Introduction to Cathodic Protection and Testing

August 1, 2019
NEIWPCC Webinar

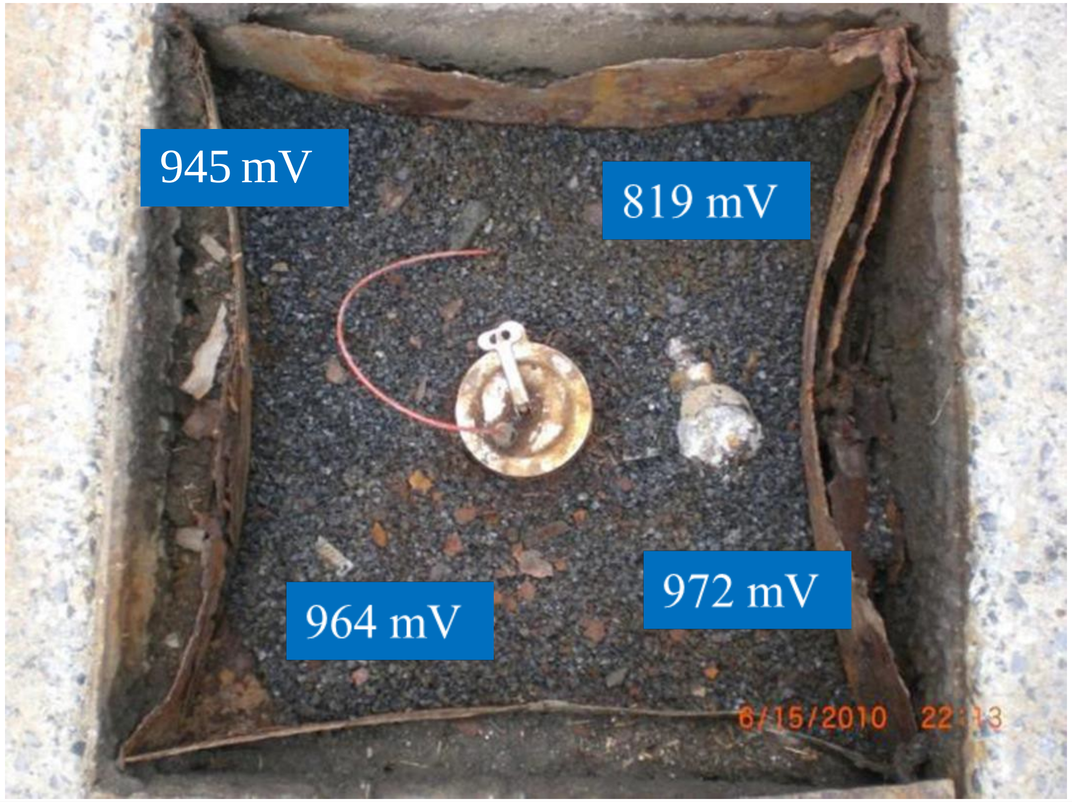
Steve Pollock

Technical Manager

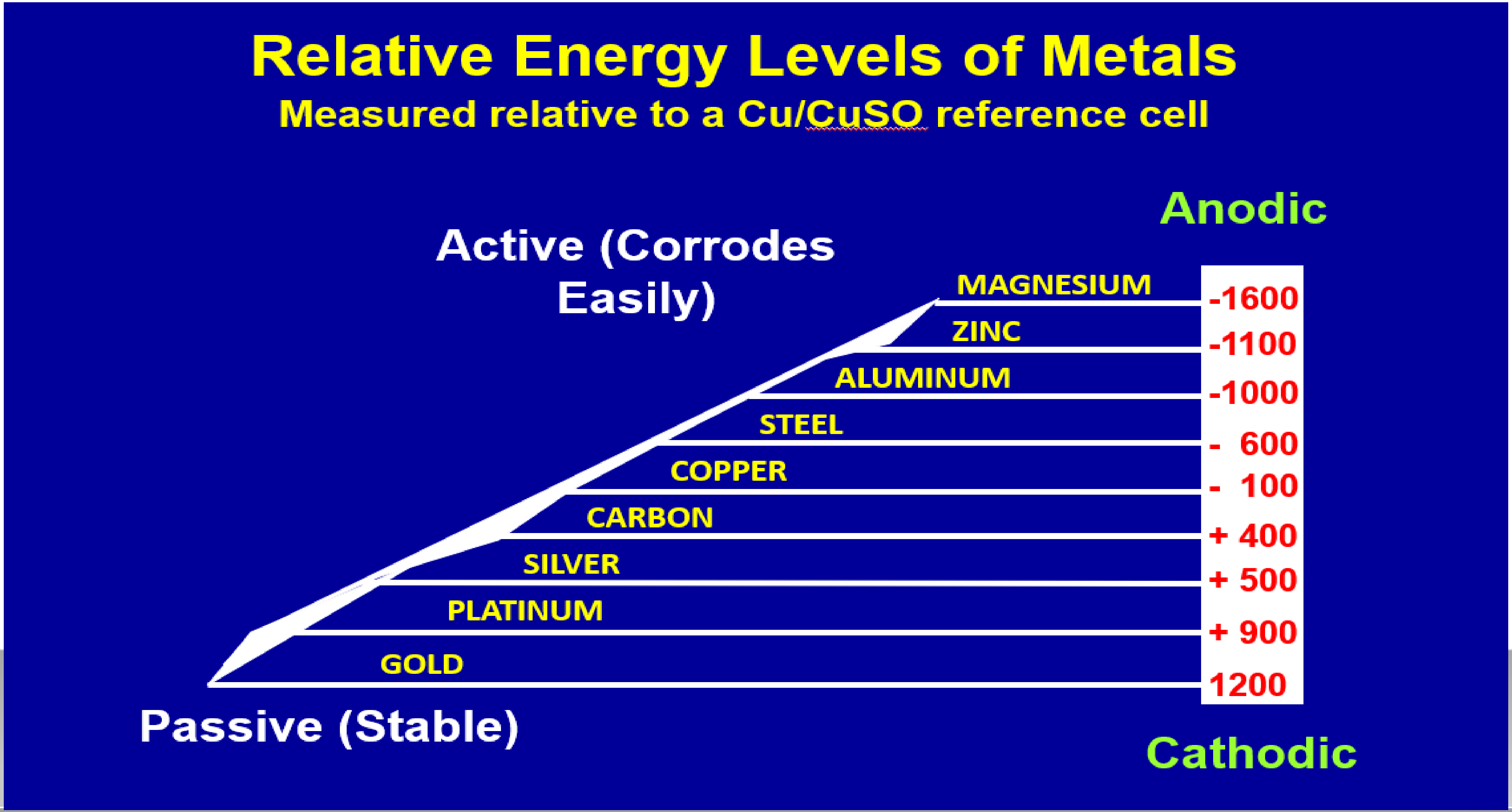
Steel Tank Institute/Steel Plate Fabricators Association

What we will cover

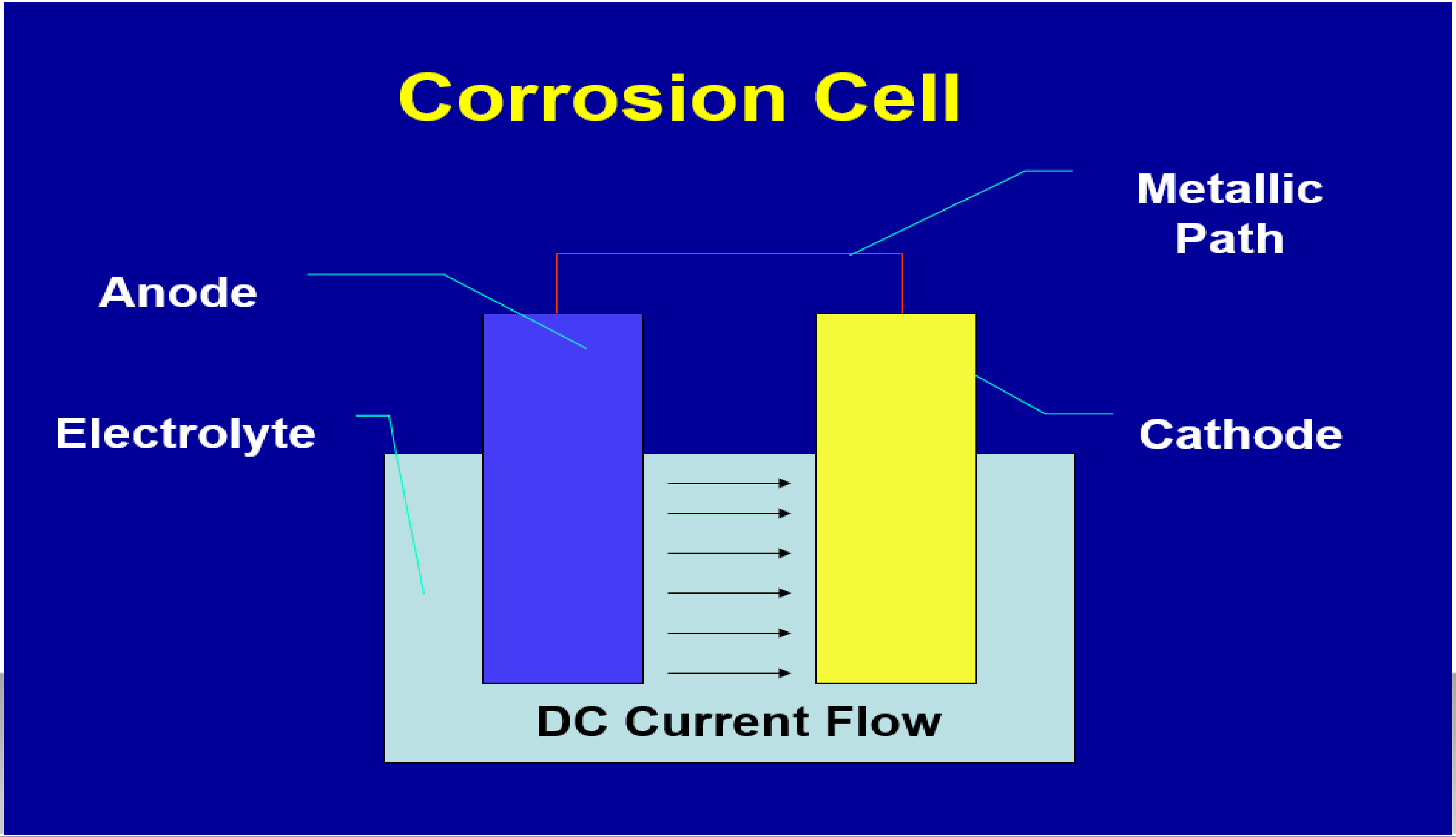
- Degradation and corrosion
- Corrosion Control
  - Galvanic series
  - Corrosion cell
- History of steel tank corrosion protection
- UL 1746 – External Corrosion Protection for Steel Underground Storage Tank Systems
- Test Protocol
- Supplemental Anodes



Corrosion Control



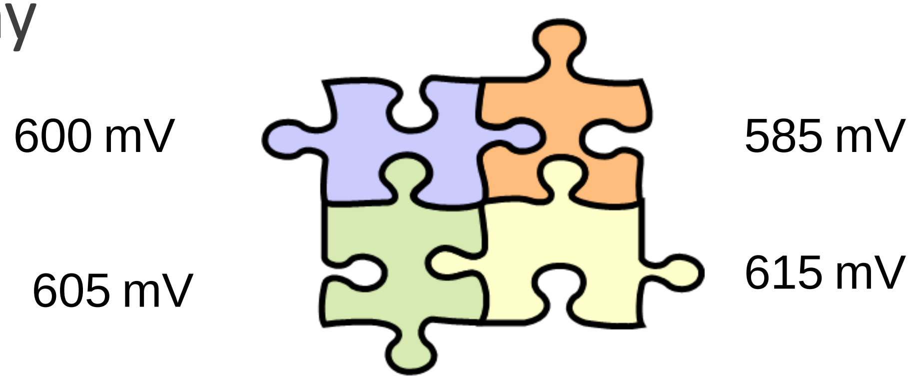
Corrosion Control



Corrosion Control

So if a buried steel tank is completely isolated from soil (like a sti-P3 tank) why are we concerned about corrosion?

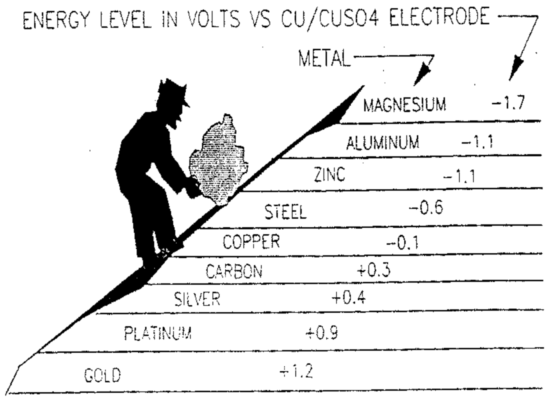
- Steel is made up of many different “crystals”, each of which could have a different electropotential.
- The potential you measure is actually an average of all the steel “crystals” that make up a typical tank.



