Cathodic Protection for AST's

Presented by:
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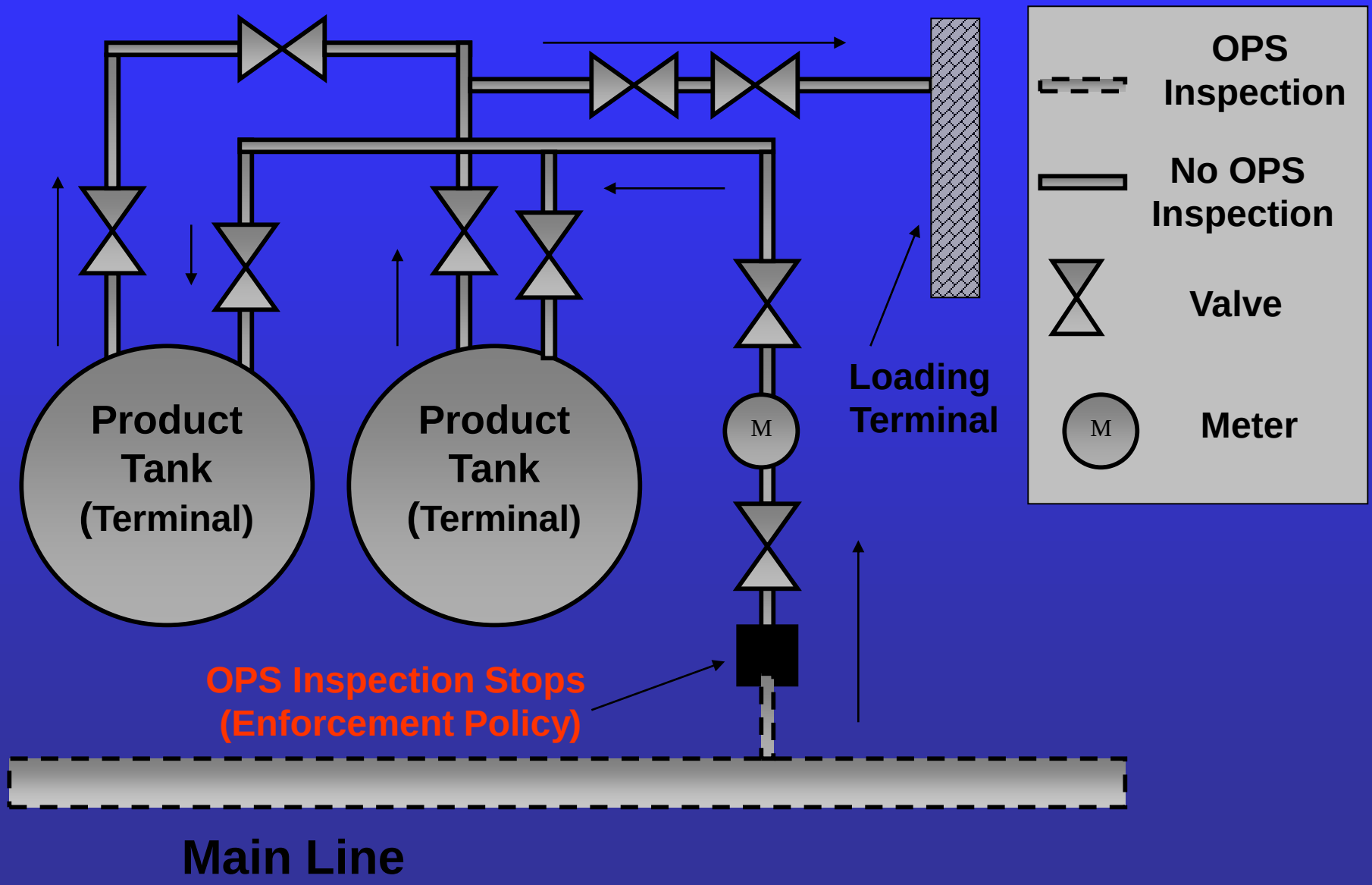
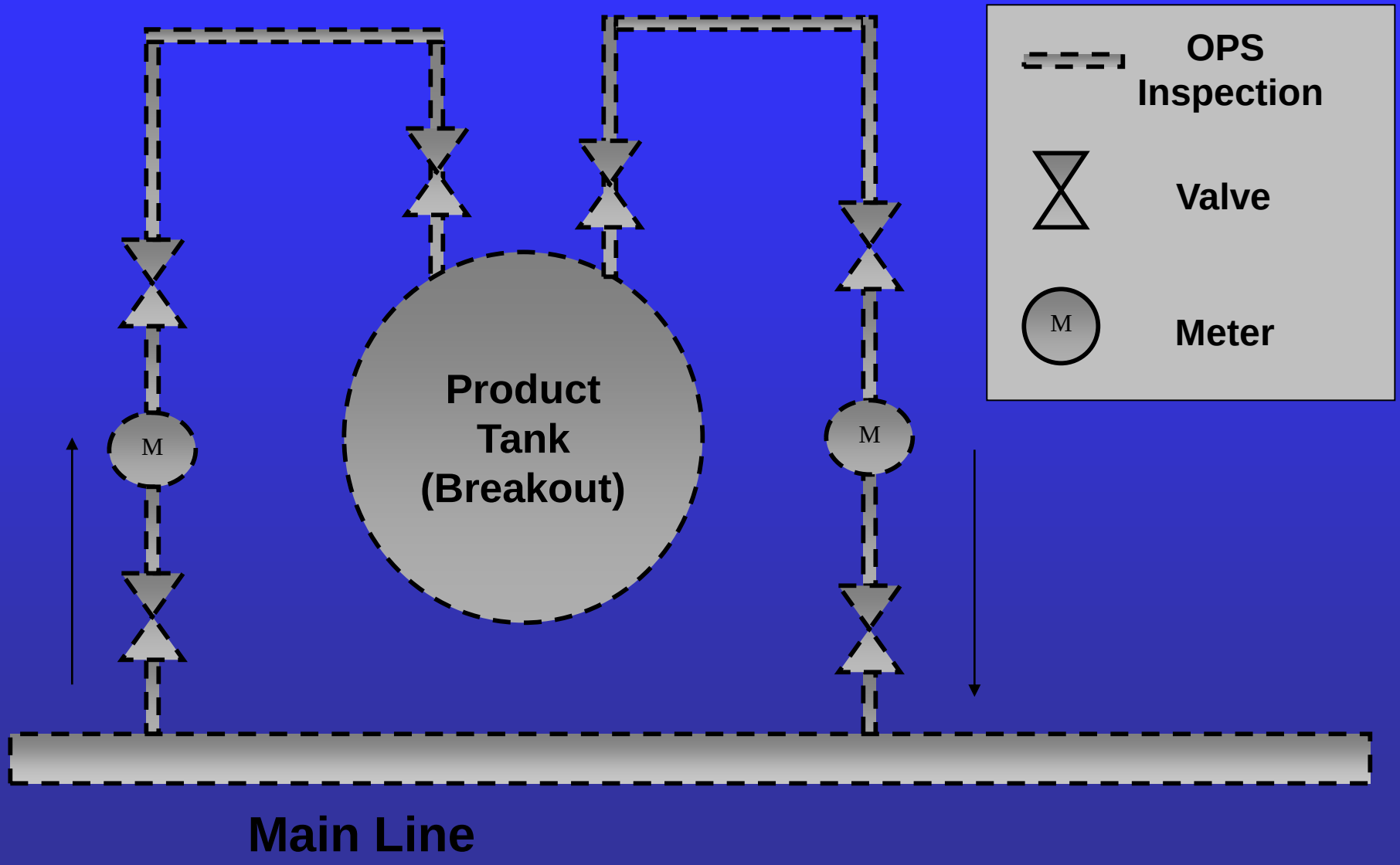
Why is Cathodic Protection Important?

- Preserve Assets
- Avoid Disruption of Service
- Enhance Safety
- Prevent Leaks
- Governmental Regulations
- Reduce Maintenance Costs

Terminal Tankage



Breakout Tank



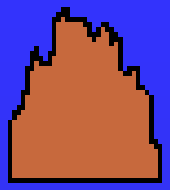
Charleston, WV Spill

The investigation found that two small holes ranging in size from about 0.4-inch to 0.75-inch in the bottom of the 48,000-gallon tank 396 were caused by corrosion, likely resulting from water leaking through holes in the roof and settling on the tank floor. Furthermore, the CSB inspection found a similar hole penetrating the bottom of nearby tank 397, containing the same chemical at the facility, located in Charleston. Other tanks also showed multiple signs of pitting and metallurgical damage, investigators said. The growing corrosion in these tanks went unnoticed until the bottom of 396 was breached and up to an estimated 10,000 gallons of product made their way through the underlying mixture of soil and gravel under the facility and into the Elk River on January 9, 2014.

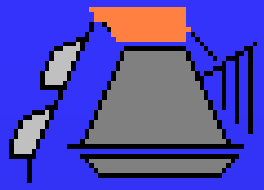
What we will cover….

