Cathodic Protection

A SHORT PRIMER

Objectives

- Corrosion
  - What is corrosion
  - What causes corrosion
- Cathodic Protection
  - What is cathodic protection
  - How does cathodic protection work
- Testing
  - Review of some reports

Corrosion

- *noun* cor·ro·sion \kə-ˈrō-zhən\
- *1* : the action, process, or effect of corroding
- *2* : a product of corroding

- **Corrode**
- *verb* cor·rode \kə-ˈrōd\
- : to slowly break apart and destroy (metal, an object, etc.) through a chemical process
- : to gradually destroy or weaken (something)

Source: www.merriam-webster.com

Corrosion Mechanisms

- Electrolytic Corrosion
- Galvanic Corrosion

Terms Explained

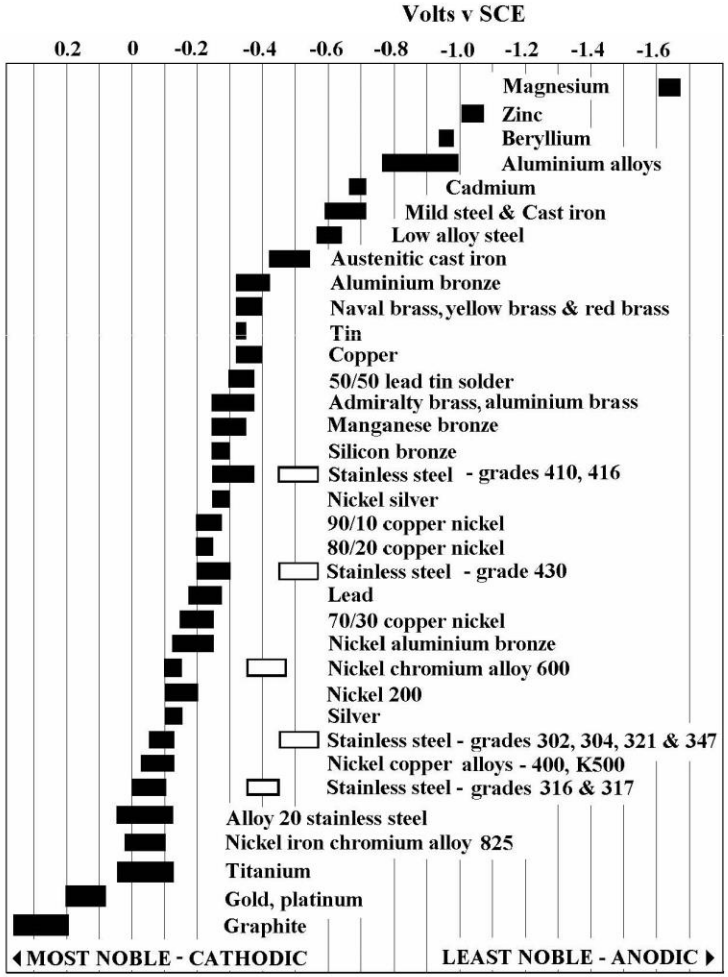
- Electrolytic Corrosion
  - The result of direct current from outside source(s) entering and then leaving a particular metallic structure by way of an electrolyte; man made
- Galvanic Corrosion
  - The result of the difference in corrosion potential between two metals by way of an electrolyte; natural process
    - May also occur due to electrolyte: differences in soils, soil resistivity, oxygen concentration, moisture content
- Electrolyte
  - A conductor in which electric current is carried by the movement of ions that are not metallic

