



# Liabilities to Assets

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IRON OXIDE



REFINING



MILLING



STEEL



CORROSION



IRON OXIDE

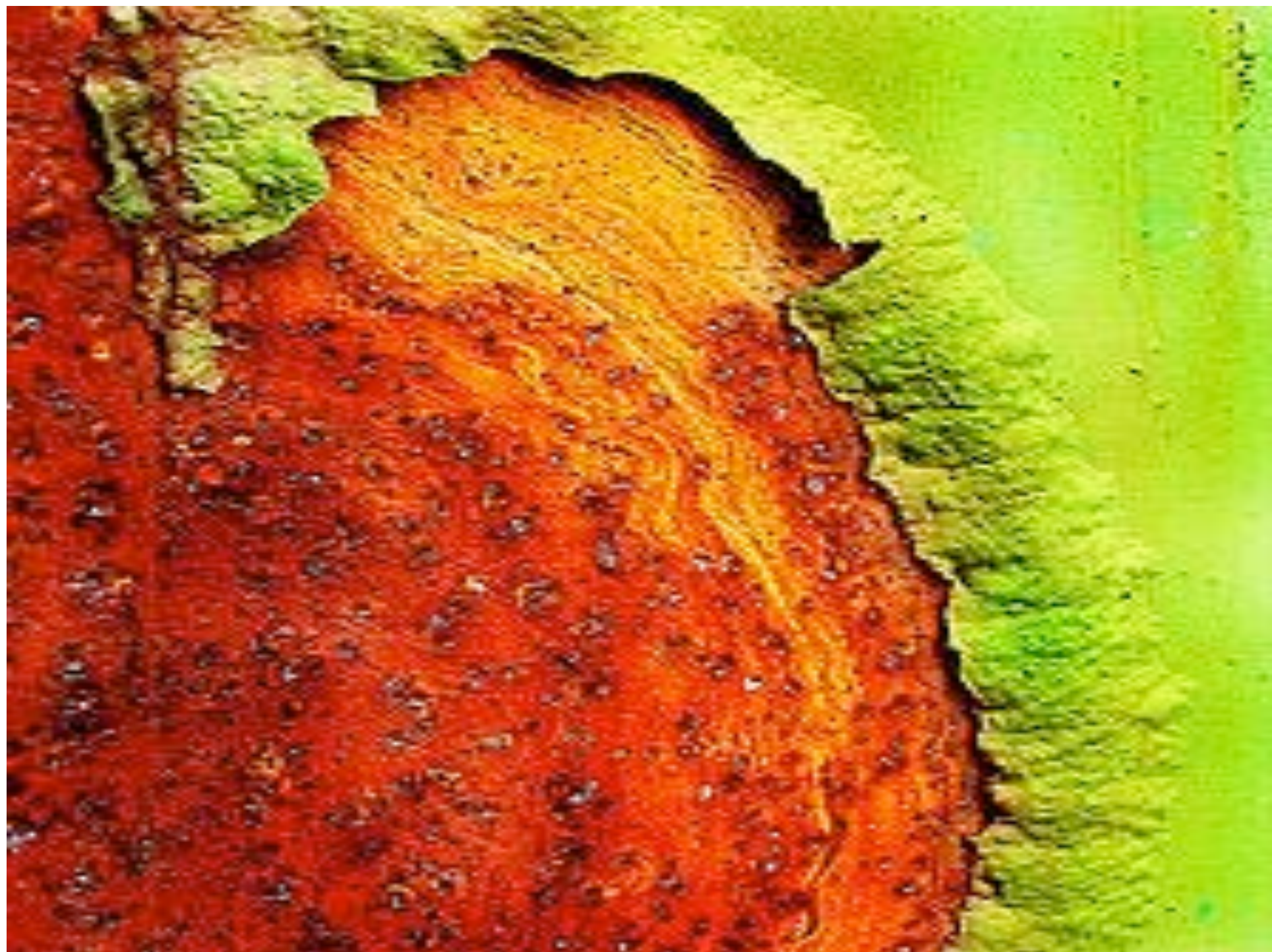
***THE PROBLEM.....***





# Why Provide Corrosion Control?

- **Regulatory Compliance**
- **Preserve Assets That Have Become LIABILITIES!**
- **Dramatically Reduce Likelihood of Product Releases**
- **Significantly Reduce Maintenance Costs**
- **Environmental Preservation**





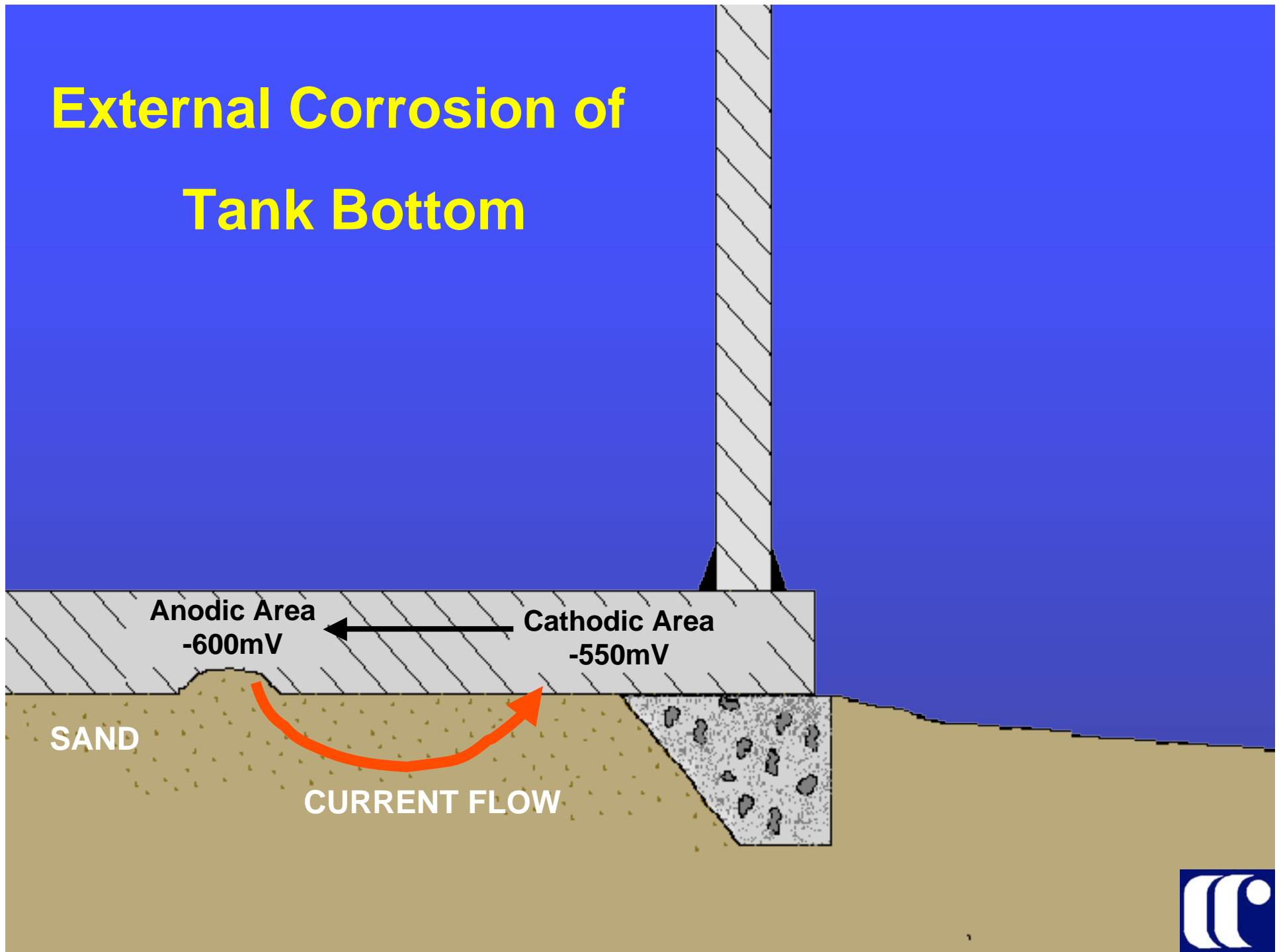


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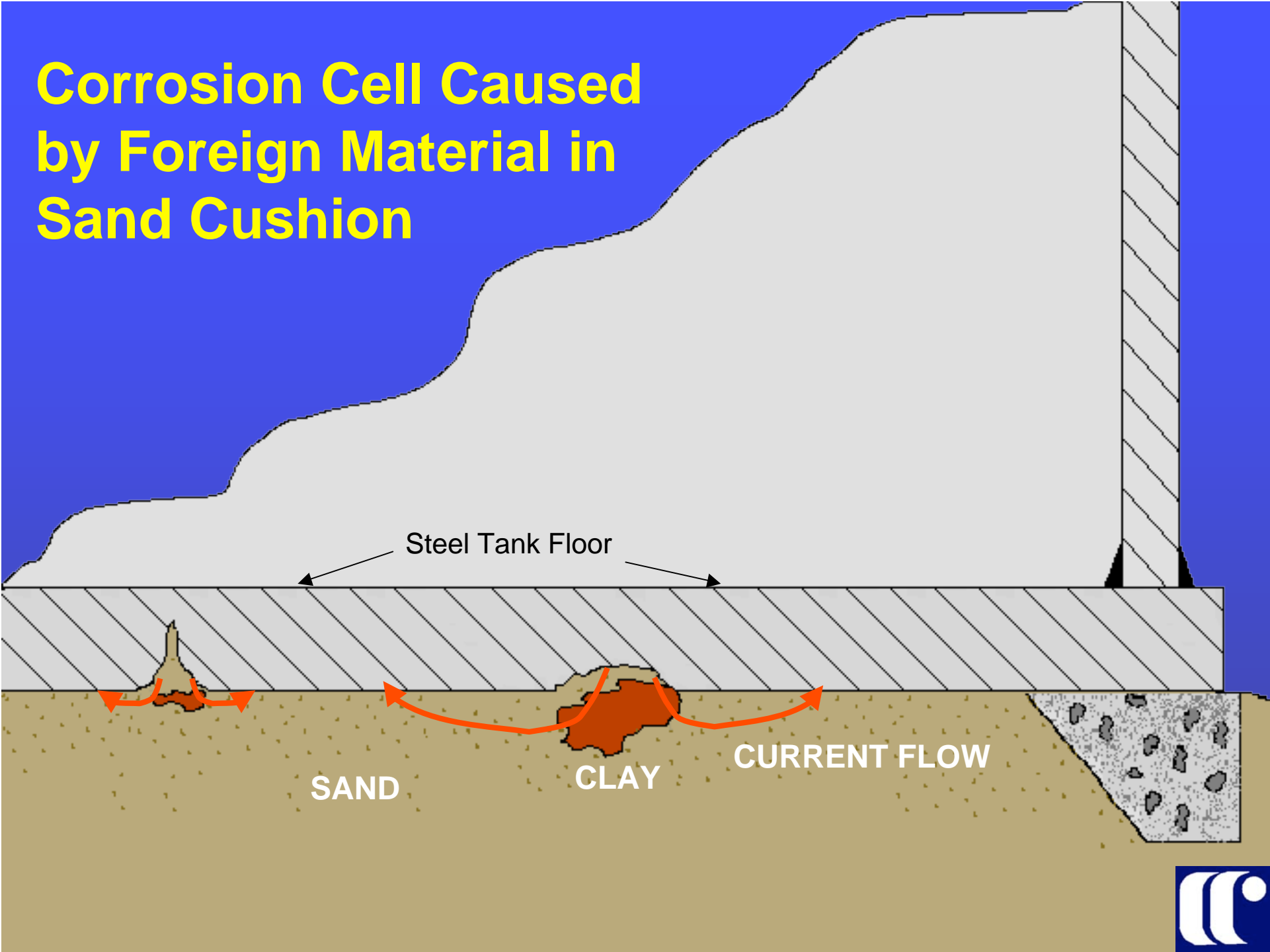