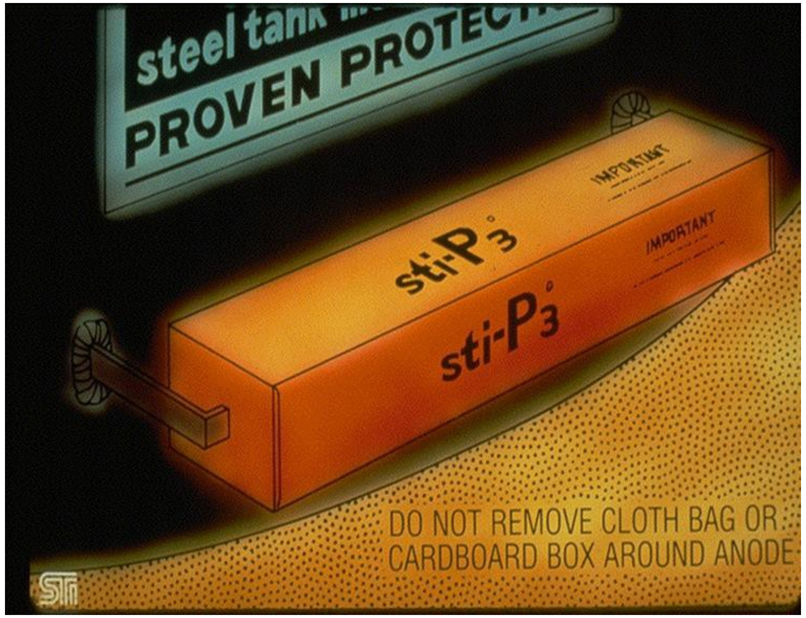
What is a sti-P3 tank?

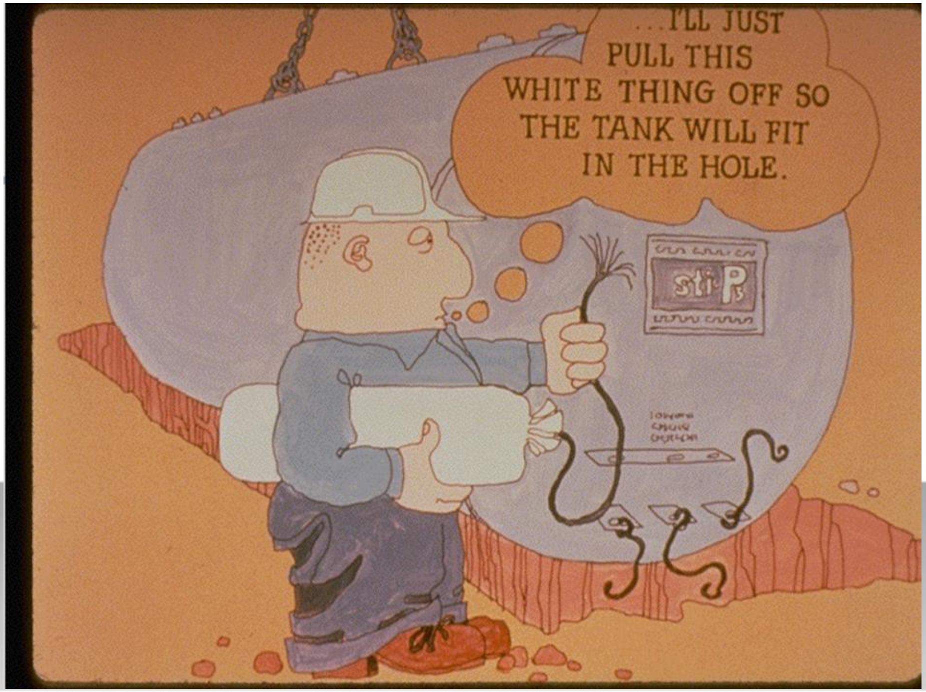
- Pre-engineered factory fabricated cathodically protected steel tank with three modes of corrosion control
- 1 electrical isolation
- 2 external coatings
- 3 galvanic anodes
  - a. weld-on anodes

Nature has endowed each metallic substance with a certain natural energy level or potential.



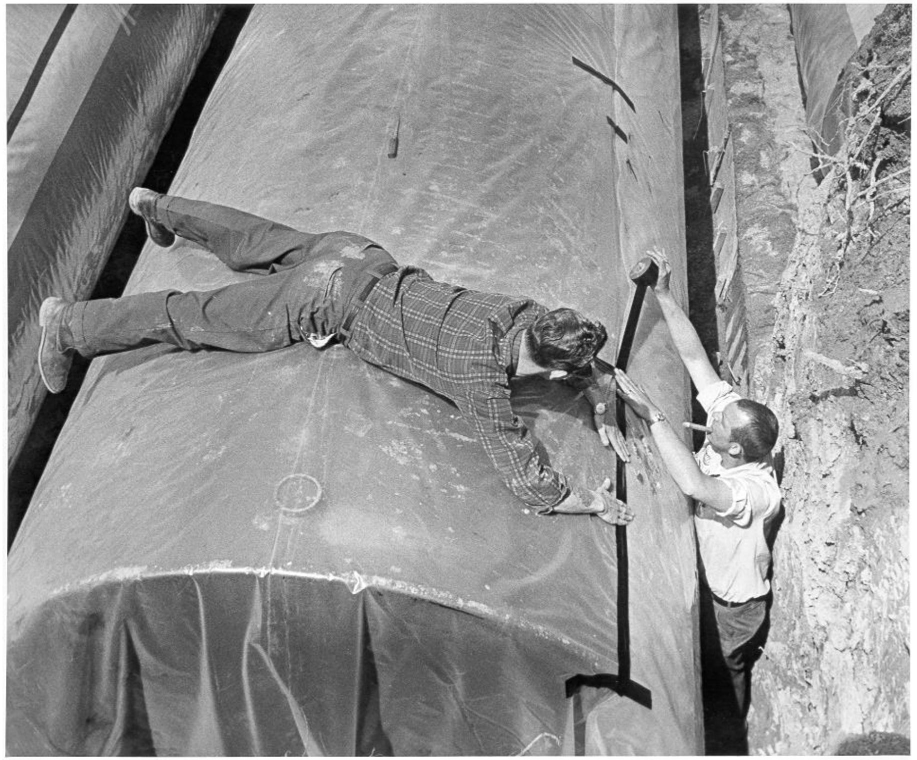
GALVANIC ENERGY SERIES





Steel Tank Corrosion Control

- 1959 – bag wraps
- 1968 STI-LIFE
  - Steel with fiber reinforced plastic coating
  - Standard in effect for 5 years
  - Production specs, QC program
- 1969 – sti-P3
  - Coating improvements
  - Anode and bushing testing
- 1987 – ACT-100 (Association of Composite Tanks)

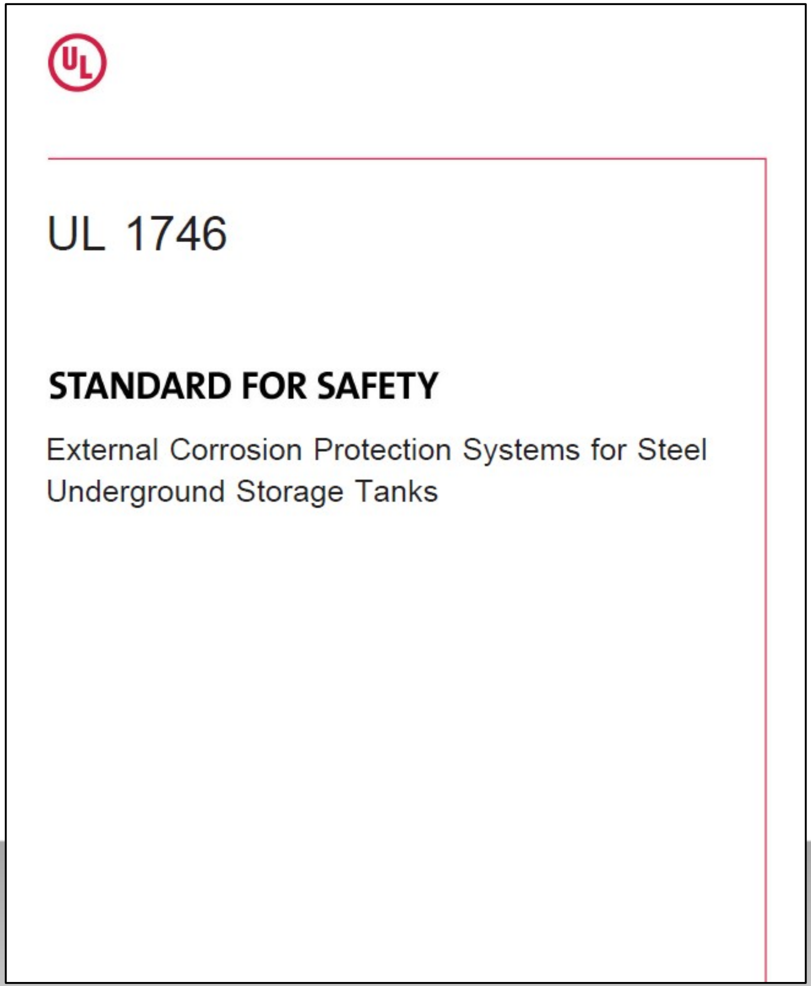


UL 1746 – designs and testing

- Tanks built to UL 58
- Part I Preengineered Cathodic Protection Systems
  - Components are: galvanic anodes; backfill material for anodes; insulating bushings and gaskets; dielectric coatings; pressure wire connectors; test station provision
- Part II Composite Tanks
  - Components are: steel tank; non-metallic external coating fabricated to at least 0.100”; nonmetallic caps for attachments
- Part III Jacketed Tanks
  - Components are: steel tank with a nonmetallic external FRP, polyurethane, polyurea or thermoplastic jacket; nonmetallic caps to cover external attachments; interstitial space providing minimum of 300 degrees of secondary containment centered at tank bottom and 100% containment at heads.

UL 1746 – designs and testing

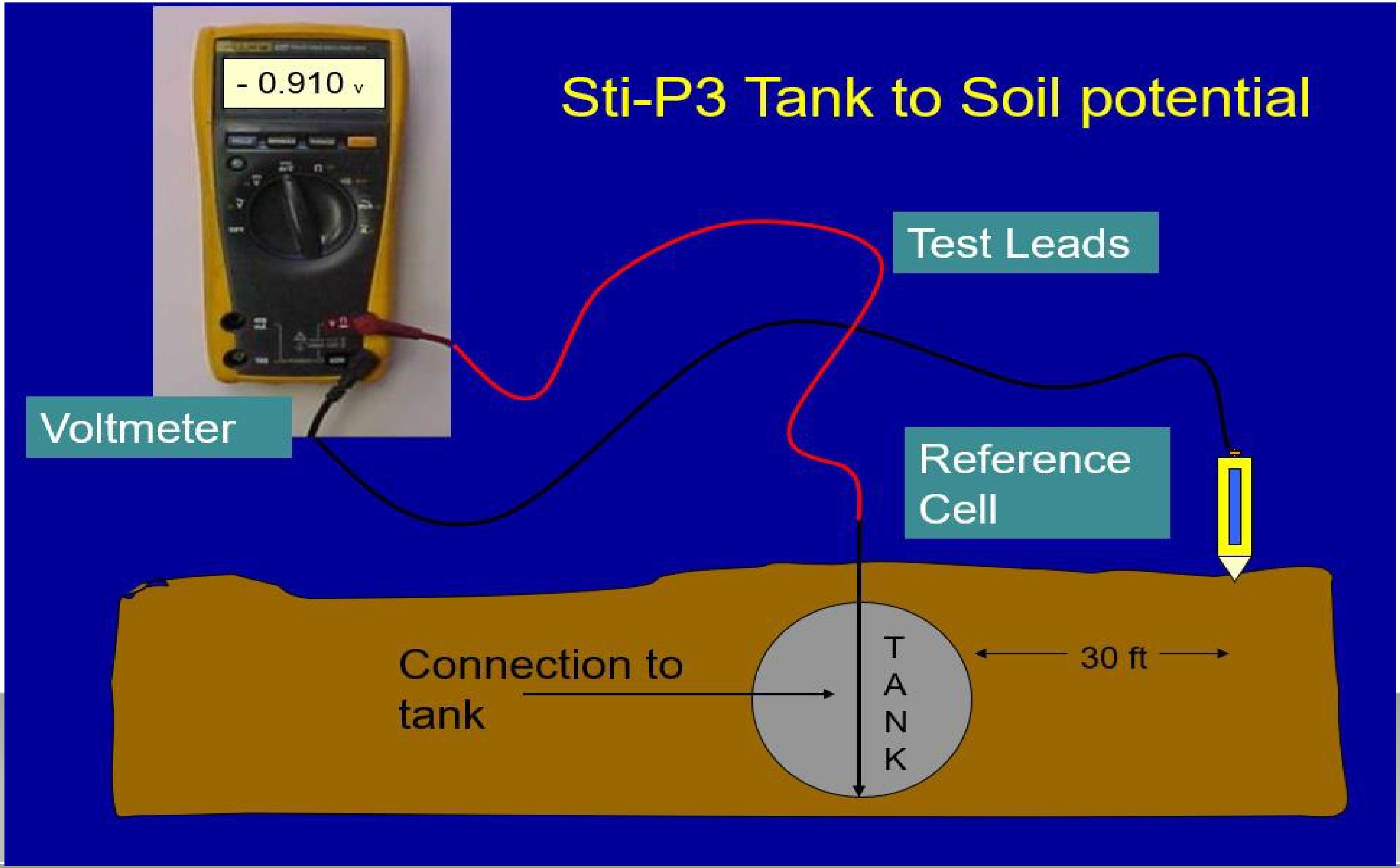
- UL performance testing (not all inclusive)
- Components
  - Aging
  - Flexibility
  - Liquid compatibility
  - Environmental performance
  - Corrosion and permeation
- Completed tank
  - Impact
  - Lift lugs
  - Annulus
  - Holiday