Sources: www.merriam-webster.com and www.corrosionpedia.com

Terms Explained

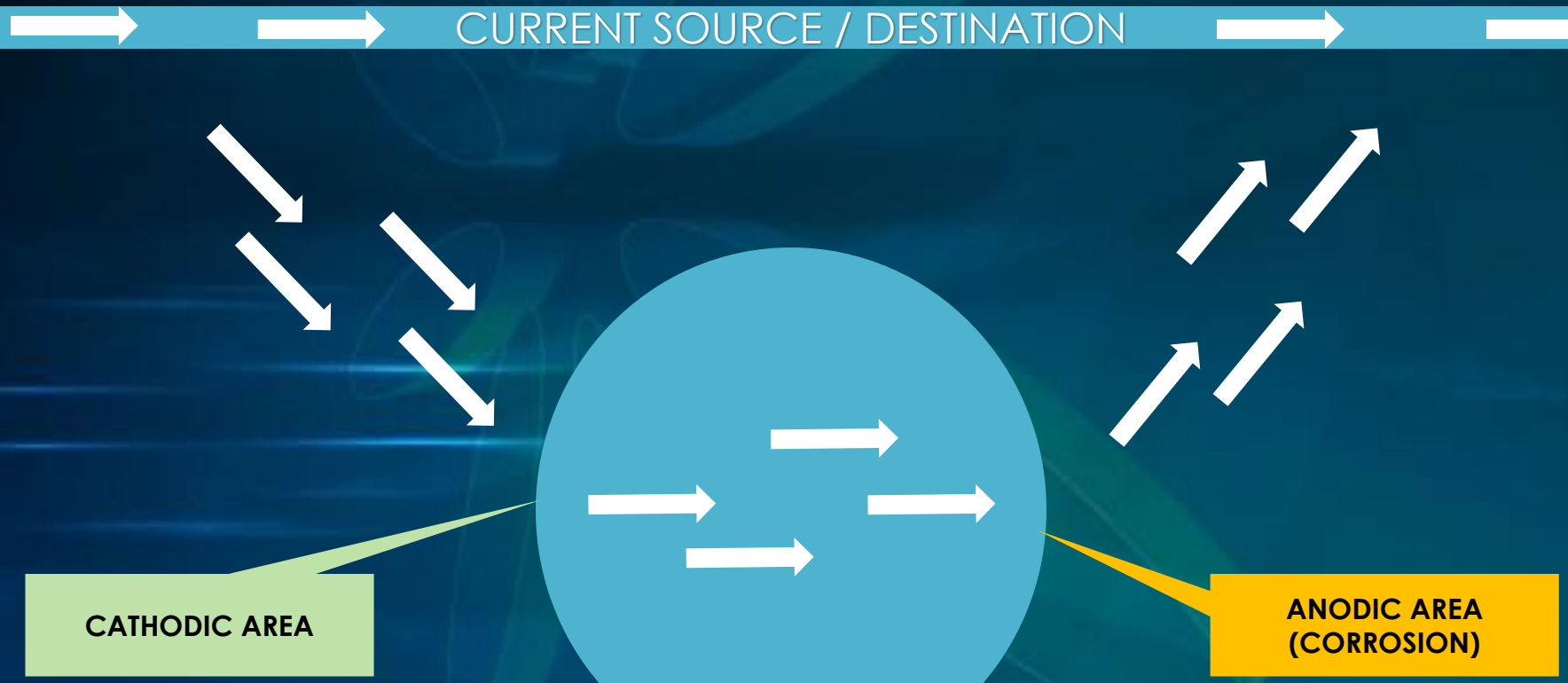
- Anode
  - The part of an electrochemical cell at which oxidation occurs; the part from which electrons leave
  - The part of the "system" which is destroyed or weakened (jas)
- Cathode
  - The part of an electrochemical cell at which reduction occurs; the part where electrons enter
  - The part of the "system" which is "protected" (jas)
- Galvanic Series
  - A chart showing the electrical potential of metals compared to a known standard

