Collaborate with industry to develop new technologies that will improve the longevity of the bridges.
  - Utilize the SMO lab facilities to test new technologies.

# WHAT IS CORROSION ?

- Corrosion is a naturally occurring phenomenon commonly defined as the deterioration of a material (i.e. steel, zinc, aluminum) that results from a chemical or electrochemical reaction with its environment.
- In Florida, over 8,000 miles of tidal coastline and over 10,000 bridges are considered extremely corrosive.
- Bridge substructure is commonly affected by corrosion induced damage.





# WHY CORROSION MATTER?

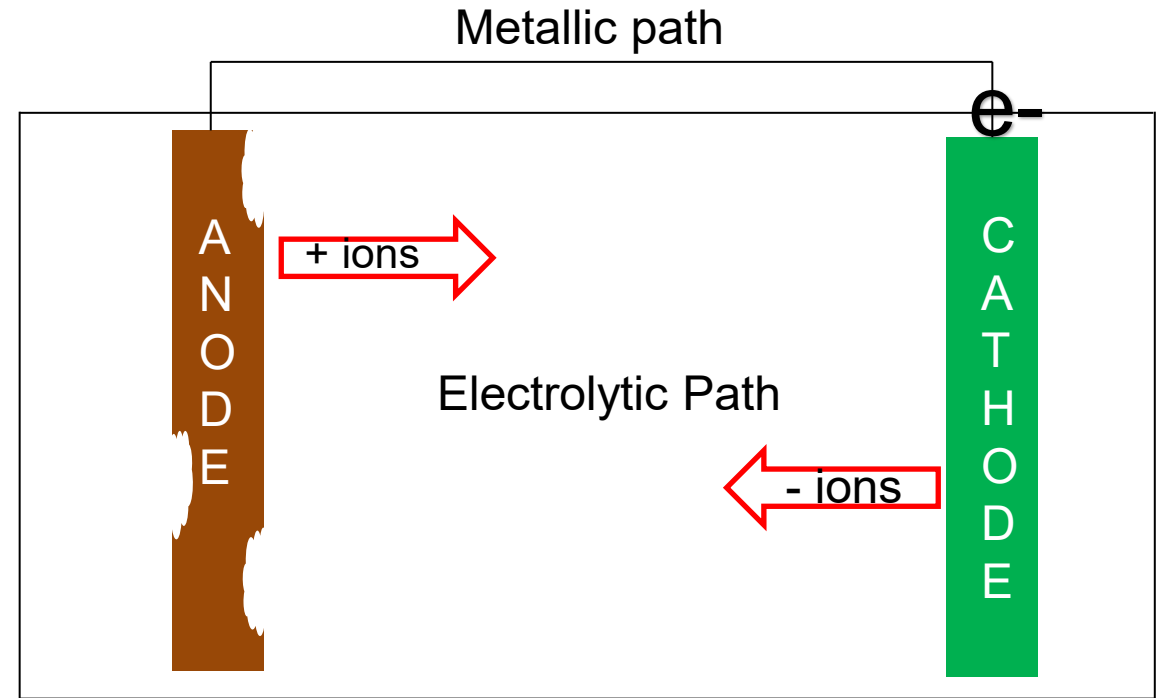
- Safety
- Service Life Reduction
- Structure Integrity
- Maintenance Costs
- Environmental Impact



Fern Hollow Bridge, Pittsburgh, Allegheny County, Pennsylvania January 28, 2022.