UL 1746

STANDARD FOR SAFETY

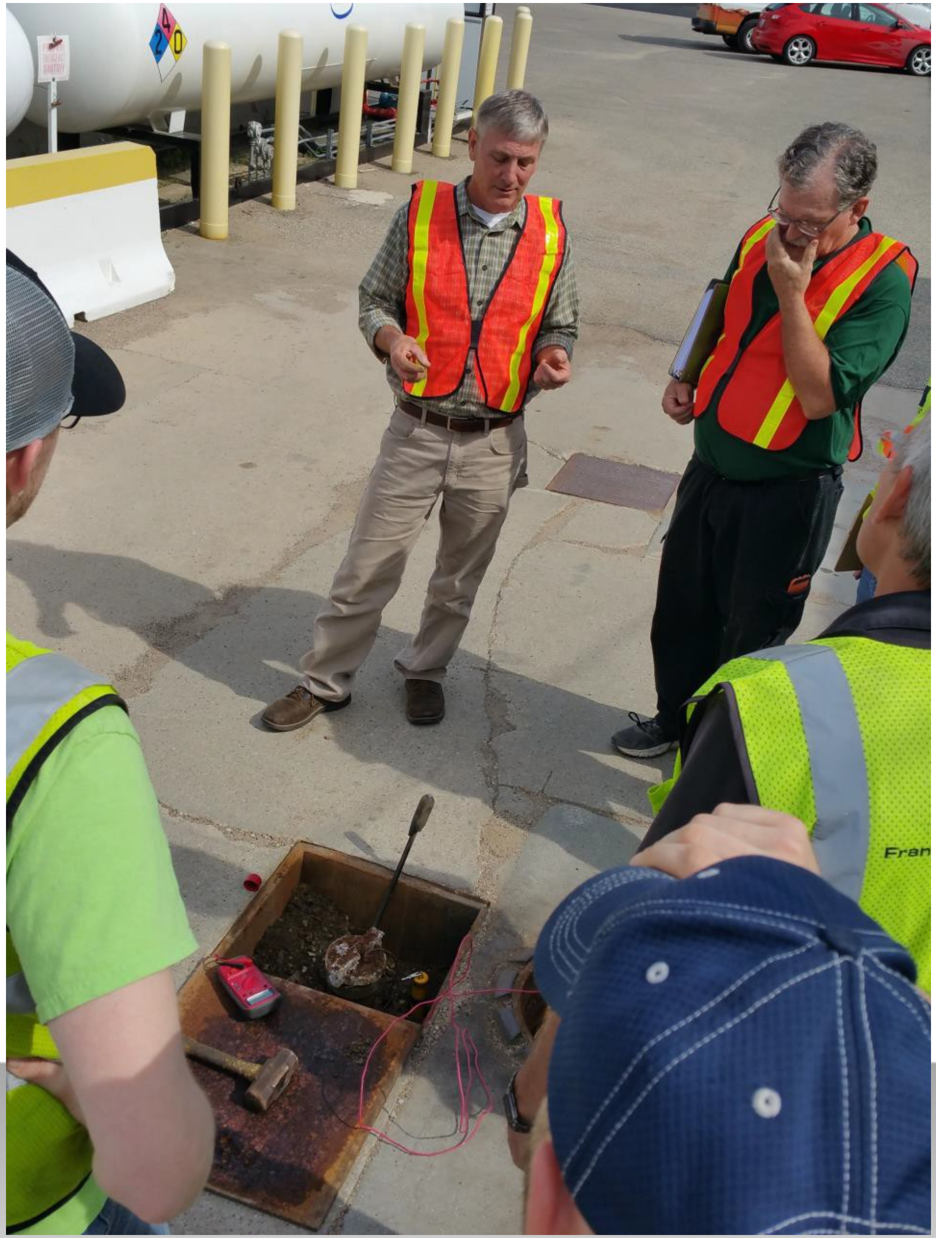
External Corrosion Protection Systems for Steel Underground Storage Tanks

Galvanic System Testing

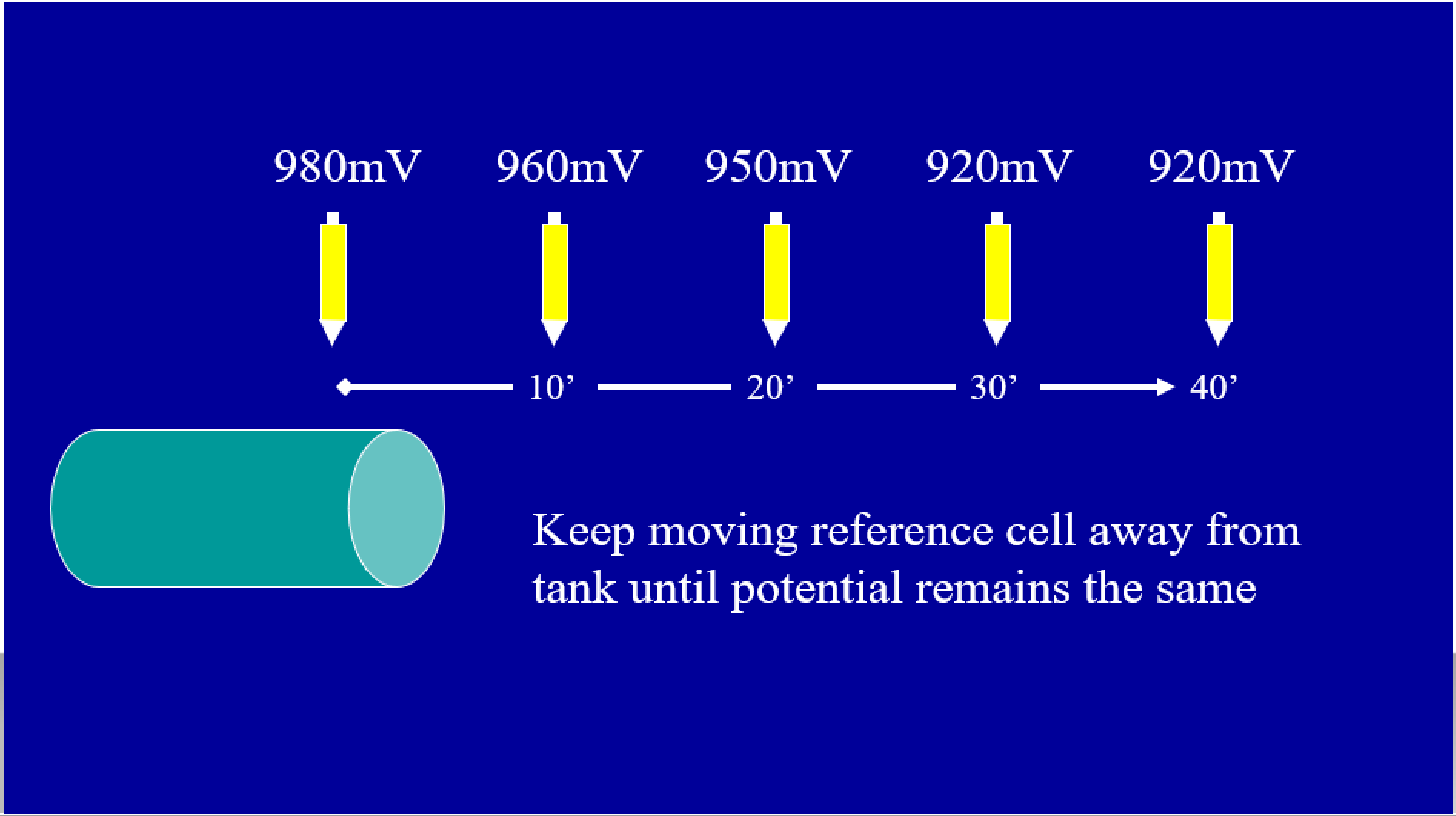


Pass/Fail Criteria for Galvanic Systems

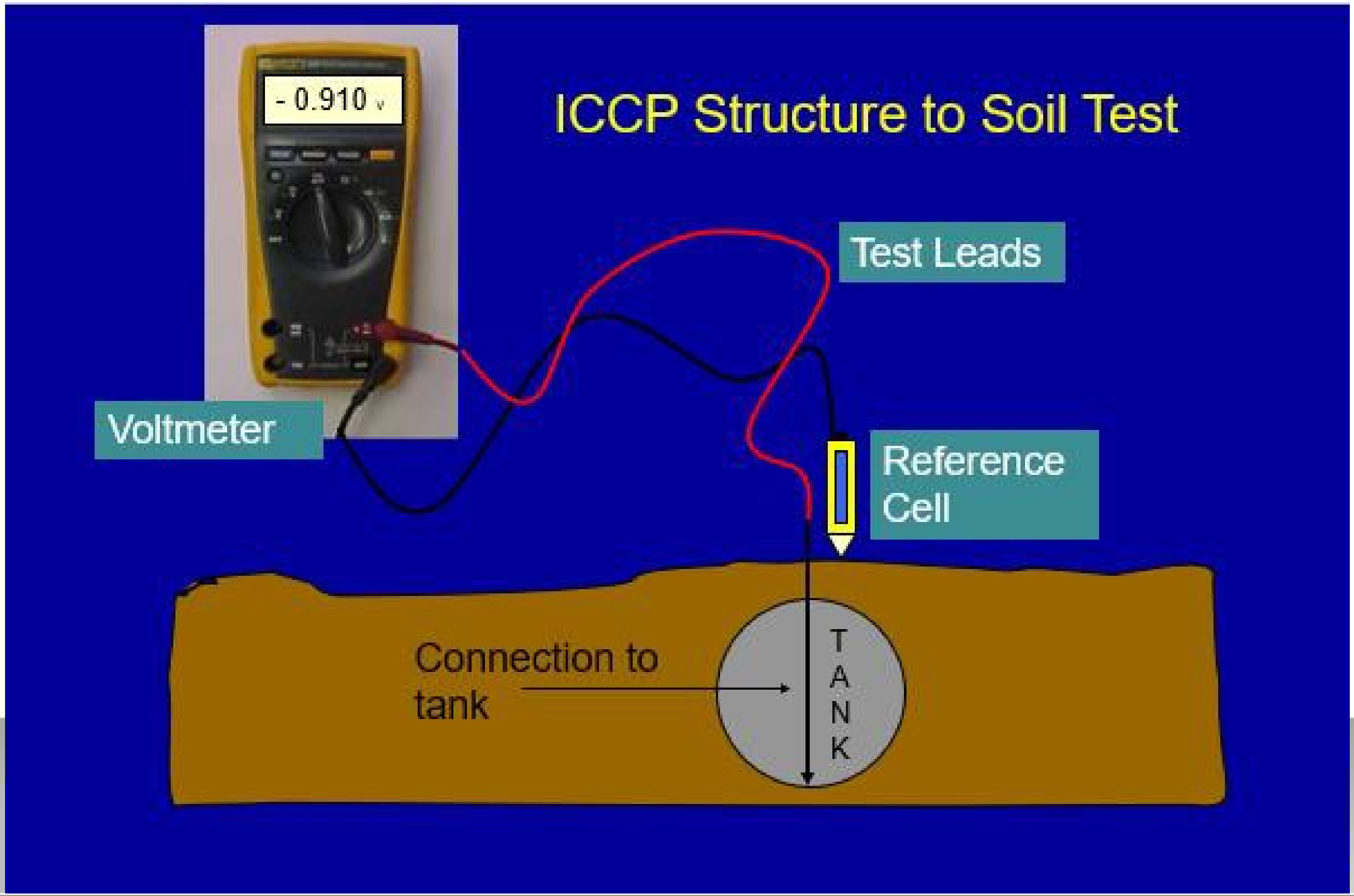
- PASS: -850 mV or more negative for ON readings for local and two remote readings (true remote); OR
- PASS: -850 mV or more negative instant off readings for all recorded readings. This may apply to field-installed sacrificial anodes.