Sources: www.merriam-webster.com and www.corrosionpedia.com

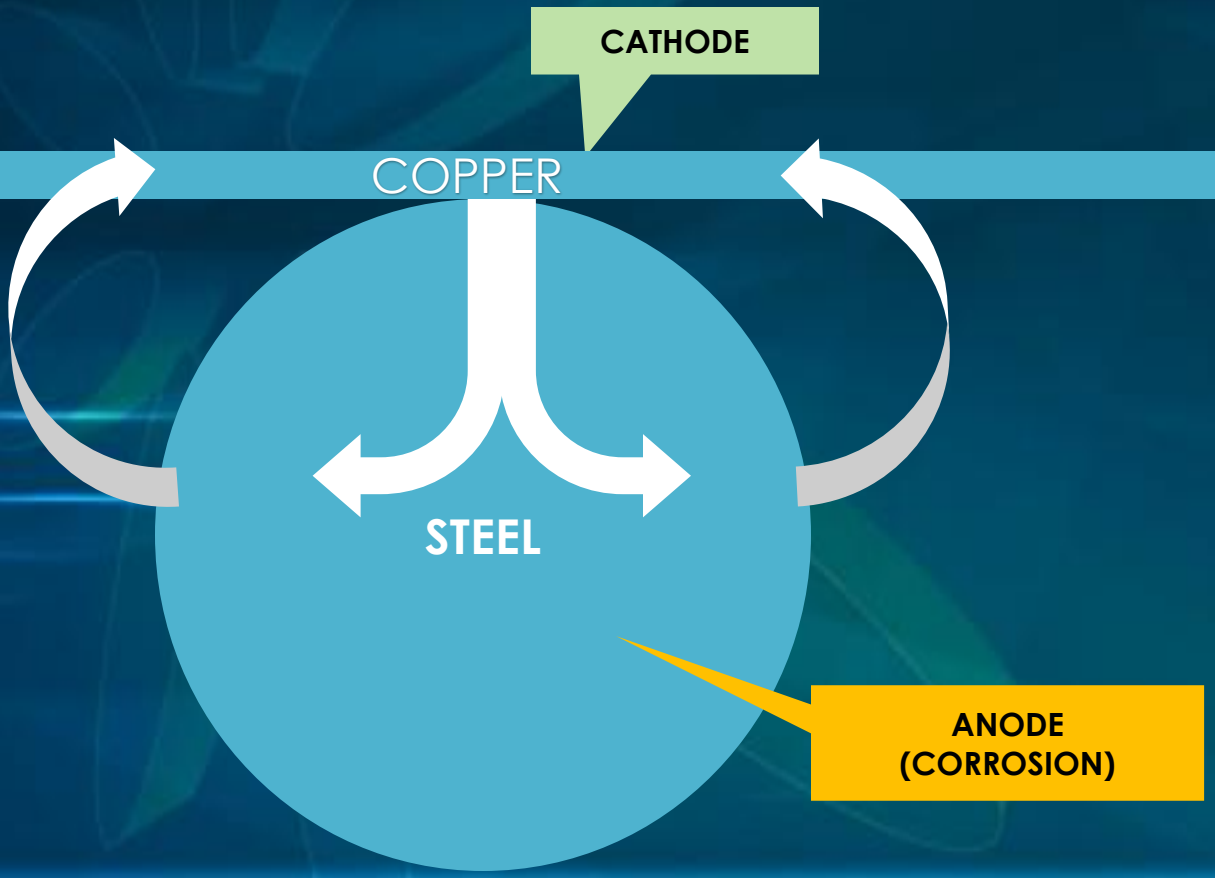


Corrosion potentials in flowing sea water at ambient temperature. The unshaded symbols show ranges exhibited by stainless steels in acidic water such as may exist in crevices or in stagnant or low velocity or poorly aerated water. The more Noble materials at the left side tend to be cathodic and hence protected; those at the right are less Noble and tend to be anodic and hence corroded in a galvanic couple.

Electrolytic Corrosion



Galvanic Corrosion



Corrosion Control Mechanisms

- Non-Metallic Coating
- Non-Metallic Coating with
  - Sacrificial or Impressed Current Cathodic Protection
- “Bare” Steel with
  - Sacrificial or Impressed Current Cathodic Protection

Sacrificial Anode Cathodic Protection (SACP)

- Sacrificial anode cathodic protection (SACP) is a type of cathodic protection where a less noble material that acts as a sacrificial anode is connected by metallic conductors to the structure to be protected. The materials used for this purpose are magnesium, aluminum and zinc. They provide electrons to the structure to be protected and are consumed.
- Generally SACP is used for protection of well coated areas where protective current requirements and soil or water resistivity are low. It is also used where the surface area of a protected structure is relatively small.

