

## Cathodic Protection for AST's



*Presented by:*  
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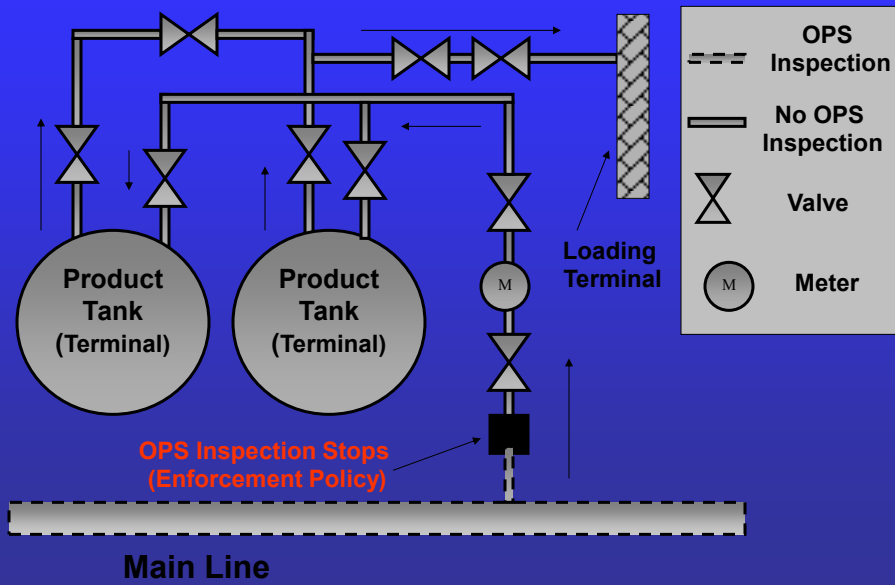


## Why is Cathodic Protection Important?

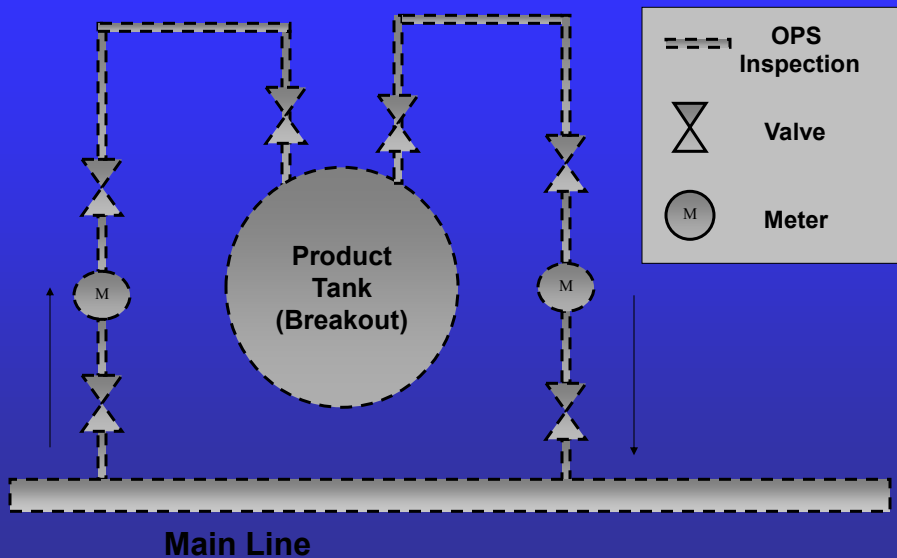


- **Preserve Assets**
- **Avoid Disruption of Service**
- **Enhance Safety**
- **Prevent Leaks**
- **Governmental Regulations**
- **Reduce Maintenance Costs**

# Terminal Tankage



# Breakout Tank



# Charleston, WV Spill

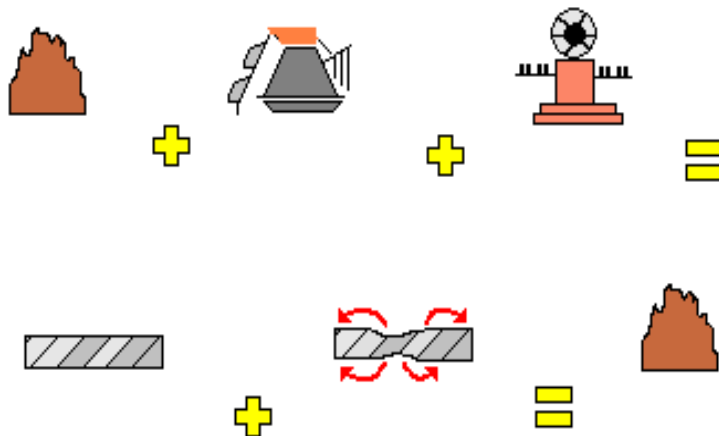


The investigation found that two small holes ranging in size from about 0.4-inch to 0.75-inch in the bottom of the 48,000-gallon tank 396 were caused by corrosion, likely resulting from water leaking through holes in the roof and settling on the tank floor. Furthermore, the CSB inspection found a similar 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**

