"Give me a Break" Uncovering the Truth of Water Main Breaks

Presented By:
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Streamwood, IL 60107
Tel. 630-483-2500
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http://www.corrpro.com

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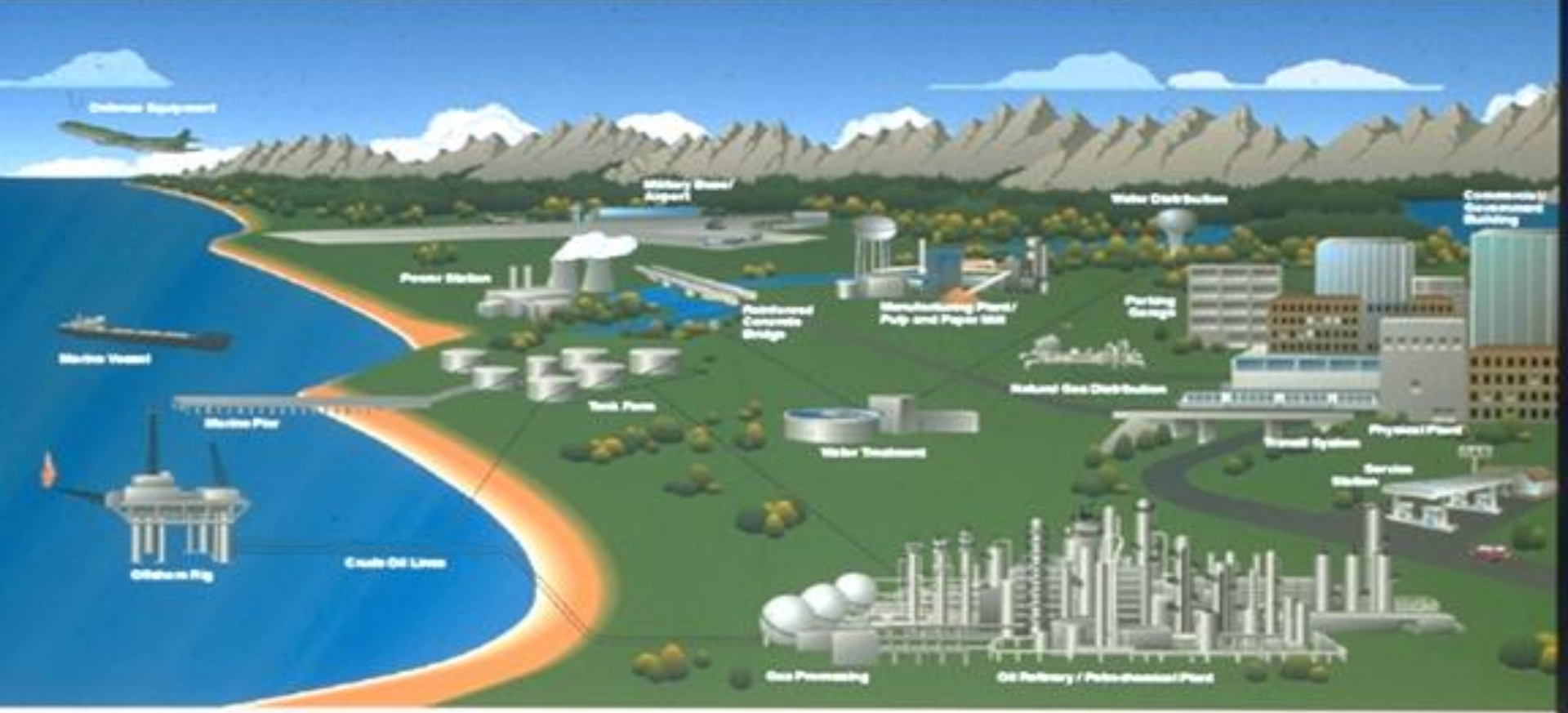


Worldwide Corrosion Control Source

Corrpro Companies Incorporated

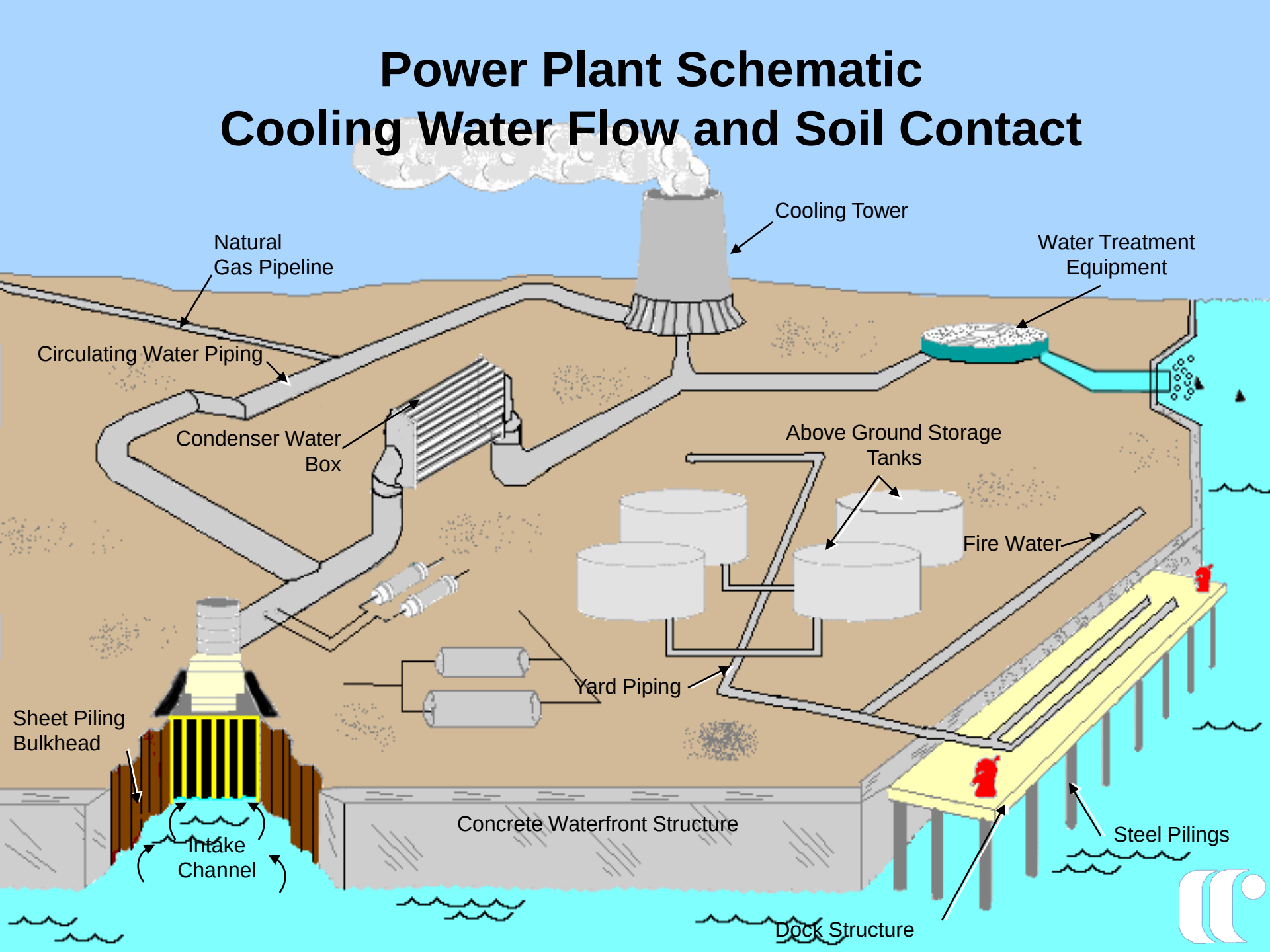
"A Commitment to Excellence"

GOOD-ALL ELECTRIC

Ocean City Research

CPS

Power Plant Schematic
Cooling Water Flow and Soil Contact



Diverse Markets / Applications

- Oil & Gas Industry
- Government Agencies
- Water Tanks
- Above & Underground Storage Tanks
- Water Transmission & Distribution
- Wastewater Treatment Equipment
- Electric Power Facilities
- Steel Reinforced Concrete Structures
- Mass Transit
- Petrochemical Complexes
- Offshore Rigs, Platforms & Pipelines
- Ships, Moving Vessels, Boats

Corrosion

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

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The estimated annual cost to repair water piping breaks in North America alone is estimated to be*:

$1.5 Billion

* based on 250,000 breaks at a repair cost of $5,875.00 U.S.D. each

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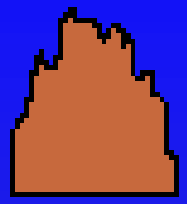
Structure Applications

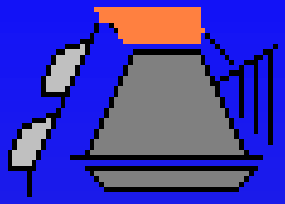
- 60% to 70% of our technologies are retrofitted to existing structures

- 30% to 40% of our technologies are applied to new structures

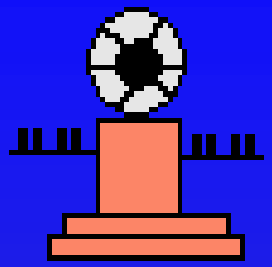
Corrosion - A Natural Process



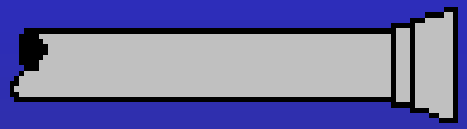
IRON OXIDE



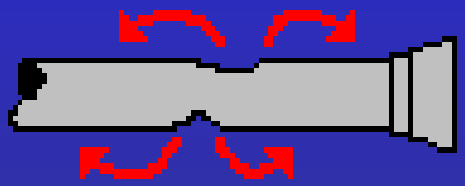
REFINING



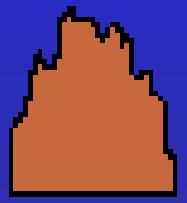
MILLING



IRON,STEEL,PCCP



CORROSION



IRON OXIDE

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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___

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Prerequisites for Corrosion

- Anode
- Cathode
- Electrical Connection Between Anode and Cathode
- Electrolyte

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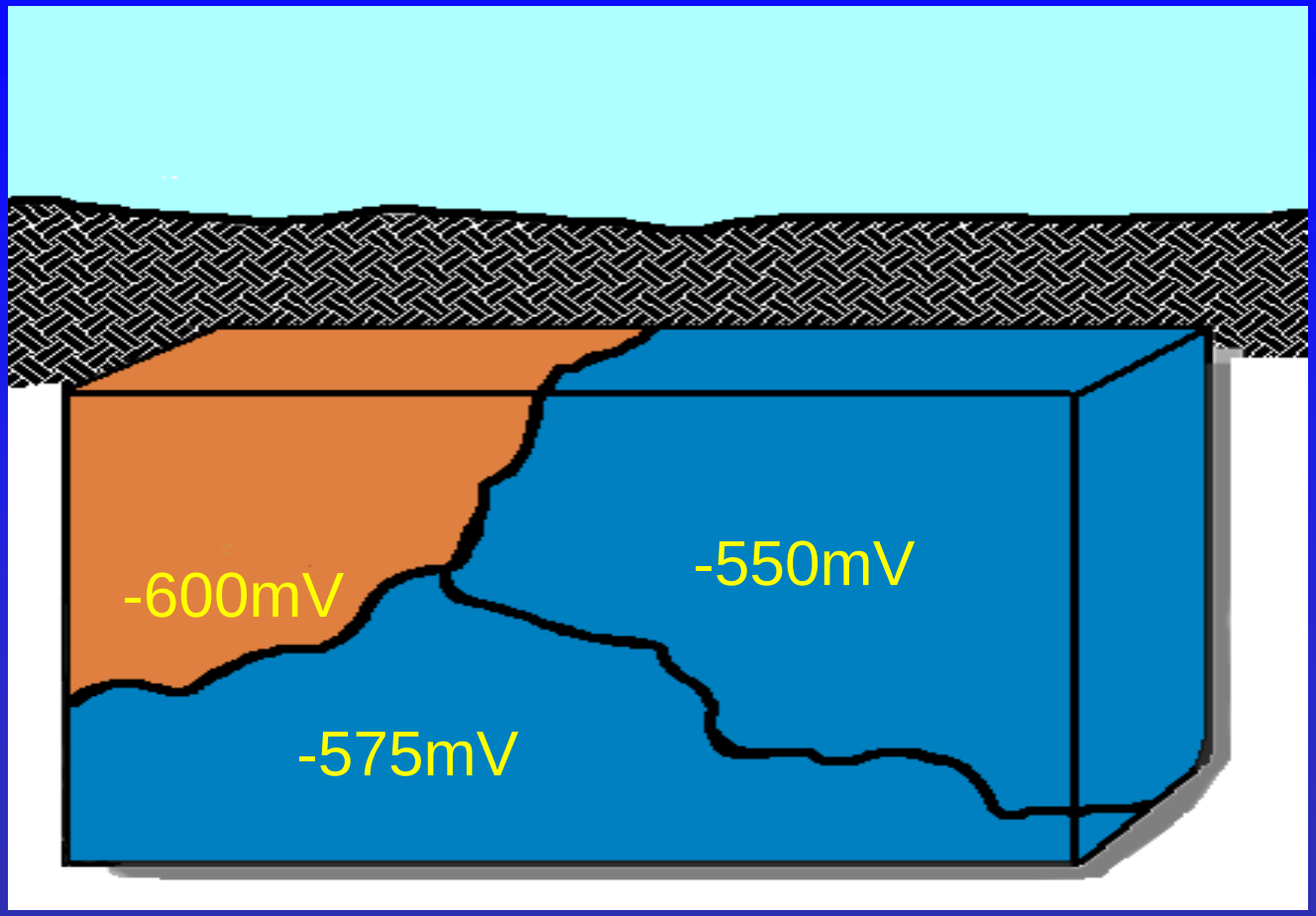

Potential Differences on Steel Surface

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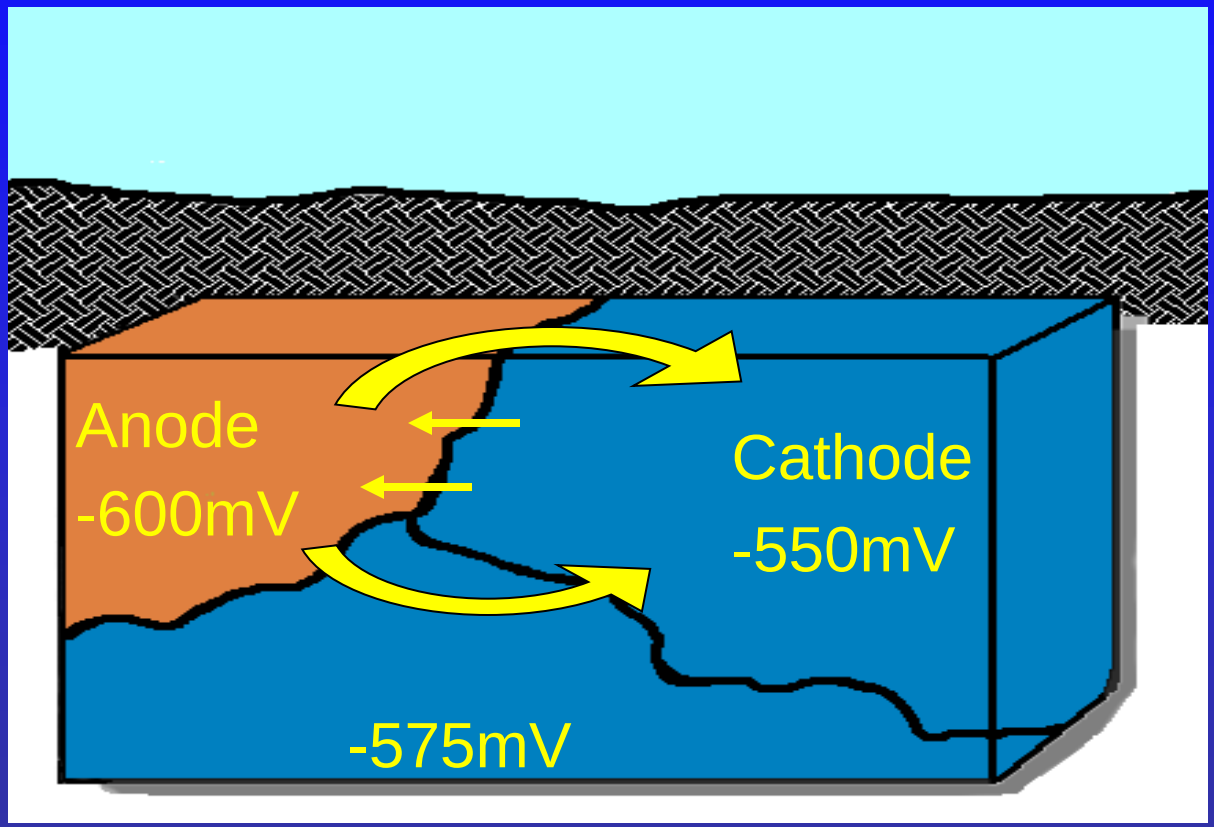
1) ANODE

2) CATHODE

3) ELECTROLYTE

4) ELECTRICAL CONNECTION



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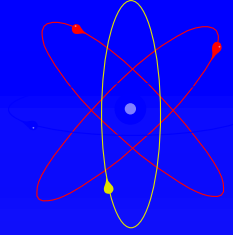

PRACTICAL GALVANIC SERIES

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/Ductile 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

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Ohm's Law

$$I \text{ (current)} = \frac{E \text{ (voltage)}}{R \text{ (resistance)}}$$

How We Prevent Corrosion Attack?