- Causes of Corrosion
- Cathodic Protection Applications
- Installation & Maintenance
- Rectifier Monitoring

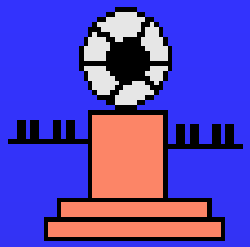
Early Oil Tanks & Piping did not Employ CP



IRON OXIDE

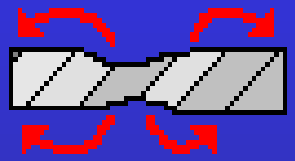


REFINING

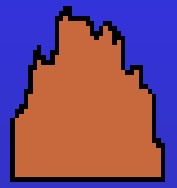


MILLING

STEEL



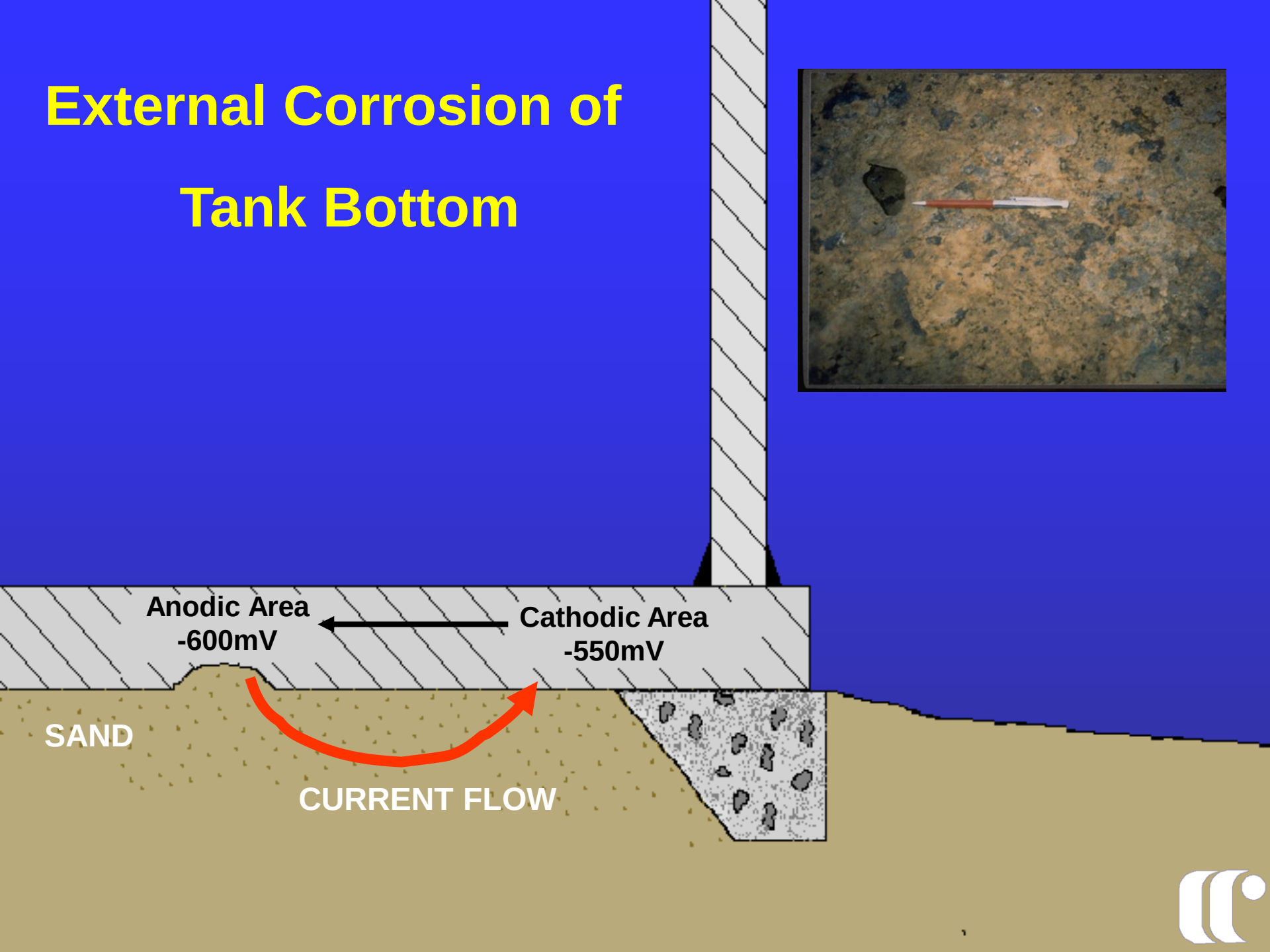
CORROSION



IRON OXIDE

THE PROBLEM…..