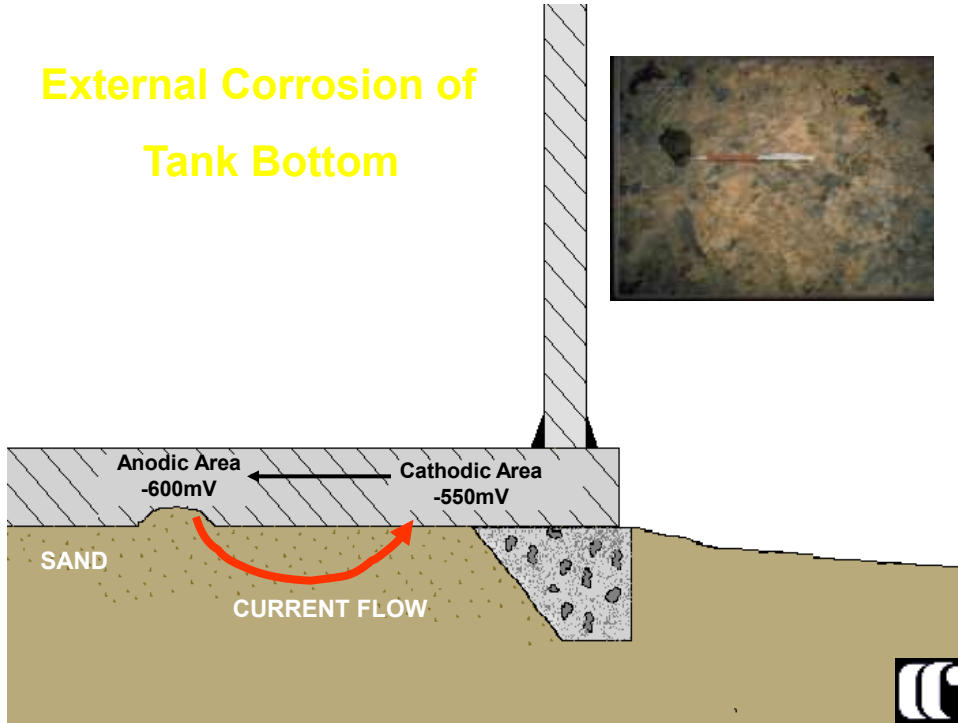
# Early Oil Tanks & Piping did not Employ CP