- Corrosion occurs where current discharges from metal to electrolyte
- To prevent corrosion we must make the pipe a cathode by forcing current to flow on to it.

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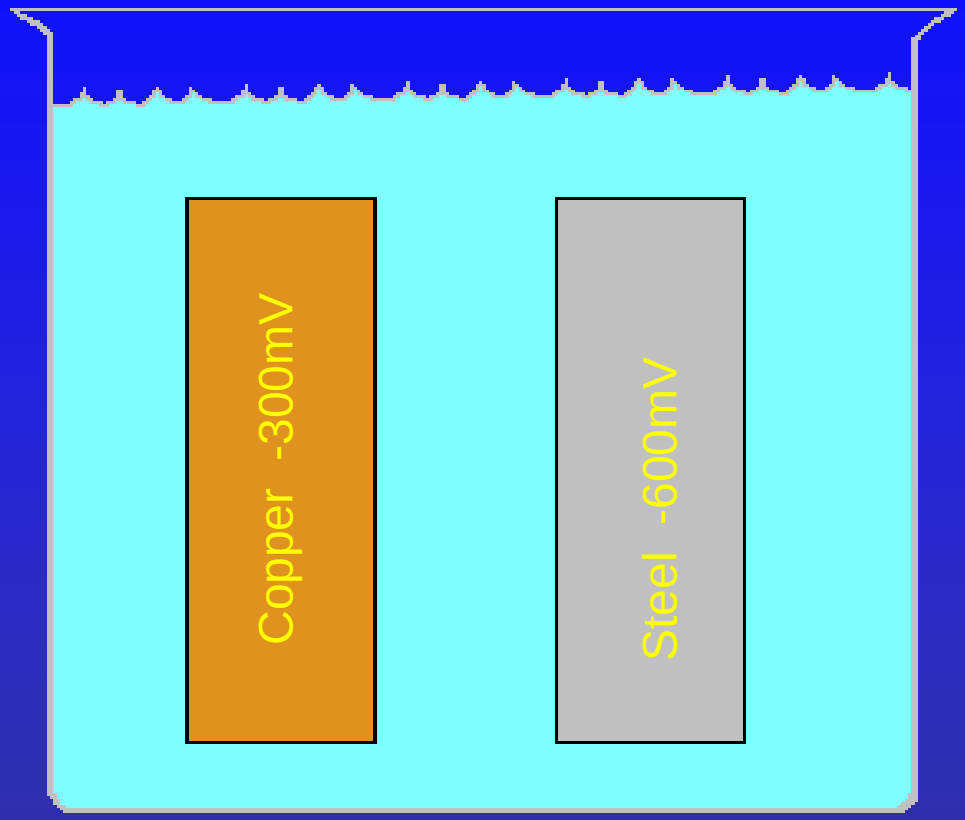
1) ANODE

2) CATHODE

3) ELECTROLYTE

4) ELECTRICAL CONNECTION

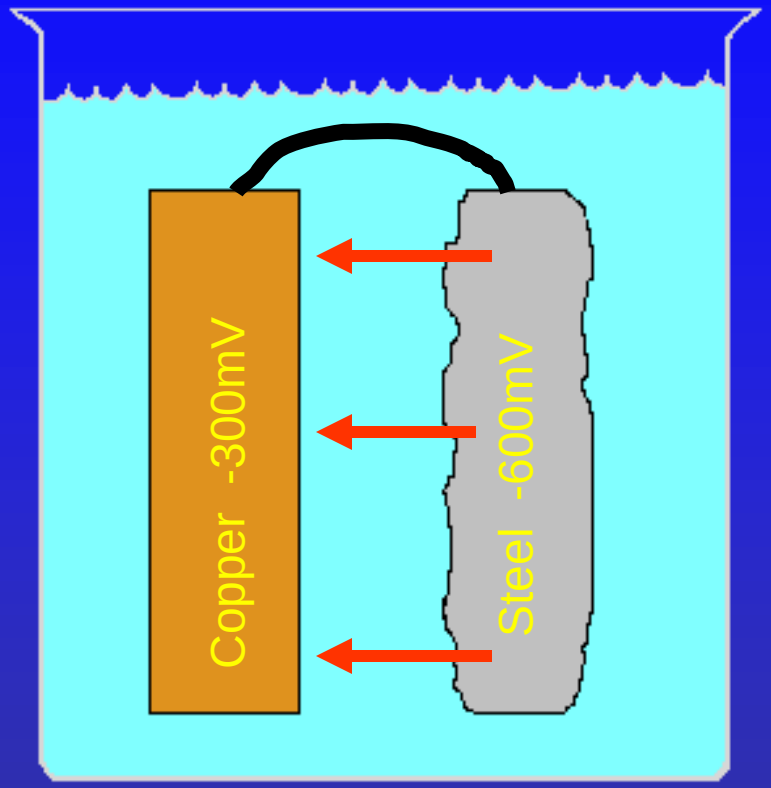


1) ANODE

2) CATHODE

3) ELECTROLYTE

4) ELECTRICAL CONNECTION



1) ANODE

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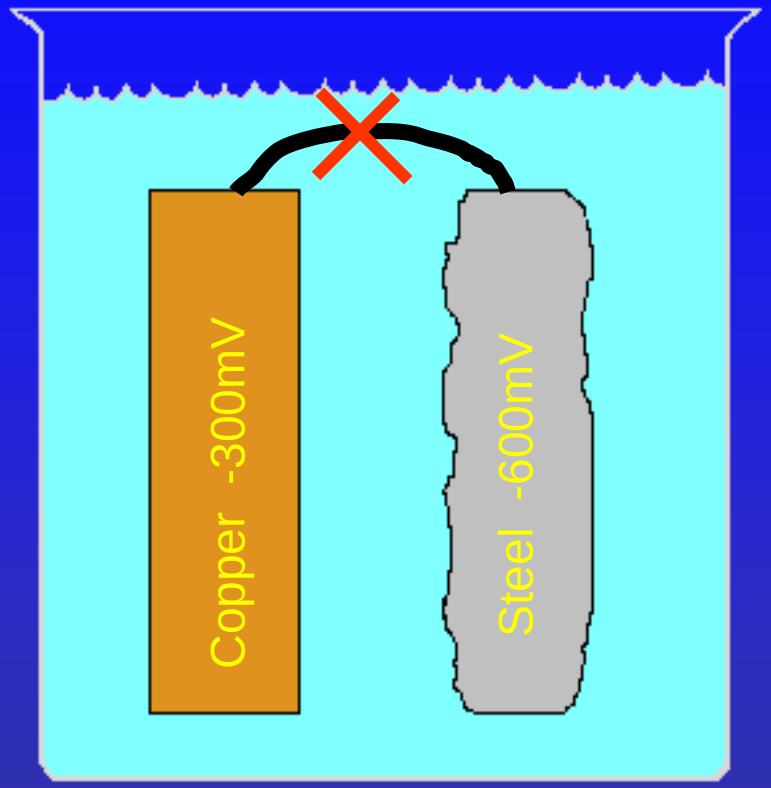
4) ELECTRICAL CONNECTION