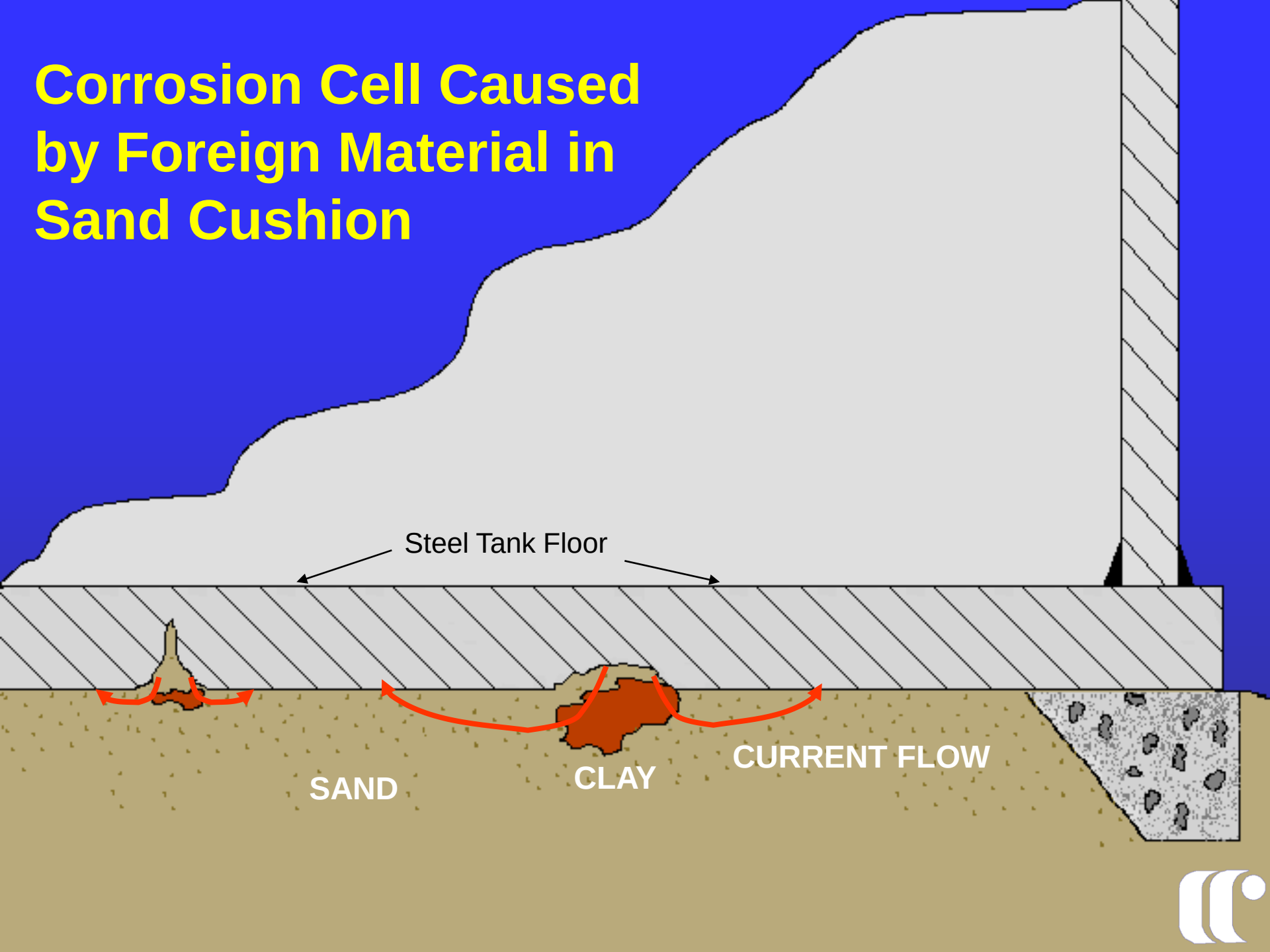
External Corrosion of Tank Bottom



MFL Floor Inspection

133

Corrosion Cell Caused by Foreign Material in Sand Cushion



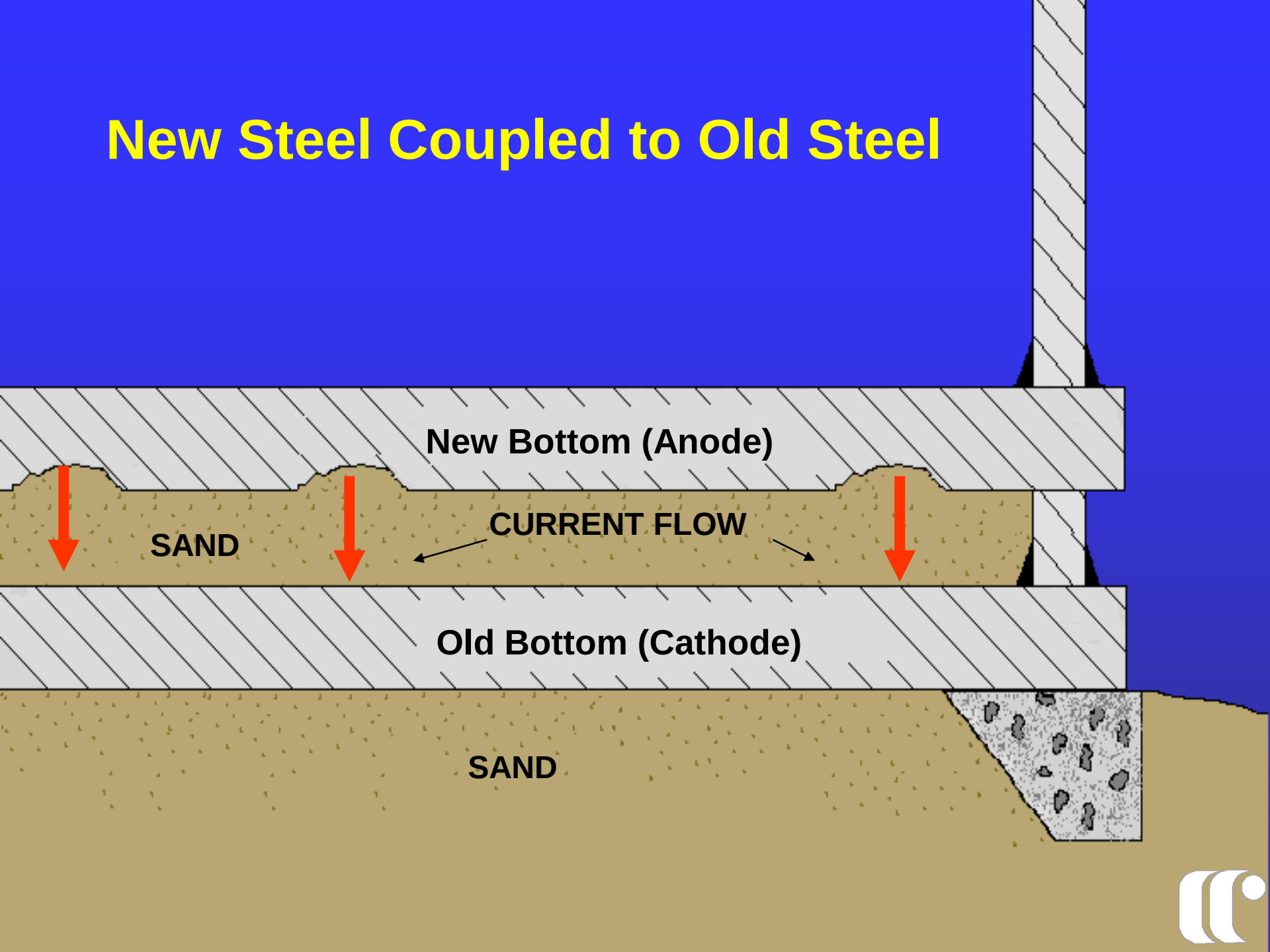
Corrosion Caused by Poor Water Drainage

WATER

MOIST SAND

DRY SAND

New Steel Coupled to Old Steel



Concrete Slab

Leak detection grove under under bottom

Tank bottom required 30% floor replacement after 5 years in service

Types of Cathodic Protection

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

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

System Characteristics

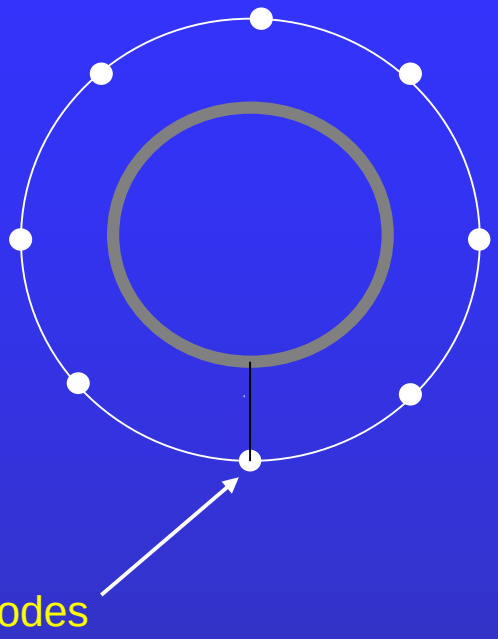
Galvanic

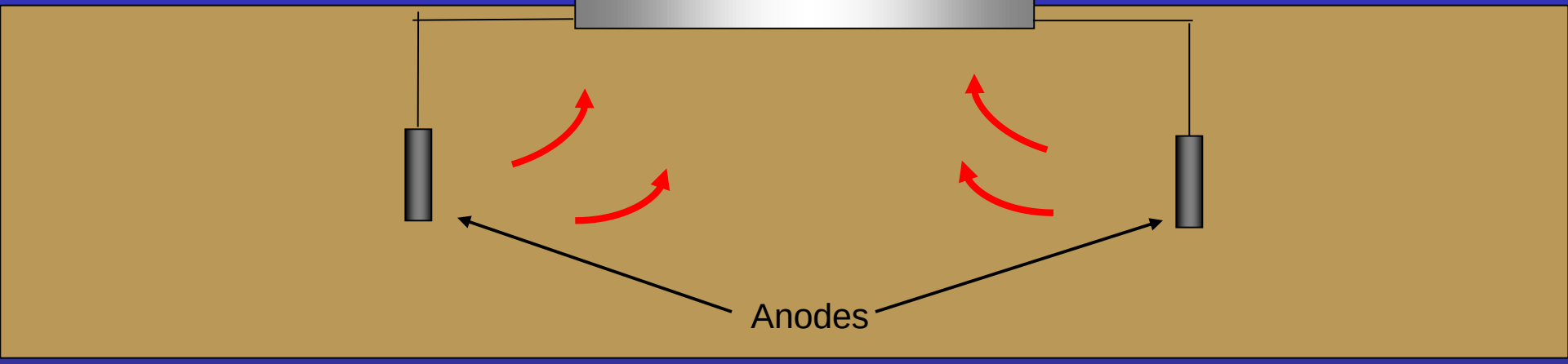
- No external power
- Fixed driving voltage
- Limited current
- Small current requirements
- Used in lower resistivity environment
- Usually negligible interference

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

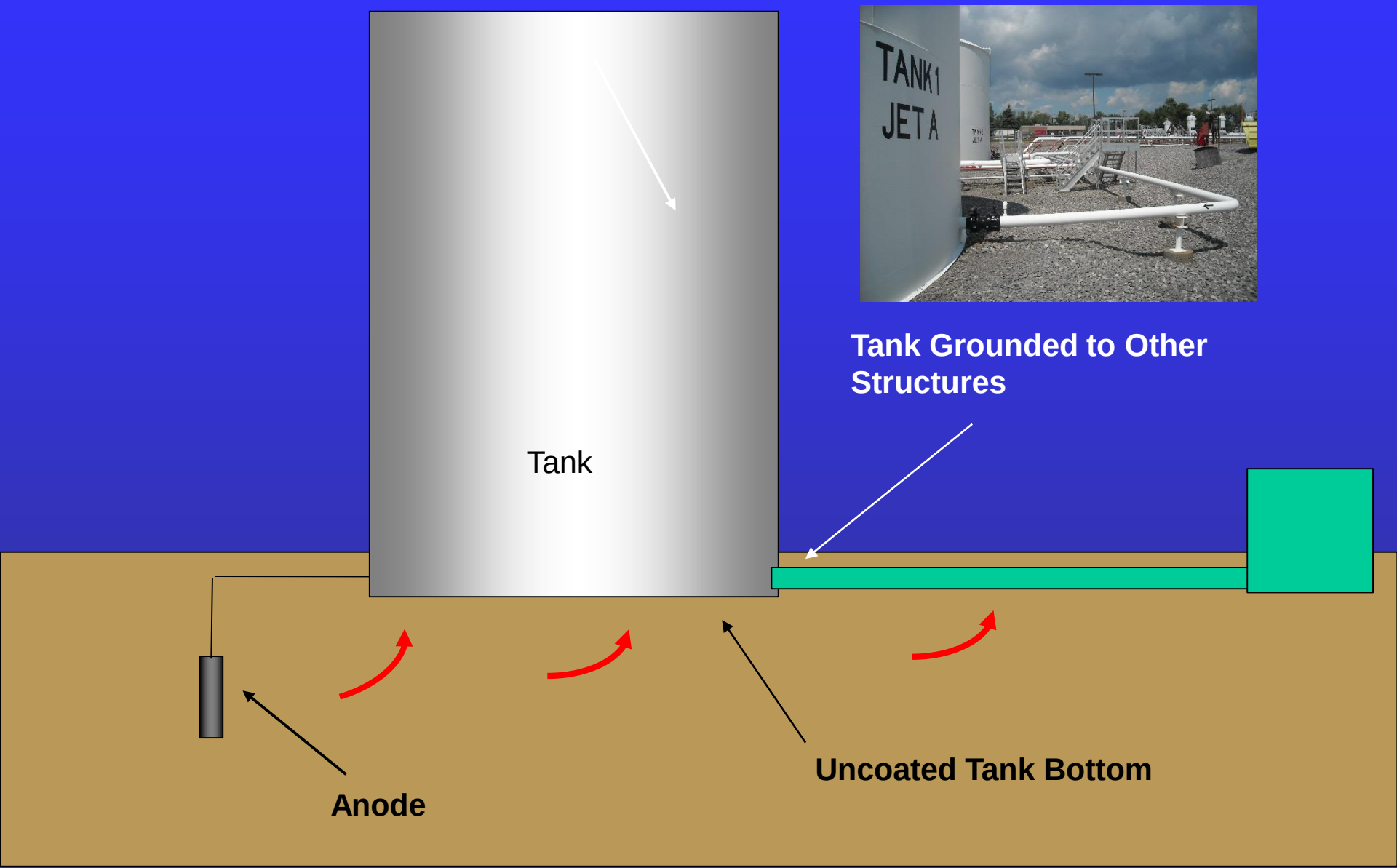
Above Ground Storage Tank With Galvanic Anodes





Above Ground Storage Tank With Galvanic Anodes

Is Protection Being Achieved?



