Steel Underground Storage Tank
Cathodic Protection Testing Seminar

Presented by
STEEL TANK INSTITUTE

Repeatability

• Methods that help increase repeatability of results
  – Test in same locations from year to year
  – Always add water to reference cell location
  – Aim for clean, tight connections to structures

Objectives to Understand

➢ Basic principles of corrosion
➢ Basic principles of cathodic protection
➢ Criteria for adequate cathodic protection
➢ Types of instruments & equipment required
Objective to Understand

- Effects of field conditions on measurements
- Importance of reference cell placement
- Determination of electrical continuity
- Need for documentation

DEMONSTRATE

- Use of standard equipment to obtain field data
- Knowledge of continuity verification techniques
- Techniques to minimize measurement errors
- Monitoring of cathodic protection systems

Exam Requirements

- Written Exam
  - Passing grade is 75% or higher
  - Open book
  - Most questions multiple choice
- Practical Exam
  - Uses labs from class
Practical Exam

• Must be able to demonstrate:
  – Take accurate tank to soil potentials on both galvanic & IC systems.
  – From readings obtained, identify which structures pass/fail.
    • Must be able to identify what criteria (e.g. -850 mV) you used to determine pass/fail.
  – Test and identify continuity/isolation.

Purpose Of Lab A

1) Become familiar with meters & reference cells.
2) Become familiar with test boards.
3) Measure potentials of 4 metals.
4) Determine which is most anodic.
5) Learn proper way to record measurements.

Purpose Of Lab B

• Determine which metal is the anode for the 4 combinations of metals given.
• Determine which metal is the cathode for the 4 combinations of metals given.
Purpose Of Lab C

• Learn two methods to test underground structures for continuity and isolation.
• Isolation is the opposite of continuity.
• Learn what the criteria is to determine if two structures are either continuous or isolated.

Purpose Of Lab D

• Add cathodic protection to a metal.
• Learn what is:
  – Native potential
  – On potential
• Learn how to measure Instant off potential.
• Calculate polarization shift
• Learn if 100 mv criteria met.

Purpose Of Lab E

• Learn to measure output voltage and current of operating rectifier in Impressed Current System (ICCS)
• Record tap settings
• Measure resistance of potentiostat.
• Calculate output current of each shunt.
Purpose Of Lab C

- Determine if system is protected using 100 mv shift criteria.
  - Measure "on" potential,
  - Measure “instant off” potential,
  - Calculate polarization decay,
  - Is decay greater than 100 mv?
  - If so, 100 mv shift criteria is met.

Section 2
Corrosion Basics

Corrosion

- Corrosion is defined as the degradation of a material or its properties due to a reaction with the environment.
- While corrosion exists in virtually all materials, it is most often associated with metals.
Naturally Occurring Corrosion Process

- Metals Corrode in an attempt to achieve a Balance of Energy

The making of a tank...

Iron Ore → Furnace → Steel → Steel Rolling & Welding & Bending & Tightening → Tank or Pipe

METALS HAVE DIFFERENT ENERGY LEVELS

- ACTIVE (-)
- NOBLE OR PASSIVE (+)

THE ENERGY HILL
Relative Energy Levels of Various Refined Metals

<table>
<thead>
<tr>
<th>Metal</th>
<th>Energy Level (Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOLD</td>
<td>-1.7</td>
</tr>
<tr>
<td>COPPER</td>
<td>+1.2</td>
</tr>
<tr>
<td>STEEL IN CONCRETE WITHOUT Cl</td>
<td>-0.1</td>
</tr>
<tr>
<td>ZINC</td>
<td>-0.1</td>
</tr>
<tr>
<td>MAGNESIUM</td>
<td>+0.4</td>
</tr>
<tr>
<td>ALUMINUM</td>
<td>+0.9</td>
</tr>
<tr>
<td>CARBON</td>
<td>+1.2</td>
</tr>
<tr>
<td>SILVER</td>
<td>+0.9</td>
</tr>
<tr>
<td>PLATINUM</td>
<td>+0.9</td>
</tr>
<tr>
<td>GOLD</td>
<td></td>
</tr>
</tbody>
</table>

Terminology

- Cathodic protection always uses DC units
- Volts = V or E, a measure of the change in energy between two points
- Current = A, a measure of the flow of electric charge
**Terminology**

