

Cathodic Protection for On-Grade Storage Tanks and Buried Piping

*John Fitzgerald
Corrpro
Freshwater Spills Symposium
April 6-8, 2004*



Why is Corrosion Control Important?

- **Preserve Assets**
- **Reduce Maintenance Costs**
- **Governmental Compliance**
- **Preserve The Environment**

What I Will Cover....

- Causes of Corrosion
- SPCC/State/OPS Regulations
- Cathodic Protection Applications
- Maintenance Requirements

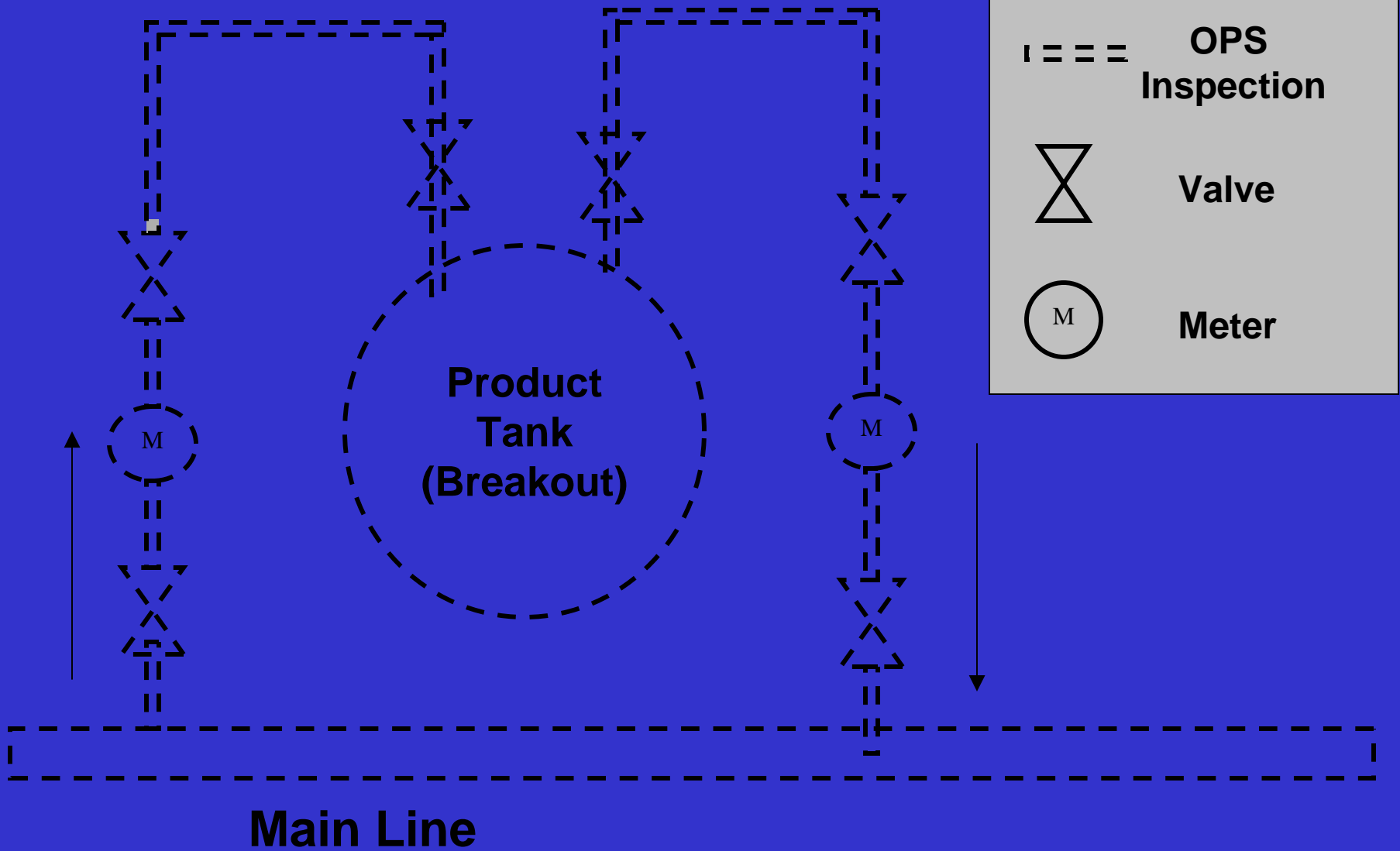
Spill Prevention Control and Countermeasure (SPCC) Regulation (Implementation Required by 2/18/05)

- Provide buried piping that is installed or replaced after August 16th, 2002 with a protective coating and cathodic protection.*
- Should a section of line be exposed for any reason it must be inspected for deterioration. If corrosion damage is found you must take additional examination and corrective action.*

Federal Level (Breakout Tanks)

a) Relieves surges in a hazardous liquid pipeline system or b) receive and store hazardous liquid transported by a pipeline for reinjection and continued transportation by pipeline

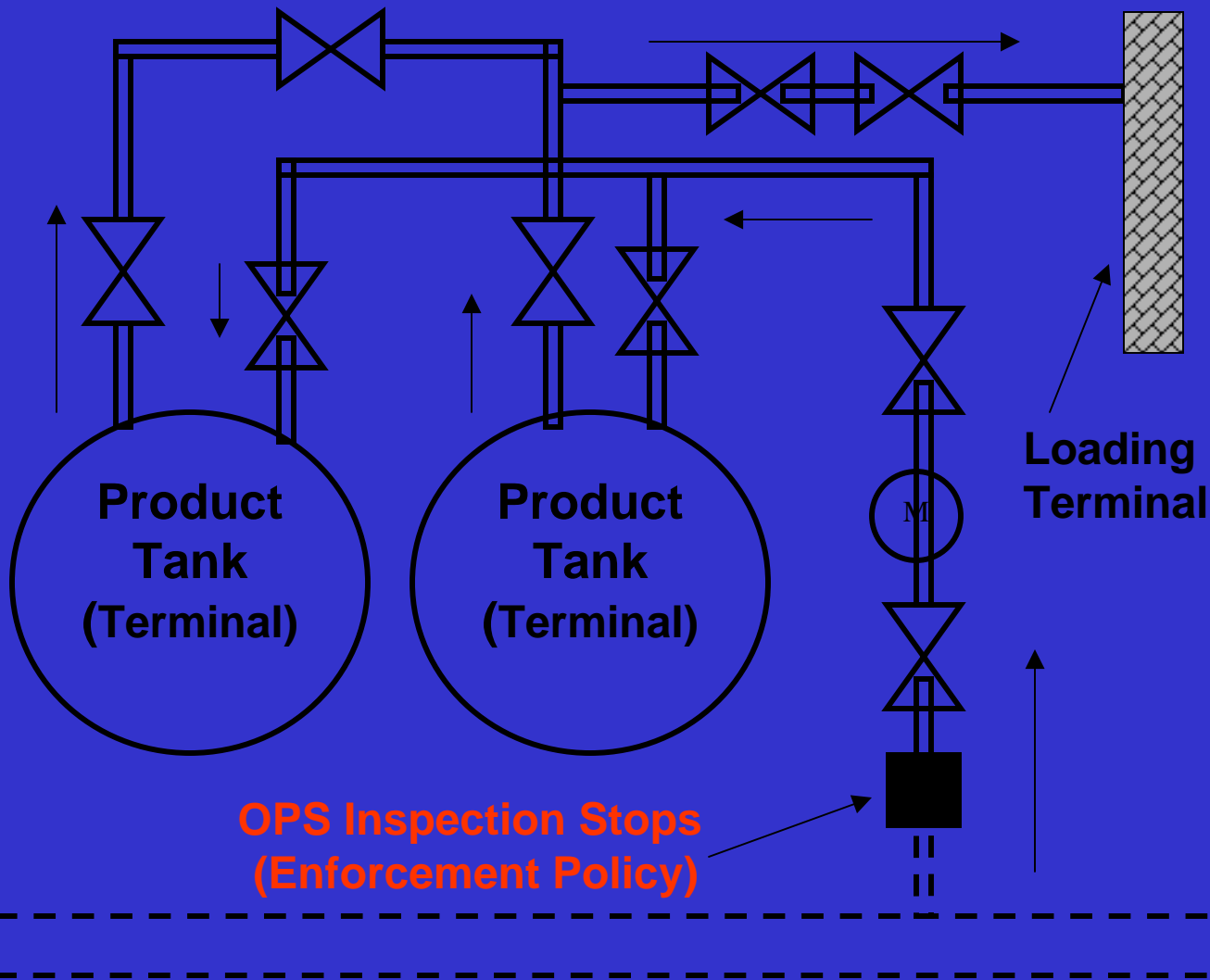
Breakout Tank Piping (DOT)



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.

Terminal Tankage



	OPS Inspection
	No OPS Inspection
	Valve
	Meter

Main Line

Corrosion Can be Defined as Either:

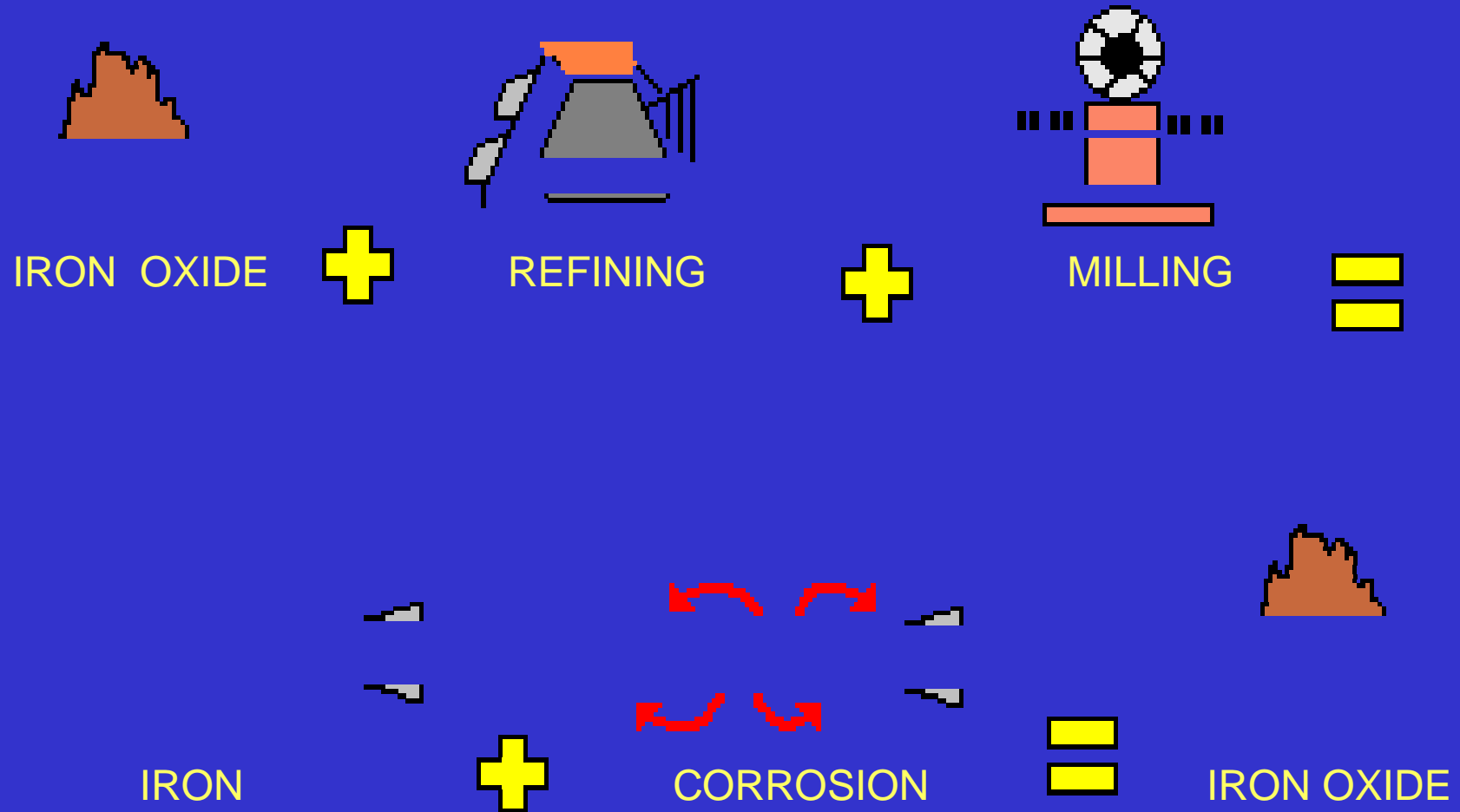
▶ Practical

Tendency of a Metal to Revert
to its Native State

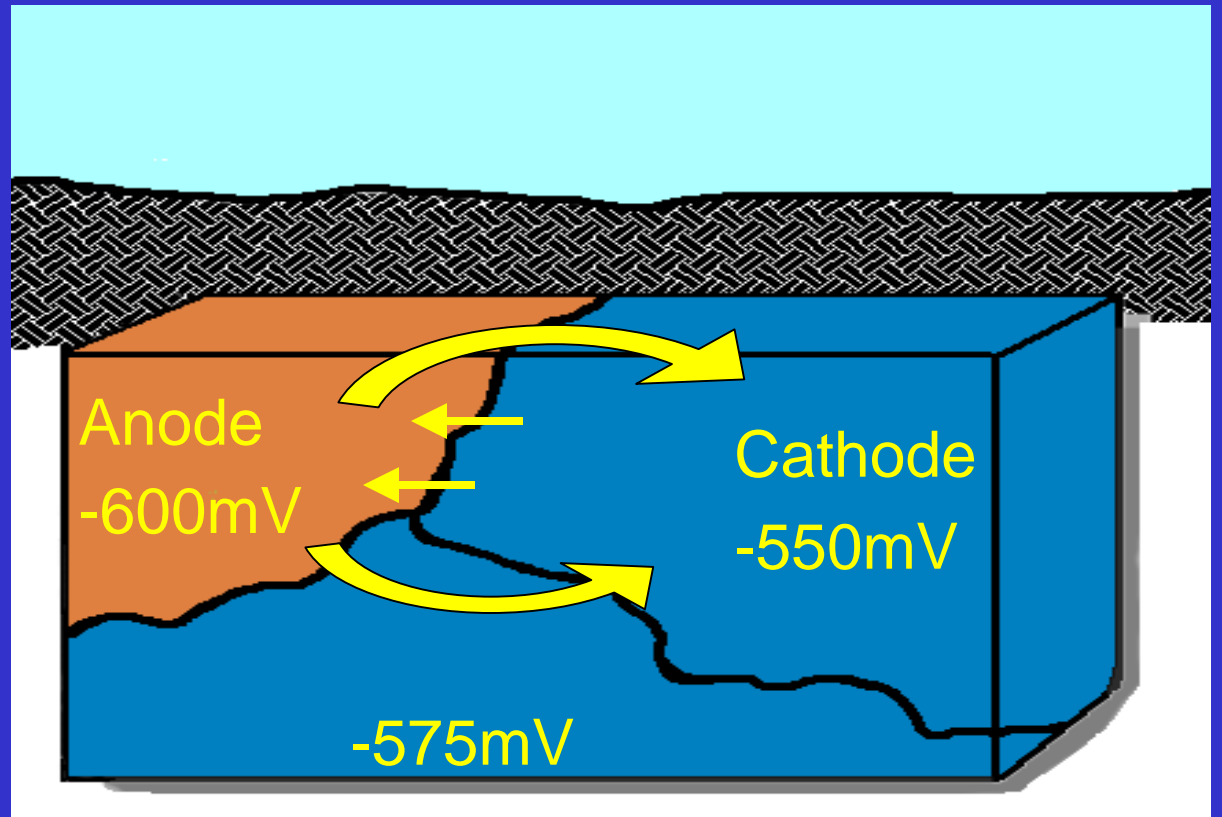
▶ Scientific

Electrochemical Degradation
of Metal as a Result of a Reaction
with its Environment