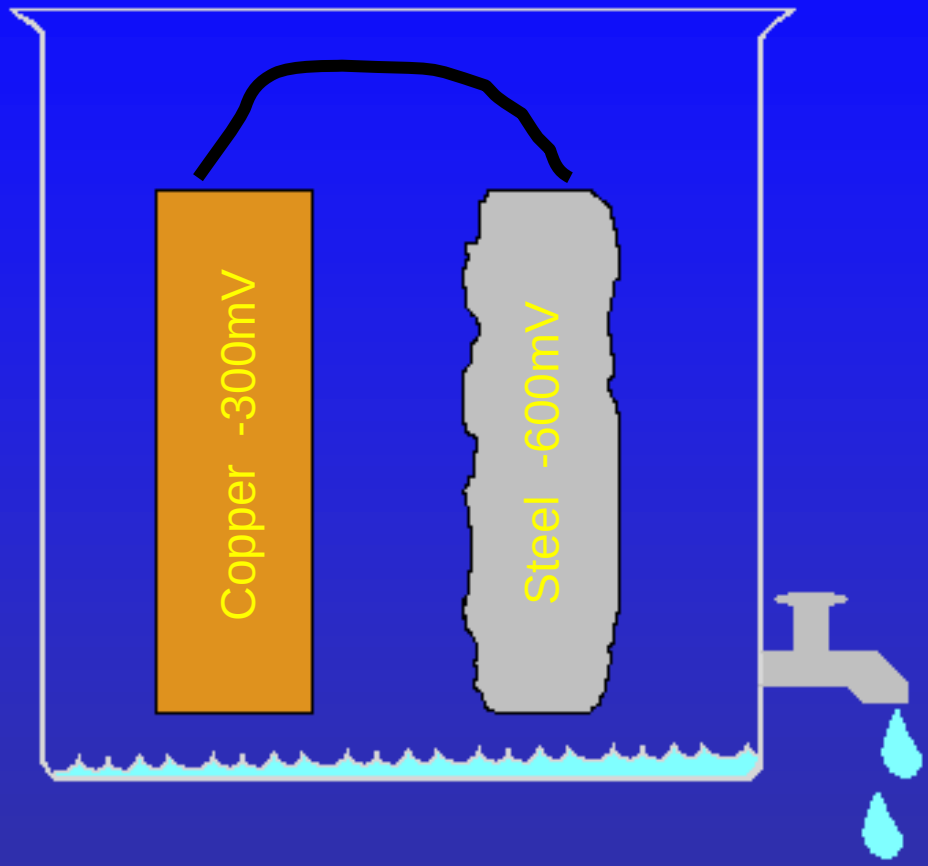


1) ANODE

2) CATHODE

3) ELECTROLYTE

4) ELECTRICAL CONNECTION

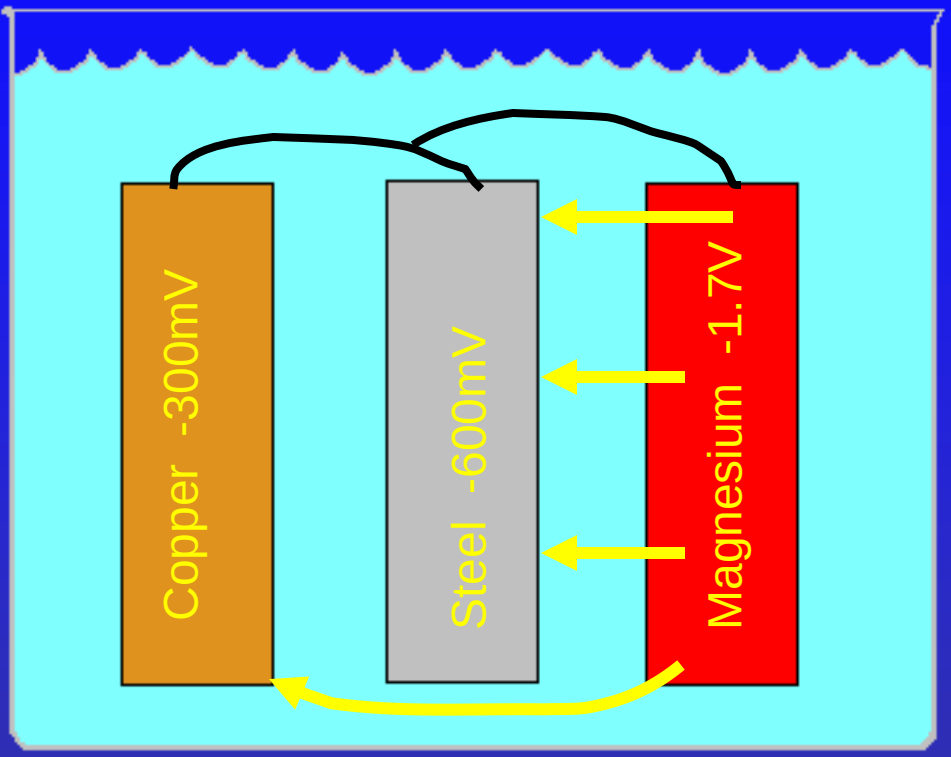


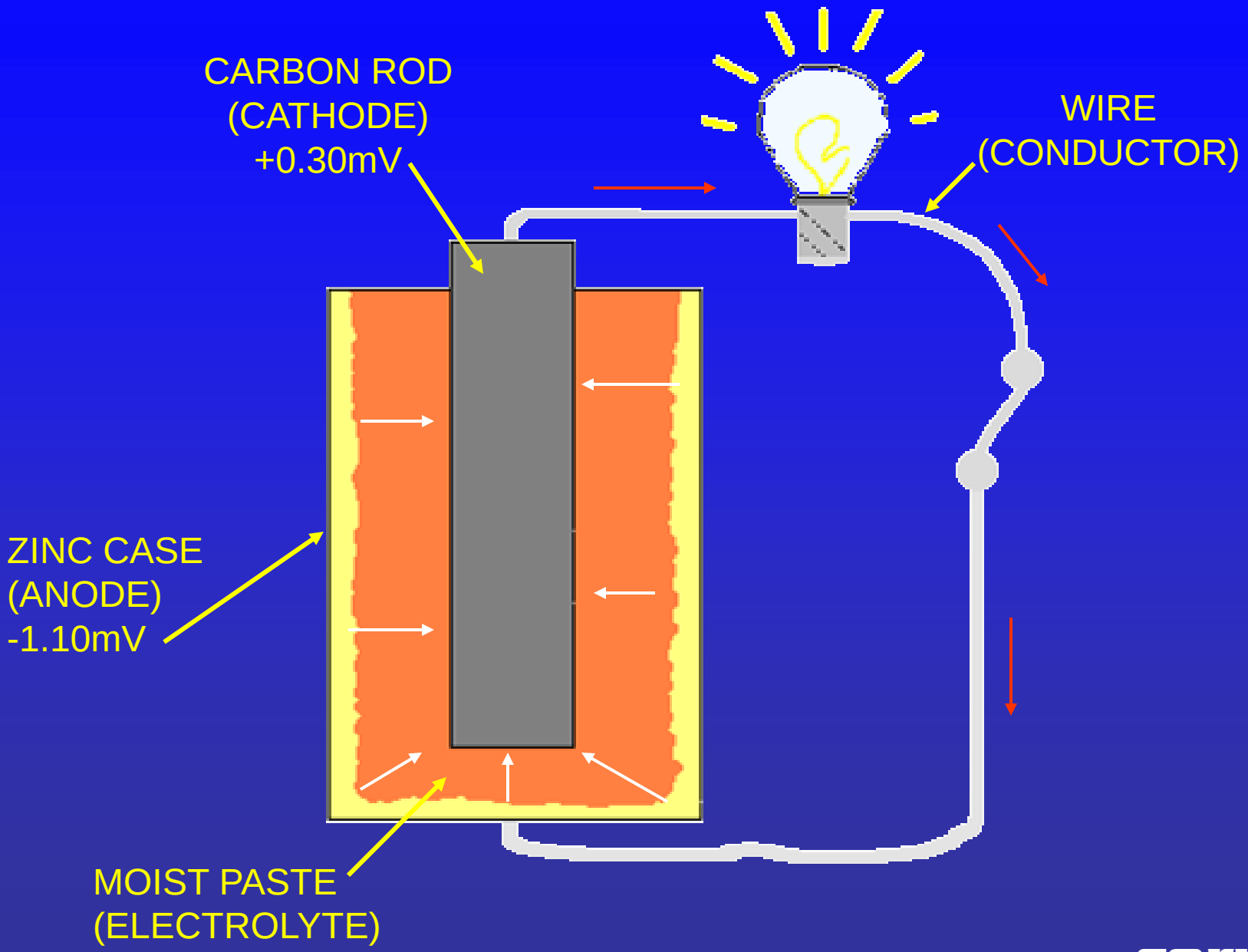
1) ANODE

2) CATHODE

3) ELECTROLYTE

4) ELECTRICAL CONNECTION




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

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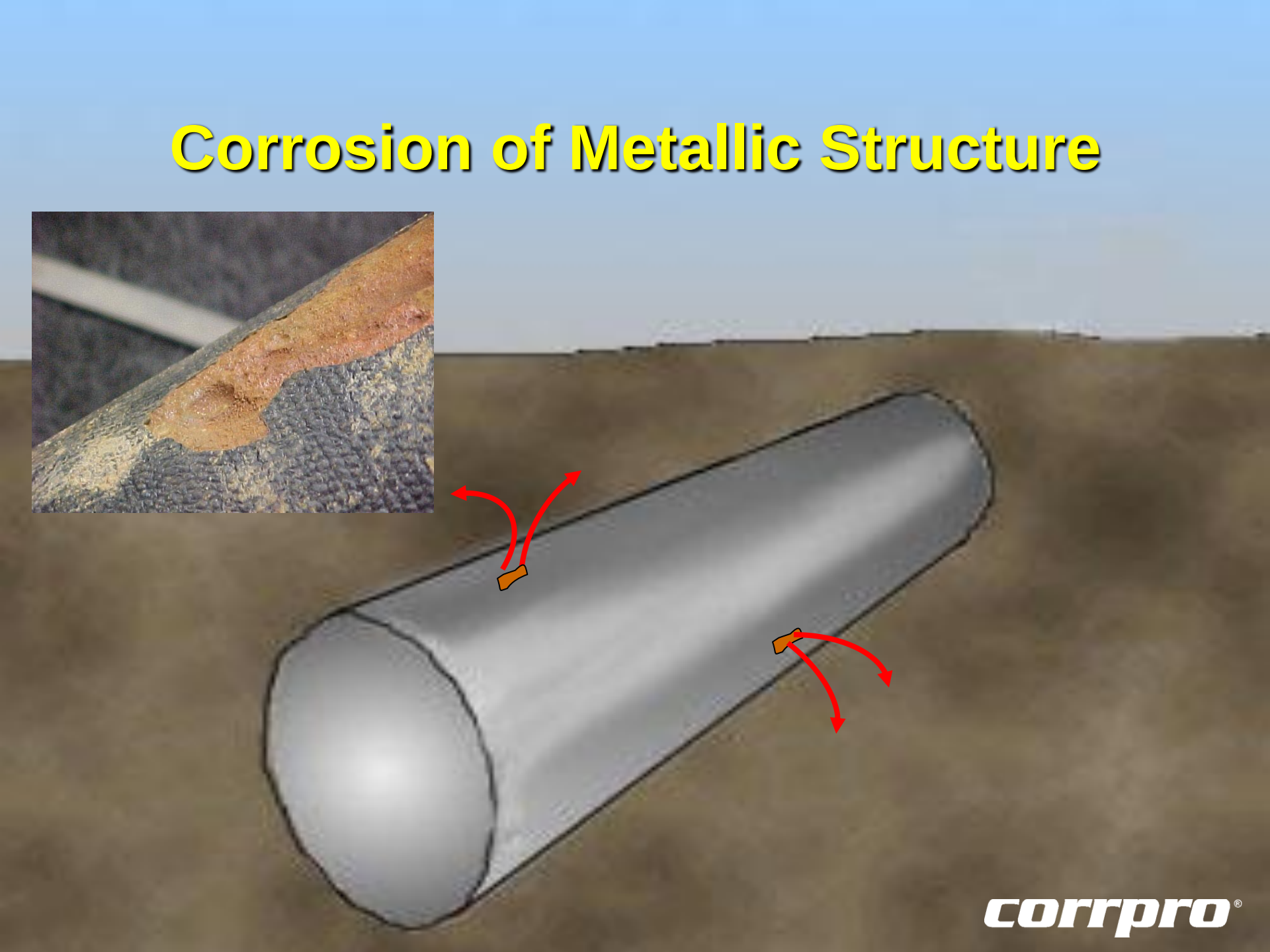
Corrosion of Metallic Structure



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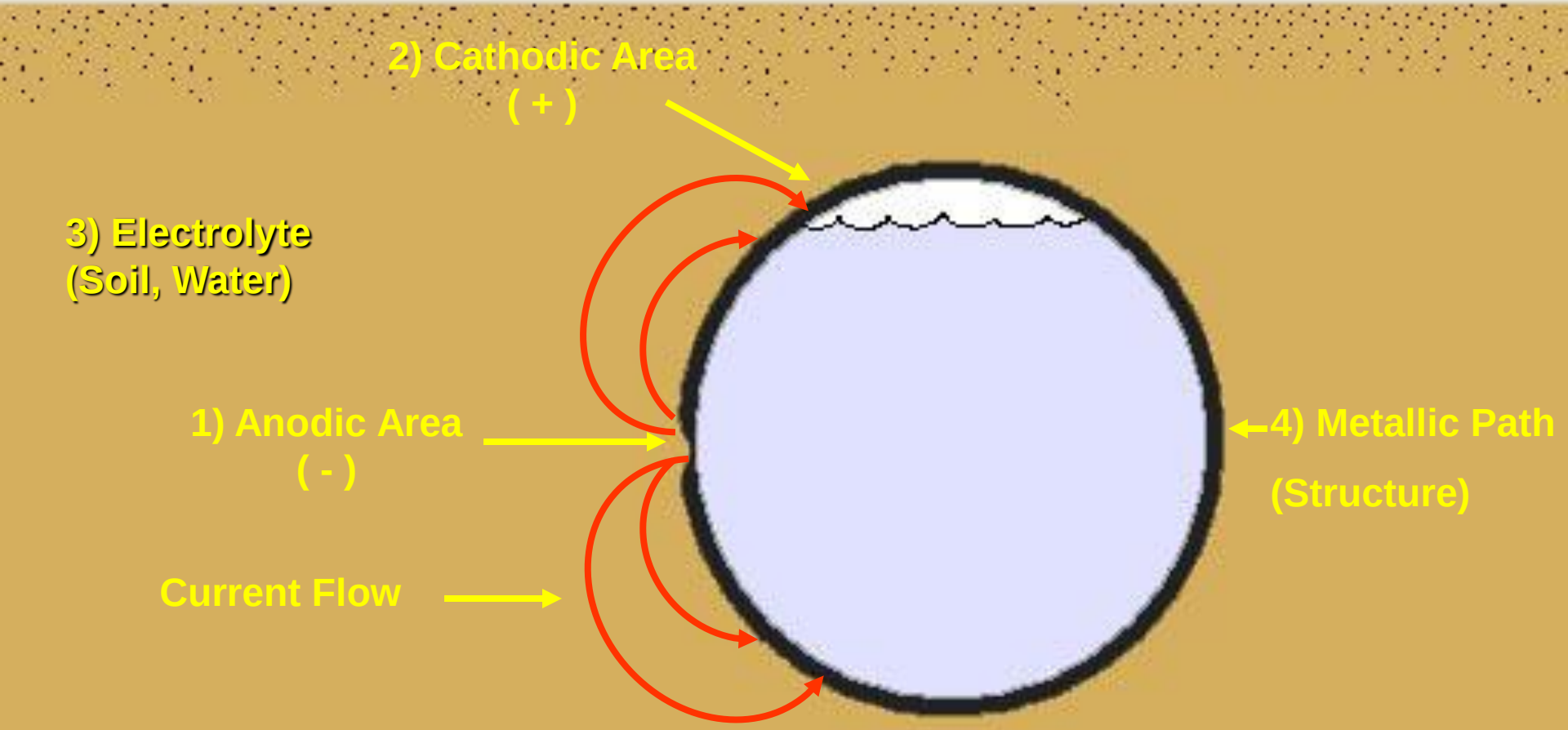
Basic Corrosion Cell



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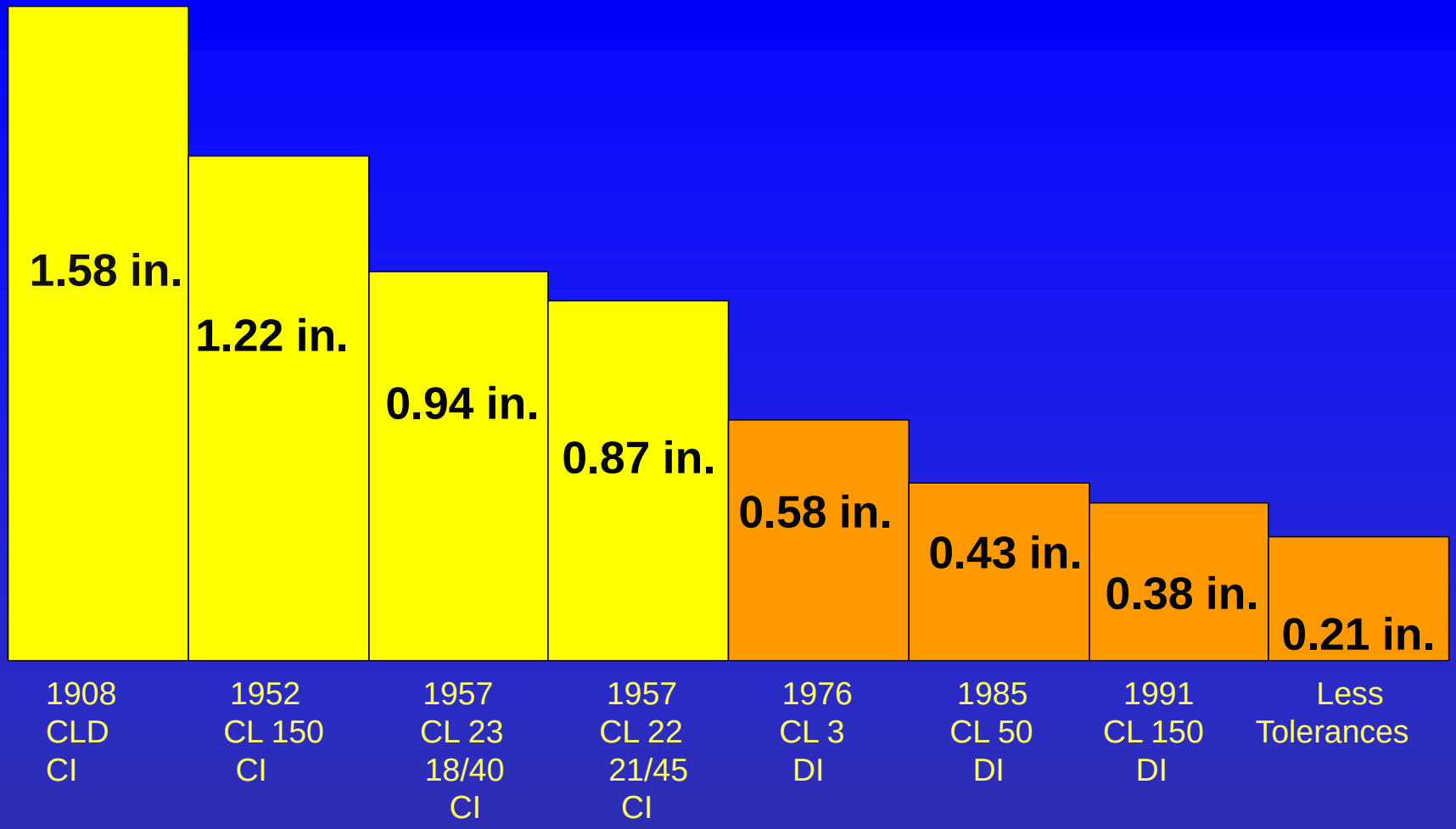

Actual size of AWWA Specification Thickness Reductions for 36-inch Diameter Cast and Ductile Iron Pipe - 1908 to Present (150 PSI Operating pressure)

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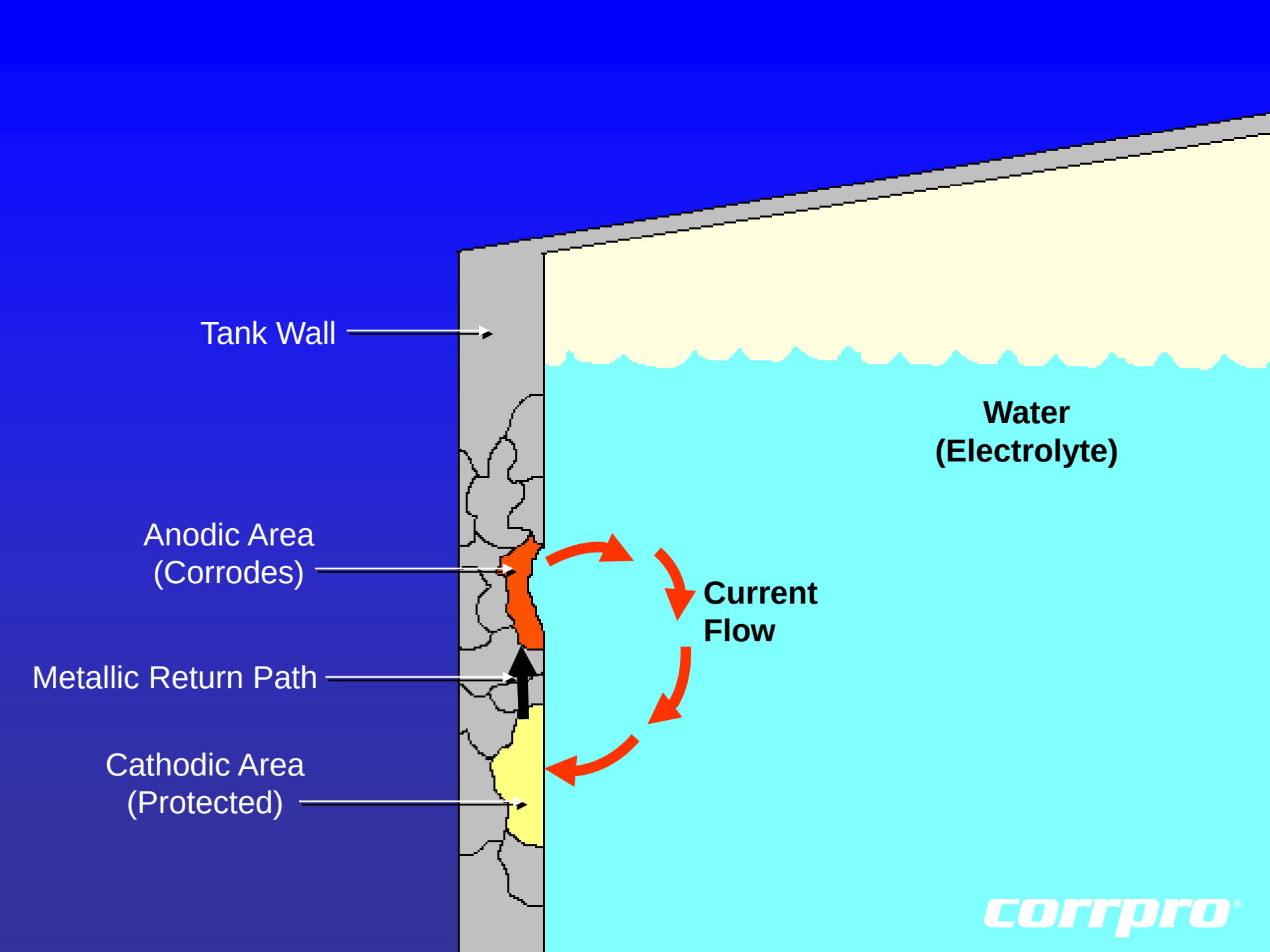
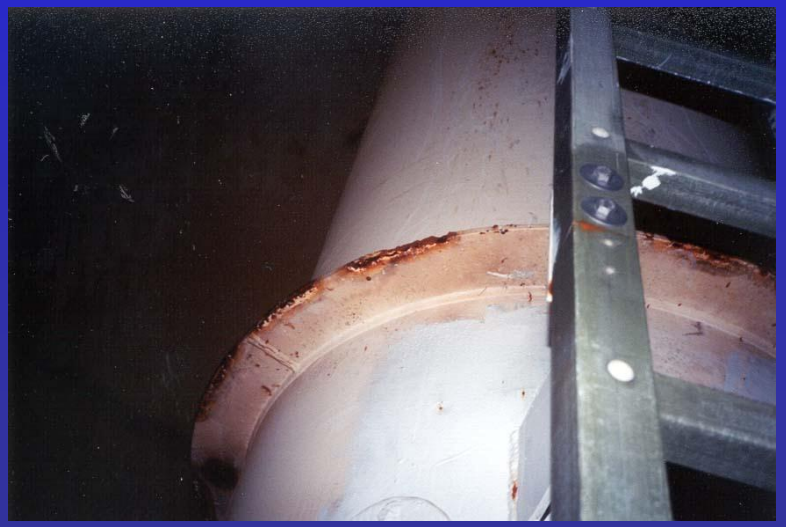