How to establish true remote

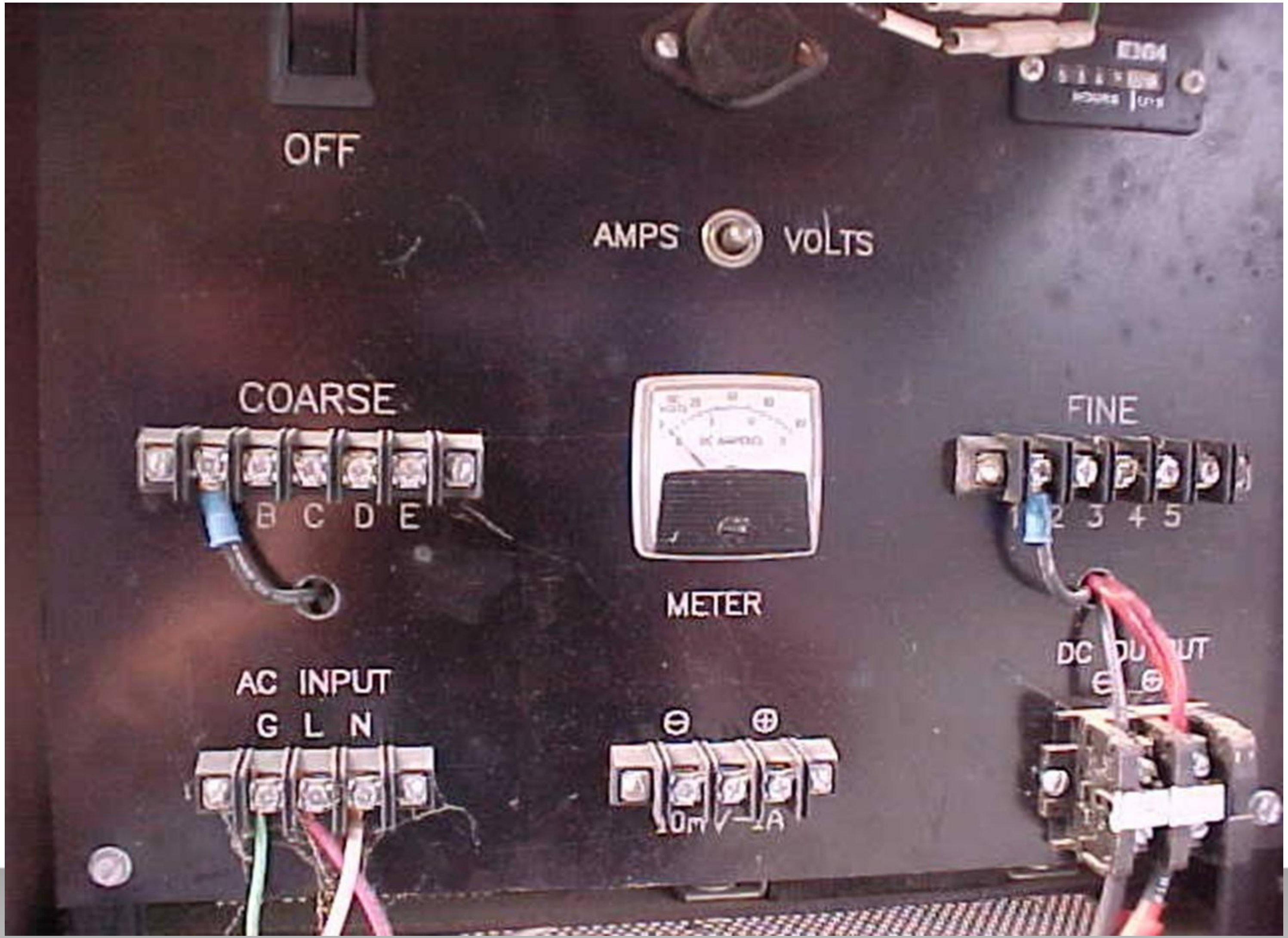


Impressed Current System Testing



Impressed current terms

- **Native Potential** - Potential measured before any CP has been applied
- **Static Potential** – Also called the depolarized potential…it is measured after CP has been interrupted and structure is allowed to depolarize completely
- **Polarized Potential** – Also called the instant off potential… the 2nd number observed on digital voltmeter after rectifier power has been interrupted



Pass/Fail Criteria for Impressed Current Systems

- PASS: -850 mV DC or more negative for INSTANT OFF or 100mV shift readings at all three local test locations; OR
- FAIL: unable to obtain -850mV DC instant off or 100 mv shift at one or more local test points
- FAIL: continuity of protected structures cannot be established

No testing through asphalt or concrete cracks. Drill a hole to contact soil/backfill

Continuity Testing

- Structures that are galvanically protected must be isolated from other metallic structures
  - troubleshooting
- With Impressed Current systems, all structures are bonded together (continuous)
  - Continuity is CRITICAL for Impressed Current systems

RP 972 Addition of Supplemental Anodes

- Main purpose is to provide a simple solution to bring sti-P3 tanks back to NACE criteria
- Conservative RP that gives step-by-step directions to contractors for adding supplemental anodes
- Must conduct current requirement test
- Provides option to hiring a CP Specialist

STI SPFA

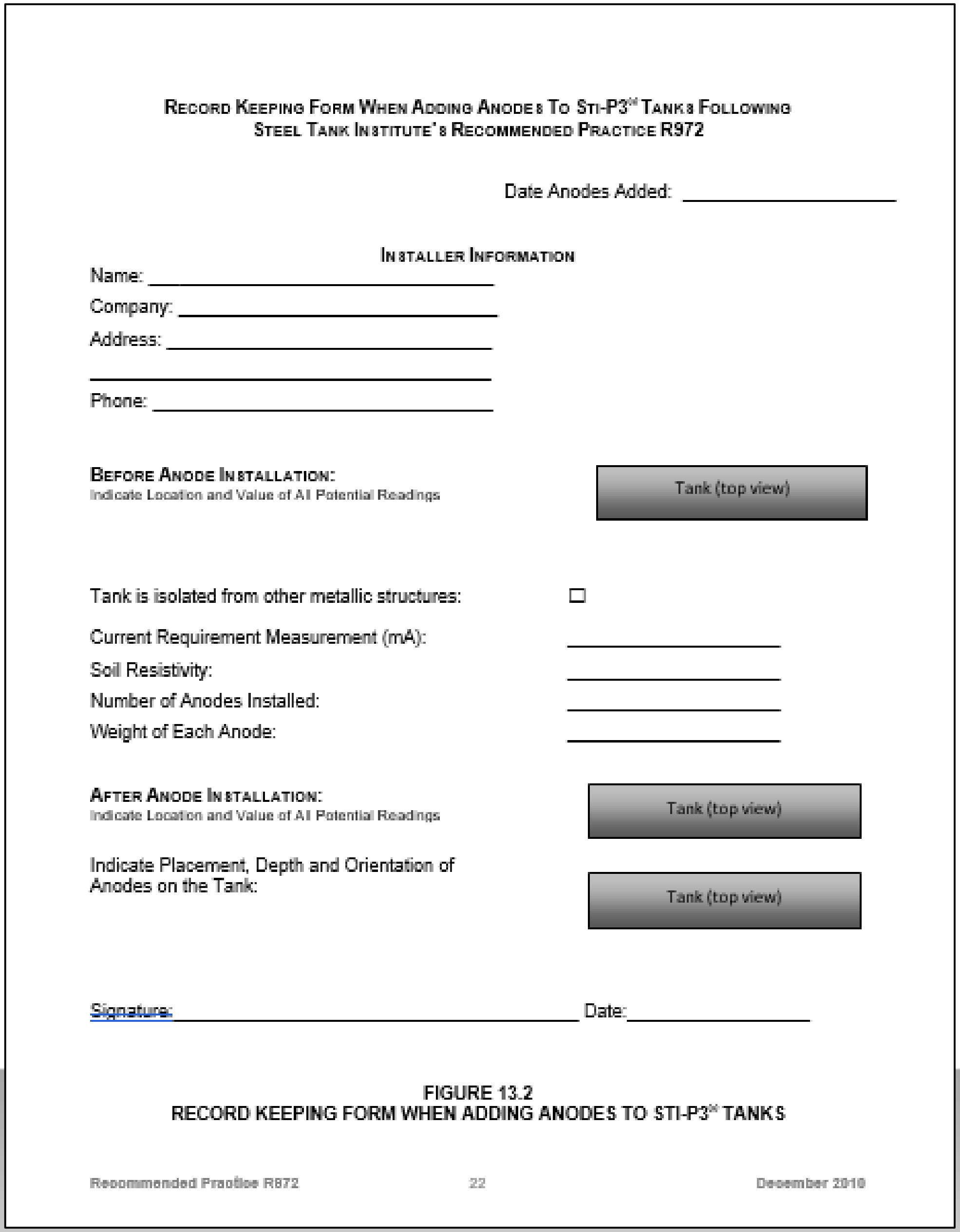
RECOMMENDED PRACTICE
FOR THE ADDITION OF
SUPPLEMENTAL ANODES
TO STI-P3® USTs
R972

REVISED
DECEMBER 2010

Steel Tank Institute
A Division of STI/SPFA
944 Donata Court
Lake Zurich, IL 60047
Phone: 847/438-8265
Fax: 847/438-8766
www.steeltank.com

RP 972 Addition of Supplemental Anodes

- Current requirement result limited to 30 milliamps to bring tank back to -850 mV DC or more negative criteria
- Minimum of 2 anodes per tank
- Regulators should request the installer's record keeping form for adding anodes



RECORD KEEPING FORM WHEN ADDING ANODES TO STI-P3® TANKS FOLLOWING STEEL TANK INSTITUTE'S RECOMMENDED PRACTICE R972

Date Anodes Added: ____________________

INSTALLER INFORMATION

Name: ______________________________

Company: ______________________________

Address: ______________________________

____

Phone: ______________________________

BEFORE ANODE INSTALLATION:
Indicate Location and Value of All Potential Readings

Tank (top view)

Tank is isolated from other metallic structures: ☐

Current Requirement Measurement (mA): ____________

Soil Resistivity: ____________

Number of Anodes Installed: ____________

Weight of Each Anode: ____________

AFTER ANODE INSTALLATION:
Indicate Location and Value of All Potential Readings

Tank (top view)

Indicate Placement, Depth and Orientation of Anodes on the Tank:

Tank (top view)

Signature: ______________________________ Date: ____________

FIGURE 13.2
RECORD KEEPING FORM WHEN ADDING ANODES TO STI-P3® TANKS

Recommended Practice R972 22 December 2010

Thank you for your time!

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NEIWPCC WEBINAR

Monitoring Impressed Current Cathodic Protection Systems

August 1, 2019

STORAGE TANK PROFESSIONALS

COMPLIANCE TESTING

TRAINING

CATHODIC PROTECTION

KEVIN HENDERSON CONSULTING, LLC

QUESTION

Why Is Monitoring of the Rectifier Required?

(It is not just to verify the AC power is on)

RECTIFIER MONITORING

1. How is monitoring accomplished?

2. What does monitoring tell us?

   What am I looking for?

3. What happens as a result?

   What action(s) must be taken?

4. How can we make things better?

WHY IS MONITORING REQUIRED?

<u>CP Testing required every three years</u>

Galvanic Systems = O.K.

Impressed Current Systems = Not Cool!

- Way too many things can go wrong
- Waiting until the next test to find out could mean this

WHY IS MONITORING REQUIRED?

Impressed Current testing should be required annually but probably not going to happen

Instead - MONITORING is required to ensure system is operating correctly.

Monitoring frequency is 60 days

Should be 30 days (like most everything else)

WHY SHOULD WE PAY MORE ATTENTION TO MONITORING?

Generally Speaking

Oldest tanks = Impressed Current

Most Impressed Current systems installed in 1997 – 1998 (upgrading deadline)

Impressed Current systems are now 20+ years old

Tanks are now 25 – 50+ years old

WHY SHOULD WE PAY MORE ATTENTION TO MONITORING?

Not Going Away anytime soon

Most of these ancient tanks will be left in operation for the foreseeable future

Most are in operation at marginally profitable locations

Far too expensive to install a new UST system (secondary containment/interstitial monitoring requirements)

HOW IS MONITORING ACCOMPLISHED?

Typically Involves Looking at Gauges and Recording:

- Volts
- Amps
- Hours

Verifying Gauges Are Accurate

Check accuracy of the rectifier voltmeter with portable multimeter

Verifying Gauges Are Accurate

Check accuracy of the rectifier ammeter with portable multimeter

Requires simple calculation to figure amperage

22.0 mV x 0.2 amps/mV = 4.40 amps

Verifying Gauges Are Accurate

Clamp meters can read amperage directly

DOCUMENTATION - TYPICAL RECTIFIER LOG

60-DAY RECORD OF RECTIFIER OPERATION FOR IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM

- This form should be utilized to document that the cathodic protection system rectifier is checked for operation at least once every 60 days.
- Checked for operation is taken to mean that it was confirmed the rectifier was receiving power and is "turned on".
- If your rectifier is so equipped, you should also record the output voltage, amperage and the number of hours indicated on the meter.
- Any significant variance should be reported to your corrosion professional so that any repairs and/or adjustments necessary can be made.