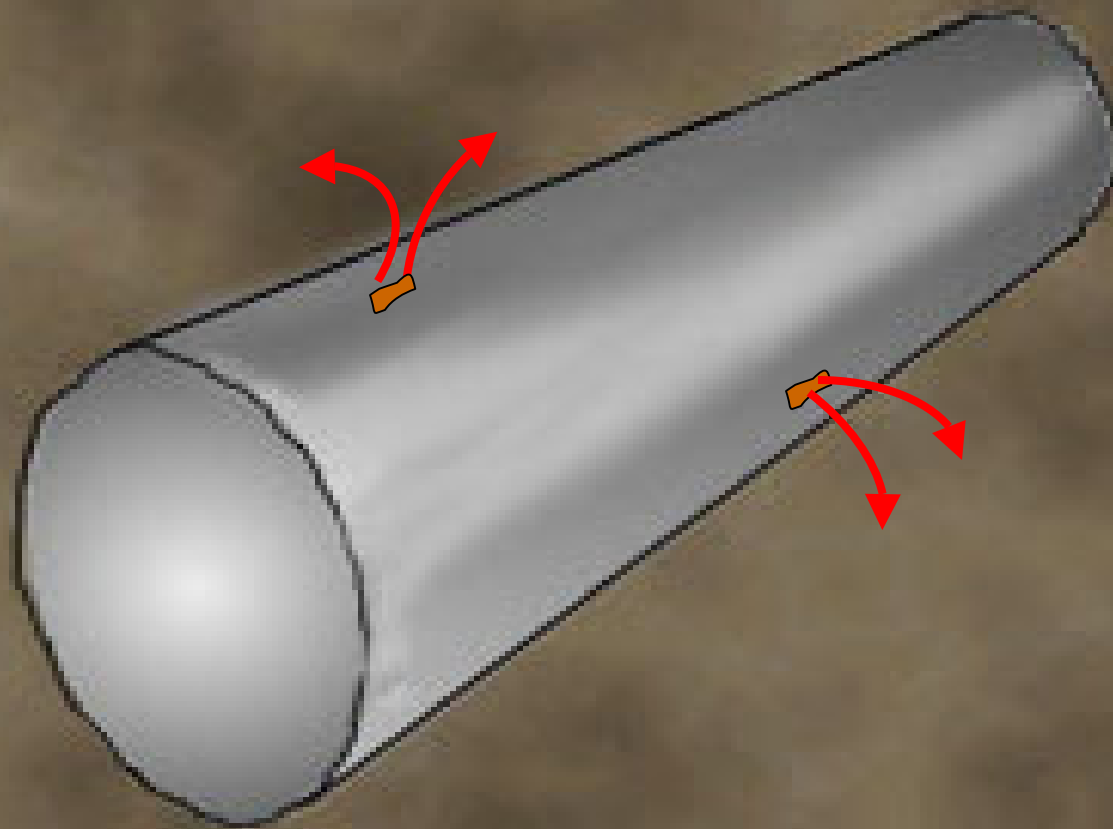
Corrosion - A Natural Process

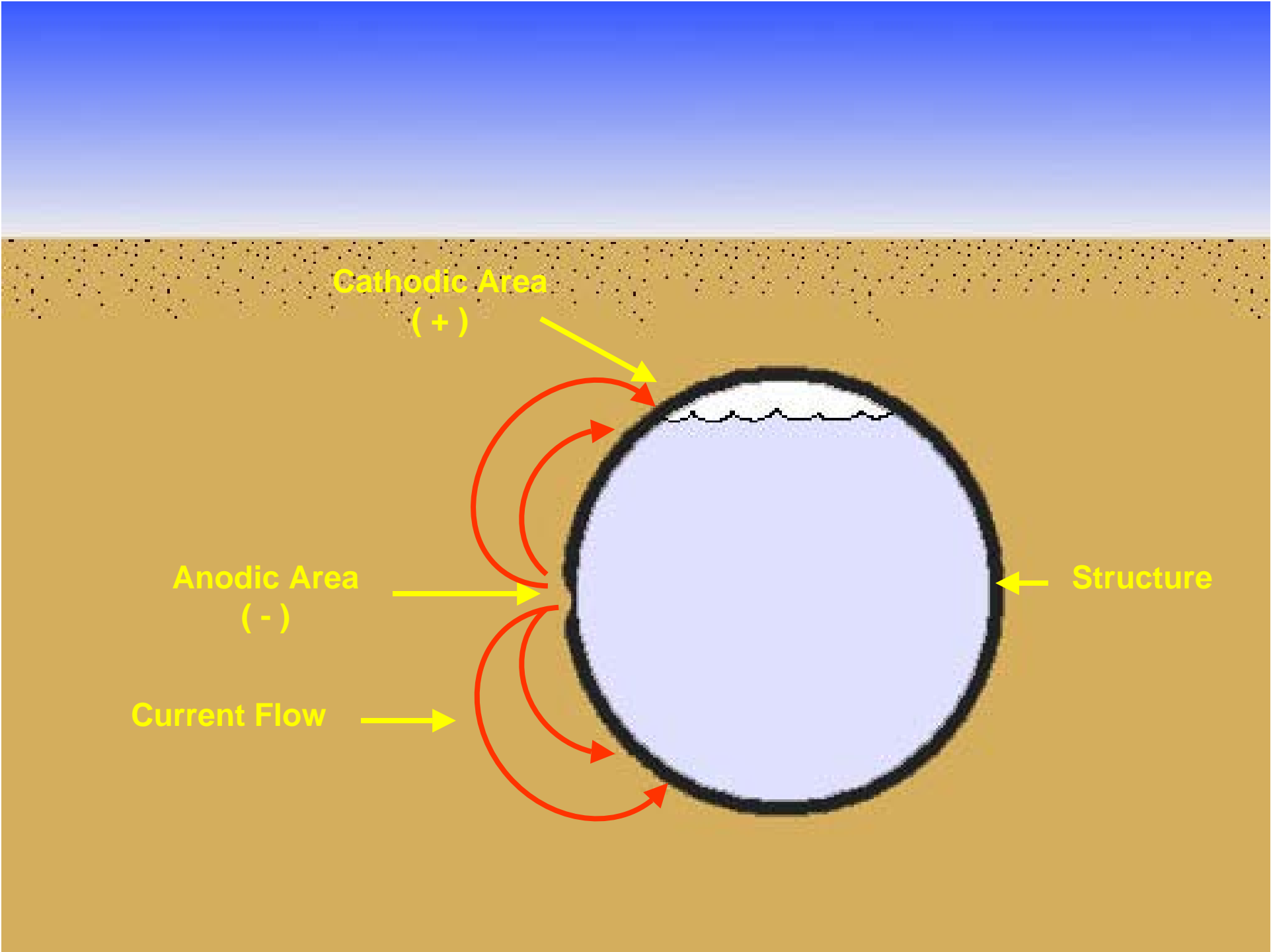


- 1) ANODE
- 2) CATHODE
- 3) ELECTROLYTE
- 4) ELECTRICAL CONNECTION



Corrosion of Metallic Structure



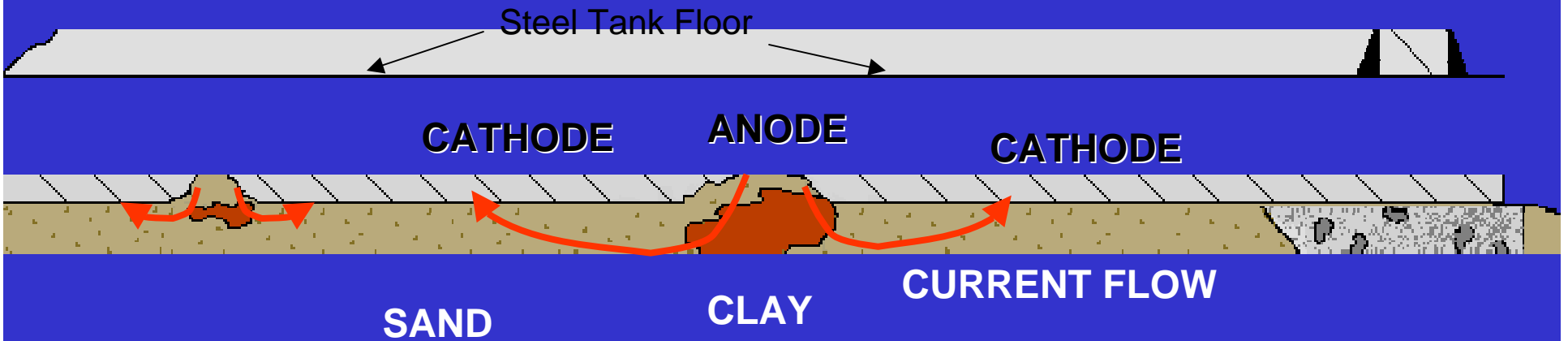




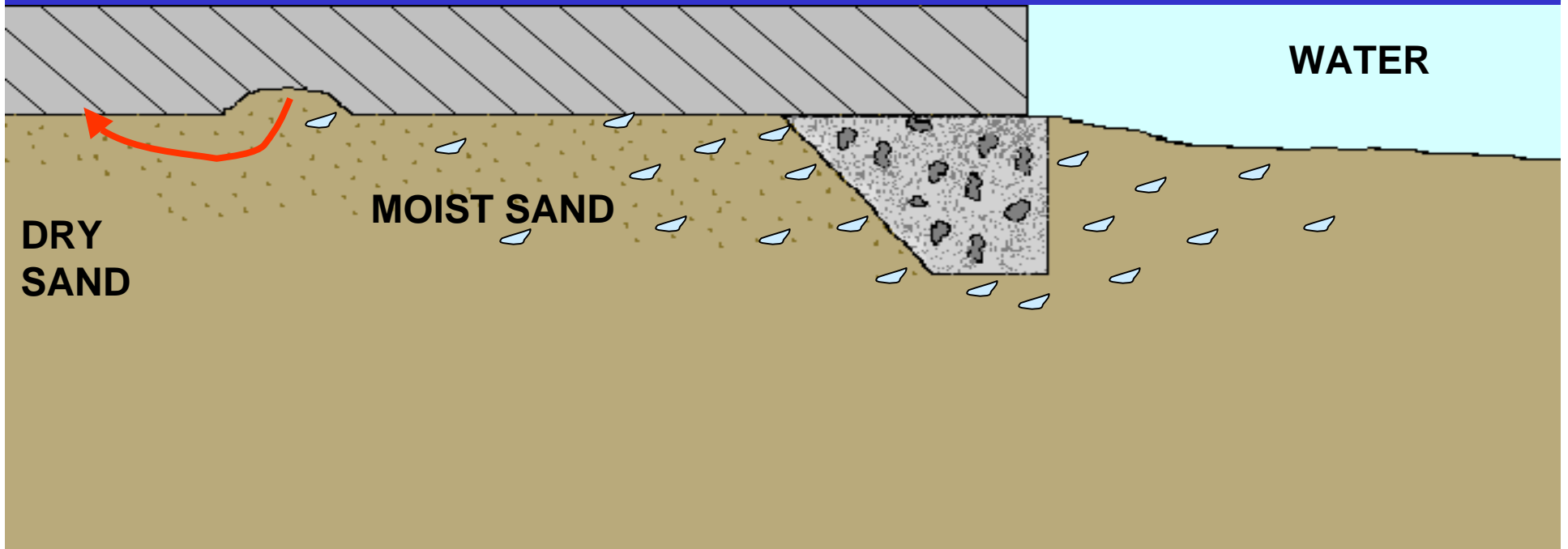




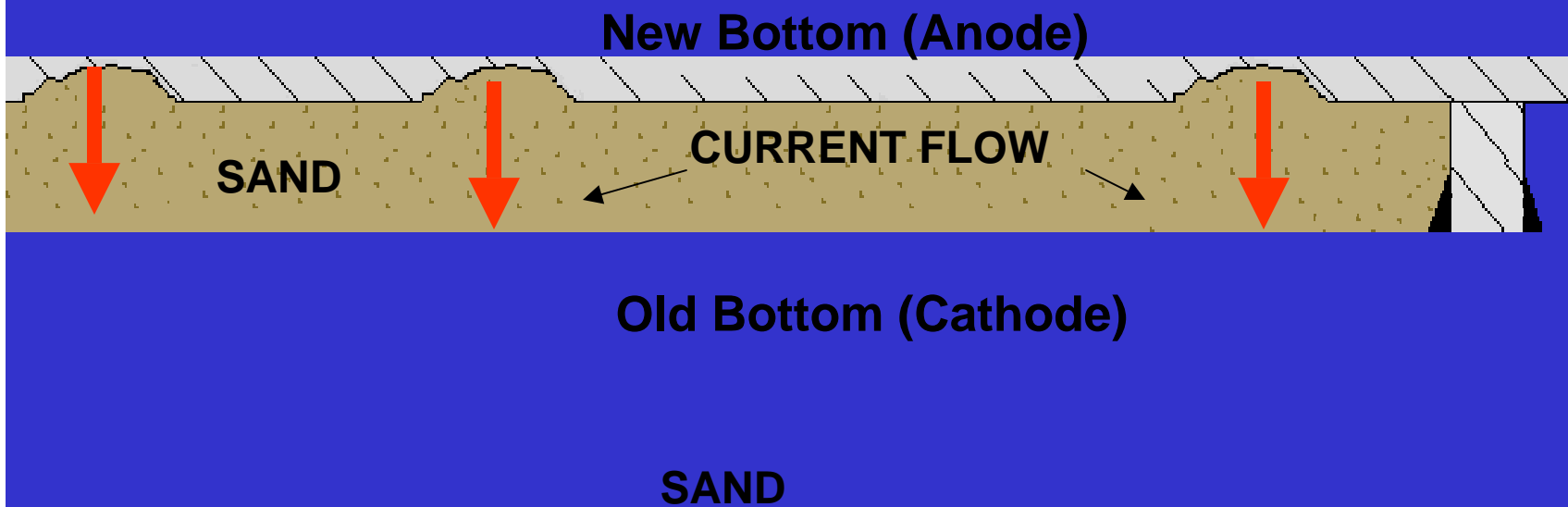
Corrosion Cell on Tank Bottom



Corrosion Caused by Poor Water Drainage



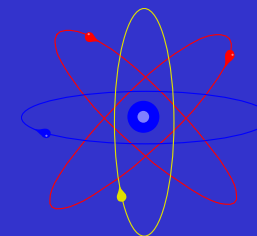
New Steel Coupled to Old Steel



Galvanic Anode Cathodic Protection

- ▶ Current is obtained from a metal of a higher energy level

PRACTICAL GALVANIC SERIES

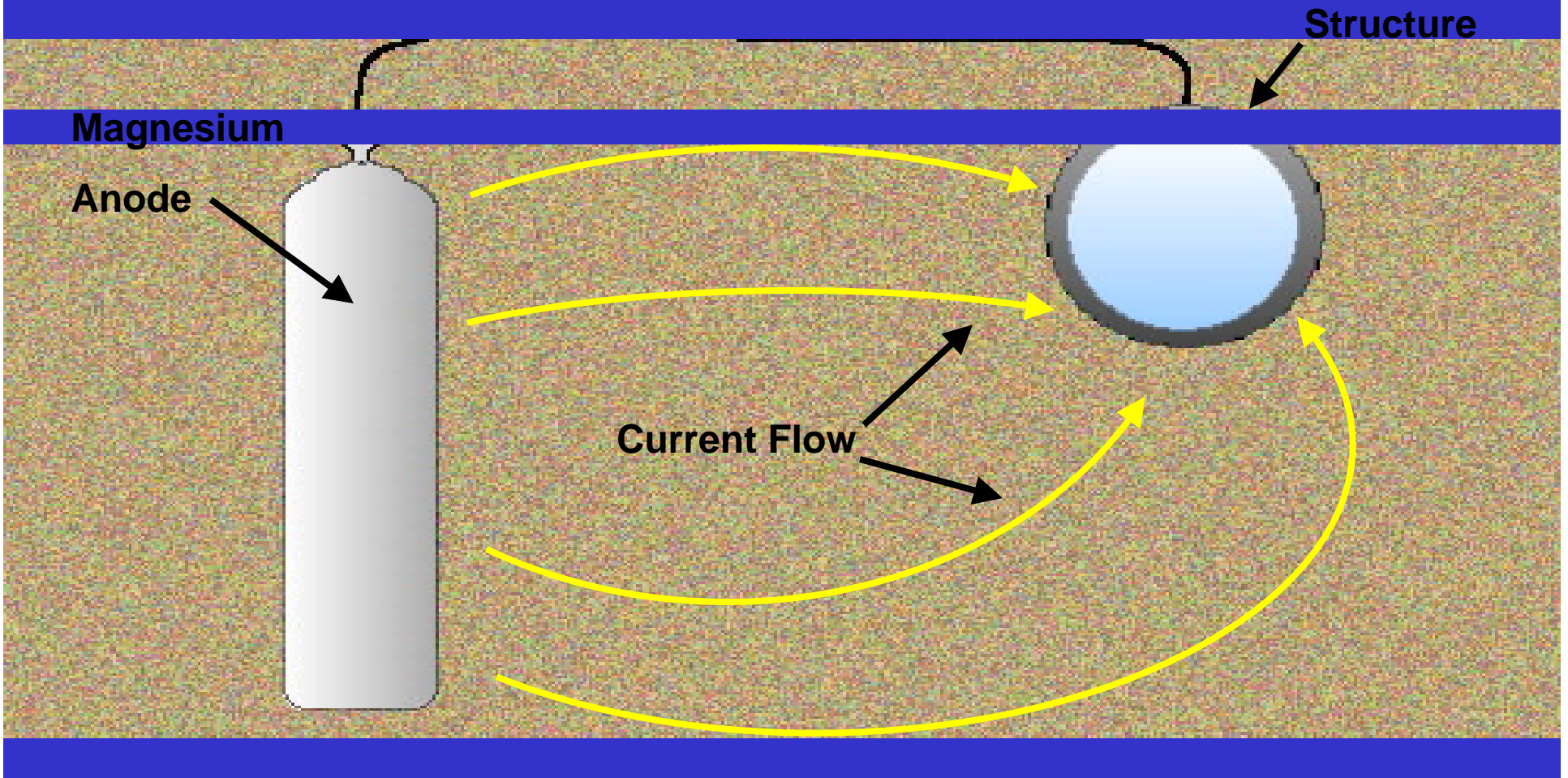


Material	Potential*
Pure Magnesium	-1.75
Magnesium Alloy	-1.60
Zinc	-1.10
Aluminum Alloy	-1.00
Cadmium	-0.80
Mild Steel (New)	-0.70
Mild Steel (Old)	-0.50
Cast Iron	-0.50
Stainless Steel	-0.50 to + 0.10
Copper, Brass, Bronze	-0.20
Titanium	-0.20
Gold	+0.20
Carbon, Graphite, Coke	+0.30