Tank Wall
Water
(Electrolyte)
Anodic Area
(Corrodes)
Current
Flow
Metallic Return Path
Cathodic Area
(Protected)
corrpro

Coating Flaws (Holidays)



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Adverse Conditions for Metallic Pipe

- High Chlorides
- Low Soil/Water Resistivity
- High Sulfates
- Acidic Soils
- Wet/Dry Fluctuations
- Bimetallic Couplings
- Stray Current Interference

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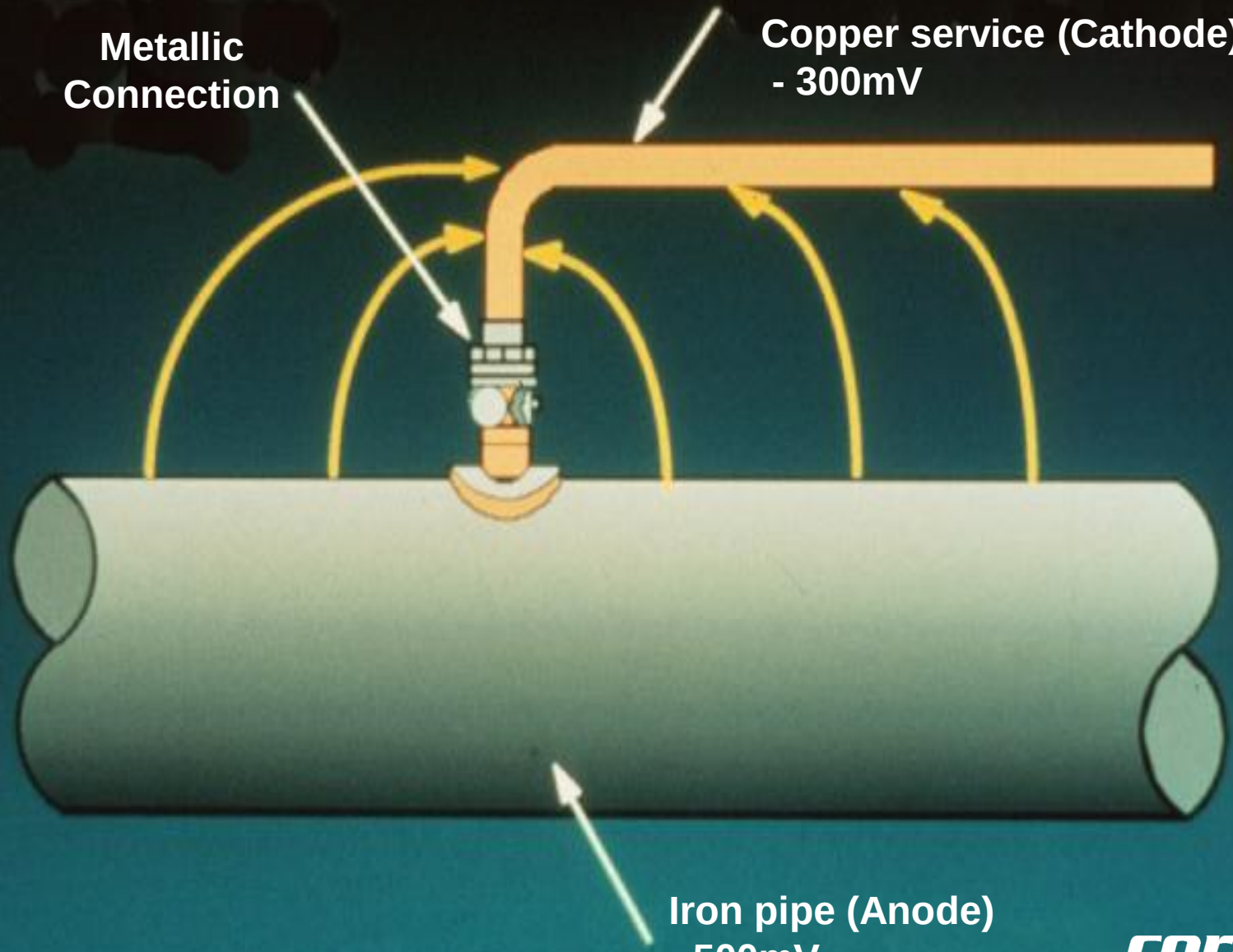
Coupling to Dissimilar Metals



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Corrosion of iron when coupled to copper service line.

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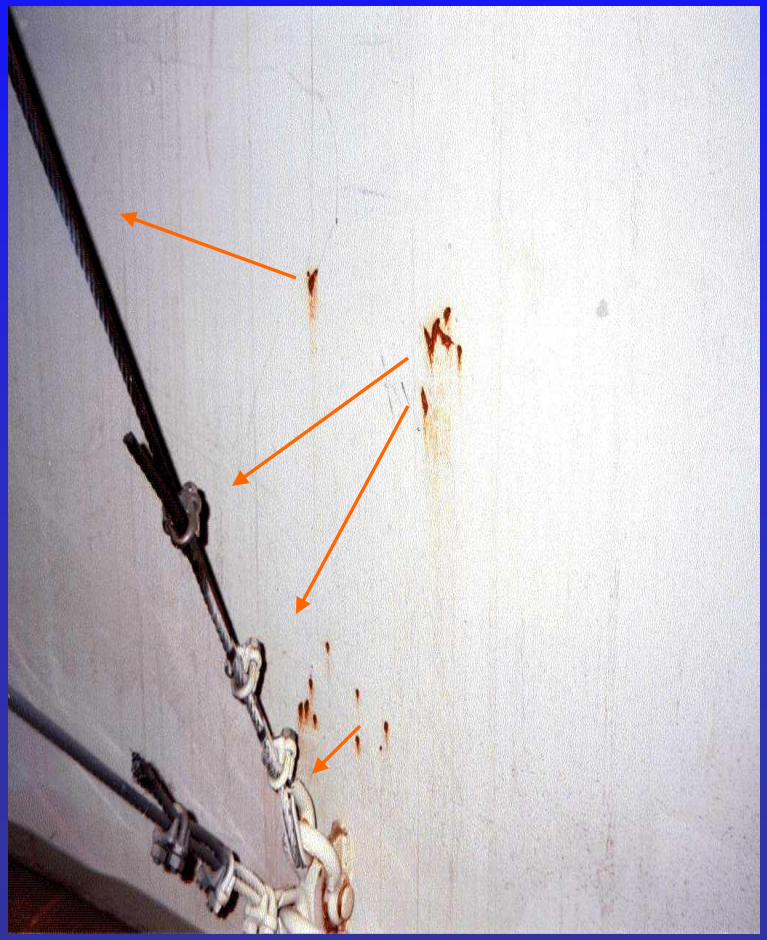
Dissimilar Metal Corrosion (Inside Water Tank)



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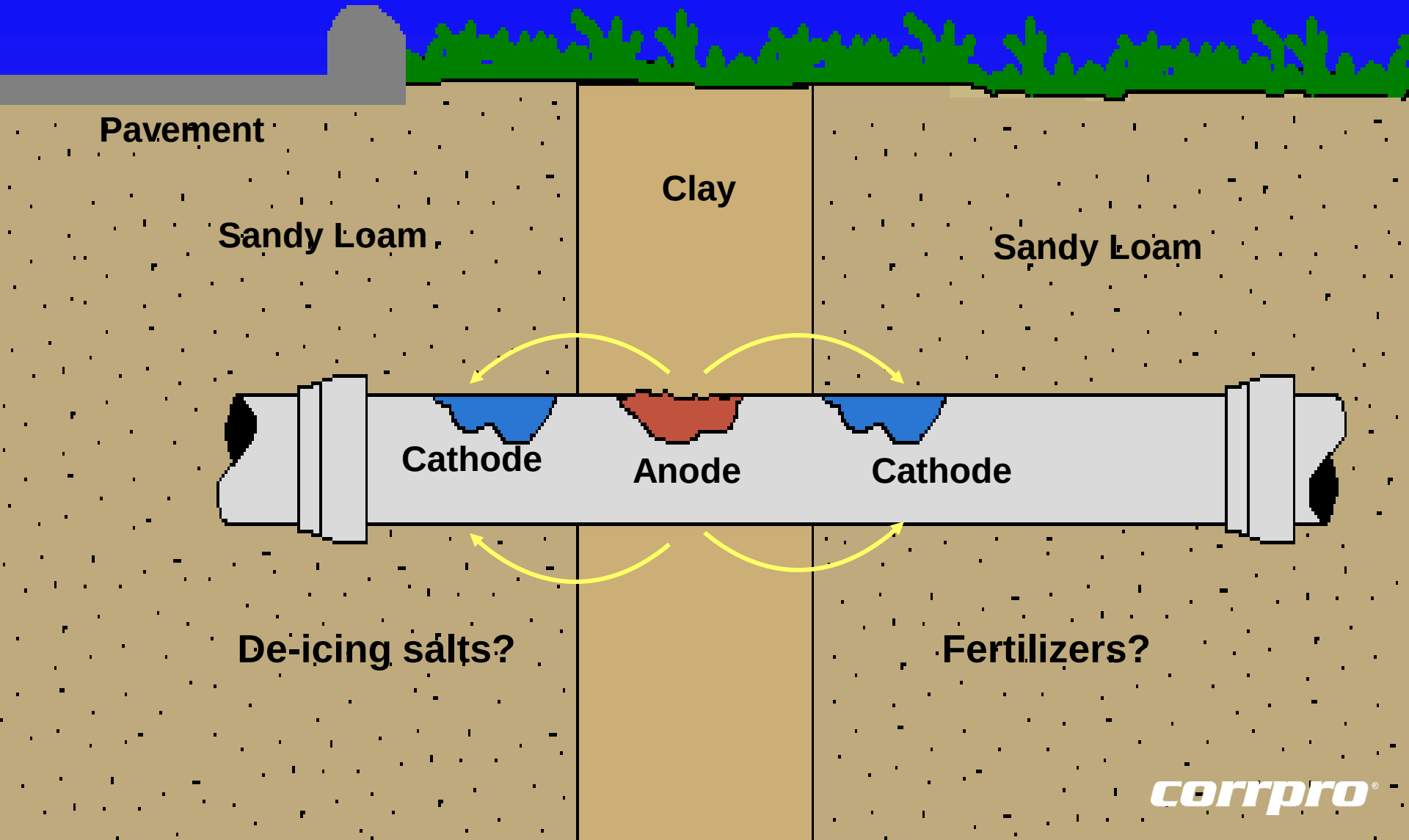
Dissimilar Soils



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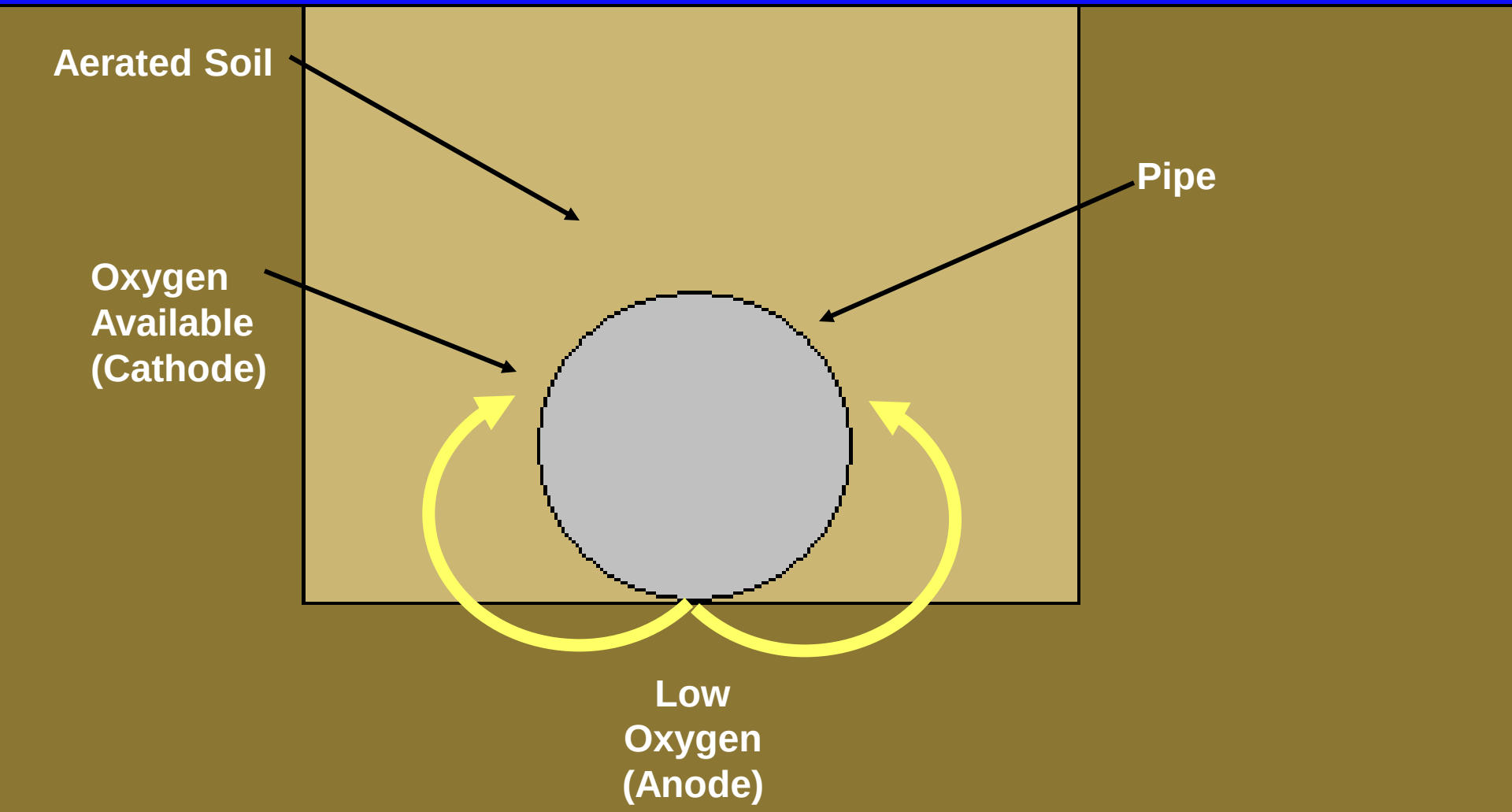
Corrosion Caused by Differential Aeration



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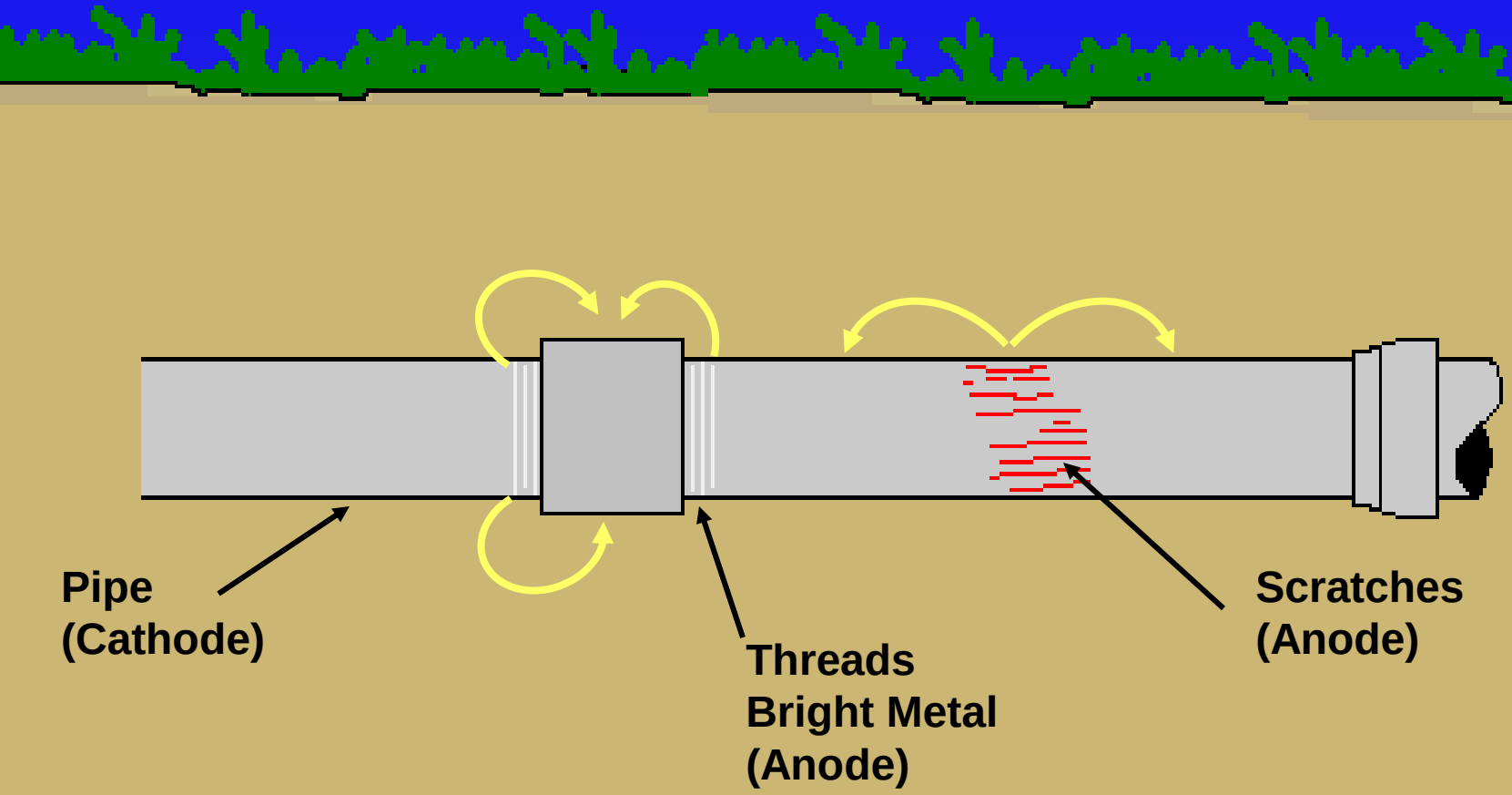
Dissimilar Surface Conditions