- **Amps** = the unit of current.
  Example: we measure distance in feet just as current is measured in amps.
- **R** = Resistance
  Unit of measurement is ohms, Ω.
- **Ohm’s law**: \( V = R \times I \)

**Piping Analogy**

- **Voltage** is equivalent to water pressure.
- **Current** is equivalent to flow rate.
- **Resistance** is like the pipe size.
- **Ohm’s law**: \( V = R \times I \)

**Analogy:** If you have a garden hose, and water pressure is increased, you get more water. The same happens if you increase your flow rate or your hose dia.
**Corrosion Cell**

- Cathode: Metal that receives energy and does not corrode
- Metallic Path: Metal connection that moves energy from anode to cathode
- Electrolyte: Material surrounding anode and cathode that permits ion transfer and supplies oxygen

All four components are required for corrosion to occur.

**Dry Cell Battery**

- Carbon Rod
- Zinc Casing
- Conductive Paste
- Switch
A COMMON DRY CELL BATTERY IS A GALVANIC CORROSION CELL

- Carbon Rod (Cathode)
- Zinc Case (Anode)
- Moist Paste (Electrolyte)
- Wire (Conductor)

CONVENTIONAL CURRENT

Galvanic Corrosion Process

- Metals Corrode in an attempt to achieve a Balance of Energy
- Anode - Corroding Metal Surface
- Cathode - Non-Corroding Metal Surface
- Metal Connection - Path for electron energy transfer
- Electrolyte Connection - Path for ionic energy transfer
Corrosion Control

- Isolation
  - Breaks the connection between different metals
- Coatings
  - Isolates the structure from the electrolyte
- Cathodic Protection
  - Creates a corrosion cell where structure is the cathode instead of the anode

Corrosion Cell

Coatings
Cathodic Protection

- Galvanic
  - Uses the energy inherent in different materials to create current flow.

- Impressed Current
  - Uses an outside power source to create current flow.

Galvanic Cathodic Protection

- Low Cost
- Limited current output
- Often used in new construction applications
- Typically used with coatings for corrosion control
- Typically used with dielectric fittings to contain current
Galvanic Cathodic Protection

- Magnesium and Zinc are common materials for underground applications
- Most common UST application is the sti-P3 tank
- Common application is for flex connectors used with FRP piping
- Does not require monthly monitoring

Galvanic Cathodic Protection
DIRECT ANODE CONNECTION

Anode → Current Flow → Tank
STI-P3 DESIGN FEATURES

- **Coating:** Urethane, Coal Tar Epoxy, FRP

- **Electrical Isolation:** Nylon Bushing, Flange Isolation

- **Galvanic Anodes:** Magnesium, Zinc or both

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**Impressed Current Cathodic Protection**

- Unlimited power available
- Typically used where large surface areas must be protected
- Often the only choice for upgrade of existing tank systems
- Requires bi-monthly rectifier monitoring
- Allows maximum flexibility in design
- Can create electrolytic corrosion
Section 3
Testing Equipment

Testing Equipment

Reference Cells
Voltmeters
Test Leads
Multimeters

- High input impedance
  10 MΩ minimum

- High internal resistance
  limits error in measurements

Multimeters

Auto Scale –
Useful, not mandatory

UNITS OF MEASURE

<table>
<thead>
<tr>
<th>Unit</th>
<th>Equivalent Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MILLIVOLT</td>
<td>0.001 VOLTS</td>
</tr>
<tr>
<td>VOLT</td>
<td>1.000 VOLTS</td>
</tr>
<tr>
<td>KILOVOLT</td>
<td>1,000,000 VOLTS</td>
</tr>
<tr>
<td>MEGAVOLT</td>
<td>1,000,000,000</td>
</tr>
</tbody>
</table>

Do not mix units, i.e.,
use Volts with Amps and
millivolts with milliamps
Which TERMINAL CONNECTIONS are used for each type of measurement?

- Calibrate meters at least annually, in accordance with manufacturers instructions

- Use 99% pure Copper Sulphate crystals
- Add distilled water or special antifreeze solution, about ¾ full, at least night before use
- Crystals must be visible to know that solution is saturated and good for use
- Reference cell liquid should be clear blue, not milky
REFERENCE CELLS

- Calibrate at least yearly.
- If used frequently, calibrate weekly or when exposed to contaminants.
- Reference cells are calibrated by comparing to “virgin” reference cell that is not used in field (See procedure, sect 1).