**THE PROBLEM.....**



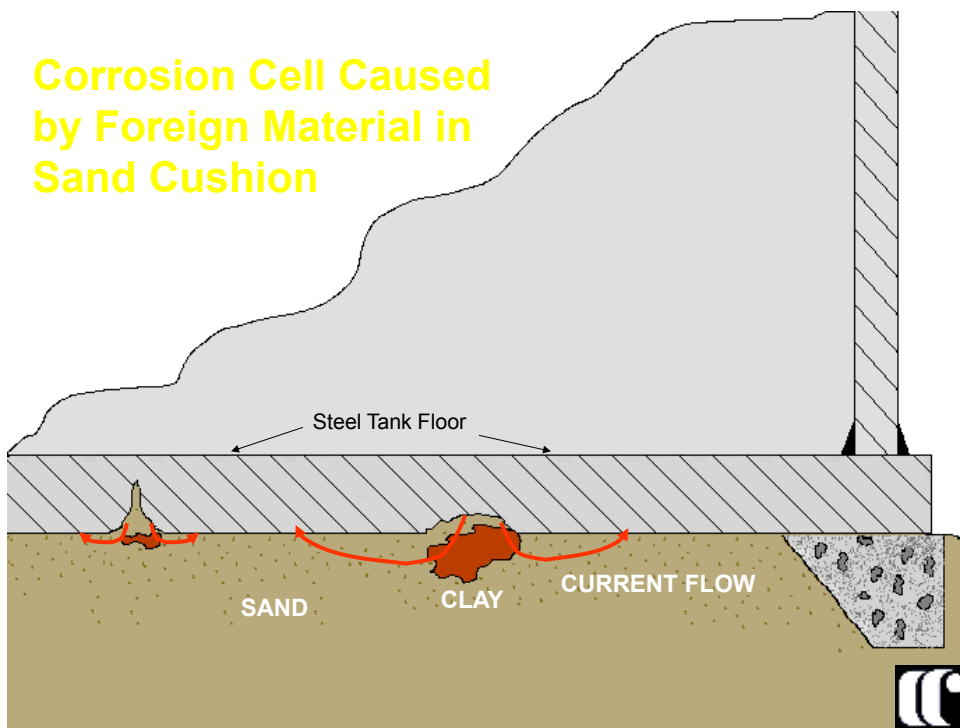
## External Corrosion of Tank Bottom



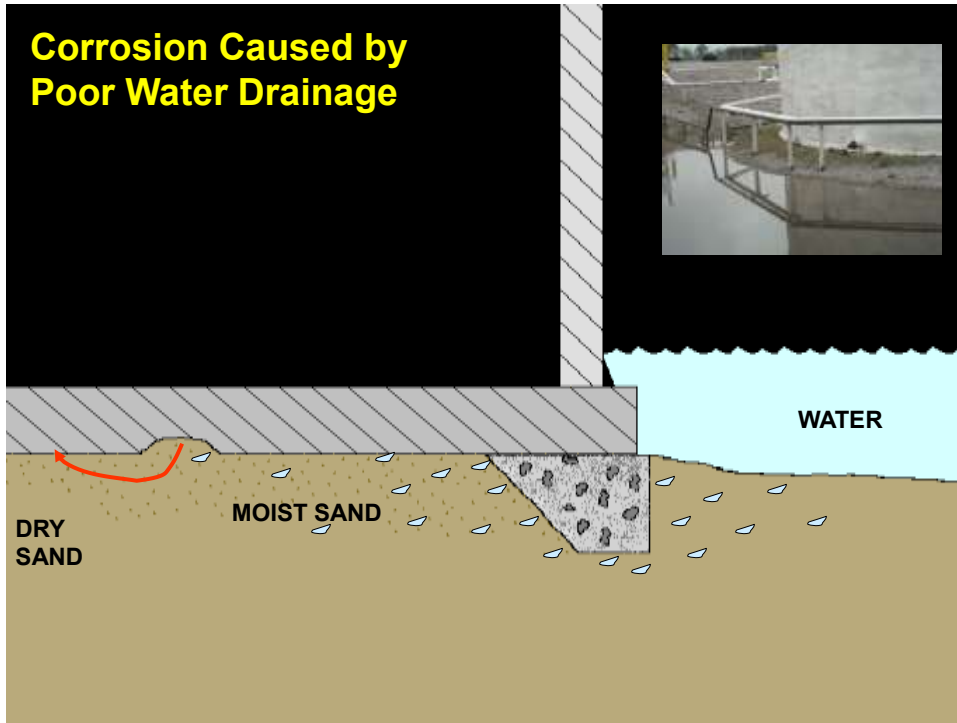
## MFL Floor Inspection



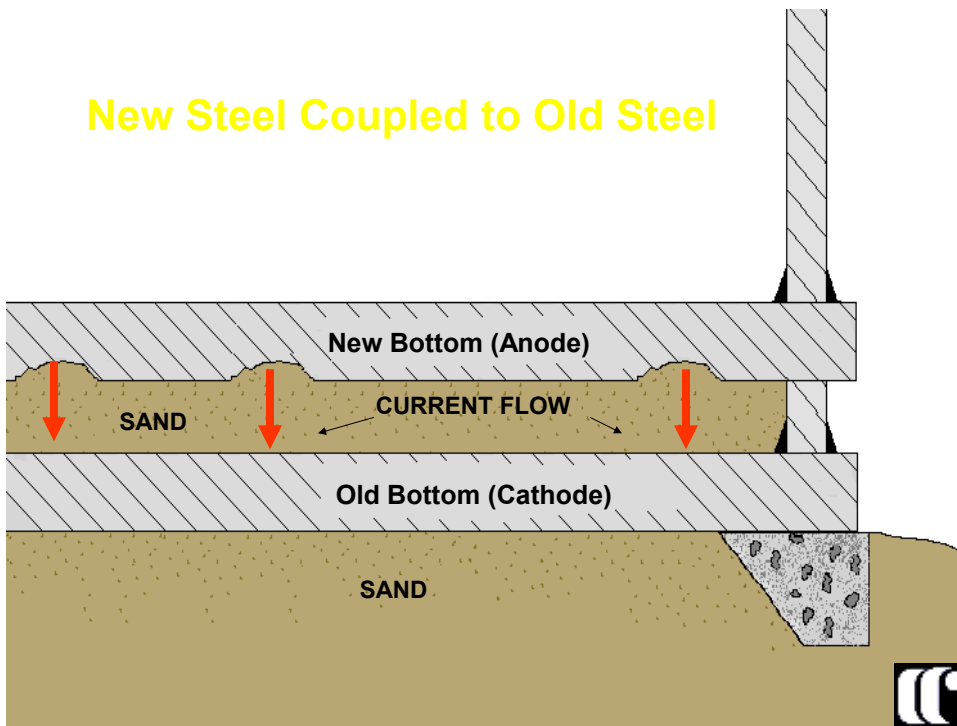
## Corrosion Cell Caused by Foreign Material in Sand Cushion