# CATHODIC PROTECTION

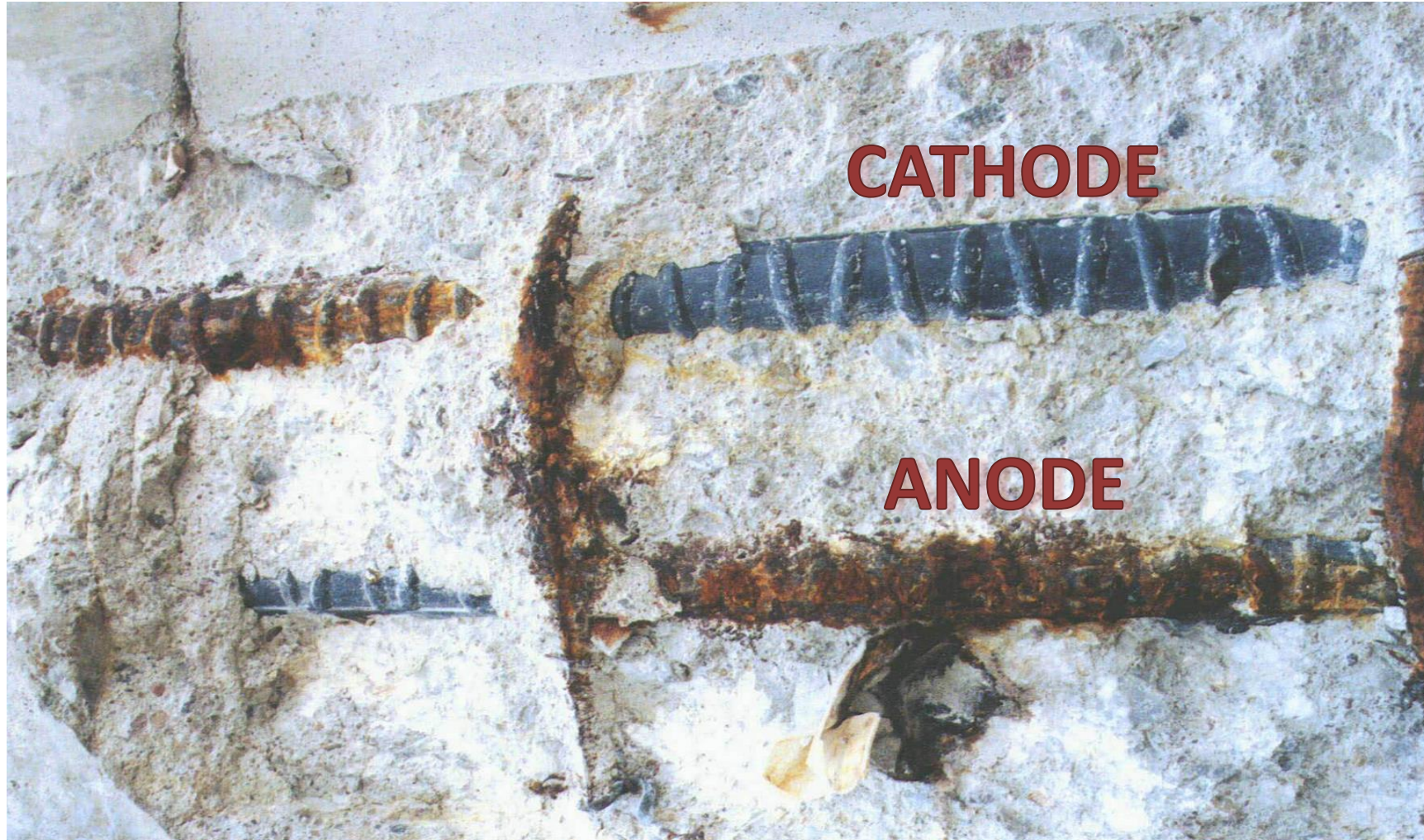
- CP is an electrochemical method of corrosion control/protection that takes advantage of the electrochemical nature of corrosion by transforming a metal (anode) into a non-corroding cathode.
- Types of CP
  - Galvanic cathodic protection (GCP)
  - Impressed current cathodic protection (ICCP)