TEST LEADS

- Check your Test Leads
- SPLICES
- FRAYED ENDS
TEST LEADS

Poorly insulated test lead in puddle of water will create error in measurement

Section 4
CP test – sti-P3 tank
Basic Test Equipment

Tank to soil potential

Tank to soil potential readings

- Place reference cell in moist soil or backfill
- Fuel, frost, vegetation will affect readings
- Do not place reference cell on concrete
Summary of Test Procedure for sti-P3 Structure Potentials

- Set Meter to 2 DC Volts (unless auto-adjusting)
- Take the cap off the reference cell
- Plug black lead into the negative terminal on multi-meter and clip to reference cell.
- Place red lead into the positive terminal and clip to the structure under test.
- Place reference cell in remote earth – normally 30 ft from tank, adding water to dirt as needed
Summary of Test Procedure
For sti-P3
Structure Potentials

- Record the measurement and reference cell placement on site map
- Move reference cell to center of tank
- Continue moving reference as needed to obtain required number of readings & accurate test.
- Record all measurements and reference cell placements on site map
LOCAL & REMOTE TESTING OF GALVANIC CP SYSTEMS

Local Potential
Reference cell is directly over tank

Note that Reference Cell element has been covered with at least 6" of approved moist backfill.
LOCAL & REMOTE TESTING OF GALVANIC CP SYSTEMS

Remote Potential
Reference cell is 25-100 feet away from tank

WHY MEASURE THE REMOTE?

- Mitigate environmental factors that can influence test measurements over tank ("shielding")
- Eliminate influence nearby anodes can have on test measurements over tank ("raised earth")

WHAT DOES THE LOCAL POTENTIAL MEASURE?

3 test point rule commonly applied
4X
Only the top portion of tank is measured
Reference Cell radius of influence = 4X height above structure

LOCAL & REMOTE TESTING OF GALVANIC CP SYSTEMS

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WHAT DOES THE LOCAL POTENTIAL MEASURE?

3 test point rule commonly applied
4X
Only the top portion of tank is measured
Reference Cell radius of influence = 4X height above structure
Accurate Structure Potentials

Observe the potential. If it’s jittery or unstable re-adjust clips. Check electrode contact. Check the test leads.

CIRCUIT RESISTANCE

STRUCTURE CONNECTIONS

Poor Cadweld Connection Test Lead
TEST LEADS

- FRAYED ENDS
- SPLICES

POORLY INSULATED TEST LEAD

UNDERGROUND PIPELINE

Improper Reference Cell Placement

- Concrete
- Asphalt
- Frozen Soil
- Gravel, Rock, Stone
- Dry Soil
- Plastic Lines Beneath Flower Beds
COMMON SENSE

Put on your thinking cap. If the data doesn't make sense it's probably wrong!!

Testing other structures

- When testing a galvanic cathodic protection system, you should test all metal structures that routinely contain product
- Flex connectors
- Metal product piping
- Place reference cell away from anodes

Electrical Isolation

- Structures that are electrically isolated do not touch in any way
- Structures that are electrically continuous are grounded to each other
- Galvanic cathodic protection normally requires the structure to be isolated.
- sti-p3 tanks are designed to electrically isolated from all other
Nylon bushings

Not if conduit is sitting on tank

Electrical Continuity

• Structures that are electrically continuous are grounded to each other
• Impressed current cathodic protection requires all underground structures to be continuous with the system.
• Continuity is critical for ICCS
METHODS TO TEST CONTINUITY

• Do not attempt to test continuity with an ohm meter (flashlight method).
• An ohm meter is not a good instrument for continuity measurements of buried structures due to galvanic voltages between structures

FIXED CELL MOVING GROUND

• Reference cell is placed in remote soil at least 30 feet from all metallic structures
• Measure the potentials of various structures within the facility with respect to the reference cell
• Potential differences between measurements should be less than 0 or 1 millivolt

Methods To Test Continuity

FIXED CELL MOVING GROUND

• Reference cell is placed in remote soil at least 30 feet from tank and away from all metallic structures
• Measure the potentials of various structures on site with respect to the reference cell, such as tank rises, pump, ATG
• Potential differences between measurements should be greater than 10 millivolts
METHODS TO TEST CONTINUITY

POINT TO POINT METHOD
– Electrical contact is made directly to the tank and a separate contact made to another structure
– Potential difference should be 0 or 1 mV to verify continuity
– Potential difference should be greater than 10 mV to verify isolation
– Readings between 2 and 9 mV unsure

Lab C - Continuity
• Learn two methods to test underground structures for continuity and isolation.
• Isolation is the opposite of continuity.
• Learn what the criteria is to determine if two structures are either continuous or isolated.