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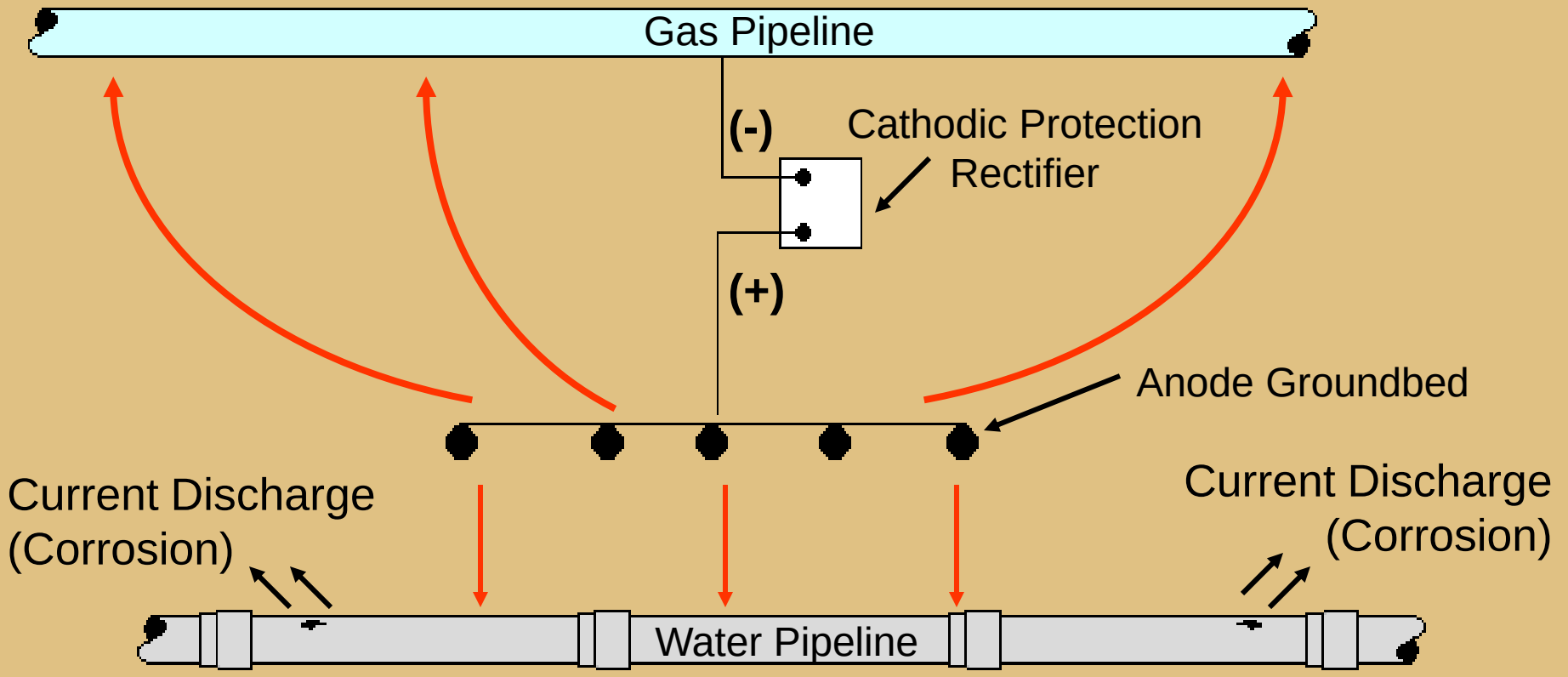

Stray Current Due to Impressed Current Cathodic Protection System

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Impressed Current CP System on Oil/Gas Lines can Create Stray Current Problem on Water Lines

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AC Mitigation

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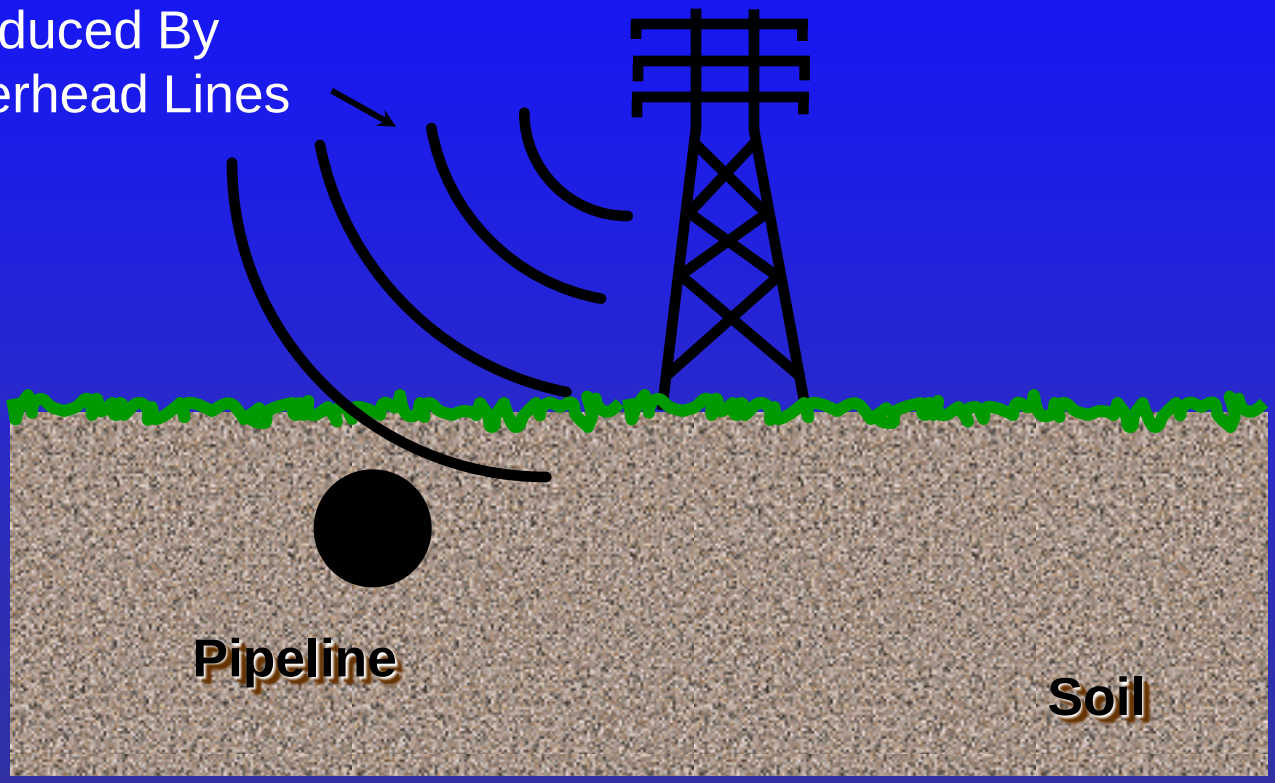
AC Interference on Pipeline from Changing Electromagnetic Field

Magnetic Field
Produced By
Overhead Lines



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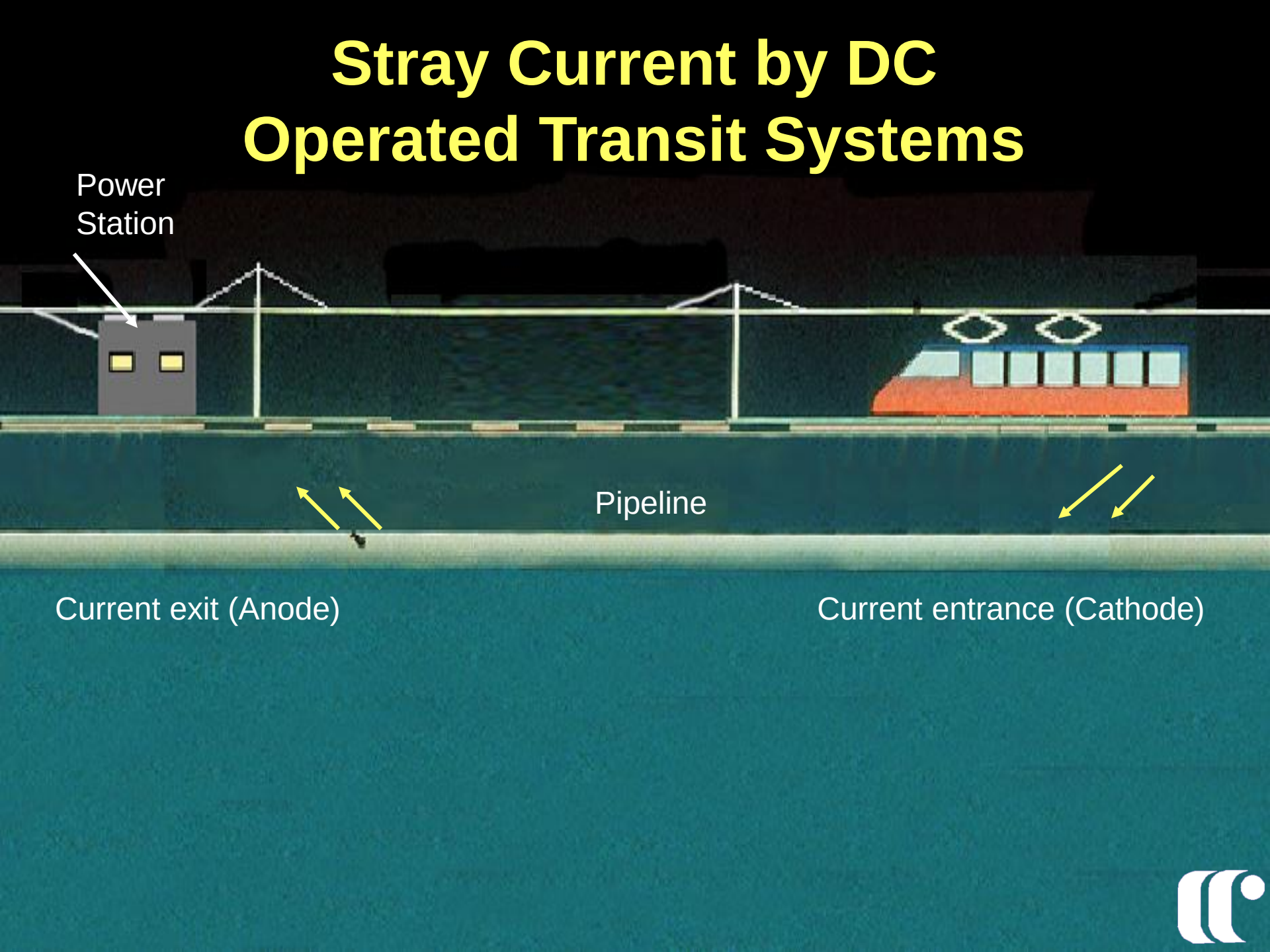
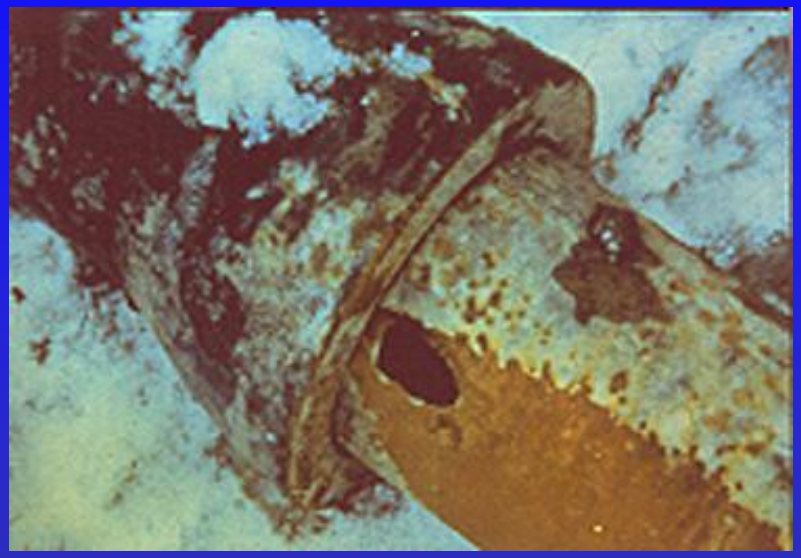
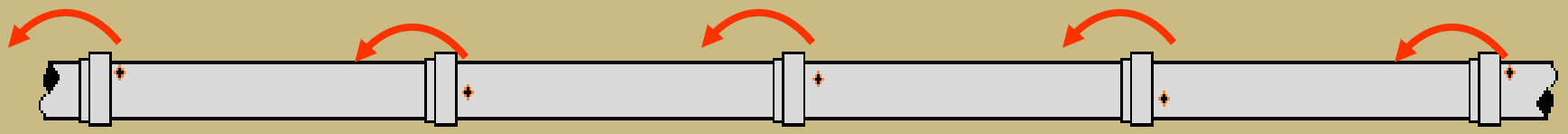
Stray Current by DC Operated Transit Systems



Stray Current





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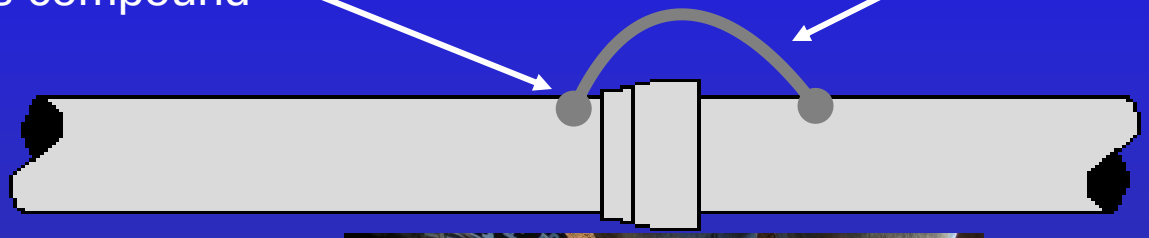
Bonding Across a Bell and Spigot or Slip-joint

Thermite brazed connection coated with bitumous compound

Copper wire with direct burial insulation



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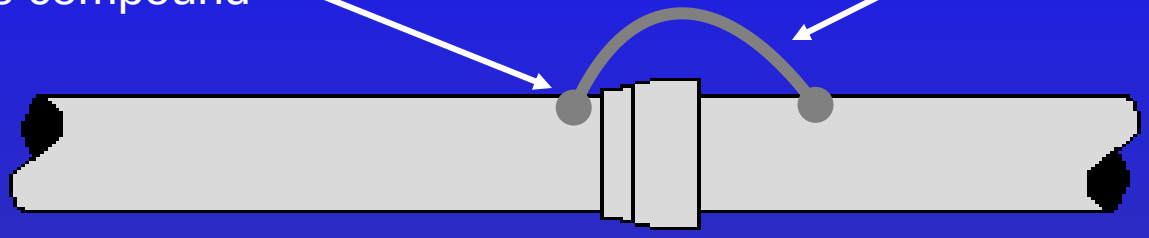
Bonding Across a Joint

Thermite brazed connection coated with bitumous compound

Copper wire with direct burial insulation



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INSULATING UNIONS

FLANGE INSULATION KIT

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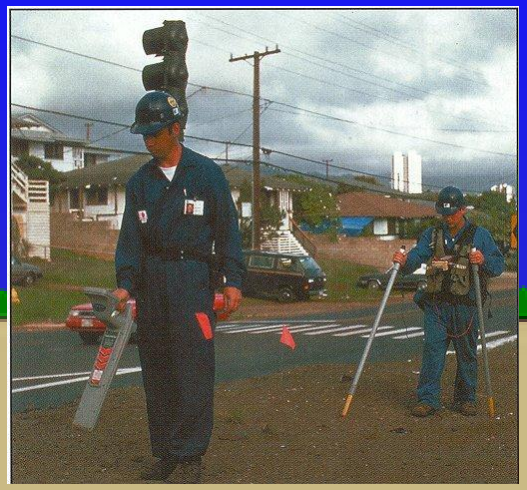
Computerized Potential Logging Survey



Test Station

Backpack Computer Unit

Chainer/Wire Dispenser & Counter

Reference Cells

Bonded Joints

Pipeline

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Lower Stress Area
(Cathode)

Pipe

Threaded Bolt
Higher Stress Area
(Anode)

Metallic Coupling

Stress Corrosion

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How We Prevent Corrosion Attack?