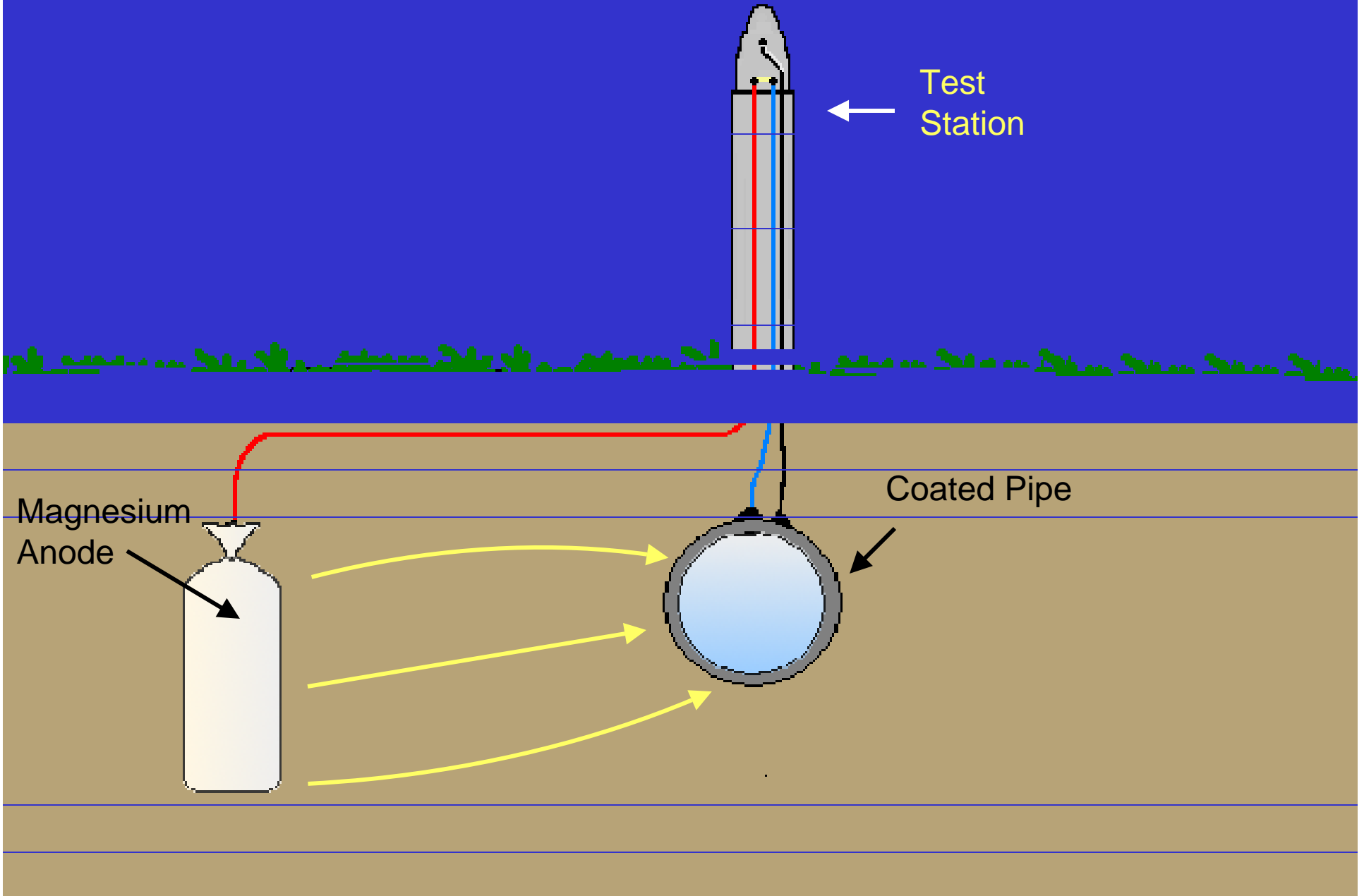
* Potentials With Respect to Saturated Cu-CuSO₄ Electrode

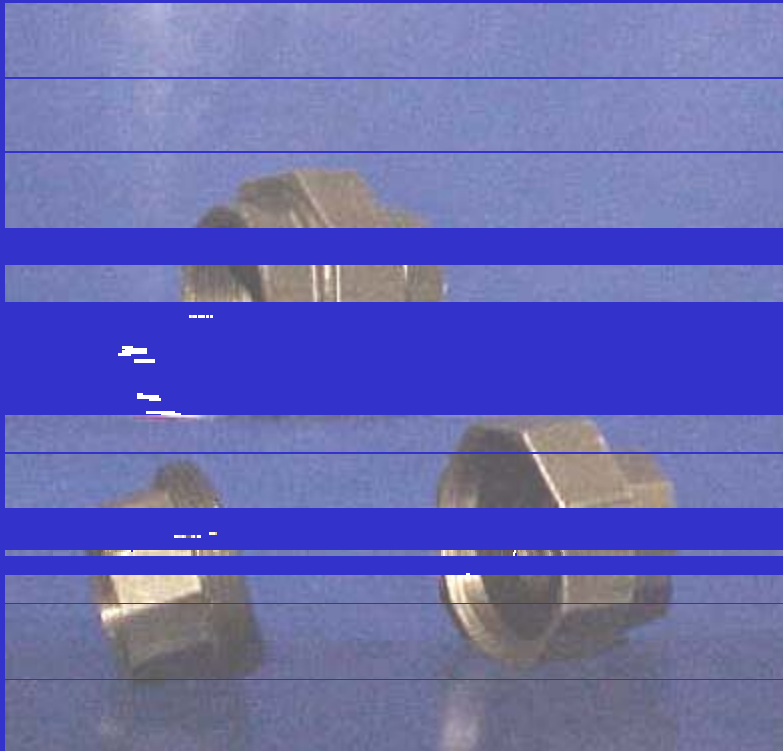


Galvanic Cathodic Protection on Coated Pipeline



Cathodic Protection Test Station





INSULATING UNIONS



FLANGE INSULATION KIT

Galvanic Anodes

- Typically limited to new piping, that has a good quality coating and electrical isolation.
- If the particular location is lacking any of the above, an impressed current system may be warranted.