Test Box

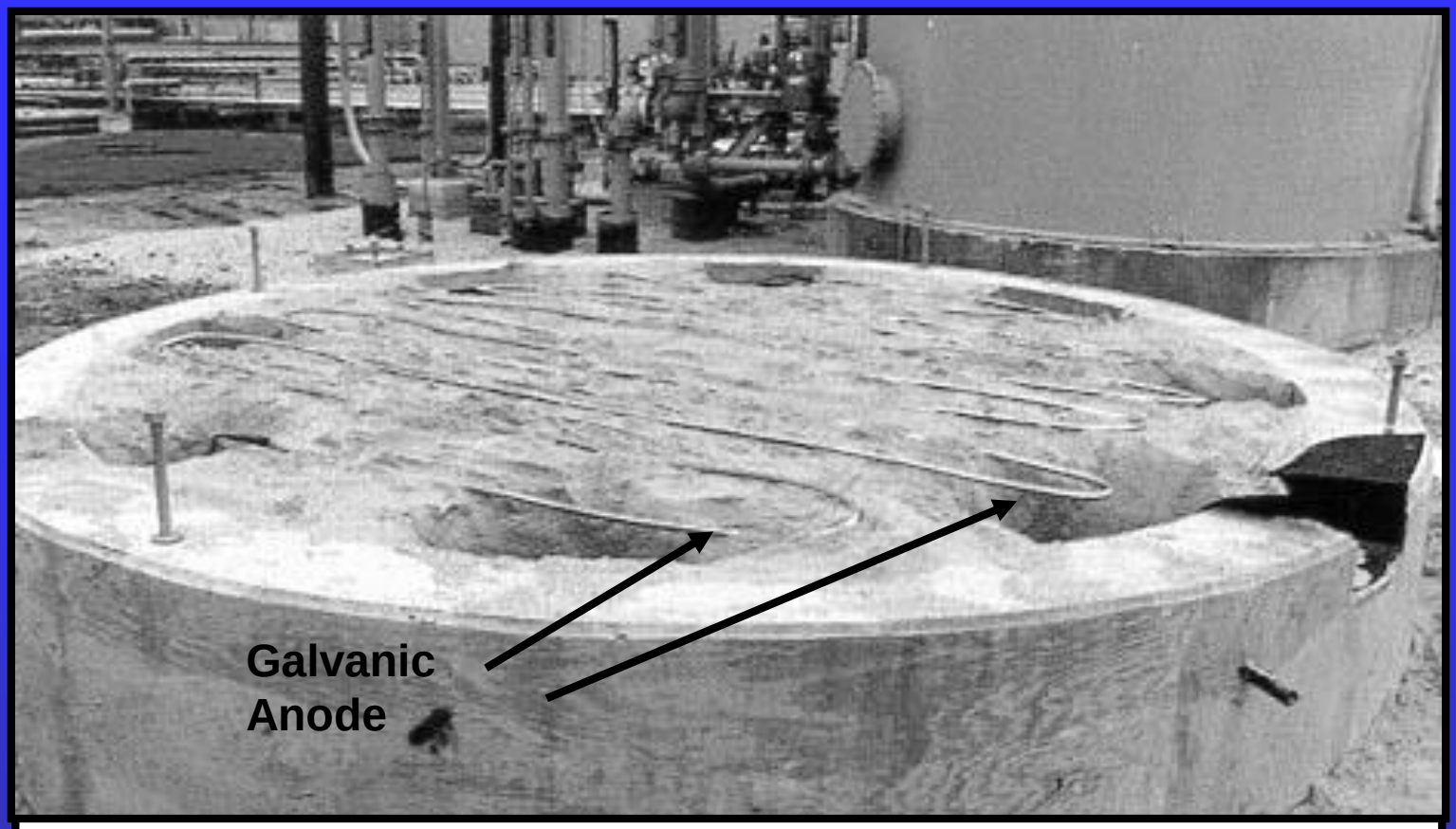
Cells

Anode

Tank

Galvanic Anodes

- With the advent of secondary containment liners for AST's, some oil companies initially installed galvanic (zinc or magnesium) anode cathodic protection systems. Many of these same companies have now abandoned this approach due to the inability to obtain effective levels of cathodic protection or limited system design life.
- The industry preference for cathodic protection for large AST's is now impressed current.



Galvanic Anode Installation on AST. Note that anode life and current output are dependent upon sand / backfill conditions. Reference cells were rarely installed to monitor performance.

(Many galvanic systems installed by tank contractor)

Recommended Practices

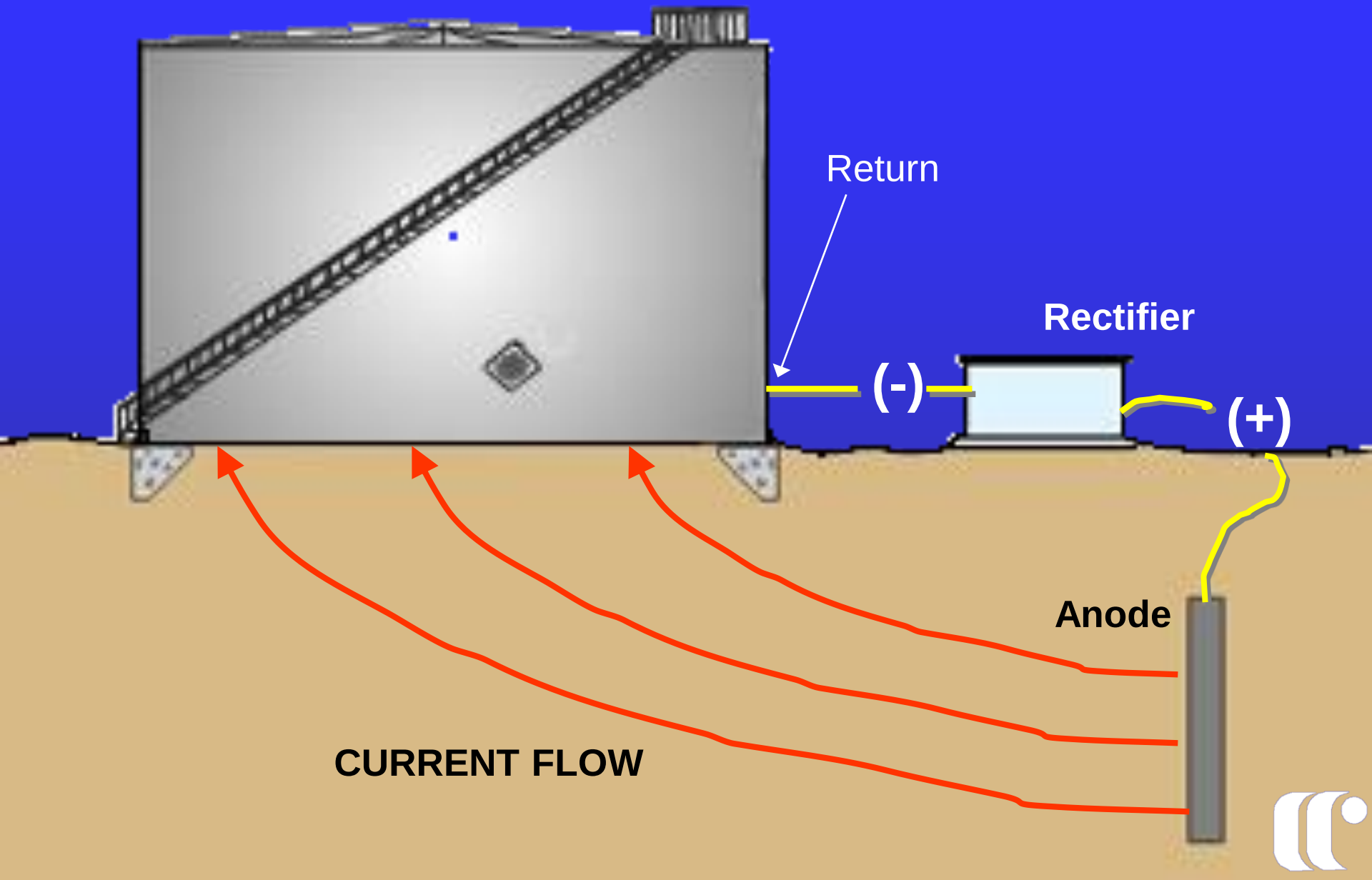
API-651 - Cathodic Protection of Aboveground Petroleum Storage Tanks:

> "*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."*

Impressed Current Cathodic Protection

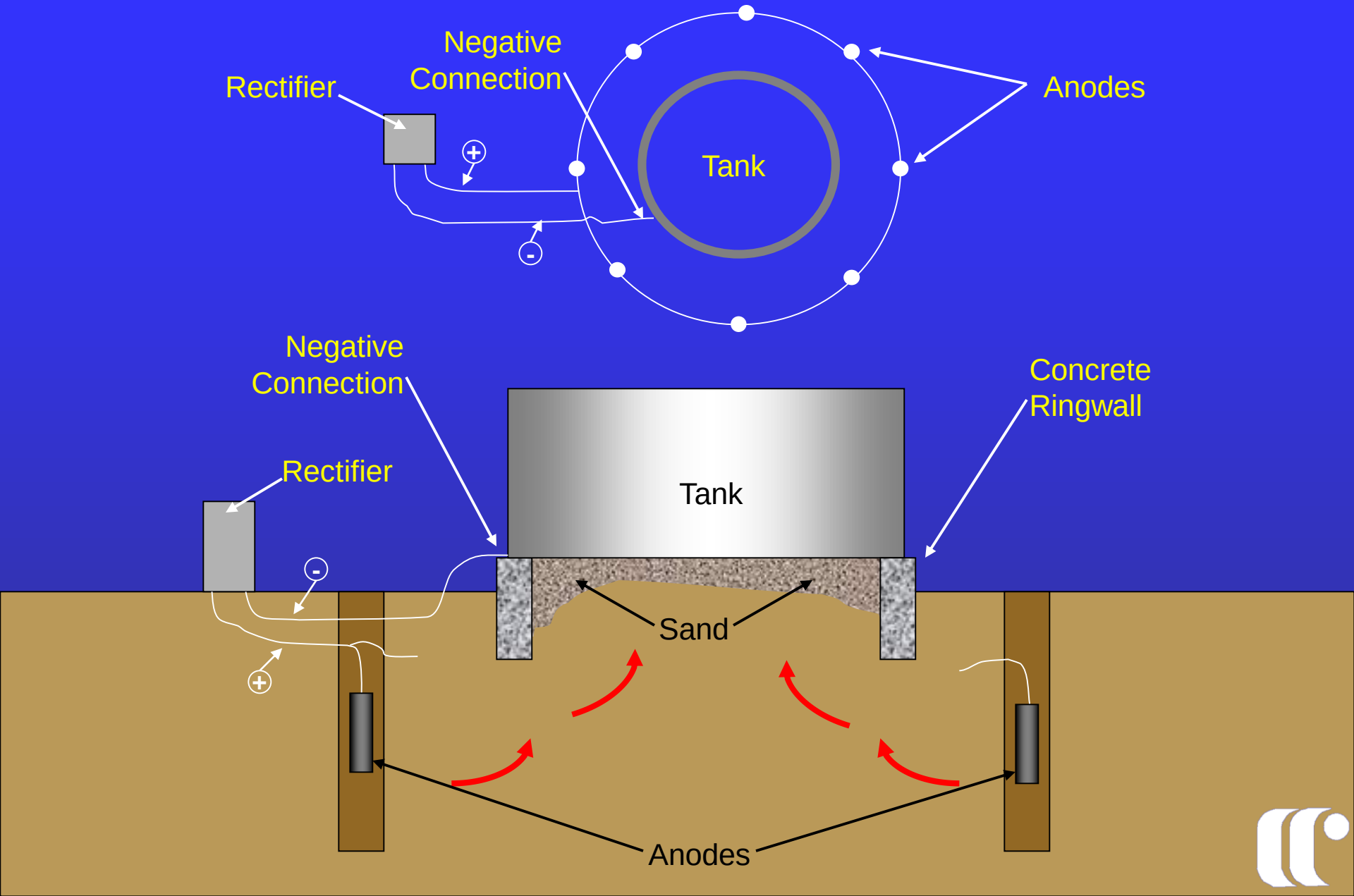


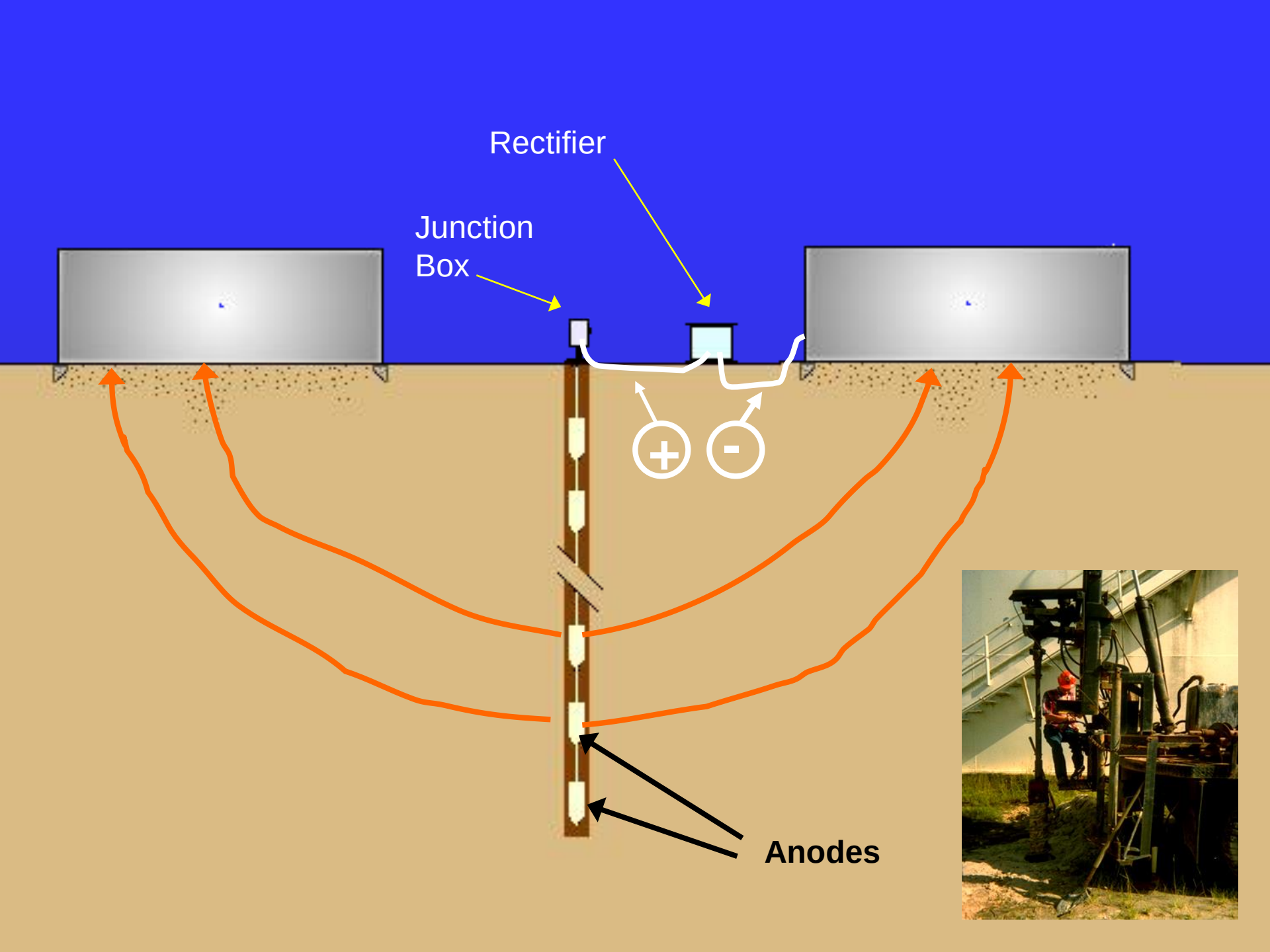
Impressed Current Cathodic Protection System

