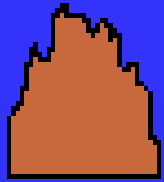


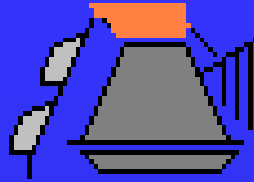
Liabilities to Assets

Presented by:
Eric Bonner
Corrpro Companies, inc.
Atlanta, Georgia
EBonner@corrpro.com
(678) 848-0688

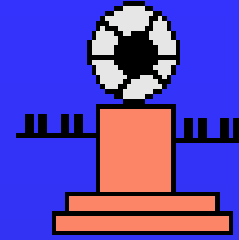




IRON OXIDE



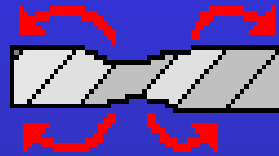
REFINING



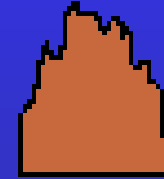
MILLING



STEEL



CORROSION



IRON OXIDE

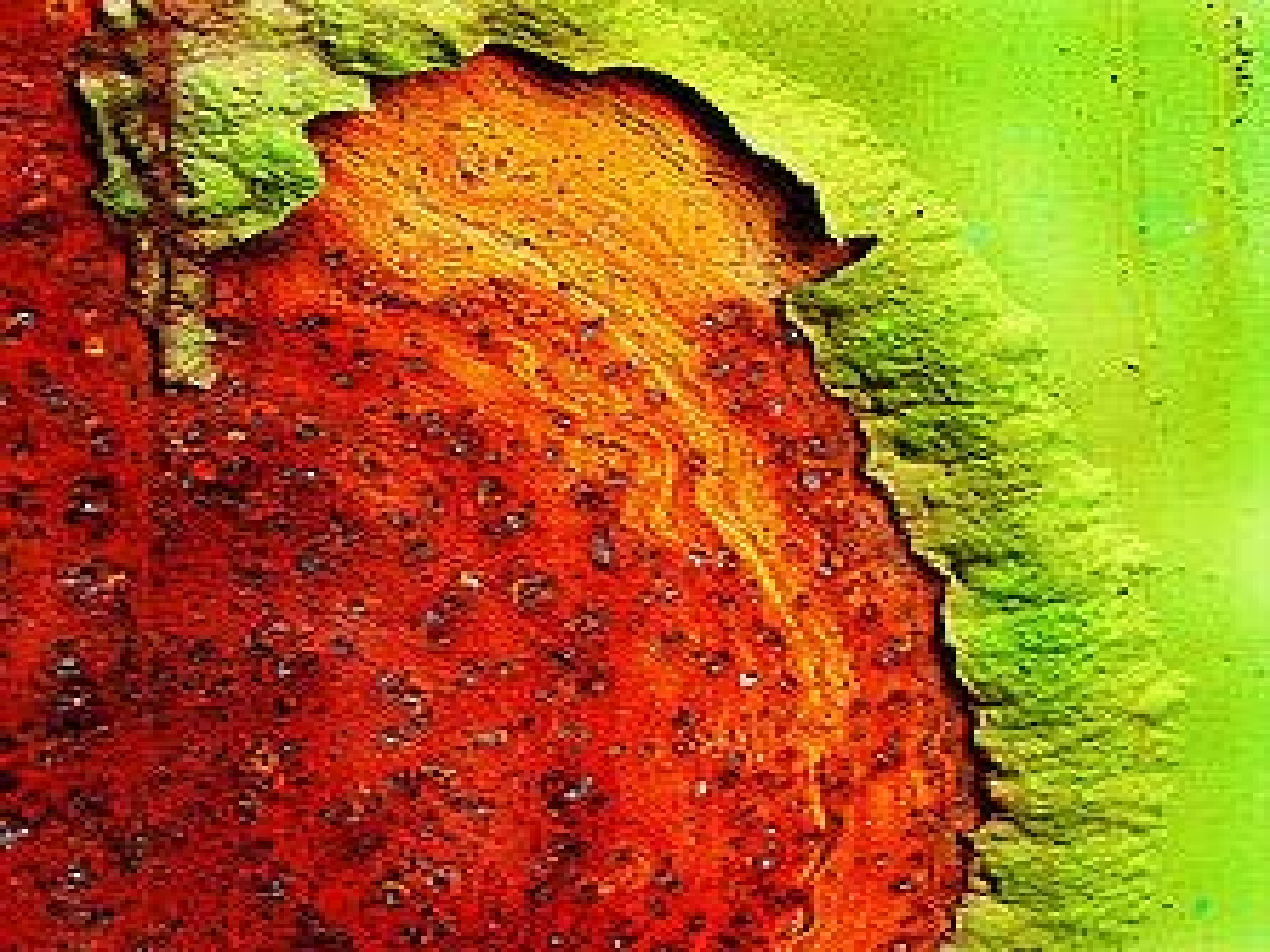
THE PROBLEM.....





Why Provide Corrosion Control?