# External Corrosion of Tank Bottom

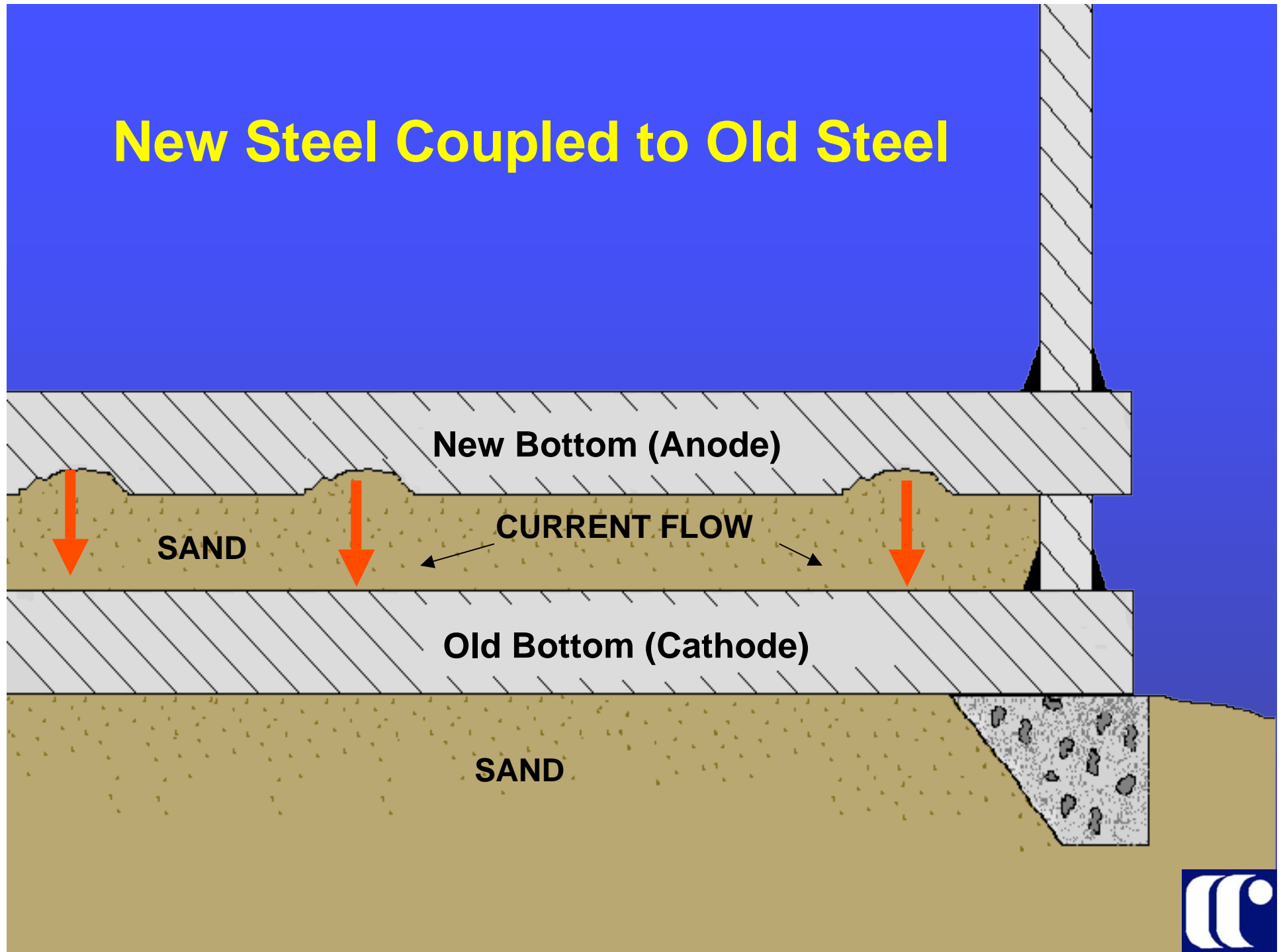


# Corrosion Cell Caused by Foreign Material in Sand Cushion

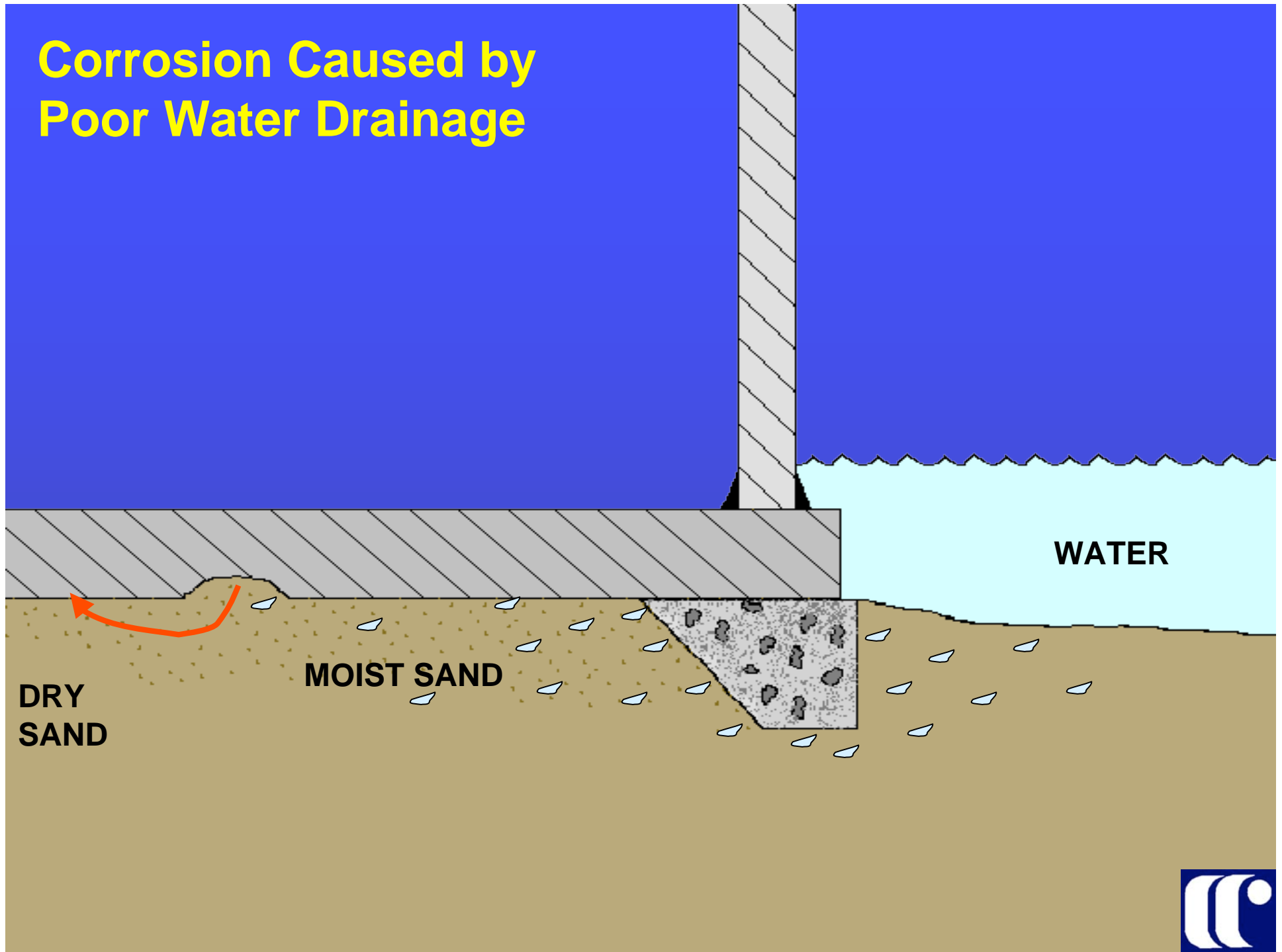




# New Steel Coupled to Old Steel



# Corrosion Caused by Poor Water Drainage



## **State Level**

- **Approximately 25% of States now require cathodic protection be installed and maintained on new, refurbished, or repaired tanks in contact with soil or sand foundations.**
- **A number of other states are in the process of implementing regulations governing AST's.**

# MAJOR OIL

- **Vast Majority of Oil Marketers Have Employed CP for Decades**
- **Laws Changing Dramatically**

# Types of Cathodic Protection

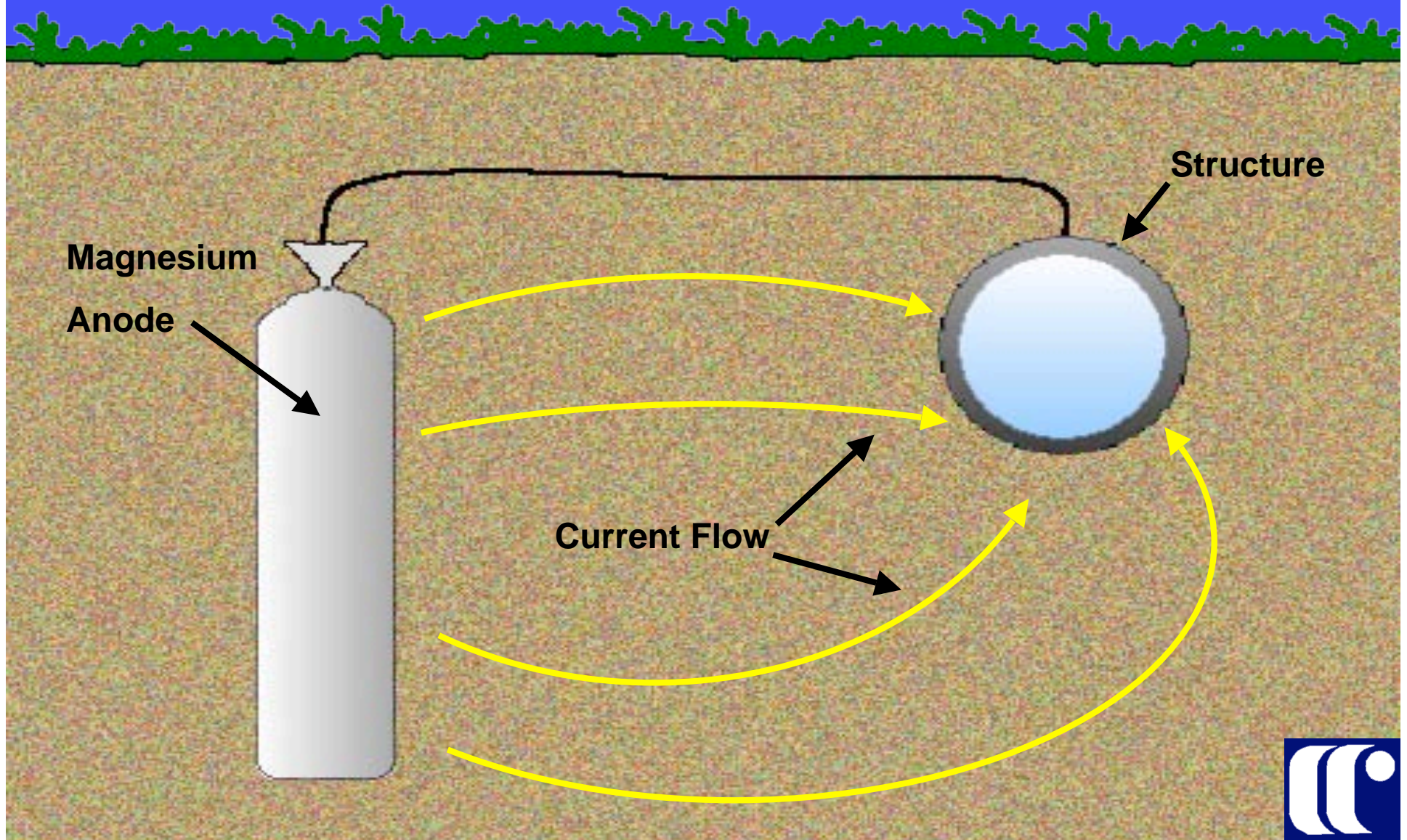
**Galvanic: Current obtained from a metal with a higher energy level.**