- Corrosion occurs where current discharges from metal to electrolyte
- To prevent corrosion we must make the pipe a cathode by forcing current to flow on to it.

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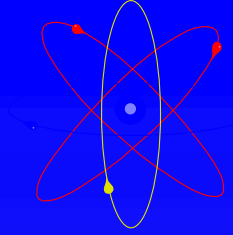

PRACTICAL GALVANIC SERIES

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Zinc	-1.10
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Cadmium	-0.80
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Mild Steel (Old)	-0.50
Cast/Ductile 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

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How Cathodic Protection Works

- Corrosion occurs where current discharges from metal to electrolyte
- The objective of cathodic protection is to force the entire surface to be cathodic to the environment

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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. 63A.
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.
63A

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

Galvanic Anode Cathodic Protection

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

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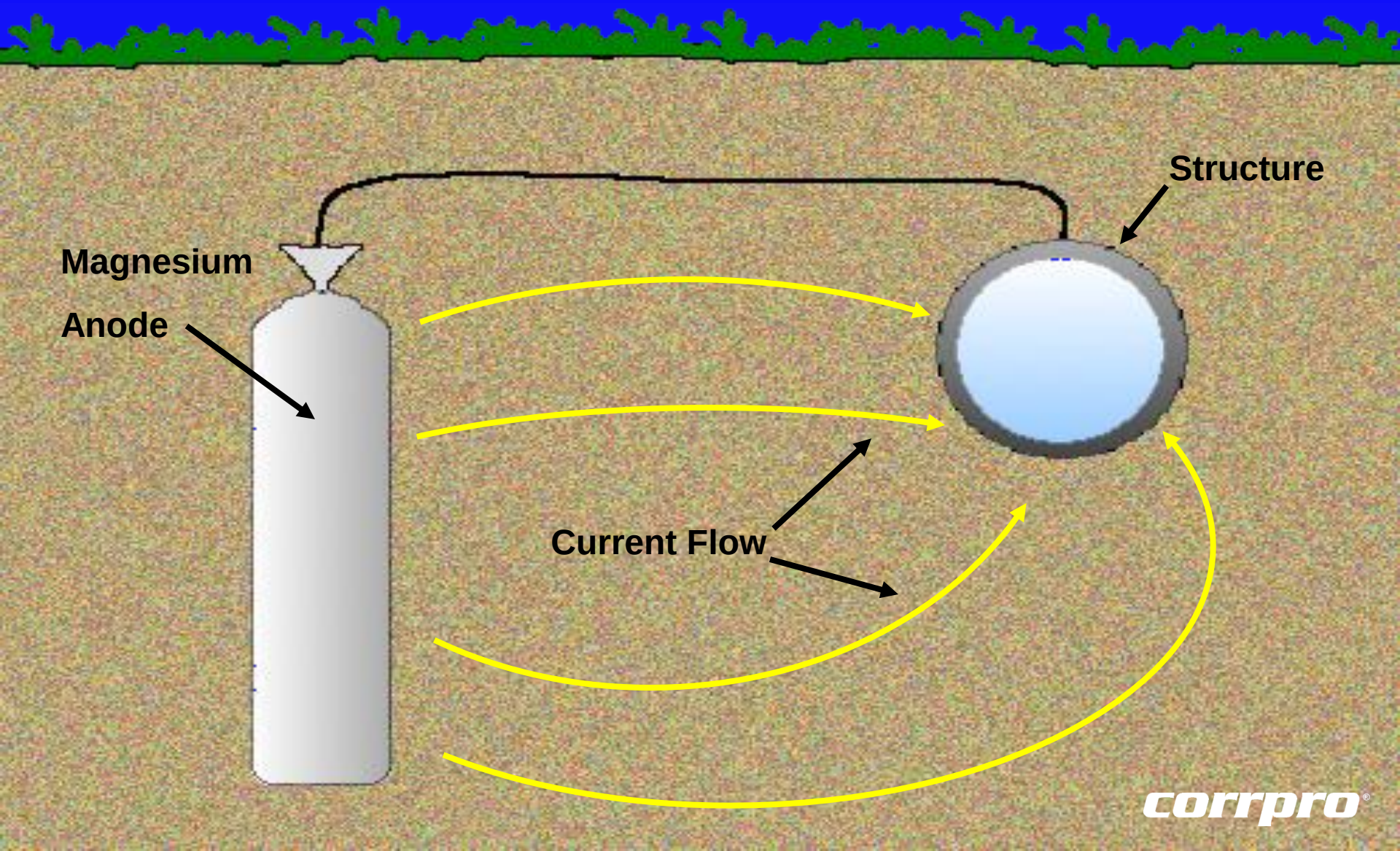
Galvanic Cathodic Protection



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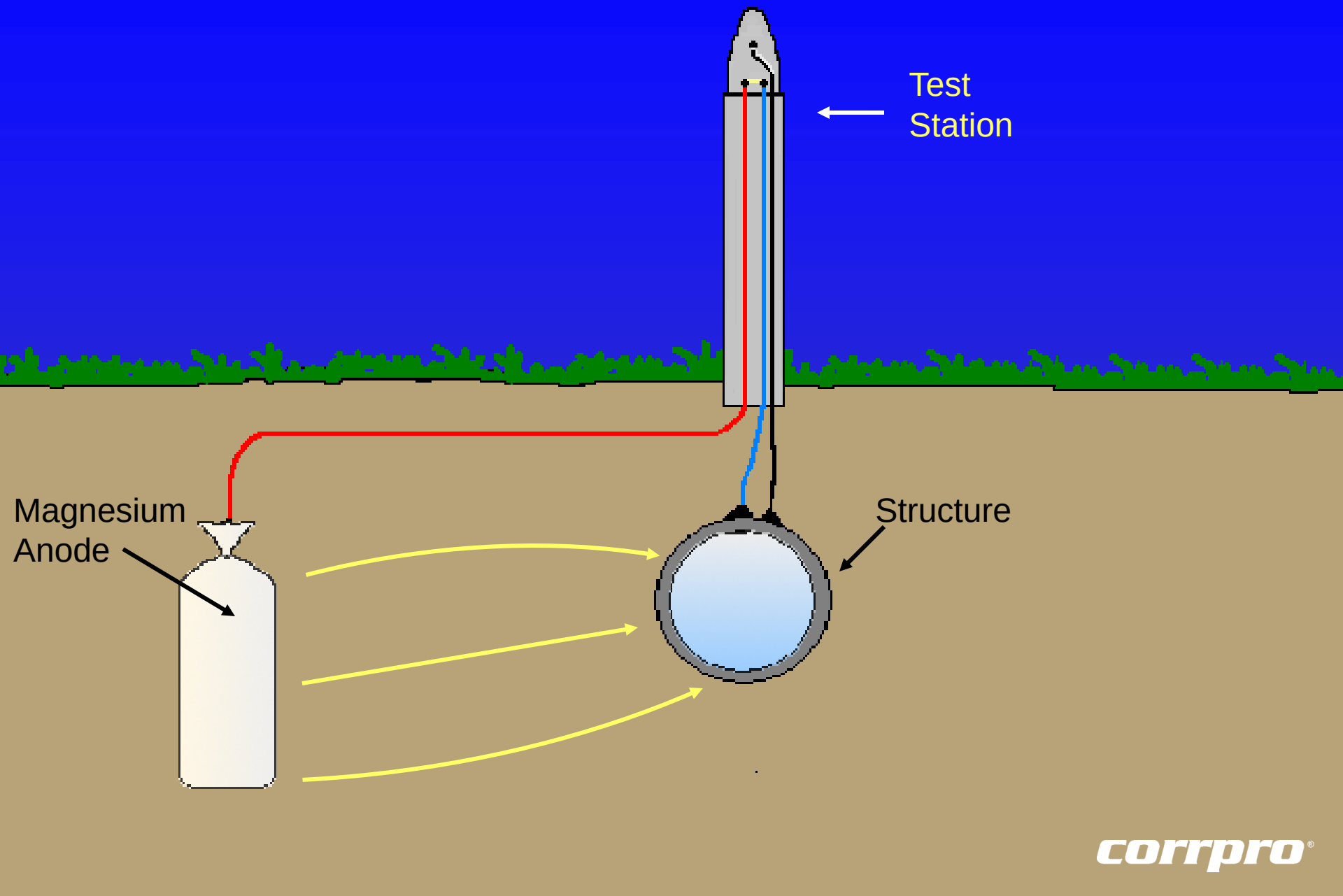
Cathodic Protection Test Station



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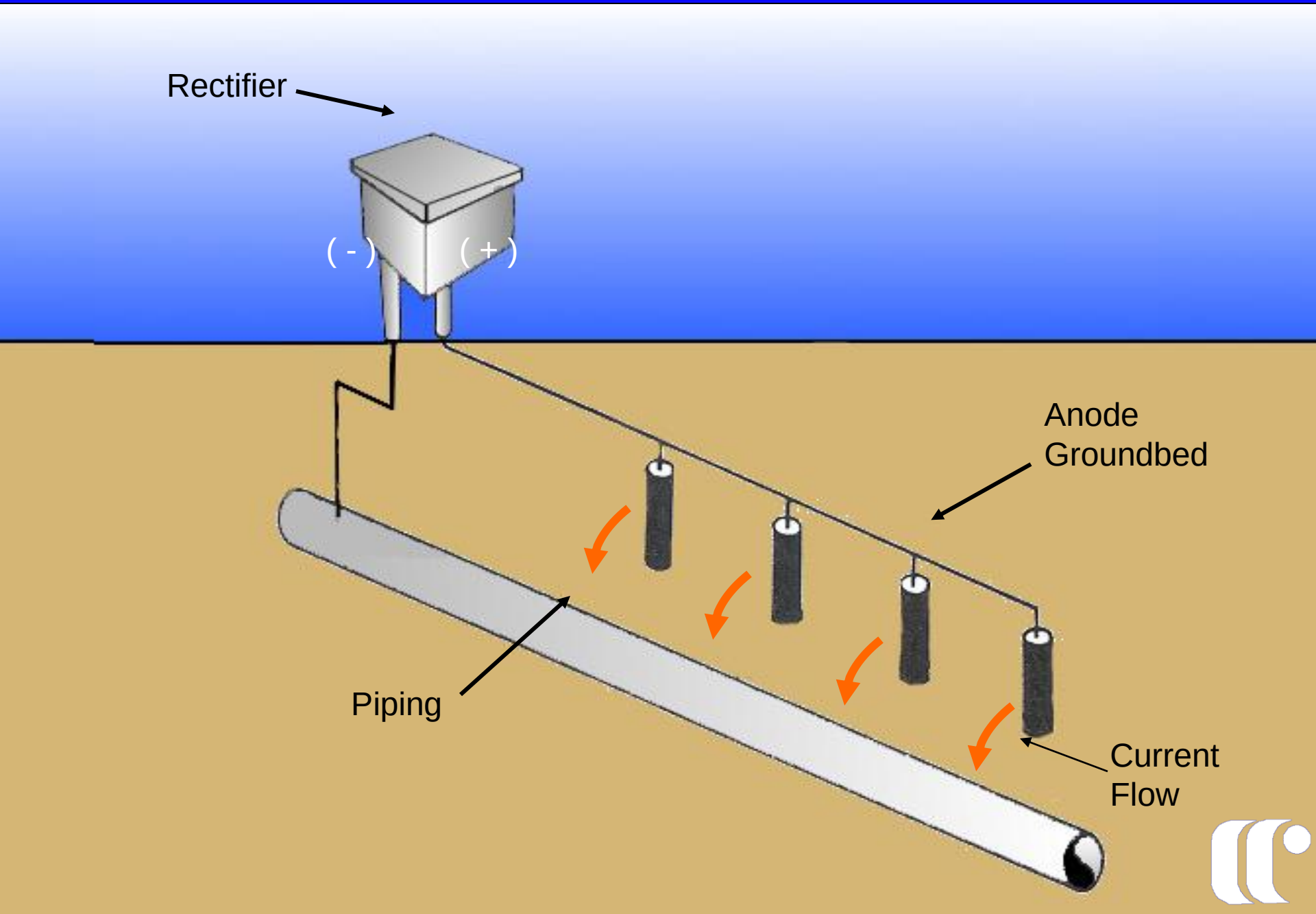
Impressed Current Cathodic Protection System

- Anodes
- Rectifier
- Wiring

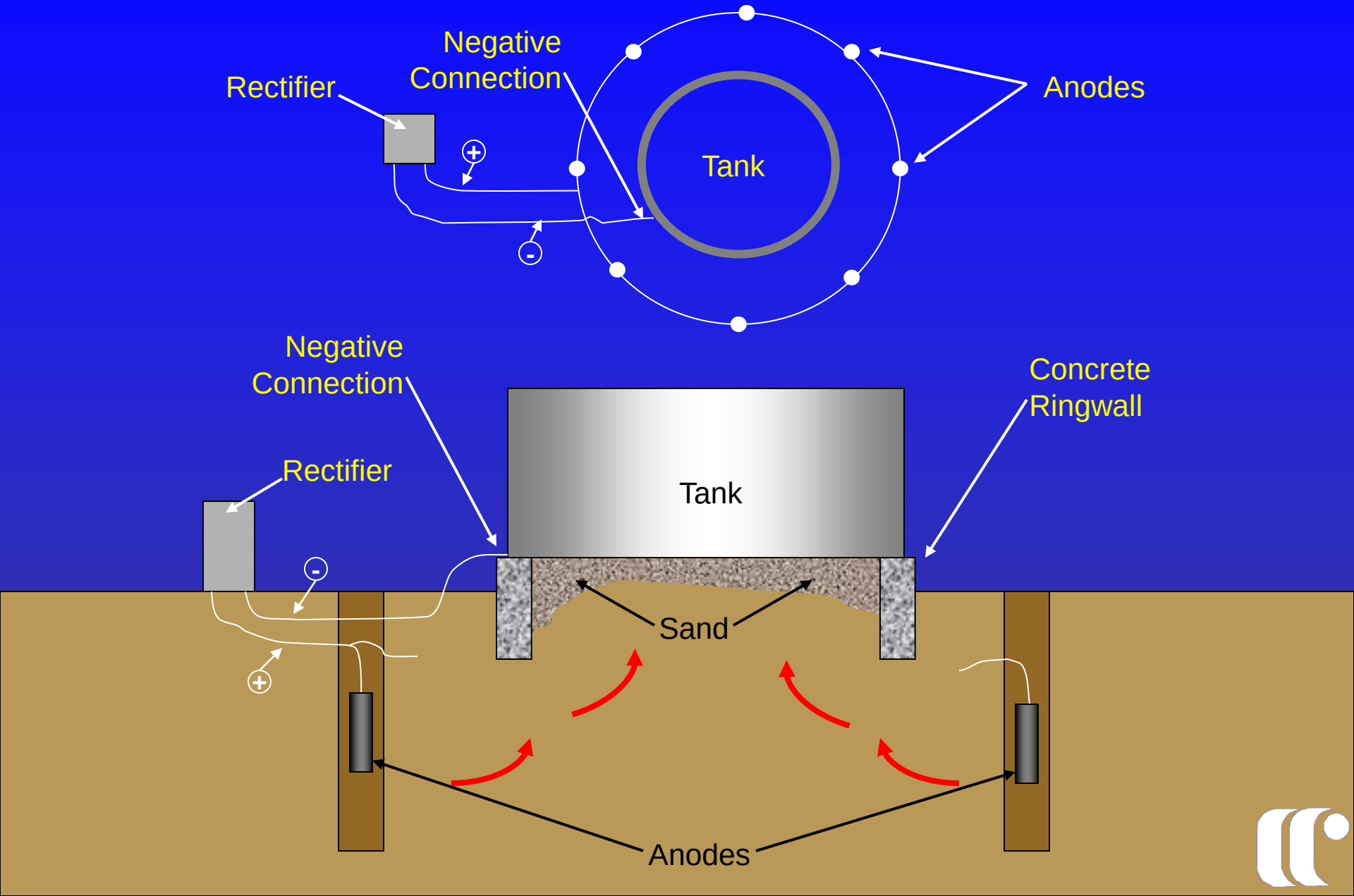
Yard Piping Distributed Anode Impressed Current System