Section 6
CP Test – Impressed Current Cathodic Protection System (ICCS)
Rectifier

Anode Junction Box

Rectifier

Used for Impressed Current Cathodic Protection

Rectifier models differ by manufacturer and project specifications

Transformer Taps

For Adjusting AC To Diodes

Panel Meter

Fuse

Shunt

Circuit Breaker

Structure Connection (Negative)

Anode Connection (Positive)

Diodes To Convert AC To DC Located Behind Panel

Typical Rectifier Components
TYPICAL RECTIFIER

1. Data Plate
2. On/Off Switch
3. Tap Settings
4. Fuse
5. Hour Meter
6. Amperage
7. Voltage
8. Shunt
9. Negative
10. Positive

Impressed Current System

• The negative connection from the rectifier ALWAYS goes to the structure being protected!
Impressed Current Cathodic Protection

Typical Impressed Current System

One math fact you need to know!
OHMS LAW

E = Volts, I = Current, R = Resistance
SAFETY FIRST!!!!

Rectifier Testing
DO NOT TURN THE RECTIFIER OFF PRIOR TO INITIAL TEST
• There is 110 or 220 Volts AC to rectifiers
• Tap the rectifier with the back of your hand before grabbing for the lock.
• If you’re not comfortable working on a live unit
  • Turn it off
  • Make your connections
  • Turn it back on
  • Make measurements
  • Turn it off
  • Disconnect test leads
  • Turn it back on

Test Procedure for ICCS Structure Potentials
1. Set Meter to 20 DC Volts (unless auto-adjusting)
2. Take the cap off the reference cell
3. Plug black lead into the negative terminal on multi-meter and clip to reference cell.
4. Place red lead into the positive terminal and clip to the structure under test.
5. Place reference cell directly over center of tank, or as close as possible adding water to backfill as needed
Test Procedure for ICCS Structure Potentials

6. At rectifier, measure output voltage of rectifier
   1. Connect negative end of voltmeter to negative on rectifier
   2. Connect positive end of voltmeter to positive on rectifier

MEASURE RECTIFIER OUTPUT VOLTAGE
Set voltmeter to DC volts
Select scale (or auto ranging)
Read directly off voltmeter

Rectifier Voltage Measurements
Test Procedure for ICCS Structure Potentials

7. At rectifier, using rectifier shunt, measure output current

1. The following series of slides will illustrate how to do this.

**RECTIFIER SHUNTS**

Common Ratings

- 50 mV = 5 A
- 50 mV = 10 A
- 50 mV = 15 A

The Shunt Rating will be provided on the rectifier or the shunt

**OHMS LAW**

\[ I = \frac{E}{R} \]

\[ E = I \times R \]

\[ R = \frac{E}{I} \]

E = Volts, I = Current, R = Resistance
**Rectifier Shunts**

Common Sizes
- 50 mV = 5 A
- 50 mV = 10 A
- 50 mV = 15 A

Calculate Shunt Factor
- 50 mV = 5 A: \( \frac{5}{50} = 0.1 \)
- 50 mV = 10 A: \( \frac{10}{50} = 0.2 \)
- 50 mV = 15 A: \( \frac{15}{50} = 0.3 \)

**Measure Rectifier Current Output**

Rectifier Shunt: 50 mV = 10 A
Shunt Factor: \( \frac{10}{50} = 0.2 \)

Set voltmeter to mV scale

Current = 20 mV x 0.2 = 4 Amps = 4000 mA

**Rectifier Current Measurements**

- Turn Meter to millivolt scale
- Connect Red Test Lead to one screw as shown
- Connect Black Test Lead to other screw as shown
- Record the millivolt reading
- Record the shunt rating
- Calculate the actual current output and compare to the Rectifier Ammeter.
Rectifier Current Measurements

**Test Procedure for ICCS Structure Potentials**

8. Record “on” reading at first reference cell location for Structure #1
9. Take instant off potentials at same location
10. Take minimum 3 readings on all tanks
11. Each time reference cell is moved, take instant off potential

**STRUCTURE CONNECTIONS**

- Good electrical contact to structure critical
- Use test wires if present. Probe interior of tanks to verify wires are continuous
- Do not use rectifier negative cables for potential measurements
- Verify continuity between fills, tank risers, etc.
Instant off readings:
1) See Procedure in Section 1
2) Record tank potential “on” readings
3) Temporarily interrupt rectifier
4) Record 2\textsuperscript{nd} reading on voltmeter when anode disconnected as “Instant Off”
5) The 2\textsuperscript{nd} number is used because of the way digital voltmeters display data

Current Interrupters
Eliminate IR Drop by temporarily turning the rectifier off
When \( I = 0 \), \( I \times R = 0 \) and IR Drop error is removed from measurement.