**Impressed Current: Requires external power source (transformer rectifier).**





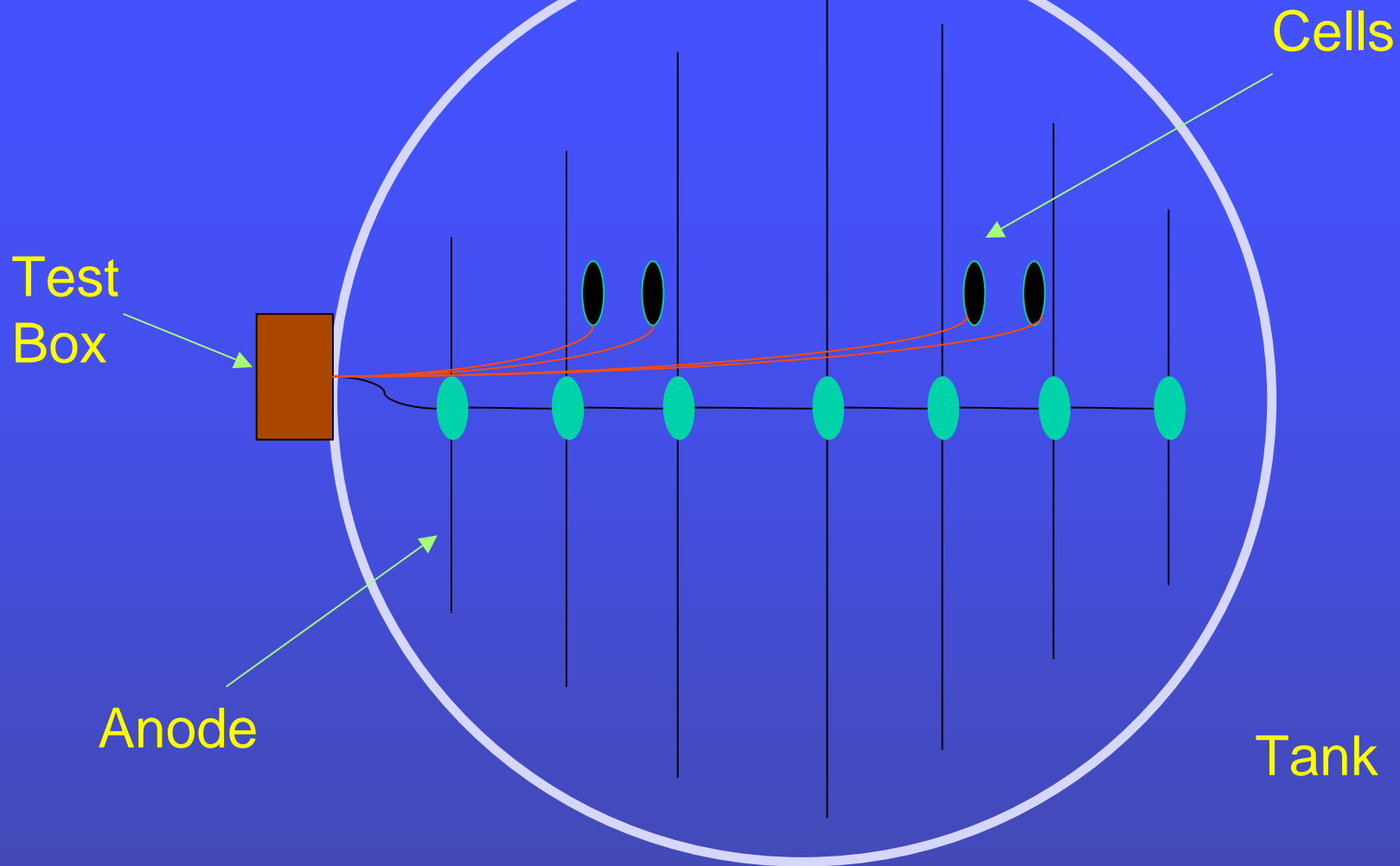
# Galvanic Cathodic Protection



# Galvanic System

- **Difficulty in meeting NACE -850mV Criteria**
- **Sand Quality impacts anode performance / life**
- **Typically Very Short Life / Poor Track Record**
- **Not recommended for large diameter AST's**





# Galvanic Anodes



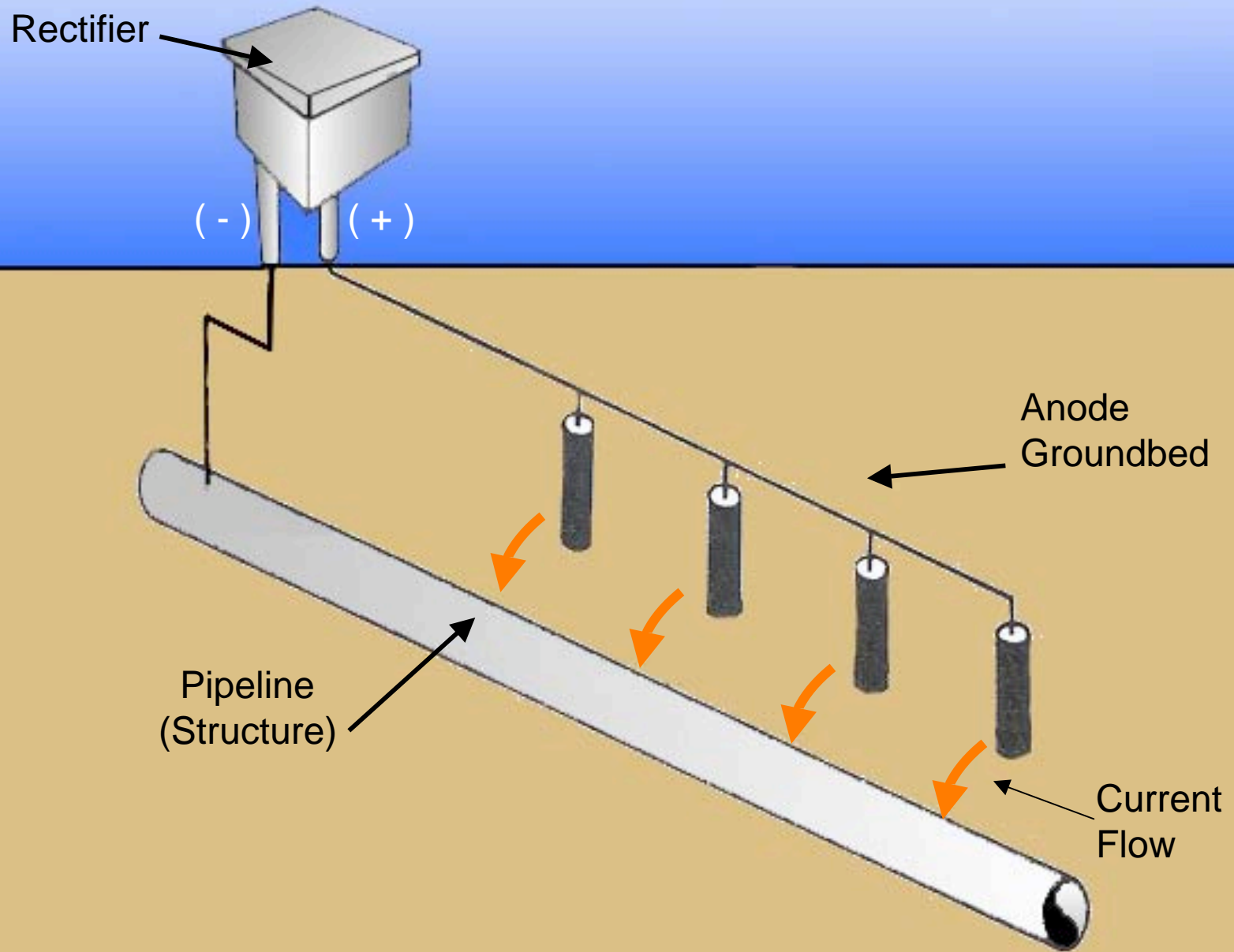
# SAND QUALITY

- **The rate of corrosion is dependent on the characteristics of the sand.**
- **The 1<sup>st</sup> means of corrosion control is a good quality sand material.**
- **On-site testing has indicated that provided sand is as much as ten times more corrosive than recommended sand.**

# Sand Recommendation

- **Silica**
- **pH Between 6.5 and 8.5**
- **Moisture less than 5%**
- **Chlorides less than 10 ppm**
- **Resistivity greater than 30,000 ohm-cm**