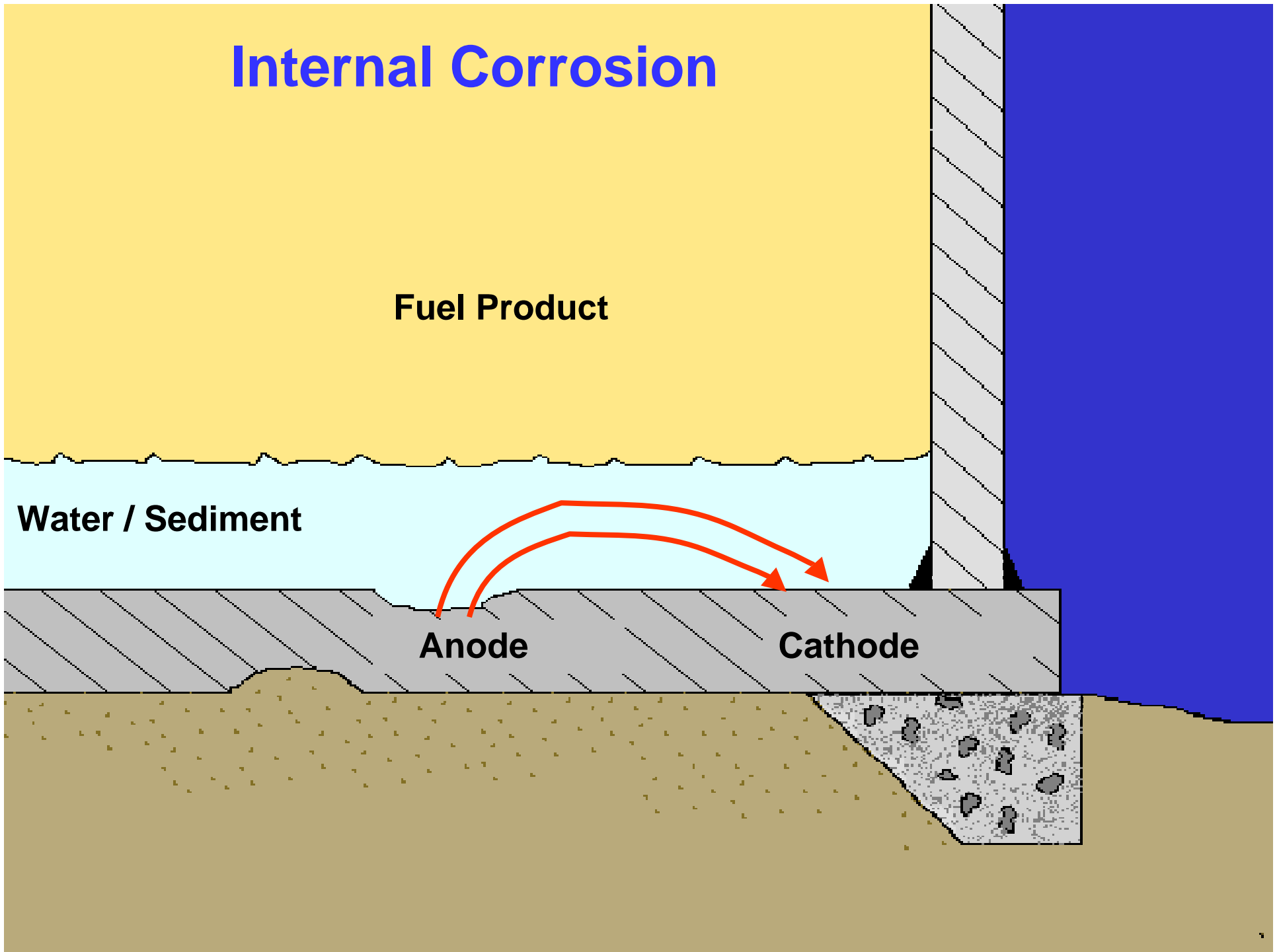
Internal Corrosion

Fuel Product

Water / Sediment

Anode

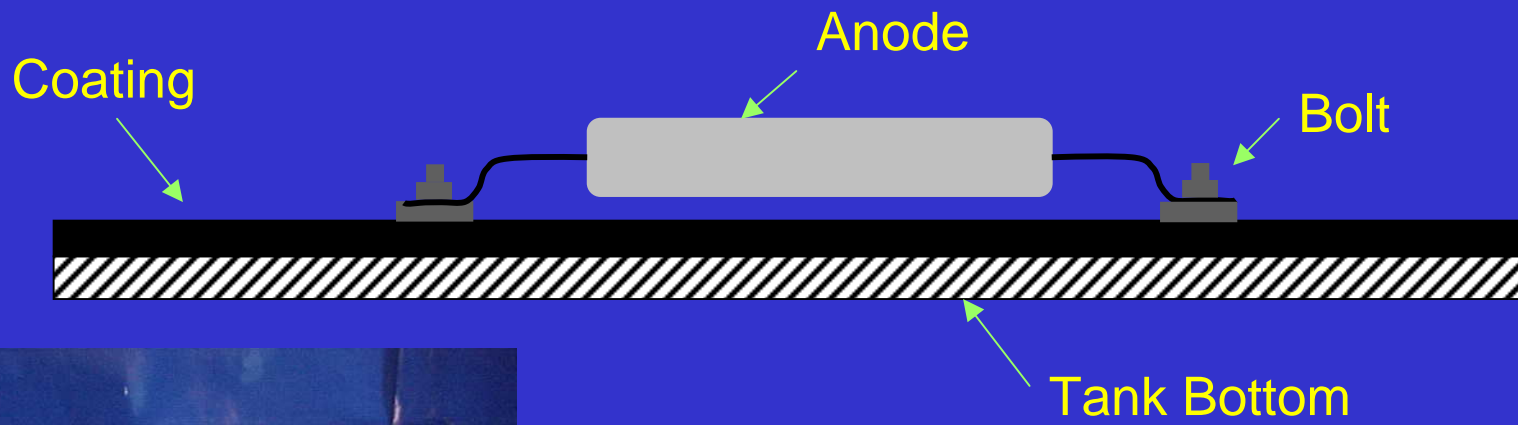
Cathode





Internal Corrosion





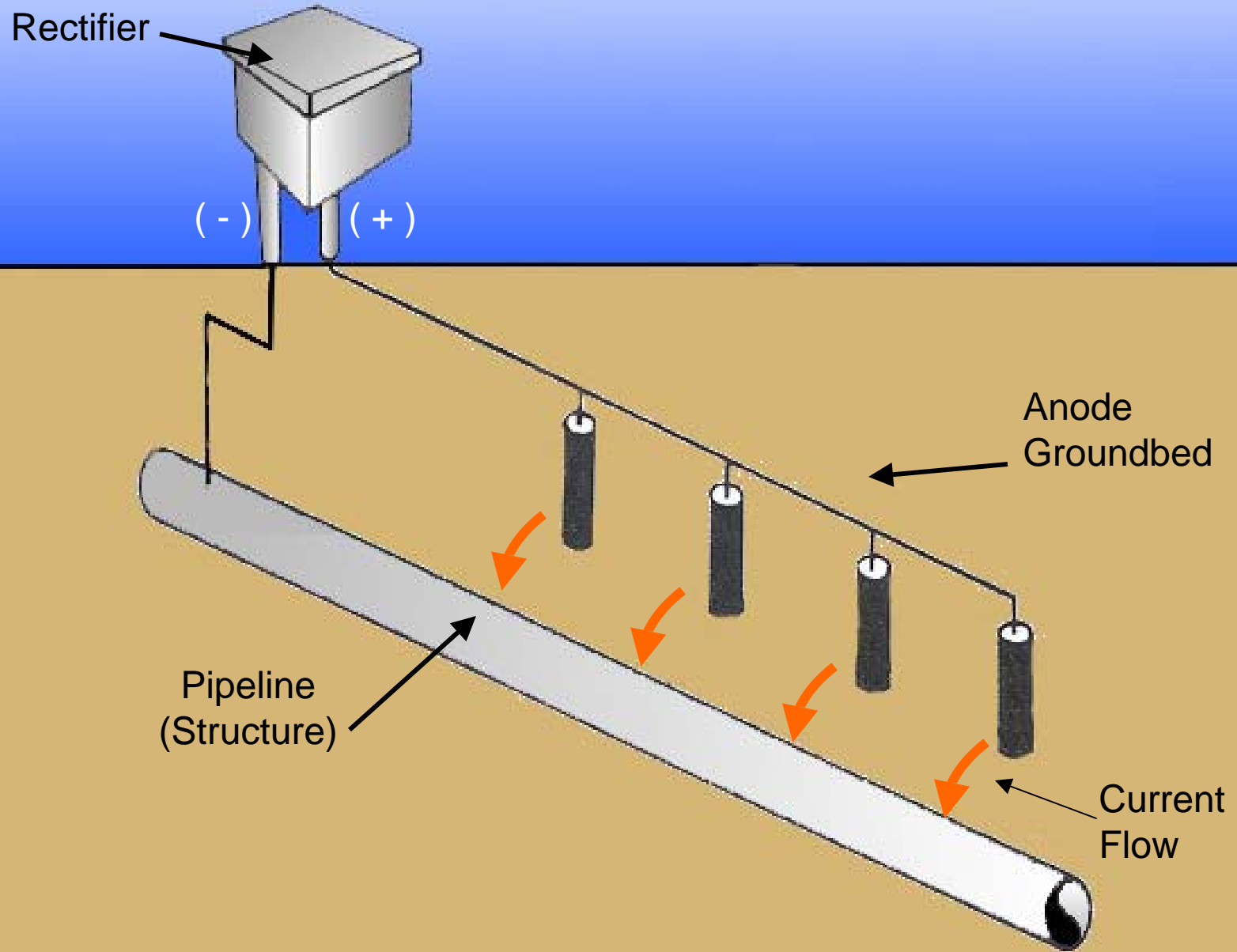
Conventional CP Systems for AST's

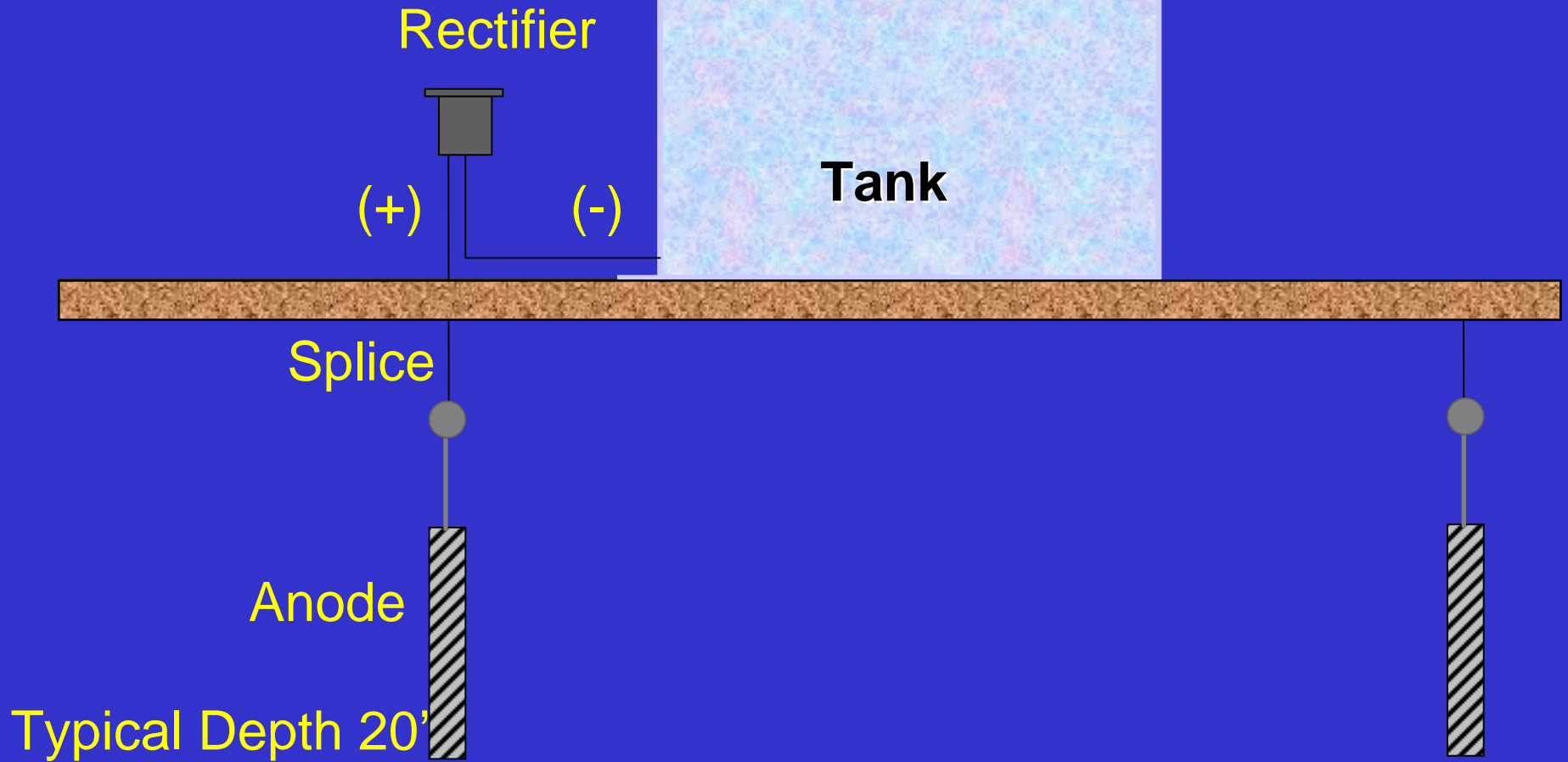
- Shallow (Distributed) Anodes
- Deep Anode Groundbed



Impressed Current Transformer Rectifier Unit

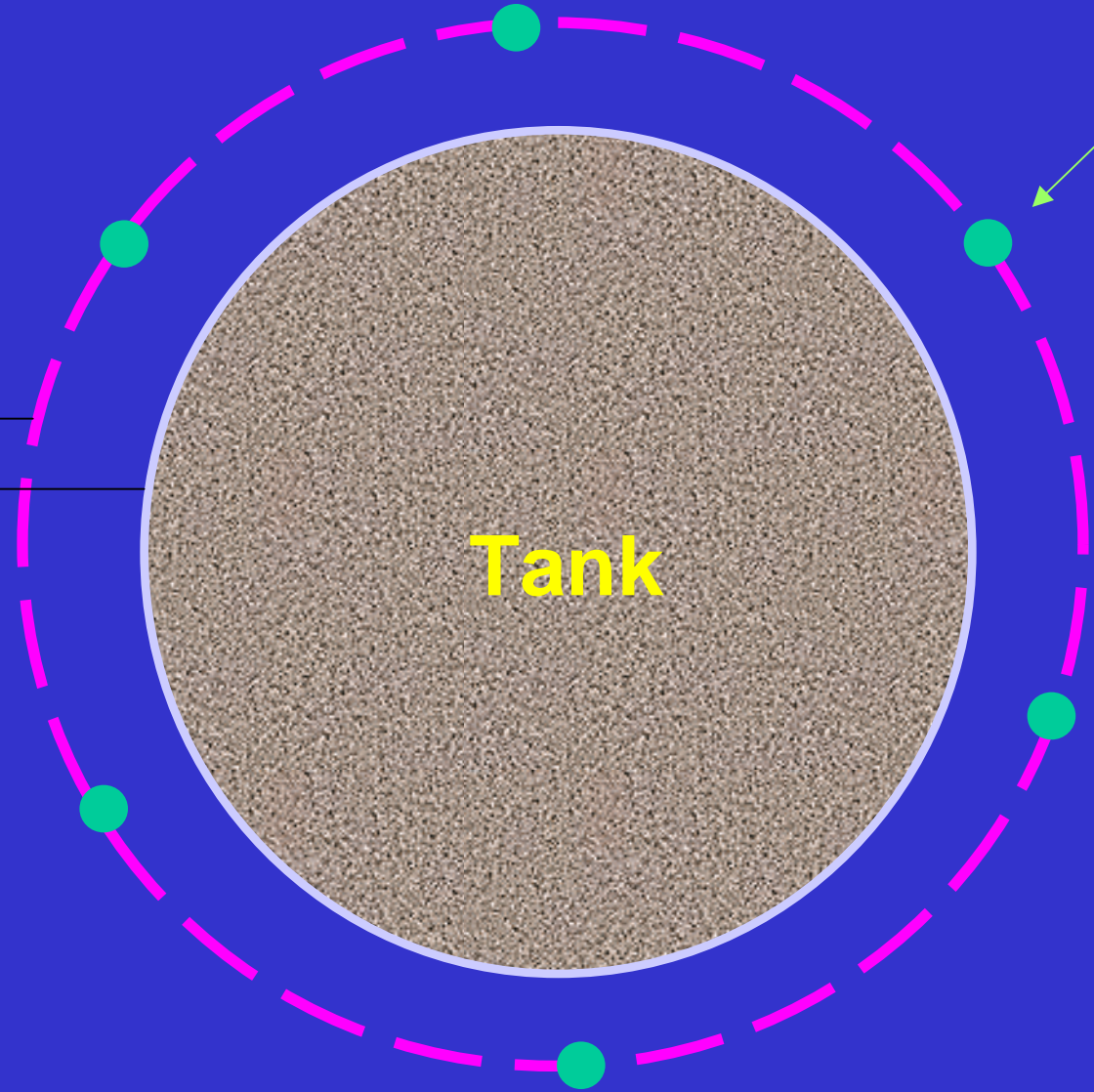
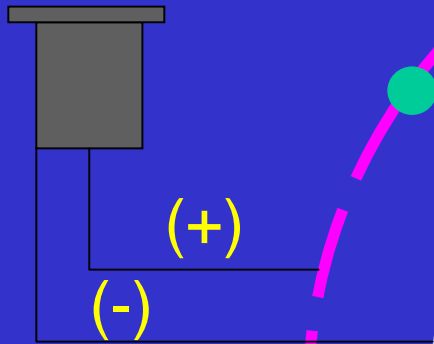
Impressed Current System



