Corrosion Prevention for AST's and Piping Systems
2004 OSC Readiness Training Program

Presented by:
James T. Lary
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Medina, Ohio 44256
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Corrosion of Tanks and Piping

James T Lary
November 16, 2004
OSC Readiness Training

NACE INTERNATIONAL
THE CORROSION SOCIETY

NACE International – The Corrosion Society

1. NACE International Overview
2. Cost of Corrosion
3. Aboveground, Underground Storage Tanks, and Associated Piping Systems
4. NACE Resources

NACE INTERNATIONAL
THE CORROSION SOCIETY

NACE International – Overview

Our Vision

NACE International will be recognized as a world-class corrosion society by contributing significantly to the enhancement of global corrosion efforts.

Our Mission

To reduce the impact of corrosion.

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THE CORROSION SOCIETY

NACE International – Overview

- Global Forum for Corrosion Technology
- Global Source for Corrosion Education & Training
- Internationally Recognized Standards

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NACE International – Overview

- 60th Anniversary
- Not-for-Profit Organization
- 15,000 Individual Members in 91 Countries
- 275 Corporate Members
- Organized in 82 Sections

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THE CORROSION SOCIETY

NACE International – Overview

- Education Programs
- Professional Recognition
- Coating Inspector Training
- Cathodic Protection Certification

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THE CORROSION SOCIETY

NACE International – Overview

- NACE Standards
- Conferences/Expos
    - •CORROSION/2004 – Houston, TX. March 2005
    - •Corrosion Technology Week 2004 – Phoenix, AZ, Sept. 2004
- Periodicals
- Publications & Software

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NACE International – Education & Certification

NACE Education Classes Designed To:

- Introduce fundamentals of corrosion control
- Expand existing knowledge
- Provide professional recognition & certification

NACE International – Education & Certification

10 Certification Categories

- Coating Inspector Program
  - Three Courses
  - 5,500 recognized individuals – worldwide
- Cathodic Protection Certification

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NACE International – Education & Certification

- NACE Certification Specified Worldwide
- Qualified Personnel
- Ensure Safe Operations
- Extend Asset Life
- Reduce Downtime
- Improved Quality Assurance

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NACE International – Standard & Reports

Standards Recognized Worldwide

- 118 NACE Standards
  - 19 Material Requirements
  - 69 Recommended Practices
  - 30 Test Methods
- 60 Technical Committee Reports

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What is the Cost of Corrosion?

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$276 Billion

The United States Cost of Corrosion Study

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Cost of Corrosion

- All costs are direct corrosion costs
  - Cost of labor attributed to corrosion management activities
  - Cost of the equipment required because of corrosion related activities
  - Loss of revenue due to disruption in supply of product
  - Cost of loss of reliability
  - Cost of lost capital due to corrosion deterioration

Methods & Services

- All costs are direct corrosion costs
- Disadvantage: many costs are missed
  - Cost of labor attributed to corrosion management activities.
  - Cost of the equipment required because of corrosion-related activities.
  - Loss of revenue due to disruption in supply of product.
  - Cost of loss of reliability.

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Cost of Corrosion – Industry Sector Analysis

AIRCRAFT ACCIDENT REPORT
ALOHA AIRLINES, FLIGHT 243
BOEING 737-200, N7371I,
NEAR MAUI, HAWAII
APRIL 28, 1988

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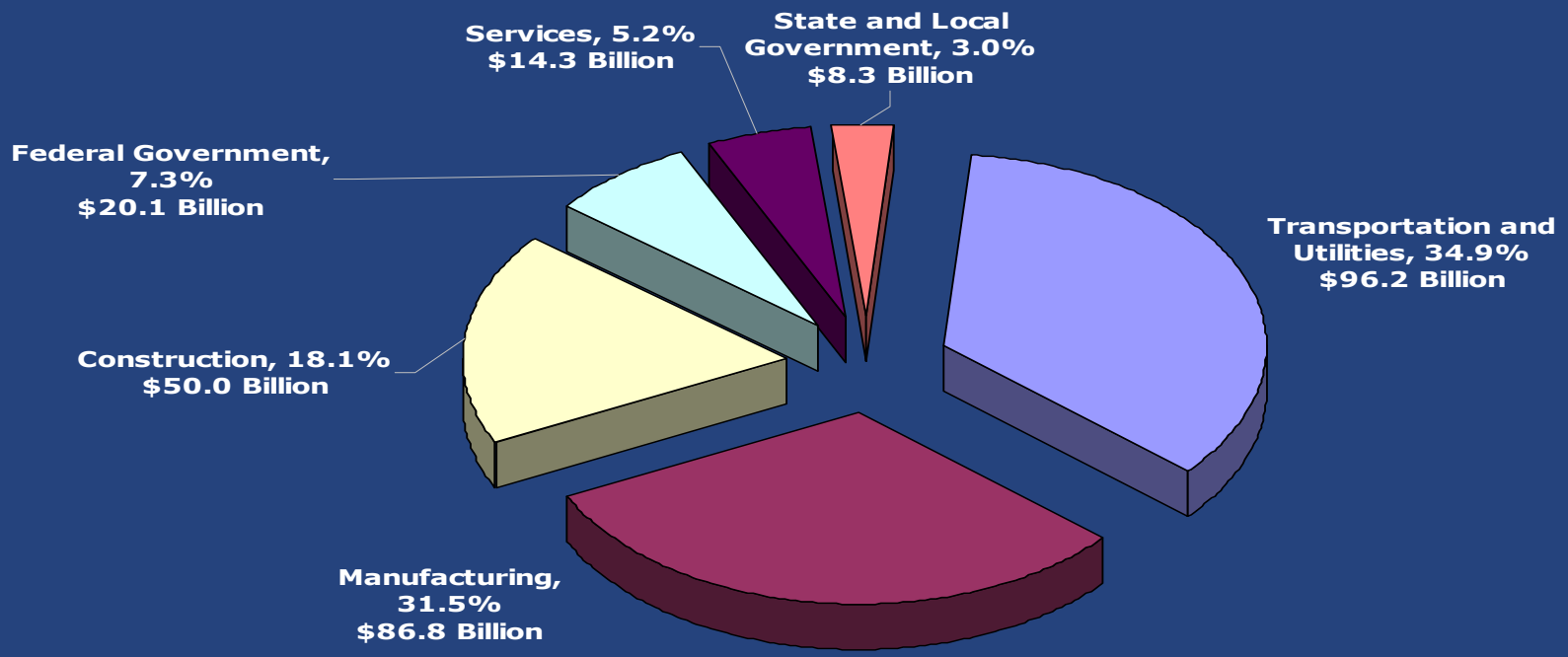
Extrapolated Corrosion Costs: $276 Billion, 3.1% of GDP



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Non-Technical Preventive Strategies

- Increase awareness of the widespread effects of corrosion
- Build awareness of the huge cost associated with corrosion
- Build awareness of potential savings
- Change the misconception that nothing can be done about corrosion
- Change policies, regulations, standards, and management practices to increase corrosion savings
- Improve education and training of staff

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Technical Preventive Strategies

- Advance design practices for better corrosion management
- Advance life prediction and performance assessment methods
- Advance corrosion technology through:
    - Research
    - Development
    - Implementation

Recognize the commonality of the problem regardless of the structure; but also that corrosion may manifest itself differently in each application.

Aboveground and Underground Storage Tanks and Associated Piping Systems

Impact of Corrosion

8.5 million tanks in the U.S. (regulated and non-regulated)
$ 4.5 Billion Cost to AST
$ 2.5 Billion Cost to UST
Total Cost of $7 Billion annual cost

Corrosion is one of the leading causes of storage tank and piping failures

Corrosion Control Regulations

- By the Oil Pollution Act of 1990:
  - The owner *must* have a Spill Response Plan
  - The owner must put in place measures, practices, etc. to limit the possibility of releases based upon industry accepted sound engineering practice in design, operation, and maintenance of the facility
  - The reg. does not regulate corrosion control, but does say prevent release.

- 1998 EPA Regulation for UST – Requires that all tanks to have corrosion control, as well as overflow and spill protection

Corrosion Control Regulations

Spill Prevention Control and Countermeasure (SPCC) Regulation

- *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.*

NACE Standards

NACE has either developed or is in the process of developing standards to address Tank and Pipeline integrity:

- RP0169-2002, Control of External Corrosion on Underground or Submerged Metallic Piping Systems
- TM0101-2001, Measurement Techniques Related to Criteria for Cathodic Protection
- RP0193-2001, External Cathodic Protection of On-Grade Carbon Steel Storage Tank Bottoms

NACE Standards (con.)

- RP0285-2002, Corrosion Control of Undergorund Storage Tank Systems by Cathodic Protection

- TM0497-2002, Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems

API Standards

- API 570 Piping Inspection Code
- API 651 Cathodic Protection of Aboveground Petroleum Storage Tanks
- API 652 Lining of Aboveground Petroleum Storage Tanks Bottoms
- API 653 Tank Inspection, Repair, Alteration, and Reconstruction
- API 1632 Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems

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Thank You!

Corrosion Control & Cathodic Protection for Storage Tanks and Piping Systems

Presented by:
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What we will cover….

- Causes of Corrosion
- Regulatory Issues (State/Federal)
- Cathodic Protection for Tanks and Piping
- Operation & Maintenance

API Definition

1.2.1 An aboveground storage tank is a stationary container of greater then 500 barrel capacity, usually cylindrical in shape, consisting of a metallic roof, shell, bottom, and support structure where more then 90% of the tank surface is above grade

AST Storing

- Gasoline
- Diesel
- Kerosene
- Aviation Fuel
- Fuel Oil
- Hazardous Material/Chemicals

Spill Prevention Control and Countermeasure (SPCC) Regulation (Implementation Required by 8/16/06)

- 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.

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

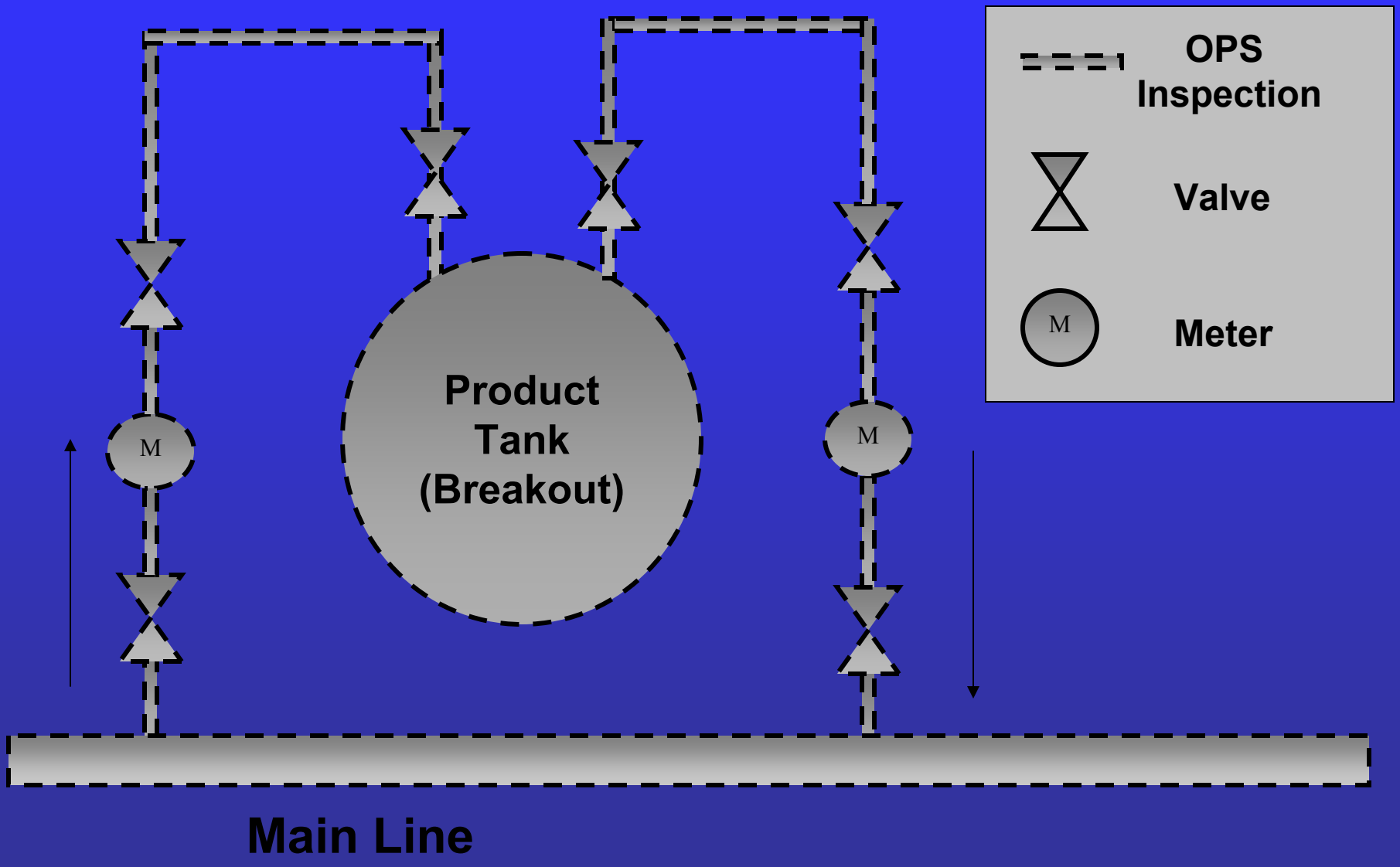
- Provide buried piping that is installed or replaced after August 16th, 2002 with a protective coating and cathodic protection.

- 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

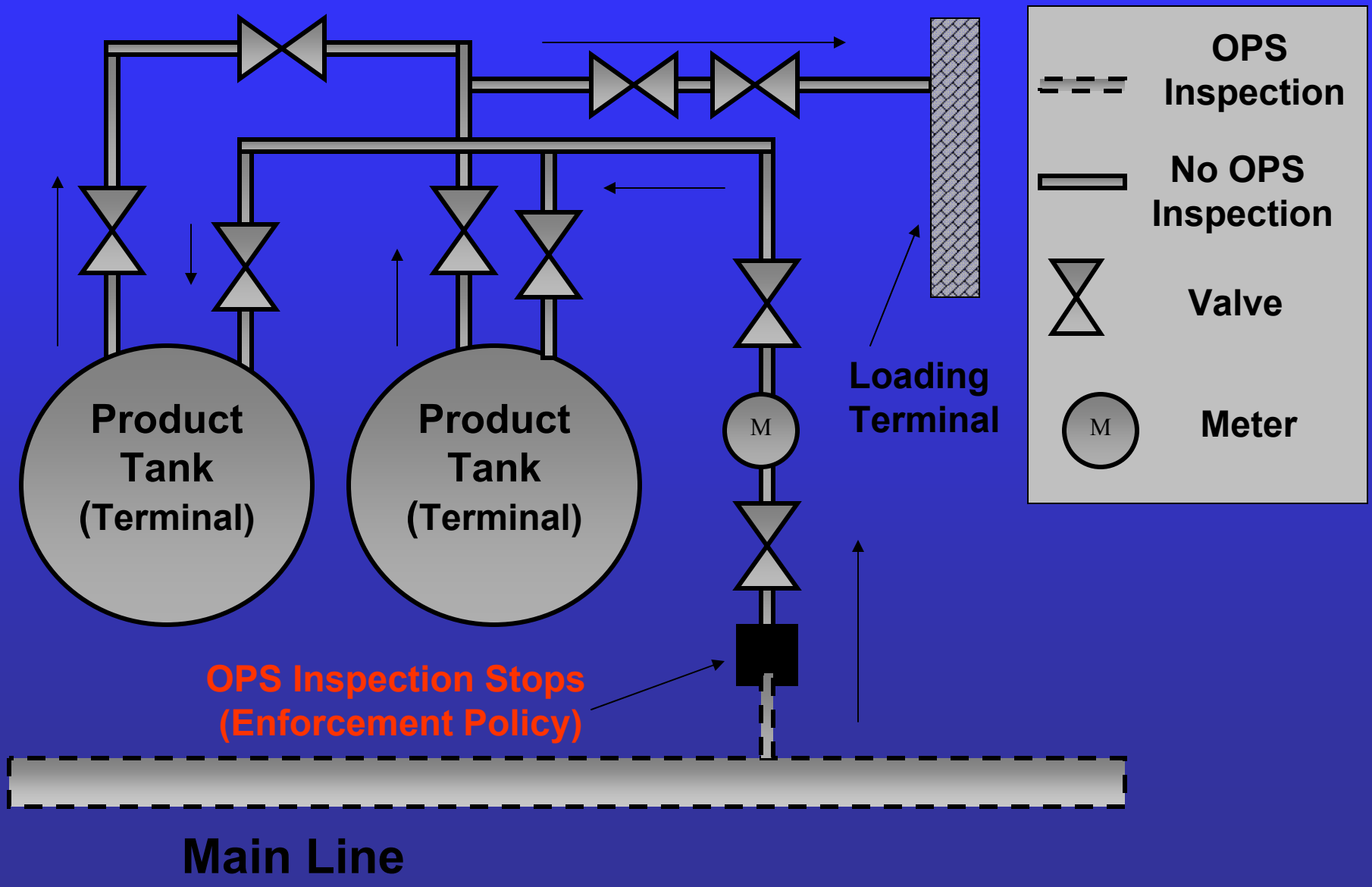


State Level

- 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



Why is Cathodic Protection Important?

- Preserve Assets
- Reduce Maintenance Costs
- Reduce Inspection Cost
- Company/Government Requirement
- Preserve The Environment

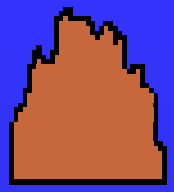
Corrosion Can be Defined as Either:

- Practical

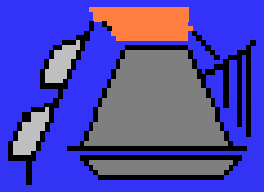
  Tendency of a Metal to Revert to its Native State

- Scientific

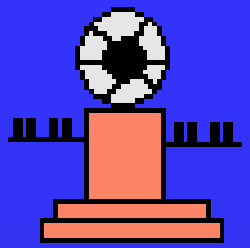
  Electrochemical Degradation of Metal as a Result of a Reaction with its Environment



IRON OXIDE

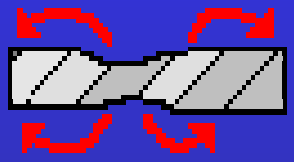


REFINING

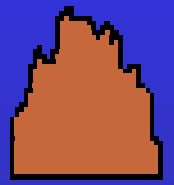


MILLING

STEEL



CORROSION



IRON OXIDE

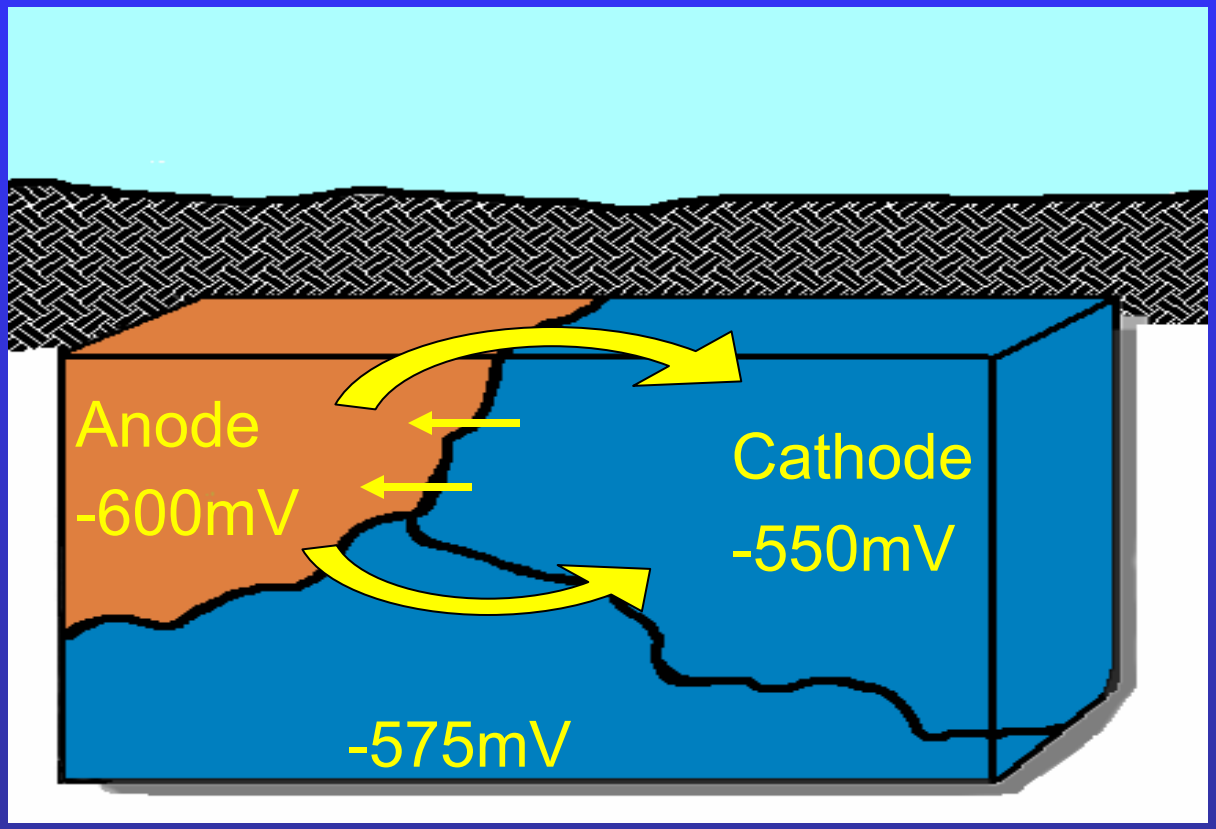
THE PROBLEM…..