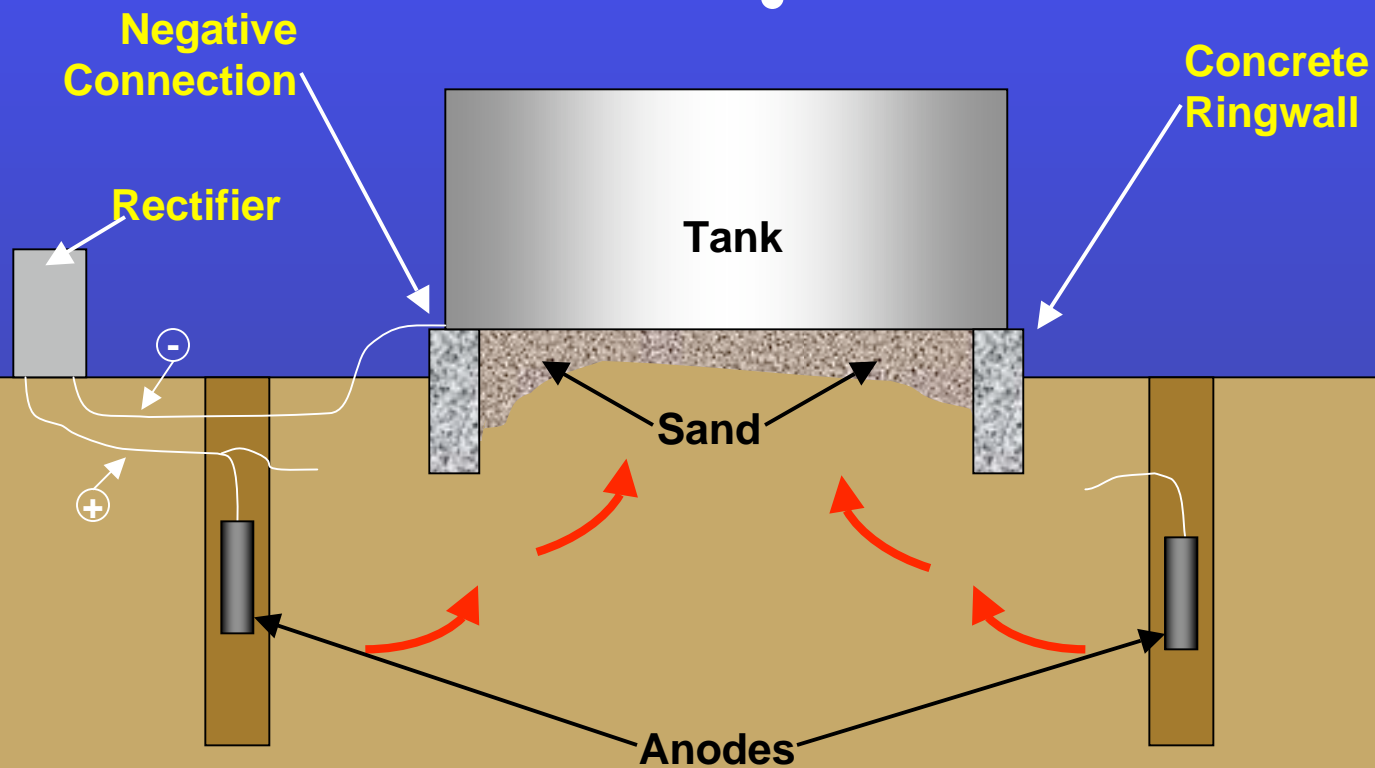
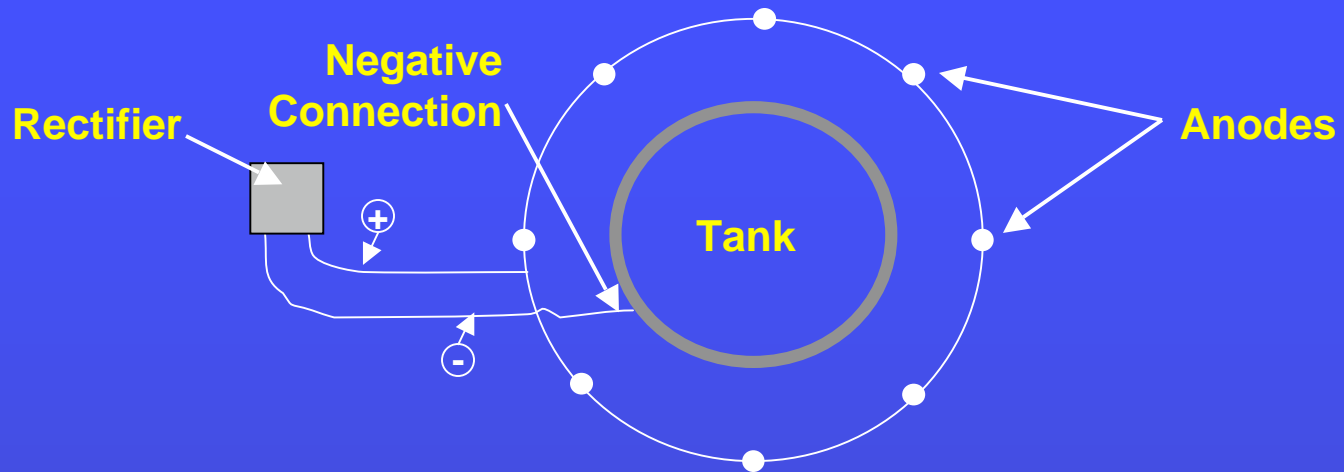
# Impressed Current System





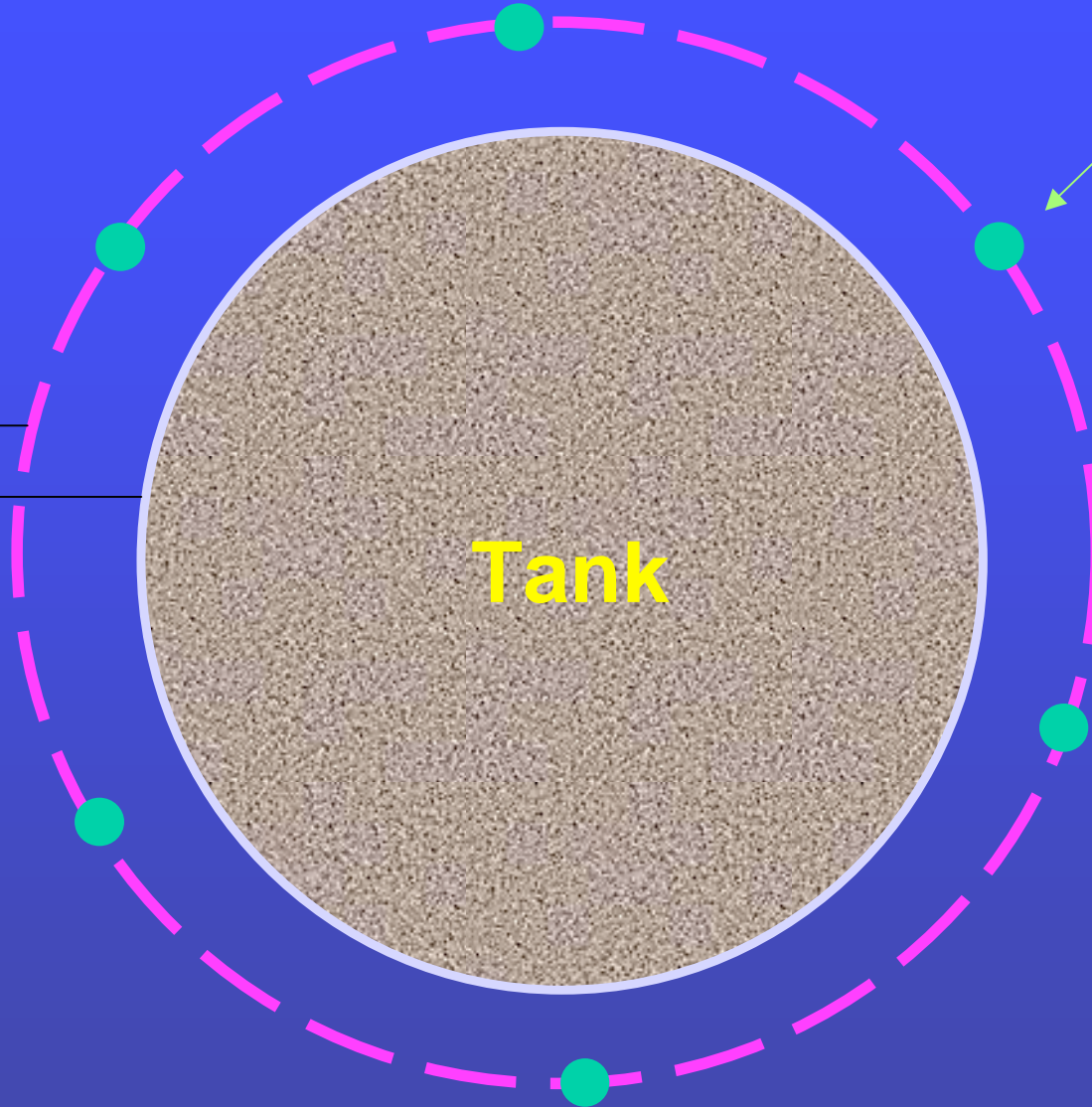
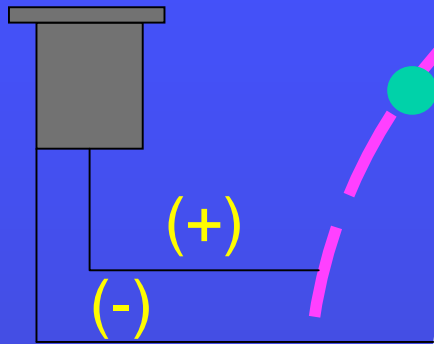


# Above Ground Storage Tank Vertical Impressed Current Anodes - Existing Tanks



Rectifier

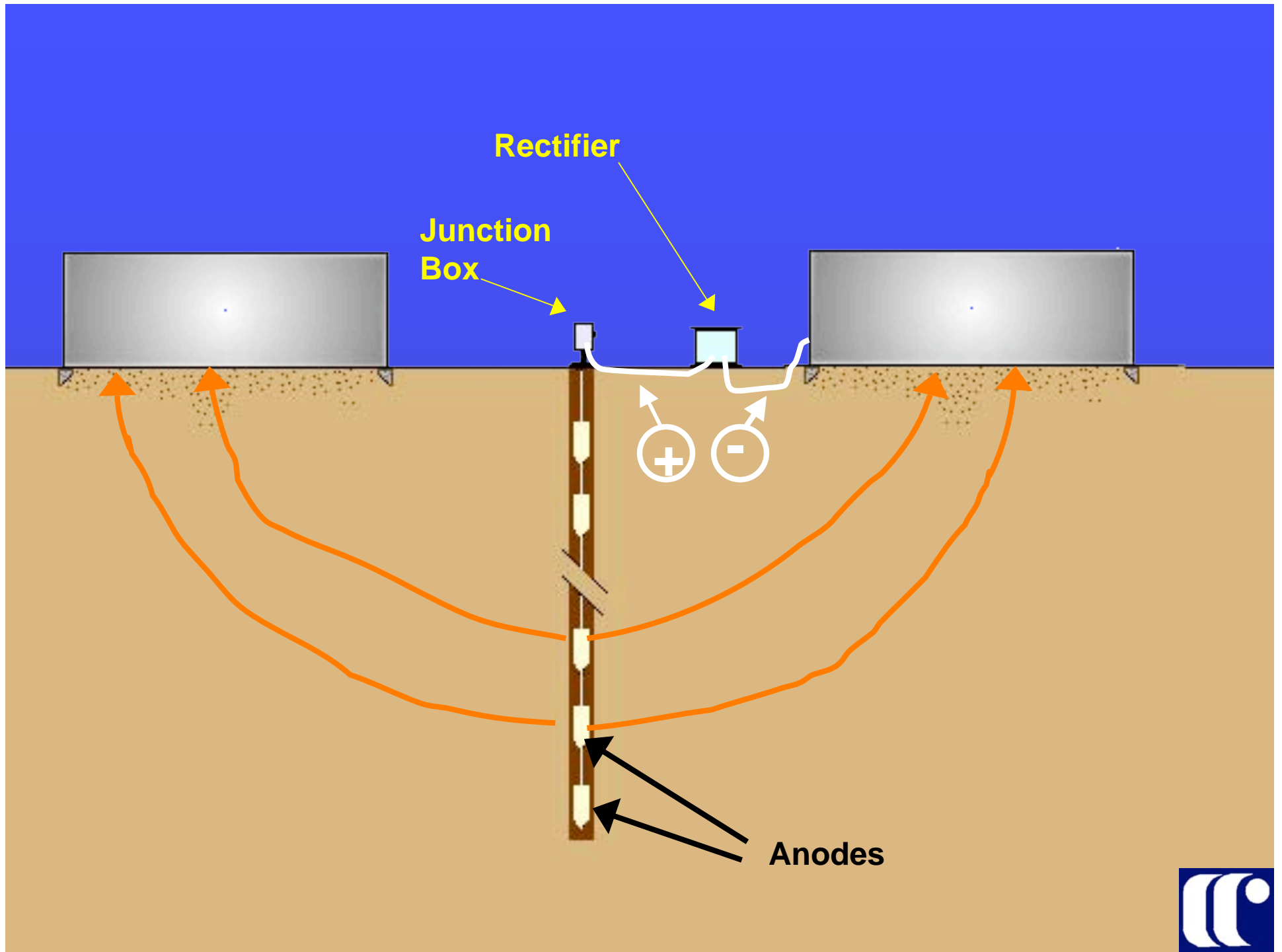
Anode



Tank

# Shallow Anodes



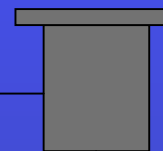




(+)