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

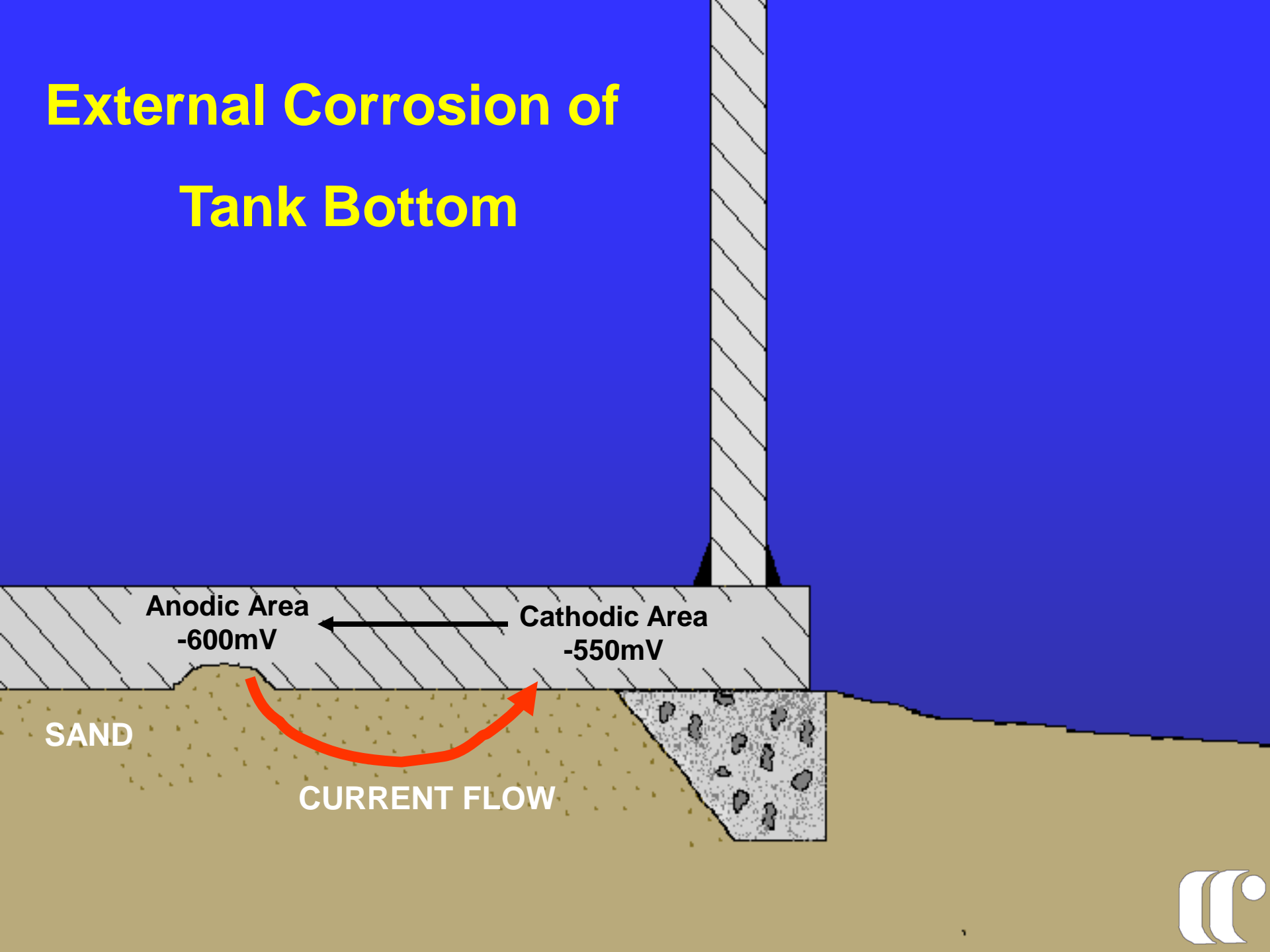




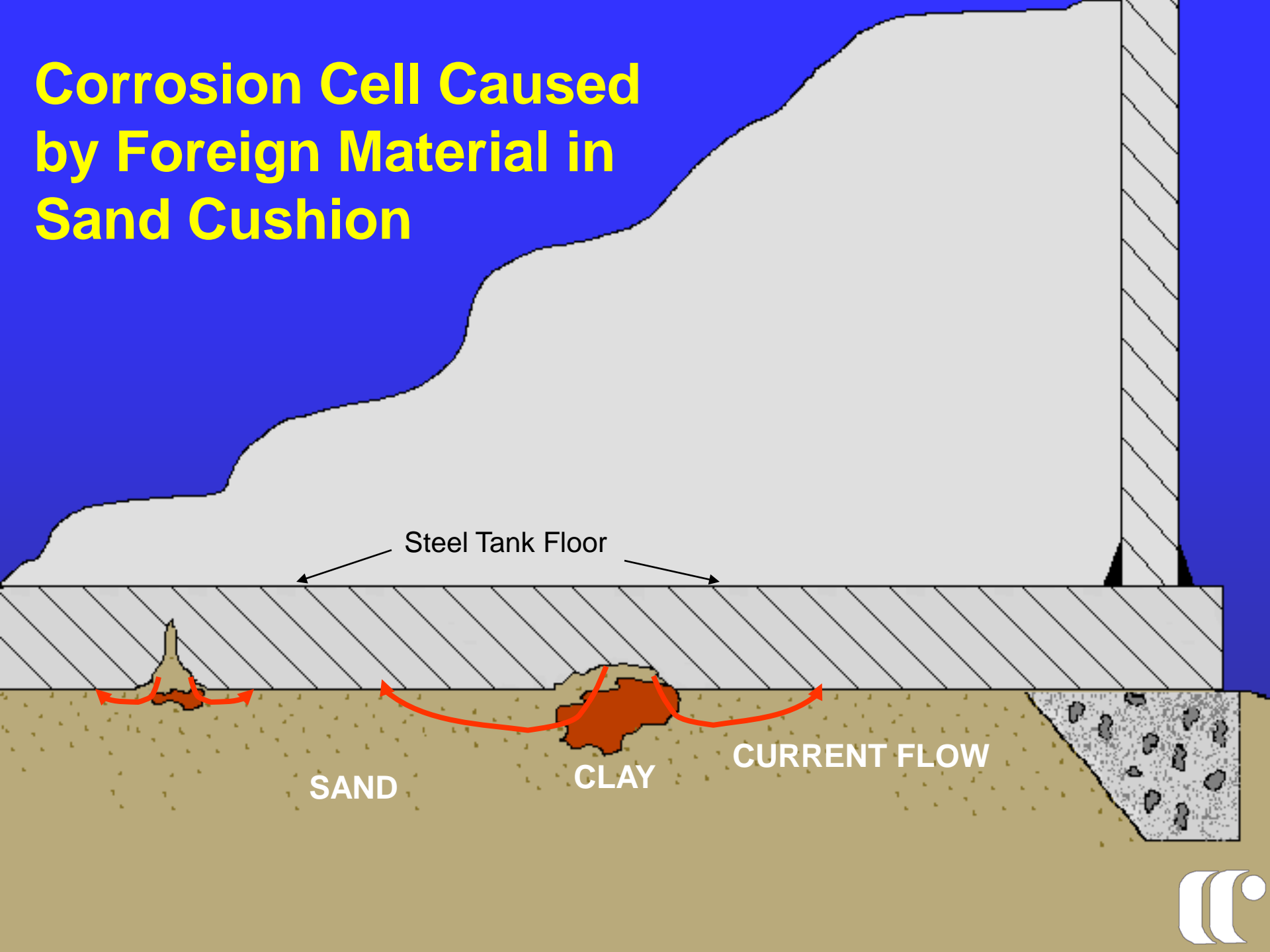




External Corrosion of Tank Bottom

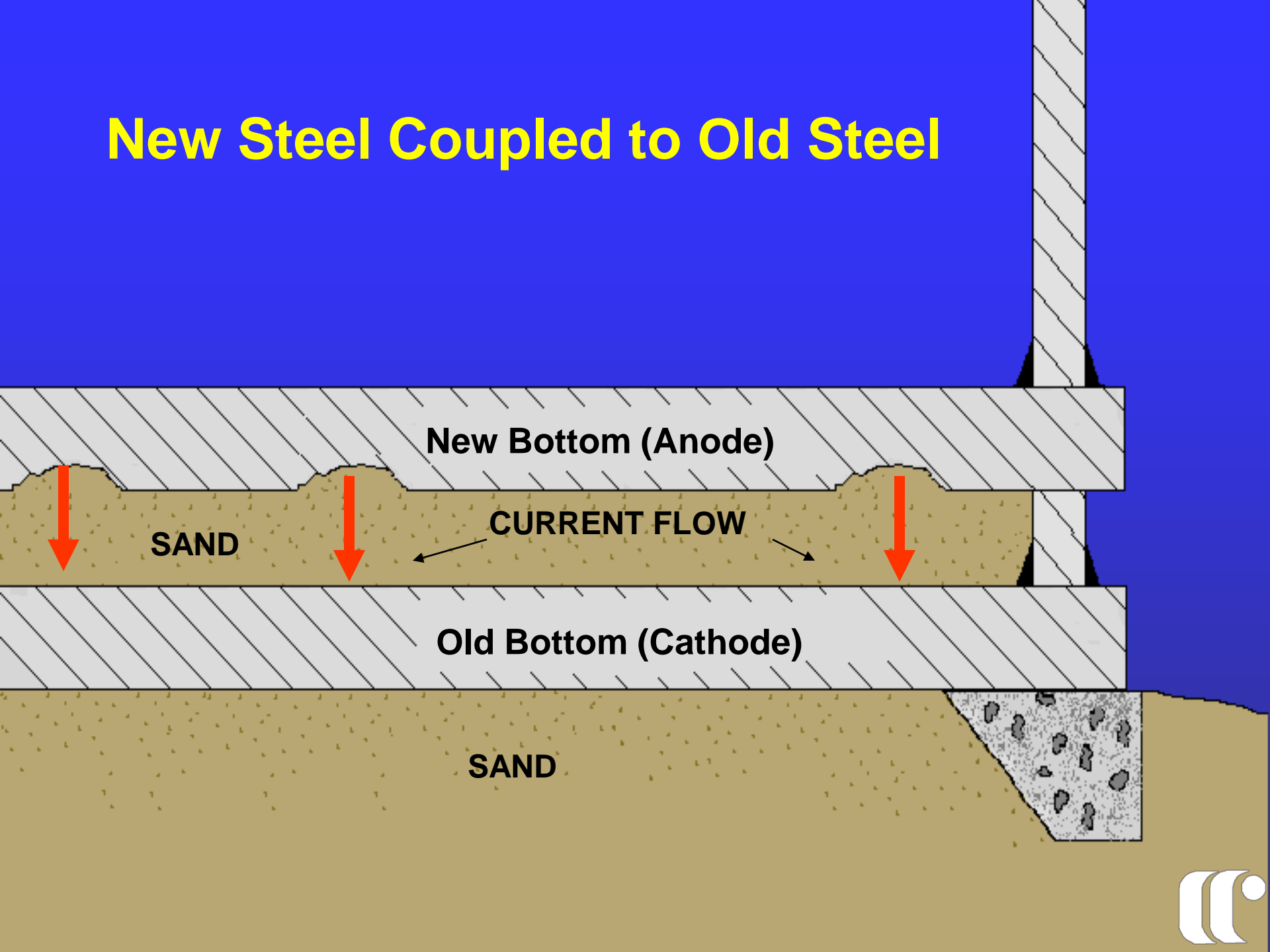


Corrosion Cell Caused by Foreign Material in Sand Cushion

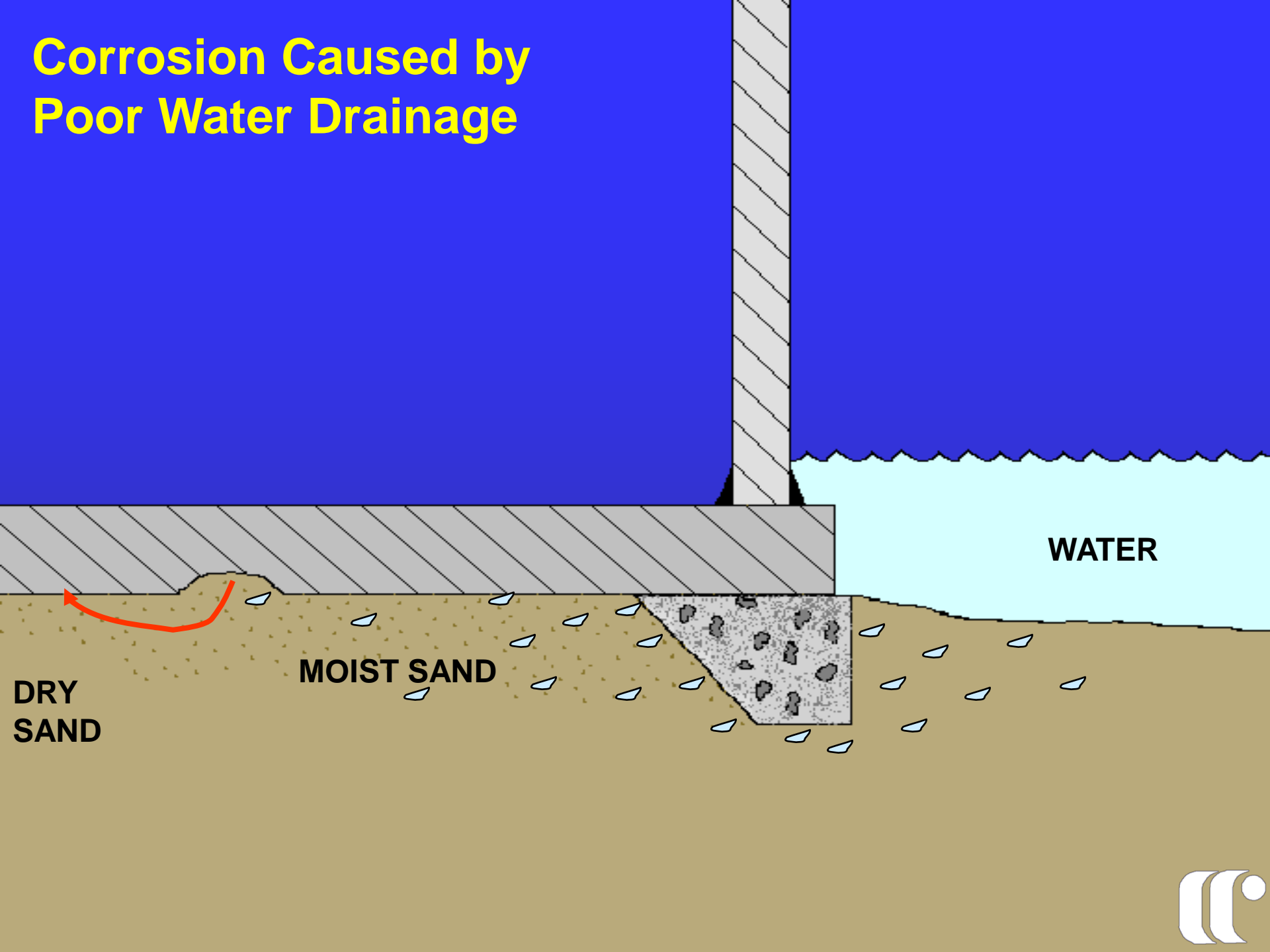




New Steel Coupled to Old Steel



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**

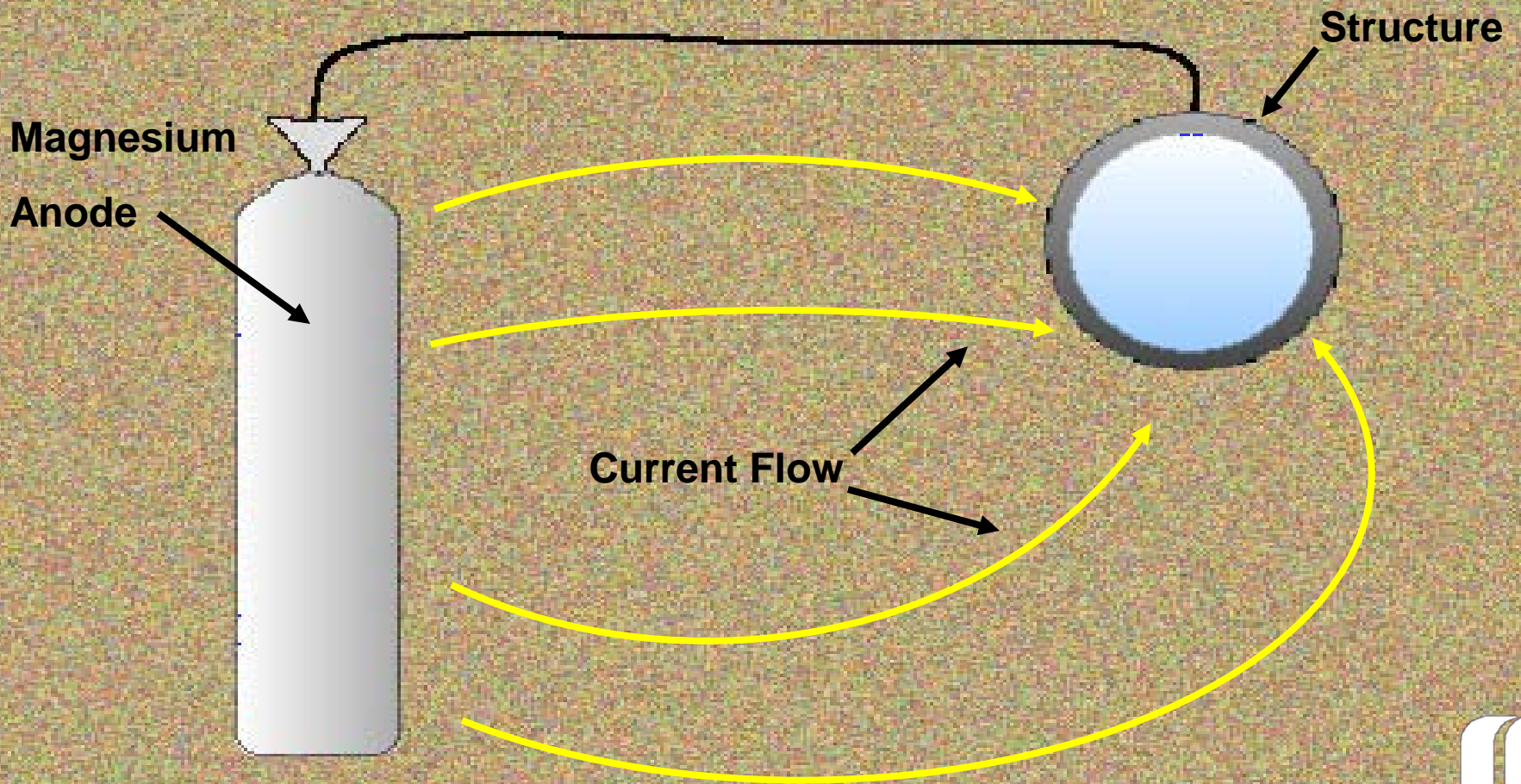