## Corrosion Caused by Poor Water Drainage



## New Steel Coupled to Old Steel



## Concrete Slab



Leak detection groove  
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



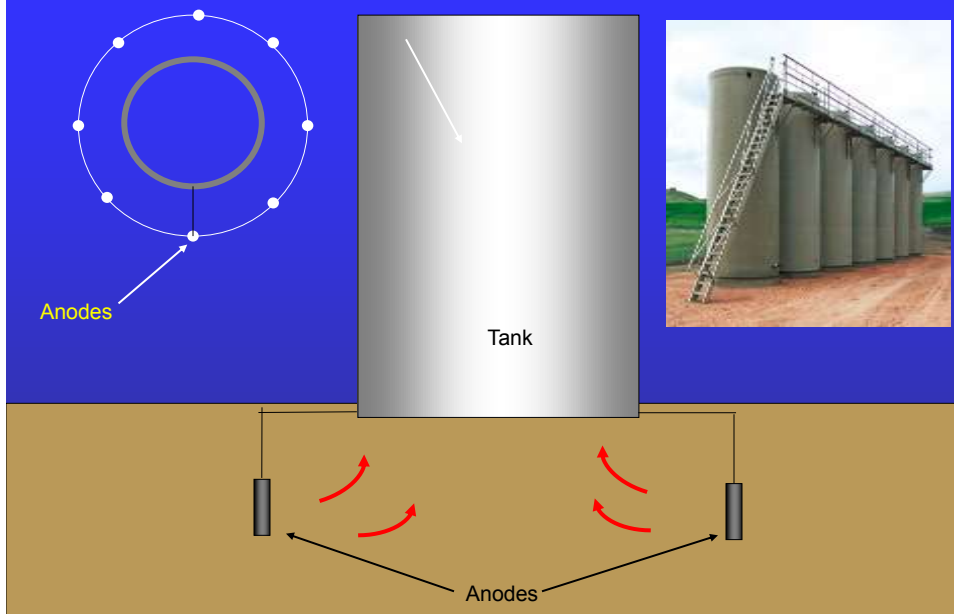
## Galvanic

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

## Impressed

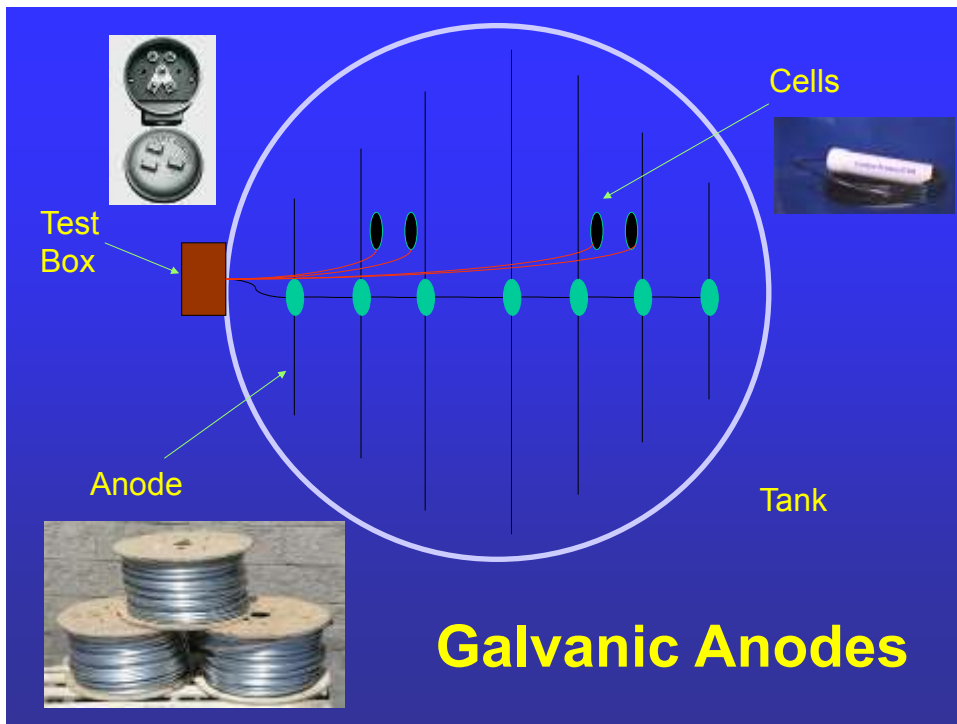
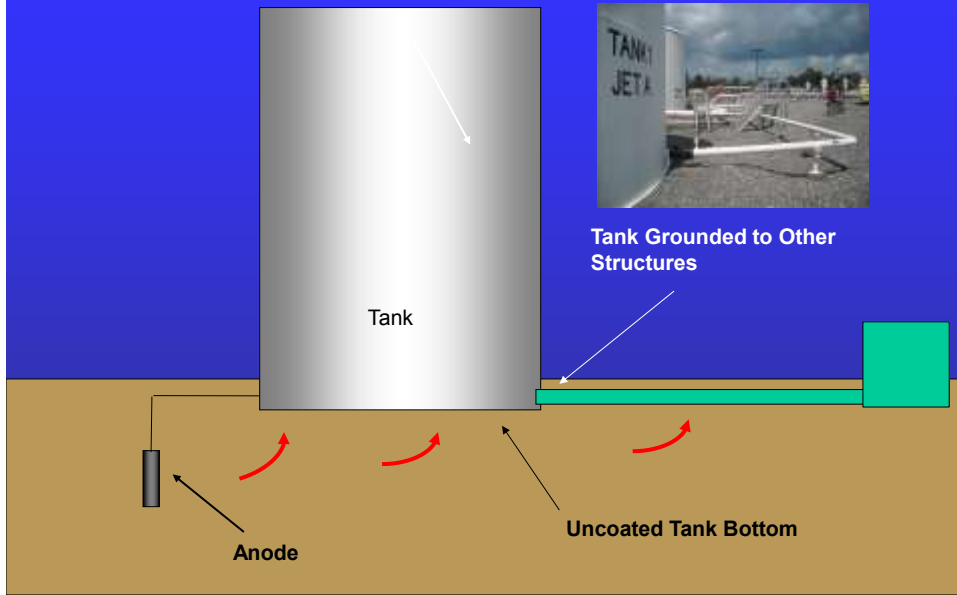
- ▶ External power required
- ▶ Voltage can be varied
- ▶ Current can be varied
- ▶ High current requirements
- ▶ Used in almost any resistivity environment
- ▶ Must consider interference with other structures

## Above Ground Storage Tank With Galvanic Anodes

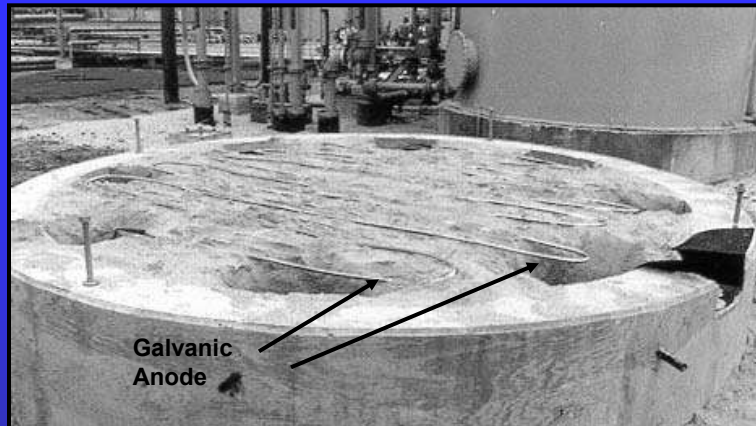


# Above Ground Storage Tank With Galvanic Anodes

## Is Protection Being Achieved?



- 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

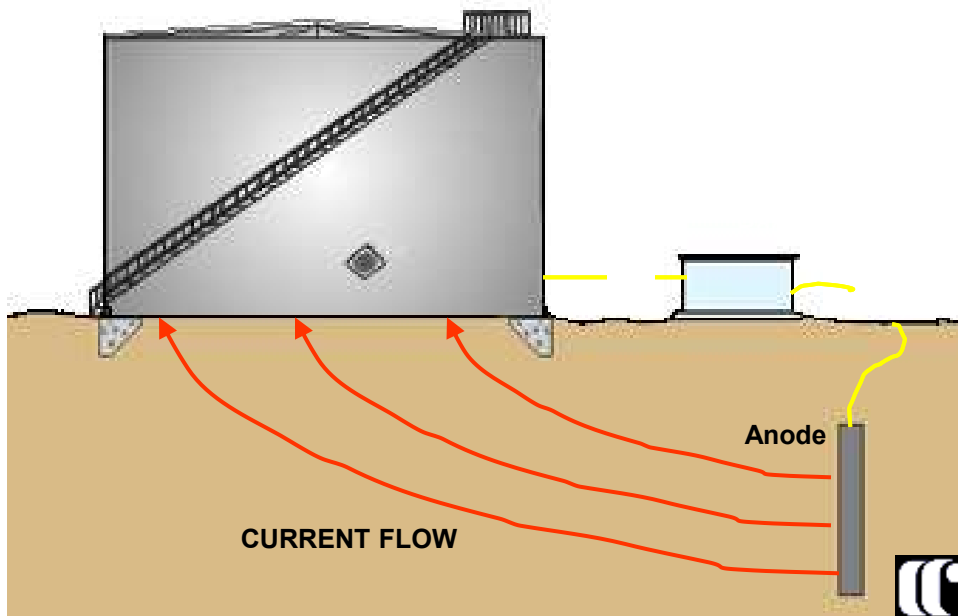
**API-651** - Cathodic Protection of Aboveground Petroleum Storage Tanks:

*“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

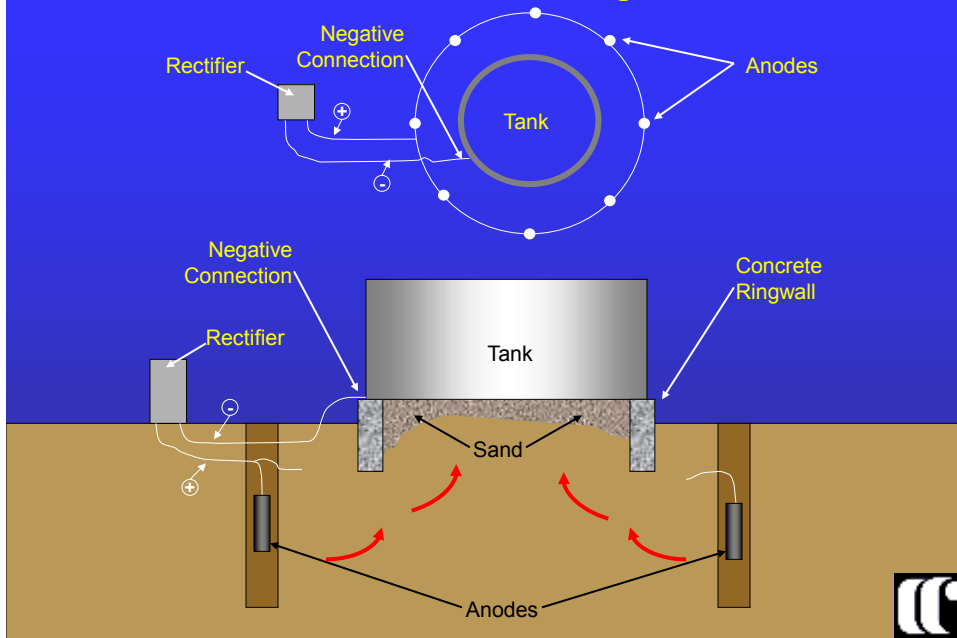
- ▶ Anodes
- ▶ Rectifier
- ▶ Wiring

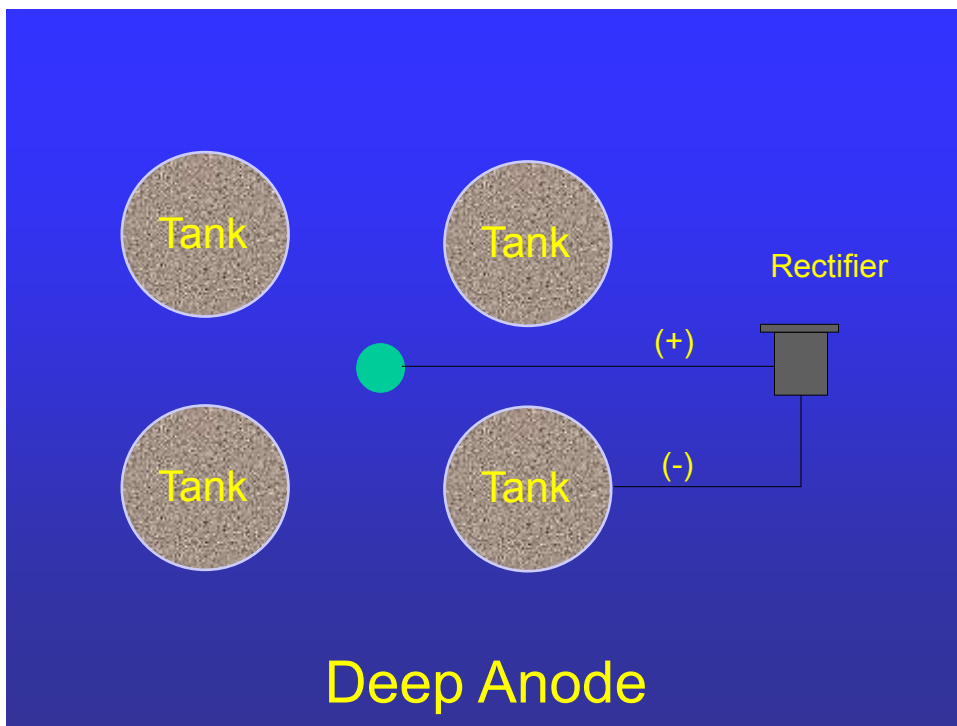
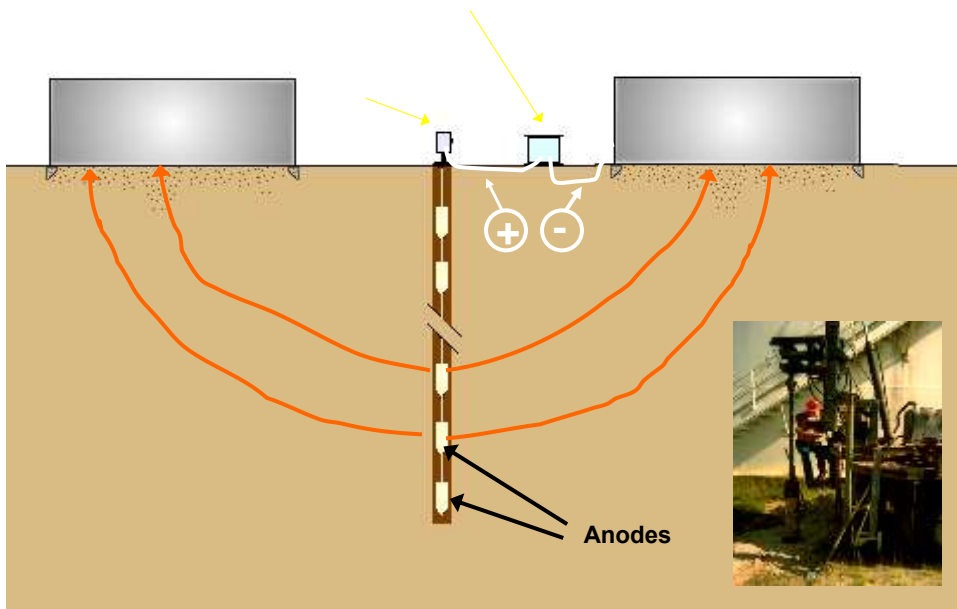