I. UST OWNER

NAME: Clark's Pump-N-Shop
ADDRESS: 1045 Winchester Ave
CITY: Ashland STATE: KY

II. SITE INFORMATION

NAME: Super Test Food Mart
AI NUMBER:
ADDRESS: 210 N. Main St.
CITY: Winchester COUNTY: Clark

XI. IMPRESSED CURRENT RECTIFIER DATA

In order to conduct an effective evaluation of the cathodic protection system, a complete evaluation of rectifier operation is necessary

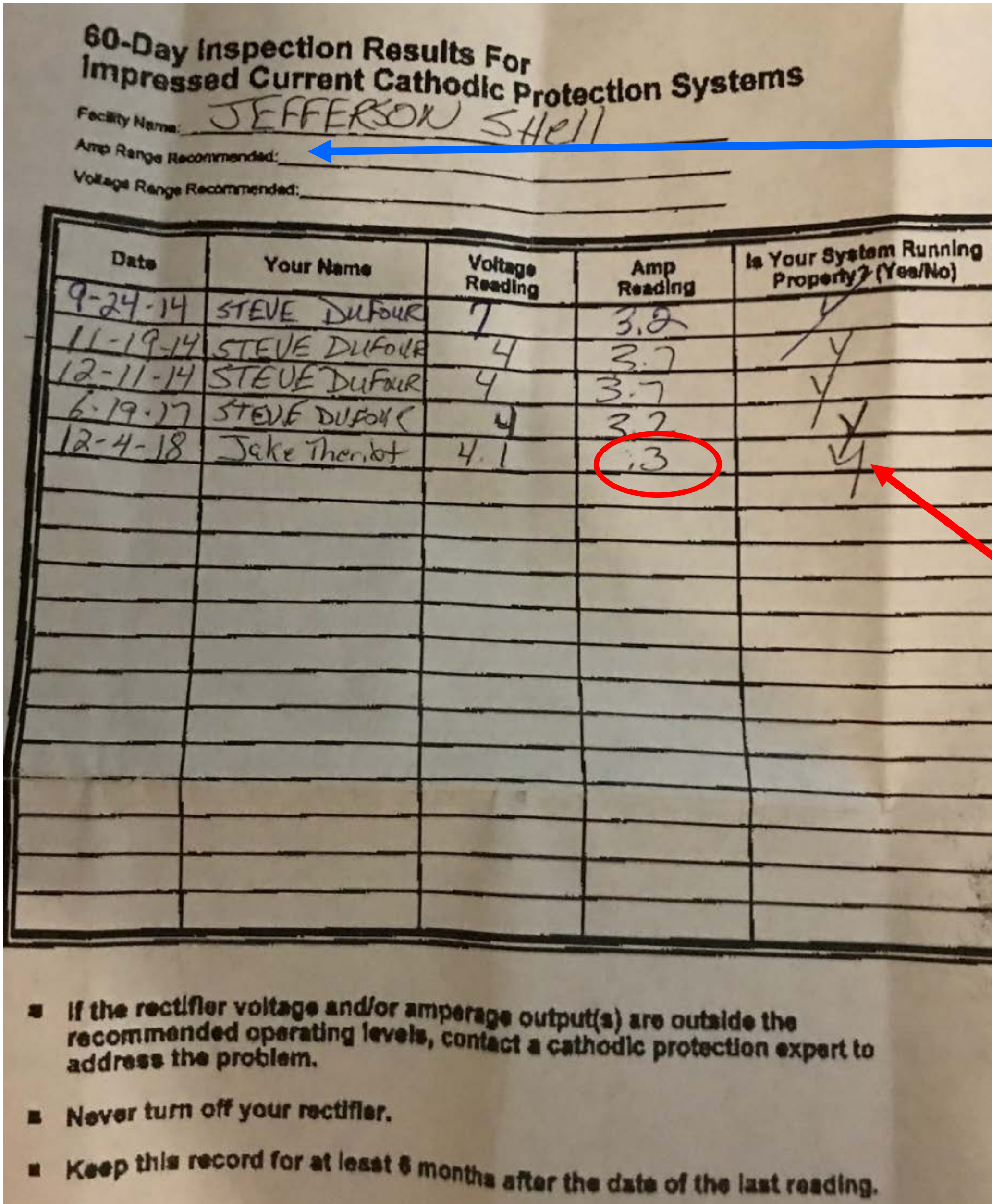
RECTIFIER MANUFACTURER: Brance Krachy RATED DC OUTPUT: 36 VOLTS 12 AMPS
RECTIFIER MODEL: CSAI RECTIFIER SERIAL NUMBER: 974496

What is the "as designed" or "lastly recommended" rectifier output: ______ VOLTS ______ AMPS

DATE INSPECTED	RECTIFIER TURNED ON?	TAP SETTINGS		DC OUTPUT		HOUR METER	INSPECTOR INITIALS	COMMENTS
		COARSE	FINE	VOLTS	AMPS			
3/4/10	YES	2	1	13	4.4	93467	DR	
5/5/10	YES	2	1	12.8	5.2	94964	DR	
7/2/10	YES	2	1	13	6	96345	DR	
9/7/10	YES	2	1	12.8	5.5	97952	DR	
11/3/10	YES	2	1	13	5	99322	DR	
1/4/11	YES	2	1	14	4	00814	DR	
3/1/11	YES	2	1	14.5	3.5	02129	DR	

NO SPECIFICATION OF WHAT AMPERAGE IS "NORMAL"

DOCUMENTATION - TYPICAL RECTIFIER LOG



60-Day Inspection Results For
Impressed Current Cathodic Protection Systems

Facility Name: JEFFERSON Shell

Amp Range Recommended:

Voltage Range Recommended:

Date	Your Name	Voltage Reading	Amp Reading	Is Your System Running Properly? (Yes/No)
9-24-14	STEVE DUFOUR	7	3.2	Y
11-19-14	STEVE DUFOUR	4	3.7	Y
12-11-14	STEVE DUFOUR	4	3.7	Y
6-19-17	STEVE DUFOUR	4	3.2	Y
12-4-18	Jake Theriot	4.1	.3	Y

- If the rectifier voltage and/or amperage output(s) are outside the recommended operating levels, contact a cathodic protection expert to address the problem.
- Never turn off your rectifier.
- Keep this record for at least 6 months after the date of the last reading.

Amp Range Recommended (no value given)

3.2 – 3.7 Amps = “Normal” Range

June 2017 = 3.2 amps

December 2018 = **0.3 amps**

“Is Your System Running Properly”

YES - ?

How Many Amps are Required?

Depends on many factors – Should be specified by design engineer

RULE OF THUMB

One amp per 10,000 gallon bare steel tank {Coated tanks, (sti-P3 or ACT-100} typically require very little current)

If not specified, then look at voltage/amperage when last passing test was conducted

WHAT ARE THOSE GAUGES TELLING US?

Volts and Amps =
“Normal” Operation

Action = Routine monitoring/testing

WHAT ARE THOSE GAUGES TELLING US?

Zero Volts
(Not uncommon to indicate small voltage)

Zero Amps

Action = No Brainer!

WHAT ARE THOSE GAUGES TELLING US?

"Normal" Volts
(Not uncommon to be maxed out)

Zero Amps

Action = Respond ASAP

Only the Amperage Matters

It does not really matter what the voltage is but:

ZERO AMPS = ZERO CP

What is the Rectifier Log Telling Us?

MINIMUM DESIGN AMPERAGE

The output at the time of the last passing test was **4.3** amps Date of Test: 09-12-2017

The minimum output needed to provide adequate cathodic protection is: **3.5** amps.

Contact a qualified person to investigate if the observed amperage falls below this value

Note: Relatively small variations in the rectifier amperage are normal. If there is no minimum amperage specified, contact a qualified person to investigate if the amperage decreases by more than 20% from the last passing test.

RECTIFIER INSPECTION LOG

DATE INSPECTED	ON / OFF	TAP SETTINGS		DC OUTPUT		HOUR METER	INSPECTOR INITIALS	COMMENTS
		COARSE	FINE	VOLTS	AMPS			
01-12-18	ON	2	4	28	4.2	28428	KSH	
02-11-18	ON	2	4	28	4.1	29142	KSH	
03-15-18	ON	2	4	28	4.1	29924	KSH	
04-18-18	ON	2	4	28	4.0	30732	KSH	
05-15-18	ON	2	4	28	3.9	31368	KSH	
06-12-18	ON	2	4	28	3.8	31998	KSH	
07-11-18	ON	2	4	28	0	32685	KSH	
08-12-18	ON	2	4	28	0	33438	KSH	
09-11-19	ON	2	4	28	0	34129	KSH	
10-10-18	ON	2	4	28	0	34818	KSH	
11-11-18	ON	2	4	28	0	35567	KSH	
12-12-18	ON	2	4	28	0	36319	KSH	
01-11-19	ON	2	4	28	0	37008	KSH	
02-12-19	ON	2	4	28	0	37753	KSH	
03-11-19	ON	2	4	28	0	38408	KSH	

Volts but no Amps

Circuit is Open

Voltage stays the same

Sudden Loss of all amps

Usually means all anode wires cut

What is the Rectifier Log Telling Us?

MINIMUM DESIGN AMPERAGE

The output at the time of the last passing test was 4.3 amps Date of Test: 09-12-2017

The minimum output needed to provide adequate cathodic protection is: 3.5 amps.

Contact a qualified person to investigate if the observed amperage falls below this value

Note: Relatively small variations in the rectifier amperage are normal. If there is no minimum amperage specified, contact a qualified person to investigate if the amperage decreases by more than 20% from the last passing test.

RECTIFIER INSPECTION LOG

DATE INSPECTED	ON / OFF	TAP SETTINGS		DC OUTPUT		HOUR METER	INSPECTOR INITIALS	COMMENTS
		COARSE	FINE	VOLTS	AMPS			
01-12-18	ON	2	4	28	4.2	28428	KSH	
02-11-18	ON	2	4	28	4.1	29142	KSH	
03-15-18	ON	2	4	28	4.1	29924	KSH	
04-18-18	ON	2	4	28	4.0	30732	KSH	
05-15-18	ON	2	4	28	3.9	31368	KSH	
06-12-18	ON	2	4	28	3.8	31998	KSH	
07-11-18	ON	2	4	28	3.4	32685	KSH	Take Action Now
08-12-18	ON	2	4	28	3.4	33438	KSH	
09-11-19	ON	2	4	28	3.0	34129	KSH	
10-10-18	ON	2	4	28	3.0	34818	KSH	
11-11-18	ON	2	4	28	3.0	35567	KSH	
12-12-18	ON	2	4	28	2.4	36319	KSH	
01-11-19	ON	2	4	28	2.3	37008	KSH	
02-12-19	ON	2	4	28	2.5	37753	KSH	
03-11-19	ON	2	4	28	2.4	38408	KSH	

Voltage steady but Amps falling

Voltage stays the same

Gradual Loss of amps

Usually means incremental failure of anodes

If no minimum amperage is specified

Generally Accepted Rule of Thumb

20% of last passing test amperage

<u>EXAMPLE</u>

5.0 amps at last passing test

5.0 amps x 0.20 = 1.0 amps

5.0 – 1.0 = 4.0 amps

Minimum Amperage = 4.0

RECTIFIER LOG - AS IT SHOULD BE

IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM
RECORD OF RECTIFIER OPERATION

This form may be utilized to document the proper operation of the rectifier (performed at least once every 60 days).
The design corrosion engineer should specify the minimum amperage required to provide adequate cathodic protection

UST OWNER		UST FACILITY	
NAME: HMS Properties		NAME: 5 Star Mart	I.D.# 8602
ADDRESS:		ADDRESS: 526 E. Railroad Ave.	
CITY: Gulfport	STATE: MS	CITY: Long Beach	STATE: MS

RECTIFIER DATA

MANUFACTURER: WB Cathodic Services	RATED DC OUTPUT: 80 Volts 15 Amps
MODEL: UST8015H	SERIAL NUMBER: 02980149

MINIMUM DESIGN AMPERAGE

The output at the time of the last passing test was: **4.5** amps — Date of Last Passing Test: **04-10-2019**

The minimum output needed to provide adequate cathodic protection is: **3.5** amps

Contact a qualified person to investigate if the observed amperage falls below the specified minimum value

Note: Relatively small variations in the rectifier amperage are normal. If there is no minimum amperage specified, contact a qualified person to investigate if the amperage output decreases by more than 20% from the last passing test.

RECTIFIER INSPECTION LOG

DATE INSPECTED	ON / OFF	TAP SETTINGS		DC OUTPUT		HOUR METER	INSPECTED BY	COMMENTS
		COARSE	FINE	VOLTS	AMPS			
04-10-19	On	C	2	44	4.5	N.A.	K. Henderson	Initial survey after anodes installed
05-11-19	On	C	2	44	4.6	N.A.	K. Henderson	
06-09-19	On	C	2	44	4.3	N.A.	K. Henderson	
07-07-19	On	C	2	44	4.4	N.A.	K. Henderson	

Last Passing Test

Minimum Amperage Needed

Amperage Column Emphasized

RECTIFIER LOG – 3 YEAR VERSION

IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM
RECORD OF RECTIFIER OPERATION

This form may be utilized to document the proper operation of the rectifier (performed at least once every 60 days).
The design corrosion engineer should specify the minimum amperage required to provide adequate cathodic protection

UST OWNER		UST FACILITY	
NAME:		NAME:	I.D.#
ADDRESS:		ADDRESS:	
CITY:	STATE:	CITY:	STATE: MS

RECTIFIER DATA

MANUFACTURER:	RATED DC OUTPUT: Volts Amps
MODEL:	SERIAL NUMBER:

MINIMUM DESIGN AMPERAGE

The output at the time of the last passing test was: amps | Date of Last Passing Test:

The minimum output needed to provide adequate cathodic protection is: amps

Contact a qualified person to investigate if the observed amperage falls below the specified minimum value

Note: Relatively small variations in the rectifier amperage (+ or -) are normal. If there is no minimum amperage specified, contact a qualified person to investigate if the amperage output decreases by more than 20% from the last passing test.