(-)

Rectifier



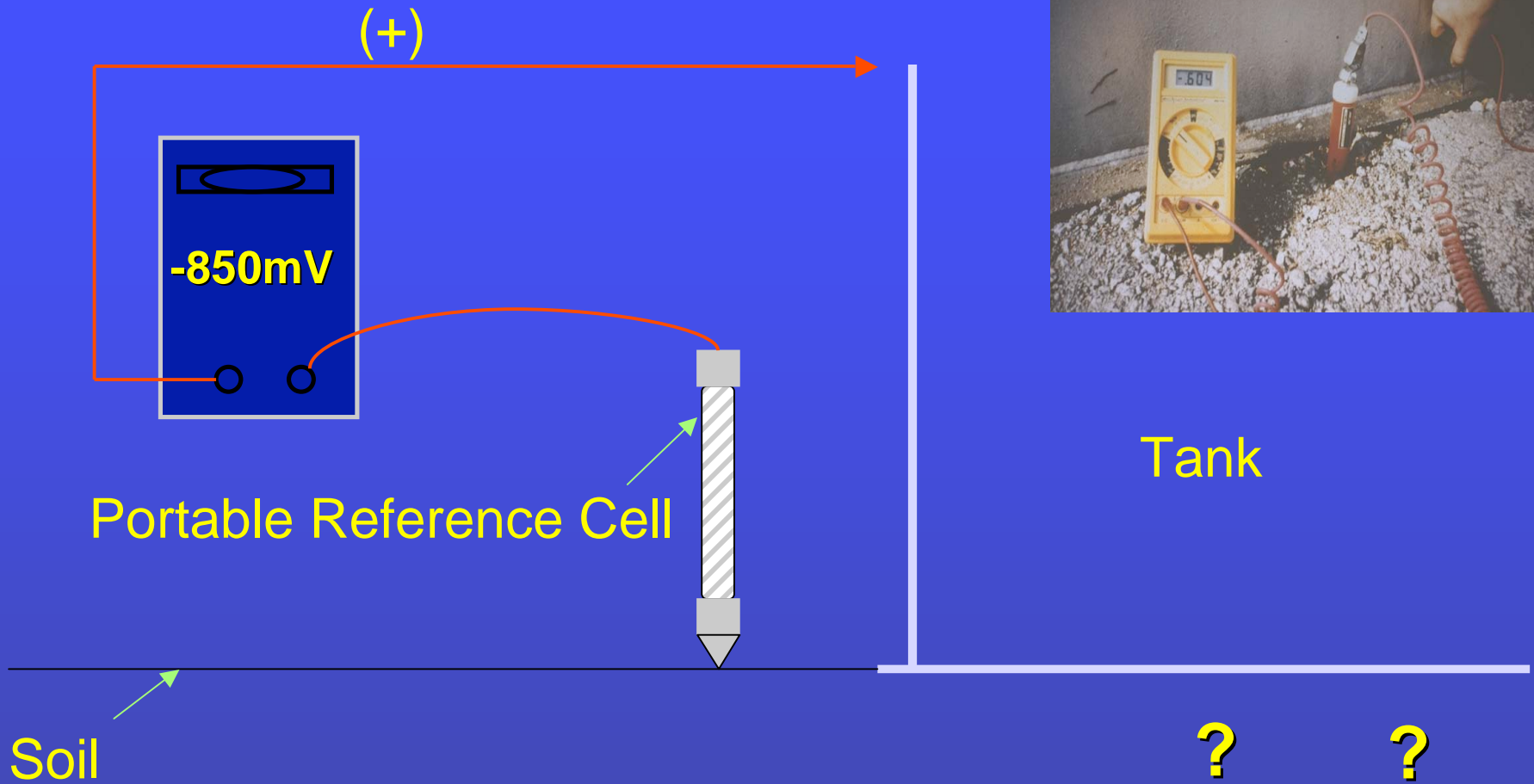
Deep Anode



## MFL Floor Inspection

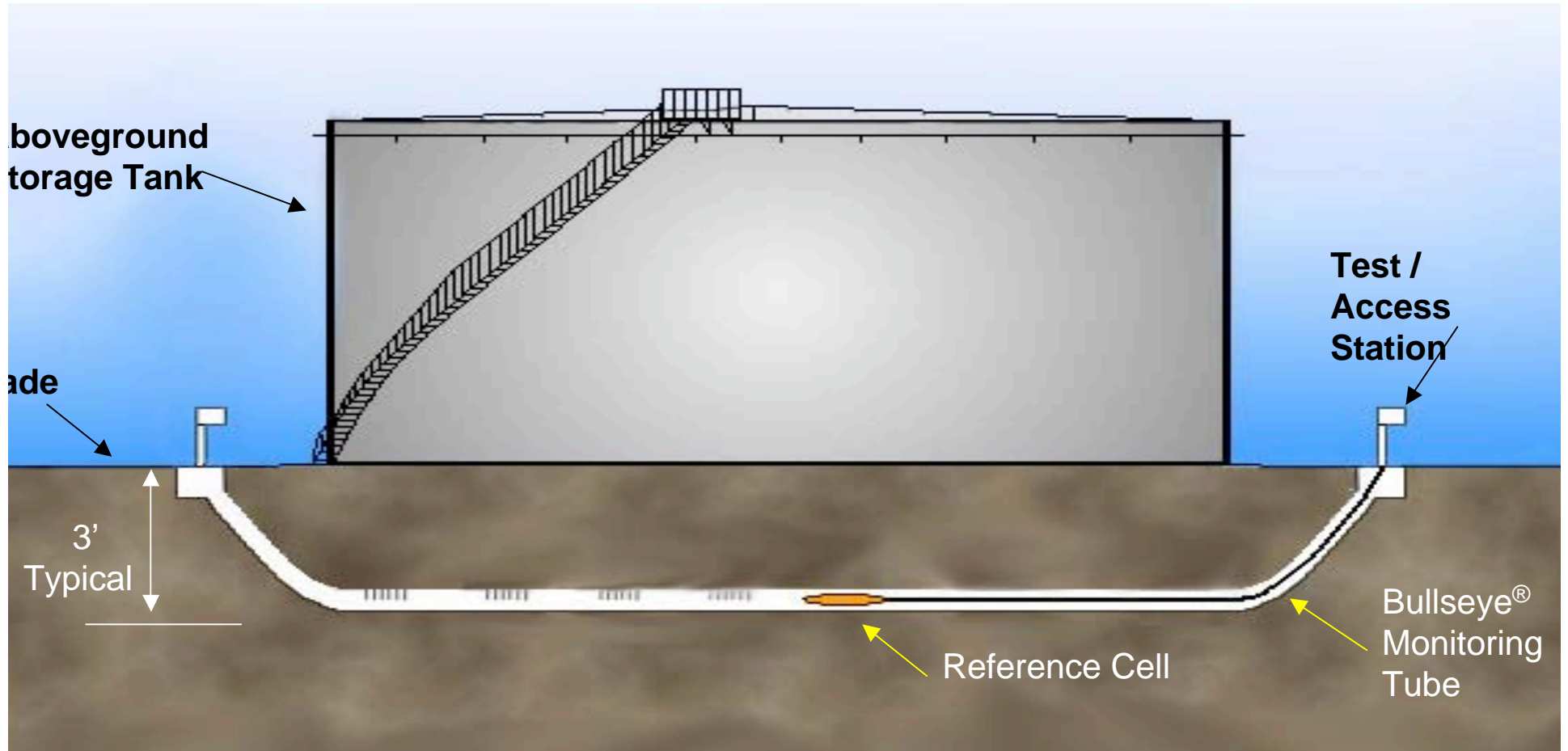
# Mechanical Integrity

- **API-653 Inspections Should Coincide With the Results of a CP System Evaluation**
- **Corrosion Engineers and Mechanical Inspectors Must be on the Same Page**



# Rim Potential Measurements





	Rim	25'	Center	55'	Rim
<b>On</b>	-1411	-698	-404	-601	-1455
<b>Off</b>	-902	-664	-402	-578	-911

Potentials (mV)