1) ANODE

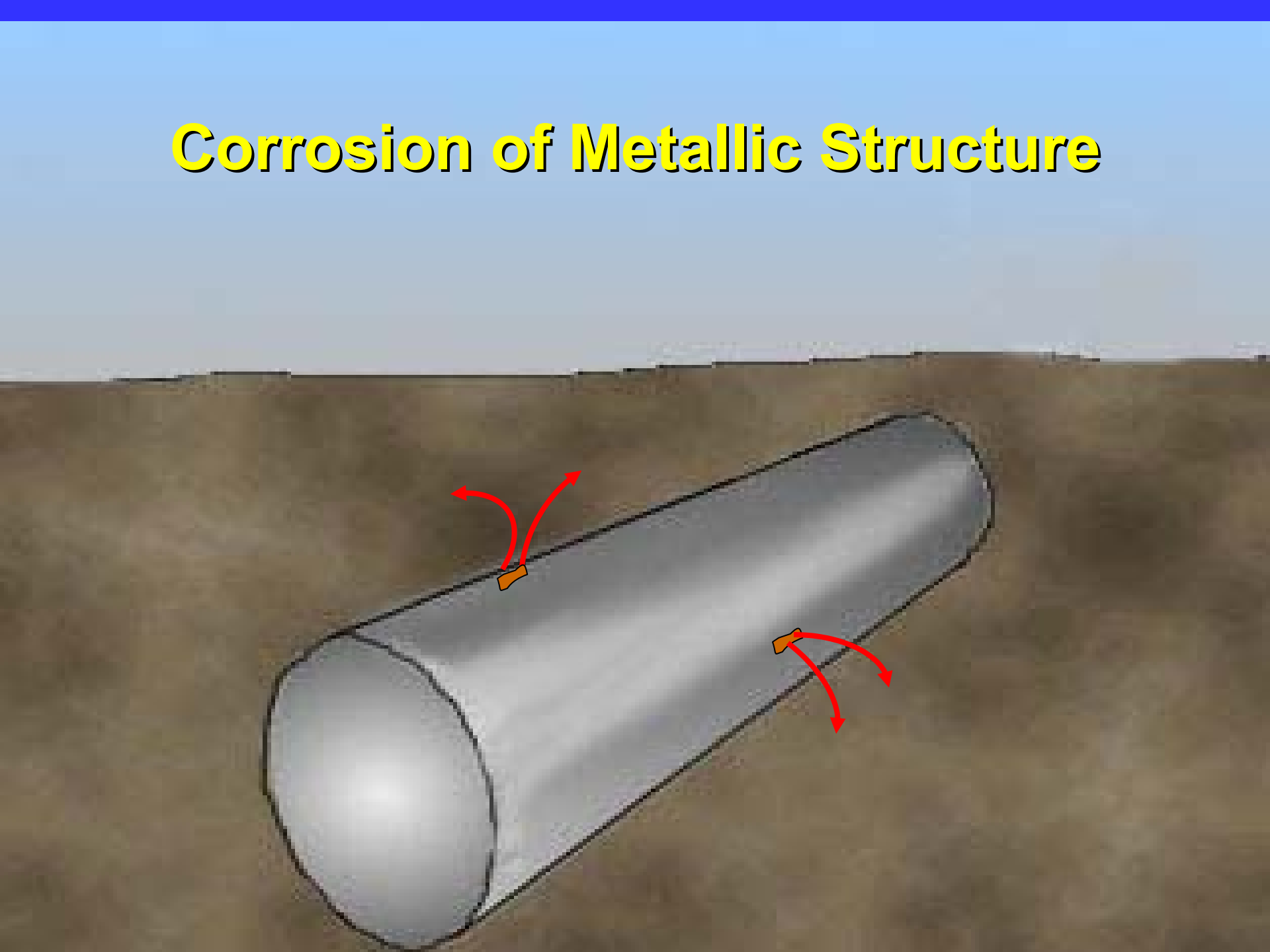
2) CATHODE

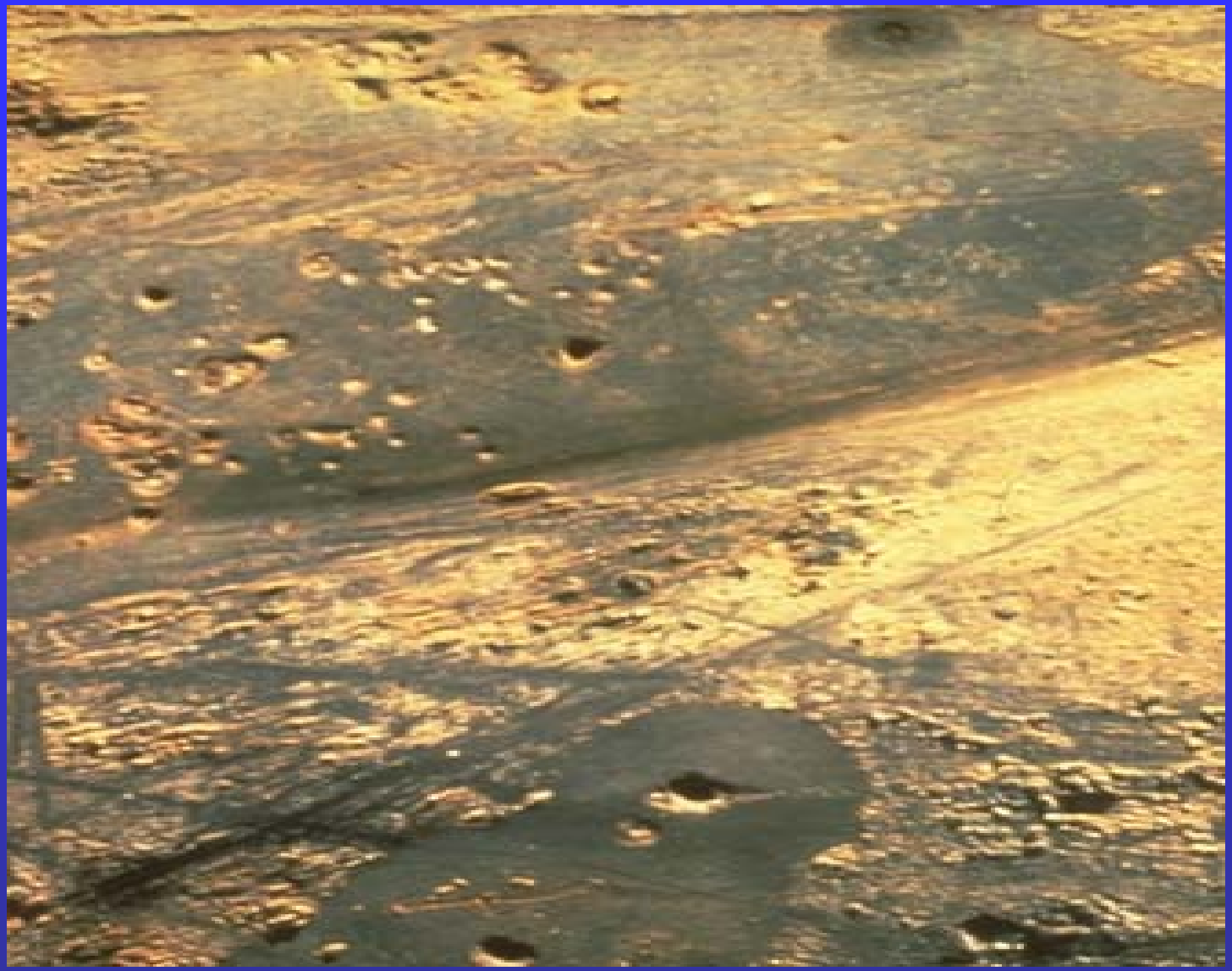
3) ELECTROLYTE

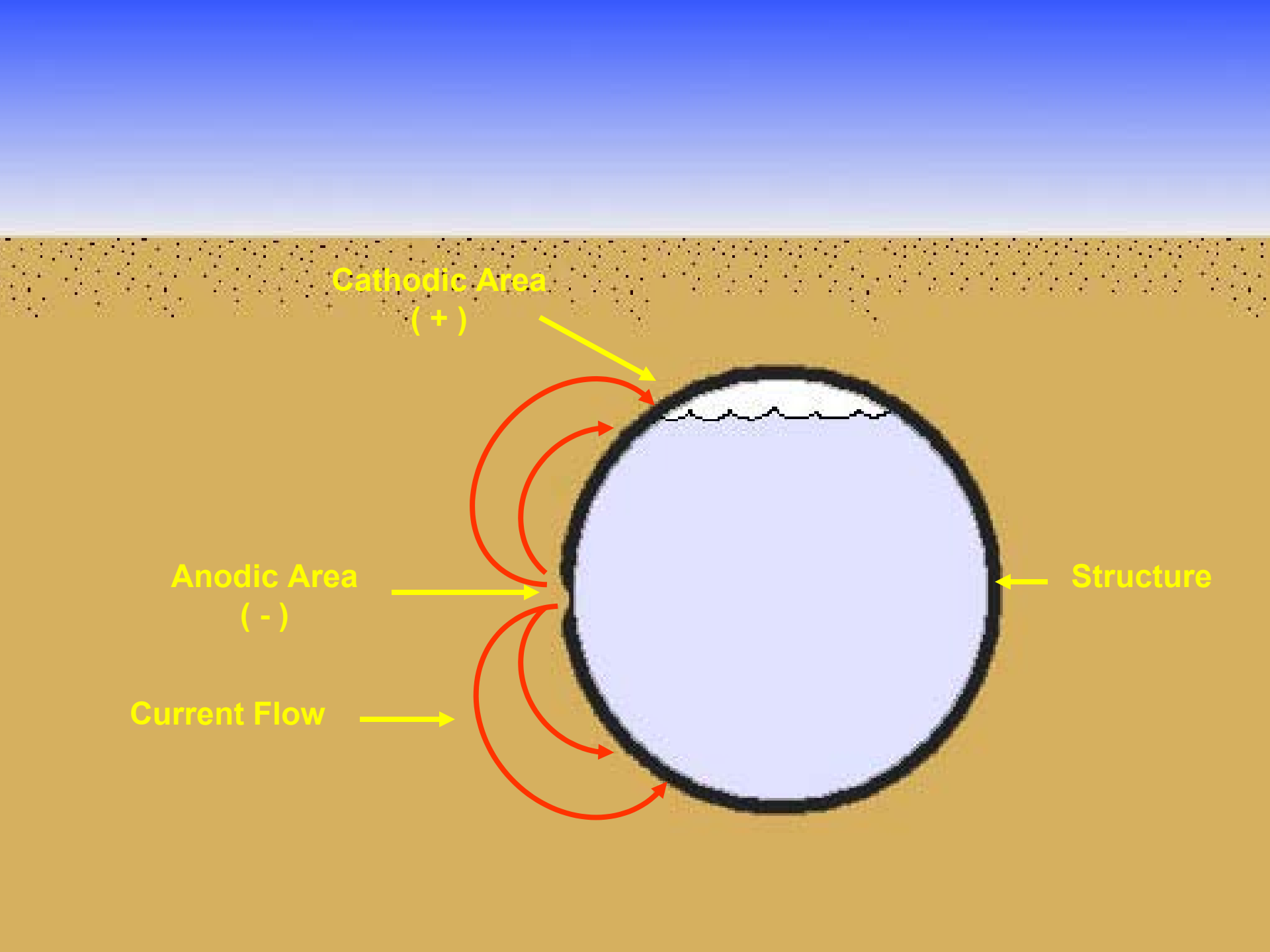
4) ELECTRICAL CONNECTION



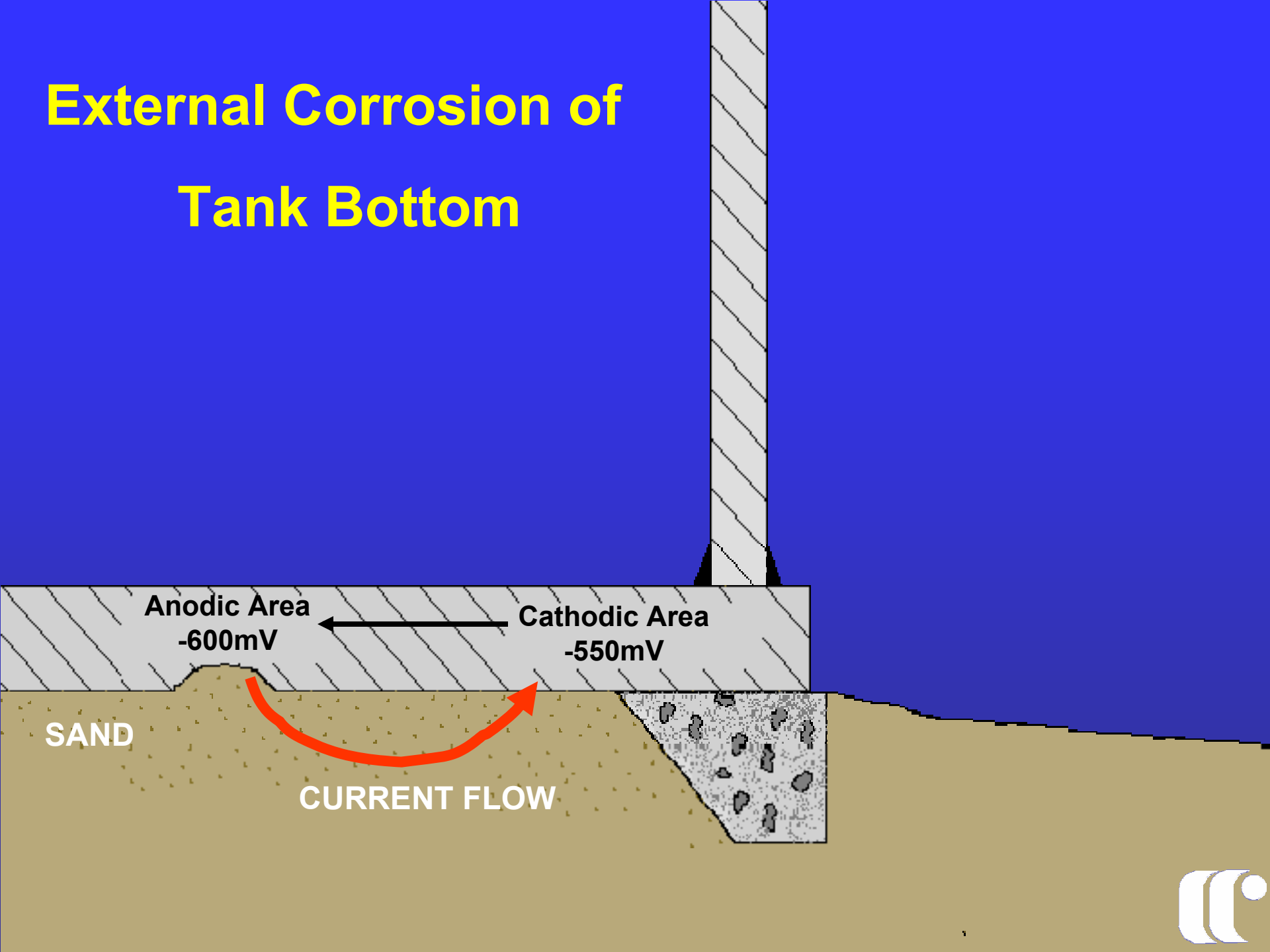
Corrosion of Metallic Structure

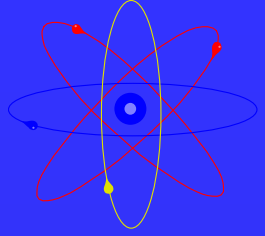





Cathodic Area
(+)
Anodic Area
(-)
Current Flow
Structure

External Corrosion of Tank Bottom





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

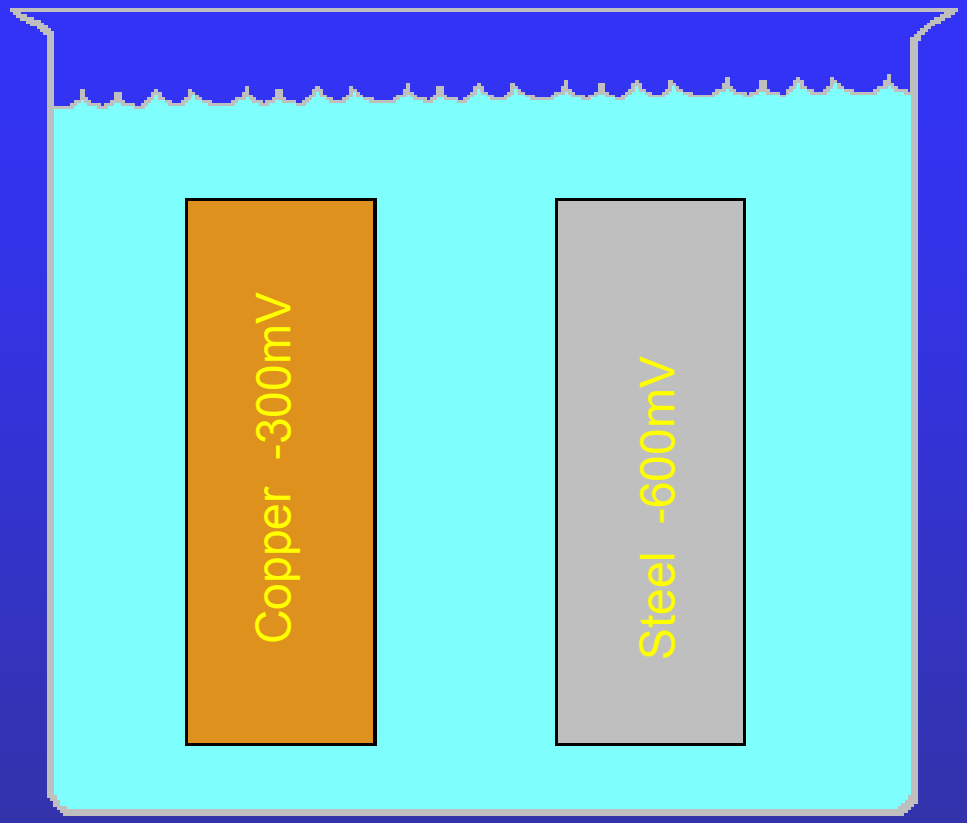
* Potentials With Respect to Saturated Cu-$CuSO_4$ Electrode

1) ANODE

2) CATHODE

3) ELECTROLYTE

4) ELECTRICAL CONNECTION



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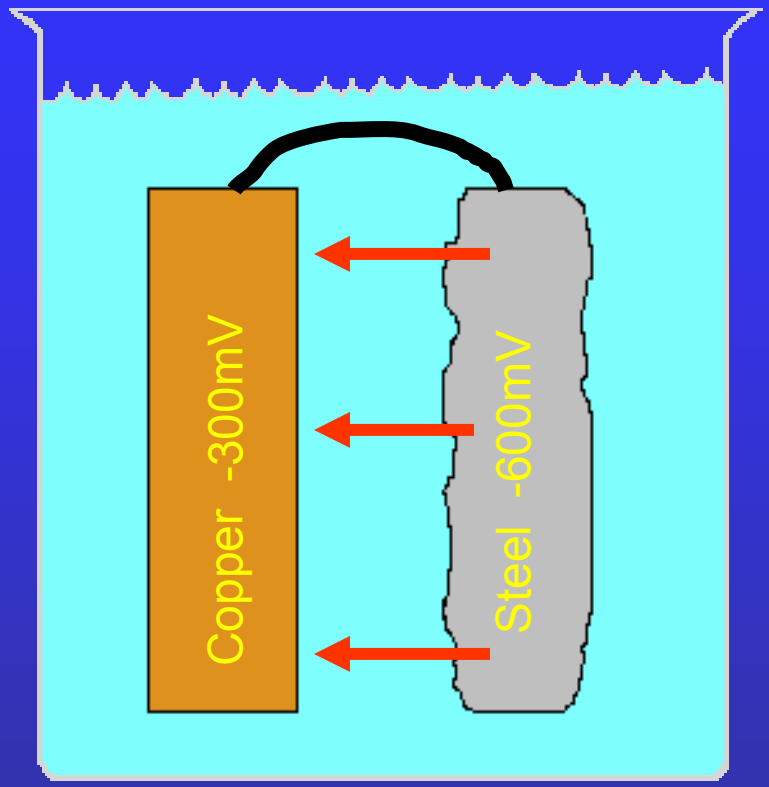

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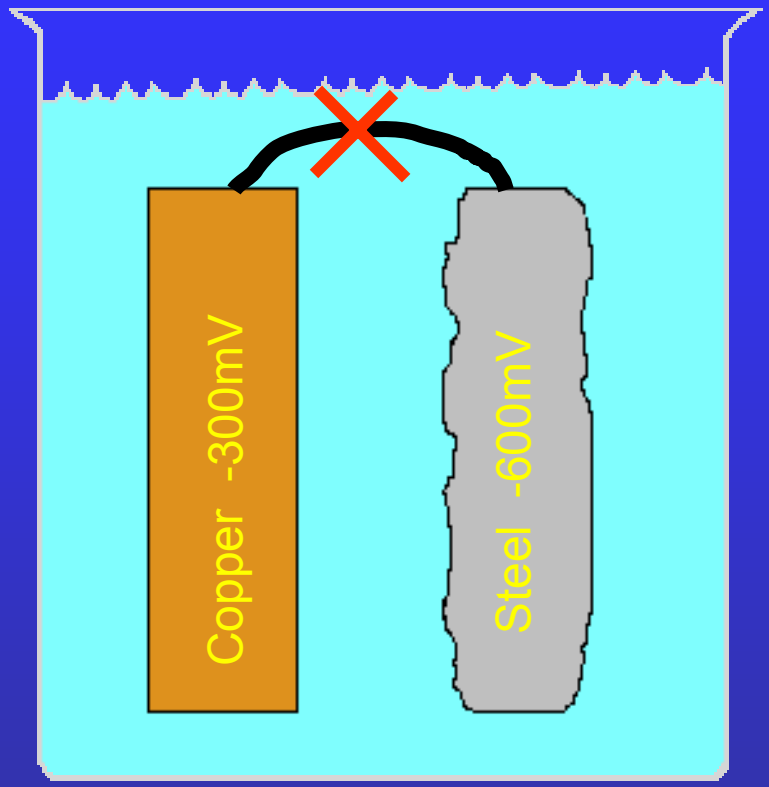

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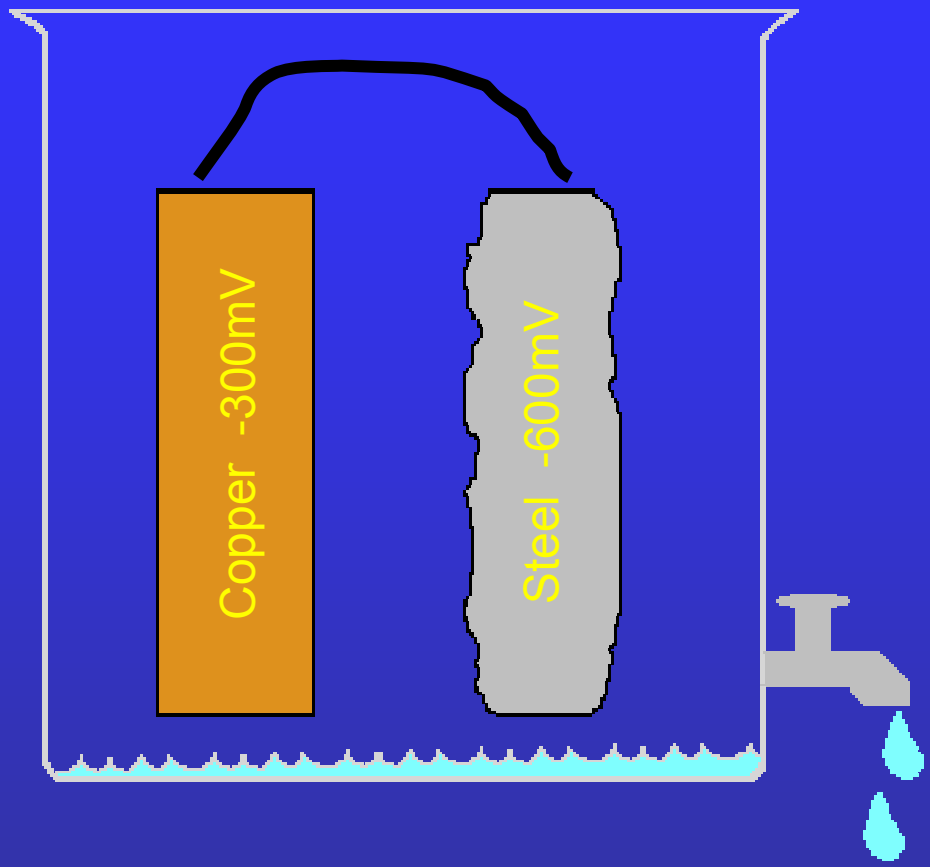

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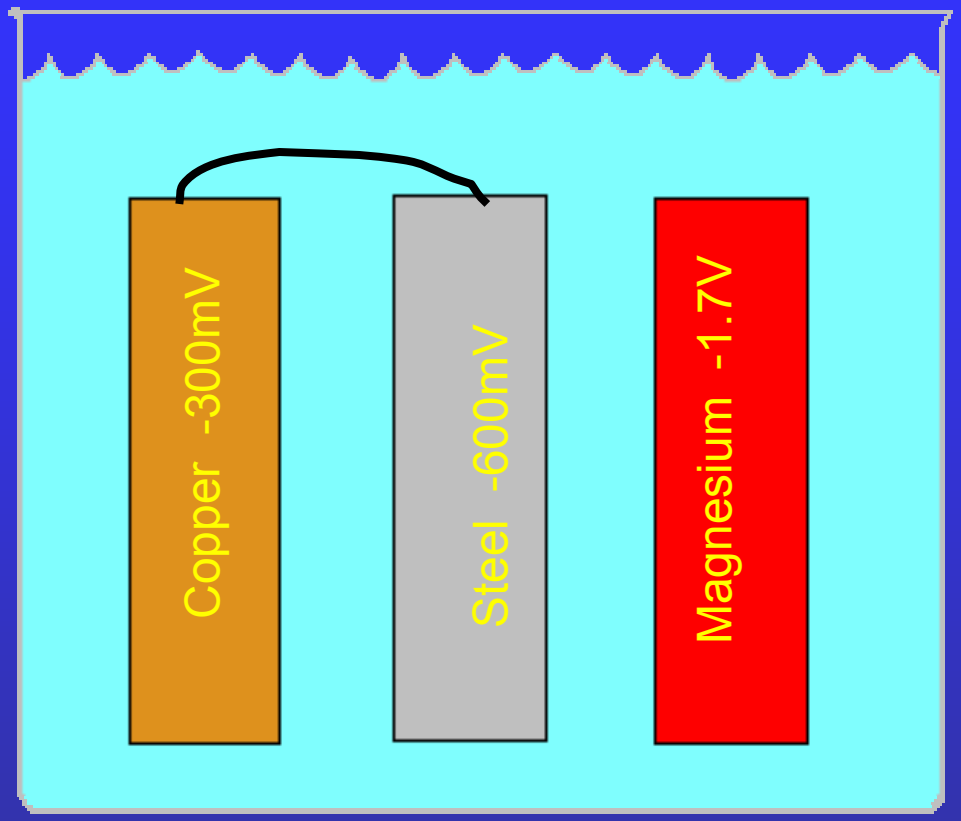

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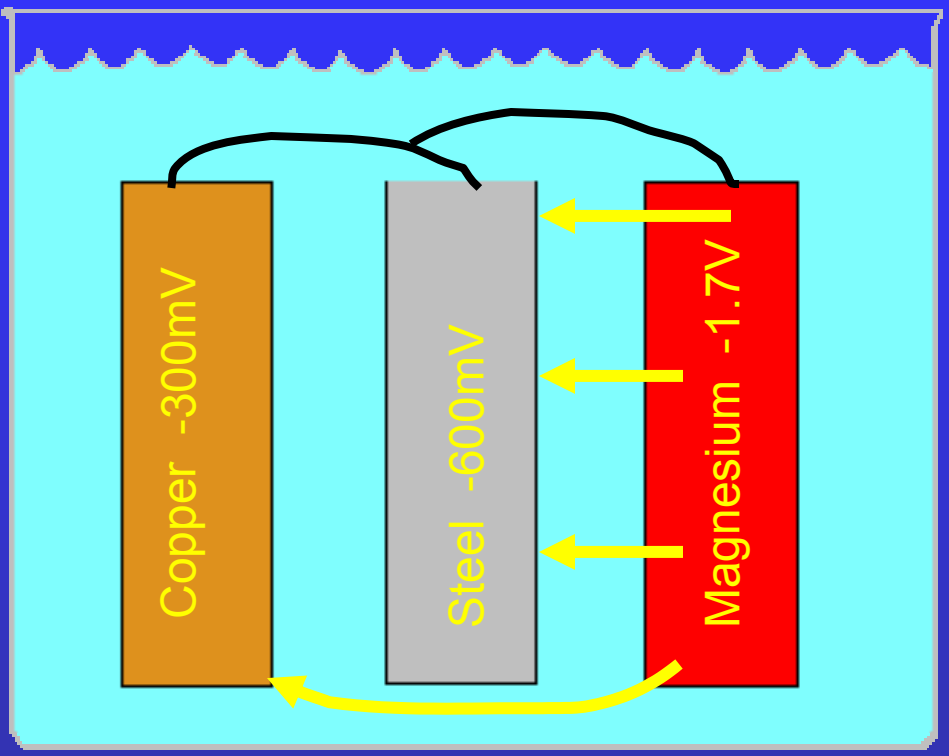
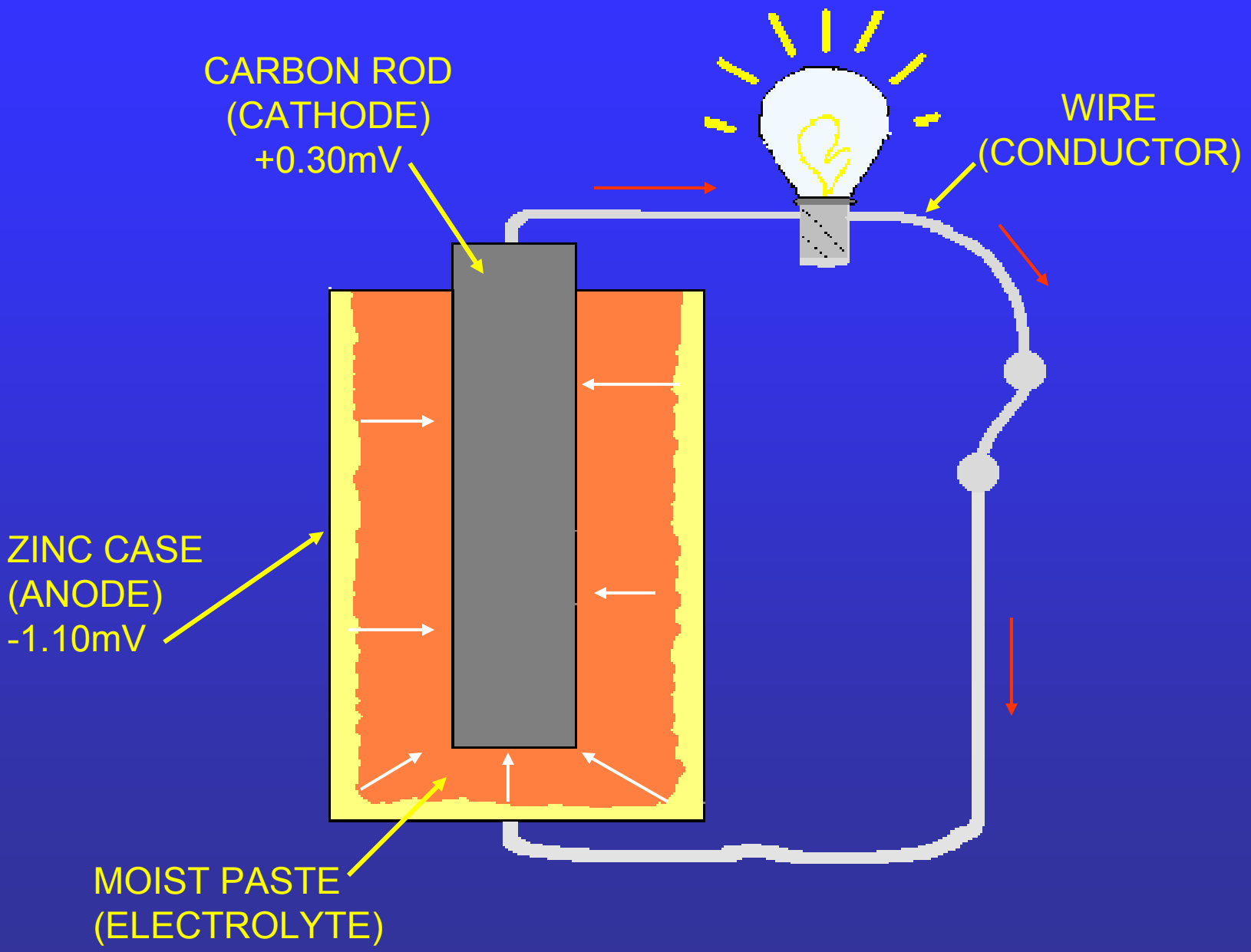
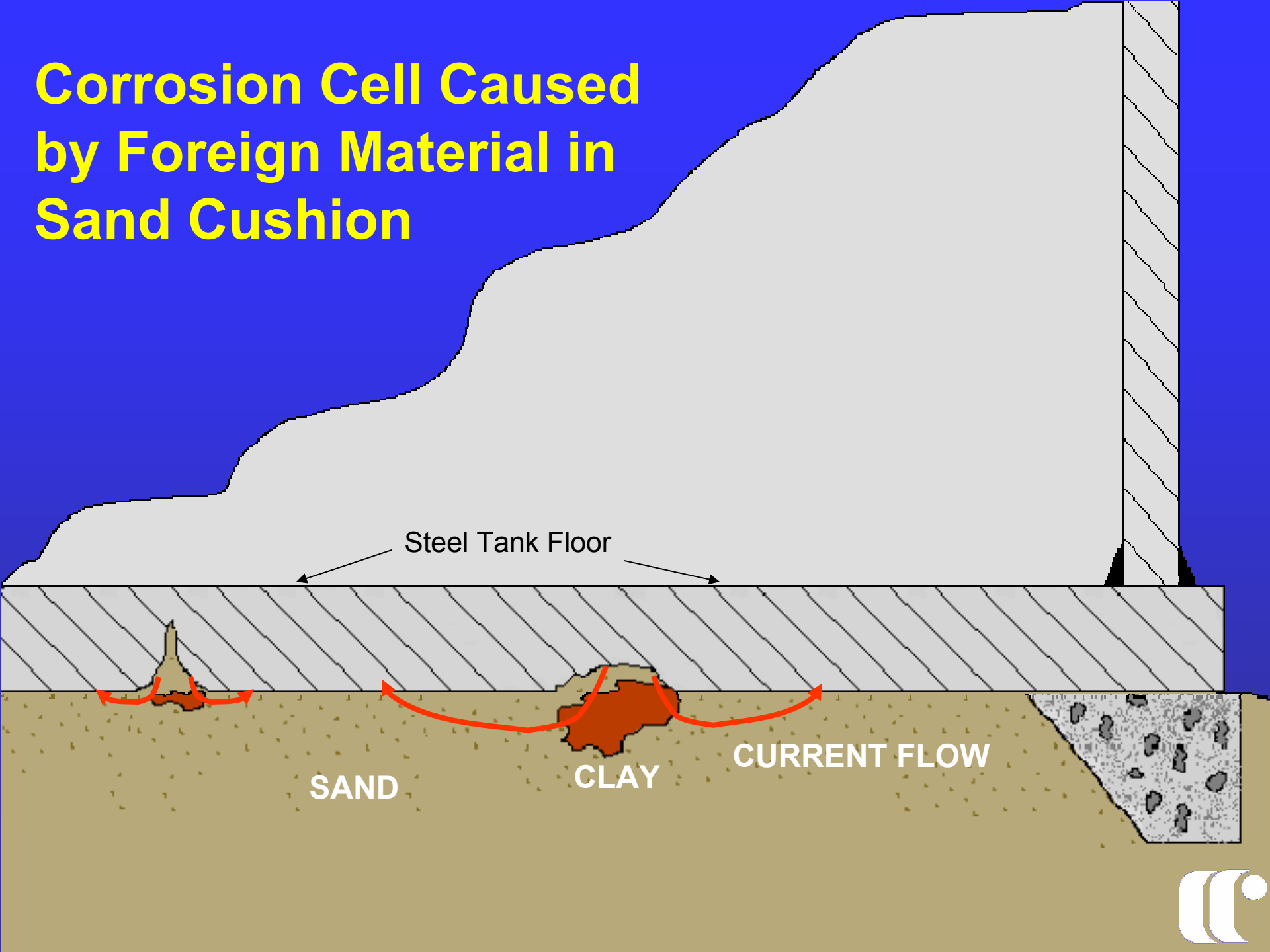