DATE INSPECTED	HOUR METER	DC OUTPUT		DATE INSPECTED	HOUR METER	DC OUTPUT		DATE INSPECTED	HOUR METER	DC OUTPUT	
		VOLTS	**AMPS**			VOLTS	**AMPS**			VOLTS	**AMPS**

Comments:

Enough space for 3 years (30 day checks)

Details are nice but the AMPS are the only thing that really matters

How Can We Make Things Better?

IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM
RECORD OF RECTIFIER OPERATION

This form may be utilized to document the proper operation of the rectifier (performed at least once every 60 days).
The design corrosion engineer should specify the minimum amperage required to provide adequate cathodic protection

UST OWNER		UST FACILITY	
NAME:		NAME:	
ADDRESS:		ADDRESS:	
CITY:	STATE:	CITY:	STATE:

RECTIFIER DATA

MANUFACTURER:	RATED DC OUTPUT: _____ VOLTS _____ AMPS
MODEL:	SERIAL NUMBER:

MINIMUM DESIGN AMPERAGE

The output at the time of the last passing test was _______ amps Date of Test: _____________

The minimum output needed to provide adequate cathodic protection is: _______ amps.

Contact a qualified person to investigate if the observed amperage falls below this value

Note: Relatively small variations in the rectifier amperage are normal. If there is no minimum amperage specified, contact a qualified person to investigate if the amperage decreases by more than 20% from the last passing test.

RECTIFIER INSPECTION LOG

DATE INSPECTED	ON / OFF	TAP SETTINGS		DC OUTPUT		HOUR METER	INSPECTOR INITIALS	COMMENTS
		COARSE	FINE	VOLTS	AMPS			

Adopt/Require form that specifies Amps

Educate Tank Owner/Operators

Enforcement

Want This Form?

Shoot Me An Email

Kevin4824@Comcast.net

STORAGE TANK PROFESSIONALS

COMPLIANCE TESTING

TRAINING

CATHODIC PROTECTION

KEVIN HENDERSON CONSULTING, LLC

Thanks For Your Time!

Cathodic Protection Test Report/Data, Is It Right?

Richard (Rick) Rogers – NACE Cathodic Protection Specialist #4394

UST Corrosion Management, Inc.

August 1, 2019

Today’s Discussion

- Approximately 25 minutes in length with some additional time for questions and answers.
- Topics
  - Is the test complete?
  - Interpreting the data provided
- Goal:
  - Adequate information for you to make accurate determination on validity of test report

Differences between Sacrificial Anode and Impressed Current Cathodic Protection Systems

Sacrificial Anode Systems

1. Uses different type of metal connected to steel to create a DC current flow in a direction that protects the steel from corroding.
2. Sacrificial Anodes are limited in the amount of DC current they can produce, in turn limited in the amount of steel they can protect.
3. Sacrificial Anodes produce anywhere between approximately 2mA to 80mA per anode depending on the anode material, size of the anode, and the environment the anode is installed in.
4. A Sacrificial Anode life is strictly dependent on the size of the anode and how much current it produces.

Impressed Current Systems

1. Impressed Current Systems use anode materials that are highly resistant to corrosion but require an outside power source (typically a Rectifier) to create the DC current.
2. Typical ICCP Anode Manufacturers rate their anodes to have a 20 year life with up to 2.0A (2000mA) of current output per anode.
3. ICCP Systems can be designed to protect any size structure for a determined length of time because the unlimited external power source and high current outputs of individual anodes.

Sacrificial Anode Cathodic Protection System Report/Data

A Sacrificial Anode Cathodic Protection System resurvey report should include a minimum of information and test data.

Information and Test Data that should be included in a Sacrificial Anode Cathodic Protection System Report

Page 1

1. **Owner and Site Information including owner name and address and site name and address.**
2. **Tester Information including name, company employed with, any certification obtained that pertains to Steel Underground Storage Tank Cathodic Protection testing with certification number, expiration of certification, signature, and date.**
3. **Date test was performed.**
4. **Pass/Fail conclusion of Cathodic Protection Test clearly stated.**
5. **Date of next full system test required by.**

Information and Test Data that should be included in a Sacrificial Anode Cathodic Protection System Report

Continued, Page 2

1. **UST System description section including number of tanks, sizes of tanks, construction material of tanks, construction material of product lines, and if flex connectors are present and touching an electrolyte.**
2. **Continuity test data section including structures tested and the exact reading obtained on each structure.**
3. **Structure-to-Soil potential reading section including the structure tested, connection point for reading taken, location of reference cell at each test point location, local and remote potential readings (should show 2 remote readings on each structure), and conclusion (Pass, Fail, and possibly Inconclusive).**
4. **Site drawing showing layout of UST system, labeled tanks, labeled dispensers if readings taken at dispensers, and labeled reference cell test point locations.**

Sacrificial Anode
Tank and Piping Information

UST-7A CATHODIC PROTECTION SYSTEM EVALUATION FOR GALVANIC SYSTEMS Pg. 2 of 5

VIII. DESCRIPTION OF UST SYSTEM

TANK #	PRODUCT STORED (PREMIUM, REGULAR, DIESEL, ETC.)	TANK CAPACITY (GAL)	CONSTRUCTION MATERIAL (TANKS)	CONSTRUCTION MATERIAL (PIPING)	FLEX CONNECTORS PRESENT (Y/N)
1	Unleaded-01	10,000	STI-P3	Non-Metallic	Yes
2	Premium	10,000	STI-P3	Non-Metallic	Yes

IX. DESCRIPTION OF CATHODIC PROTECTION SYSTEM REPAIRS AND/OR MODIFICATIONS

Cathodic protection systems must be evaluated as soon as the cathodic protection system reaches steady-state polarization design standards following any repairs and/or modifications. Complete this section if any repairs or modifications were made to the cathodic protection system in response to a "failed" evaluation. Certain repairs/modifications as determined by NCDEQ are required to be designed and/or evaluated by a corrosion expert (completion of Section V required).

- ☐ Supplemental anodes for a sti-P_3® tank were added (attach corrosion expert's design or document industry standard used).
- ☐ Supplemental anodes for metallic pipe or flex-connectors were added (attach corrosion expert's design or document industry standard used).
- ☐ Galvanically protected tanks/piping not electrically isolated (explain repairs/modifications completed in "Remarks/Other" below).

Remarks/Other:
Flex Connectors are either booted or in a containment sump.

You are looking to see that the tank(s) is some type of Galvanic (Sacrificial Anode) protected tank(s). If Flex Connectors are present, are they not touching soil or touching an electrolyte (soil and/or water) and protected by Sacrificial Anodes?

Sacrificial Anode Continuity Test Data

UST-7A CATHODIC PROTECTION SYSTEM EVALUATION FOR GALVANIC SYSTEMS Pg. 4 of 5

XI. GALVANIC (SACRIFICIAL ANODE) CATHODIC PROTECTION SYSTEM CONTINUITY SURVEY

- This section must be utilized to document measurements of continuity on underground storage tank systems that are protected by cathodic protection systems.
- When conducting a fixed cell - moving ground survey, the reference electrode must be placed in the soil at a remote location and left undisturbed.
- Conduct point-to-point test between any two structures for which the fixed cell-moving ground survey is inconclusive or indicates possible continuity.
- For galvanic systems, the structure that is to be protected must be isolated from any other metallic structure in order to pass the continuity survey.

FACILITY NAME:

NOTE: The survey is not complete unless all applicable parts of Sections I-XII are also completed

DESCRIBE LOCATION OF "FIXED REMOTE" REFERENCE ELECTRODE PLACEMENT:
In soil behind tank field in between the two parking lots. 50' from tank field

STRUCTURE "A" [1]	STRUCTURE "B" [2]	STRUCTURE "A" [3] FIXED REMOTE VOLTAGE	STRUCTURE "B" [4] FIXED REMOTE VOLTAGE	POINT-TO-POINT [5] VOLTAGE DIFFERENCE	ISOLATED/ CONTINUOUS/ INCONCLUSIVE [6]
(example) PREMIUM TANK BOTTOM	(example) PREMIUM TANK FILL RISER	(example) -921 mV	(example) -915 mV		(example) INCONCLUSIVE
(example) PREMIUM TANK BOTTOM	(example) PREMIUM TANK FILL RISER			(example) 17 mV	(example) ISOLATED
Unleaded-01 Tank Bottom	Unleaded-01 Fill Riser	-961mV	-572mV		Isolated
Premium Tank Bottom	Premium Fill Riser	-993mV	-621mV		Isolated

Most Sacrificial Anode (Galvanic) Systems will be tested using the fixed cell moving ground continuity test method because you should always take remote potential readings on the structure being tested. In the example above, you take the -961mV Unleaded 01 tank bottom reading minus the -572mV Unleaded 01 Fill Pipe reading which is 389mV difference. Based on the NACE criteria, these 2 structures are isolated from each other.

Sacrificial Anode Local and Remote Potential Readings

UST-7A CATHODIC PROTECTION SYSTEM EVALUATION FOR GALVANIC SYSTEMS Pg. 5 of 5

XII. GALVANIC (SACRIFICIAL ANODE) CATHODIC PROTECTION SYSTEM SURVEY

- This section must be utilized to document a survey of a galvanic cathodic protection system by obtaining structure-to-soil potential measurements.
- The reference electrode must be placed in the soil in a minimum of __one__ location directly over the tested structure (local) and __two__ locations 25-100 feet away from the structure (remote).
- Both the local and the remote voltage must be –850 mV or more negative, in order for the structure to pass.
- Inconclusive is indicated when both the local and the remote structure-to-soil potentials do not result in the same outcome (Both must "pass" or both must "fail").
- If the 100 mV polarization method is used to verify adequate cathodic protection, please use Section XIV of the UST-7B form

FACILITY NAME:

NOTE: The survey is not complete unless all applicable parts of Sections I-XII are also completed

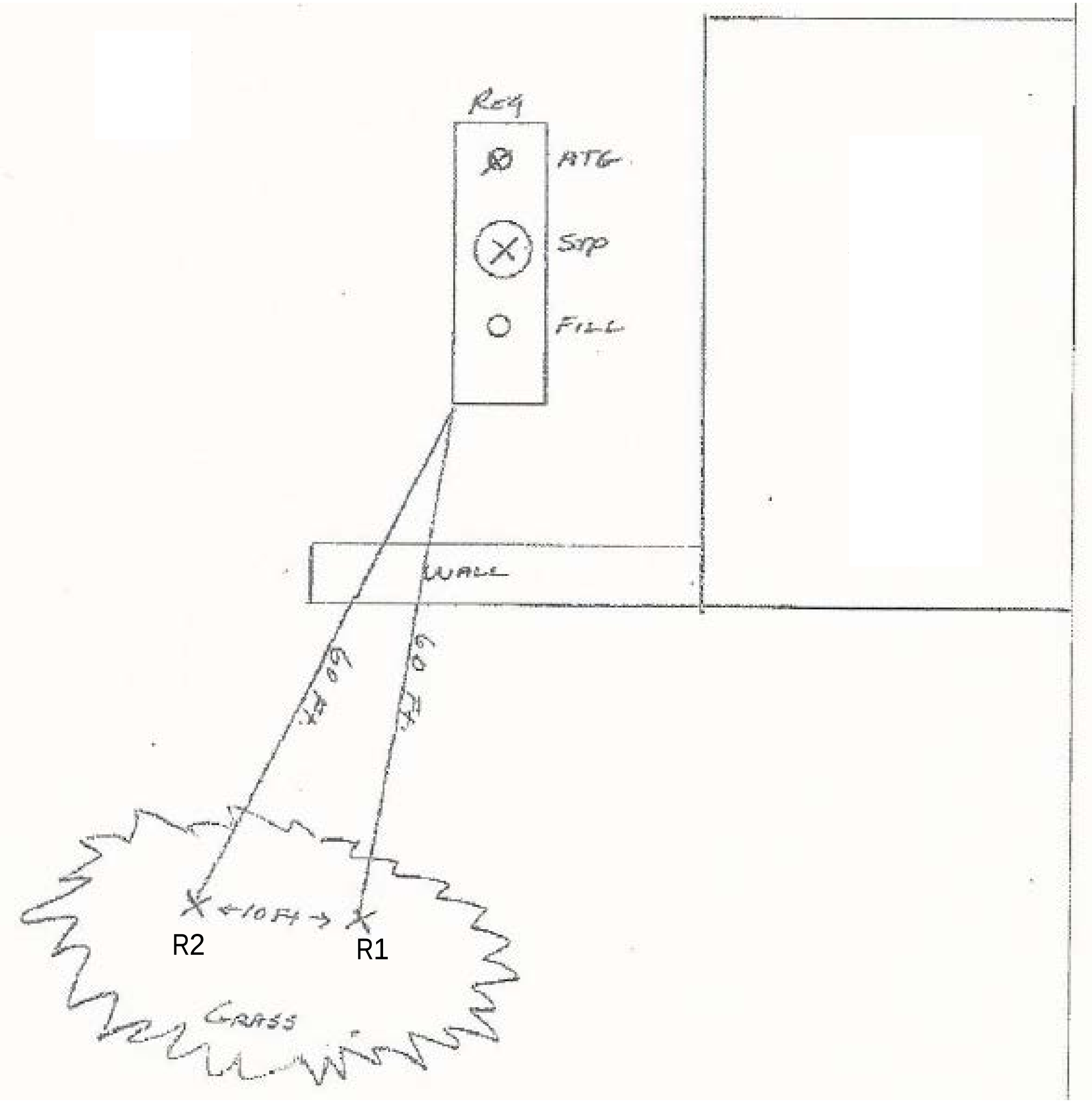
LOCATION OF REMOTE REFERENCE ELECTRODE #1 (R1): In soil behind tank field