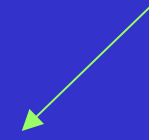


Shallow Anodes

Rectifier



Anode

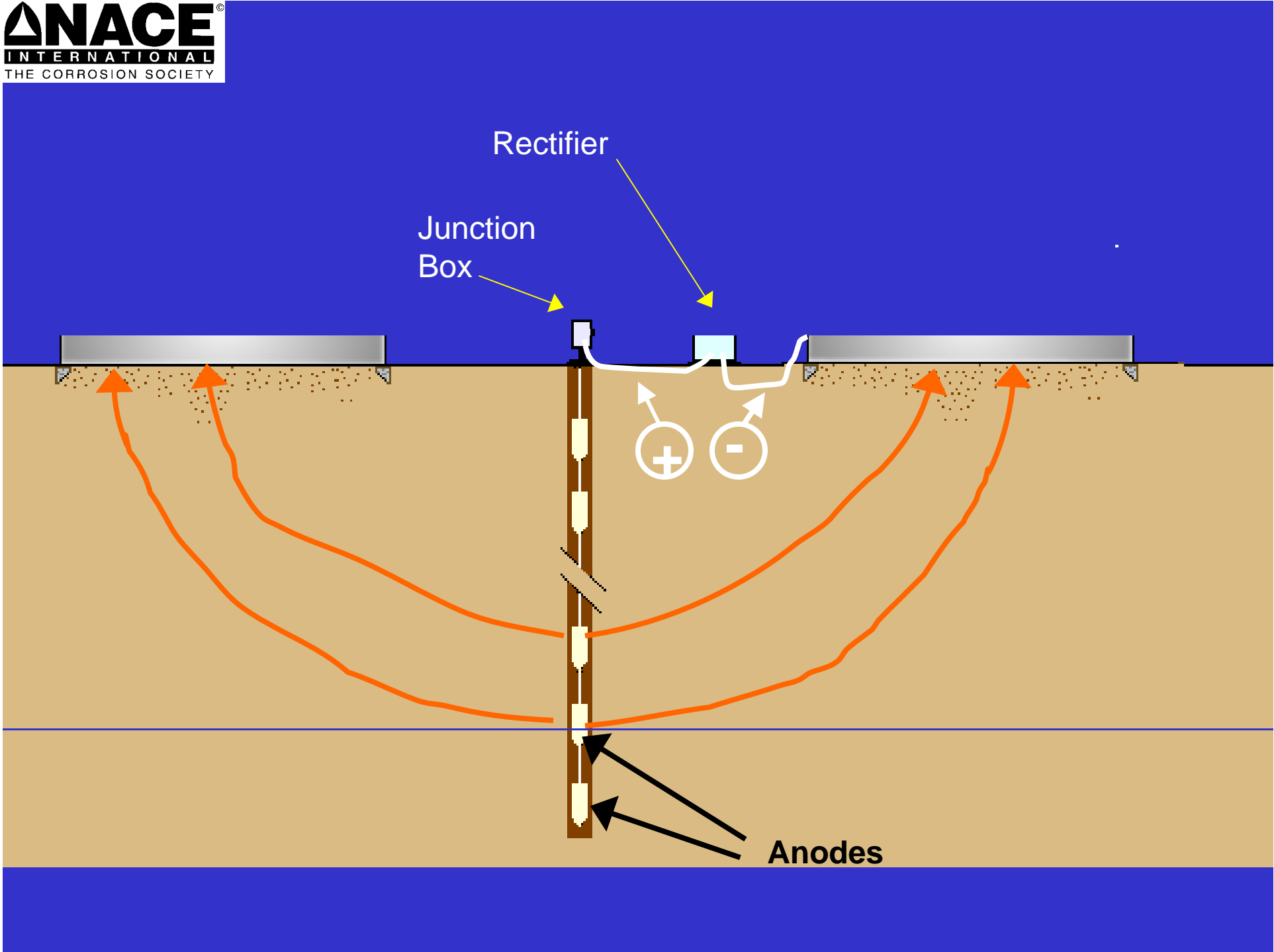


Shallow Anodes

Rectifier
Junction
Box

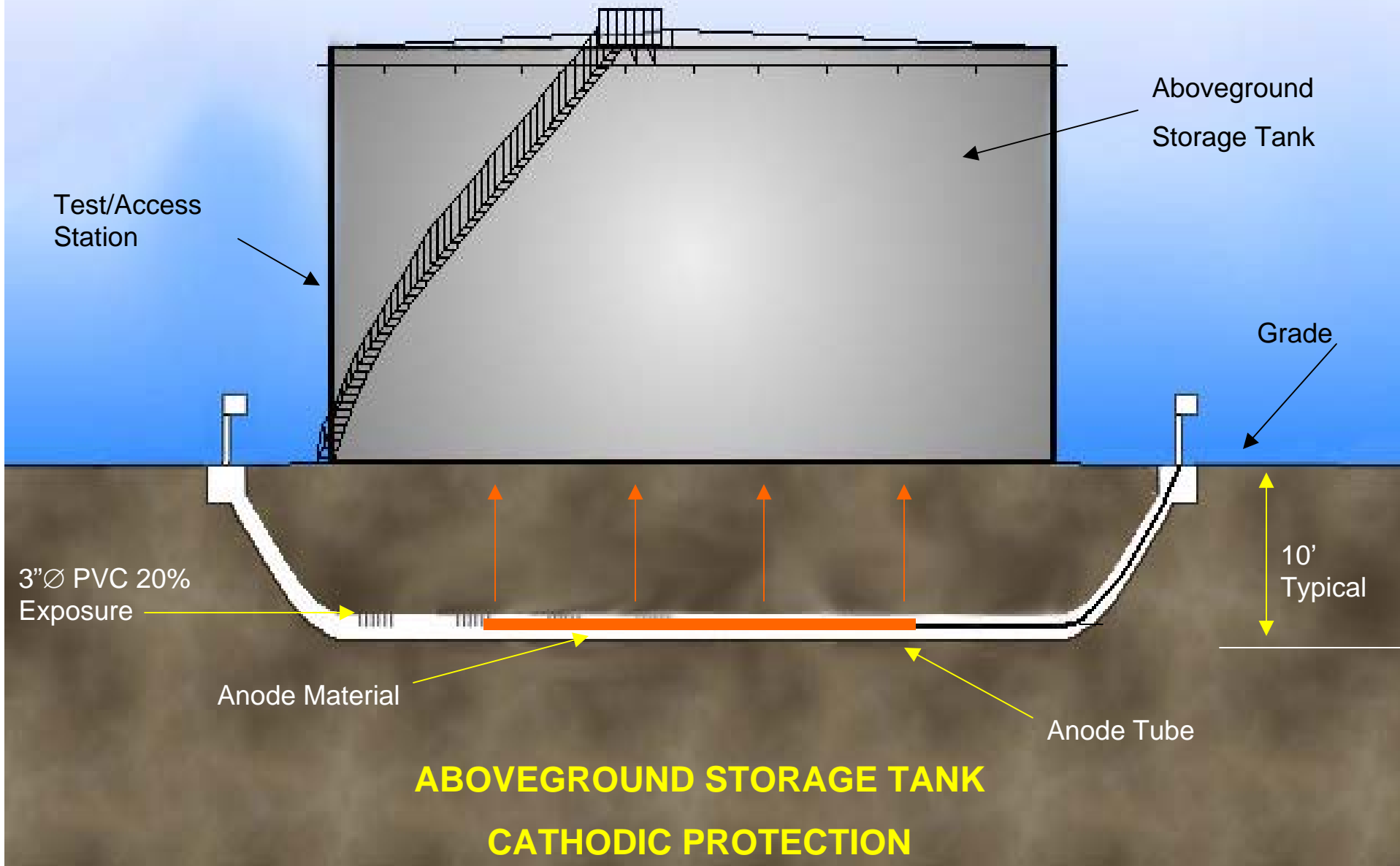


Anodes





Directional Boring Under Existing AST



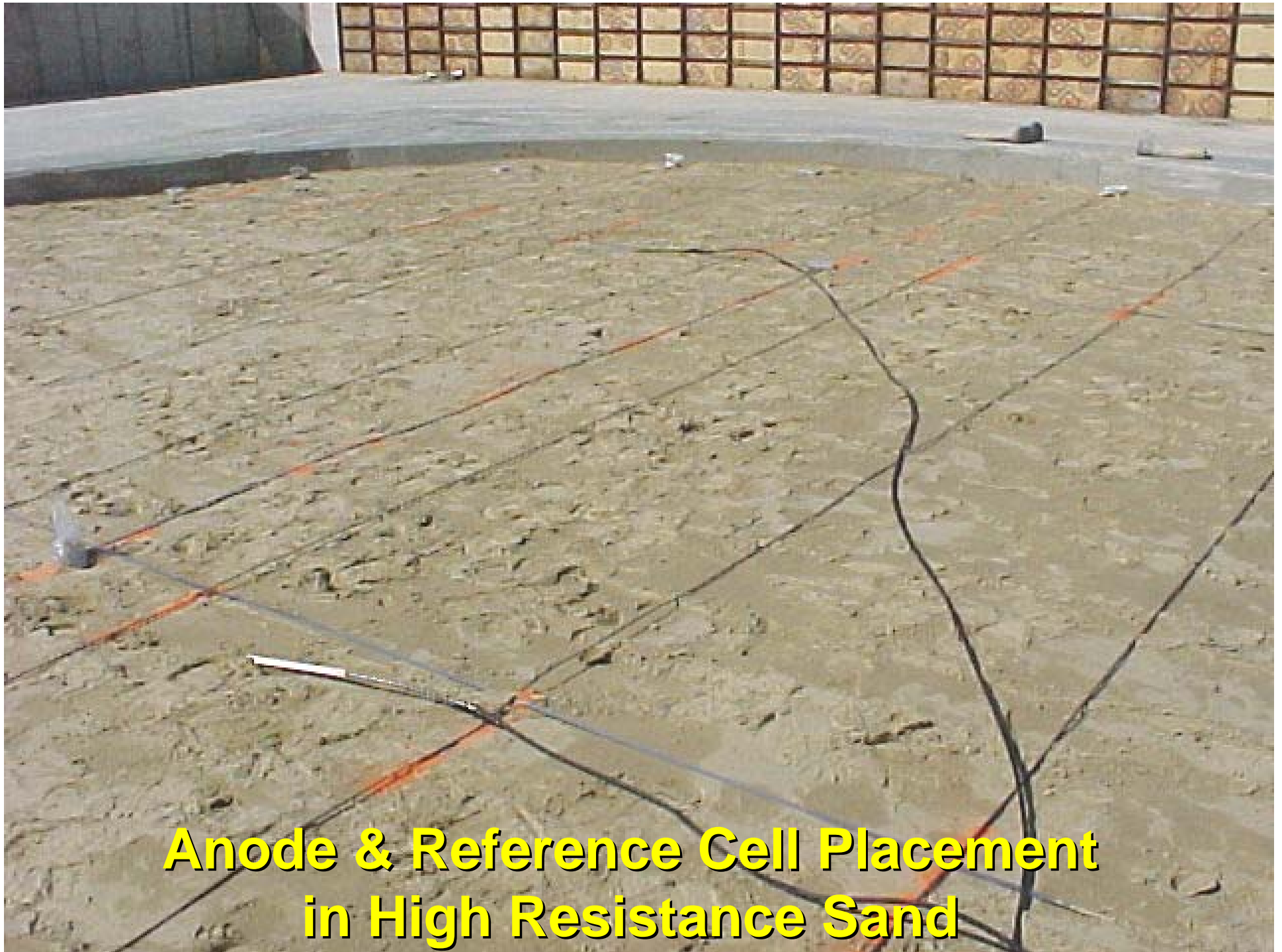
New/Refurbished AST Bottoms with or without Secondary Containment

Secondary Containment

- ▶ **Environmental Protection**
- ▶ **Minimize Liability**
- ▶ **State and Local Regulations**