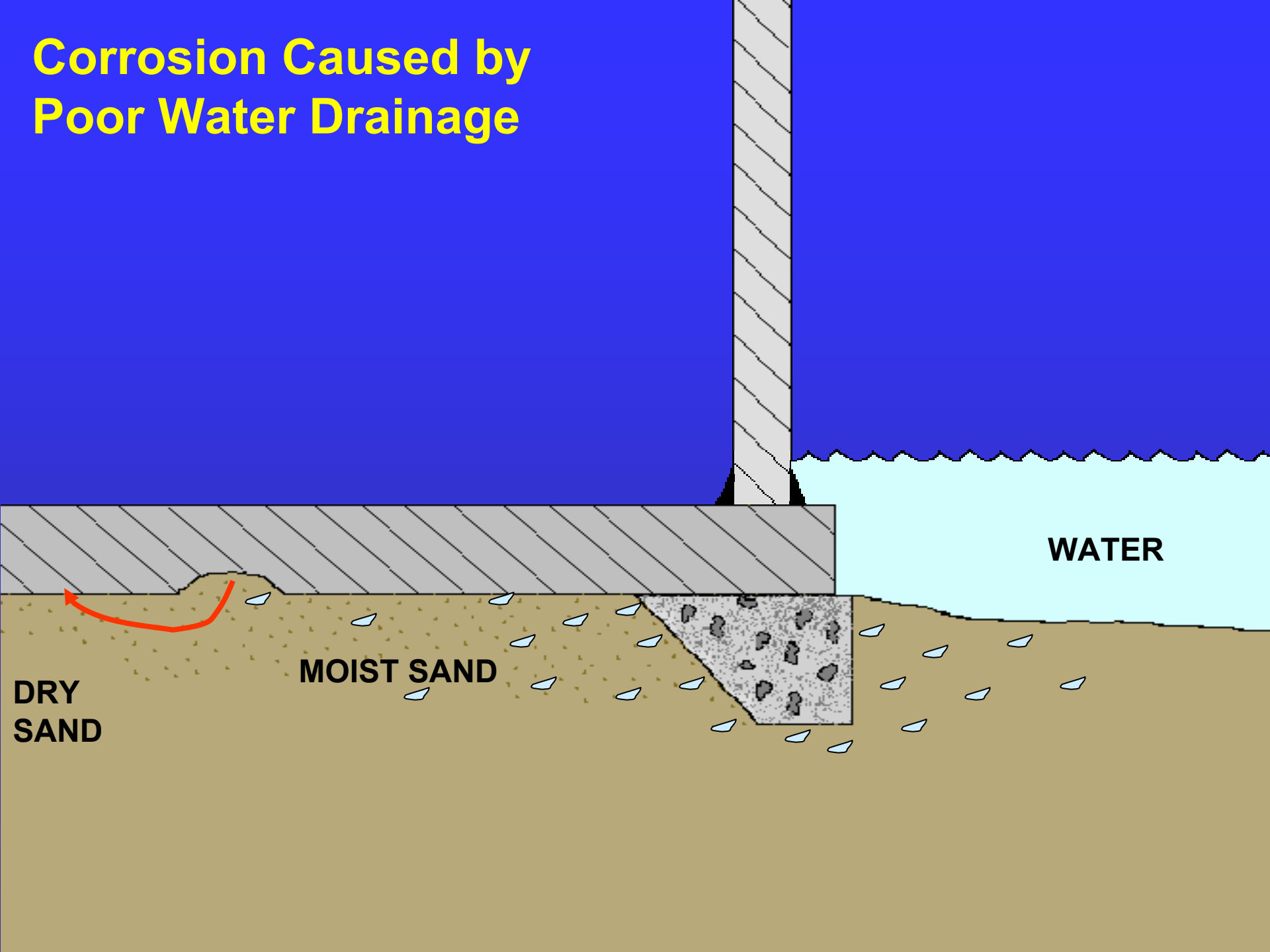

CARBON ROD
(CATHODE)
+0.30mV
WIRE
(CONDUCTOR)
ZINC CASE
(ANODE)
-1.10mV
MOIST PASTE
(ELECTROLYTE)

Piping Installation

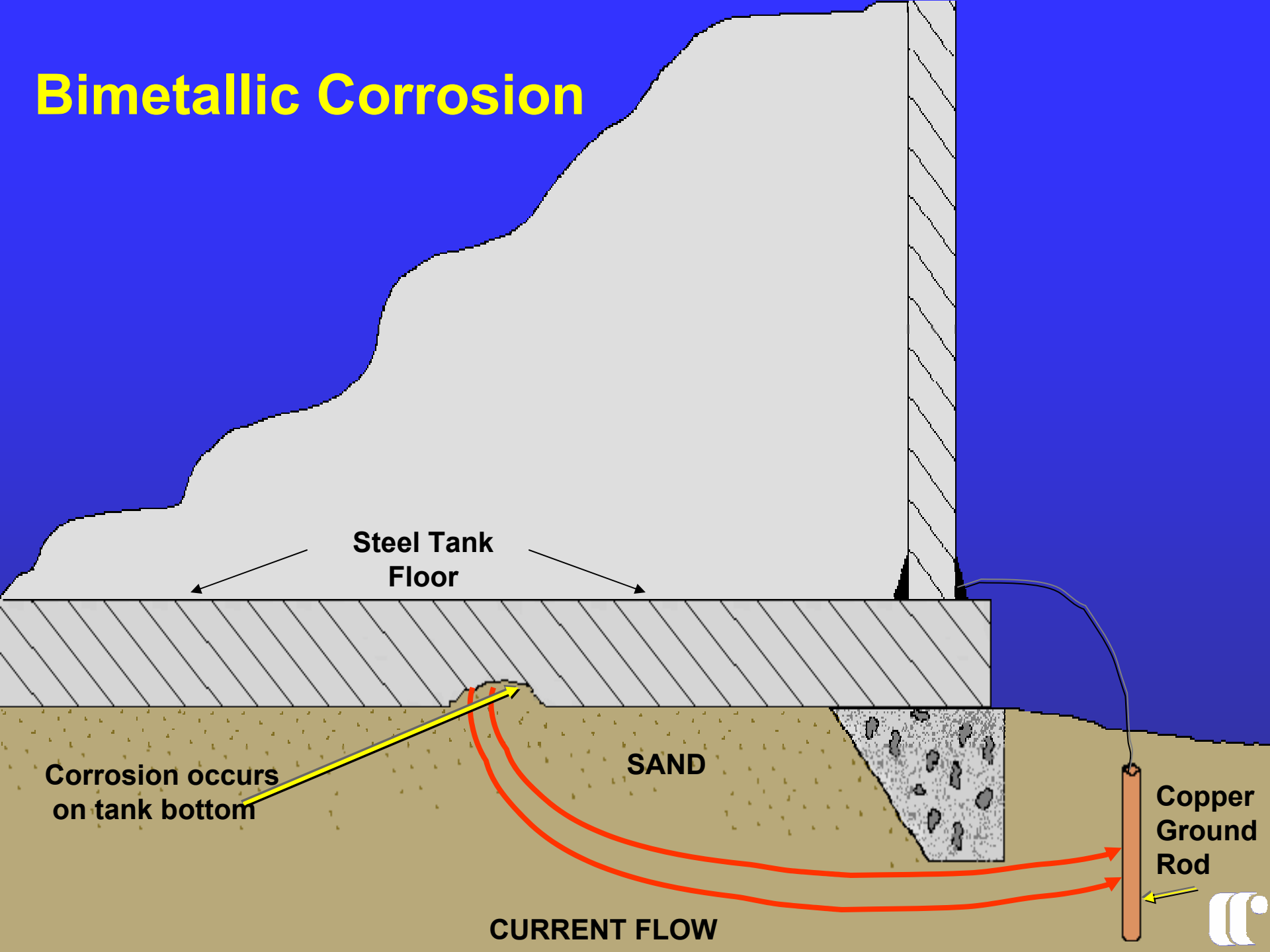
Corrosion Cell Caused by Foreign Material in Sand Cushion



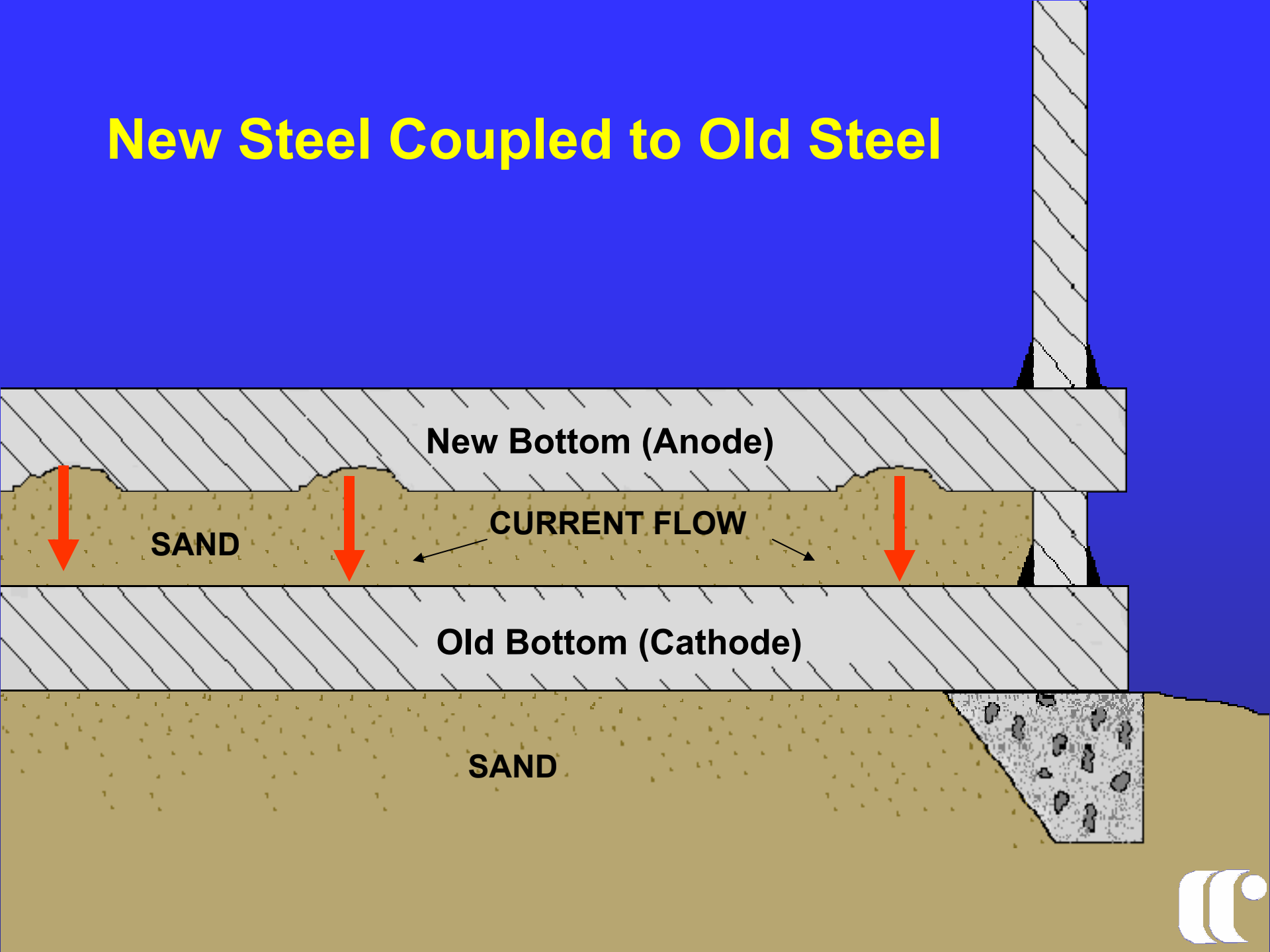
Corrosion Caused by Poor Water Drainage



Bimetallic Corrosion



New Steel Coupled to Old Steel



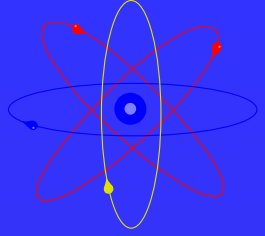
Types of Cathodic Protection

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

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

Galvanic Anode Cathodic Protection

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



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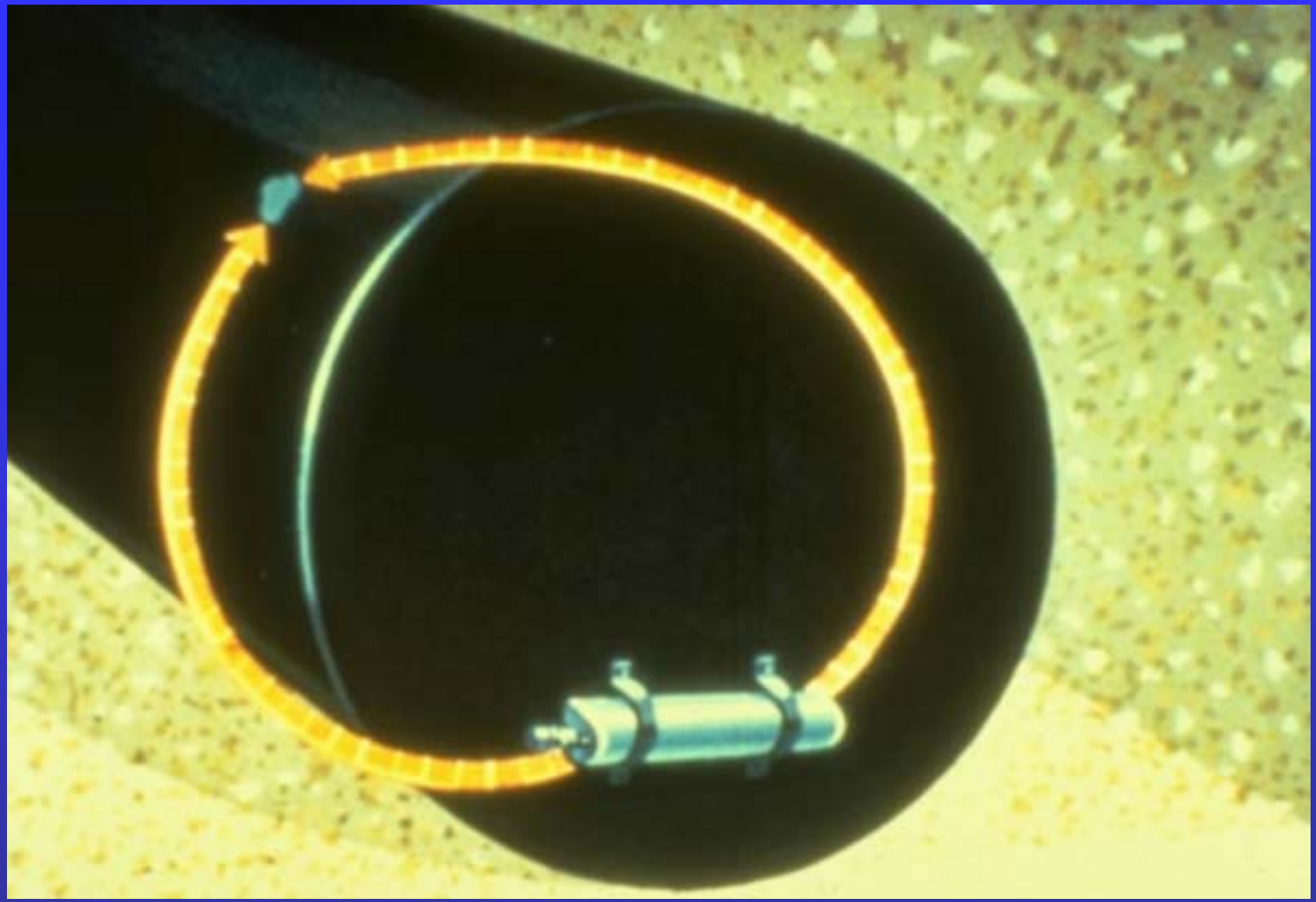
Cast Iron	-0.50
Stainless Steel	-0.50 to + 0.10
Copper, Brass, Bronze	-0.20
Titanium	-0.20
Gold	+0.20
Carbon, Graphite, Coke	+0.30

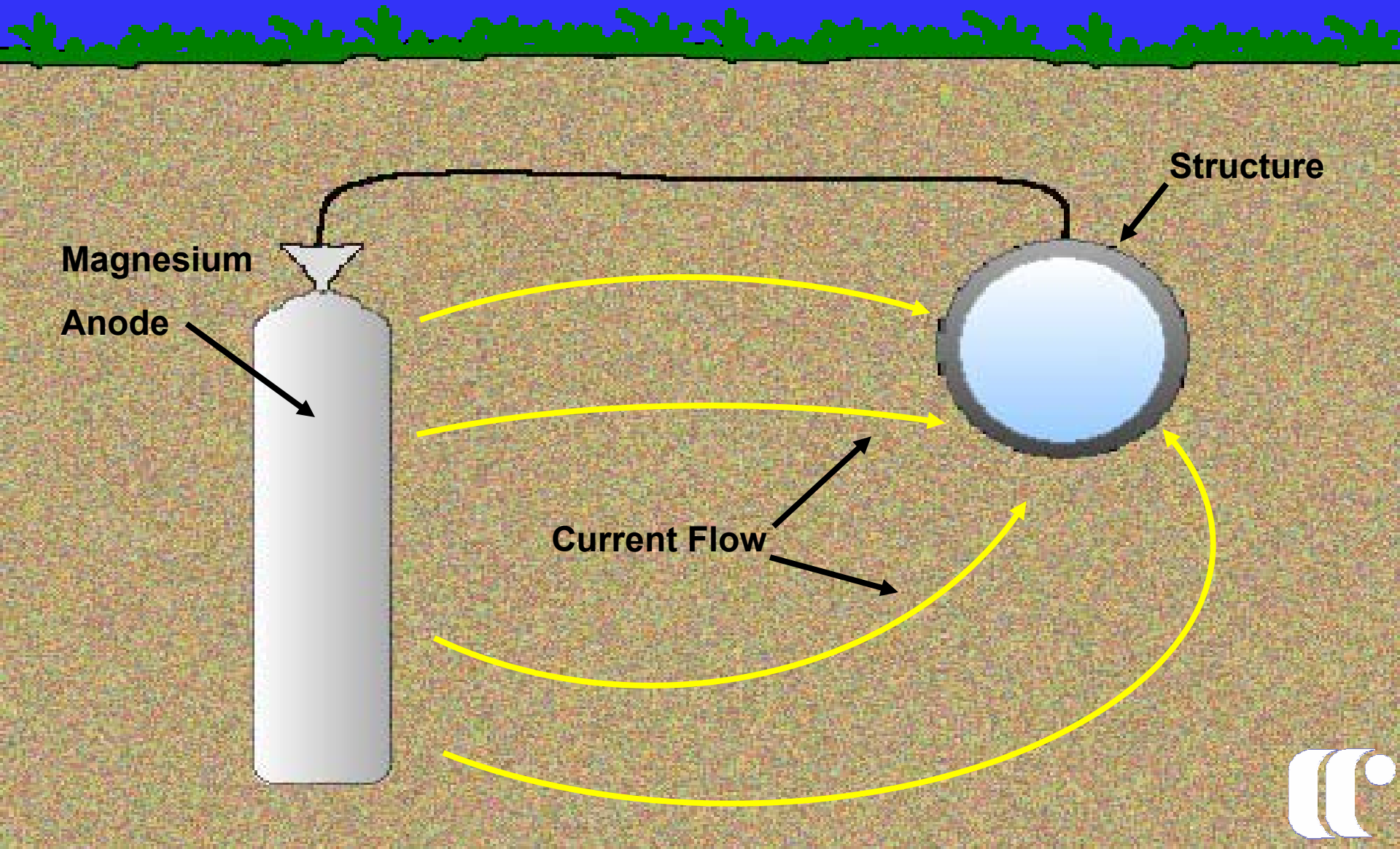
* Potentials With Respect to Saturated Cu-$CuSO_4$ Electrode