A Current Interrupter is an ON-OFF switch that operates on an operator determined timing cycle

Test Procedure for ICCS Structure Potentials
12. Record the measurement and reference cell placement on site map
13. Continue moving reference as needed to obtain required number of readings & accurate test.
14. If needed for 100 mV criteria, turn rectifier off and repeat after 1 – 24 hours to obtain static reading
**REFERENCE CELL LOCATIONS FOR TANK-TO-SOIL POTENTIALS**

- Place reference cell directly onto soil
- Over or near the tank and piping
- Maximize distance from anodes

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**Static potential**

- Static reading is sometimes called the depolarized potential... it is the potential of the structure without the influence of any cathodic protection on it.
- The static potential can be obtained by leaving rectifier off until a steady reading is obtained on the voltmeter.

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**Test Procedure for ICCS Structure Potentials**

15. Check all structures for continuity with tanks and ICCS
Cathodic Protection Monitoring

Must have:
- Electrical continuity of all protected facilities
- Good electrical contact with tanks
- Adequate records/drawings of buried facilities and cathodic protection equipment

At rectifier record:
- Rectifier operating DC Volts and DC Amperes
- Hour of operations if meter present
- Site Location
- Rectifier Serial No.

Test Procedure for ICCS Structure Potentials

16. If anode box is present, calculate current through each anode.

Anode Circuit Shunts

Common Size = 0.01 ohm

Instead of using Ohm’s Law - A shunt “factor” of 100 can be used for these wire type shunts when calculating circuit current

- “Bus Bar”
- Calibrated Shunt
- Rectifier Positive Lead
- Anode Leads (8 in this system)
**Test Procedure for ICCS Structure Potentials**

17. Compare total anode current output to measured rectifier output from step 7.

**Comparing Total Circuit Current To Rectifier Current Output**

<table>
<thead>
<tr>
<th>Positive Circuit</th>
<th>Negative Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anode 1 = 700 mA</td>
<td>Tank 1 = 1125 mA</td>
</tr>
<tr>
<td>Anode 2 = 450 mA</td>
<td>Tank 2 = 880 mA</td>
</tr>
<tr>
<td>Anode 3 = 0 mA</td>
<td>Tank 3 = 1000 mA</td>
</tr>
<tr>
<td>Anode 4 = 550 mA</td>
<td>Tank 4 = 620 mA</td>
</tr>
<tr>
<td>Anode 5 = 1200 mA</td>
<td>TOTAL = 3625 mA</td>
</tr>
<tr>
<td>Anode 6 = 680 mA</td>
<td></td>
</tr>
<tr>
<td>Anode 7 = 0 mA</td>
<td></td>
</tr>
<tr>
<td>Anode 8 = 400 mA</td>
<td></td>
</tr>
<tr>
<td>TOTAL = 3980 mA</td>
<td>Remember: Rectifier Output measured as 4000 mA</td>
</tr>
</tbody>
</table>
Comparing Total Circuit Current To Rectifier Current Output

• Conclusions
• Current distribution among anodes good
• 2 of the anodes are “dead” (0 current measured)
• Anode output (3900 mA) nearly equal to rectifier output (4000 mA)
• Most of the current is reaching tanks (only lost 300 mA)
• Impressed Current system is probably providing adequate protection

Use Ohm’s Law to find Current

Practice Problem #1
E = 6 mV
R = 0.01 ohm

Cover up the I
And you’re left with
\[ \frac{E}{R} = \frac{6 \text{ mV}}{0.01 \text{ ohm}} = 600 \text{ mA} \]

How much Current is Flowing?

Practice Problem #2
Shunt resistance =
R = 0.001 ohm

E_1 = 6.5 mV
E_2 = 3.2 mV
E_3 = 4.7 mV
Practice Problem #2

How much Current is Flowing through Shunt 1?