## Tanks & Piping

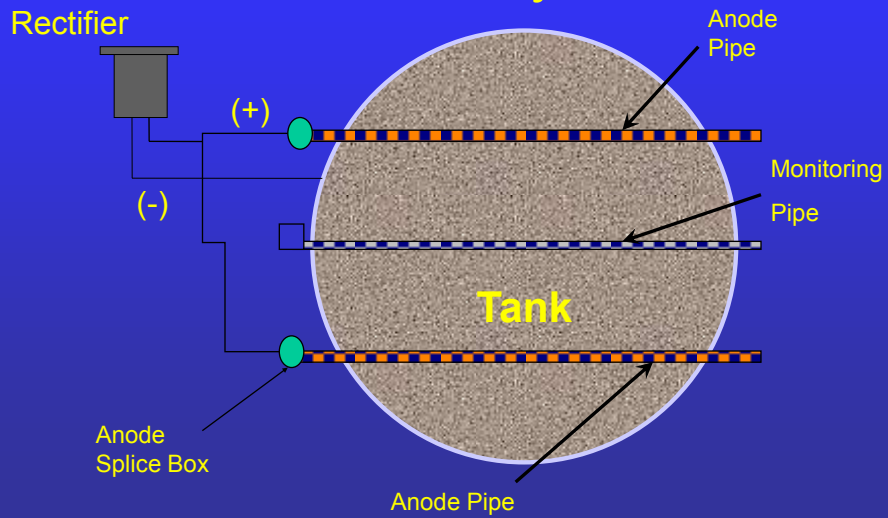


## Above Ground Storage Tank Vertical Impressed Current Anodes - Existing Tanks

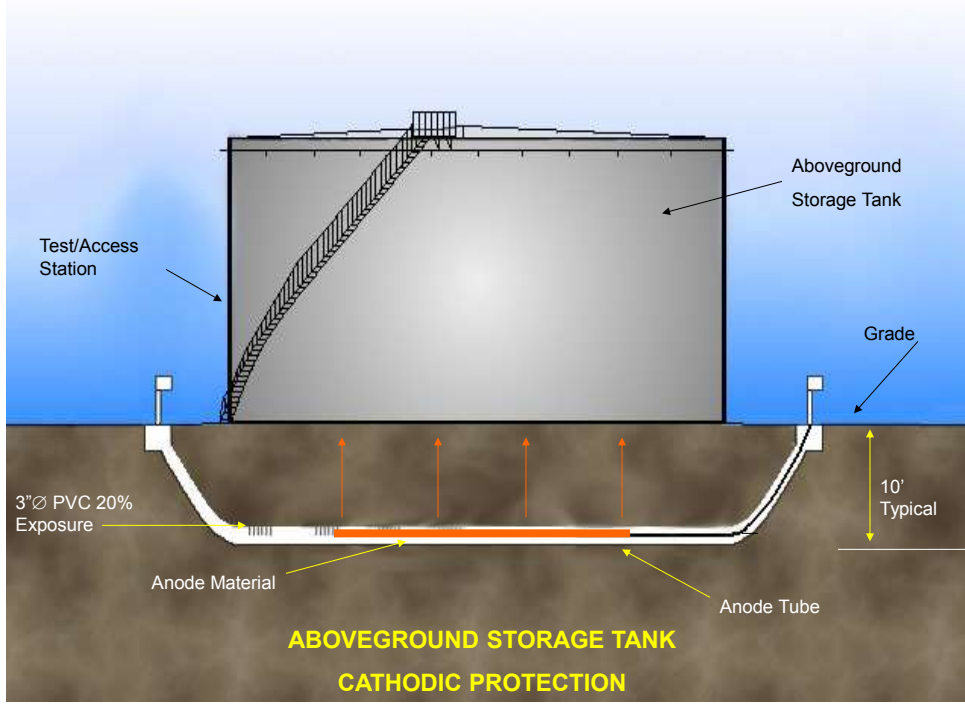




# Computer Guided Horizontally Bored Anode System







## *Rectifier Units*



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

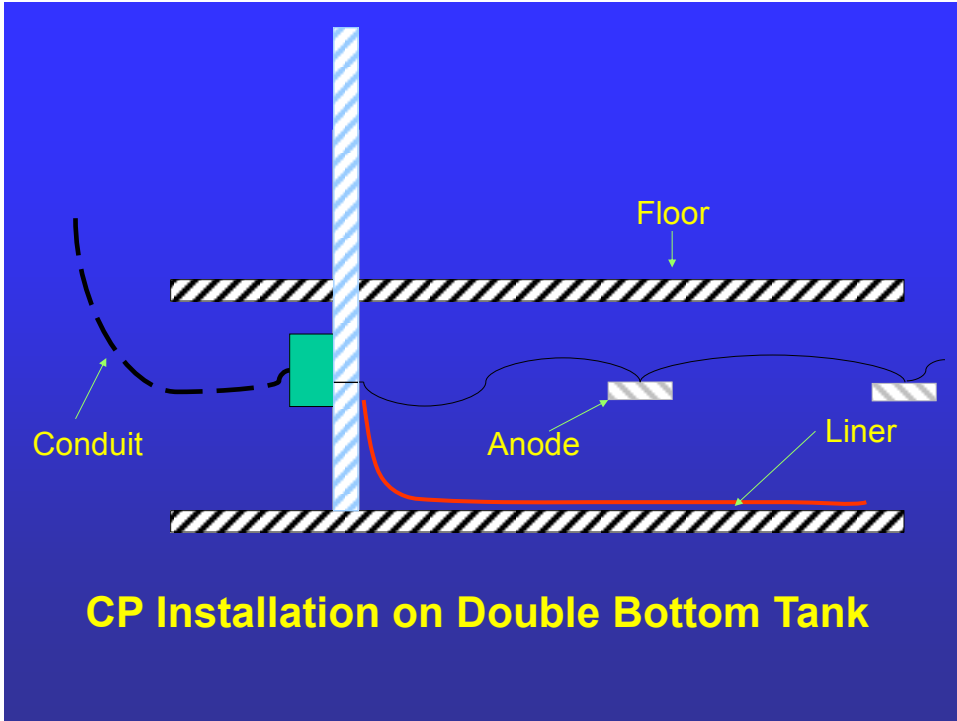
## **CP Applications for Re-bottomed or New Tanks**