MARCO
CONTENTS
1-9" "CERTIFIED"
MARCO GALVOMAG
MAGNESIUM ANODE
MARCO ENGINEERING EXCELLENCE

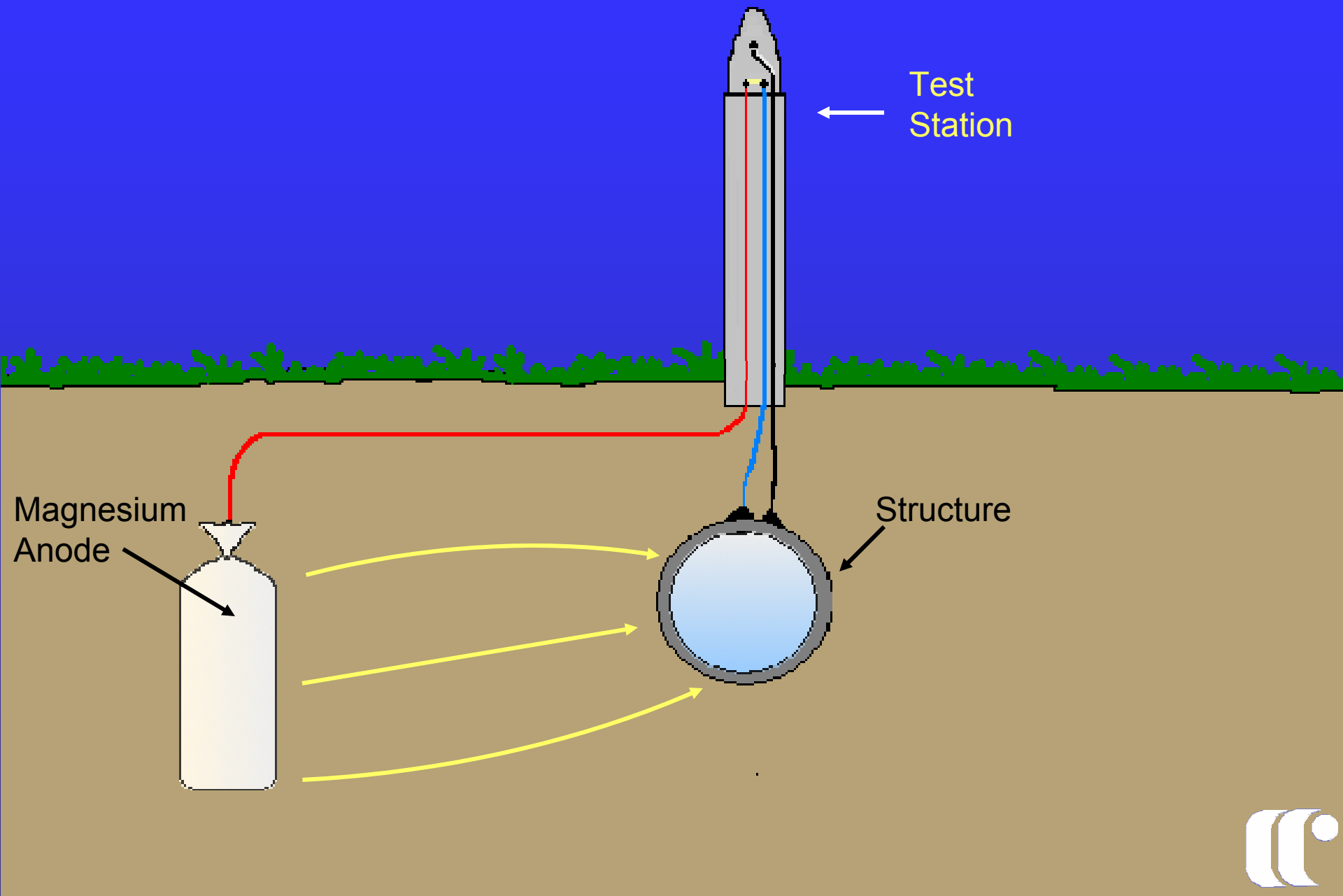


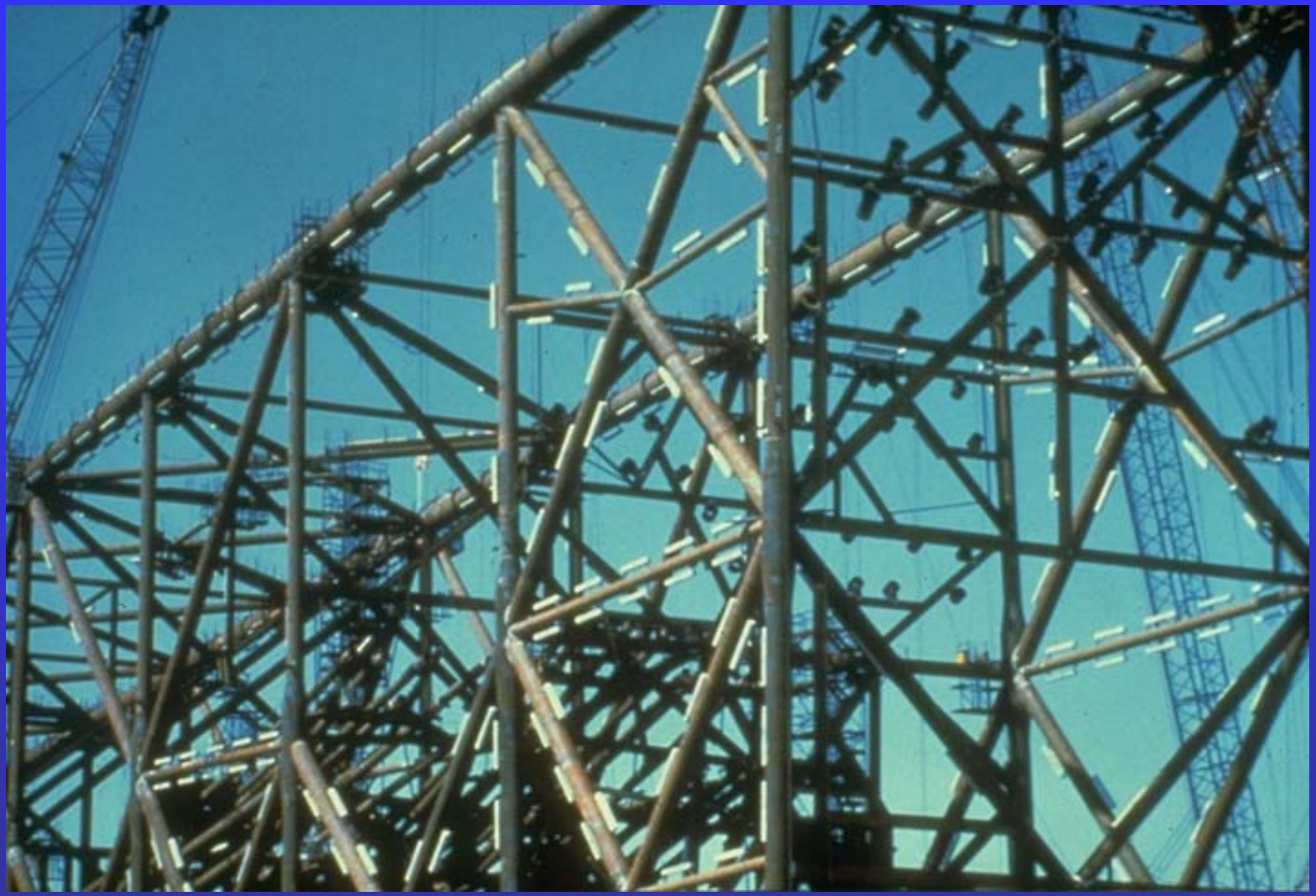

PRE-ENGINEERED
PROVEN PROTECTION
DO NOT DISCONNECT

Galvanic Cathodic Protection



Cathodic Protection Test Station





KENMORE Gas Water Heaters

It's their performance and dependability that keep you in hot water... check their features, check the facts!

- ✓ **Warranty**...our 5 to 10-year limited warranties convey our confidence in Kenmore quality and longevity
- ✓ **Polyurethane foam or fiber glass insulation** resists heat loss and helps save energy. Polyurethane insulation provides 175% greater heating insulation than fiber glass
- ✓ **Anode rods** help protect water tank from internal corrosion and premature tank failure
- ✓ **Energy cut-off** automatically shuts off power supply if thermostat fails; prevents overheating
- ✓ **Adjustable thermostat** keeps your hot water at pre-selected levels. "low" setting lets you save energy while you're away
- ✓ **Porcelain glass lining** in our steel tanks helps prevent rust to extend tank life and helps maintain hot water supply

Power Miser 10
High Performance

- ✓ Tank has limited 10-year warranty against leaks
- ✓ Roto-Swirl™ cold water inlet tube swirls water to help prevent mineral build-up at bottom of tank . . . extends tank life
- ✓ Porcelain glass lining and 2 anode rods help fight rust and corrosion
- ✓ Fastest hot water recovery rate of any gas unit we sell
- ✓ Natural gas only

$349.99 and up

$14 MONTHLY‡

Power Miser 8

- ✓ Tank has limited 8-year warranty against leaks
- ✓ 1-inch polyurethane foam insulation (R-value 8.33)
- ✓ Roto-Swirl™ cold water inlet tube swirls water to help prevent mineral build-up at bottom of tank . . . extends tank life
- ✓ Natural or LP gas

$239.99 and up

$11 MONTHLY‡

Money-saving coupon. Be sure to clip and save our coupon on p. 93A.

Tired of high gas bills? Fight back with our finest gas water heater. It has a recovery efficiency of over 80% thanks to its unique combustion chamber and air intake design. The polyurethane foam insulation retains heat 2½ times longer than standard fiberglass insulation plus heat trap nipples on cold and hot water inlet connections help to lower fuel bills. Adjustable gas control automatically maintains temperature you select. High temperature safety cut-off. Drain valve. Requires 3" or 4-inch vent. Design certified by the American Gas Association. 10-year limited warranty against tank leaks. Warranted by Sears. Write for free copy; see page 325A. Not for mobile homes.

Estimated annual energy costs based on U.S. Dept. of Energy test procedures and 1983 national average utility rates.

Tank vols. gals.	Diameter x height for jacket type	Btuh input per hr.	Recovery in gals. per hr. at 90°F rise	Catalog Number	Shpg. wt. lbs.	Price
Order relief valve at p. 98A. For all except Greensboro area and North Carolina points						
40	18x58½ in.	40,000	46.0 gals.	42 T 33842N	110	$349.99
50	20x58½ in.	40,000	46.0 gals.	42 T 33852N	172	379.99
With factory installed relief valve per North Carolina law. For Greensboro area and North Carolina points only.						
40	18x58½ in.	40,000	46.0 gals.	42 T 33843N	101	$359.99

†Allow about 18 inches for diameter, fiberglass elbow and ceiling clearance. Horizontal run should slope up ¼ inch per foot.

Catalog Number	A	B	Annual energy cost range for all brands by first hour rating range
33137-38	238	46	$176 to $266
33147-48	253	58	188 to 295
33337-38	190	51	176 to 266
33347-48	194	60	188 to 295
33357	204	67	176 to 273
33412	194	53	176 to 269
33423-23	196	64	188 to 295
33571	257	52	290 to 407
33587	268	68	255 to 377
33633	199	64	188 to 295
33652	209	77	176 to 269
33662	215	67	233 to 342
33681	194	52	176 to 266
33671	201	58	188 to 295

Catalog Number	A	B	Annual energy cost range for all brands by first hour rating range
33672	209	67	$212 to $342
33682	224	84	210 to 343
33842-43	179	73	188 to 277
33852	189	80	176 to 288
33853	190	51	176 to 266
33431 ‡‡	191	66	188 to 295
33472	203	66	188 to 295
33442-43	199	65	188 to 273
33482-83	215	65	255 to 377
33492	206	72	188 to 273
33532	209	67	188 to 295
33542-43	193	69	188 to 295
33461	191	65	188 to 273
33481	193	74	188 to 273

●See page 326A

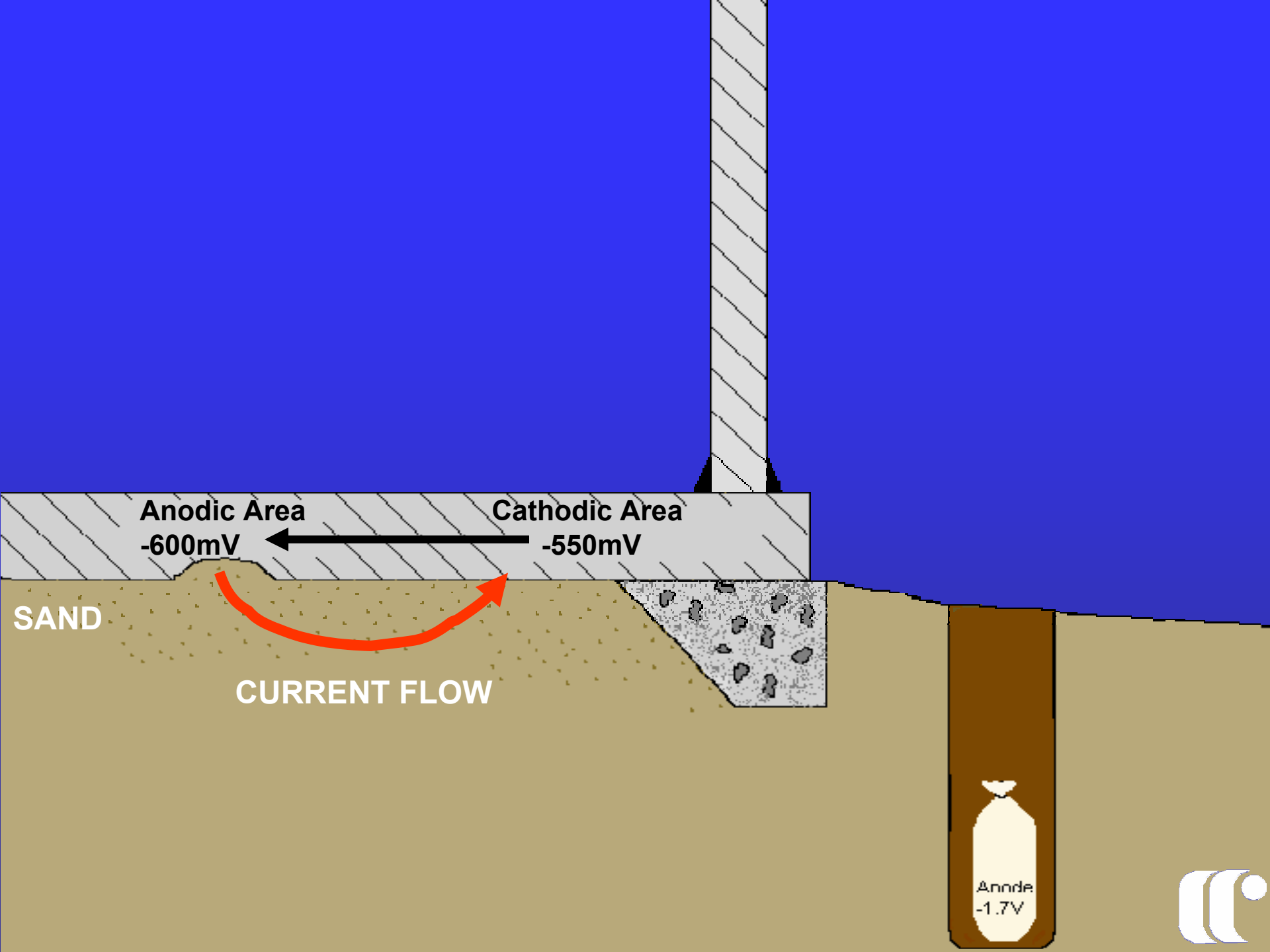
•Estimated annual energy cost for Sears model ‡First hour rating for Sears model in gallons.

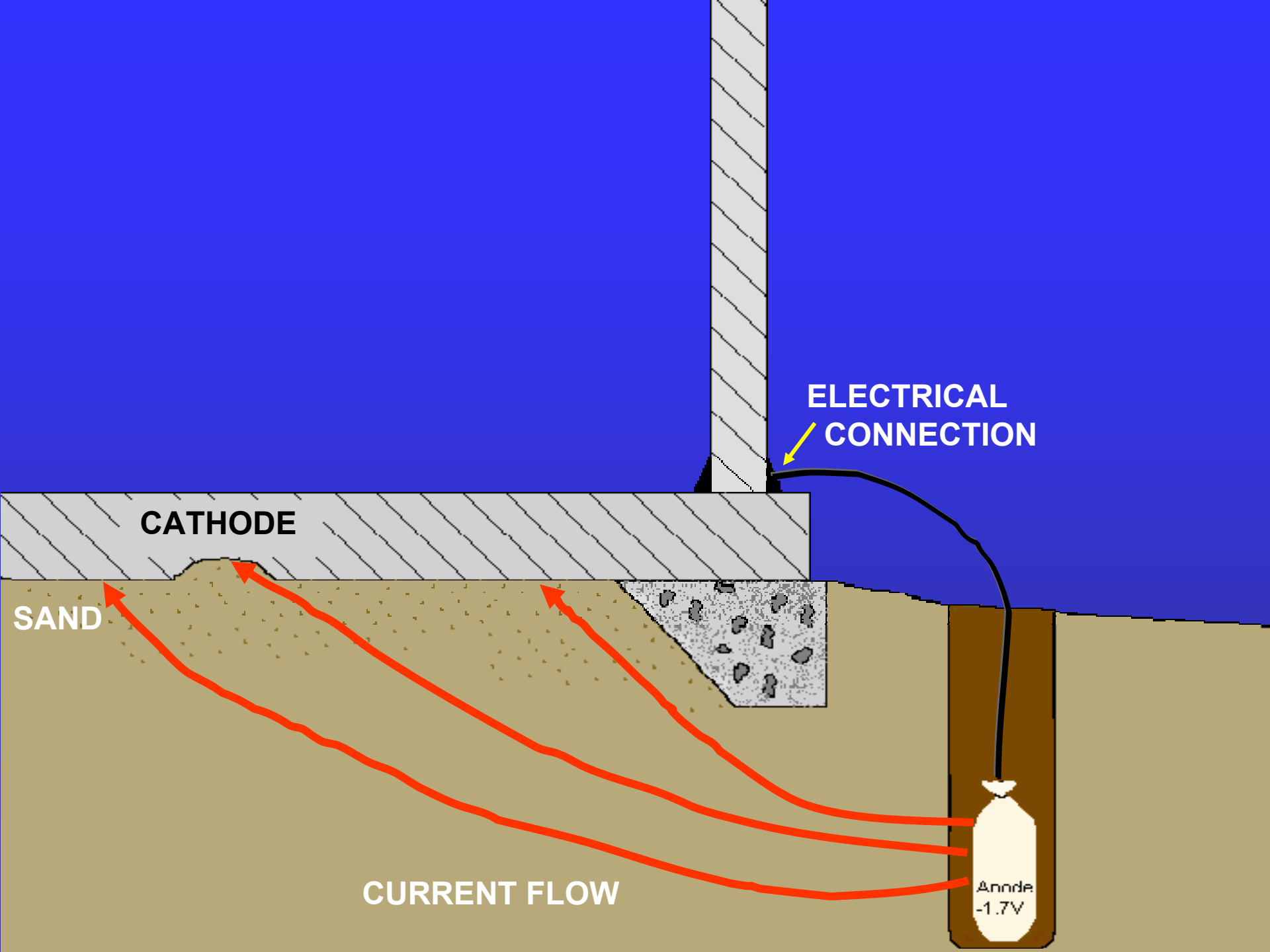
Additional important energy information available; see page 325A.

INSULATING UNIONS

FLANGE INSULATION KIT


KENMORE Gas Water Heaters
It's their performance and dependability that keep you in hot water... check their features, check the facts!
Warranty...our 5 to 10-year limited warranties convey our confidence in Kenmore quality and longevity
Polyurethane foam or fiber glass insulation resists heat loss and helps save energy. Polyurethane insulation provides 175% greater heating insulation than fiber glass
Anode rods help protect water tank from internal corrosion and premature tank failure
Energy cut-off automatically shuts off power supply if thermostat fails; prevents overheating
Adjustable thermostat keeps your hot water at pre-selected levels. "low" setting lets you save energy while you're away
Porcelain glass lining in our steel tanks helps prevent rust to extend tank life and helps maintain hot water supply
1
2
Power Miser 10 High Performance
Tank has limited 10-year warranty against leaks
Roto-Swirl™ cold water inlet tube swirls water to help prevent mineral build-up at bottom of tank . . . extends tank life
Porcelain glass lining and 2 anode rods help fight rust and corrosion
Fastest hot water recovery rate of any gas unit we sell
Natural gas only
$349.99 and up
$14 MONTHLY
Power Miser 8
Tank has limited 8-year warranty against leaks
1-inch polyurethane foam insulation (R-value 8.33)
Roto-Swirl™ cold water inlet tube swirls water to help prevent mineral build-up at bottom of tank . . . extends tank life
Natural or LP gas
$239.99 and up
$11 MONTHLY
Money-saving coupon. Be sure to clip and save our coupon on p. 93A.
Estimated annual energy costs based on U.S. Dept. of Energy test procedures and 1983 national average utility rates


Anodic Area
-600mV
Cathodic Area
-550mV
SAND
CURRENT FLOW
Anode
-1.7V


ELECTRICAL
CONNECTION
CATHODE
SAND
CURRENT FLOW
Anode
-1.7V

Recommended Practices

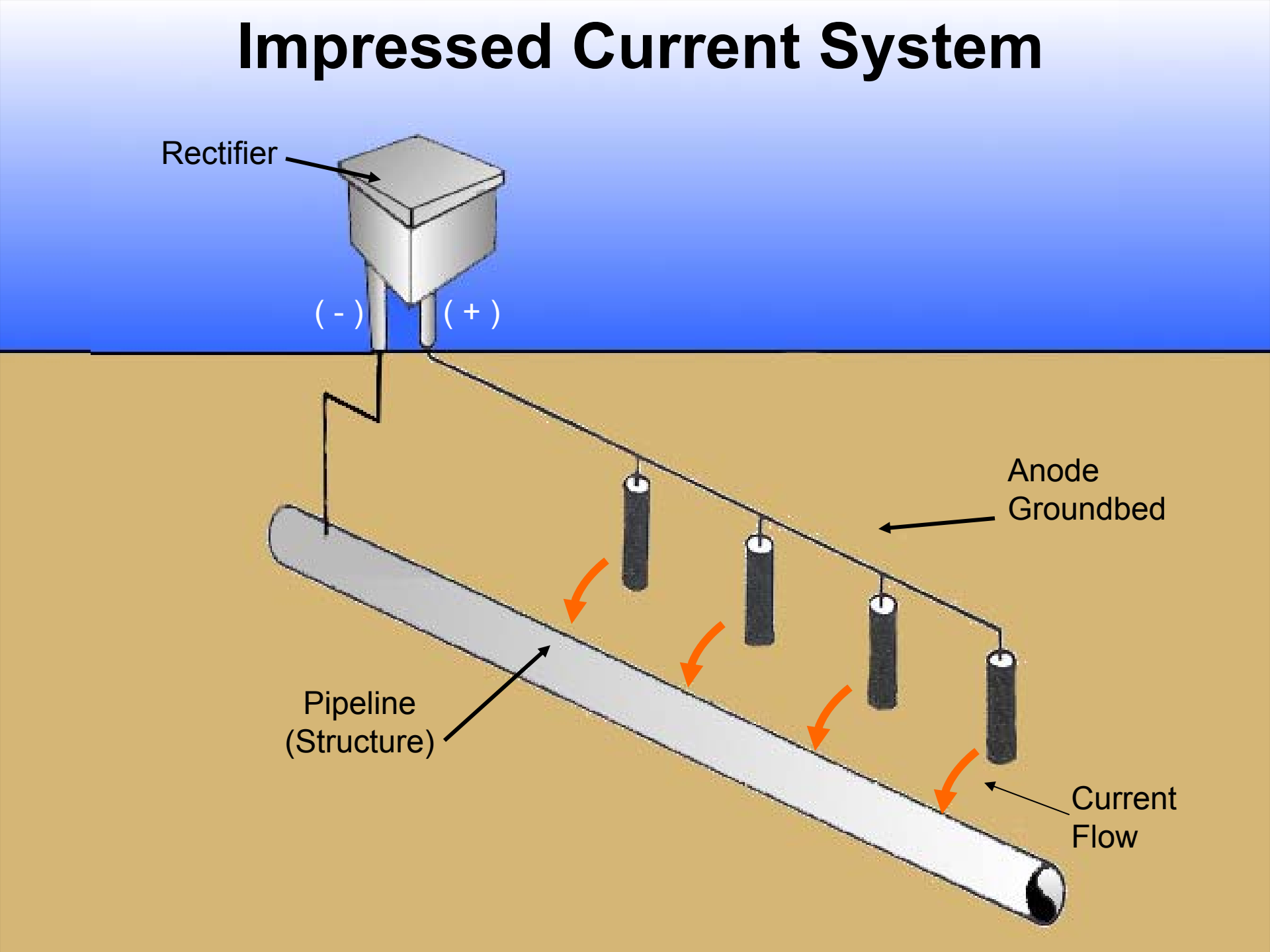
API-651 - Cathodic Protection of Aboveground Petroleum Storage Tanks:

"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 System

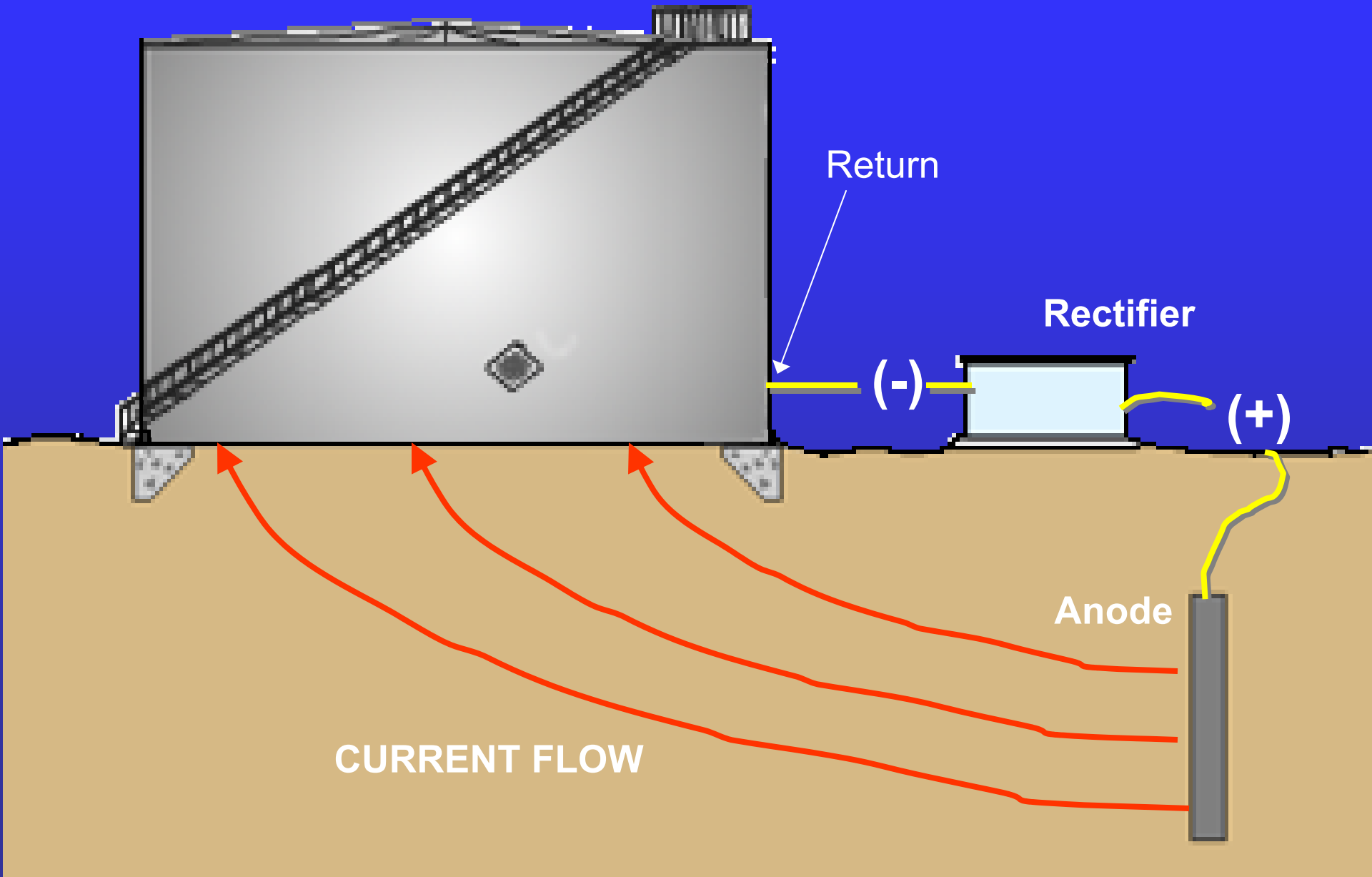


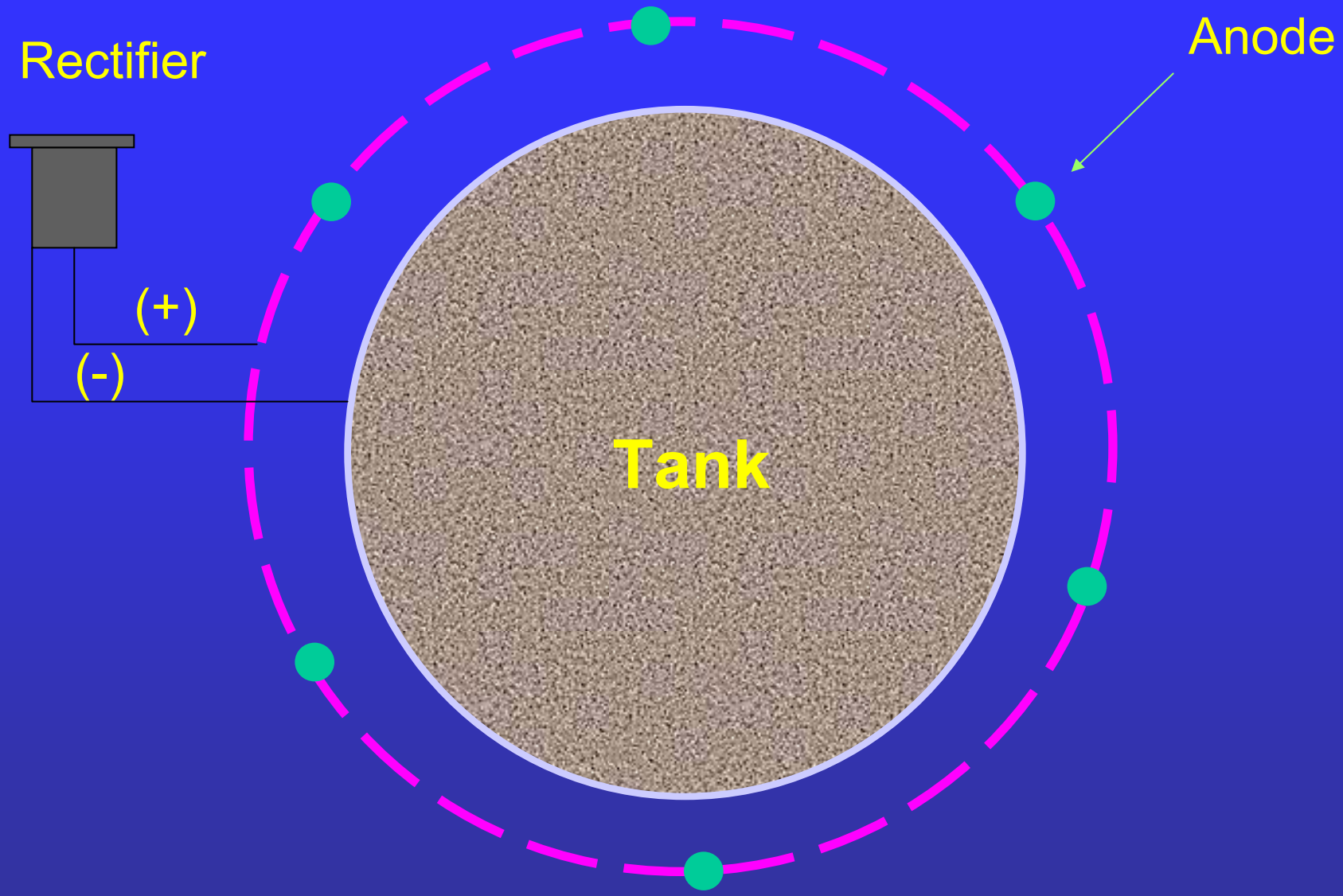

2
cathodic
protection
rectifier

Impressed Current Cathodic Protection System

- Anodes
- Rectifier
- Wiring

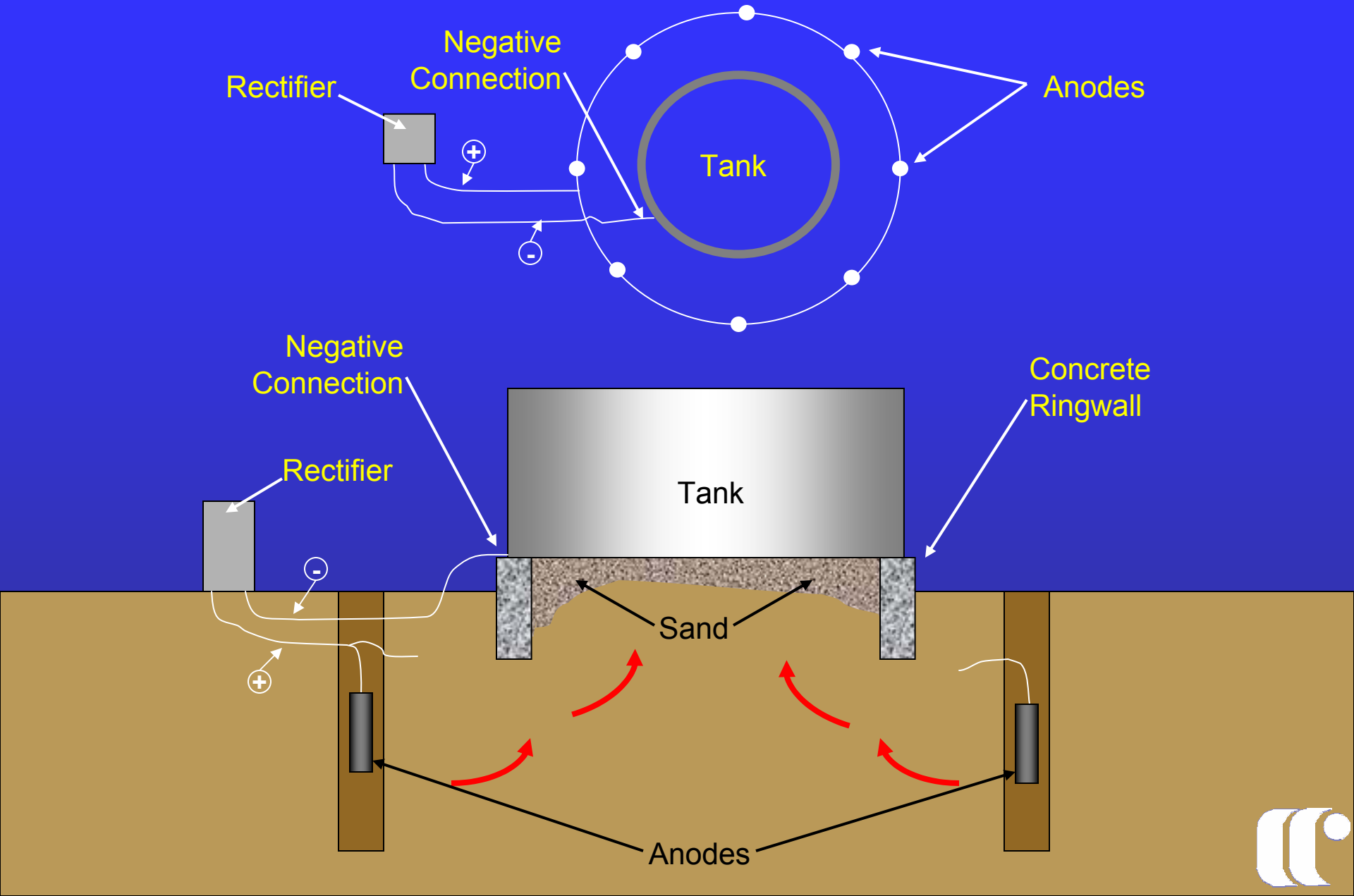
Impressed Current Cathodic Protection





Shallow Anodes

Above Ground Storage Tank Vertical Impressed Current Anodes - Existing Tanks



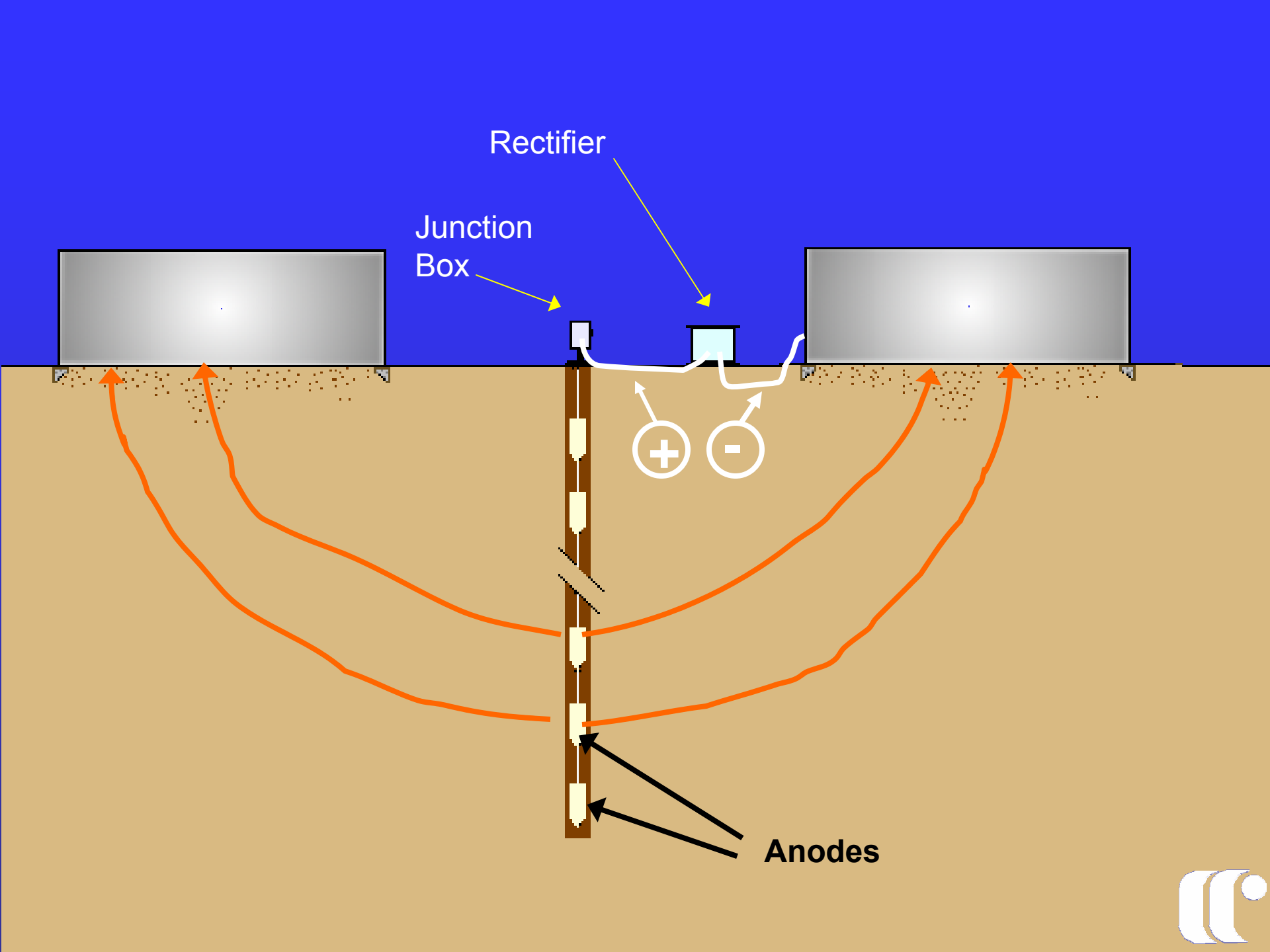
RECTIFIER

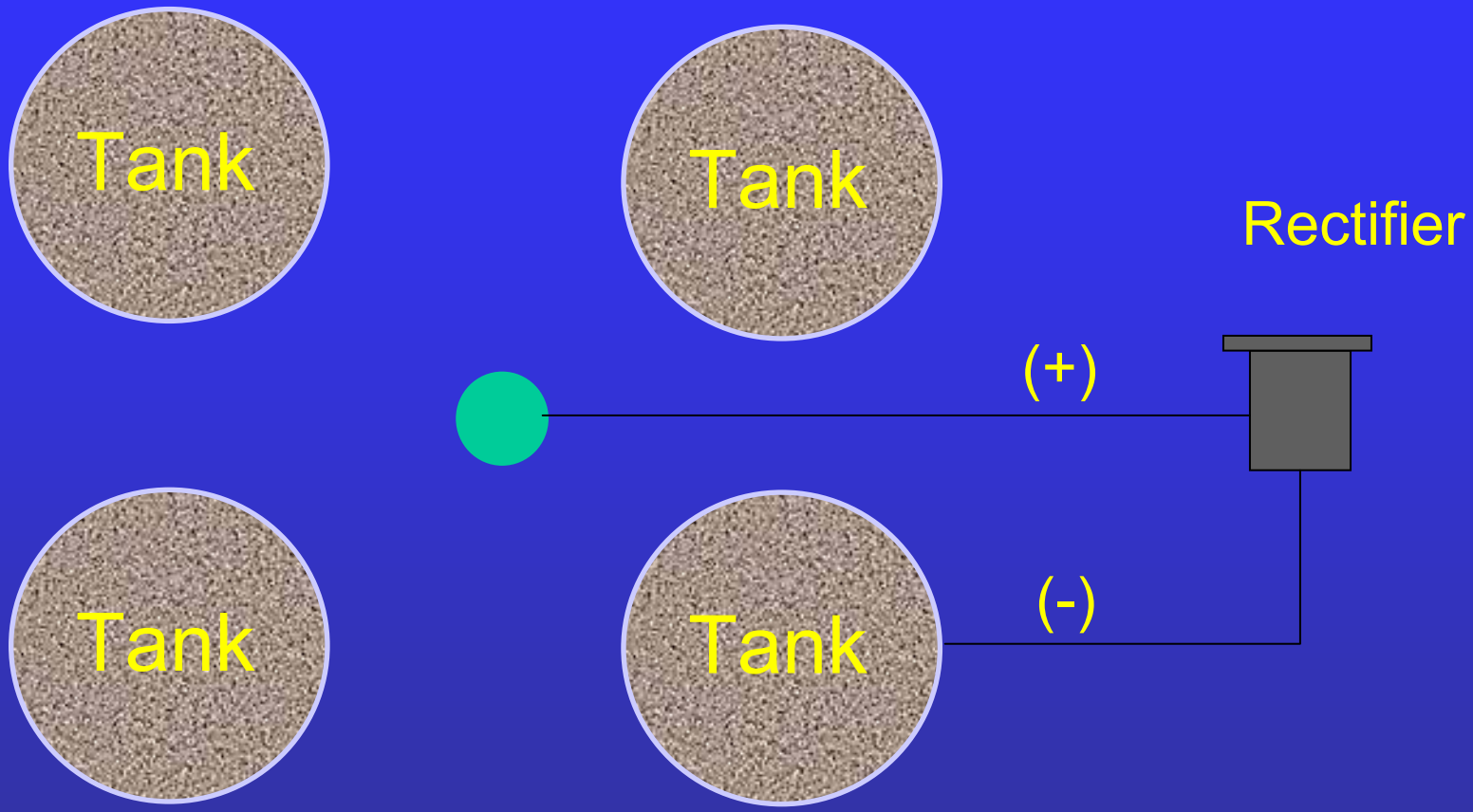
ANODE
JUNCTION BOX

Deep Anode System

“One or more anodes installed vertically at a depth of 50 feet or more below grade, in a drilled hole, for the purpose of supplying cathodic protection…”

NACE International Definition


Rectifier
Junction
Box
+
-
Anodes



Deep Anode

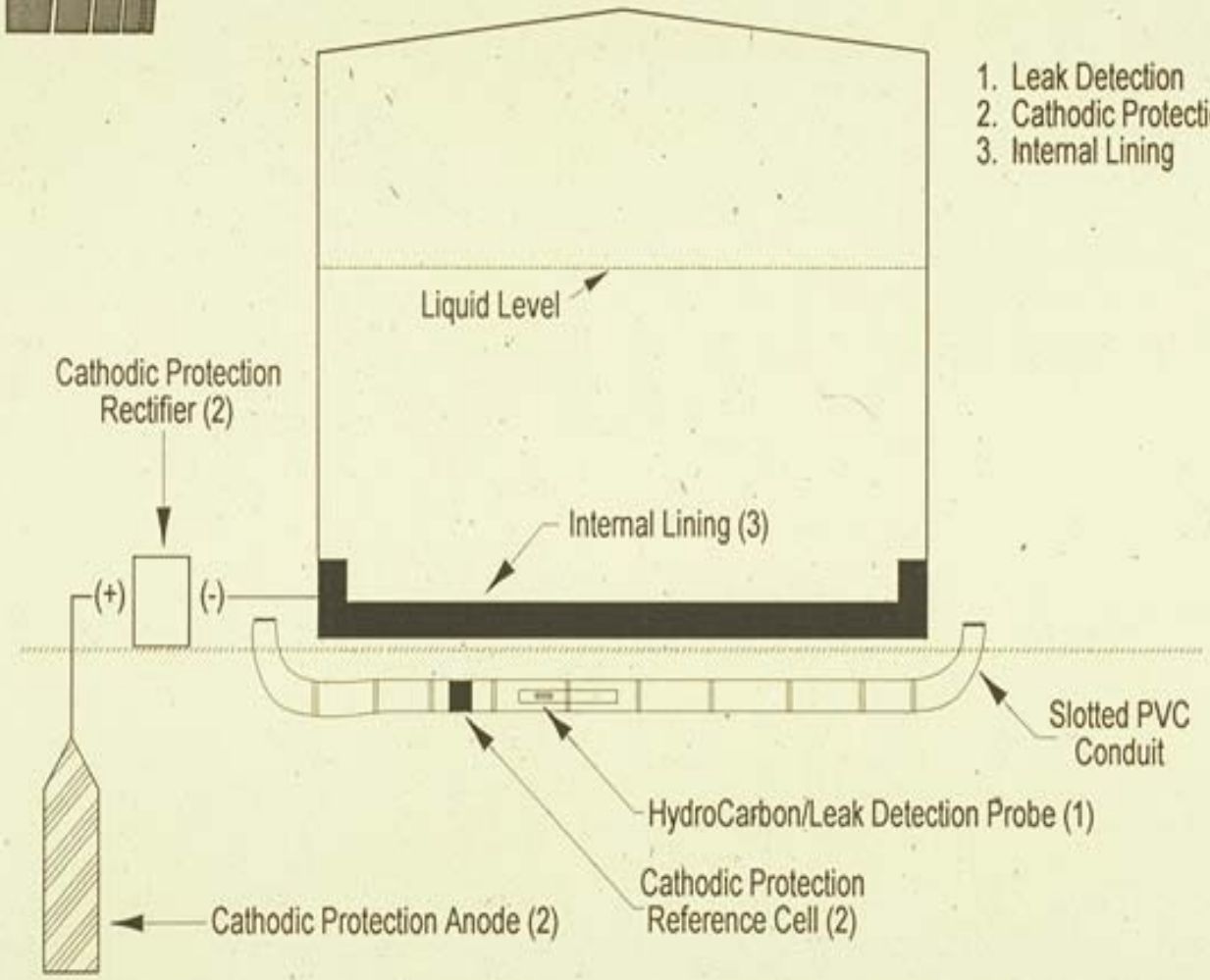
Deep Anode System Advantages

- Better distribution of protective current
- Smaller right-of-way requirements
- Easily installed in congested areas

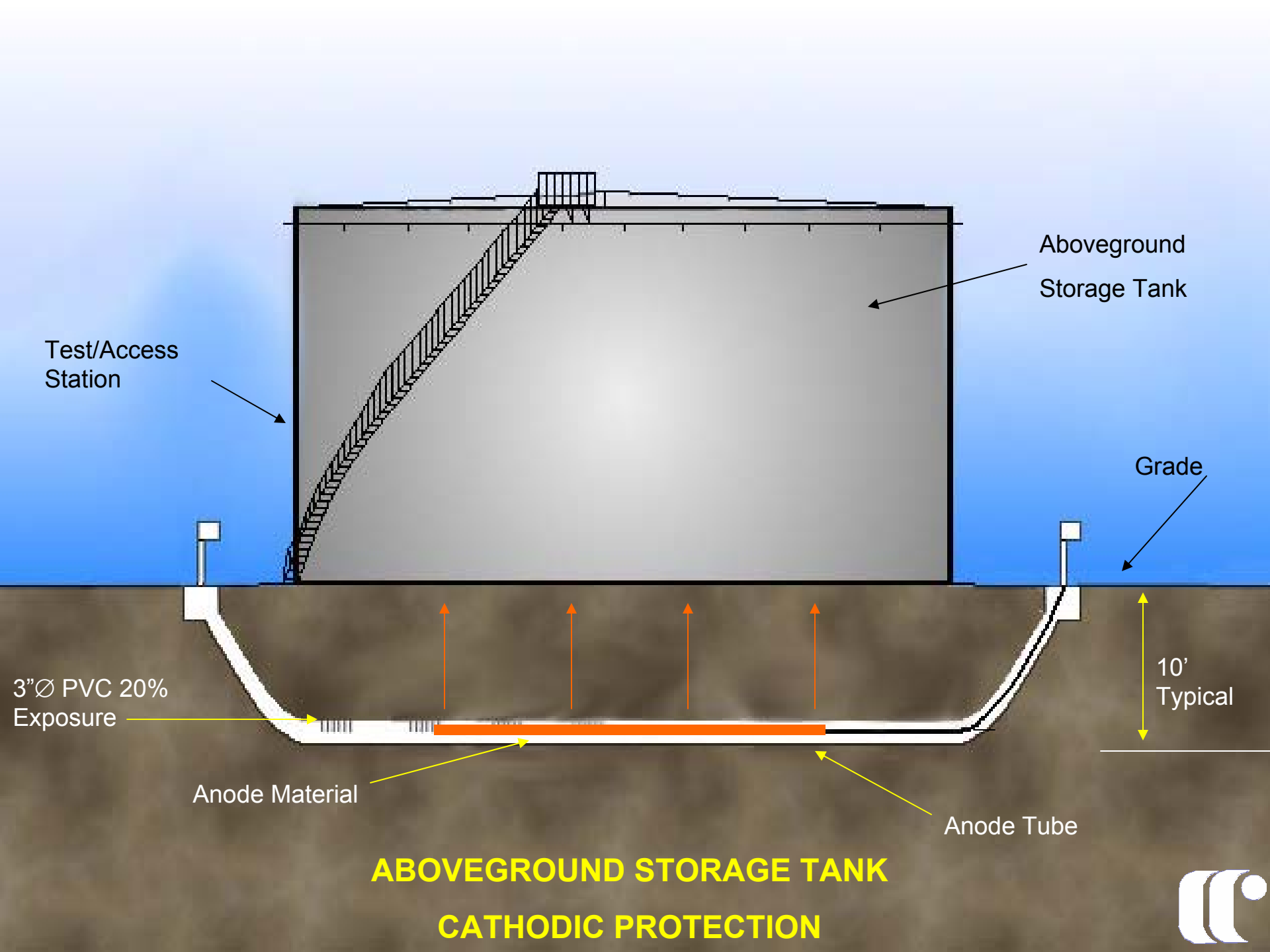
Conventional Deep Anode System Disadvantages

- Premature system failure
- Costly re-drilling at failure
- Potential for cross mixing of subsurface aquifers
- Creates conduit for surface spills

1999 REQUIREMENTS FOR ASTs

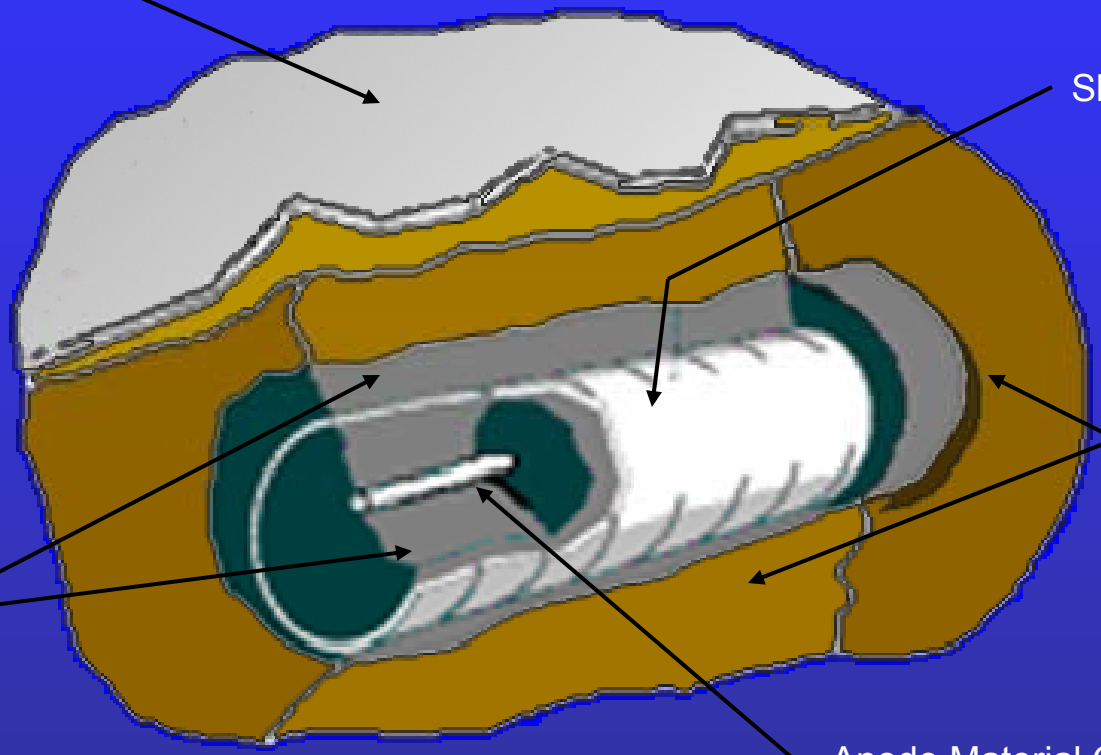


Directional Boring Under Existing AST



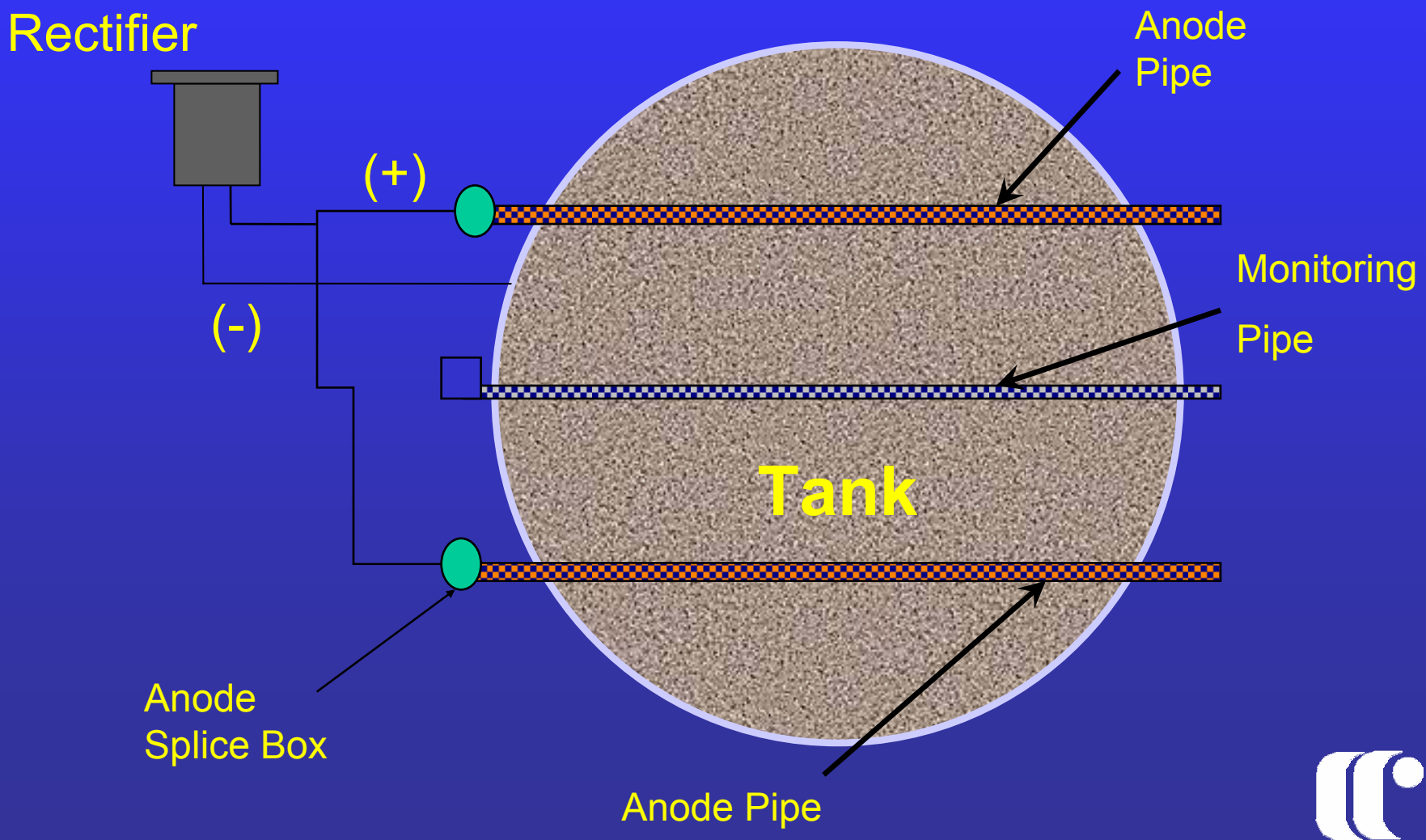
ABOVEGROUND STORAGE TANK CATHODIC PROTECTION