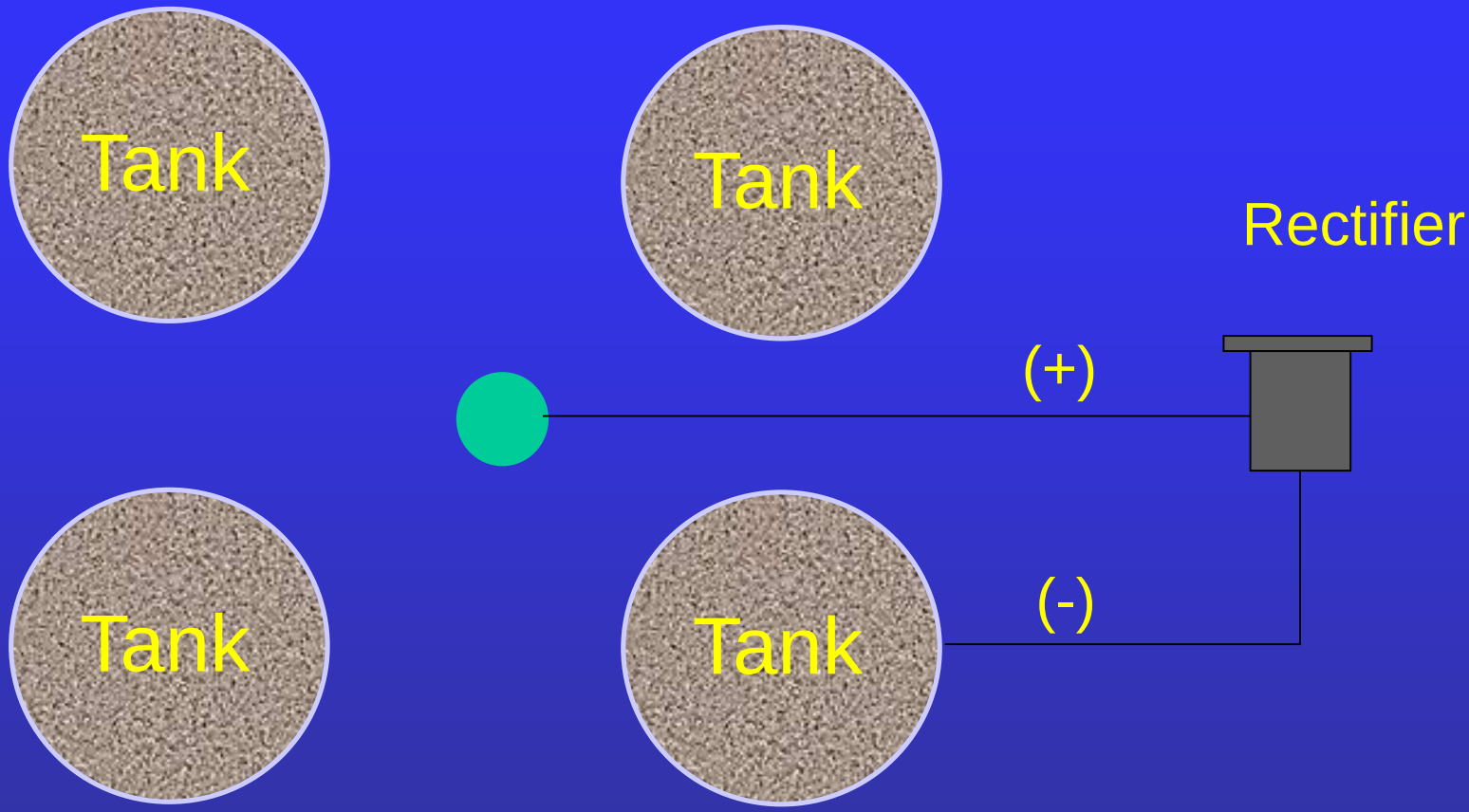
- Anodes
- Rectifier
- Wiring

Tanks & Piping

Above Ground Storage Tank Vertical Impressed Current Anodes - Existing Tanks

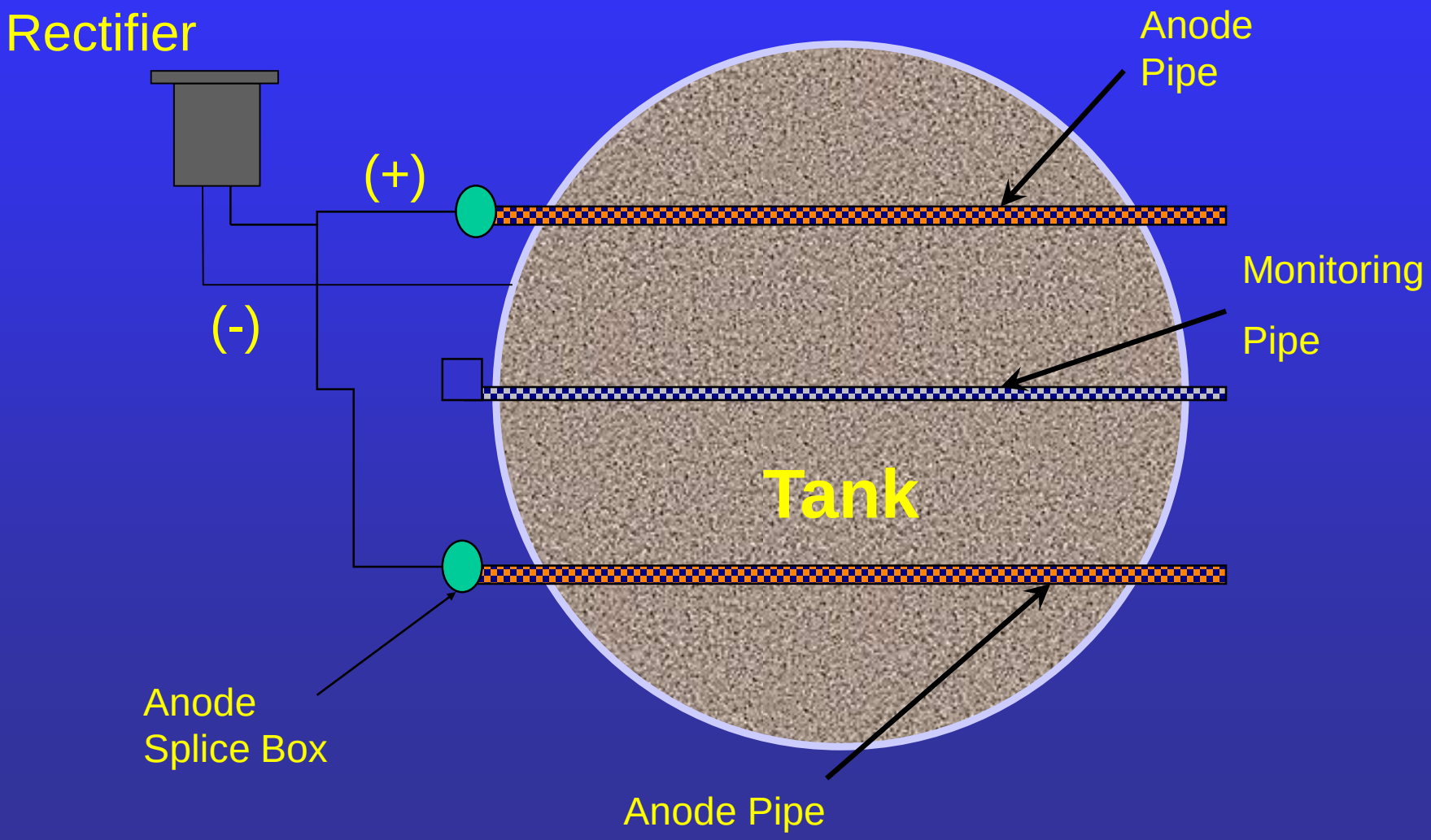


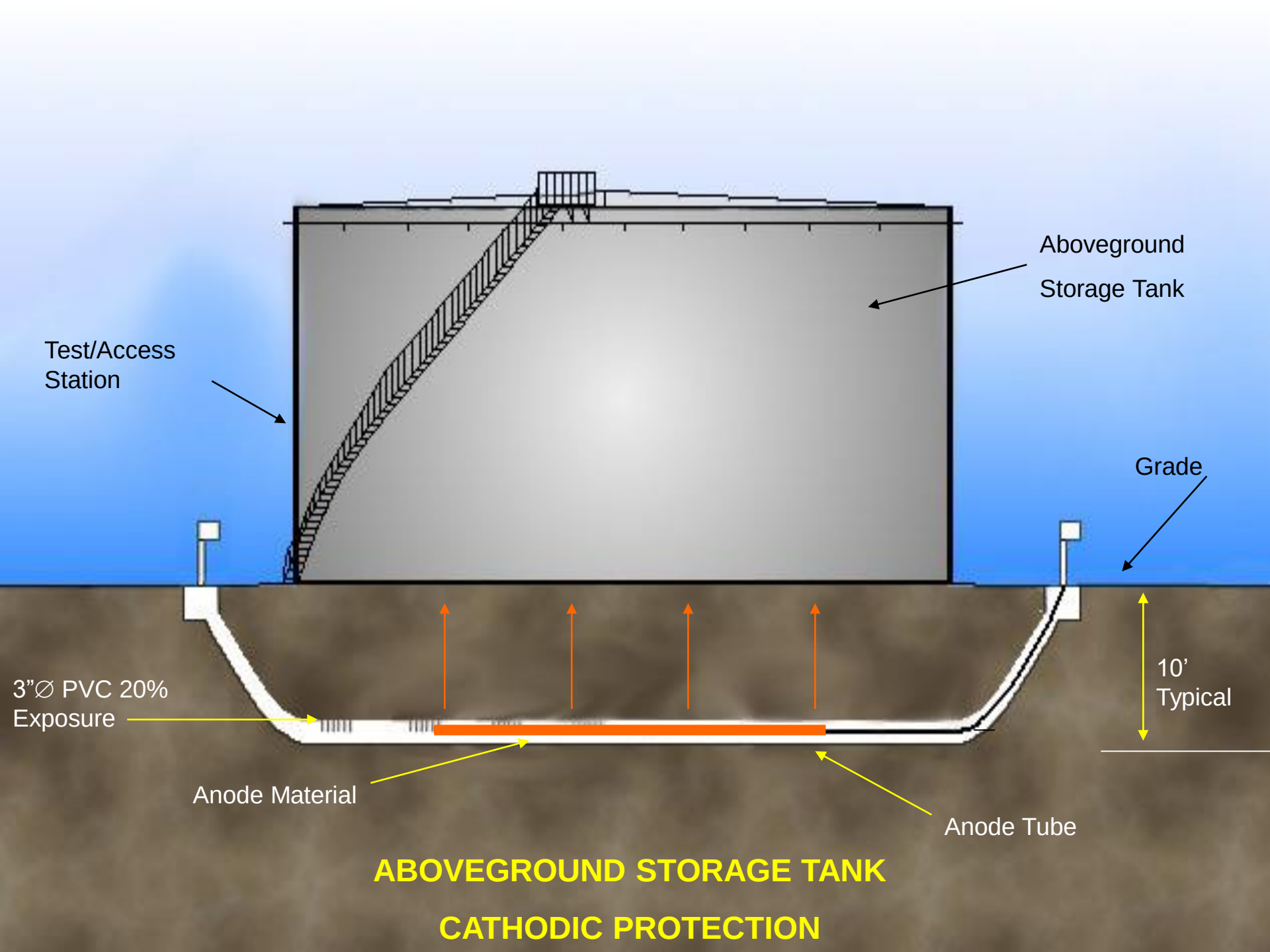

Rectifier
Junction
Box
+
-
Anodes



Deep Anode

Computer Guided Horizontally Bored Anode System





ABOVEGROUND STORAGE TANK

CATHODIC PROTECTION

Rectifier Units

Explosion or Non Explosion Proof ?
AC Input ?
AC Availability ?