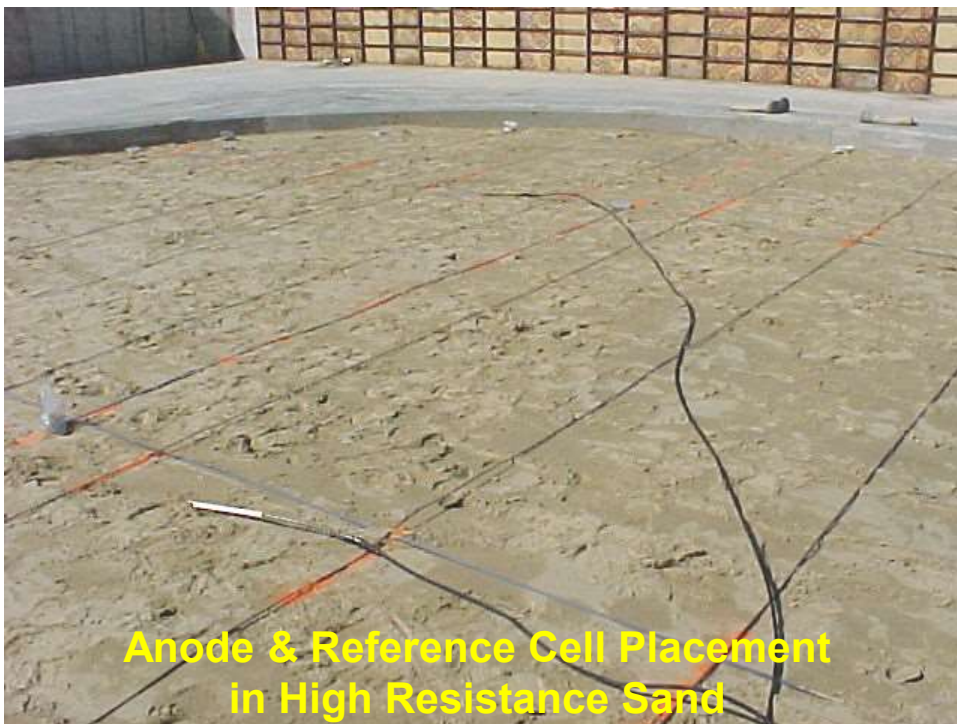
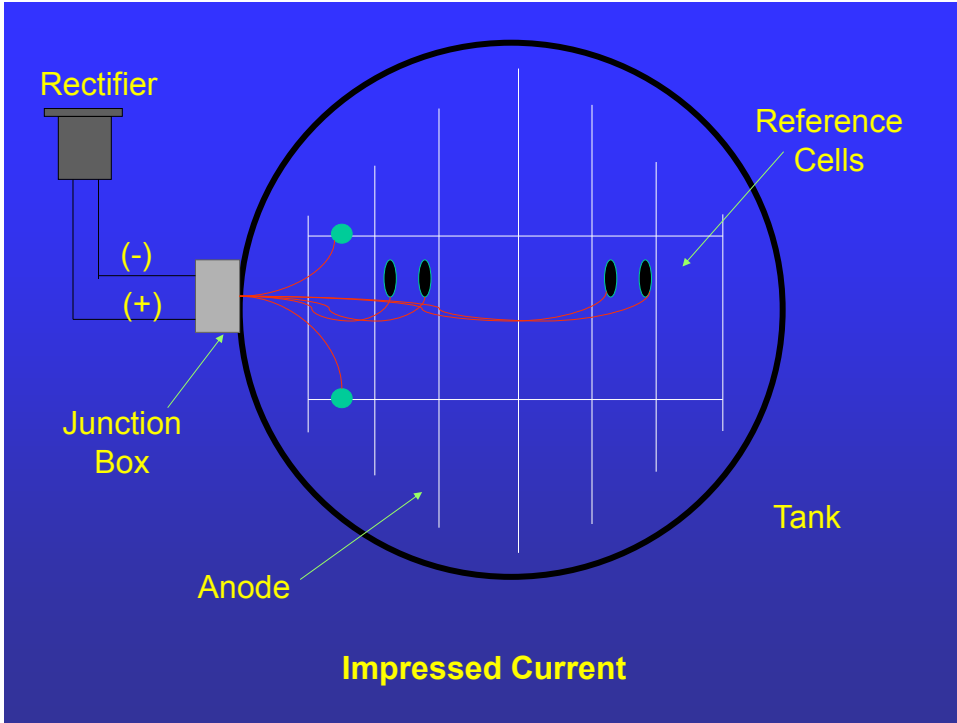