**GOAL: To provide an extension of the service life as needed.**

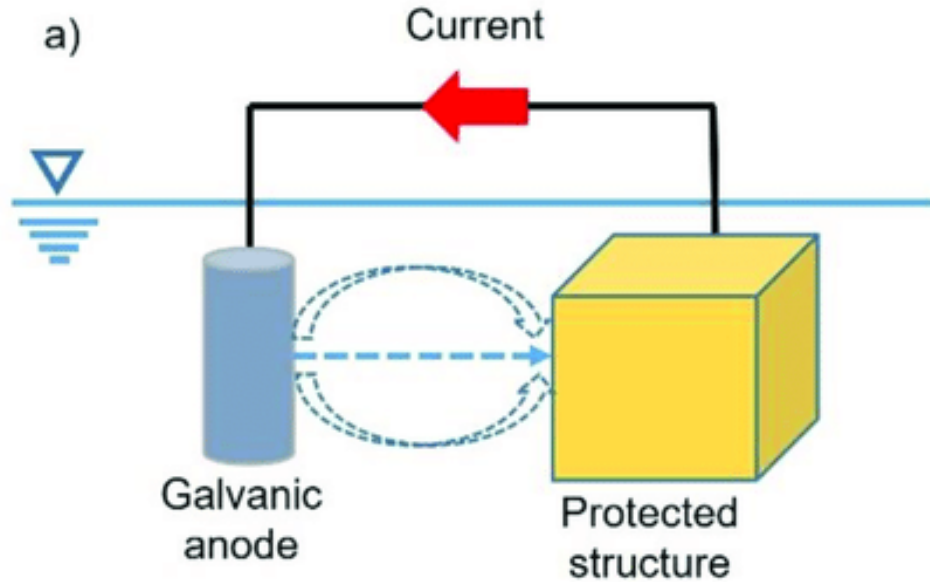


# CORROSION MACRO-CELL

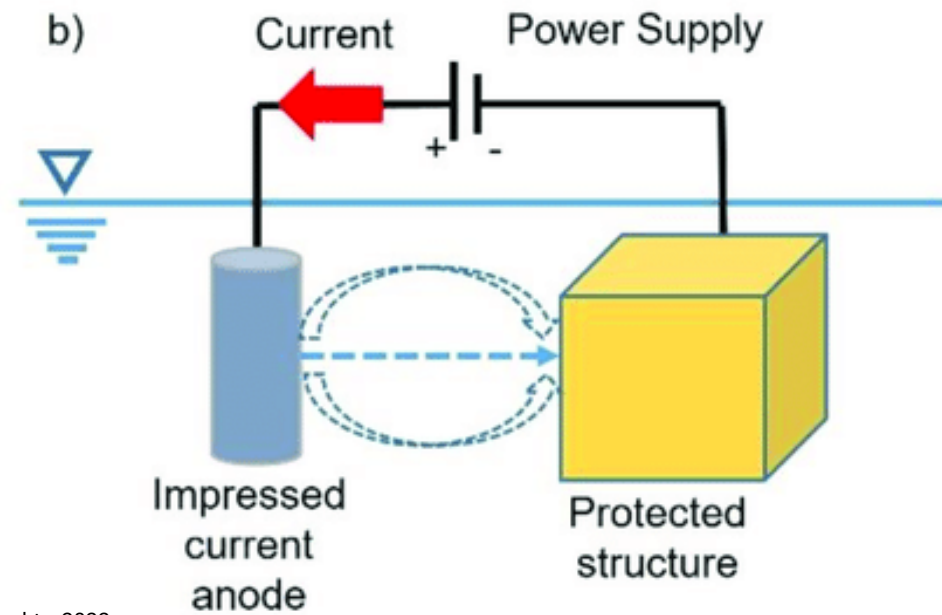


# CORROSION MITIGATION

## GCP



## ICCP



Clematis D., etc, A Critical Analysis on the Current Design Criteria for Cathodic Protection of Ships and Superyachts, 2022

➡ Which system should be designed?



# Installation of GCP



This is a system negative connection for the CP system.