TYPICAL ANODE INSTALLATION



Cathodic Protection Monitoring

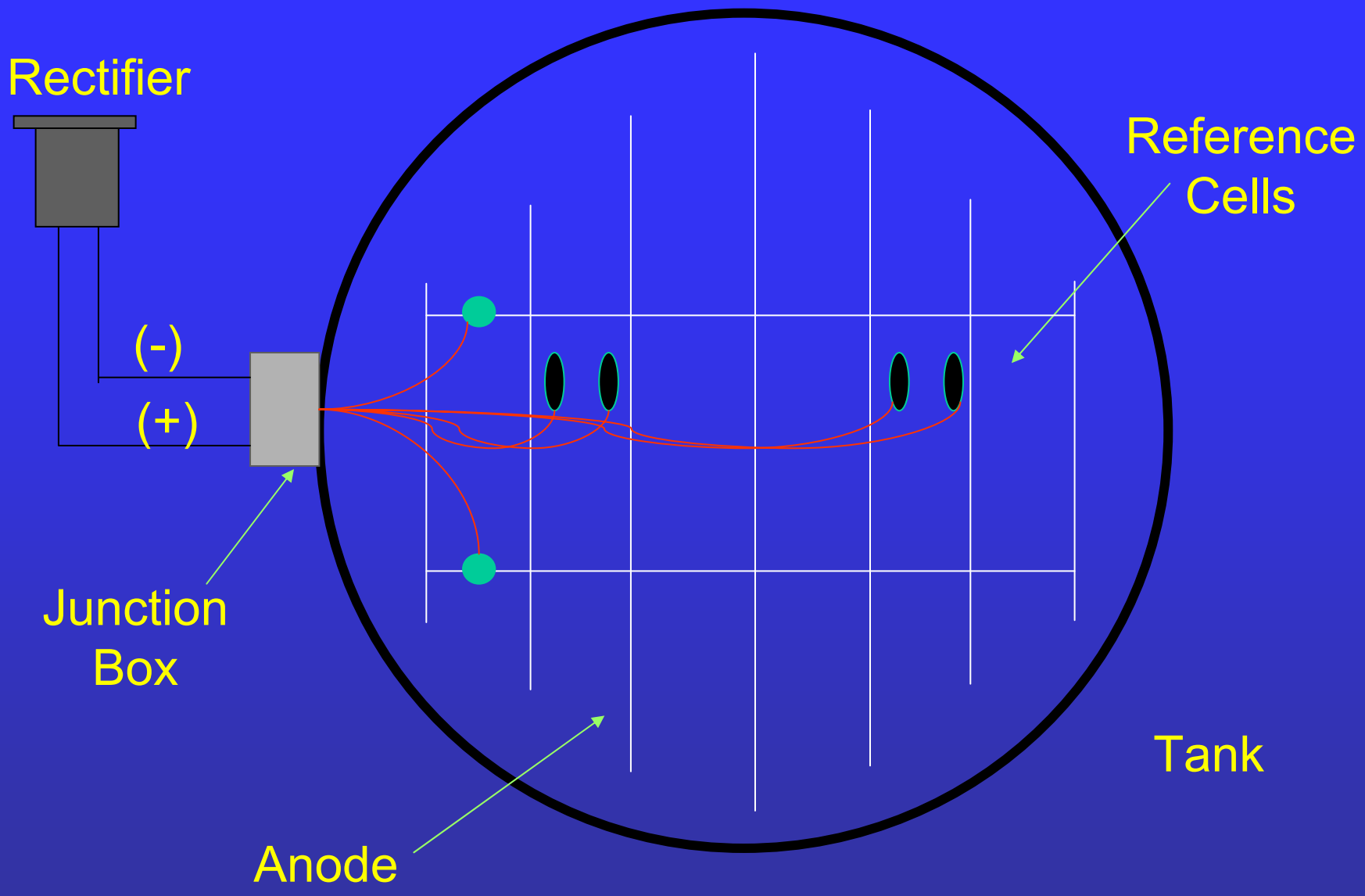
Computer Guided Horizontally Bored Anode System



Leak Detection Monitoring Station

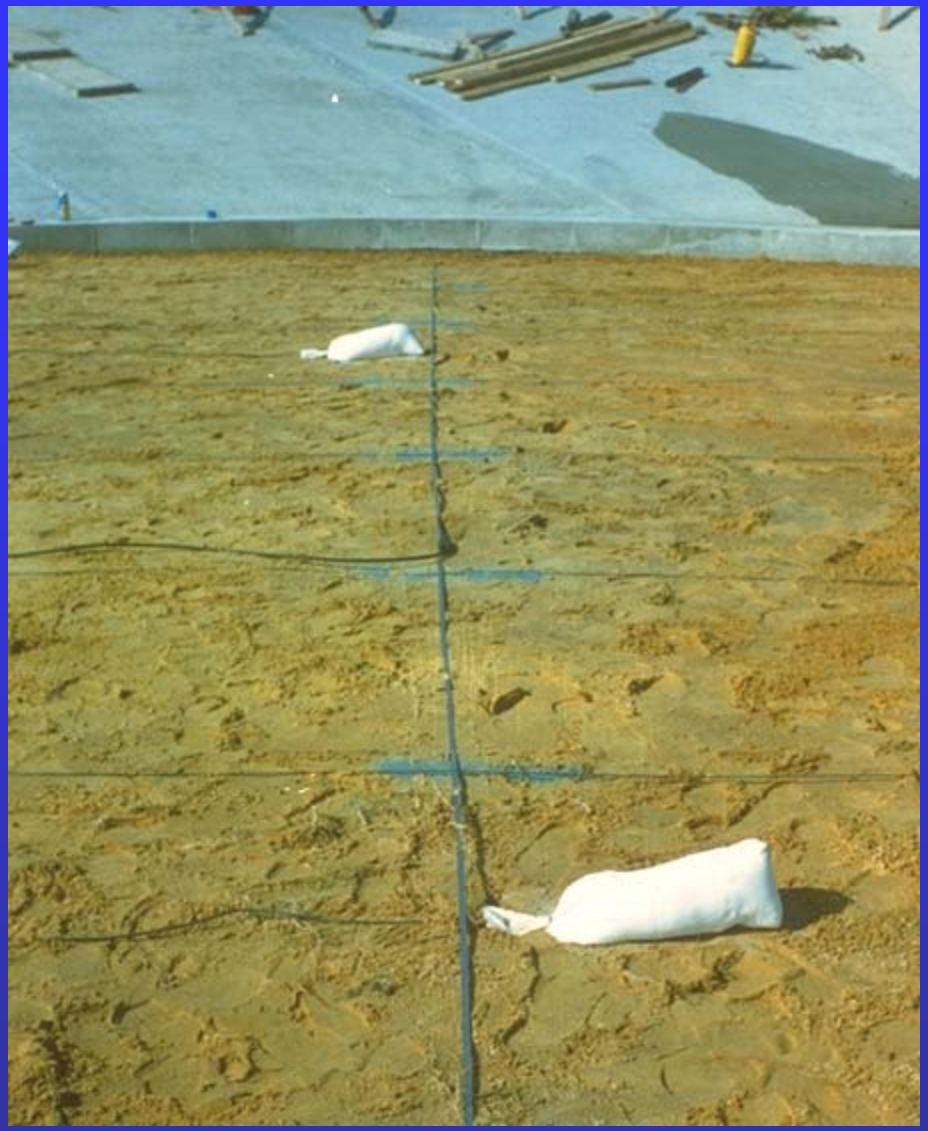
CP Applications for Re-bottomed or New Tanks

New Floor Installation on Existing AST



Impressed Current

CP Installation on Rebottomed Tank



Titanium Anode Ribbon and Reference Cells

Above Ground

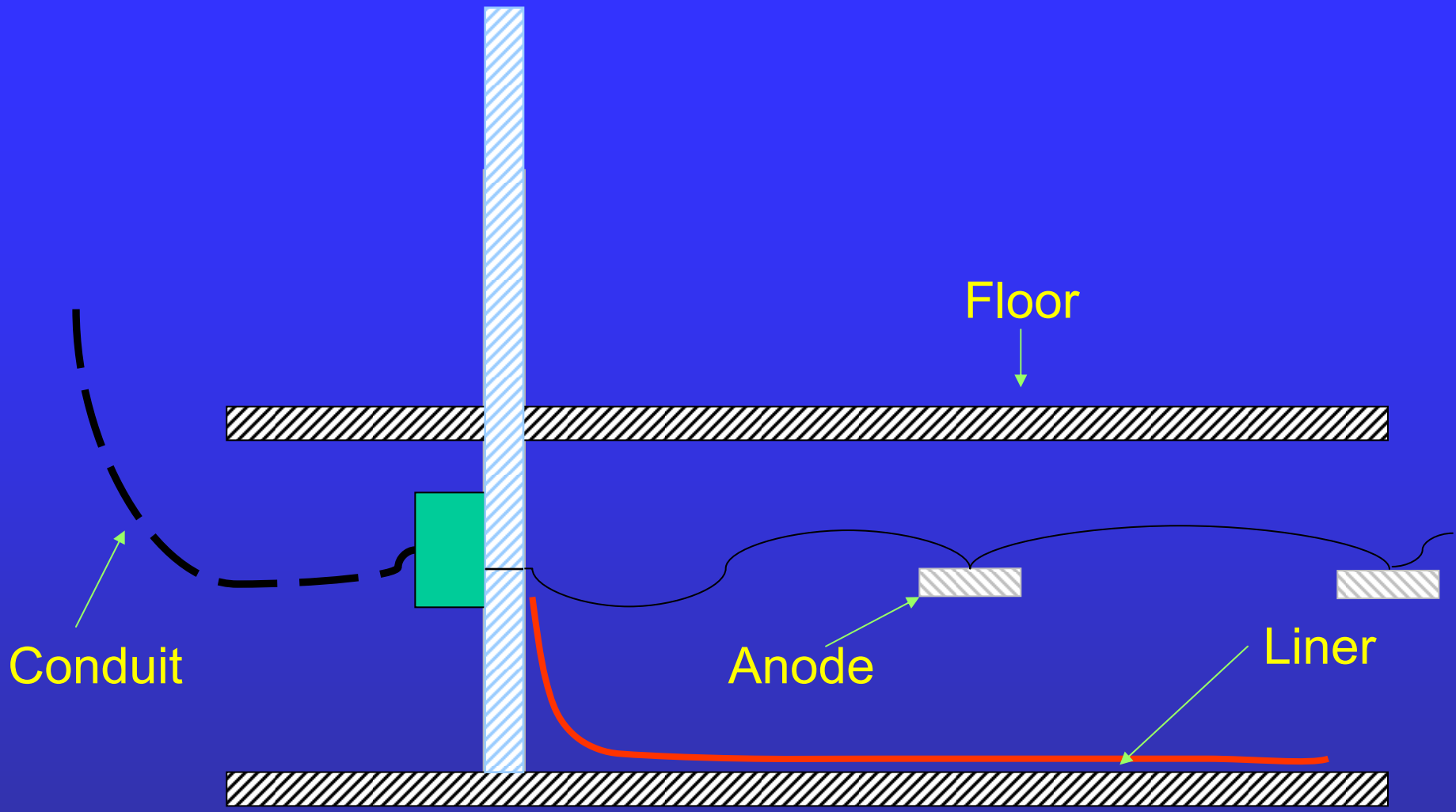
Storage Tank Bottoms

with Secondary Containment

Secondary Containment

- Environmental Protection
- Minimize Liability
- State and Local Regulations


New Tank Construction with Liner



CP Installation on Double Bottom Tank


Anode & Reference Cell Placement
in High Resistance Sand

Ringwall Conduit for CP Wiring

Floor Plate Installation


Air Bag Lift


Existing Sand Bed

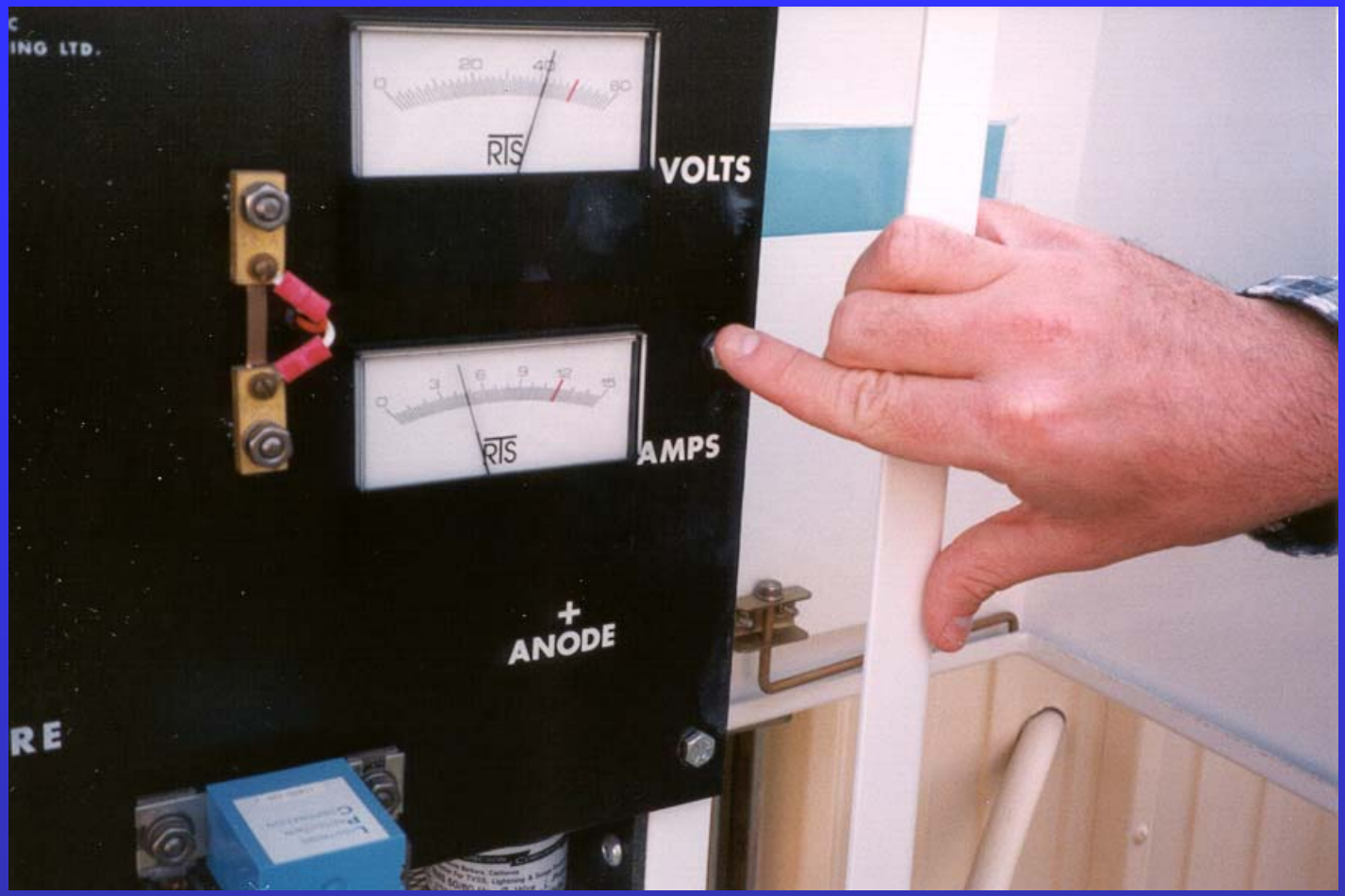
Install Containment Liner

Installation of CP System on Lifted AST

Cathodic Protection Monitoring

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

Inspection of CP System



- Record Volts/Amps
- Compare values to target settings

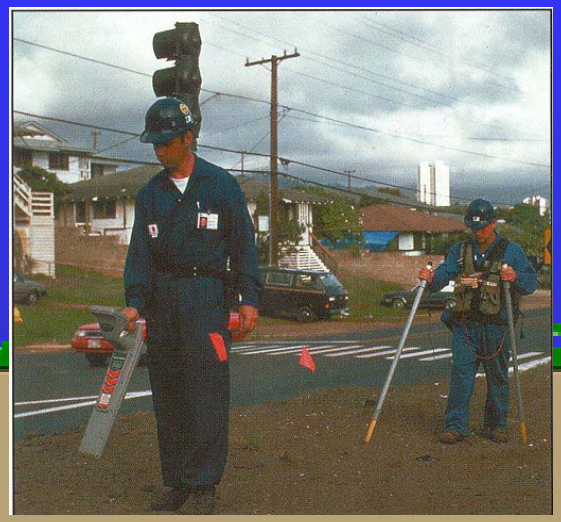
Qualifications
of the corrosion engineer