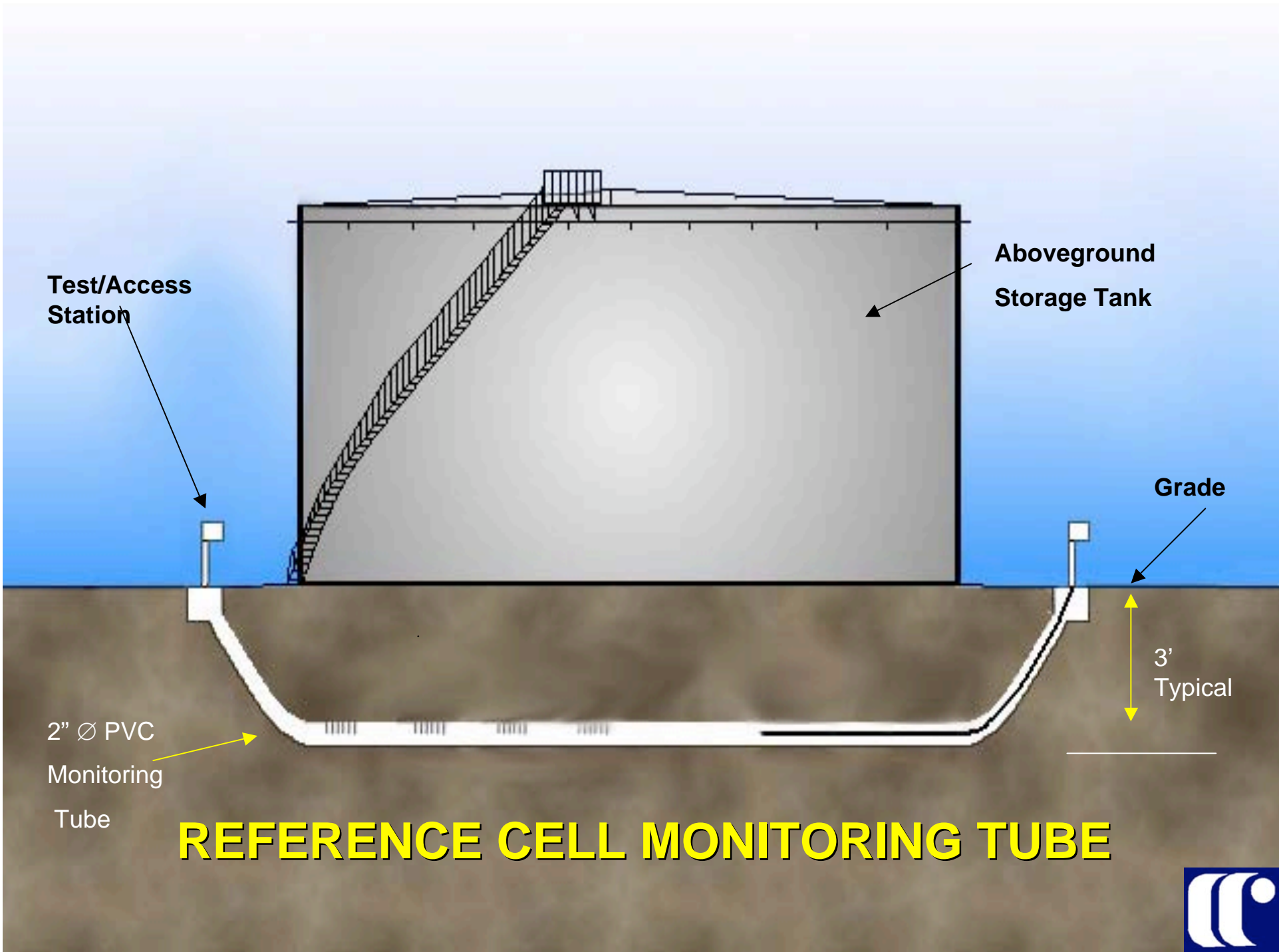






## Directional Boring Under Existing AST



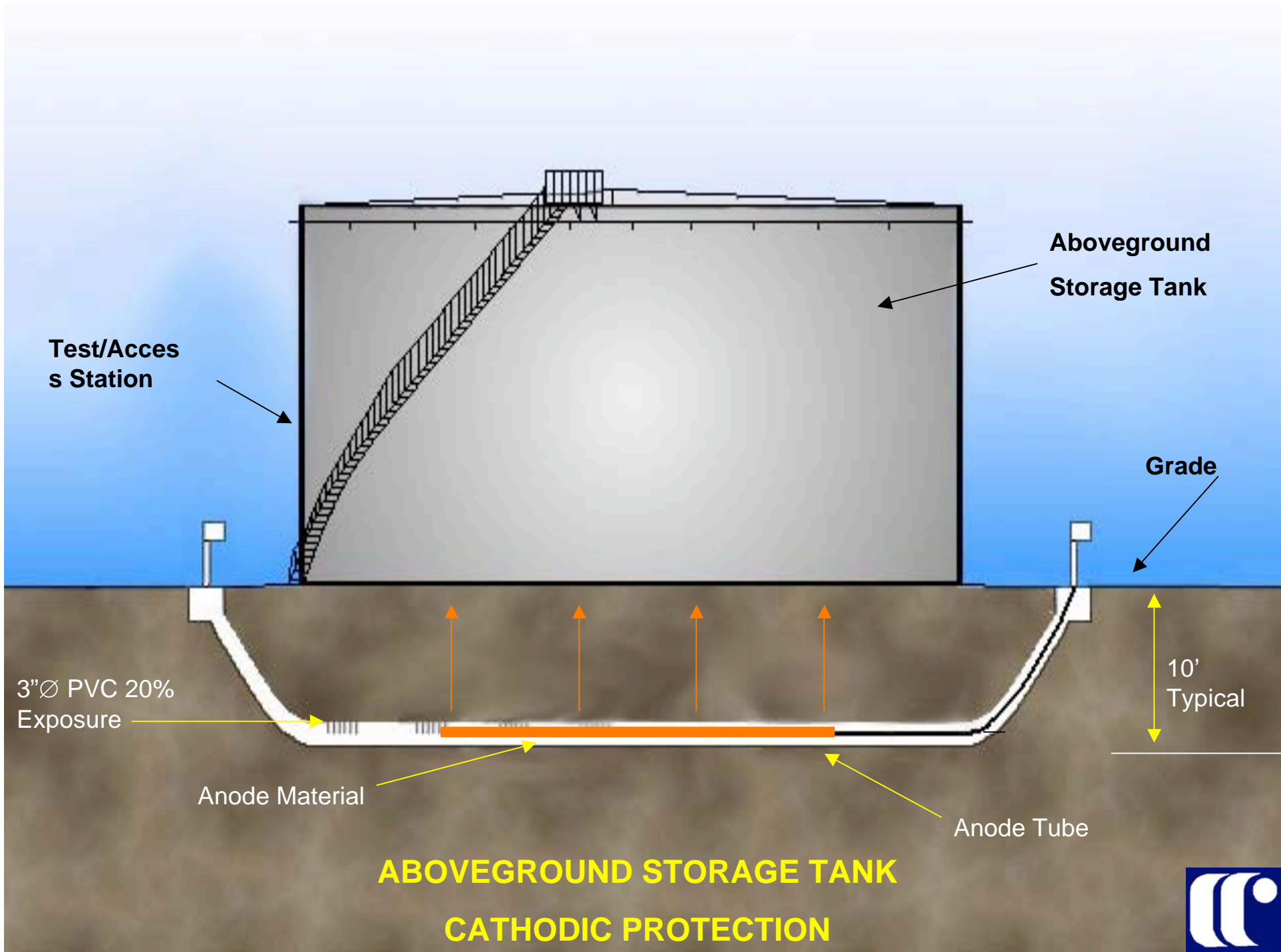


# REFERENCE CELL MONITORING TUBE



## *Directional Bore Under Tank for Anode or Reference Cell Placement*

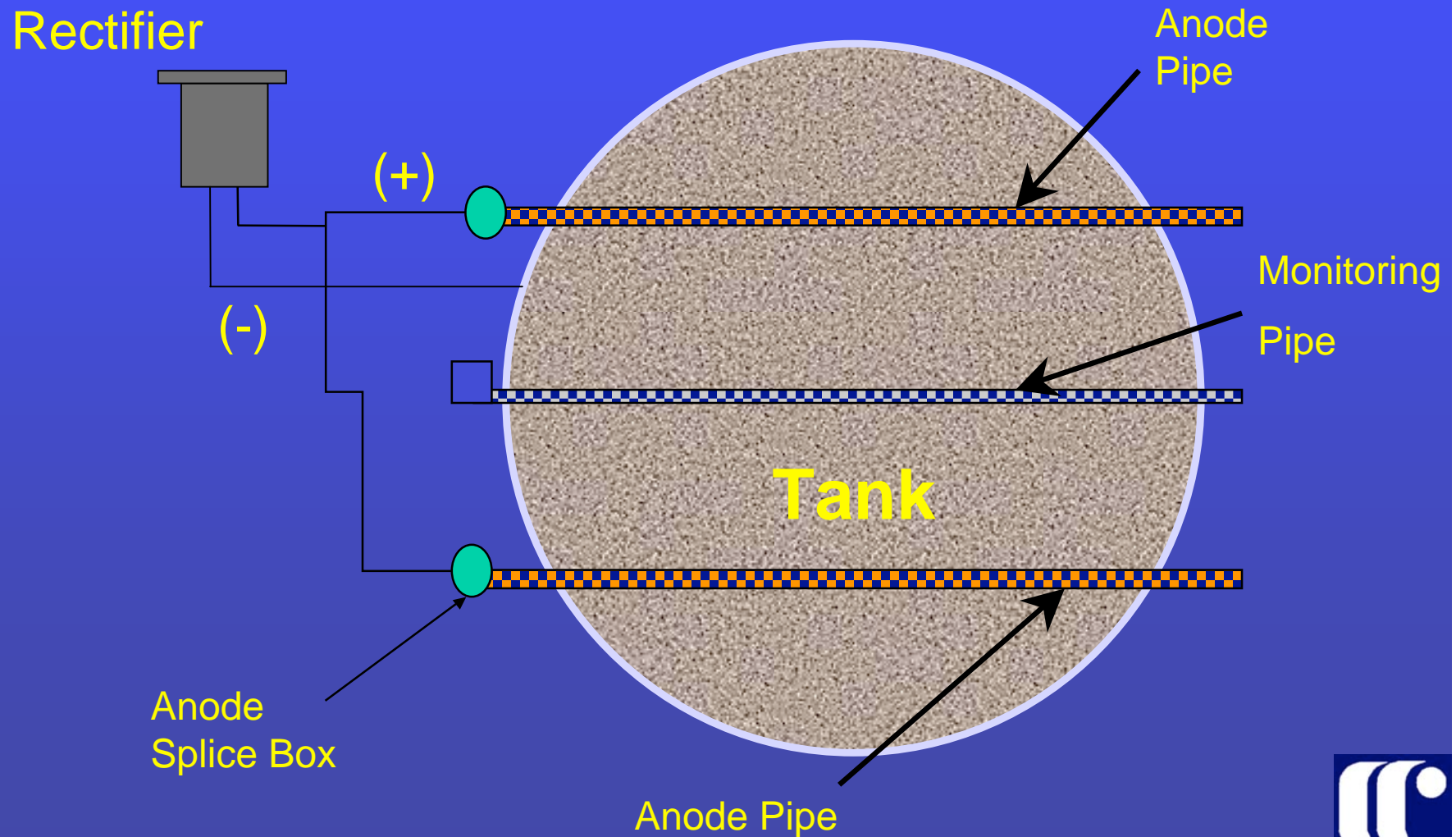




**ABOVEGROUND STORAGE TANK  
CATHODIC PROTECTION**



# Computer Guided Horizontally Bored Anode System



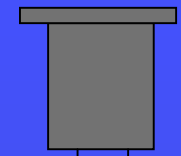
# CP Applications for Re-bottomed or New Tanks



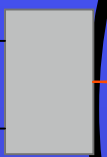


**New Floor Installation on Existing AST**

Rectifier



(-)  
(+)