LOCATION OF REMOTE REFERENCE ELECTRODE #2 (R2): 10' from (R1) location

LOCATION CODE[1]	STRUCTURE[2]	CONTACT POINT[3]	LOCAL REFERENCE CELL PLACEMENT[4]	LOCAL VOLTAGE[5]	REMOTE VOLTAGE (R1)[6]	REMOTE VOLTAGE (R2)[6]	PASS/FAIL/ INCONCLUSIVE[7]
(example) T-1	(example) PLUS TANK	(example) TANK BOTTOM	(example) SOIL @ PLUS TANK STP	(example) -928 mV	(example) -810 mV	(example) -811 mV	(example) INCONCLUSIVE
(example) P-1	(example) PLUS PIPING	(example) DISPENSER 5/6	(example) SOIL UNDER DISPENSER 5/6	(example) -890 mV	(example) -885 mV	(example) -884 mV	(example) PASS
T-1	Unleaded-01	Tank Bottom	Soil in ATG riser manway	-883mV	-959mV	-961mV	Pass
T-2	Premium	Tank Bottom	Soil in ATG riser manway	-876mV	-992mV	-993mV	Pass
	Reg STP Flex	Flex Connector	Soil in Reg STP Pit	-986 mV	-1022mV	-1018mV	Pass

<u>This example and the form layout is based on the current Steel Tank Institute Testing Guidelines</u>. In Sacrificial Anode Systems, a tester should be taking local and remote readings on each structure. All local and remote readings must be -850mV or more negative to pass a system. If any reading is -849mV or more positive, then the result must be either Fail or Inconclusive. The Remote readings must be at true remote earth locations. If any potential reading in a Sacrificial Anode System is shown as approximately -200mV or around -1900mV, these readings are likely not real or a serious problem exists with the structure.

Site Drawing



Impressed Current Cathodic Protection System Report/Data

An Impressed Current Cathodic Protection System resurvey report should include a minimum of information and test data.

Information and Test Data that should be included in an Impressed Current Cathodic Protection System Report

Page 1

1. **Owner and Site Information including owner name and address and site name and address.**
2. **Tester Information including name, company employed with, any certification obtained that pertains to Steel Underground Storage Tank Cathodic Protection testing with certification number, expiration of certification, signature, and date.**
3. **Date test was performed.**
4. **Pass/Fail conclusion of Cathodic Protection test clearly stated.**
5. **Date of next full system test required by.**

Information and Test Data that should be included in an Impressed Current Cathodic Protection System Report

Continued, Page 2

1. **UST System description including number of tanks, sizes of tanks, construction material of tanks, construction material of product lines, and if flex connectors are in the system and touching an electrolyte.**
2. **Rectifier information at a minimum including rectifier manufacturer, model number, serial number, rated DC outputs, tap settings, and meter readings.**
3. **Measured rectifier outputs, not meter readings. The meter readings should be included in the report.**
4. **The designed amperage output of the system or the amperage output during the last passing test of the system. It would also be good to include the recommended rectifier amperage output operating range.**
5. **Individual anode outputs if the system has the ability (anode junction box or individual anode cables) to measure the individual anode outputs.**

Information and Test Data that should be included in an <u>Impressed Current</u> Cathodic Protection System Report

Continued, Page 3

1. **Continuity test data section including structures tested and the exact reading obtained for each structure, not some rounded off number. <u>Continuity testing on ICCP Systems will almost always be done as a Point-to-Point test method because of testing guidelines in NACE TM-0101-2012</u>.**
2. **Local potential reading section including the structure tested, connection point for reading taken, location of reference cell at each test point location, <u>"on" potential reading (a tester will never use this reading for any reason)</u>, instant off (polarized) reading, ending potential reading (depolarized or static) if 100mv polarization criteria used, <u>voltage change (instant off reading minus ending voltage</u>), and conclusion (Pass or Fail, no inconclusive allowed).**
3. **Site drawing showing layout of UST system, labeled tanks, labeled dispensers if readings taken at dispensers, labeled reference cell test point locations, rectifier location, anode junction box location if in the system, and anode and CP cable locations if known.**

TANK AND PIPING INFORMATION

IX. DESCRIPTION OF UST SYSTEM					
Facility Name:	By Lo Market #6		Facility ID Number:	1-320373	
TANK #	PRODUCT	CAPACITY	TANK MATERIAL	PIPING MATERIAL	FLEX CONNECTORS/ LOCATION
1	Regular Gasoline	10,000	Steel	Galvanized Steel	No
2	Premium Gasoline	4,000	Steel	Galvanized Steel	No
3	Regular 100 % Gas	6,000	Steel	Galvanized Steel	No
4					
5					

You want to estimate the approximate total amount of current needed to protect the steel structures (assuming they are bare steel). This example would be approximately 1.0A for the 10K, 0.6A for the 6K, and about 0.4A for the 4K. You would also add in about 0.2A for the Steel Piping for a total of 2.2A typically to protect all structures in this system at a minimum. Every site is unique but you can get a good estimate of the current output the rectifier should be producing at this site.

Rectifier Data

X. IMPRESSED CURRENT RECTIFIER DATA (complete all applicable)

In order to conduct an effective evaluation of the cathodic protection system, a complete evaluation of rectifier operation is necessary.

Rectifier Manufacturer: Universal Goodall | Rated DC Output: 80 VOLTS 08 AMPS

Rectifier Model: JSAYSL 80-08 | Rectifier Serial Number: 96UT1342

Rectifier output as initially designed or last measured (if available): 22.5 VOLTS 1.3 AMPS

EVENT	DATE	TAP SETTINGS		MEASURED DC OUTPUT		HOUR METER	COMMENTS
		COARSE	FINE	VOLTS	AMPS		
"AS FOUND"	7-3-2019	B	3	22.5	1.3		
"AS LEFT"	7-3-2019	B	3	21	5.5		

Check all that apply: ☒ single amp/voltmeter ☐ dual amp/voltmeter ☐ red/green indicator light

Rectifier Maximum rated current output.

This is useful information. Compare to current output in this report. The estimated current output for this system is 2.2A.

The rectifier <u>measured</u> current output should never exceed the rated rectifier current output.

The main thing you are looking at in this section is the rectifier current output. Is the <u>measured</u> rectifier current output somewhere close to the estimated current output needed you calculated from the Tank and Piping Description Section? If the rectifier <u>measured</u> current output is significantly different than your estimated amount of current needed, this could indicate the system has been set to run at a current output outside of the engineered design current needed. It could also indicate a problem with the test as well.

Anode Test Data and Repair Description

XI. IMPRESSED CURRENT POSITIVE CIRCUIT MEASUREMENTS (output amperage)											
Complete if system design allows such measurements (i.e. individual lead wires for each anode are installed and measurement shunts are present).											
CIRCUIT	1	2	3	4	5	6	7	8	9	10	TOTAL
ANODE (+)	0.47	0.54	0.74	1.45	0.51	1.7					5.41

XII. DESCRIPTION OF CATHODIC PROTECTION SYSTEM REPAIRS AND/OR MODIFICATION

Complete if repairs or modifications to the cathodic protection system are made or are necessary. Certain repairs/modifications as explained in the text of the **Standardized Compliance Inspection Manual, Technical Chapter 4.1 Corrosion Protection** are required to be designed and/or evaluated by a corrosion expert (completion of Section VI. required). Attach corrosion expert's design calculations and have corrosion expert sign Section VI.

- [x] Additional anodes for an impressed current system (attach corrosion expert's design).
- [ ] Repairs or replacement of rectifier (explain in Remarks/Other below).
- [ ] Anode header cables repaired and/or replaced (explain in Remarks/Other below).
- [ ] Impressed current protected tanks/piping not electrically continuous (explain in Remarks/Other below).

Remarks/Other: Replaced MMO anodes in same borings.

First, you want to add up the outputs of every anode in the system and the total should be somewhere near the rectifier current output. If not, something is wrong. The rectifier current output in this example was 5.5A. The life of a single anode is strictly dependent on the amount of current that anode produces. In the example, there are 2 anodes producing significantly more than 1.0A. A 3' X 5' 3.0 MMO anode (LIDA Pack Canister) has a design life of approximately 20 years at 2.0A output. However, real world results have shown a slightly less anode life than 20 years at 2.0A output. Also, when you have an anode producing a higher amount of current, you can have the risk of polarizing the structure in the area of that anode to more than -1600mV. This should never be allowed to happen. Also look at the Description of Repairs section. Make sure the tester states exactly the repair work that was done as detailed as possible.

Impressed Current Continuity Test Data Is This Right?

STRUCTURE "A" [1]	STRUCTURE "B" [2]	POINT-TO-POINT[3] VOLTAGE DIFFERENCE	ISOLATED[4] CONTINUOUS/INCONCLUSIVE
Regular Tank Bottom	Rectifier Negative	0 mV	Continuous
Regular STP Riser	Rectifier Negative	0 mV	Continuous
Regular Fill Riser	Rectifier Negative	0 mV	Continuous
Regular Vent Riser	Rectifier Negative	0 mV	Continuous
Reg 100% Tank Bottom	Rectifier Negative	0 mV	Continuous
Regular 100% STP Riser	Rectifier Negative	0 mV	Continuous
Regular 100% Fill Riser	Rectifier Negative	0 mV	Continuous
Regular 100% Vent Riser	Rectifier Negative	0 mV	Continuous
Premium Tank Bottom	Rectifier Negative	0 mV	Continuous
Premium Fill Riser	Rectifier Negative	0 mV	Continuous
Premium STP Riser	Rectifier Negative	0 mV	Continuous
Premium Vent Riser	Rectifier Negative	0 mV	Continuous
MPD 1/2 Pipe Risers	Rectifier Negative	0 mV	Continuous
MPD 3/4 Pipe Risers	Rectifier Negative	0 mV	Continuous

Almost always Point-to-Point Continuity test results in an Impressed Current System will not actually be 0.0mV to all structures tested but is possible. This could indicate the tester has rounded off all the readings or that the readings are not real.

Impressed Current Continuity Test Data
What You Should Expect To See

Structure "A"	Structure "B"			Point-to-Point mV Difference	Conclusion
Rectifier Negative	Unleaded Tank Bottom			0.2mV	Continuous
Rectifier Negative	Unleaded STP and Components			0.4mV	Continuous
Rectifier Negative	Plus Tank Bottom			0.1mV	Continuous
Rectifier Negative	Plus STP and Components			0.2mV	Continuous
Rectifier Negative	Premium Tank Bottom			0.2mV	Continuous
Rectifier Negative	Premium STP and Components			0.1mV	Continuous
Rectifier Negative	Kerosene Tank Bottom			0.7mV	Continuous
Rectifier Negative	Kerosene Vent Stack			0.5mV	Continuous
Rectifier Negative	Steel Piping inside MPD 1-2			0.1mV	Continuous
Rectifier Negative	Steel Piping inside MPD 3-4			0.2mV	Continuous
Rectifier Negative	Steel Piping inside Kerosene SPD			0.4mV	Continuous

This is more typical of what you would expect to see in an Impressed Current System Point-to-Point Continuity test. <u>This example is from a different test report than the examples in the Impressed Current section that were taken from a single test report</u>.