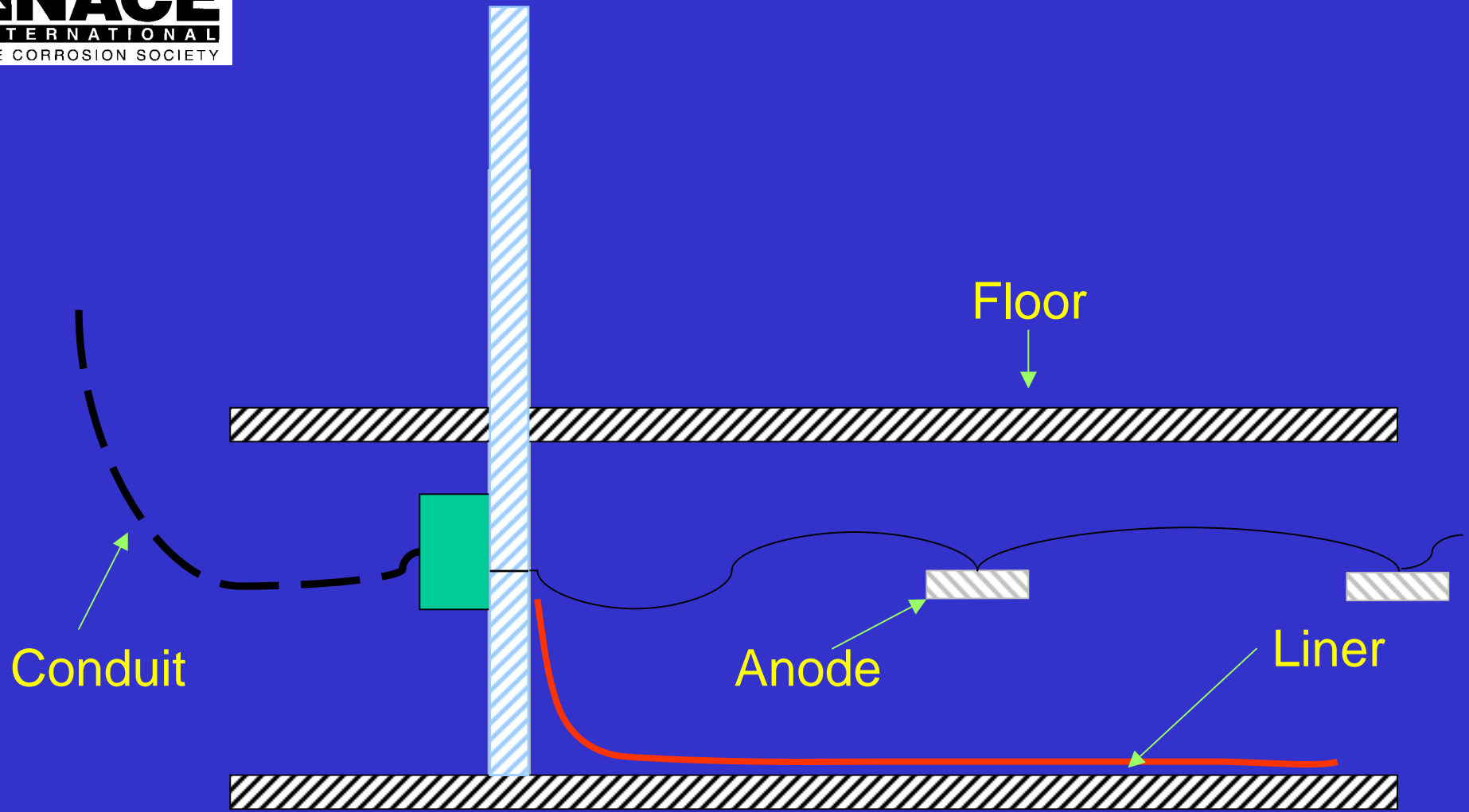


New Tank Construction with Liner



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





CP Installation on Double Bottom Tank



New Floor Installation on Existing AST



CP Installation on Rebottomed Tank

Installation of CP System on Lifted AST



Maintenance of Cathodic Protection Systems

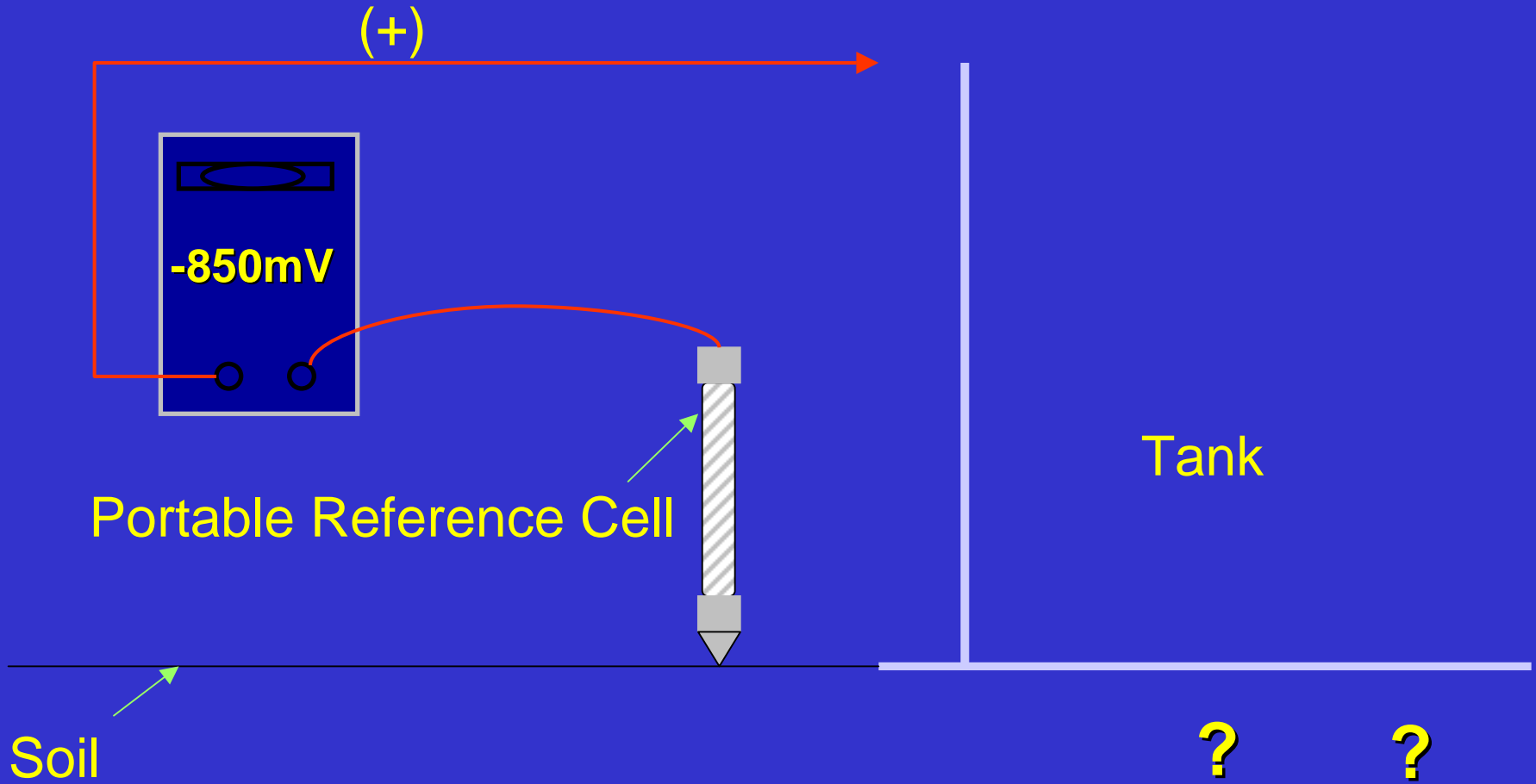
- **Conduct Annual Testing**
- **Meet NACE Criteria/Standards**
- **Conduct Bi-Monthly Rectifier Checks**
- **NACE Qualified Technicians**