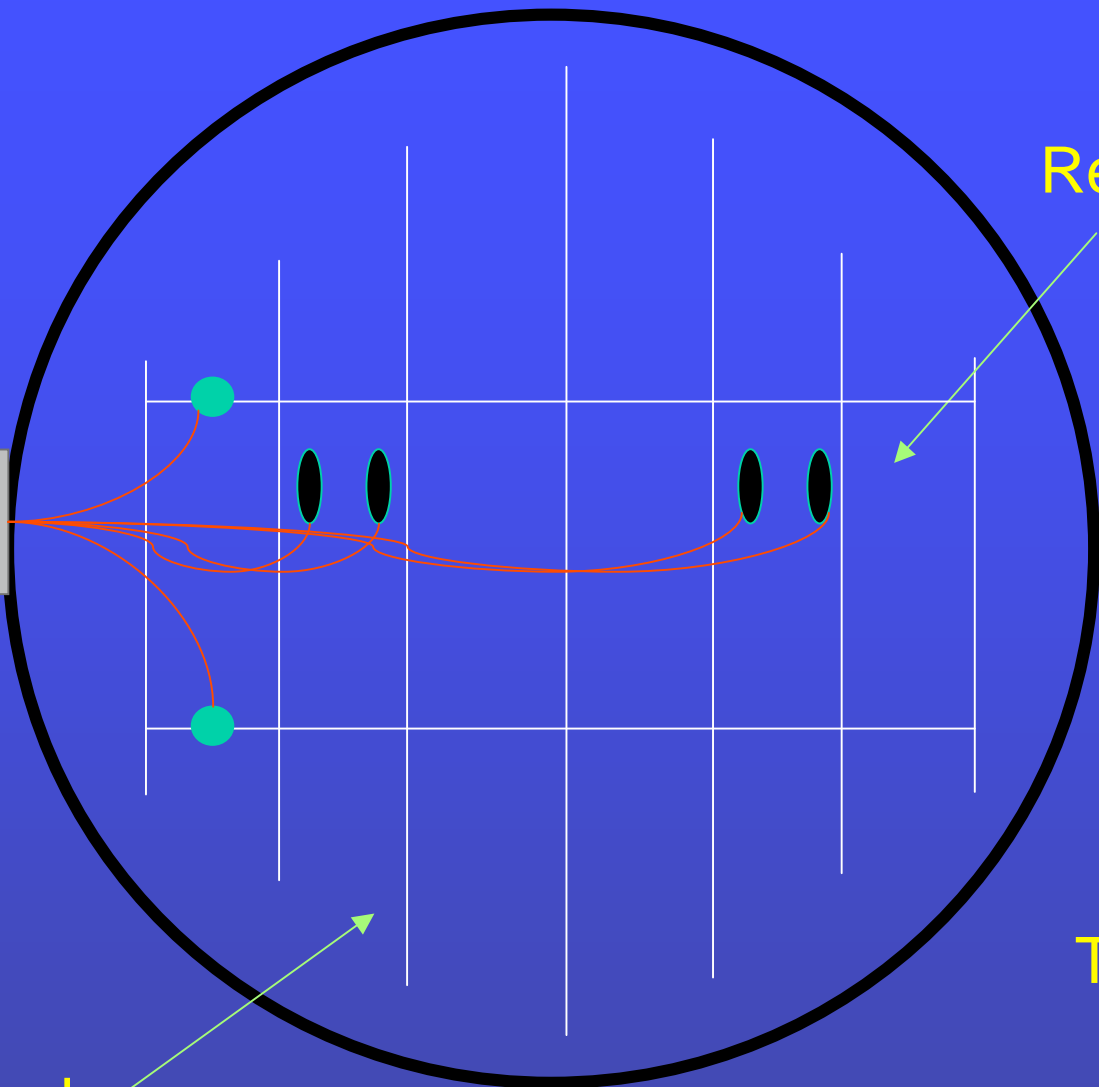
Junction  
Box

Anode

Reference  
Cells

Tank

Impressed Current







**CP Installation on Rebottomed Tank**

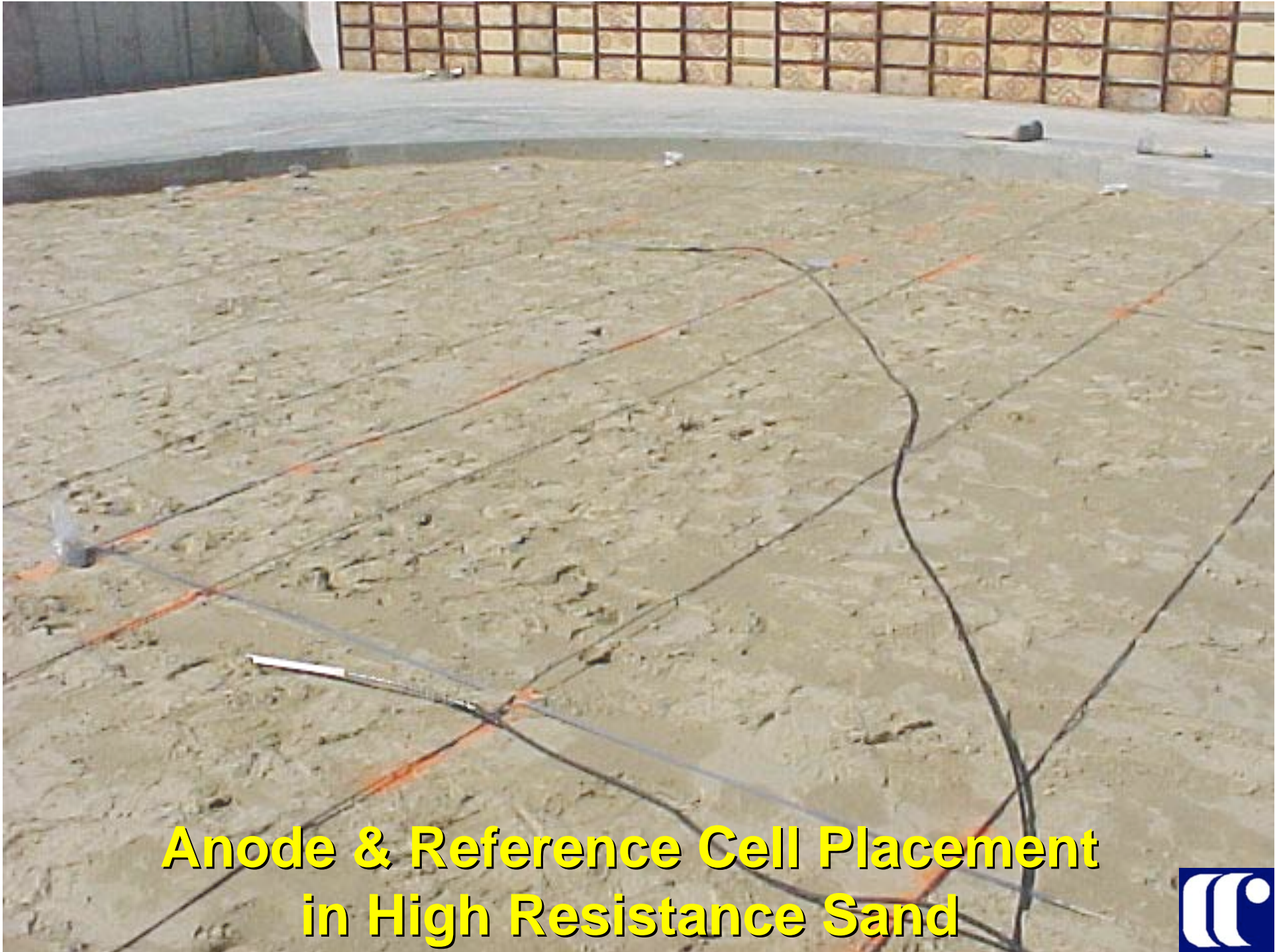
**Above Ground  
Storage Tank Bottoms  
with Secondary Containment**





**New Tank Construction with Liner**

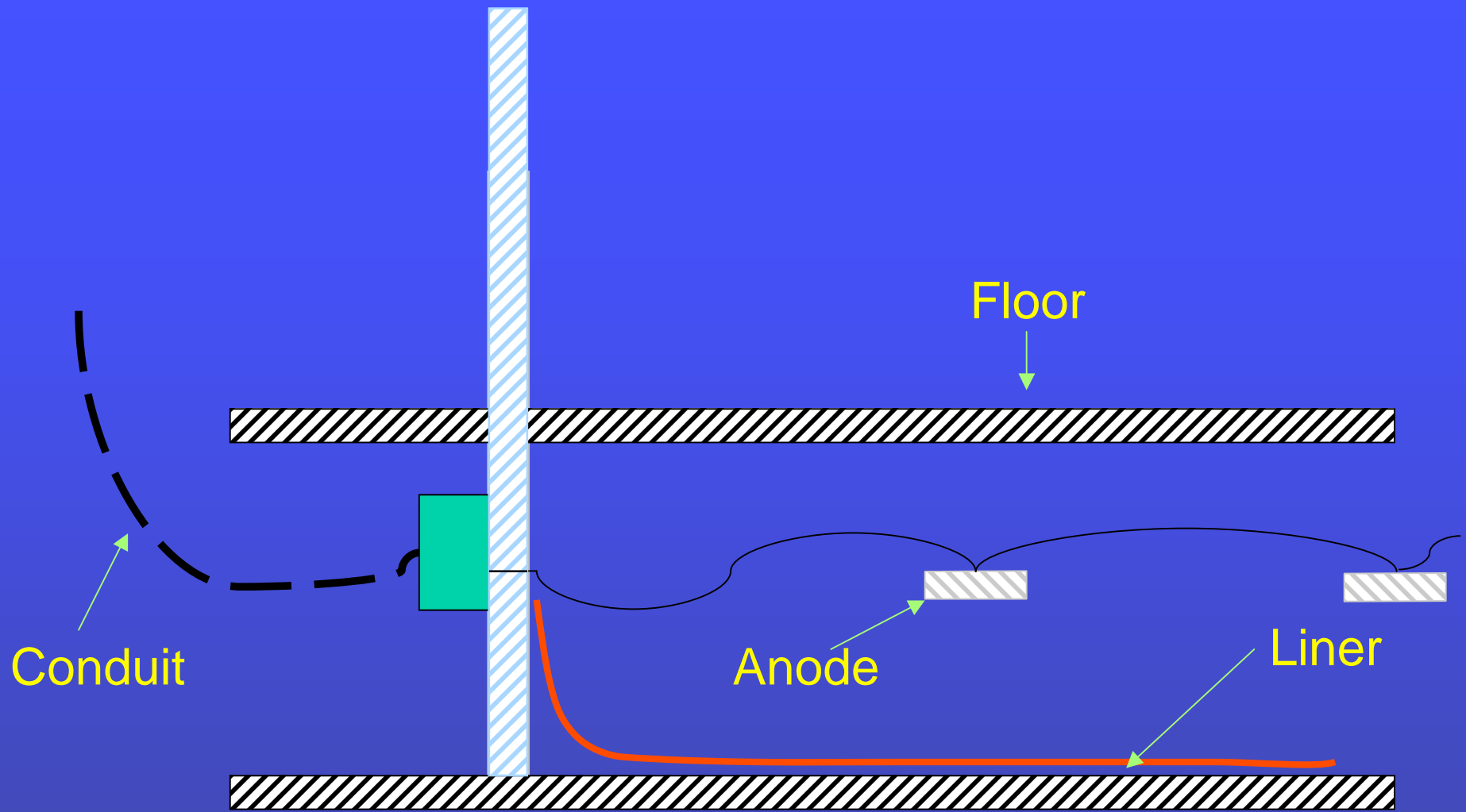




**Anode & Reference Cell Placement  
in High Resistance Sand**







## CP Installation on Double Bottom Tank



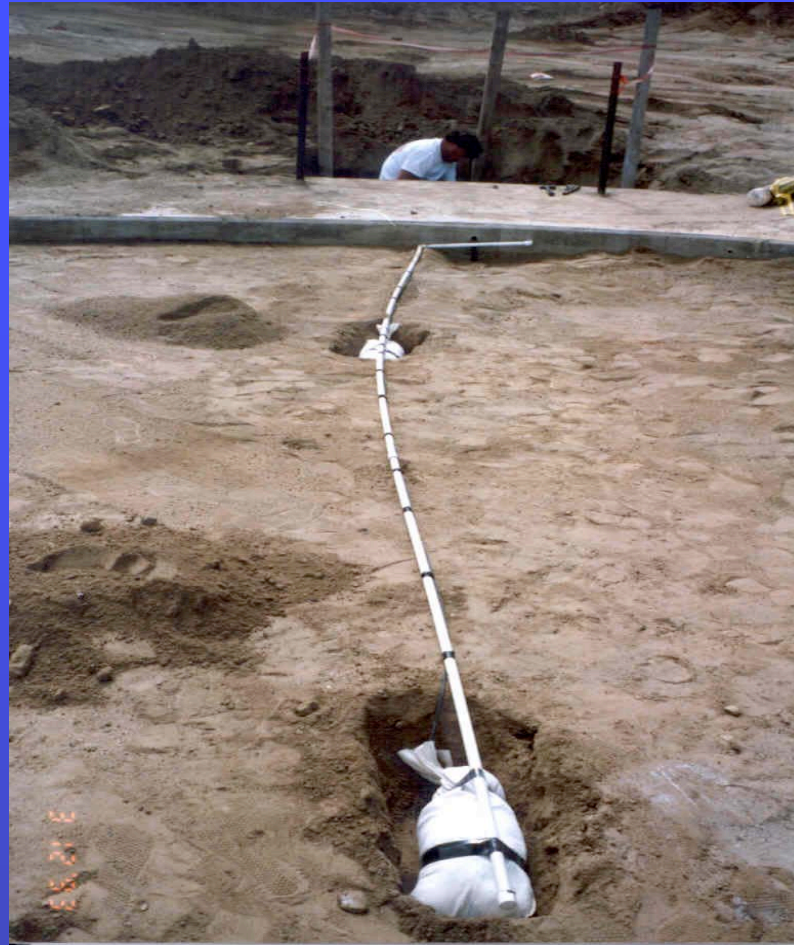
# Installation of CP System on Lifted AST