Types of Cathodic Protection

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

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



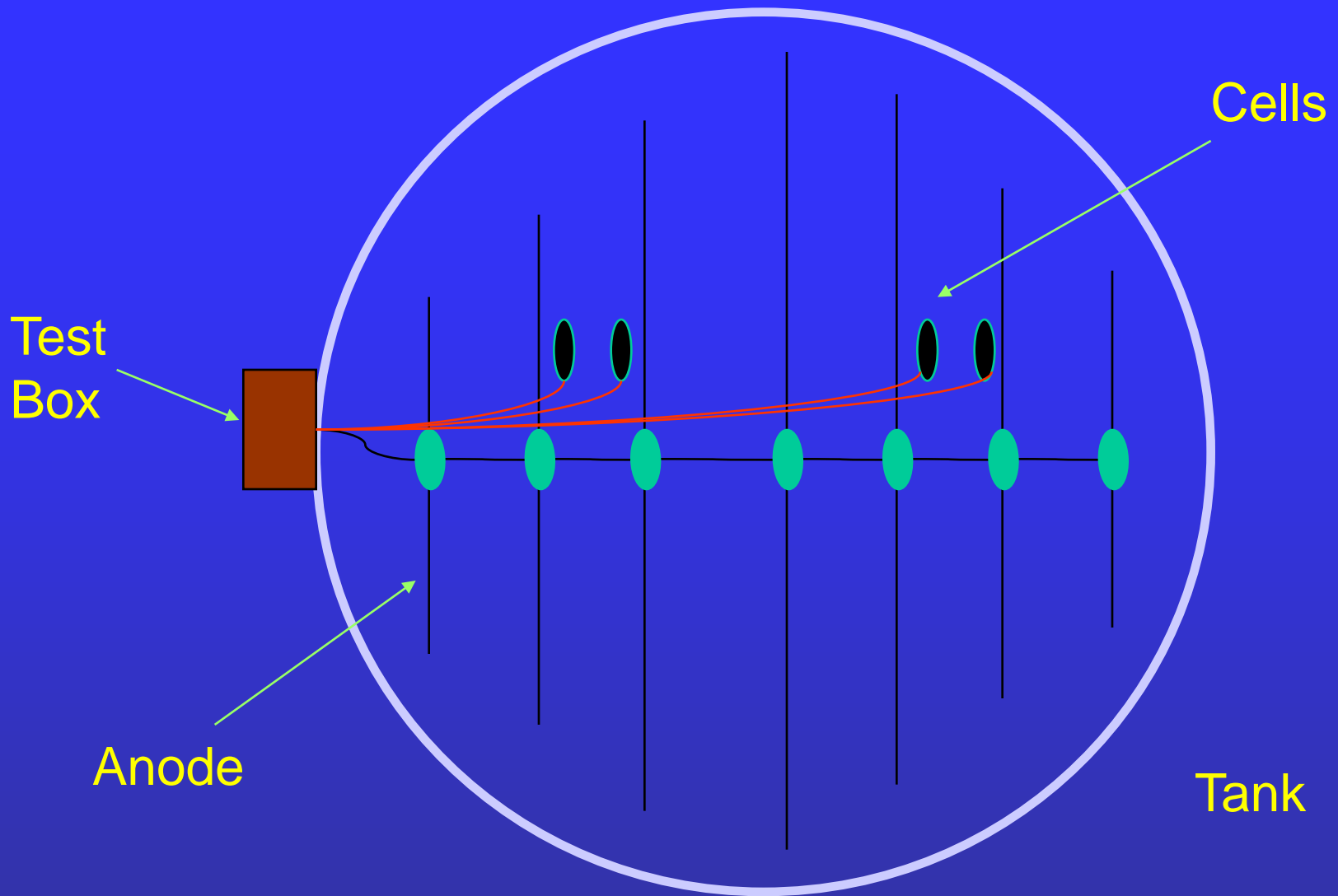
Galvanic Cathodic Protection



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



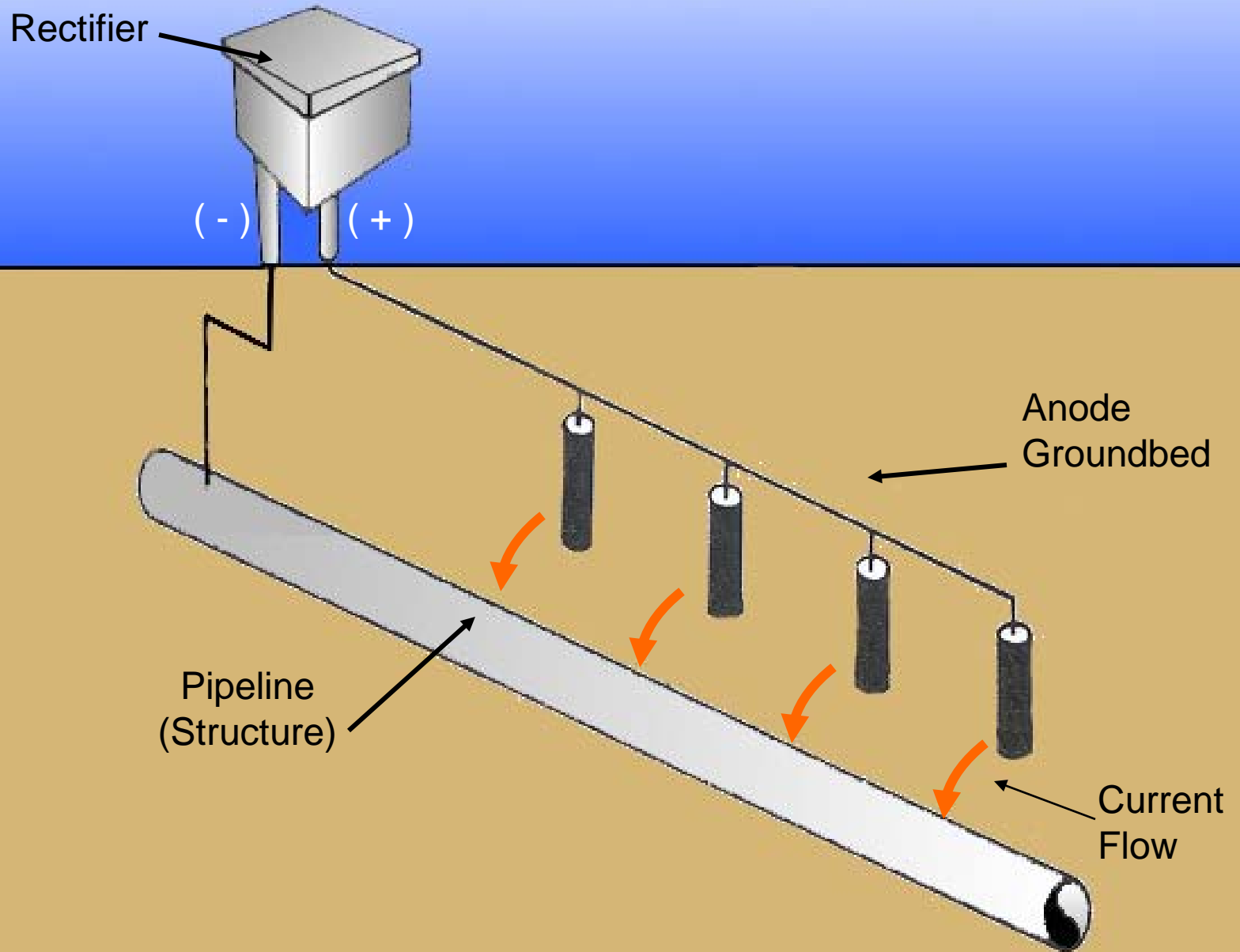
SAND QUALITY

- **The rate of corrosion is dependent on the characteristics of the sand.**
- **The 1st 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