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

Remote Monitoring of CP

Test Station

Computerized Potential Logging Survey



Test Station

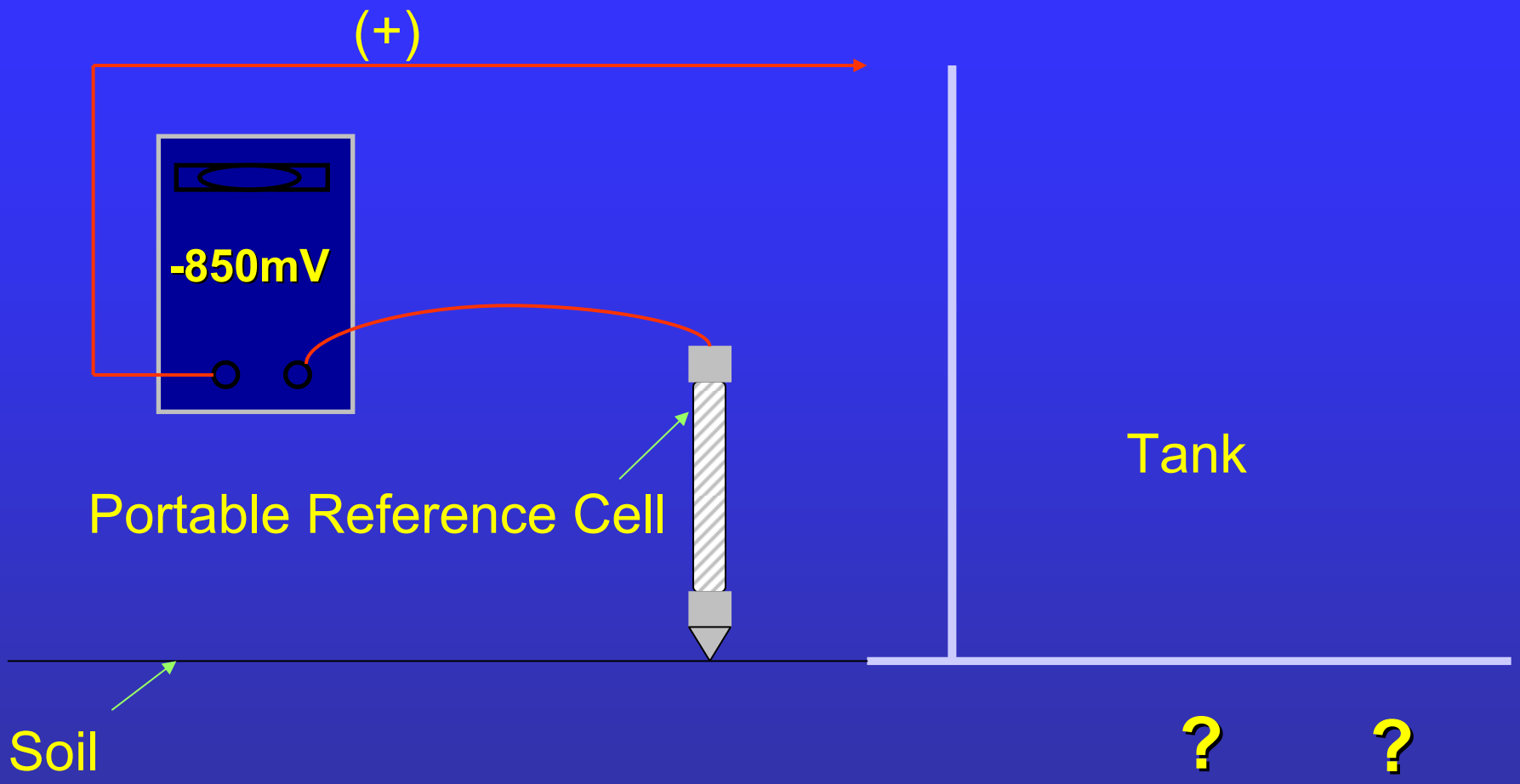
Backpack Computer Unit

Chainer/Wire Dispenser & Counter

Reference Cells

Pipeline

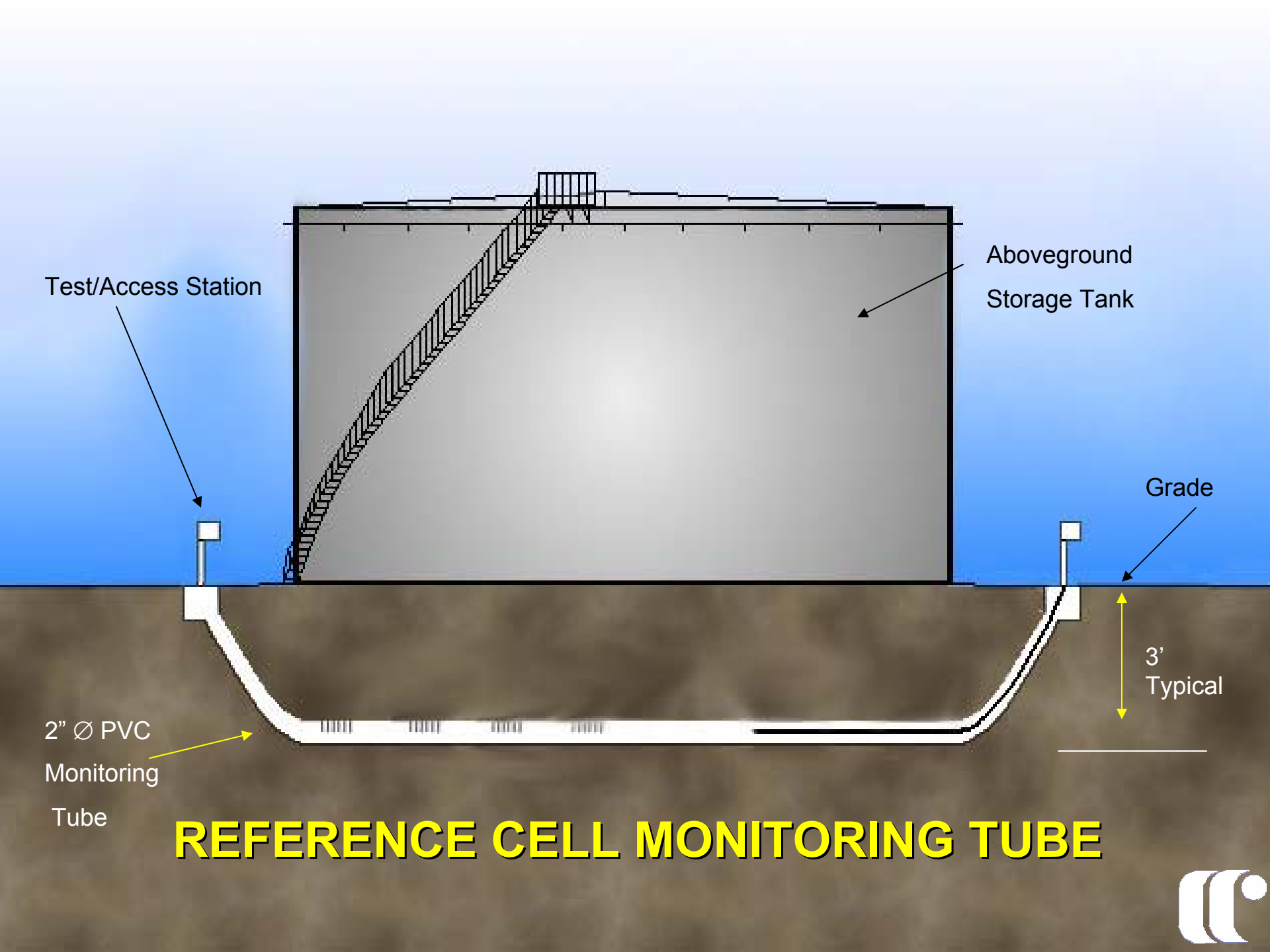
MFL Floor Inspection



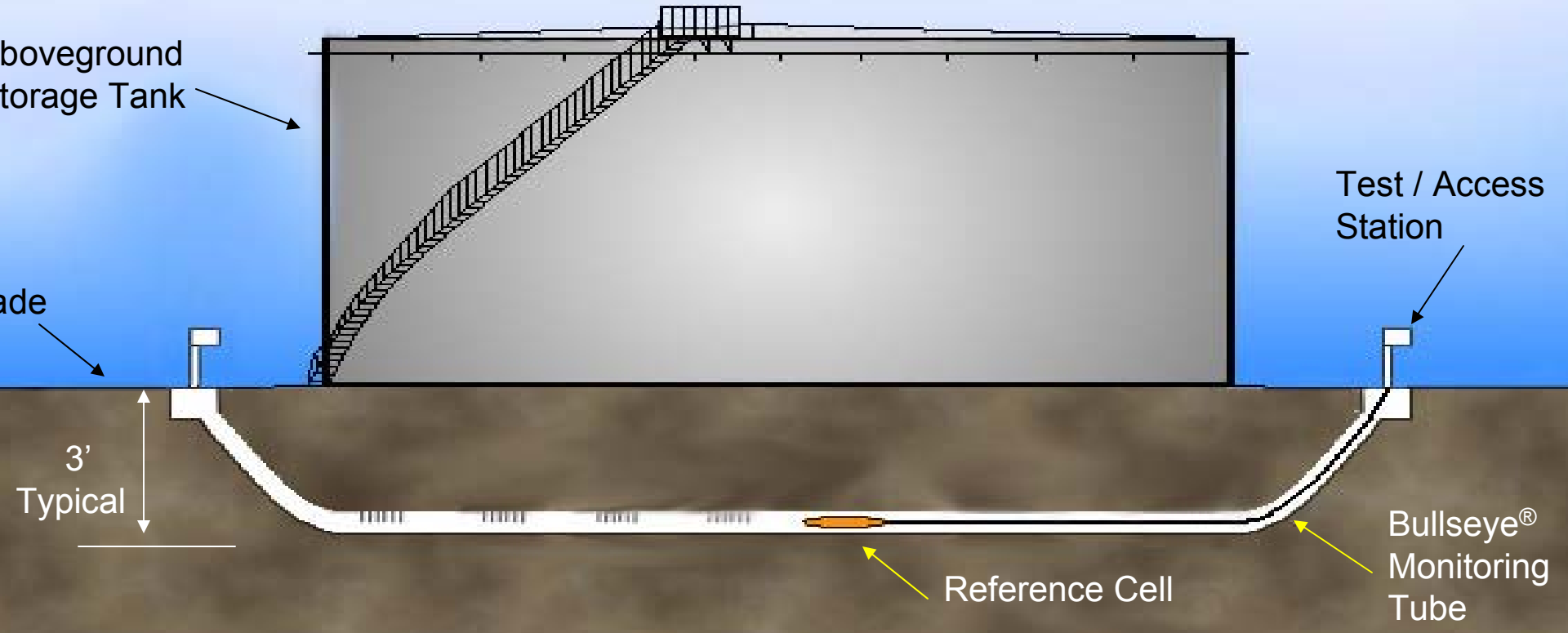
Rim Potential Measurements

Tank to Soil Potential Measurements

Annual Cathodic Protection Survey



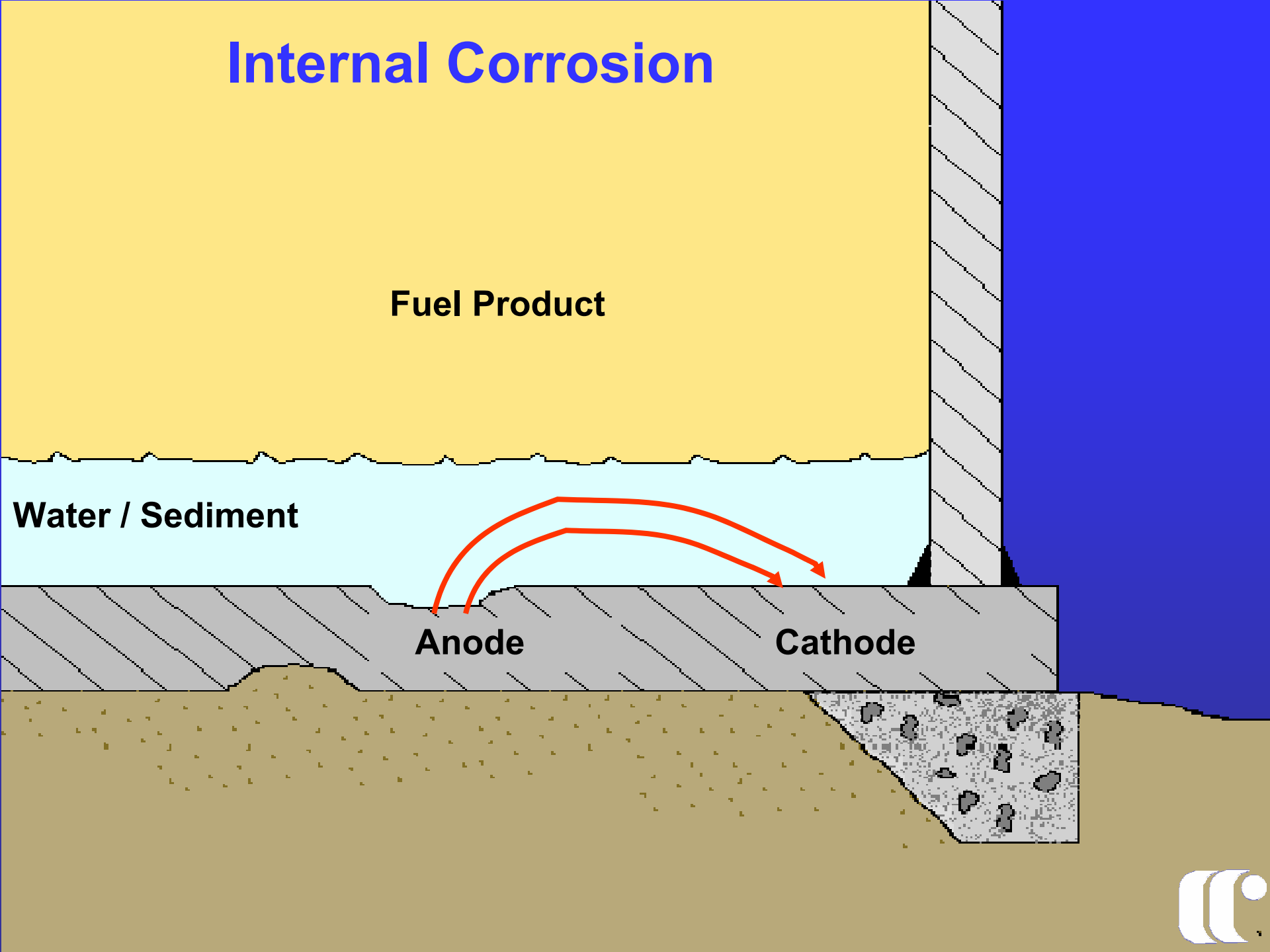
REFERENCE CELL MONITORING TUBE



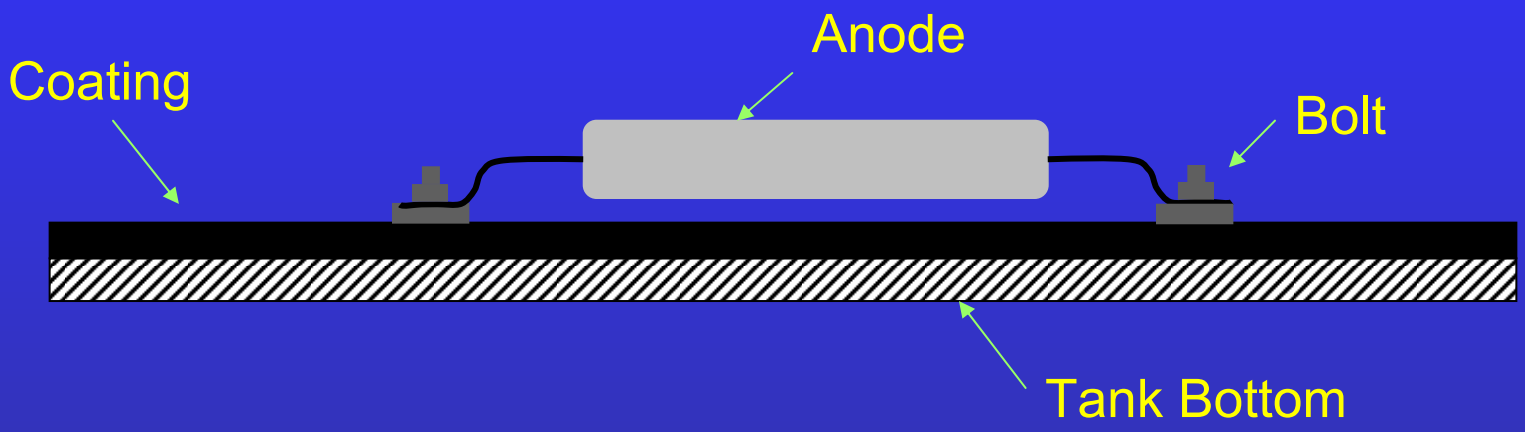
	Rim	25'	Center	55'	Rim
On	-1411	-698	-404	-601	-1455
Off	-902	-664	-402	-578	-911

Potentials (mV)

Internal Corrosion



Internal Corrosion


Anode
Coating
Bolt
Tank Bottom

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

Cathodic Protection Design Considerations

- Safety
- Codes
- Economics
- Performance
- System Life
- Interference
- Monitoring & maintenance
- Governmental Regulations

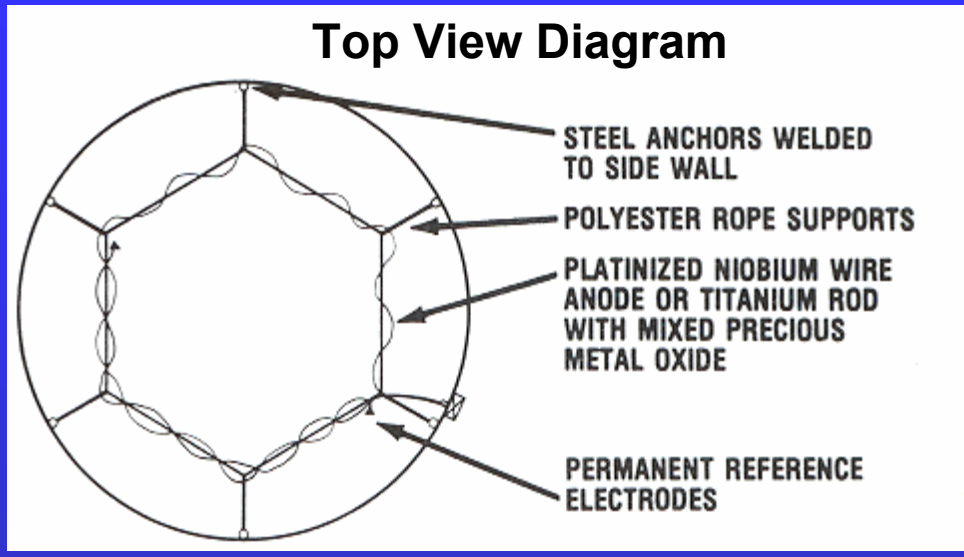
Hot Asphalt Tank Bottoms

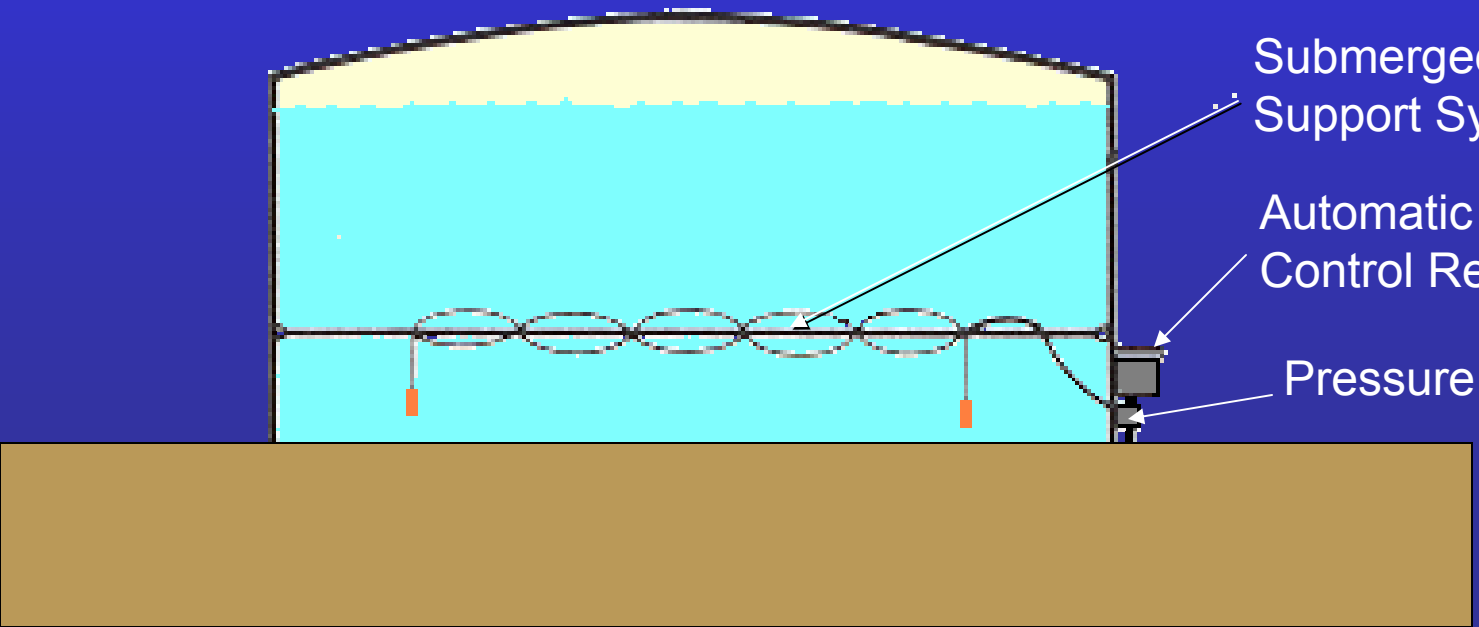
- **Linings**
  - Must be compatible with with product stored
  - Must maintain properties at operating temperatures
  - Must be applied to properly prepared surface
  - Must be applied with strict inspection

Ductile Iron Water Piping

Pitting (concentrated) corrosion attack on ductile iron pipe.

Suspended Horizontal Anode System





Cathodic Protection Design Considerations

- Safety
- Codes
- Economics
- Performance
- System Life
- Monitoring & Maintenance
- Governmental Regulations

Recommended Practices

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

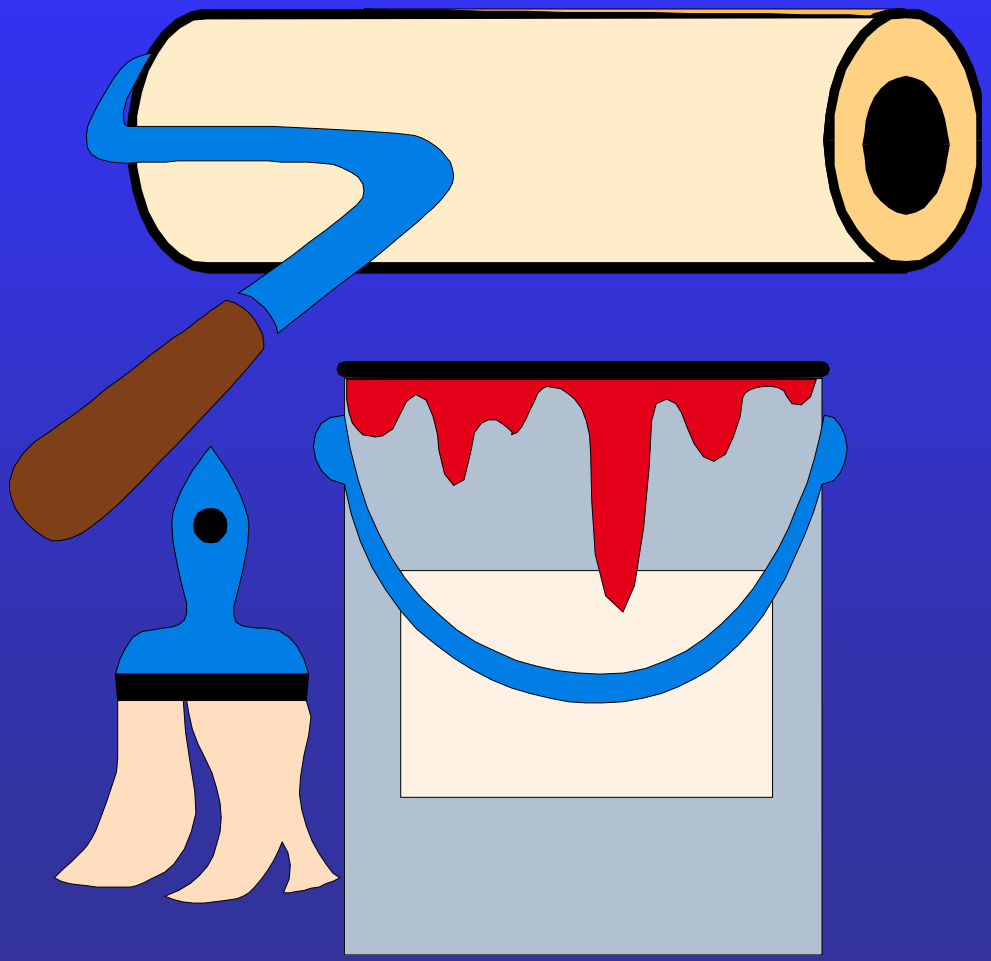
NACE RP0193-2001 - External Cathodic Protection of On-Grade Carbon Steel Tank Bottoms:

Application Makes the Difference

Good Job

Poor Job

Proper Application

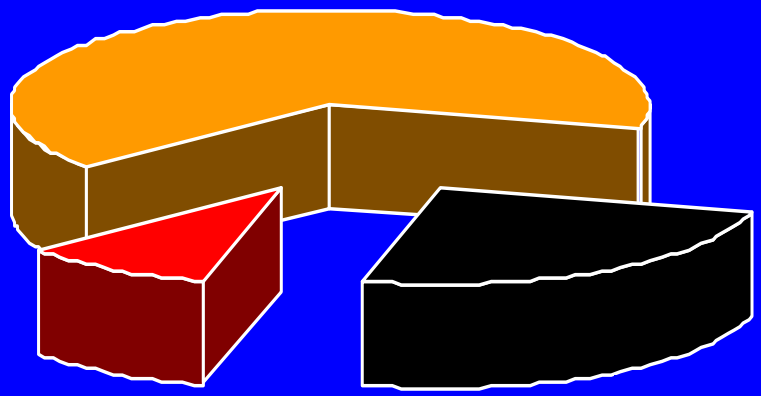


Application is the most expensive and most important part of the job…give it the attention it deserves!

Cost Breakdown

Typical Coating Project

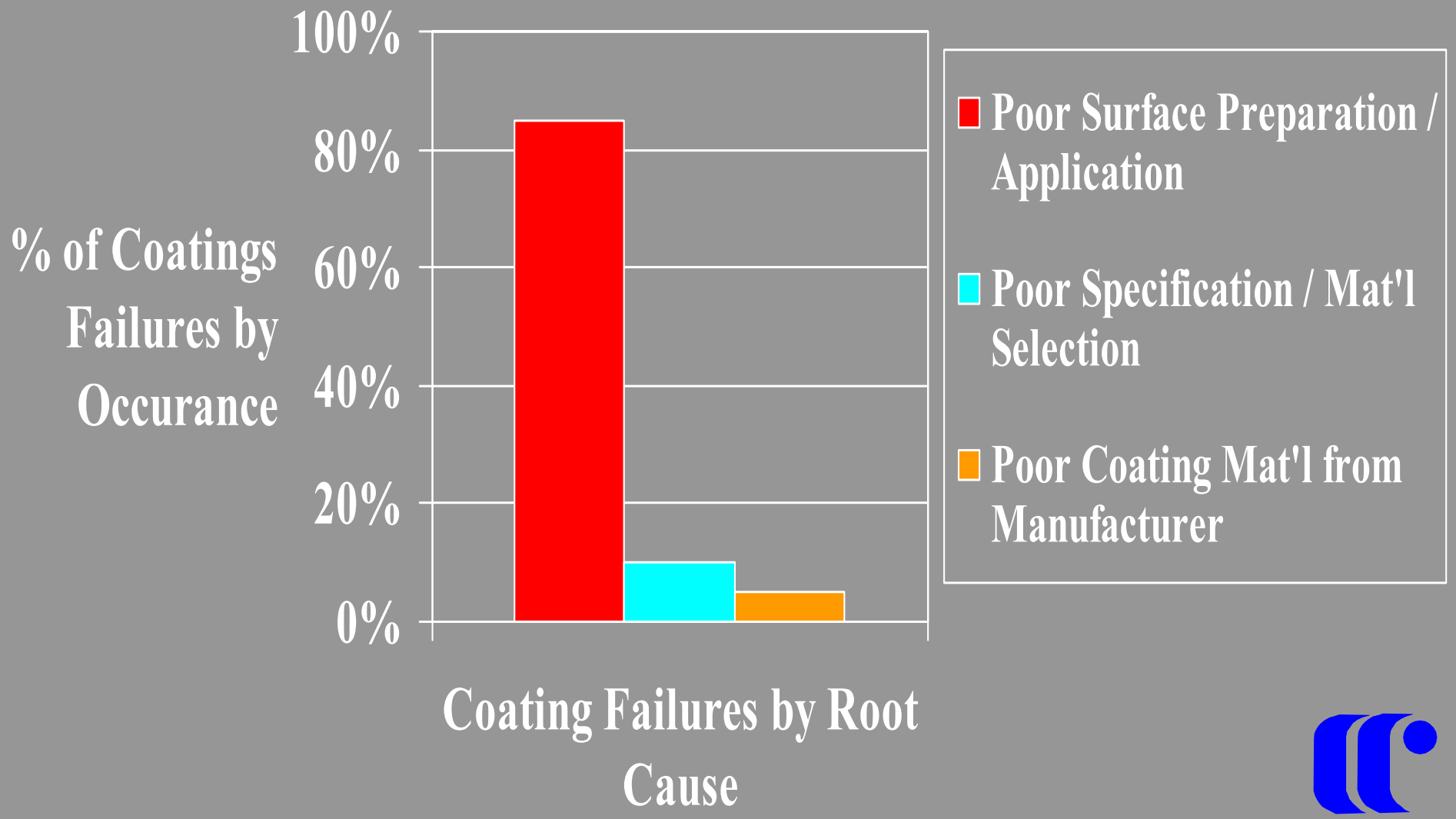
Surface Preparation 65%



Material 10%

Application 25%

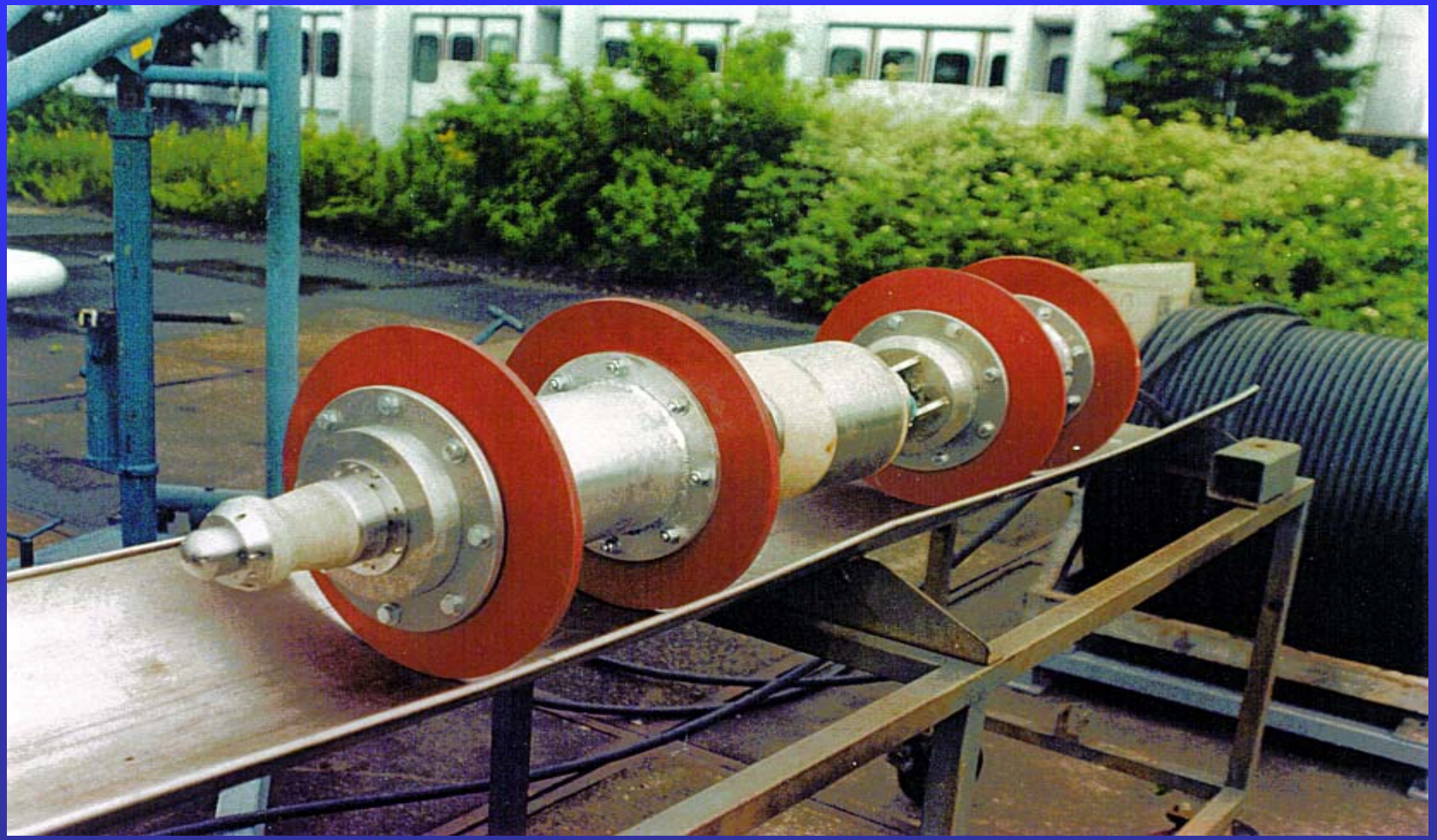
Approximate Percentage of Coating Failure
Occurrences, Grouped by Root Cause