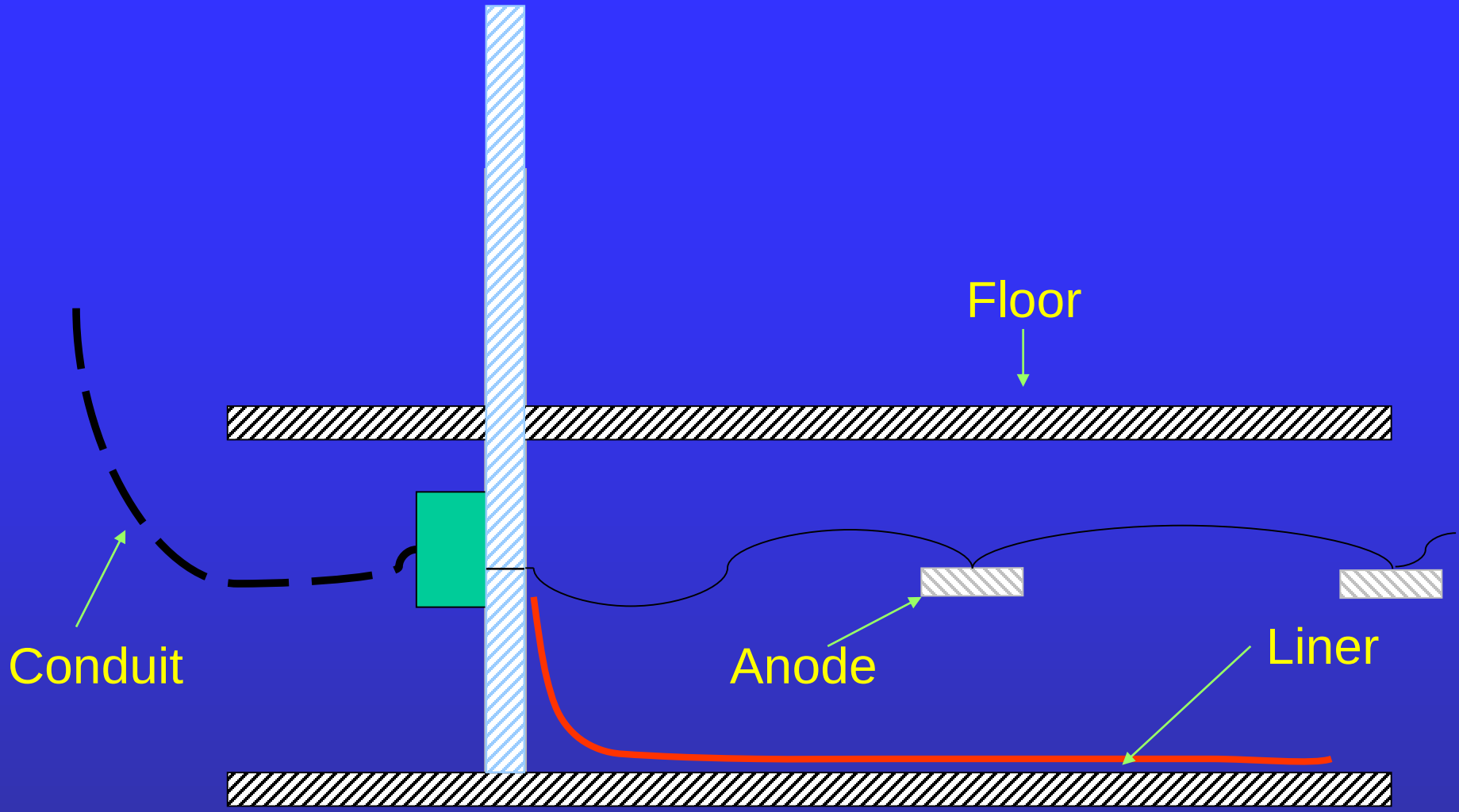
CP Applications for Re-bottomed or New Tanks

CP Installation on Rebottomed Tank

Above Ground

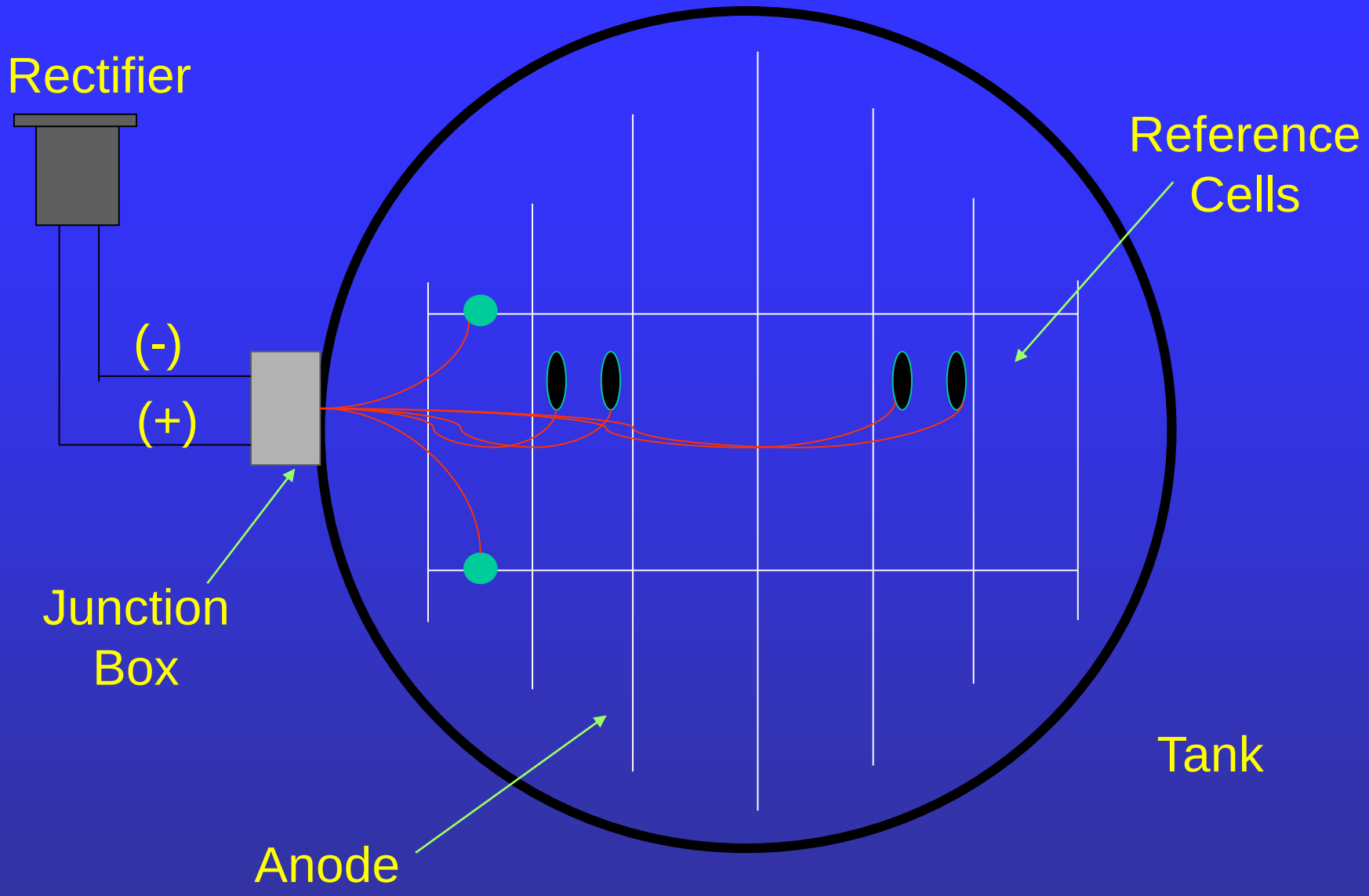
Storage Tank Bottoms

with Secondary Containment



CP Installation on Double Bottom Tank

New Tank Construction with Liner



Impressed Current

Anode & Reference Cell Placement
in High Resistance Sand

Installation of CP System on Lifted AST

Cathodic Protection Survey (When Tank is Full)

(+)

-850mV

Portable Reference Cell

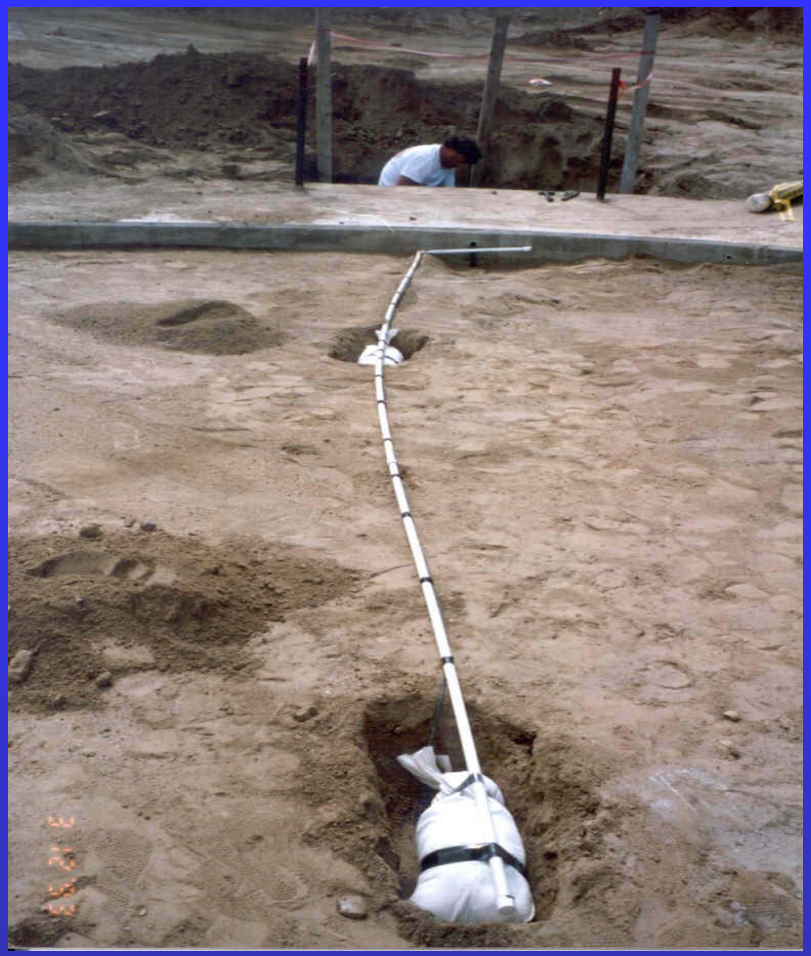
Tank

Soil

? ?