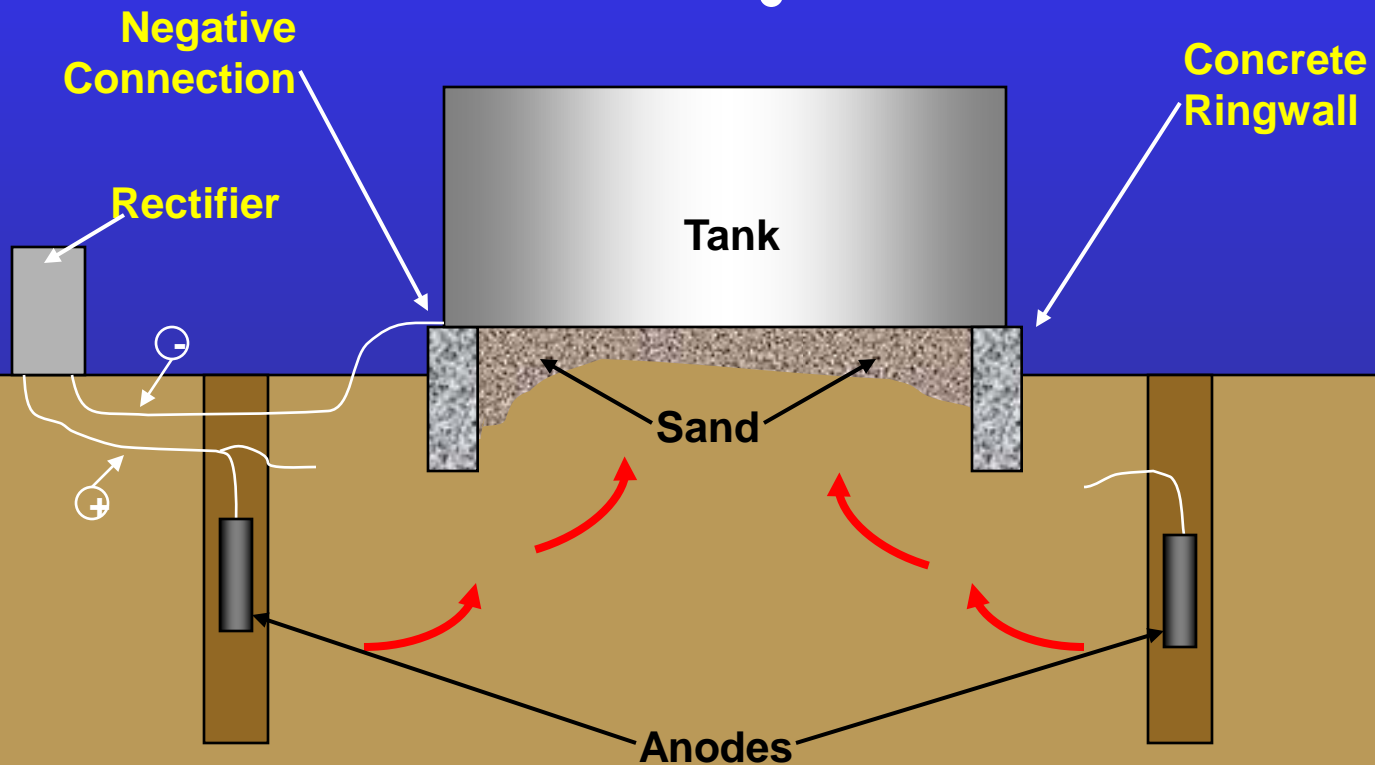
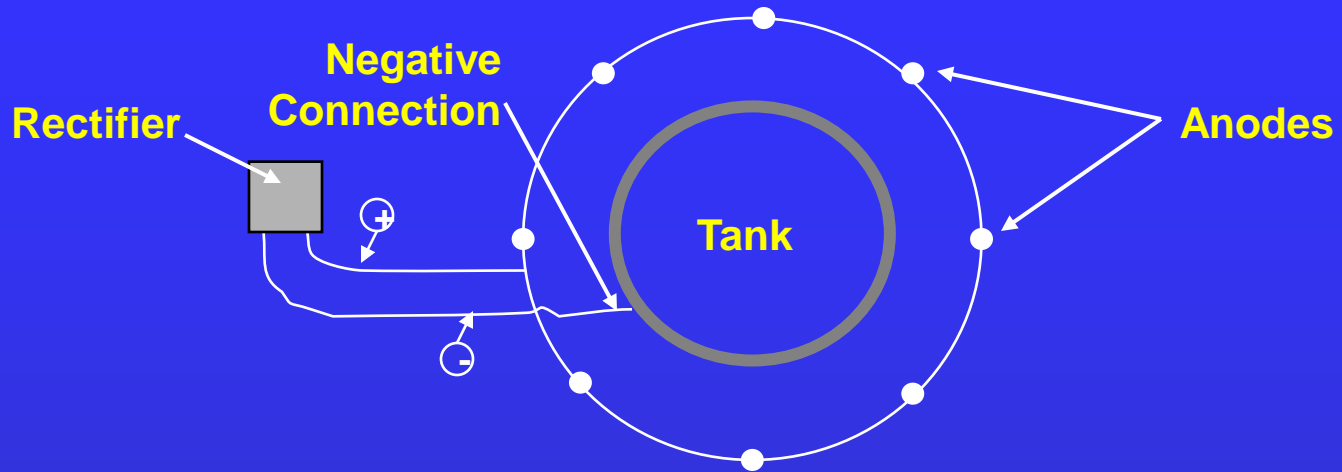
- **Silica**
- **pH Between 6.5 and 8.5**
- **Moisture less than 5%**
- **Chlorides less than 10 ppm**
- **Resistivity greater than 30,000 ohm-cm**