# *Explosion Proof Unit*





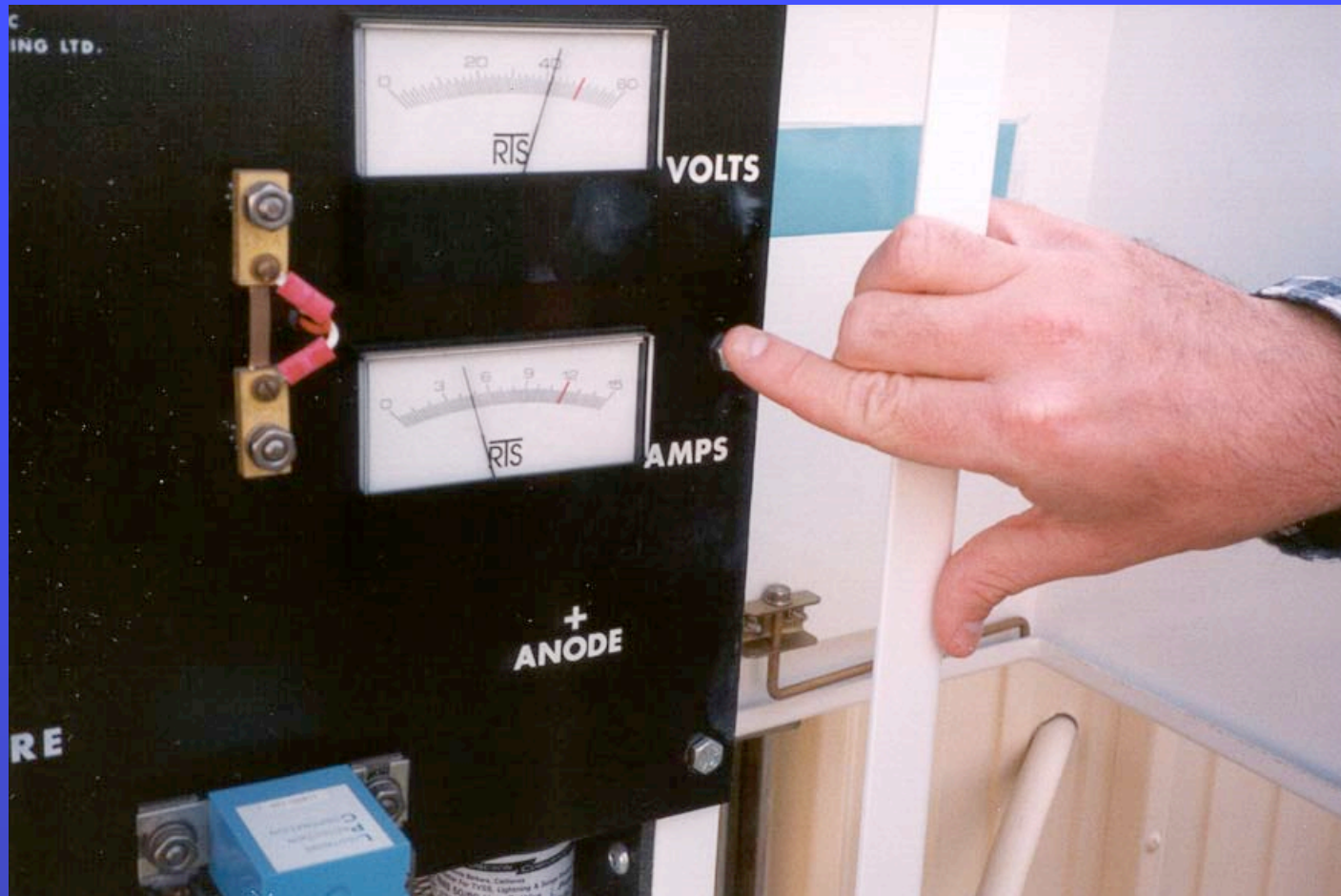


**Reference Cell Placement Under Tank Bottom**



# Inspection of CP System





- Record Volts/Amps
- Compare values to target settings





# Cathodic Protection Monitoring

- **Read rectifiers every 60 days.**
- **Conduct annual inspection (obtain potentials) by NACE certified individuals.**







**Annual Cathodic Protection Survey**







## Internal Corrosion



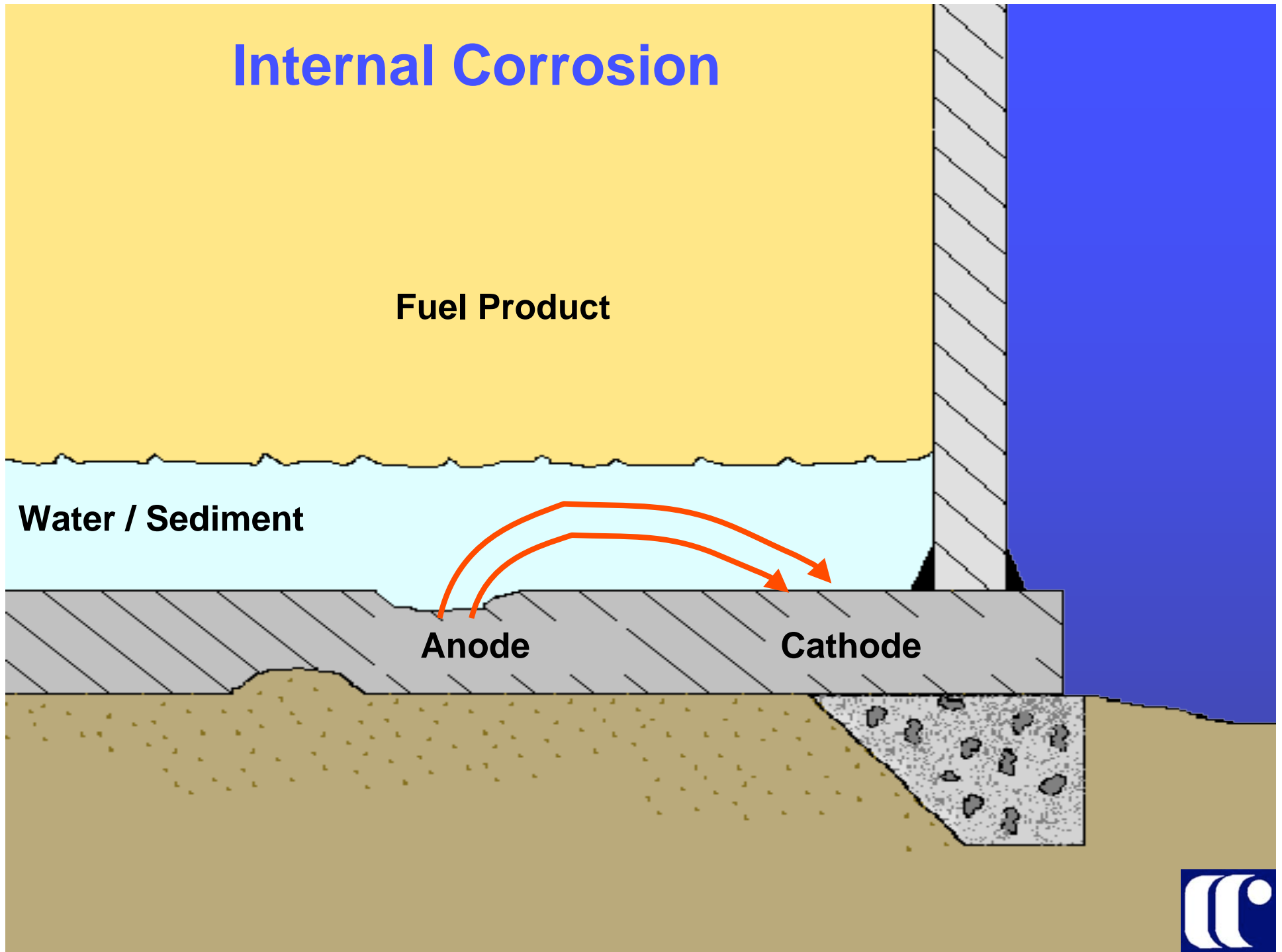
# Internal Corrosion

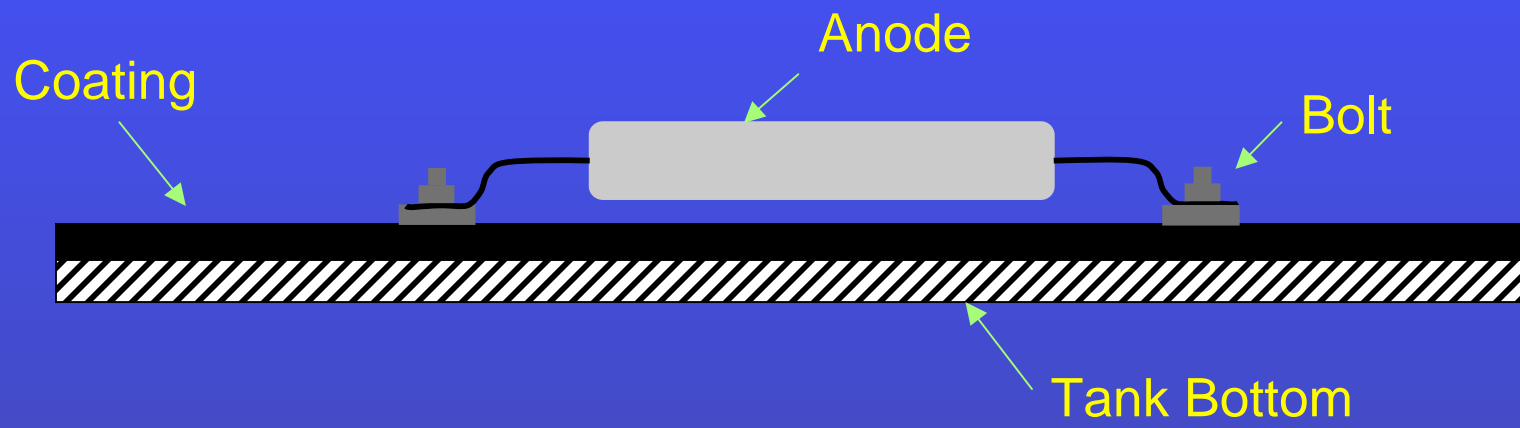
Fuel Product

Water / Sediment

Anode

Cathode







**Hot Asphalt Tank Bottoms (require special CP design considerations due to heat)**

# Recommended Practices

API-651 - Cathodic Protection of Aboveground Petroleum Storage Tanks:

NACE RP0193-2001 - External Cathodic Protection of On-Grade Carbon Steel Tank Bottoms:



# Recommended Practices

## API-651 - Cathodic Protection of Aboveground Petroleum Storage Tanks:

*“Galvanic anodes method is not practical for protection of large bare structures.”*

## NACE RP0193-2001 - External Cathodic Protection of On-Grade Carbon Steel Storage Tank Bottoms:

*“Galvanic protection systems can be applied to tank bottoms where the metallic surface area exposed to the electrolyte can be minimized through the application of a dielectric coating or the area is small due to the tank size or configuration.”*



# Summary

- **Be aware of all regulations that may pertain to your tanks and piping. When in doubt talk to the governing agencies.**
- **Engage NACE qualified & experienced personnel to engineer/maintain your cathodic protection system.**
- **Refer to NACE/API Standards for guidance.**

**Questions...**



# ***Thank You***

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