- Drill with steel drill bit
- Stainless steel self tapping screw
- Alternative connection via clamp
- Fully encapsulated in epoxy

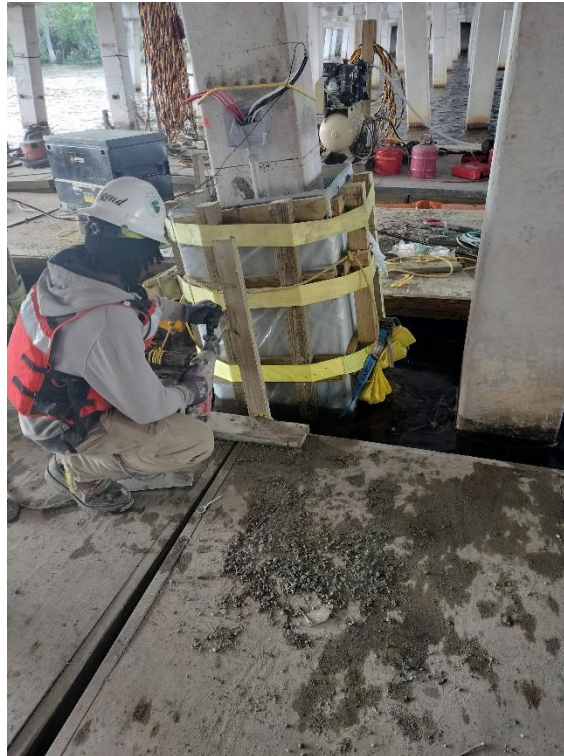




# Installation of GCP

## Goodbys Creek Project in Jacksonville

Before jacket install.  
After continuity corrections.



Beginning of concrete filling.

Near end of concrete filling. Trying to push the last of the water out before filling from top.



Three completed jackets with 45-degree chamfers and an energized CP system.

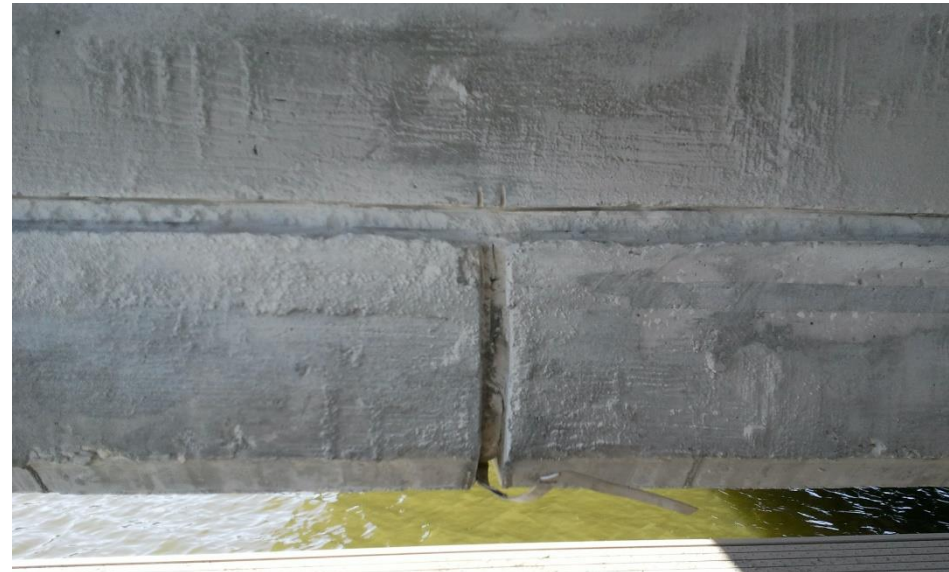
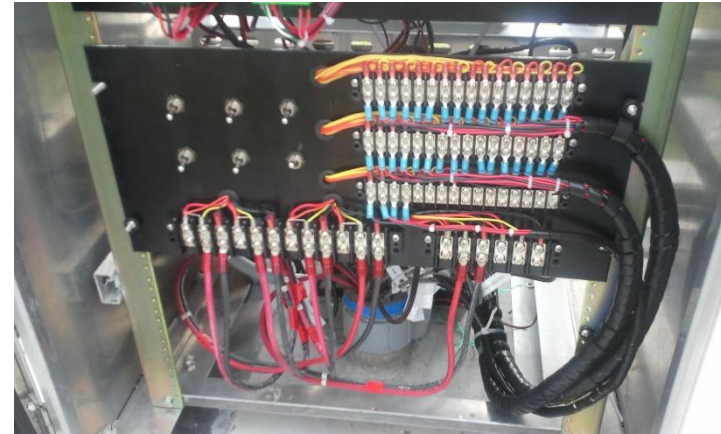
# GCP BRIDGES STATUS

- There are 206 bridges with GCP. In all districts.
- About 100 inspections per year.
- They are inspected on a continuous 2-year cycle.
- GCP is not remotely monitored yet. The technology has been developed by SMO for this. The ability to fund a project of this scale has not been sourced yet.
- On average, five new galvanic systems are designed and built each year, adding to the total inspected every year.