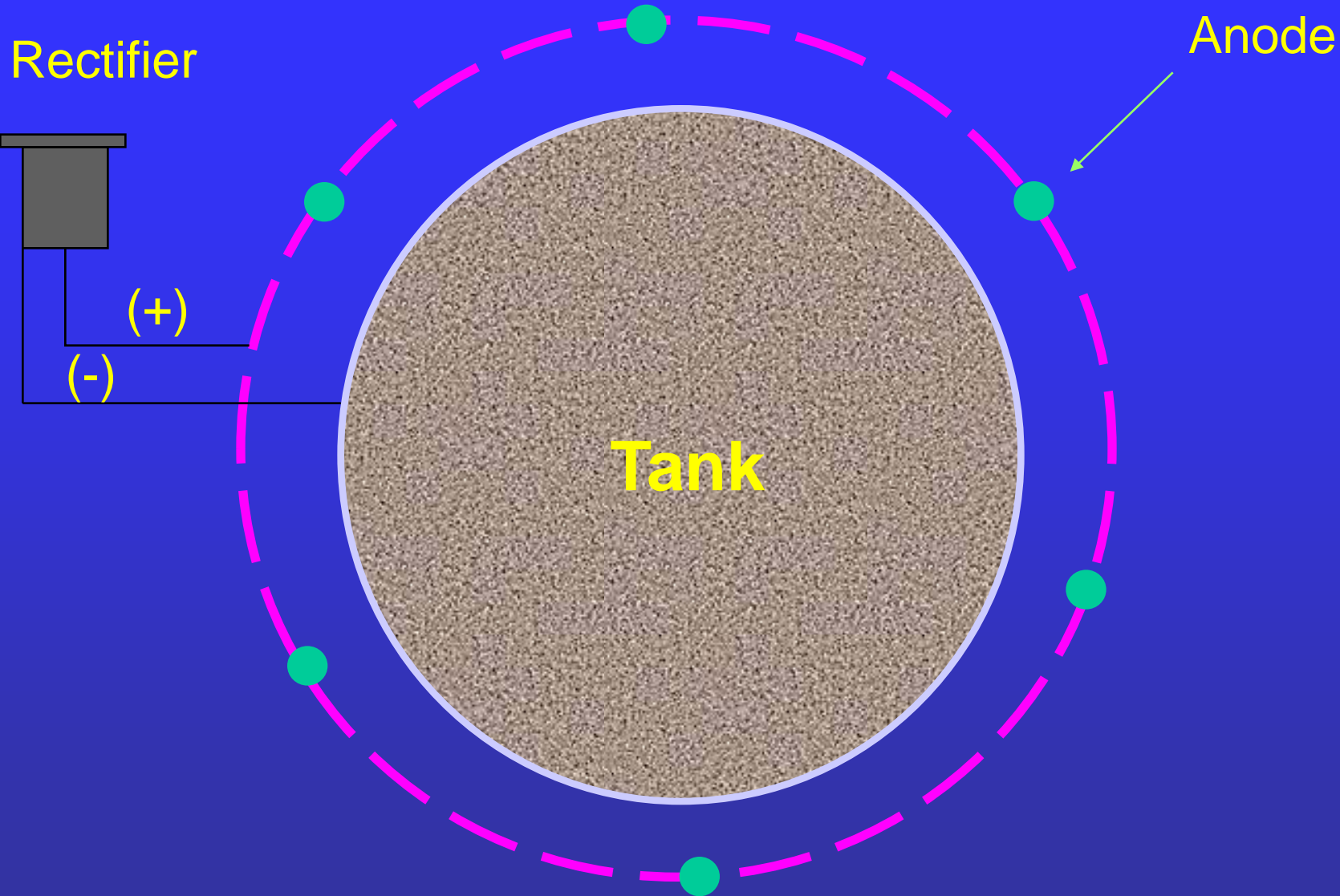
Impressed Current System





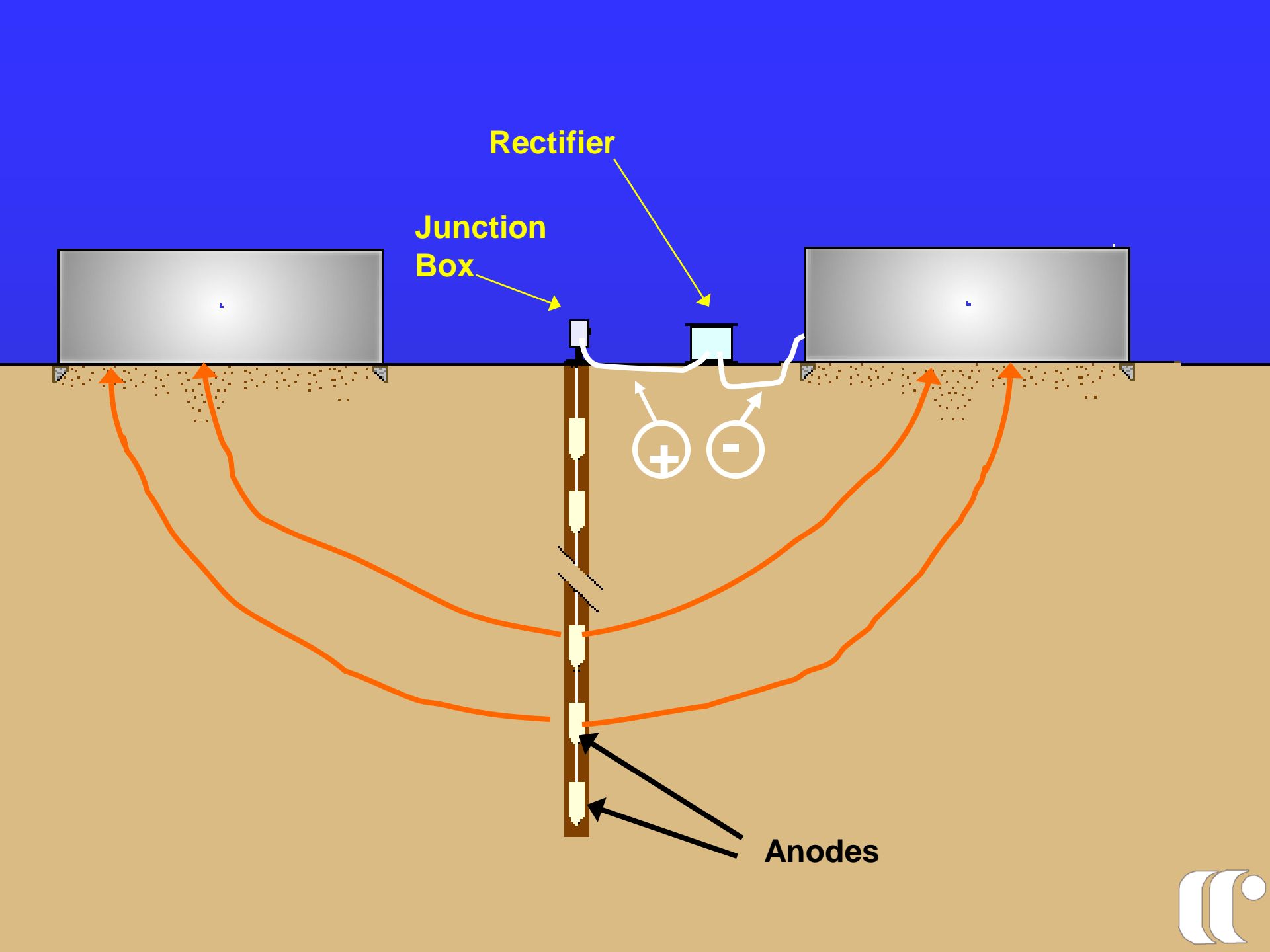
Above Ground Storage Tank Vertical Impressed Current Anodes - Existing Tanks