NACE Cathodic Protection Criteria

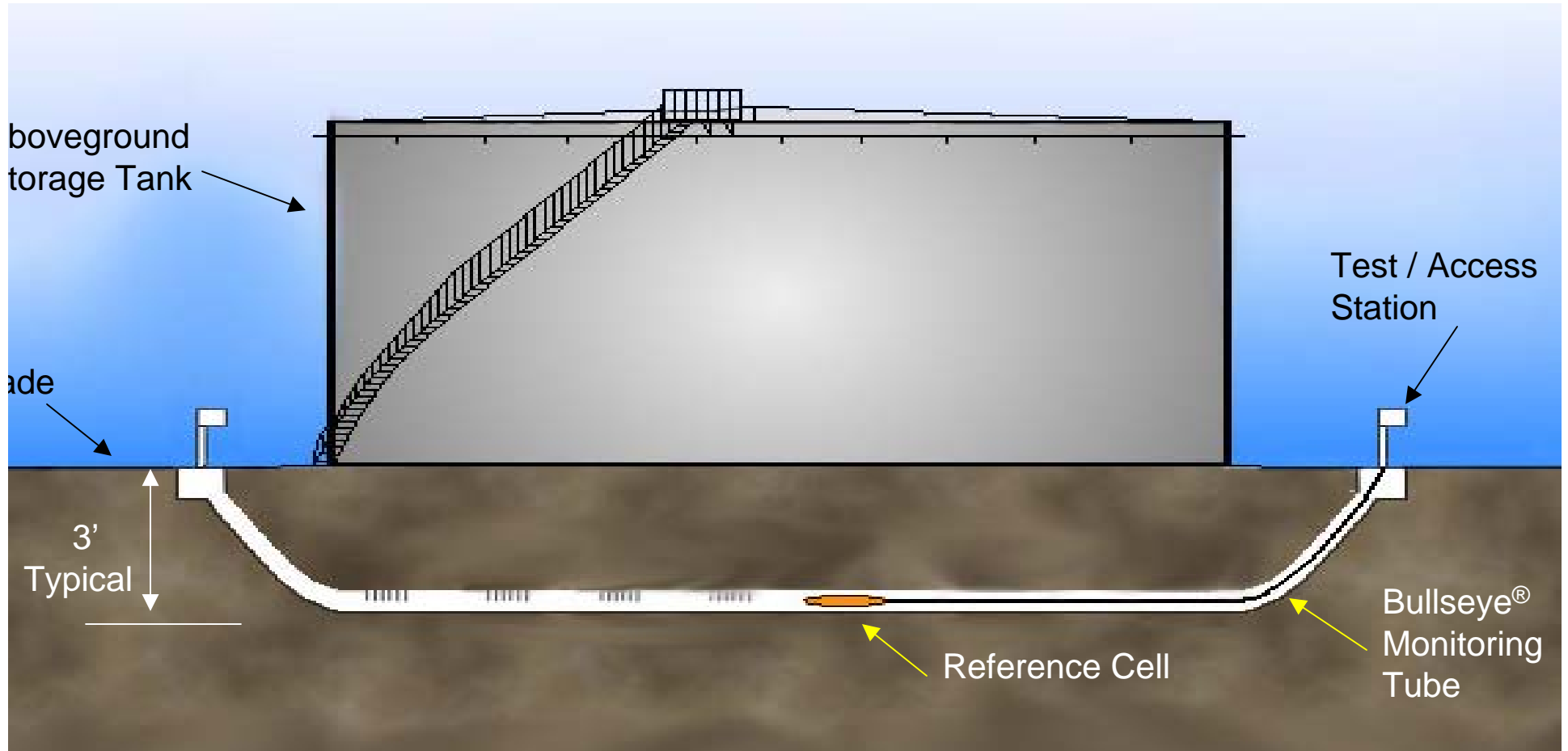
- -850mV or more negative with current applied
- -850mV “Instant off”
- -100mV shift between “Instant off” and “Native”



Annual Cathodic Protection Survey



Rim Potential Measurements



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

Potentials (mV)



Test
Station

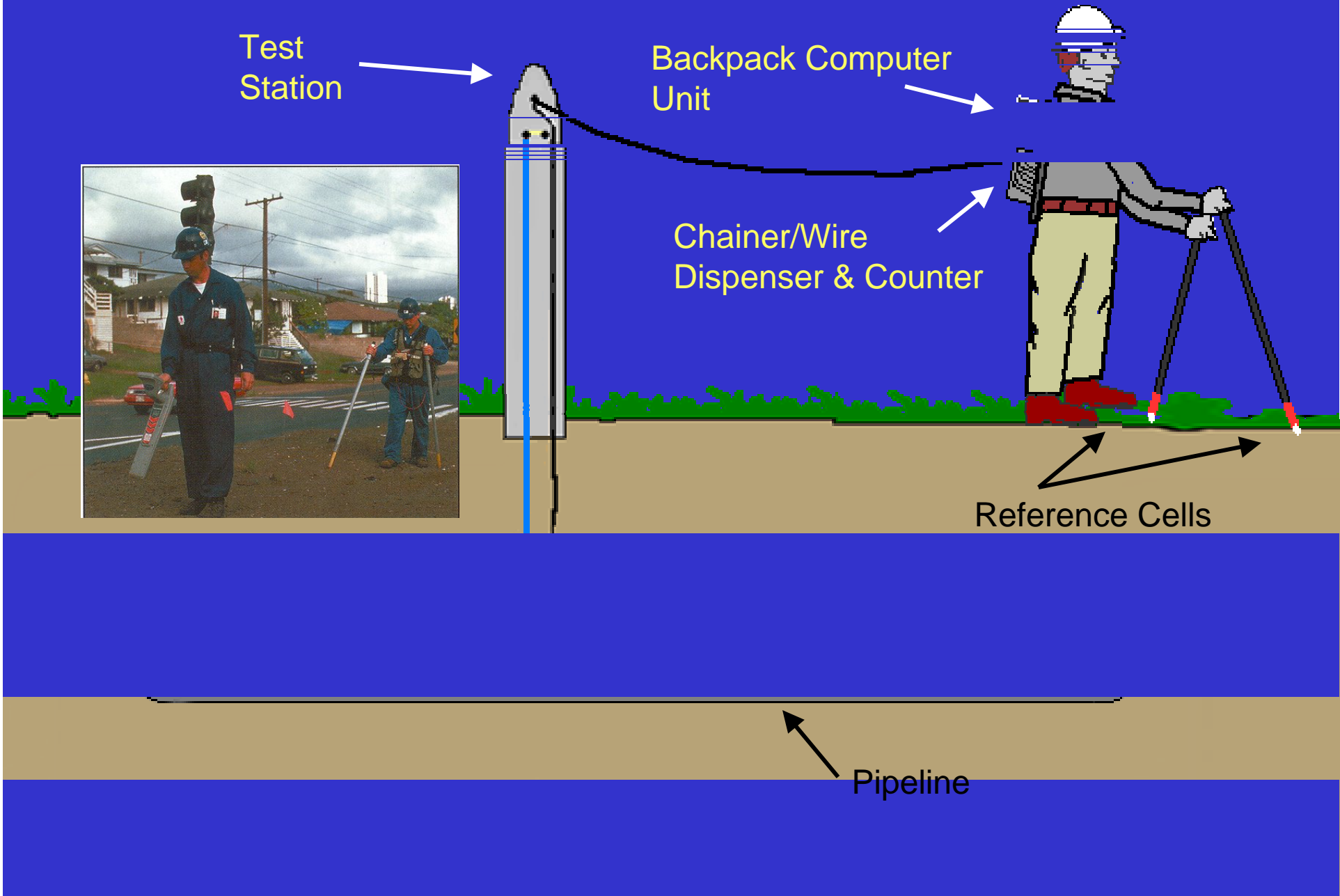


Structure



Stray Current Monitoring Test Station

Computerized Potential Logging Survey

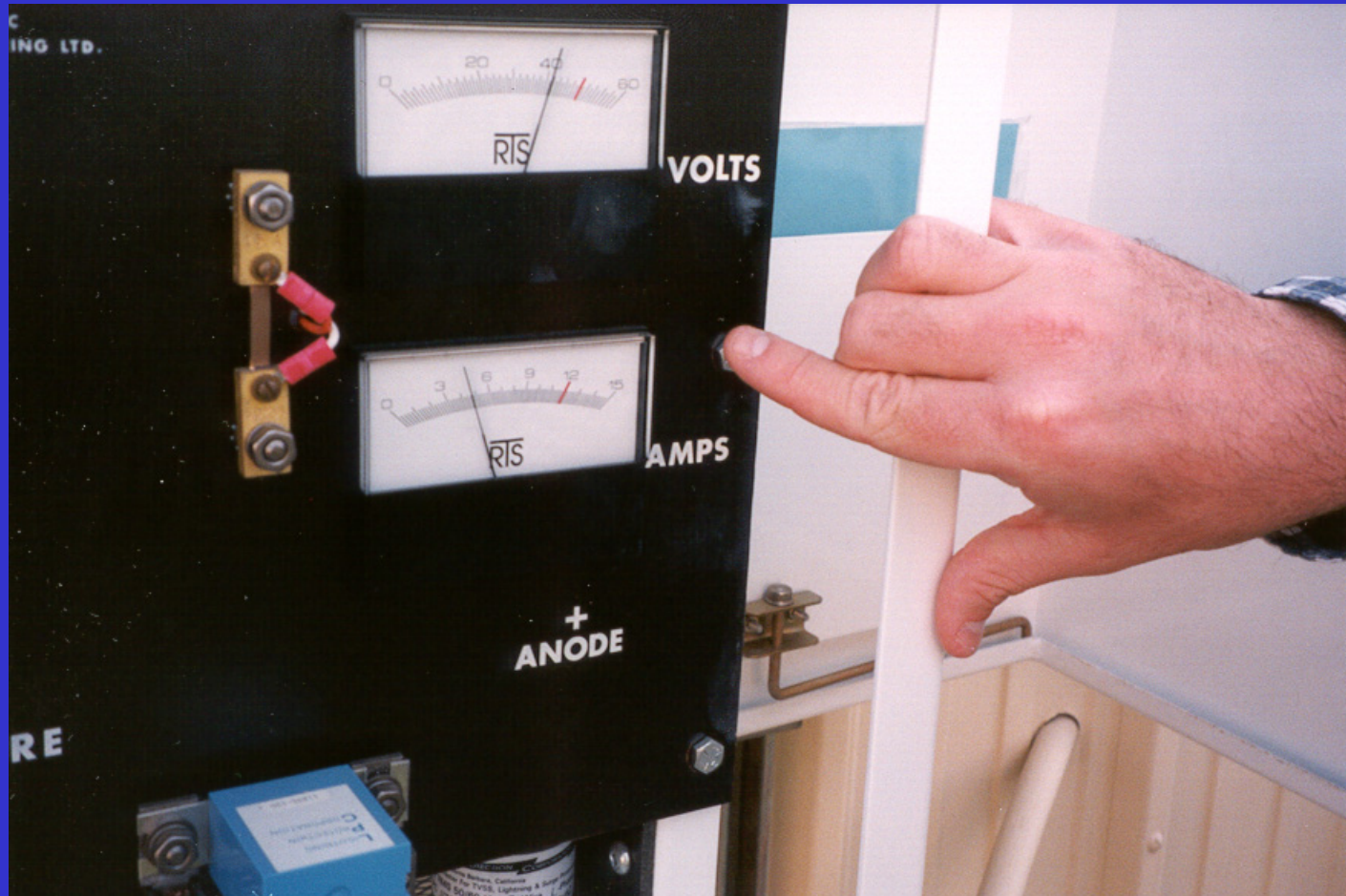


Monitoring

- Record volts and amps every 30-60 days
- Compare values to target setting
- Conduct annual cp survey by NACE engineer
- Maintain cp records



Bi-Monthly Rectifier Check



Visual Check of Volts/Amps

Record Keeping

- Provides History
- Computer Records/Data Collection
 - Remote Monitoring
 - Hand Held Computers
 - Close Interval Surveys
 - Data Printouts
 - Flagging of Problem Areas
 - Prioritize Action Items
- As Built Drawings
- Store Data & Records for Life

System Characteristics

Galvanic

- ▶ No external power
- ▶ Fixed driving voltage
- ▶ Limited current
- ▶ Small current requirements
- ▶ Used in lower resistivity environment
- ▶ Usually negligible interference

Impressed

- ▶ External power required
- ▶ Voltage can be varied
- ▶ Current can be varied
- ▶ High current requirements
- ▶ Used in almost any resistivity environment
- ▶ Must consider interference with other structures

Recommended Practices

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

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

NACE RP0193-01 - External Cathodic Protection of On-Grade Metallic Storage Tanks:

“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.”

Questions...