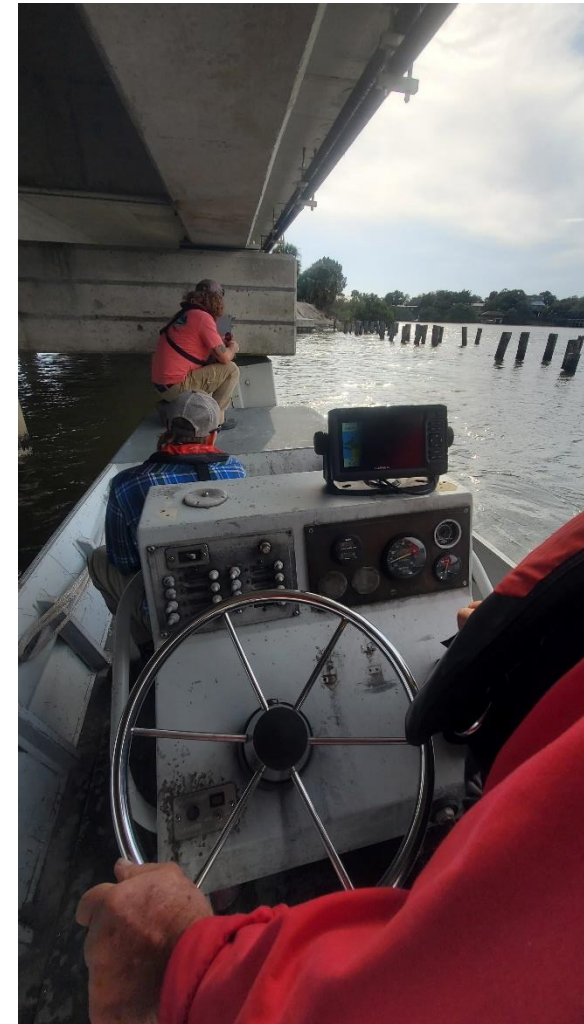
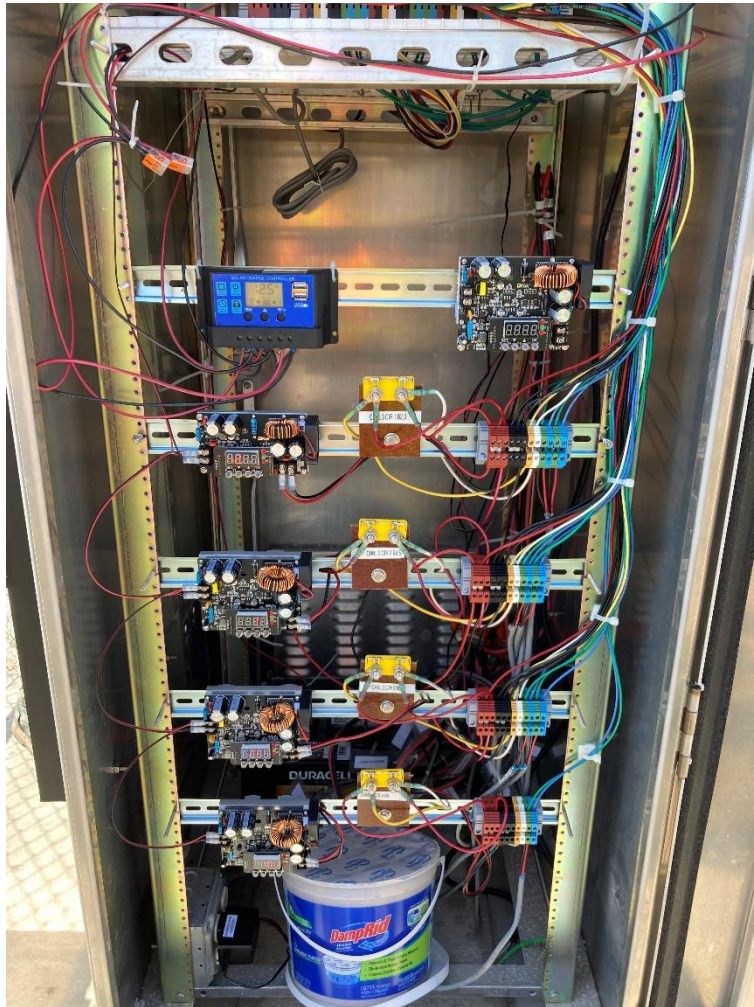