Shallow Anodes





Rectifier

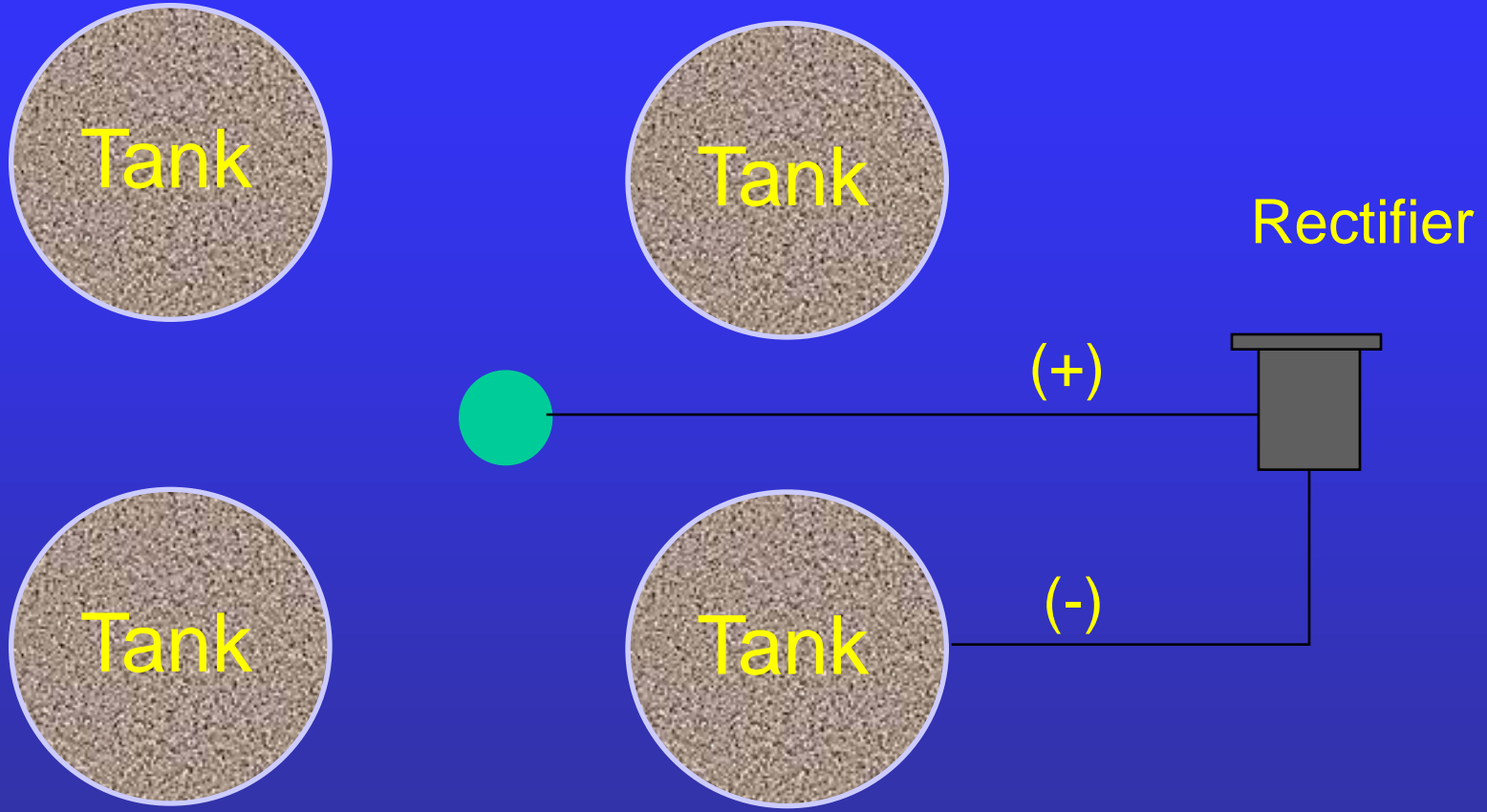
Junction Box

+

-

Anodes





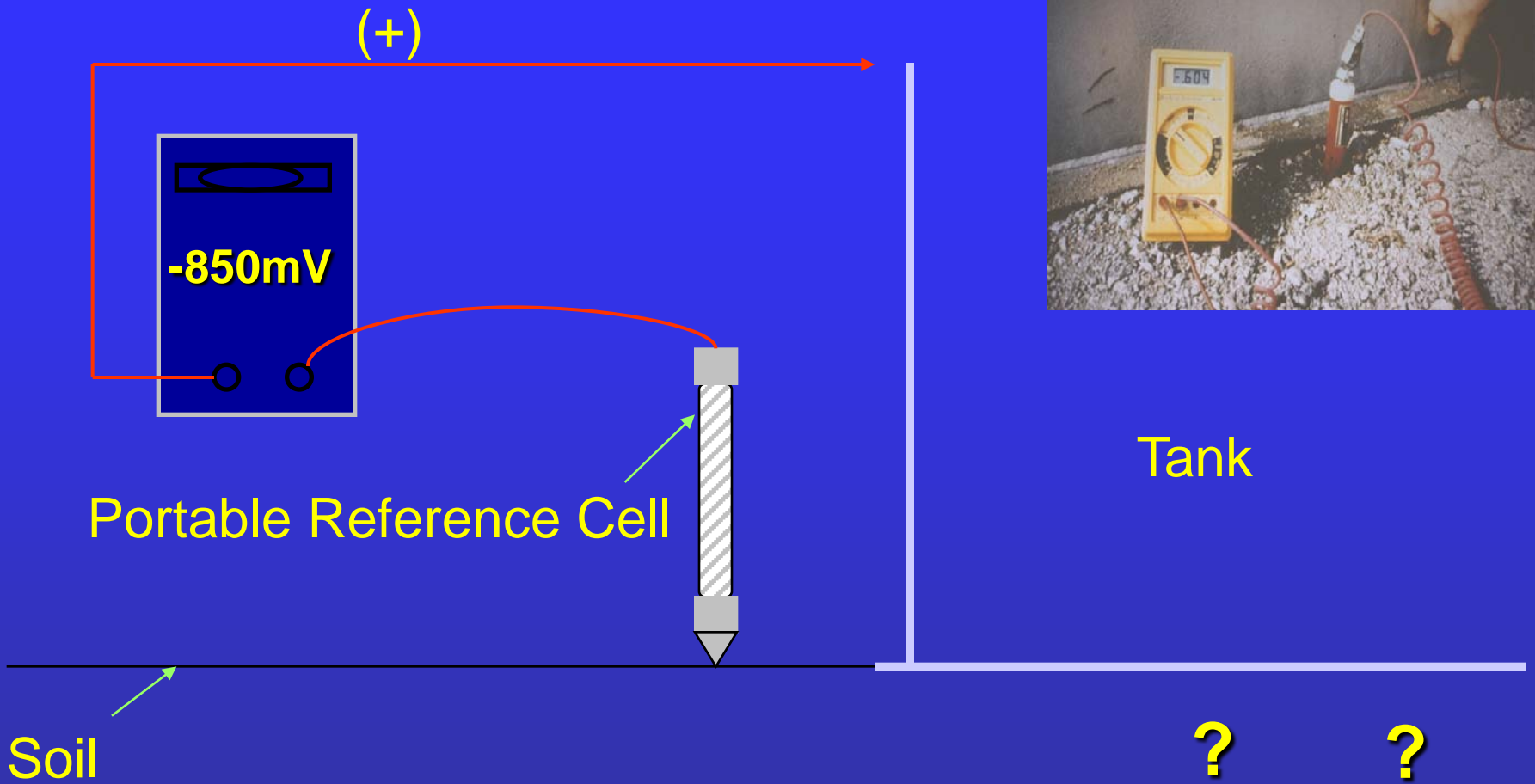
Deep Anode



MFL Floor Inspection

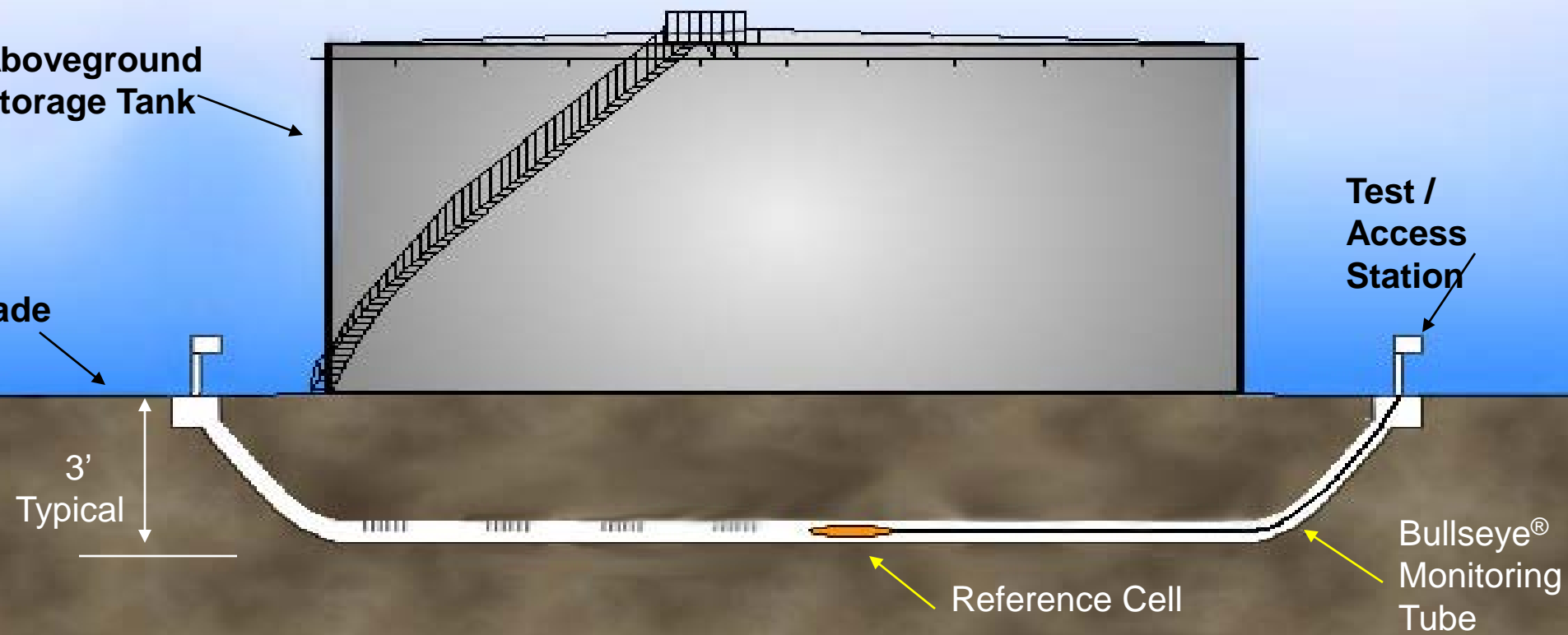
Mechanical Integrity

- **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
On	-1411	-698	-404	-601	-1455
Off	-902	-664	-402	-578	-911

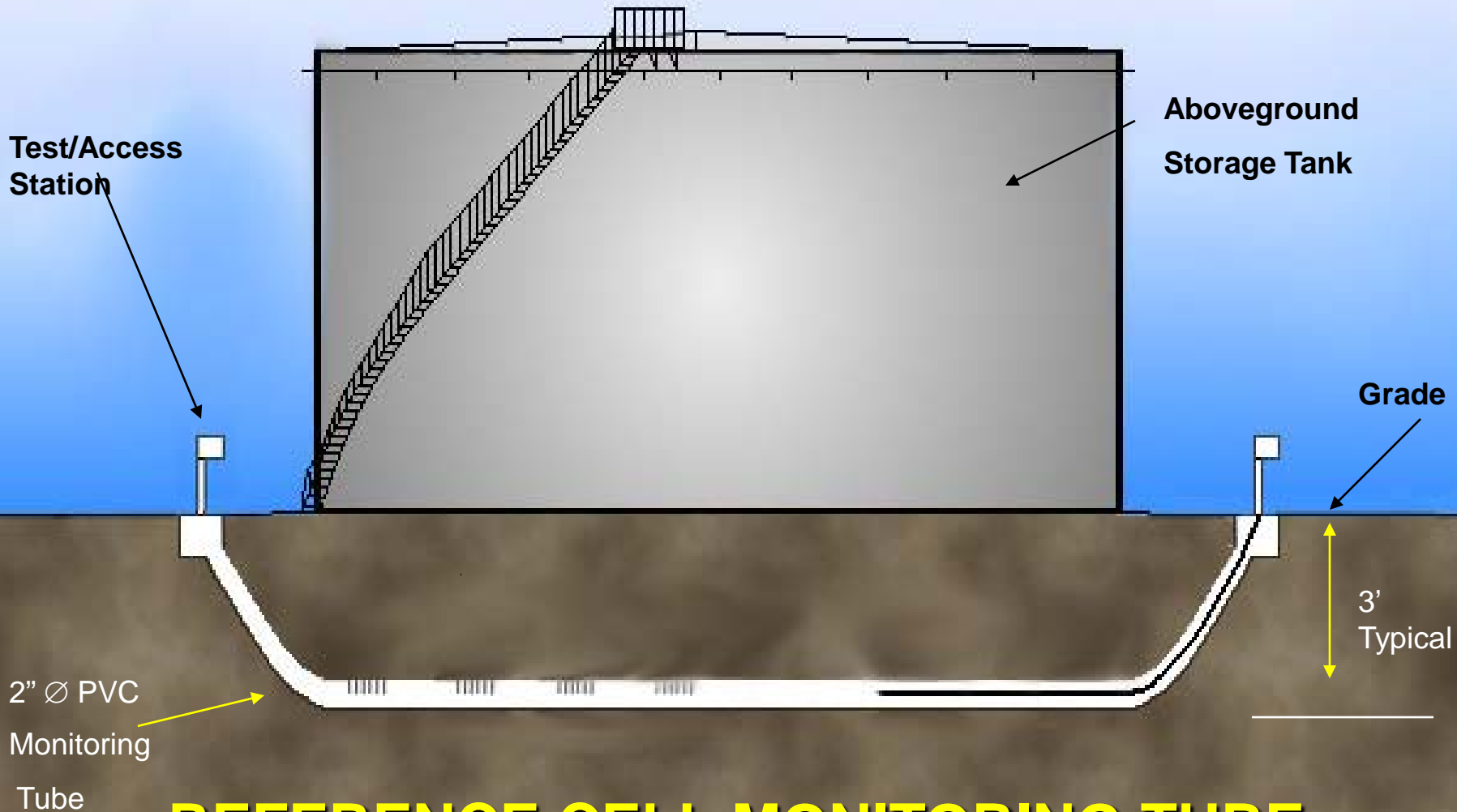
Potentials (mV)