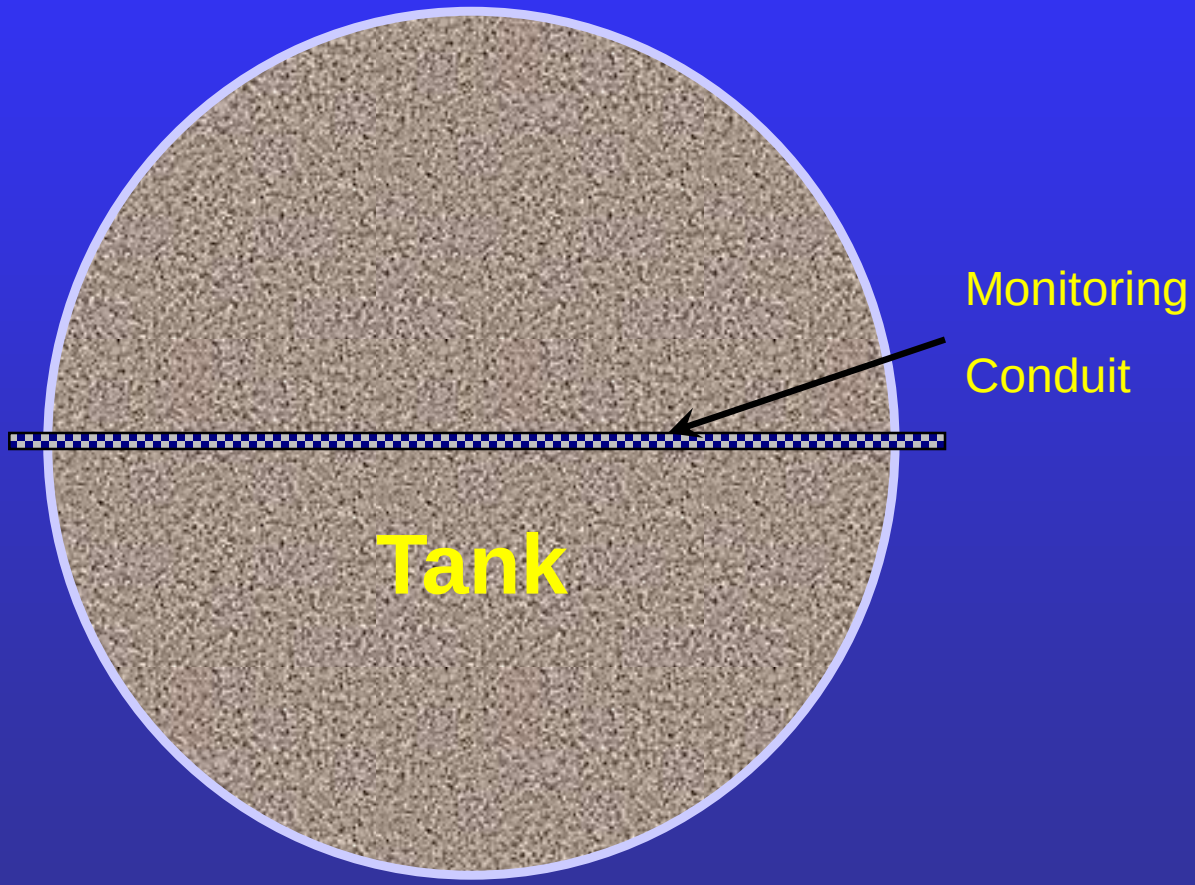
Rim Potential Measurements

Soil Access Station (Thru Liner or Asphalt)



Reference Cell Placement Under Tank Bottom
(Note obtain and store native readings)

Reference Cell Monitoring Conduit



Cathodic Protection Monitoring

- Read rectifiers every 30 days.
- Conduct annual inspection (obtain potentials) by NACE certified individuals.

Hot Asphalt Tank Bottoms

Stray Current ?

corrpro®

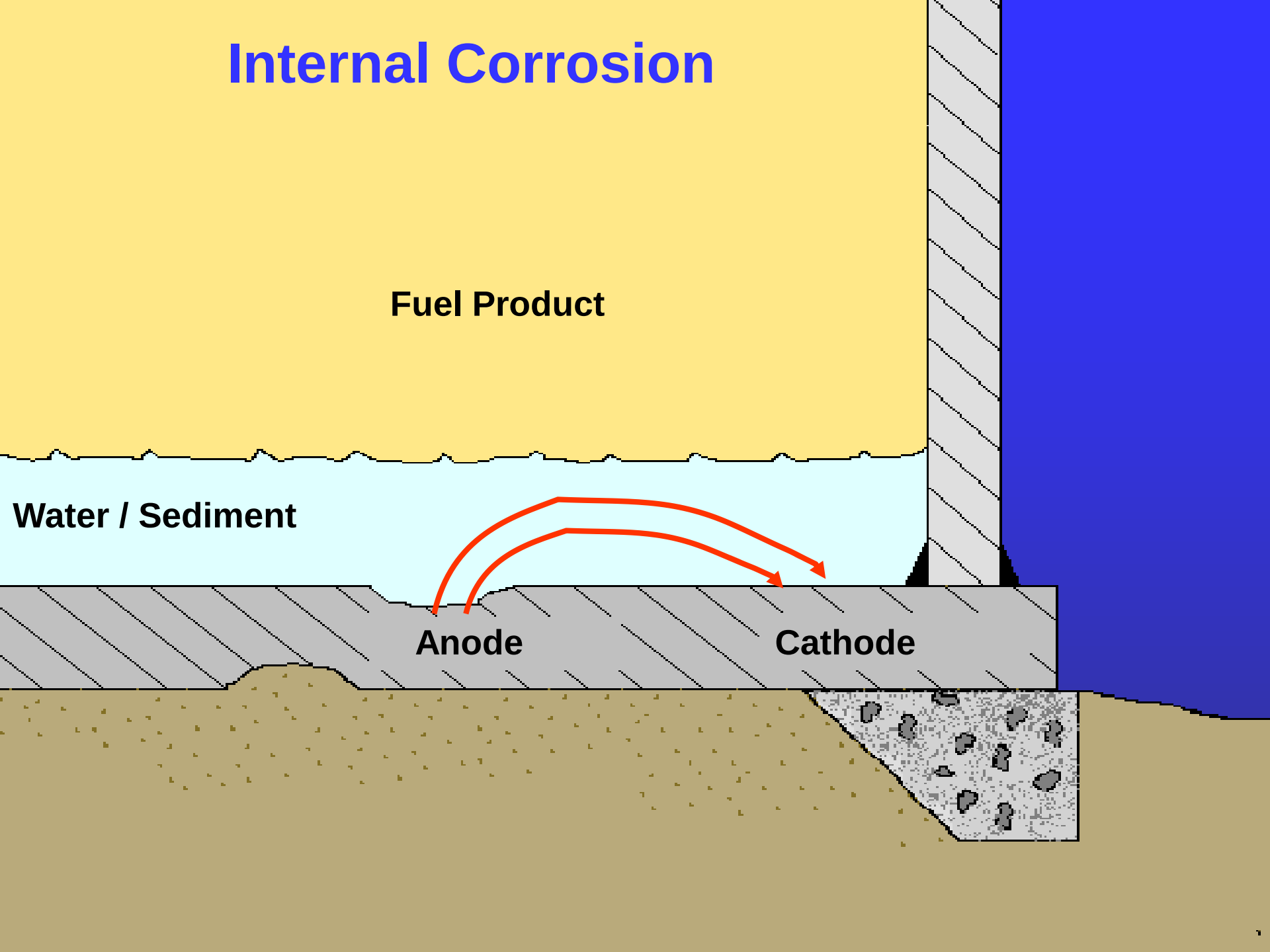
Pipeline Integrity Inspections

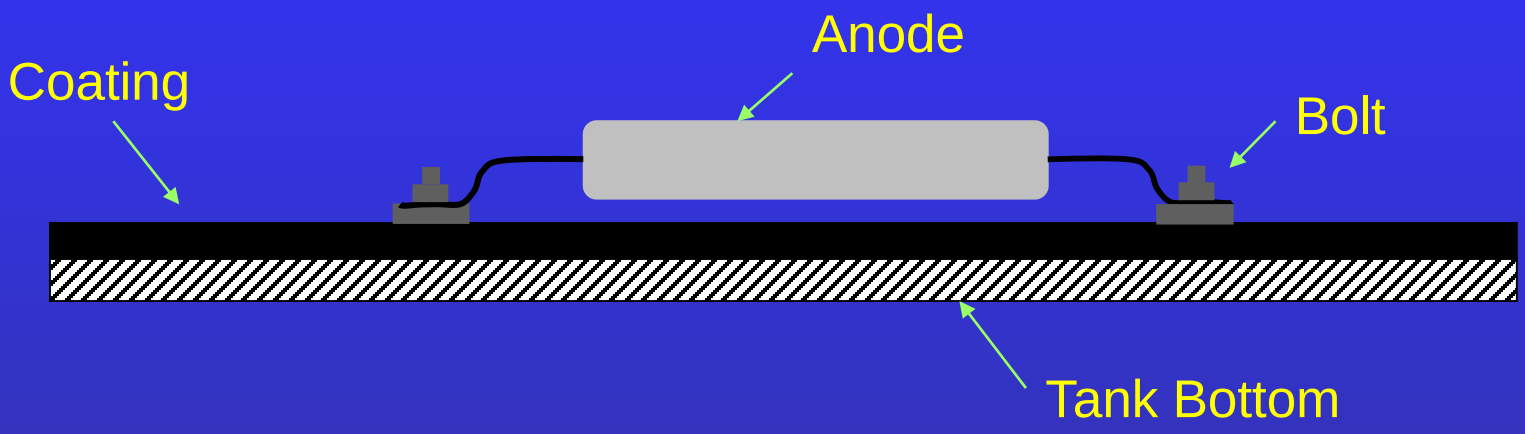
Qualifications
of the corrosion engineer

- Certified by N.A.C.E.
  (National Association of Corrosion Engineers)
- Experienced in Cathodic Protection
- Experienced in Cathodic Protection of Fuel Storage Systems

Internal Corrosion

Internal Corrosion




Anode
Coating
Bolt
Tank Bottom

Recommended Practices

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

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

Iron Water Fire Water Piping

Pitting (concentrated) corrosion attack on ductile iron pipe.

Questions?
JUN 2 2005

Thank You

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