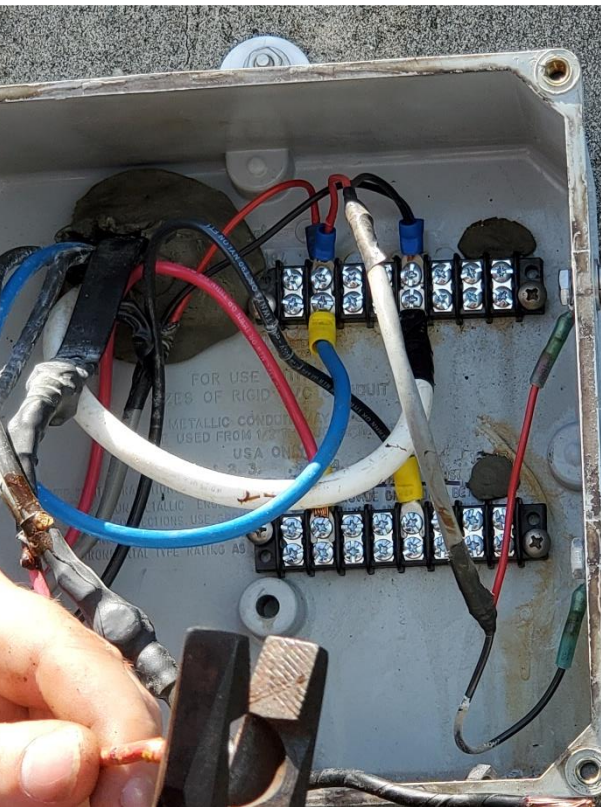
# Installation of ICCP