**CP Installation on Rebottomed Tank**

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







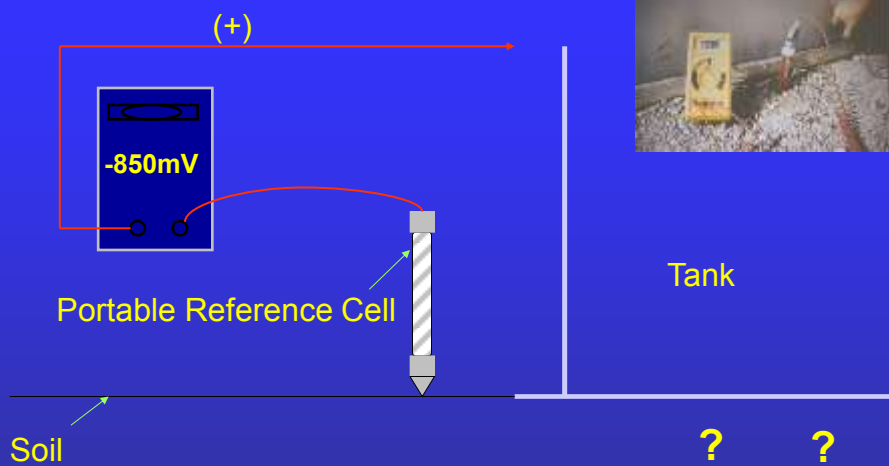


## Installation of CP System on Lifted AST





**Cathodic Protection Survey (When Tank is Full)**



**Rim Potential Measurements**



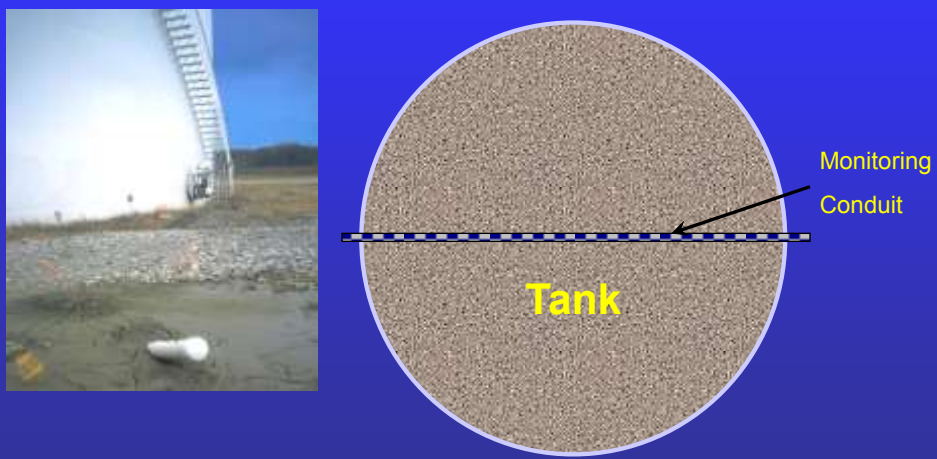
**Soil Access Station (Thru Liner or Asphalt)**



**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

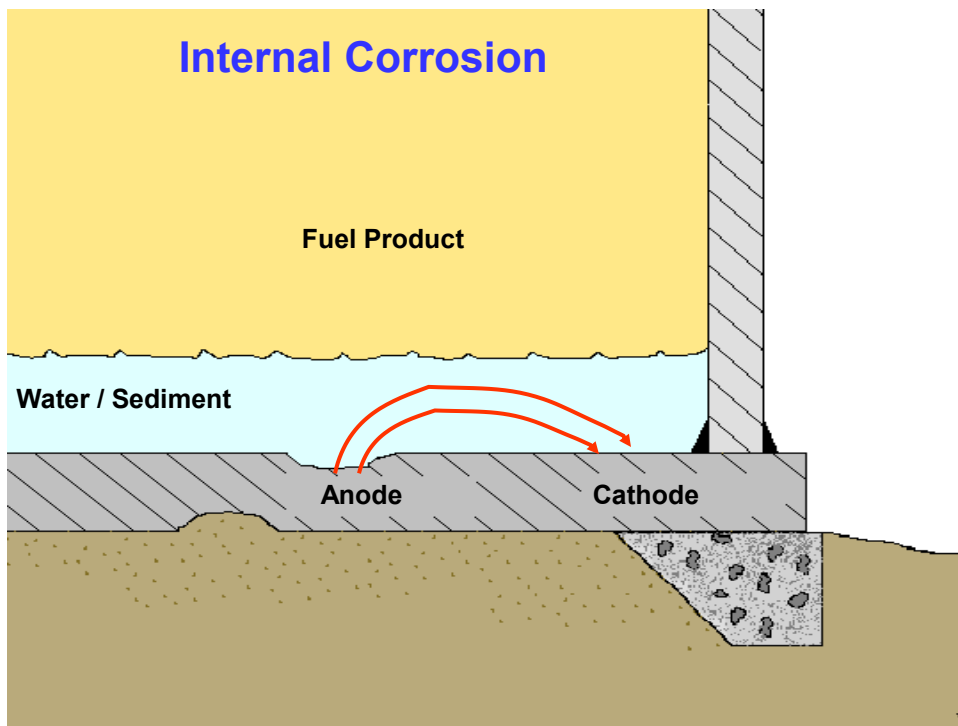


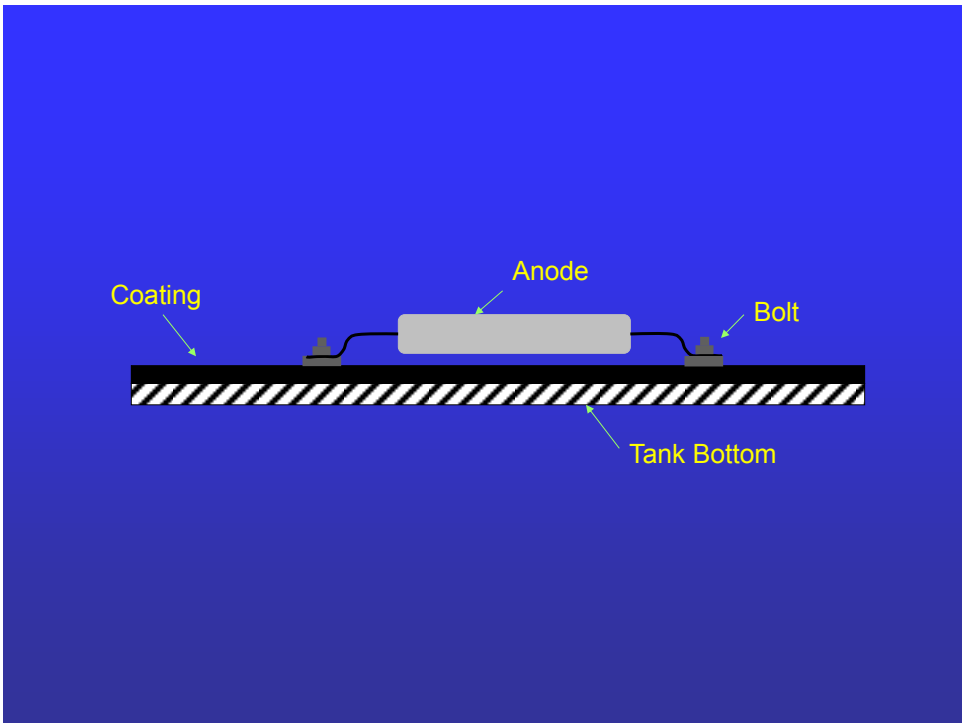
## Qualifications of the corrosion engineer

- 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**





## 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.





## *Thank You*

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