Directional Boring Under Existing AST



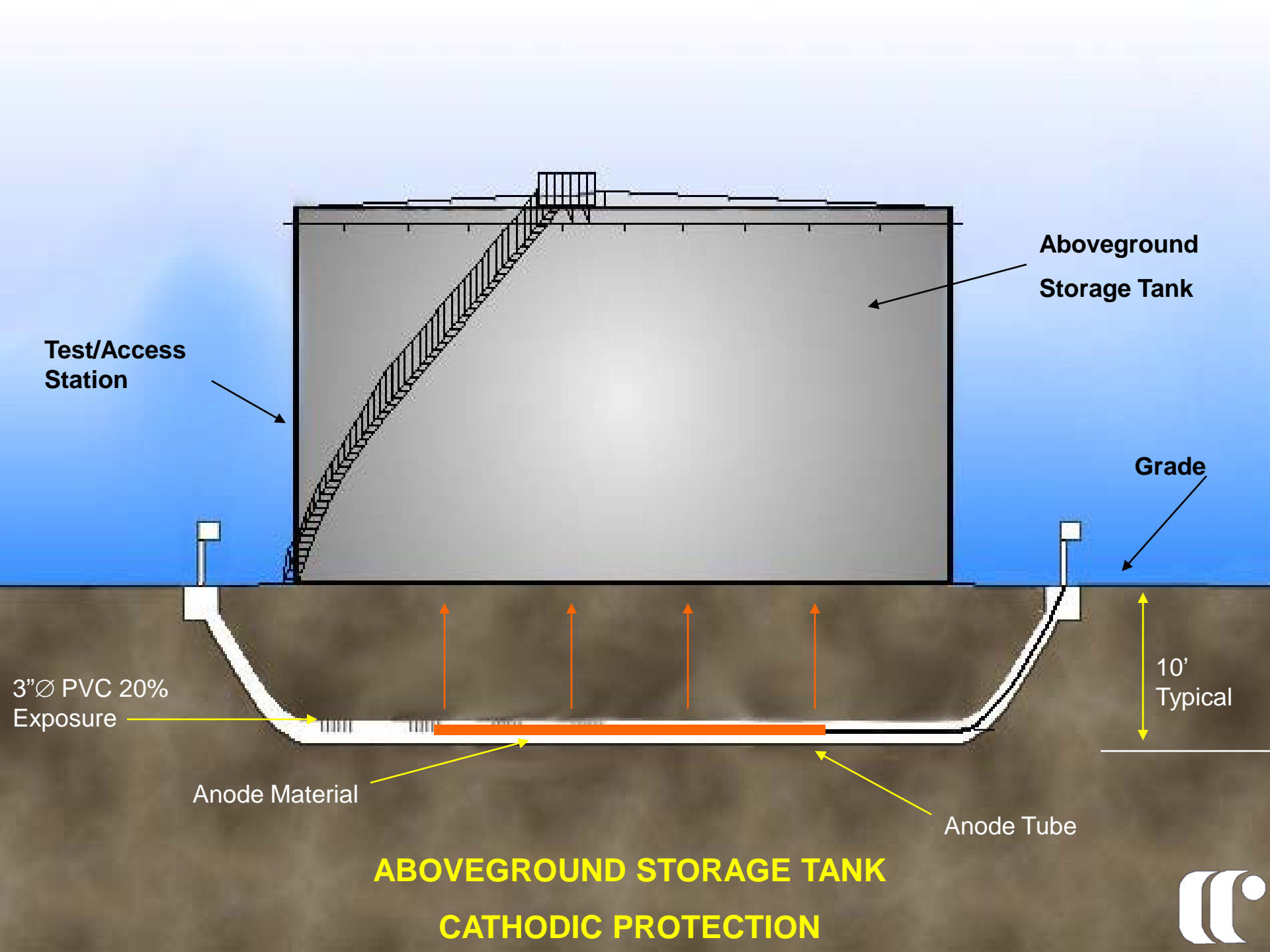


REFERENCE CELL MONITORING TUBE



Directional Bore Under Tank for Anode or Reference Cell Placement





Test/Access Station

Aboveground Storage Tank

Grade

10' Typical

3"Ø PVC 20% Exposure

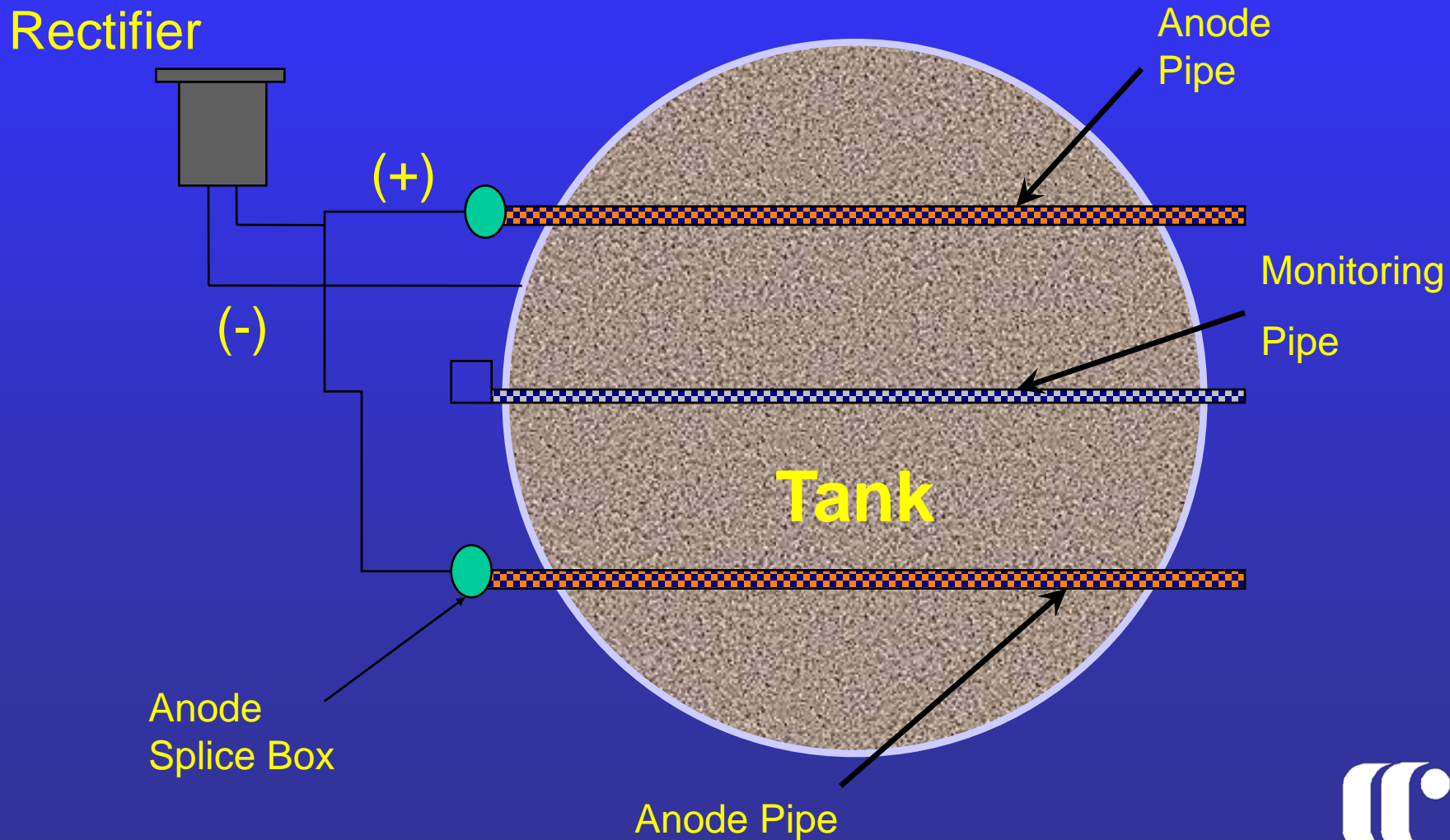
Anode Material

Anode Tube

**ABOVEGROUND STORAGE TANK
CATHODIC PROTECTION**



Computer Guided Horizontally Bored Anode System



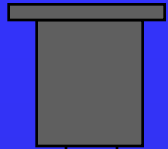
CP Applications for Re-bottomed or New Tanks





New Floor Installation on Existing AST

Rectifier



(-)

(+)