## Installation of ICCP system at Cedar Key with an anode ribbon





# Inspection of ICCP





# Solar Upgrade for ICCP System

## US-192 Solar Upgrade for ICCP System



# ICCP BRIDGES STATUS

- There are 37 bridges with ICCP. They are in Districts 2, 3, 4, 5, 6, and 7.
- 11 bridges with ICCP are solar powered.
- Six have remote monitoring capability and are inspected on a continuous 6-month cycle.
- 12 inspections per year.
- The remainder are inspected on a continuous 2-month cycle.
- 372 inspections per year.
- Seven more are scheduled for remote monitoring over the next two years.

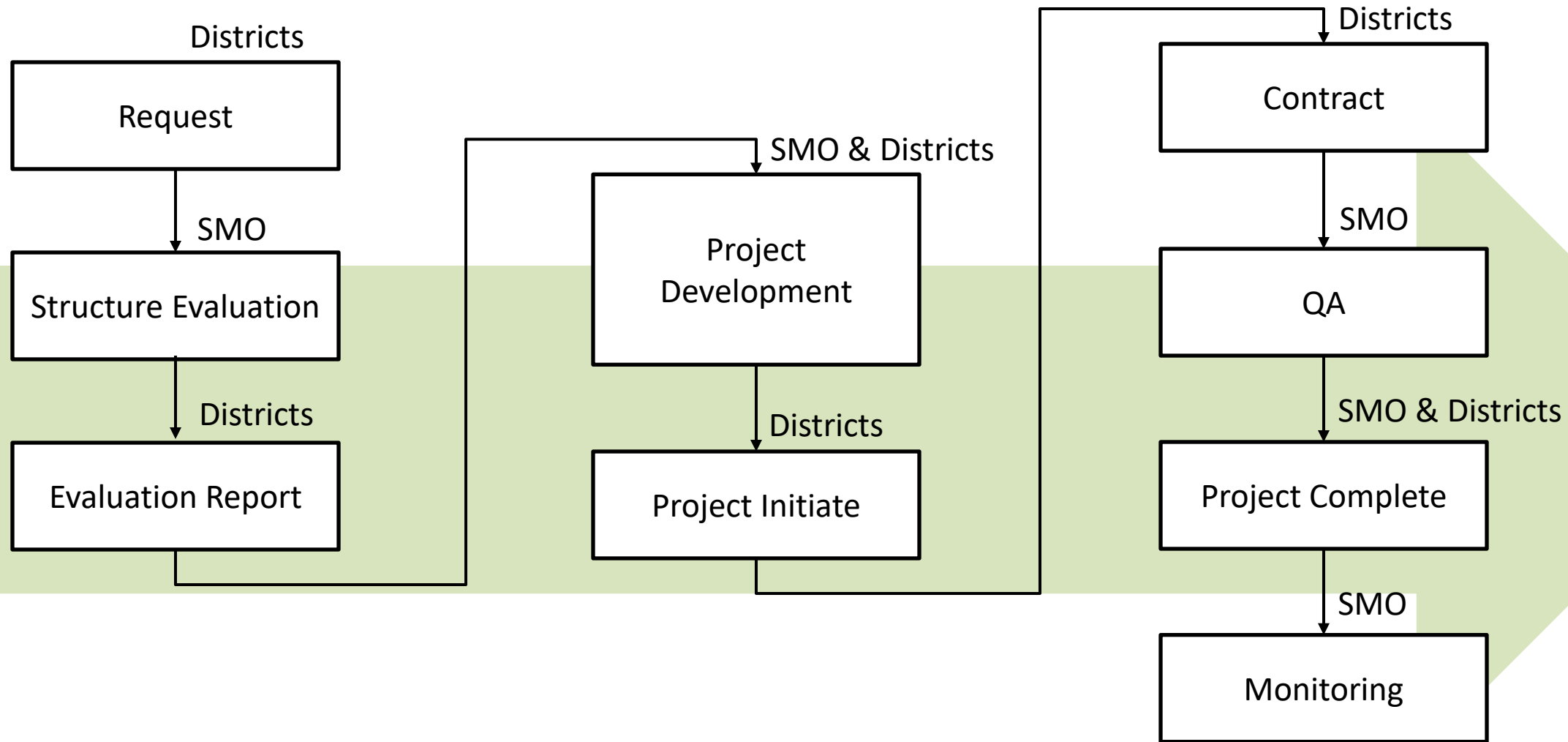
# GCP VS ICCP

Attribute	GCP (TSP T 457)	ICCP (Finalizing TSP)
Power	No external power need	External power required
Inspection Frequency	Two years (required by FHWA)	Six months (SMO frequency)
Current Control	Standard designs do not provide current control. Resistors can be added to reduce current in special situations.	Current easily controlled using rectifier output adjustability.
Current Capacity	Limited current capacity (depends on the structure)	Greater current capacity (<10 amps)
Annual Cost	Lower	Higher
Expected Service Life Before Rehabilitation	< 20 years	> 20years

<https://www.fdot.gov/programmanagement/otherfdotlinks/technical-special-provision-library/tsp-library>



# CP SYSTEM PROJECT DEVELOPMENTS



**Bridge Monitoring System**

# REMOTE MONITORING SYSTEM

- Data
  - Current output
  - Voltage output
  - Current and voltage input
  - Returning potentials (-800 mV)
  - Time & date
- Future Optional Upgrades
  - Weather station
  - Traffic camera
  - Scour monitoring system

 **Bridge Monitoring System**

# CONCLUSION

- SMO and its consultants provide inspections of existing cathodic protection systems.
- SMO inspects bridges for the districts that may have corrosion.
- SMO develops new cathodic protection systems that work more efficiently, last longer, and cost less.

# OFFICE OF MATERAILS – CMD TEAM

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"I have a  
question!"