Cover up the I
And you’re left with

\[ \frac{E}{R} = \frac{6.5 \text{ mV}}{0.001 \text{ ohm}} = 6500 \text{ mA} = 6.5 \text{ Amps} \]

Cathodic Protection Surveys

- Surveys must be performed by a cathodic protection tester
- Surveys should include:
  - Potential survey
  - Continuity testing (for impressed systems)
  - Rectifier operation (for impressed systems)
  - Shunt readings (for impressed current systems)
- Always include a detailed report of findings and recommendations for continued operation.

Cathodic Protection Surveys

- At rectifier record:
  - Rectifier operating DC Volts and DC Amperes
  - Hour of operations if meter present
  - Site Location
  - Rectifier Serial No.
Section 8 Criteria

Cathodic Protection Criteria measured with a copper/copper sulfate reference cell

• -850 mV Structure to Soil Potential
  – Measurement must allow for IR Drop.

• 100 mV Polarization

NACE CRITERIA FOR STEEL AND CAST IRON

*100 mV Polarization
  - Polarization formation
  - Polarization decay

Instant “Off”

> 100 mV Polarization Decay
IR DROP IN VOLTAGE MEASUREMENTS

Current flow through a resistor creates a voltage drop.

\[ E = I \times R \]

IR drop must be removed from the measurement to obtain the actual potential of the structure.

Eliminate the current flow for a short time period, \( I = 0 \) AND \( I \times R = 0 \)

100 MV shift

- A tank meets the 100 mV shift criteria, if:
  - The tank is not connected to significant amounts of copper or stainless steel, and
  - The difference between the instant off potential and the native potential (depolarized potential) is at least 100 mV.

\[ V \text{ “instant off”} - V \text{ “off”} \geq 100 \text{ mV} \]
Cathodic Protection Criteria measured with a copper/copper sulfate reference cell

-850 mV Structure to Soil Potential
  - Measurement must allow for IR Drop.
- 100 mV Polarization
- STI-P3 Criterion -850 mV Structure to Soil Potential.
  Anodes permanently connected to LAB

LAB

- Criteria
  - 100 mV

STRAY CURRENT

- Man made corrosion
- An external source of direct current (DC) traversing through the soil (electrolyte) strays onto the structure
- Cathodic reactions occur (protection) where the current is picked up by the structure
- Anodic reactions occur (corrosion) where the current leaves the structure
Cathodic Protection Monitoring

- All systems must provide the ability to test the cathodic protection system
- Impressed Current Rectifiers must be inspected at least every two months.
- Cathodic protection systems must be surveyed by every three years (or more often if state requires it)
Cathodic Protection Surveys

- Surveys must be performed by a cathodic protection tester
- Surveys should include:
  - Potential survey
  - Continuity testing (for impressed systems)
  - Rectifier operation (for impressed systems)
  - Shunt readings (for impressed current systems)
- Always include a detailed report of findings and recommendations for continued operation.

Section 10
Additional Field Tests

- Continuity testing
- Fixed cell moving ground
- Point to point contact method
- Current requirement test
- Soil resistivity testing

Troubleshooting tests
Soil Resistivity

Measurements

Soil Resistivity values are used to determine the number of anodes required if an STI-P3 tank requires supplemental anodes.

Soil Resistivity Test

(Big dial) * (Small dial) * (Multiplier)

Example:
Pin spacing = 10 ft 5" (therefore M = 2000)
Big dial = 2.2
Small dial = 1

2.2 * 1 * 2000 = 4400 ohm-cm
**Terminology**

- Resistance (R) = measured in ohms Ω
- Soil Resistivity is measured in ohm-cm (ohm-centimeters)
- Soil resistivity is a measure of how corrosive the soil is
- The lower the number, the more corrosive

**Current Requirement Test**

Limited to sti-P3 tanks that require no more than 30 milliamps of current to bring the tank to protected levels.

![Current Requirement Test Diagram](image)

**Figure 1**

Current Requirement Test Setup
Recommended Practice for Addition of Supplementary Anodes

- STI R972-01 (In Section 4, class book)
- Available on STI Web Site
  www.steel tank.com
- History behind original formation of document was to assist tank owners in testing their P3 tanks for cathodic protection

**Figure 3**
Placement of Supplemental Anodes Around Tank

**Record Keeping**

[Image of a record-keeping form]
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