RECTIFIER

ANODE
JUNCTION BOX

Above Ground Storage Tank Vertical Impressed Current Anodes - Existing Tanks



Deep Anode System Advantages

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

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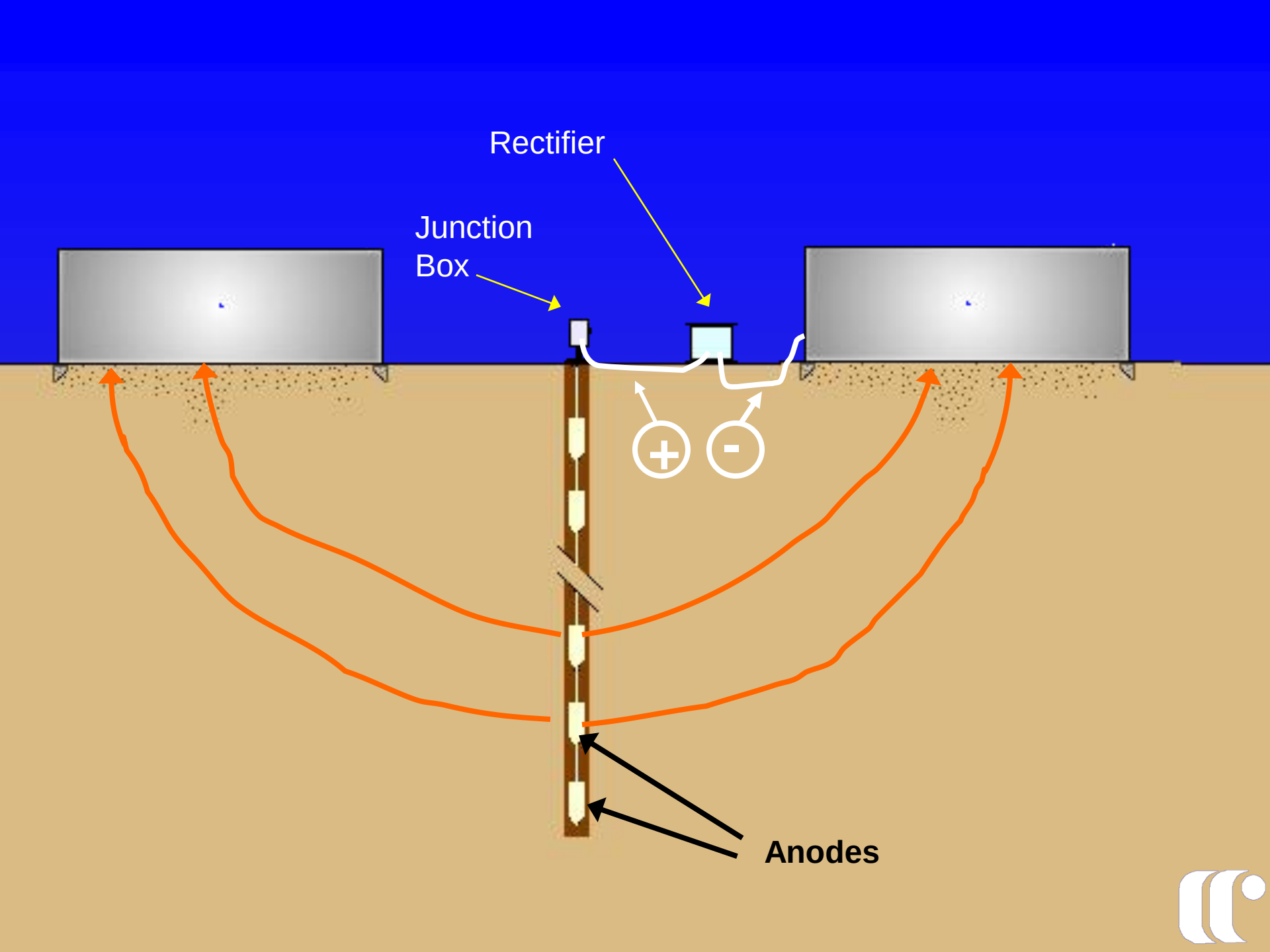
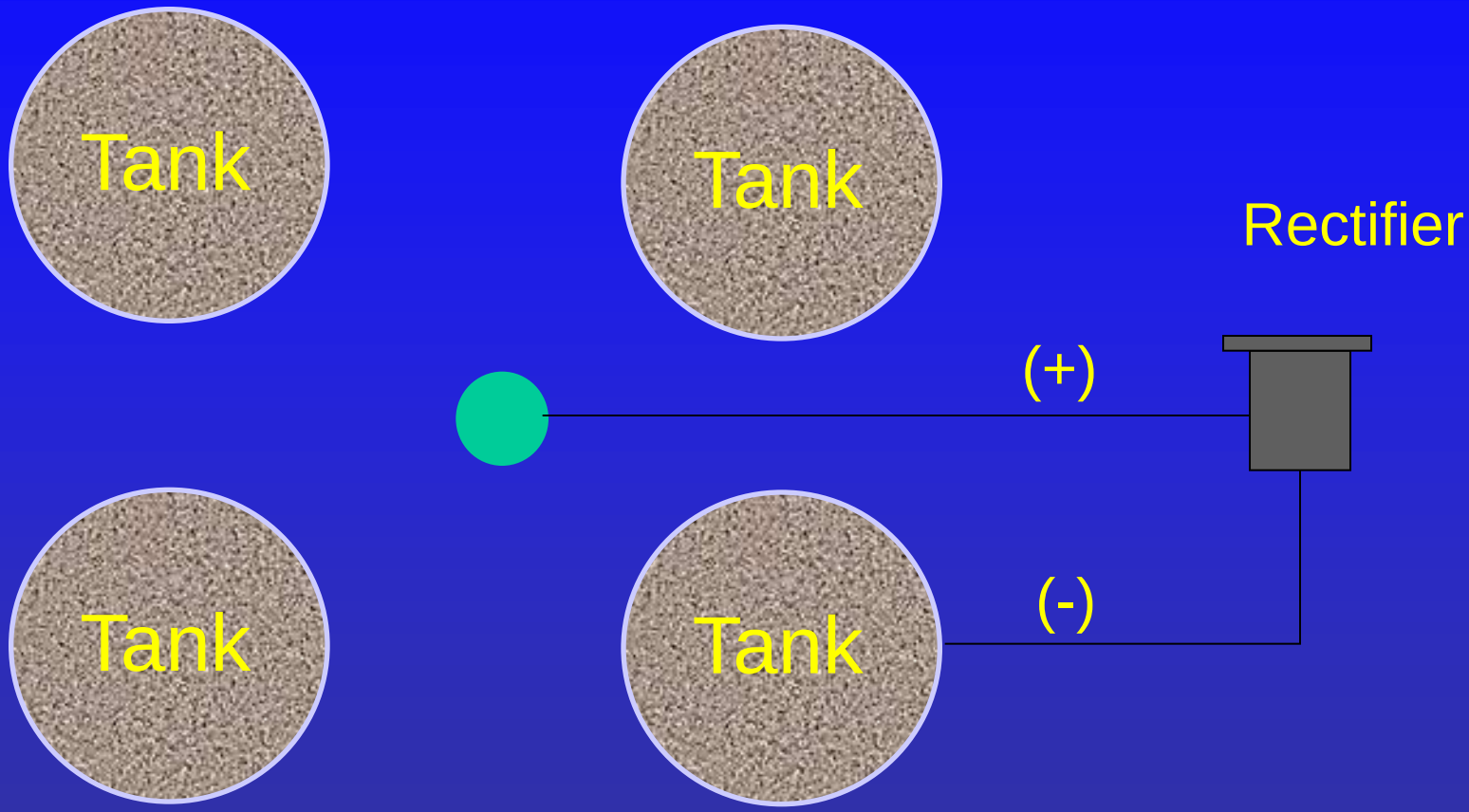

Rectifier
Junction
Box
+
-
Anodes



Deep Anode

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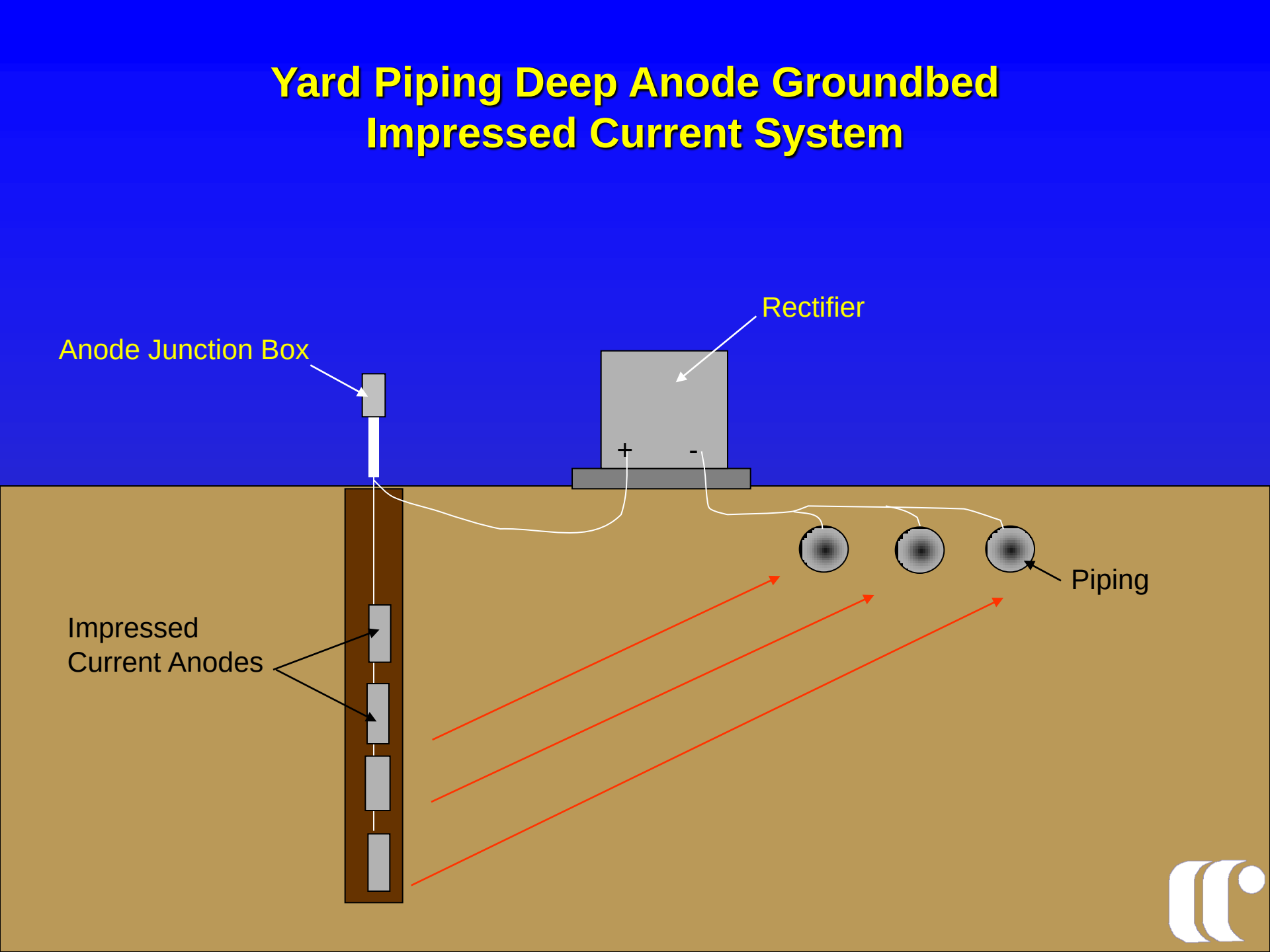
Yard Piping Deep Anode Groundbed
Impressed Current System



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

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Cathodic Protection Design Considerations

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

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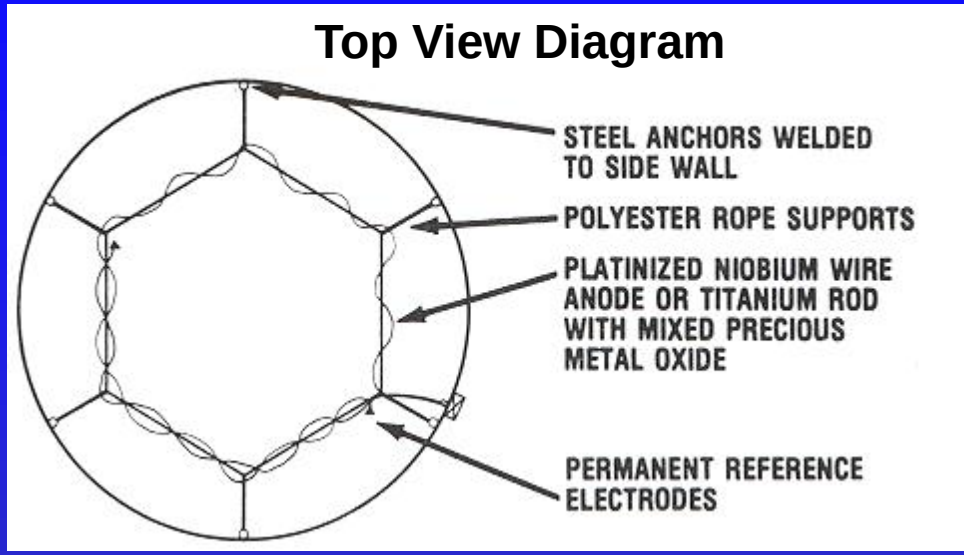
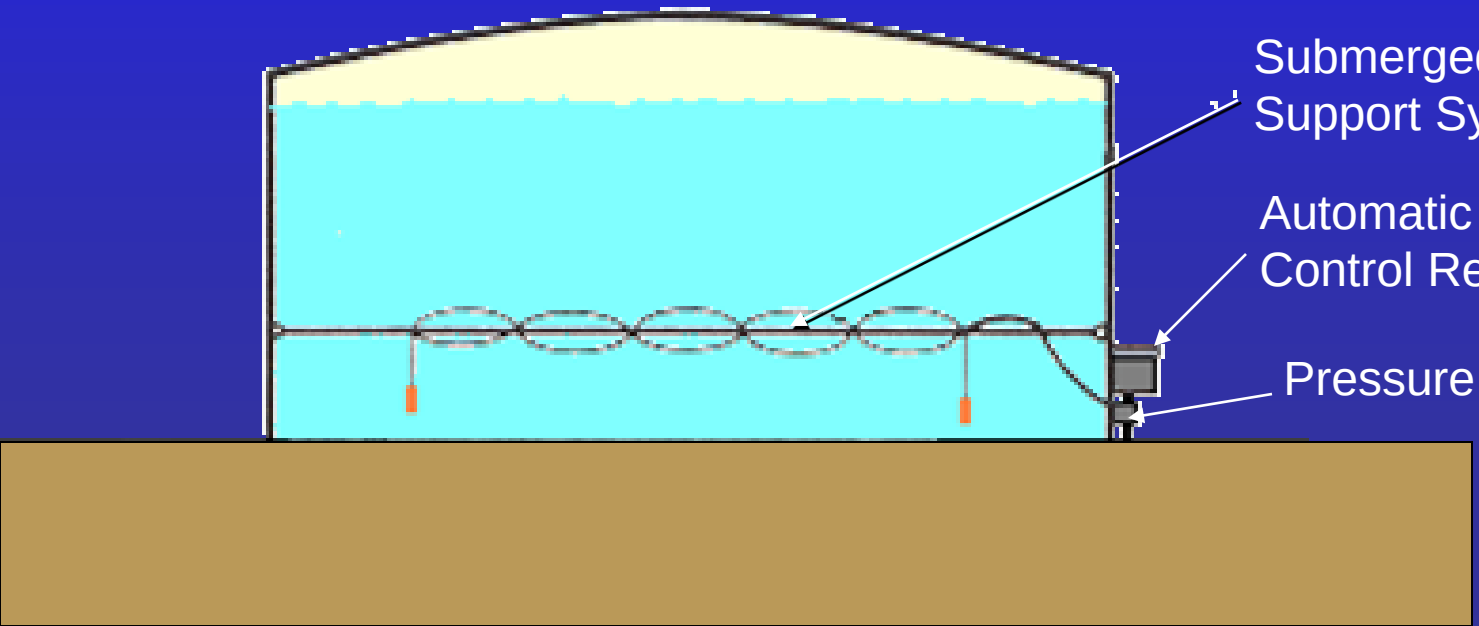
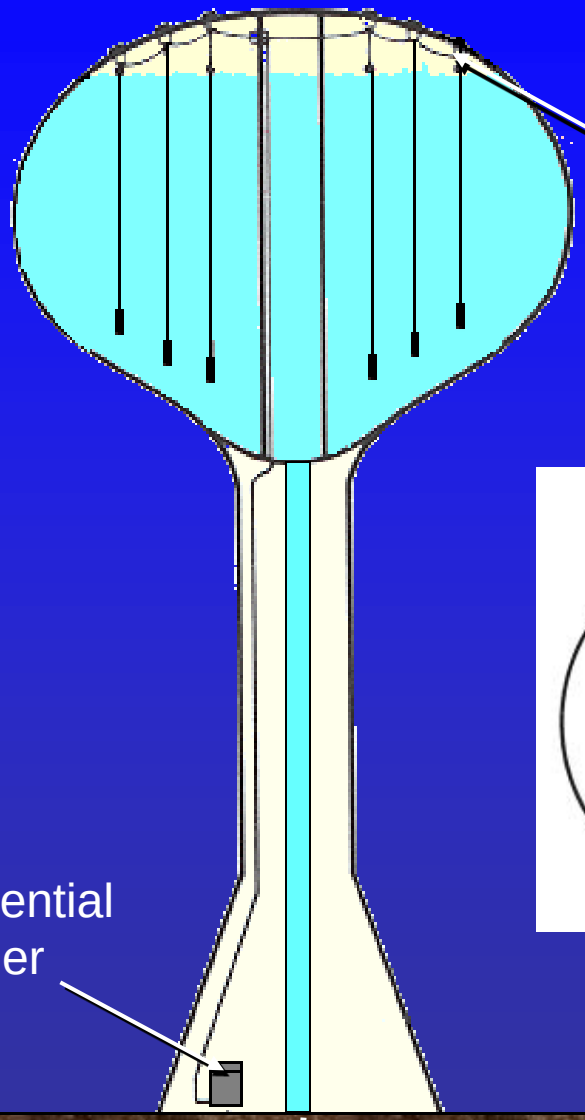
Water Storage Tanks