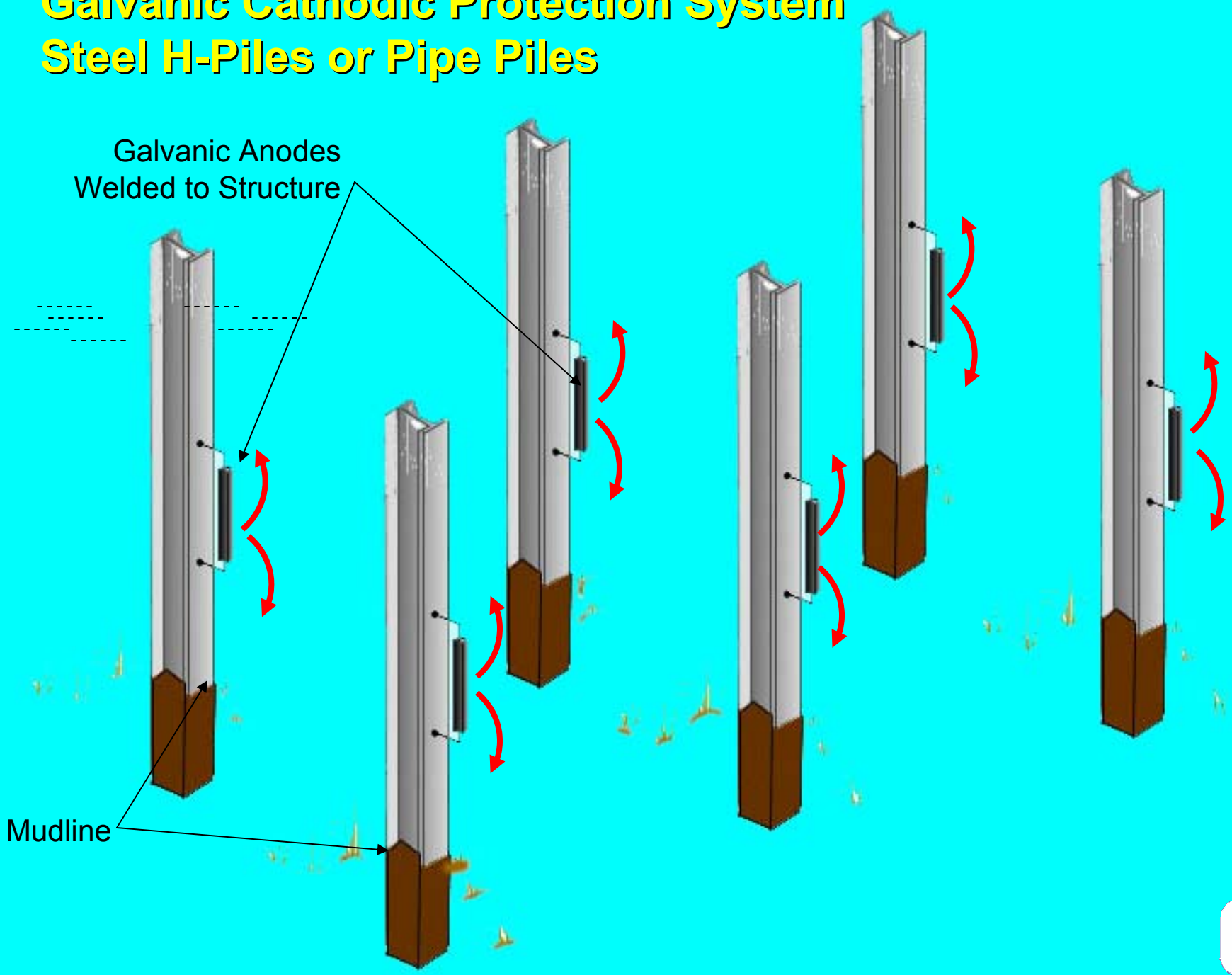
Coating Inspection

Pipeline Integrity Inspections

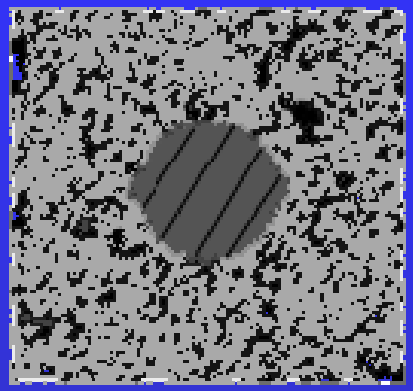
Pipeline Inspection Tool

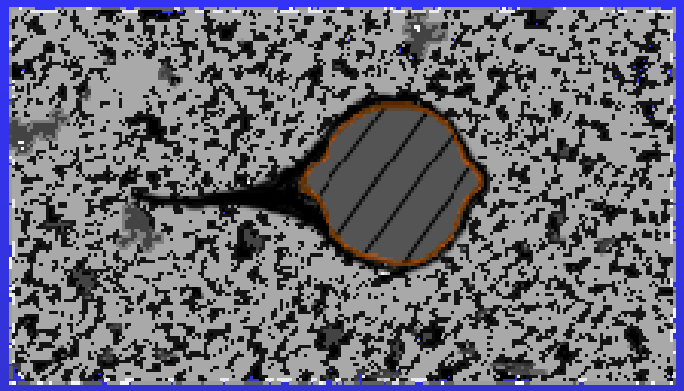


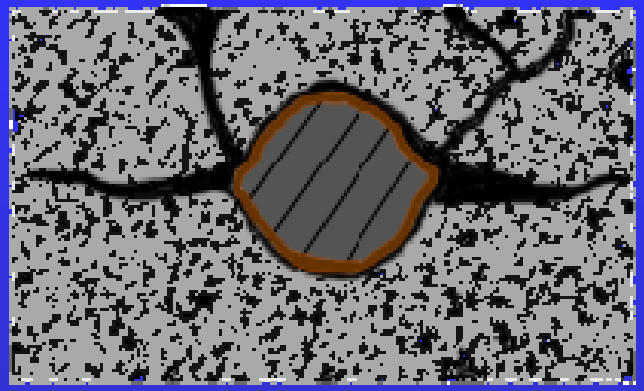
Galvanic Cathodic Protection System
Steel H-Piles or Pipe Piles



Corrosion Induced Cracking of the Concrete







- Carbonation
- Chloride Contamination

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

James T Lary
Corrpro Companies, Inc.
1090 Enterprise Drive
Medina, Ohio 44256
330-723-5082 (215)
email jlary@corrpro.com

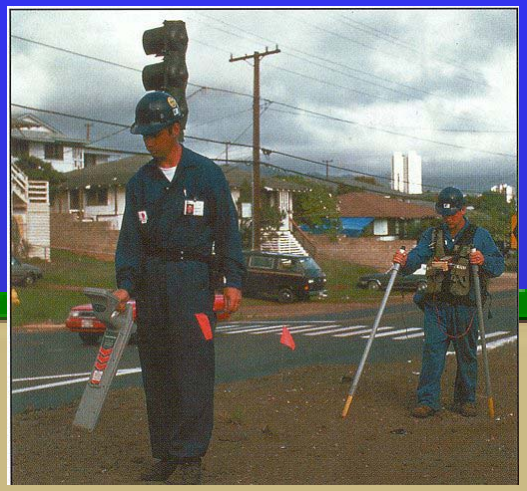
Arc-Sprayed Al-Zn-In (Galvanic)

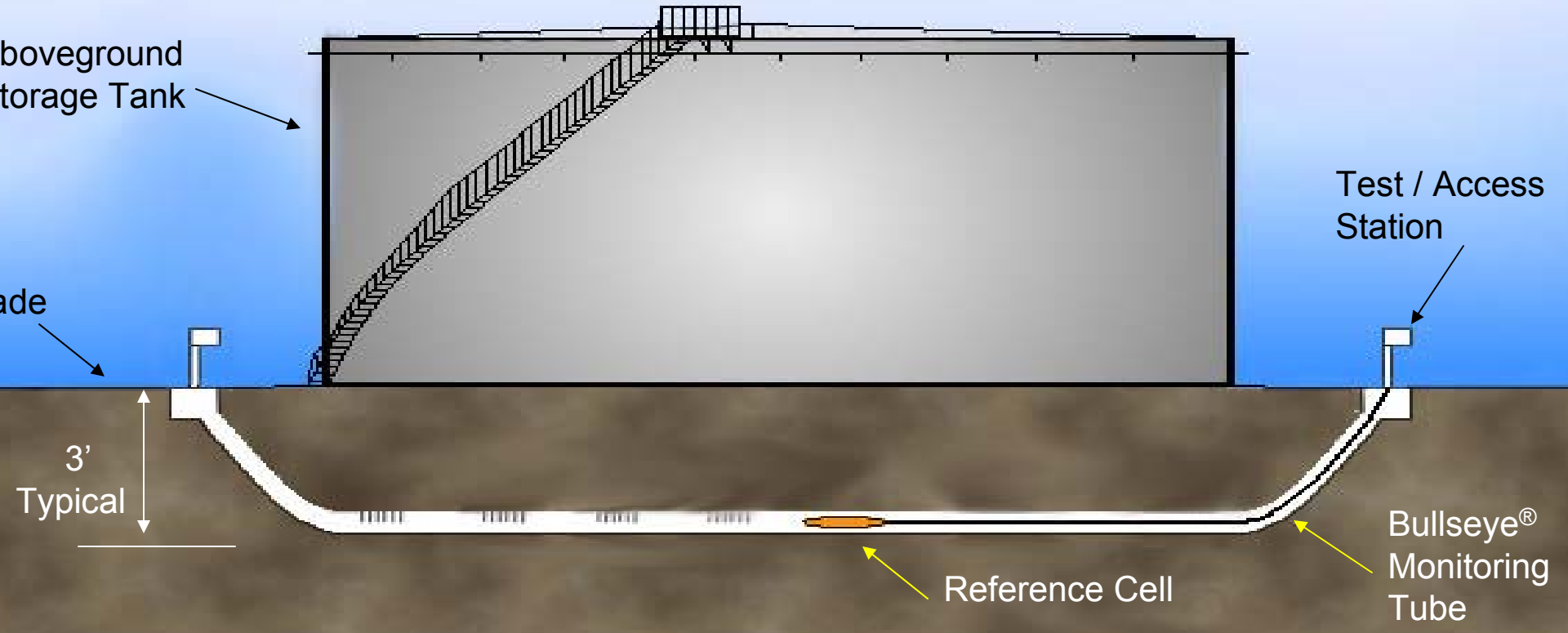
- Thermally sprayed onto concrete
- Al-20Zn-0.2In
- Applicable in marine & northern deicing salt environments
- Indium (In) used as activating agent

Presented by:

James T. Lary
Corrpro Companies, Inc.
World Headquarters
1090 Enterprise Drive
Medina, Ohio 44256
Phone: 330-723-5082
Fax: 330-723-0694
Email jlary@corrpro.com

Computerized Potential Logging Survey

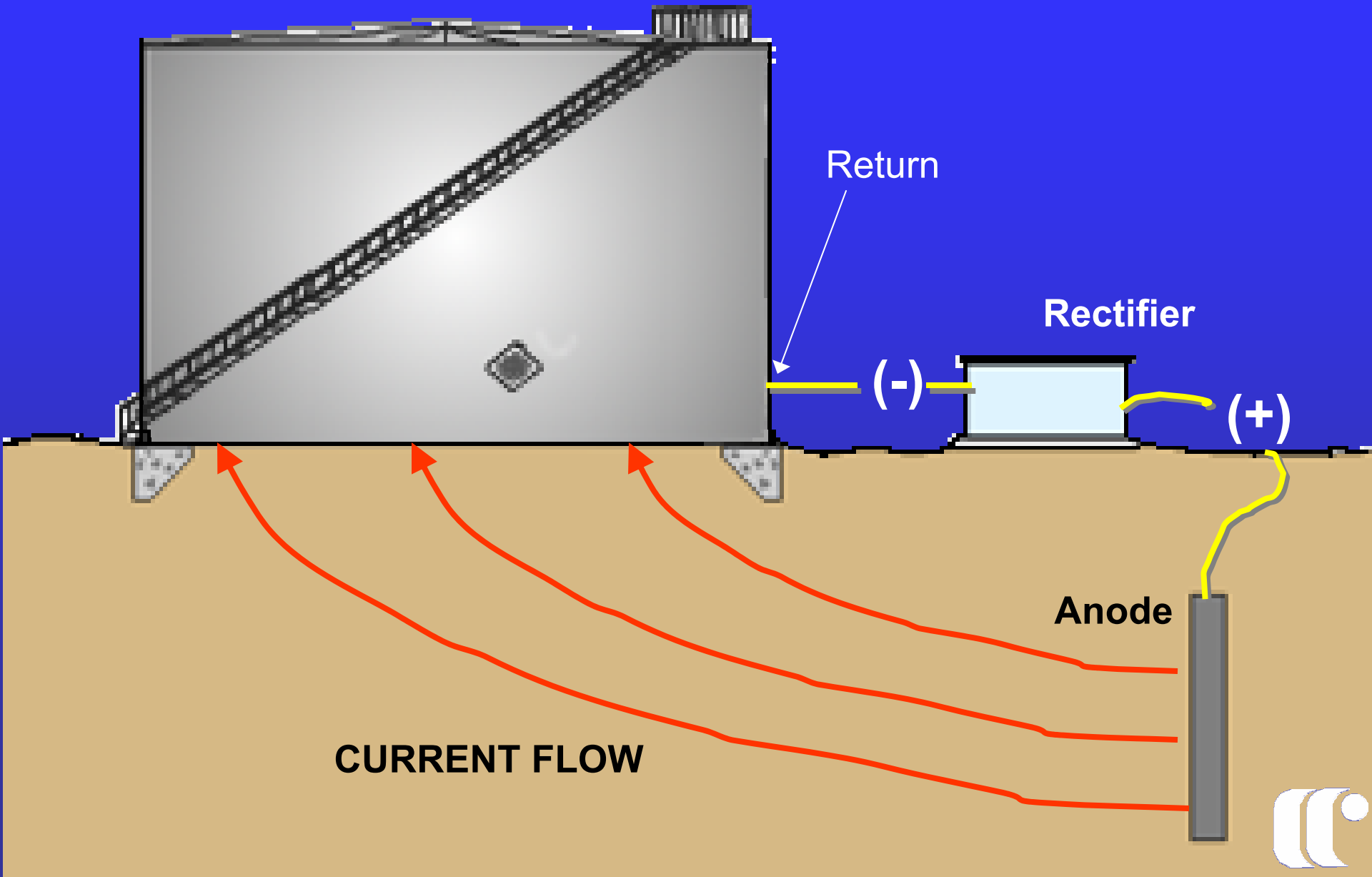




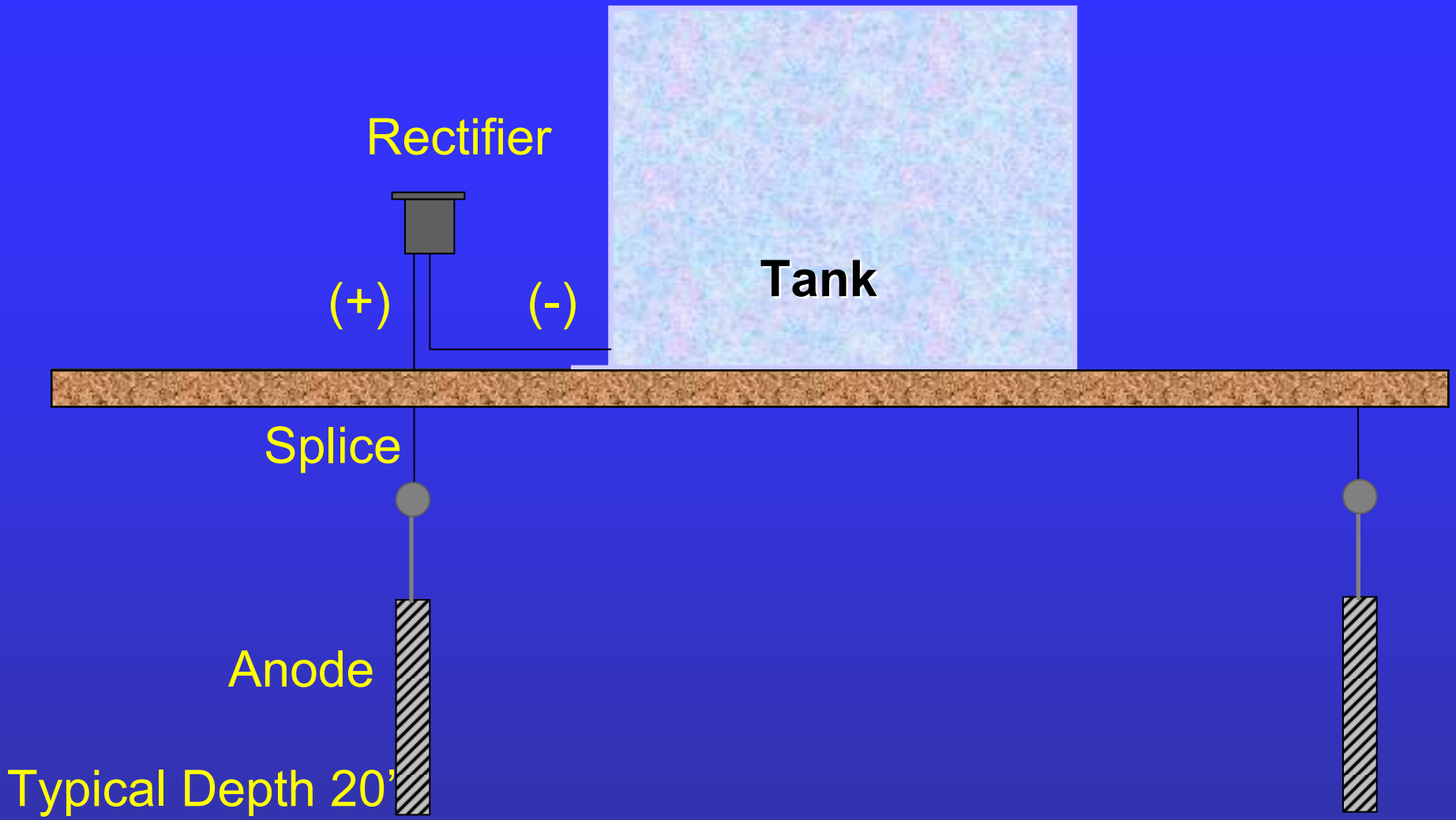
	Rim	25'	Center	55'	Rim
On	-1411	-698	-404	-601	-1455
Off	-902	-664	-402	-578	-911

Potentials (mV)

Impressed Current Cathodic Protection

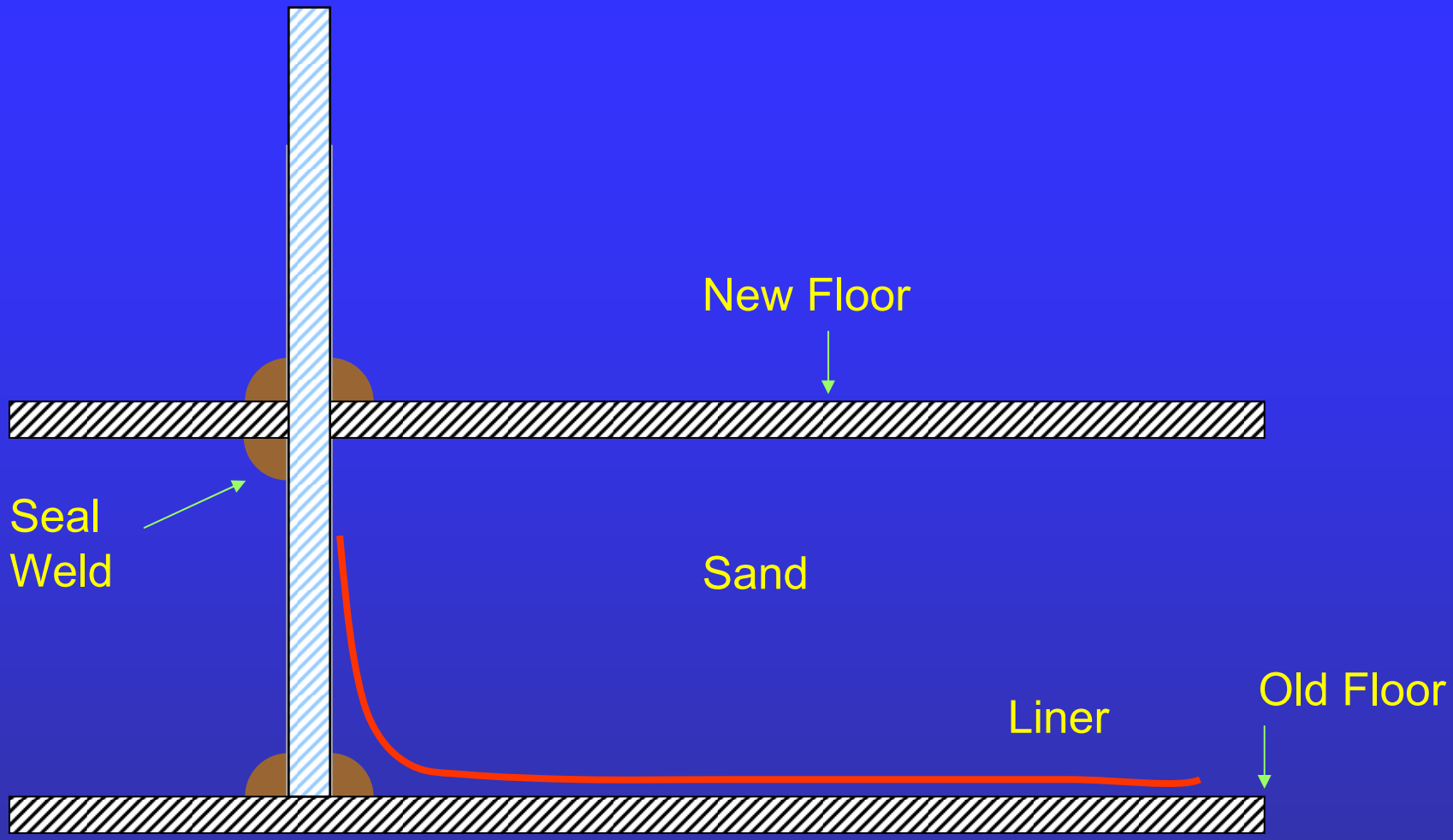


Annual Cathodic Protection Survey



Shallow Anodes


PRE-ENGINEERED
PROVEN PROTECTION
stiP3
DO NOT DISCONNECT
ANODE LEAD WIRE



Double Bottom Seal

Pennsylvania DEP Summary of Technical Requirements for Aboveground Storage Tanks, Chapter 245, Subchapter F, Effective October 11, 1997…

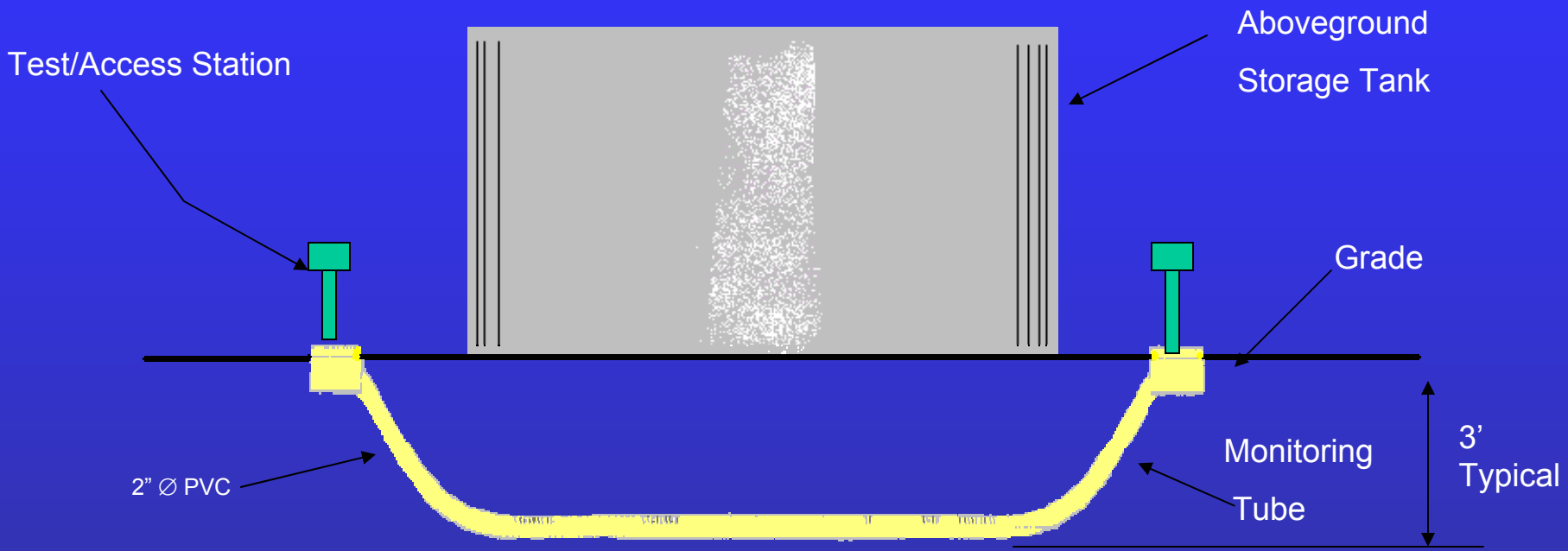
Cathodic Protection Systems (§245.532)

- "When corrosion prevention is required on new, reconstructed or relocated tanks, or on tank bottom replacement, the cathodic protection system must be either: sacrificial anodes and dielectrical coating, or impressed current. (Another method s acceptable if it is recognized in a code of practice, such as API 651, or by a nationally-recognized association, such as NACE.)"

Conventional Deep Anode System Disadvantages

- Premature system failure
- Costly re-drilling at failure
- Potential for cross mixing of subsurface aquifers
- Creates conduit for surface spills

API 653 Floor Scan

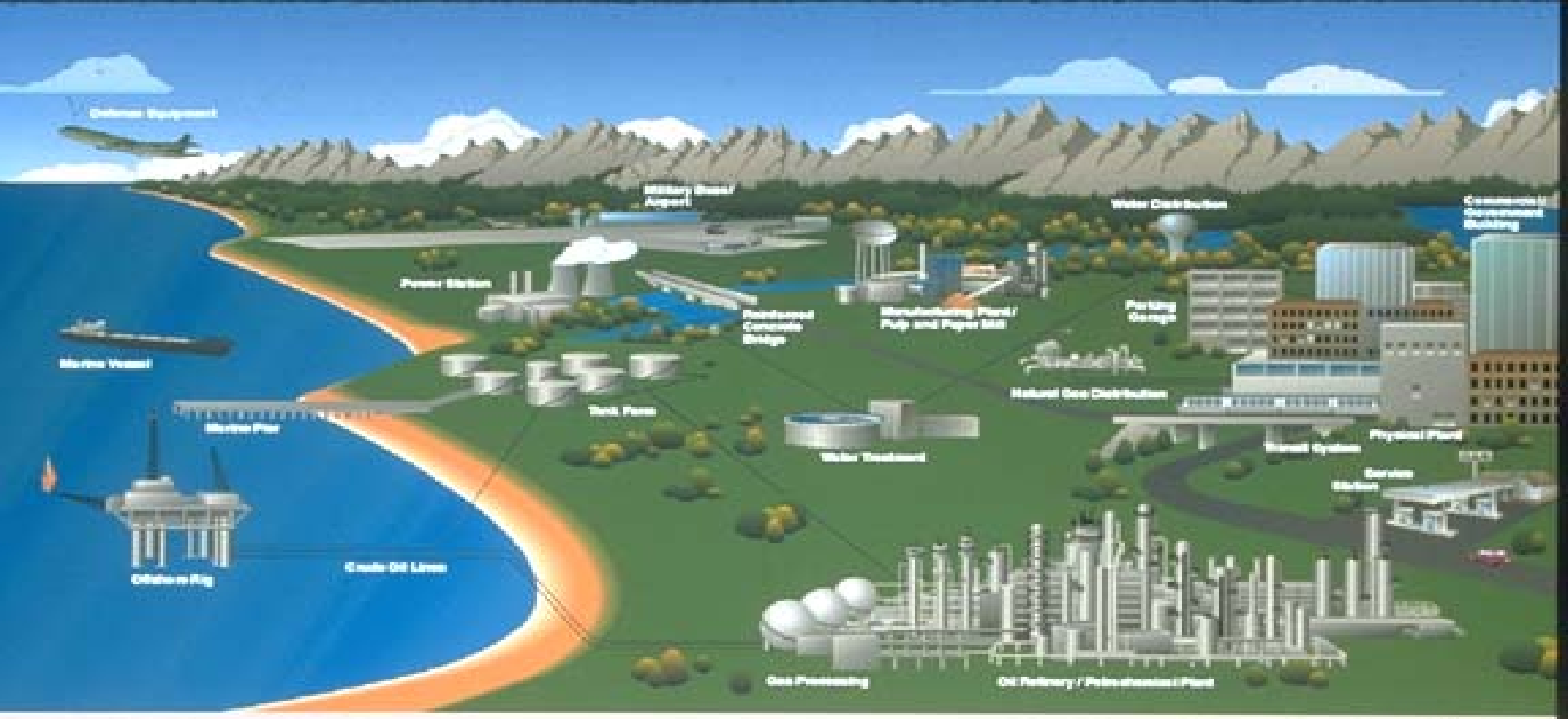


CATHODIC PROTECTION / LEAK DETECTION
MONITORING TUBE

Our Business

Engineering Design, Application & Installation of:

- Cathodic Protection
- Corrosion Monitoring
- Material Selection
- Chemical Treatment Systems
- Protective Coatings
- Pipeline Integrity Assurance Programs



Worldwide Corrosion Control Source

Corrpro Companies Incorporated

"A Commitment to Excellence"

Good-All Electric

CPS