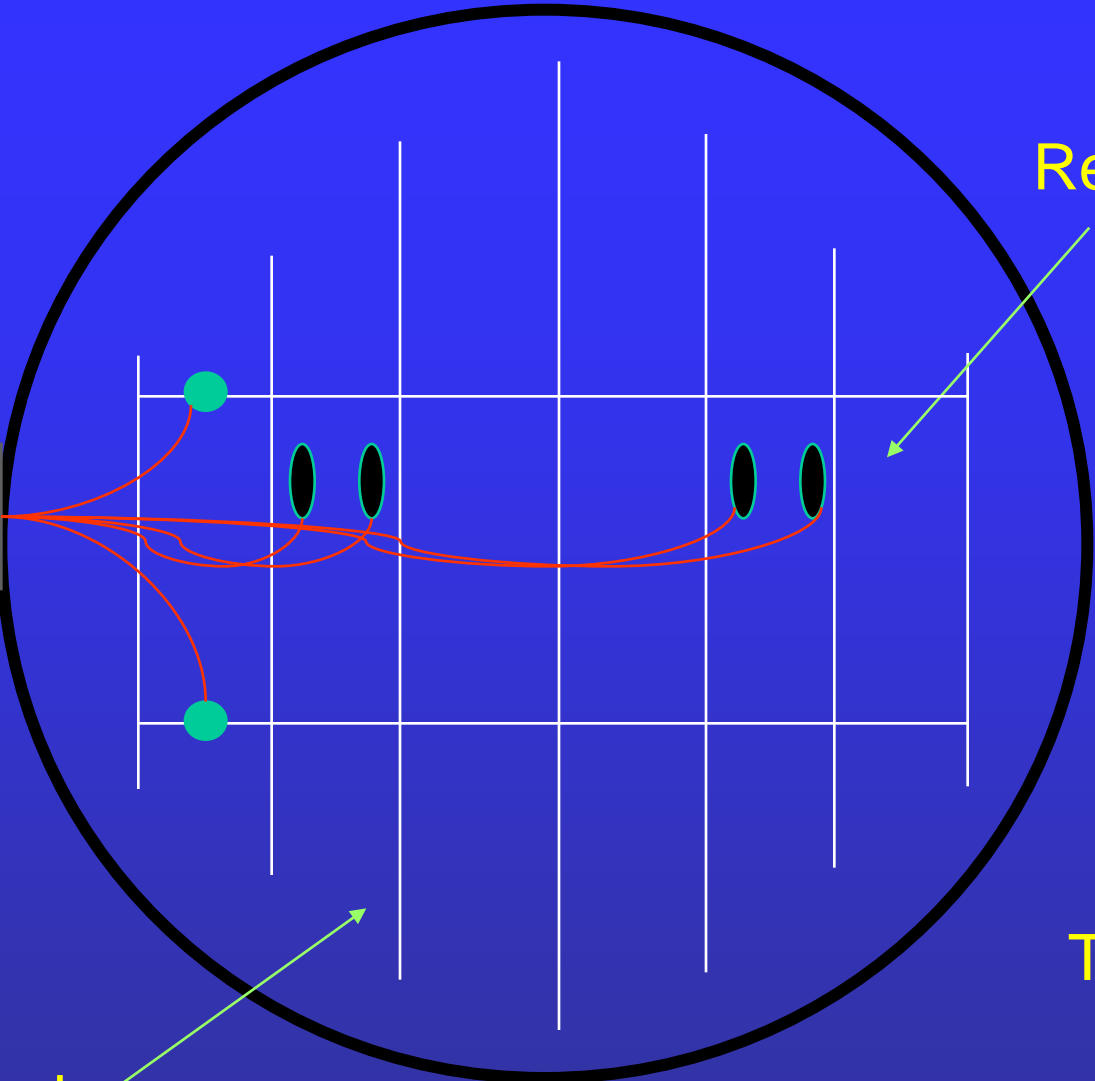
Junction
Box

Anode

Reference
Cells

Tank

Impressed Current





CP Installation on Rebottomed Tank

Above Ground

Storage Tank Bottoms

with Secondary Containment





New Tank Construction with Liner

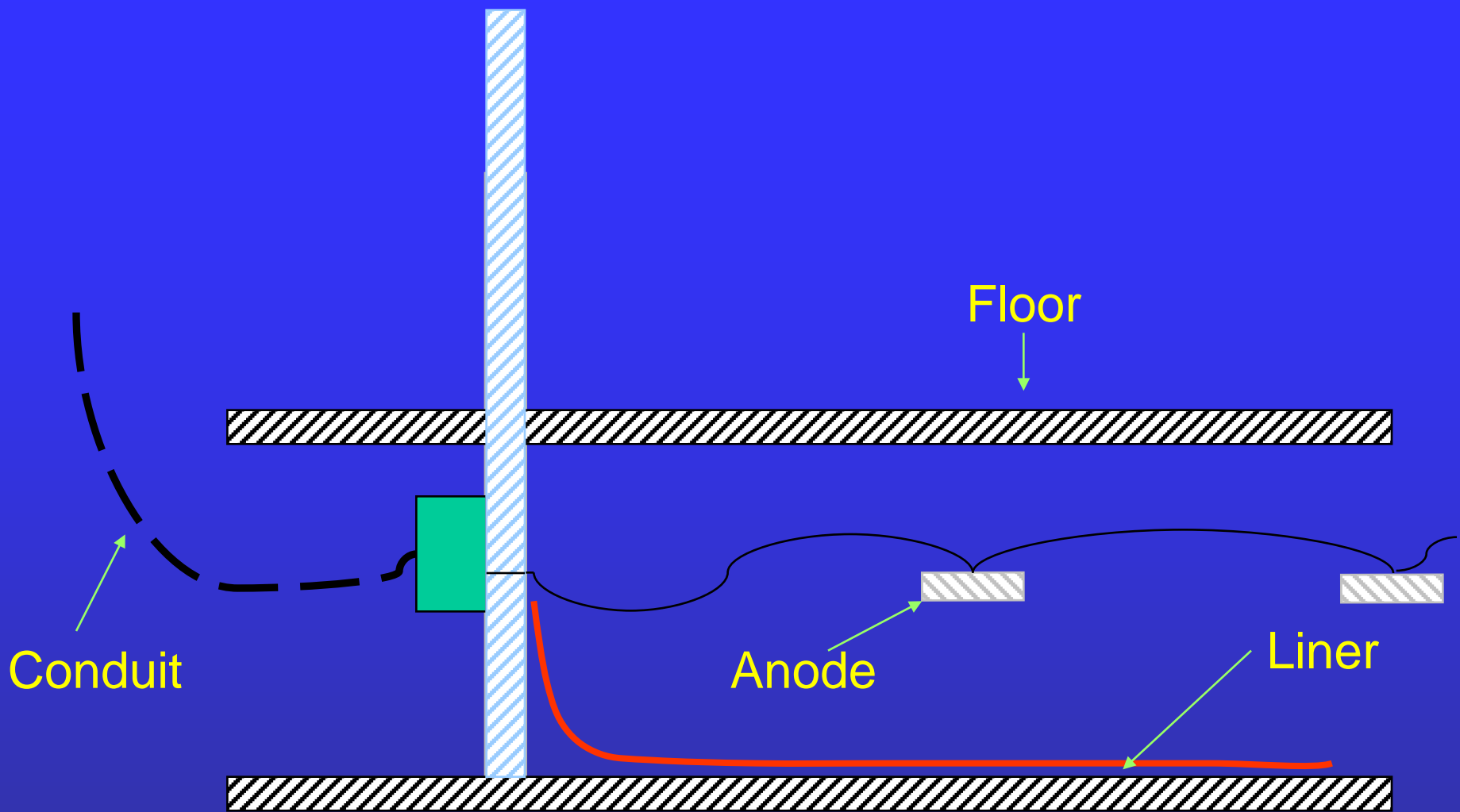




**Anode & Reference Cell Placement
in High Resistance Sand**







CP Installation on Double Bottom Tank



Installation of CP System on Lifted AST



Explosion Proof Unit



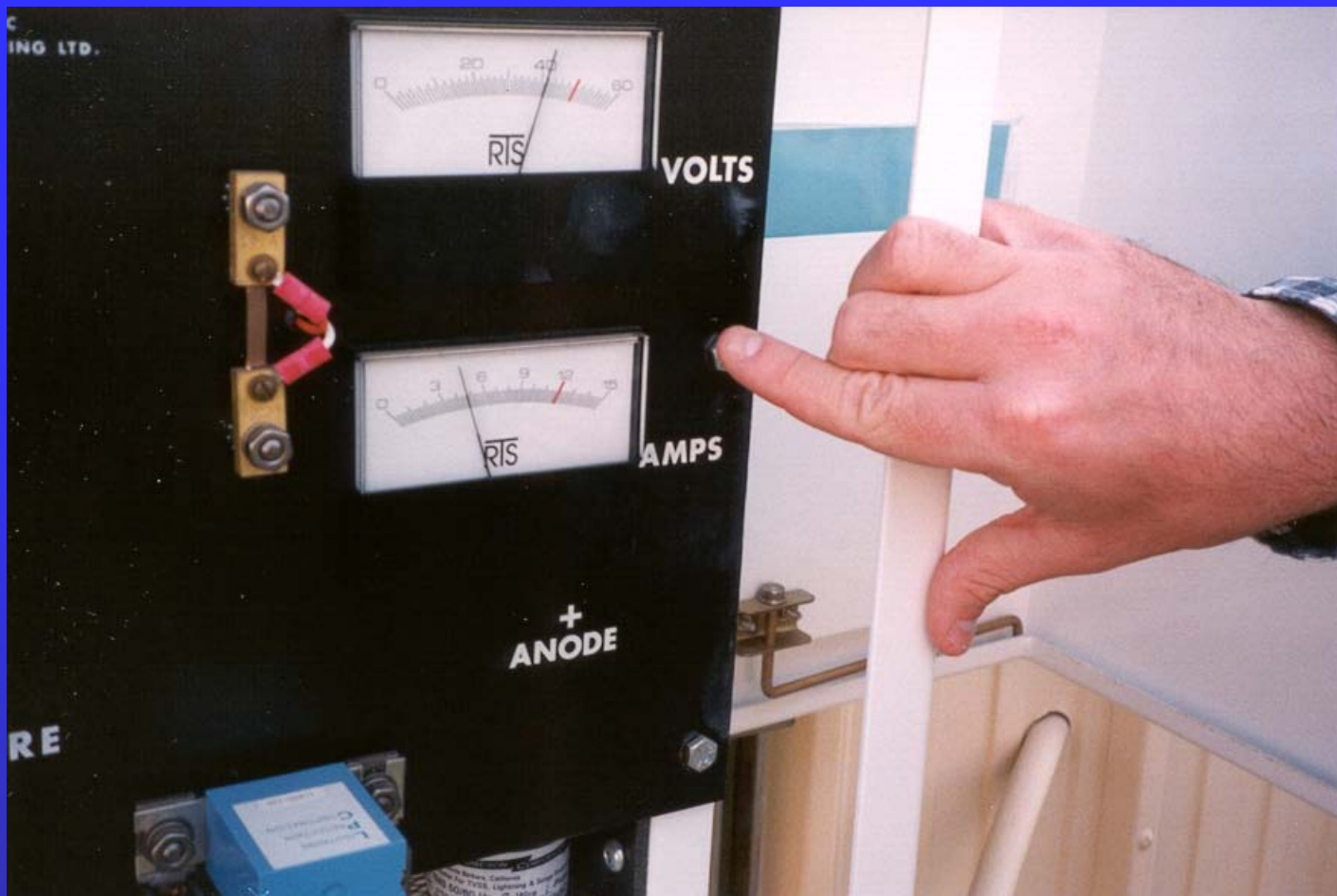


Reference Cell Placement Under Tank Bottom



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.**



TO
ELECT





Annual Cathodic Protection Survey

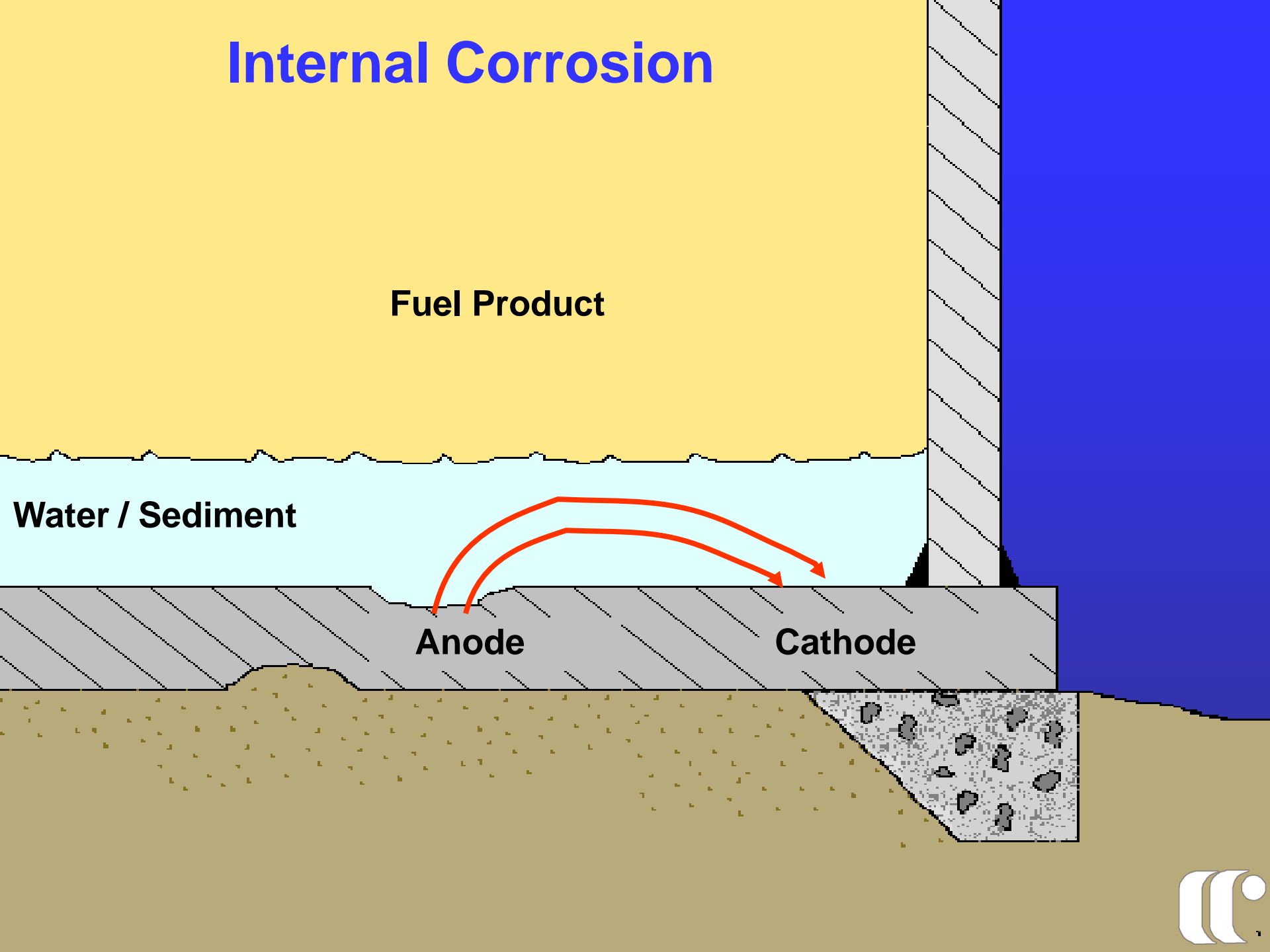




Internal Corrosion



Internal Corrosion



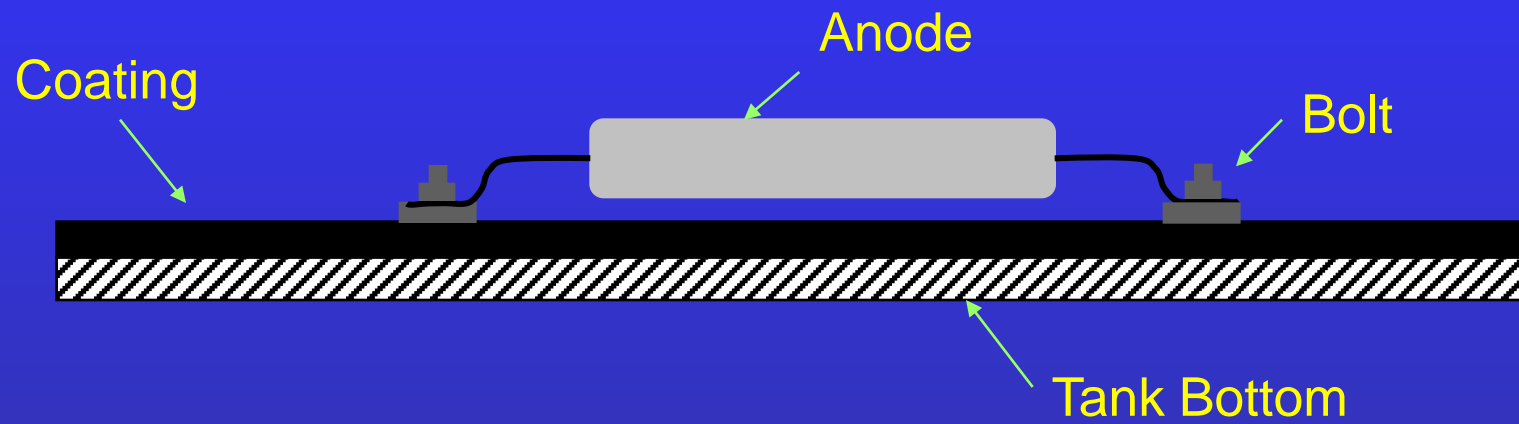
Fuel Product

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

Eric Bonner

Corrpro Companies, Inc.

Atlanta Regional Office

Office (770) 761-5400

Mobile (678) 848-0688

E-Mail – EBonner@corrpro.com