Suspended Horizontal Anode System





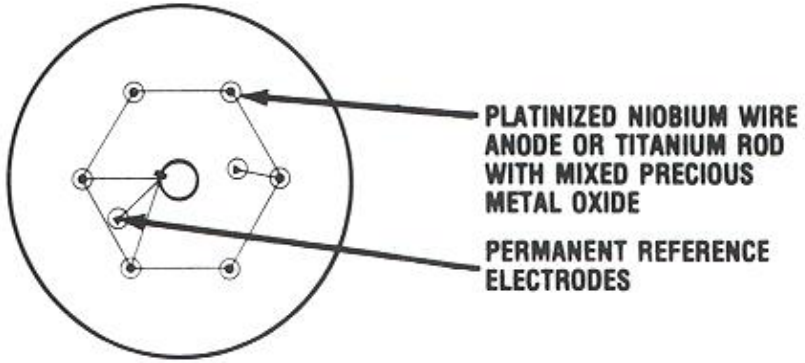
Suspended Vertical Anode System



Support System Bolted to Roof for Bowl Anodes and Reference Electrodes

Automatic Potential Control Rectifier

Top View Diagram



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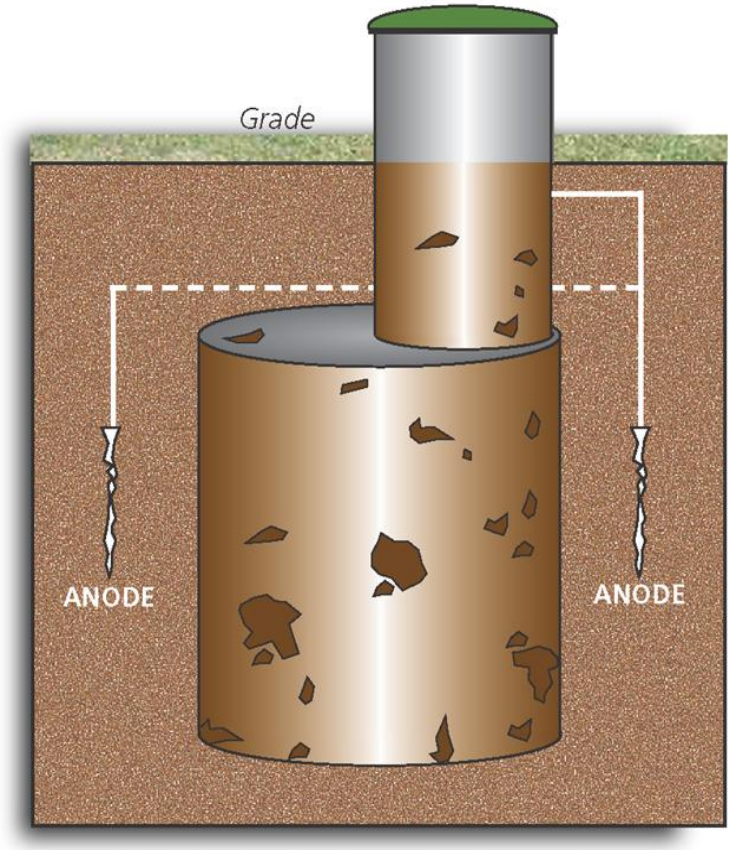
Galvanic Corrosion reaction between steel and rebar in a treatment facility

Corrosion of Clarifier Center Well

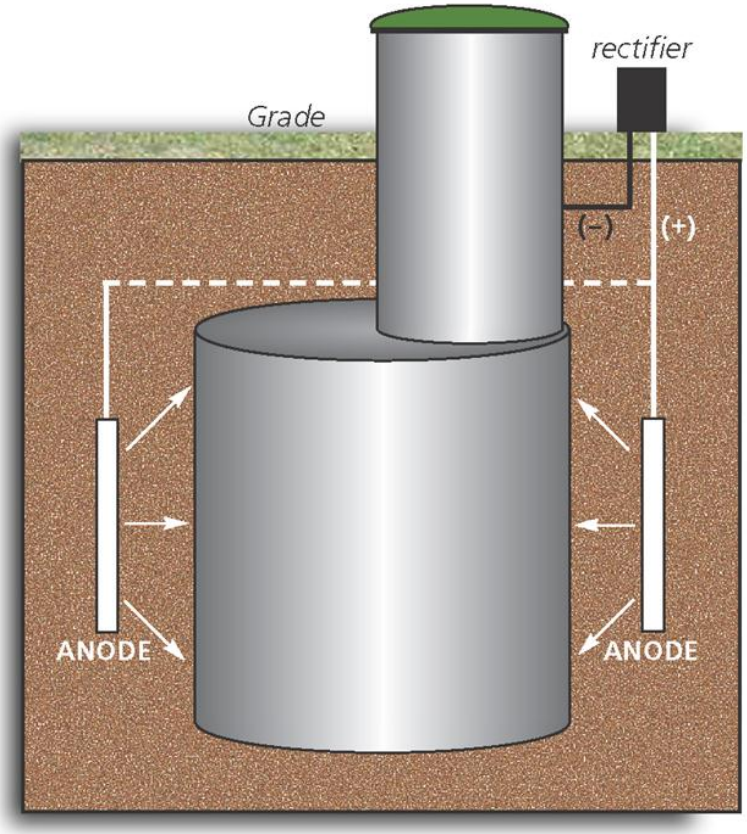
Sewage Lift Stations

CORRPRO COMPANIES INC

Depleted & Refurbished Cathodic Protection for Lift Stations



Depleted cathodic protection system allows corrosion to occur.



Effective cathodic protection system prevents corrosion and extends life of lift station.

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Factory Installed Cathodic Protection Systems

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Meter Vaults

(Keep dry if possible)

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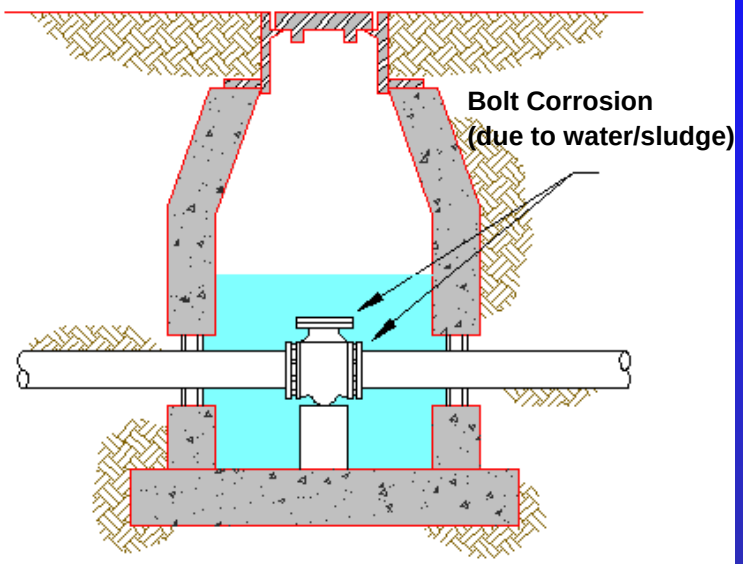
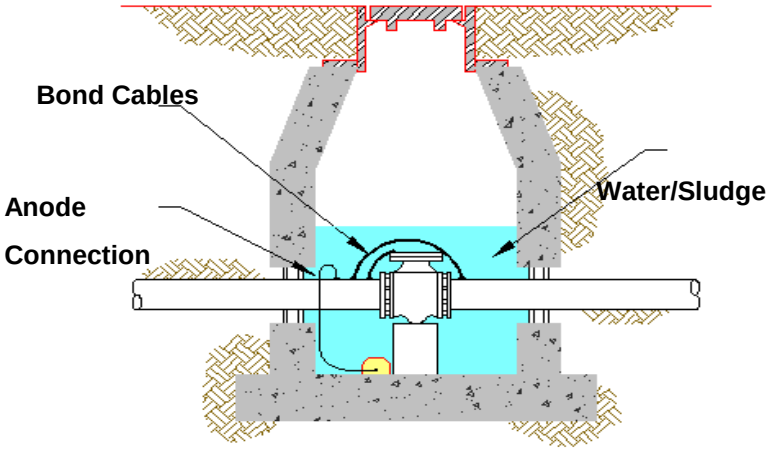


Meter Vault Corrosion



Meter Vault with Galvanic Anode

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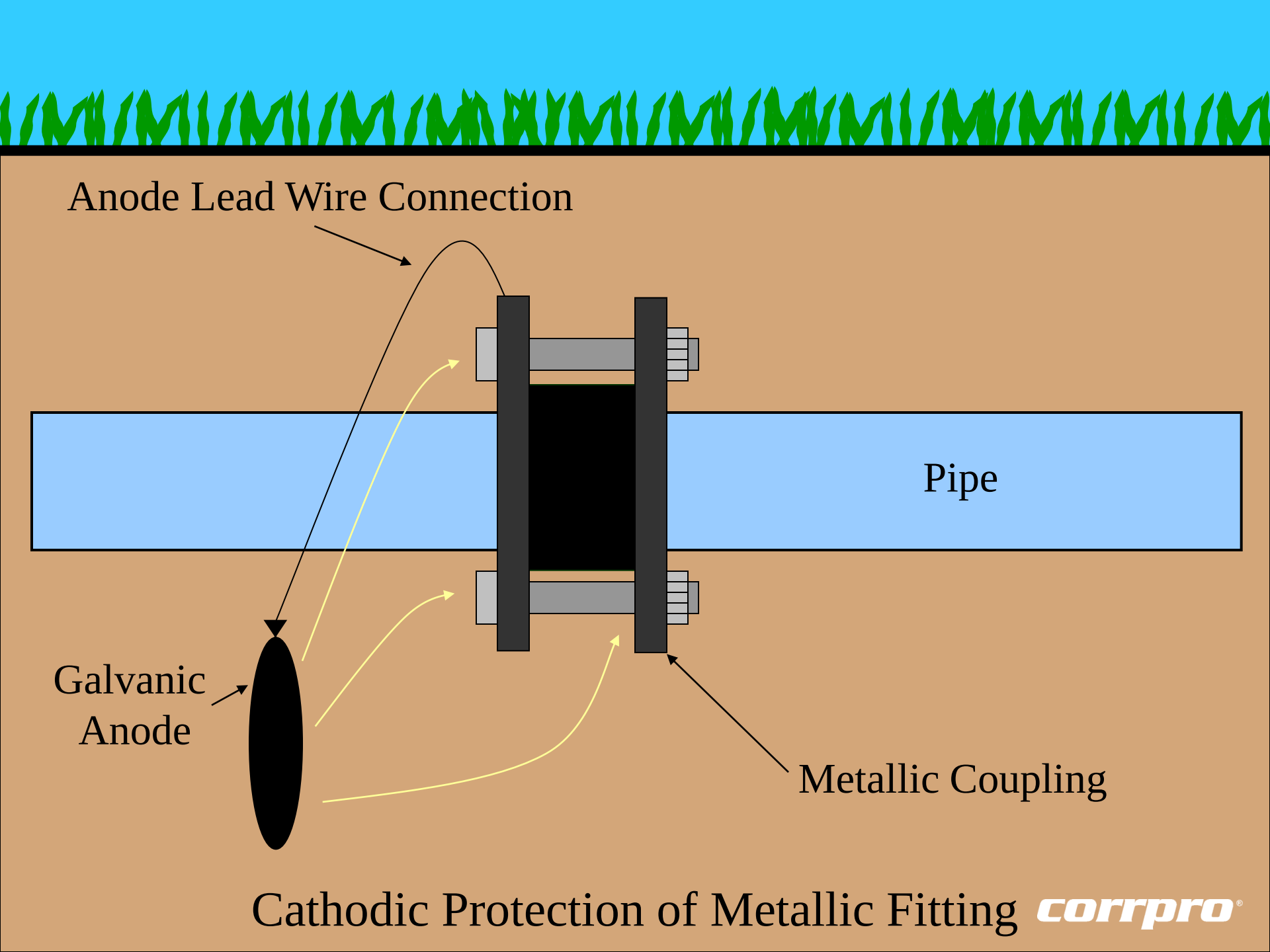
27 10:23AM



Cathodic Protection of Metallic Fitting

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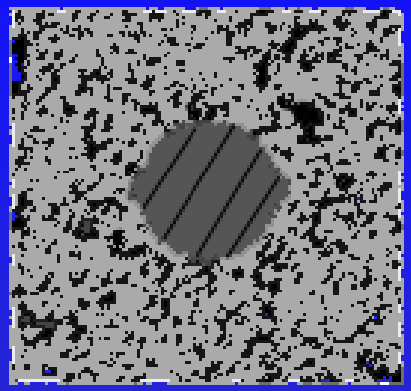
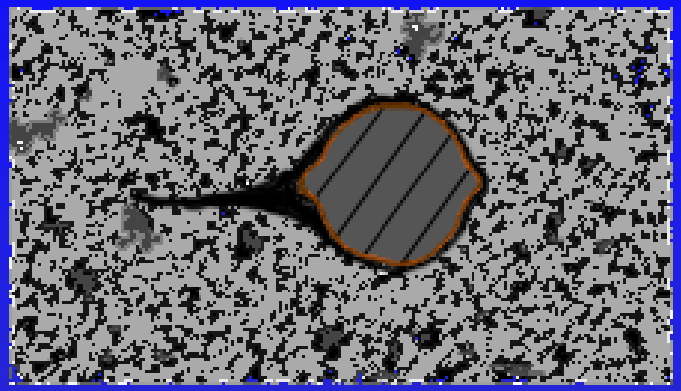
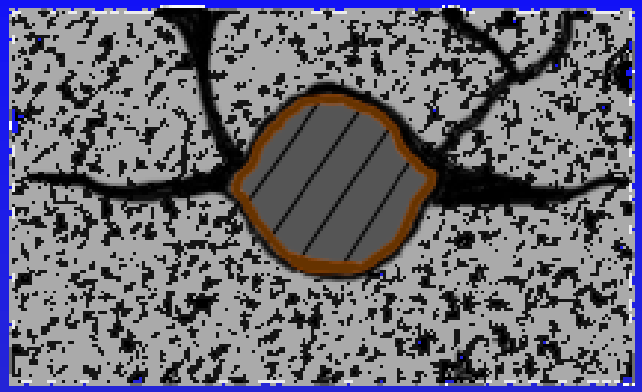
Corrosion Induced Cracking of the Concrete







- Carbonation
- Chloride Contamination

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Don’t let corrosion destroy your concrete structure!

Titanium-based anodes

Bridge Deck Installation
Baltimore, MD

LMC Overlay

Rectifier (power supply)

Summary

- Reducing corrosion rates on existing water distribution piping will result in a reduction of the number of breaks and also extend the operational life.

- Corrosion control measures should be considered during the design stage for any new metallic piping ans storage tank installations.

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Traffic Disruptions

Water Loss

Fire Protection

Legal & Environmental Claims

Damages

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QUESTIONS ?

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