Impressed Current Local Potential Readings

LOCATION [1] CODE	STRUCTURE [2]	CONTACT POINT [3]	REFERENCE CELL PLACEMENT [4]	ON VOLTAGE [5]	INSTANT OFF VOLTAGE[6]	100 mV POLARIZATION		PASS/ FAIL[9]
						ENDING VOLTAGE [7]	VOLTAGE CHANGE [8]	
R1	Regular	Tank Bottom	Soil @ Tank End	-2665	-1297			Pass
R2	Regular	Tank Bottom	Soil @ Tank Center	-2317	-1132			Pass
R3	Regular	Tank Bottom	Soil @ Tank End	-2560	-1239			Pass
R1	Reg 100%	Tank Bottom	Soil @ Tank End	-3370	-1490			Pass
R2	Reg 100%	Tank Bottom	Soil @ Tank Center	-1815	-761	-661	100	Pass
R3	Reg 100%	Tank Bottom	Soil @ Tank End	-2289	-1160			Pass
R1	Premium	Tank Bottom	Soil @ Tank End	-2930	-1505			Pass
R2	Premium	Tank Bottom	Soil @ Tank Center	-2107	-1012			Pass
R3	Premium	Tank Bottom	Soil @ Tank End	-2360	-1180			Pass
R4	Regular	STP Riser	Soil @ Tank End	-2560	-1239			Pass
R4	Reg 100%	STP Riser	Soil @ Tank End	-2289	-1160			Pass
R4	Premium	STP Riser	Soil @ Tank End	-2360	-1180			Pass
R5	Regular	MPD 1/2 Pipe	Soil @ Dispenser	-2120	-1230			Pass
R5	Reg 100%	MPD 1/2 Pipe	Soil @ Dispenser	-2120	-1230			Pass
R5	Premium	MPD 1/2 Pipe	Soil @ Dispenser	-2120	-1230			Pass
R6	Regular	MPD 3/4 Pipe	Soil @ Dispenser	-1155	-920			Pass
R6	Reg 100%	MPD 3/4 Pipe	Soil @ Dispenser	-1155	-920			Pass
R6	Premium	MPD 3/4 Pipe	Soil @ Dispenser	-1155	-920			Pass

Based on the fact that a repair was just done to this system and it is running 5.5A (estimated 2.2A needed), I would question if the test was done immediately after the repairs were completed and/or with very little polarization time. There are 2 instant off potential readings around -1500mV. It is possible these readings could go to -1600mV or more negative after a period of polarization. There should never be an instant off potential reading more negative than -1600mV. If the test was done very soon after the repair was completed or the system turned on, I would request the tester return to the site and do another test after a significant period of polarization.

Impressed Current Local Potential Readings
Is this Right?

LOCATION CODE[1]	STRUCTURE [2]	CONTACT POINT [3]	REFERENCE CELL PLACEMENT [4]	ON VOLTAGE[5]	INSTANT OFF VOLTAGE[6]	100 mV POLARIZATION		PASS / FAIL[9]
						ENDING VOLTAGE[7]	VOLTAGE CHANGE[8]	
(example) T-1	(example) PLUS TANK	(example) TANK BOTTOM	(example) SOIL @ REG. TANK STP MANWAY	(example) -1070 mV	(example) -875 mV			(example) PASS
(example) P-2	(example) DIESEL PIPING	(example) DISPENSER 7/8	(example) SOIL @ DIESEL TANK STP MANWAY	(example) -810 mV	(example) -680 mV	(example) -575 mV	(example) -105 mV	(example) PASS
	Reg Tank	Tank Bottom	Soil in Reg ATG Pit	$\boxed{\text{-1093mV}}$				Pass

The "On" reading only <u>in an Impressed Current System</u> can never be used to pass or fail a Cathodic Protection test. The "On" reading is a totally false number and can never be used to determine pass or fail in an ICCP System. An Impressed Current System can only be evaluated using the Instant Off (Polarized) potential reading and Ending Voltage (depolarized or static) if trying to meet the 100mv Polarization Criteria.

Impressed Current Local Potential Readings Is this Right?

LOCATION CODE[1]	STRUCTURE[2]	CONTACT POINT[3]	REFERENCE CELL PLACEMENT[4]	ON VOLTAGE[5]	INSTANT OFF VOLTAGE[6]	100 mV POLARIZATION		PASS / FAIL[9]
						ENDING VOLTAGE[7]	VOLTAGE CHANGE[8]	
(example) T-1	(example) PLUS TANK	(example) TANK BOTTOM	(example) SOIL @ REG. TANK STP MANWAY	(example) -1070 mV	(example) -875 mV			(example) PASS
(example) P-2	(example) DIESEL PIPING	(example) DISPENSER 7/8	(example) SOIL @ DIESEL TANK STP MANWAY	(example) -810 mV	(example) -680 mV	(example) -575 mV	(example) -105 mV	(example) PASS
	Reg Tank	Tank Bottom	In center at $\boxed{\text{crack in concrete}}$	-1234mV	-1046mV			Pass
	Reg Tank	Tank Bottom	On $\boxed{\text{asp/conc crack}}$ at fill end	-2002mV	-1214mV			Pass

Local potential readings must never be taken with the reference cell placed on concrete, on asphalt, or on a crack in the pavement.

Impressed Current Local Potential Readings
Is this Right?

LOCATION CODE[1]	STRUCTURE[2]	CONTACT POINT[3]	REFERENCE CELL PLACEMENT[4]	ON VOLTAGE[5]	INSTANT OFF VOLTAGE[6]	100 mV POLARIZATION		PASS / FAIL[9]
						ENDING VOLTAGE[7]	VOLTAGE CHANGE[8]	
(example) T-1	(example) PLUS TANK	(example) TANK BOTTOM	(example) SOIL @ REG. TANK STP MANWAY	(example) -1070 mV	(example) -875 mV			(example) PASS
(example) P-2	(example) DIESEL PIPING	(example) DISPENSER 7/8	(example) SOIL @ DIESEL TANK STP MANWAY	(example) -810 mV	(example) -680 mV	(example) -575 mV	(example) -105 mV	(example) PASS
Wrong	Reg Tank	Tank Bottom	In center drilled test hole	-806mV	-664mV	-589mV	142mV	Pass
Correct	Reg Tank	Tank Bottom	In center drilled test hole	-806mV	-664mV	-589mV	75mV	Fail

In an Impressed Current System, the "On" reading is never used to pass or fail a system for any reason. The "On" reading to a tester should never be used for any reason and means nothing to a tester. In turn, you never subtract the "Instant Off" reading from the "On" reading to determine the polarization.

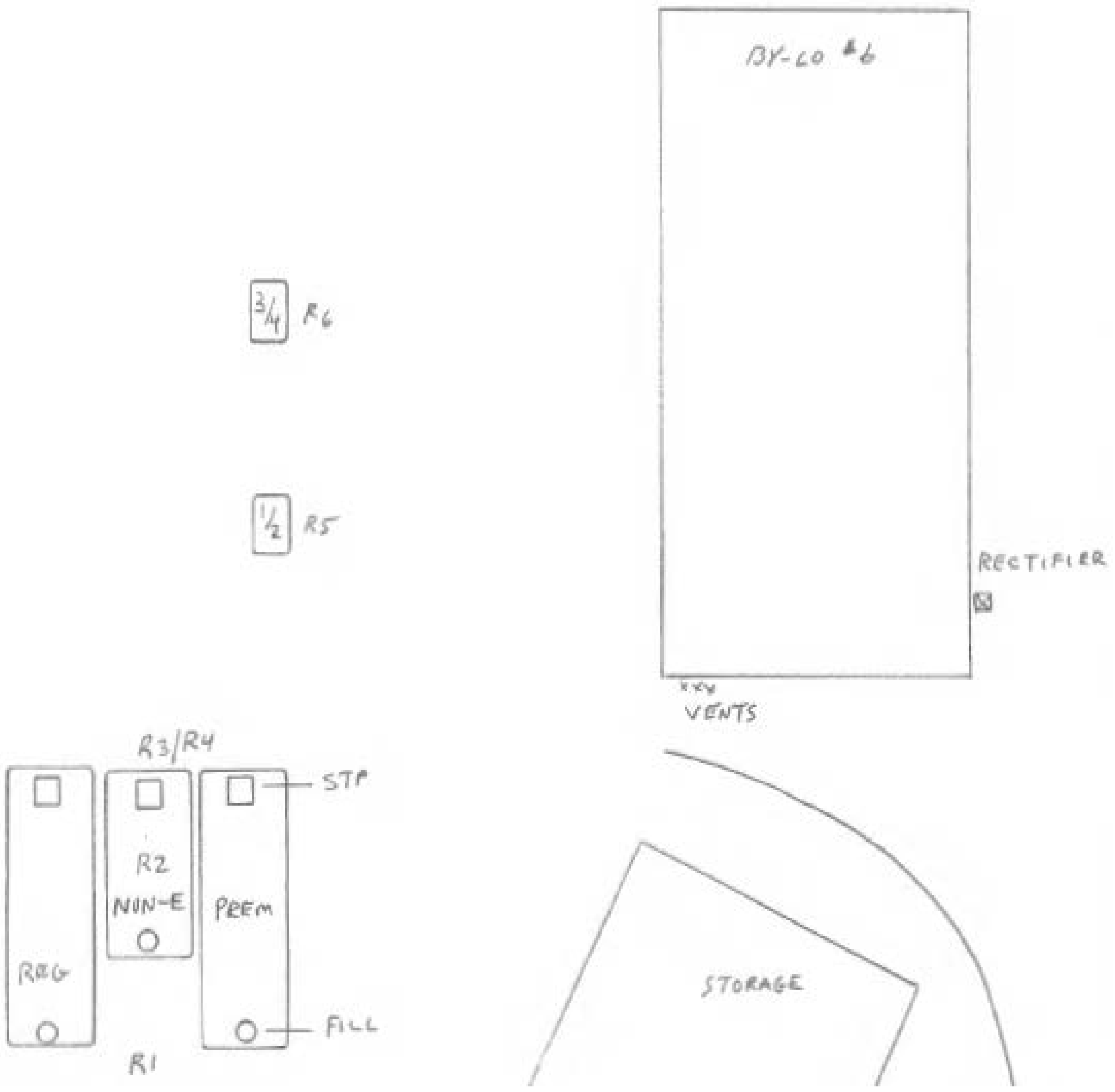
The correct method to determine the amount of polarization and whether the 100mV polarization criteria was meet is to subtract the "Ending Voltage (depolarized or static)" reading from the "Instant Off" reading. If the difference is at least 100mV or more, the readings at this test point passes.

Impressed Current Local Potential Readings

In an Impressed Current Cathodic Protection System, there must be at least 3 local potential test point locations (where the reference cell is placed) over each tank and at each end of Steel Product Lines. If there is 100' of more between the test point reference cell locations for Steel Product Lines, you must take another reading with the reference cell placed in the middle of the 100' distance and an additional test point location for each additional 50'.

In an Impressed Current Sytsem, <u>all reference cell test point locations </u>must pass either the NACE -850mV polarized potential (Instant Off) or 100mV polarization criteria for the system to pass.

Site Drawing



There a couple of things that are missing on this drawing that should be included. First, it does not show the location of the anode junction box. Most important, it does not show the location of the new 6 MMO anodes the tester says they just installed. Knowing the locations of the anodes is extremely important when evaluating the performance of an ICCP System.

Cathodic Protection Test Report/Data, Is It Right?

Presented by:

Richard (Rick) Rogers – NACE Cathodic Protection Specialist #4394
***UST* Corrosion Management, Inc.**
August 1, 2019

If anyone has any questions or wants to discuss the presentation subject matter further, do not hesitate to email me at:

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DEQ

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Virginia’s Alternatives to Closure for Upgrading Violations

An Overview

Alicia Meadows
UST Compliance Coordinator
Virginia Department of Environmental Quality
August 1, 2019

Alternatives to Closure for Upgrading Violations

Created as a way to consistently handle situations where corrosion protection is present but not in compliance or information is unknown.

Alternatives to Closure for Upgrading Violations – Decision Matrix

Scenario	Compliance Options other than closure	Comments
1. Bare or galvanized steel UST and/or underground piping known to have no lining or CP	None.	Must permanently close the unprotected steel structure and submit a closure assessment.
2. Bare steel UST with some form of CP upgrade (almost always impressed current) evident, but without documentation that an integrity assessment was properly accomplished and CP properly installed, or that the installed CP system was designed by a CP expert. Six month and three year tests may have been performed, not performed, not documented, or are overdue. **(Includes cases where CP impressed current systems were turned off for more than 90 days.)**	Owner must: (1) obtain TTT (case specifics may necessitate high level TTT); (2) perform a manned entry integrity assessment; (3) obtain corrosion expert certification of eligibility and system design; and (4) perform CP periodic testing (i.e., -850 mV or 100mV shift test).	Site specific criteria provide for some RO discretion for the appropriate TTT method.

DEQ

Alternatives to Closure for Upgrading Violations – Decision Matrix

Bare or galvanized steel UST and or piping → No options → Must permanently close

DEQ

Alternatives to Closure for Upgrading Violations – Decision Matrix

Tank owner wants to add lining to a cathodically protected tank.

- Lining may occur
- CP system MUST be maintained (tested, repaired when needed, etc.)
- Liner does not need to be maintained although encouraged

Alternatives to Closure for Upgrading Violations – Decision Matrix

Owner wants to add cathodic protection (CP) to a lined tank.

- Liner must pass lining inspection prior to adding CP.
- If liner fails, it must be repaired.
- If ineligible for repair then CP may not be added.
- Requires internal integrity assessment and CP expert certification.

Alternatives to Closure for Upgrading Violations – Decision Matrix

StiP-3 UST — Owner asserts tank is StiP-3 but has no proof.

- Require owner to physically demonstrate
- May rely on installation documentation, registration records, or a sworn affidavit

Alternatives to Closure for Upgrading Violations – Decision Matrix

StiP-3 UST with impressed current added-tank fails 100mV-shift test.

- CP expert required for modifications
- Tank must be modified according to NACE.

DEQ