Source: www.corrosionpedia.com

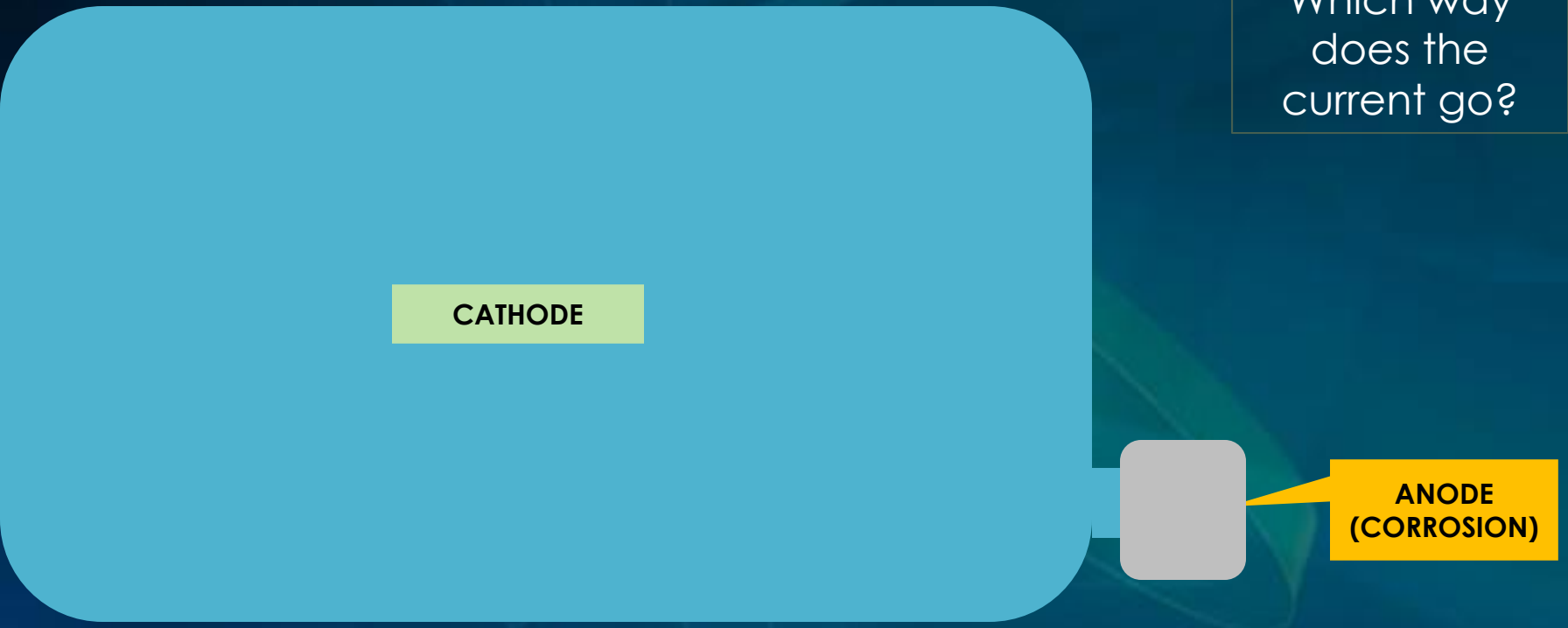
Impressed Current Cathodic Protection (ICCP)

- Impressed current cathodic protection (ICCP) is a type of system usually applied where there are elevated current requirements for protection against corrosion. This is used in cases where the driving voltage is higher than the galvanic system or if there is a need for increased system control.
- It offers permanent and automatic protection that aids in preventing galvanic and electrolytic corrosion if properly designed, installed, and maintained.

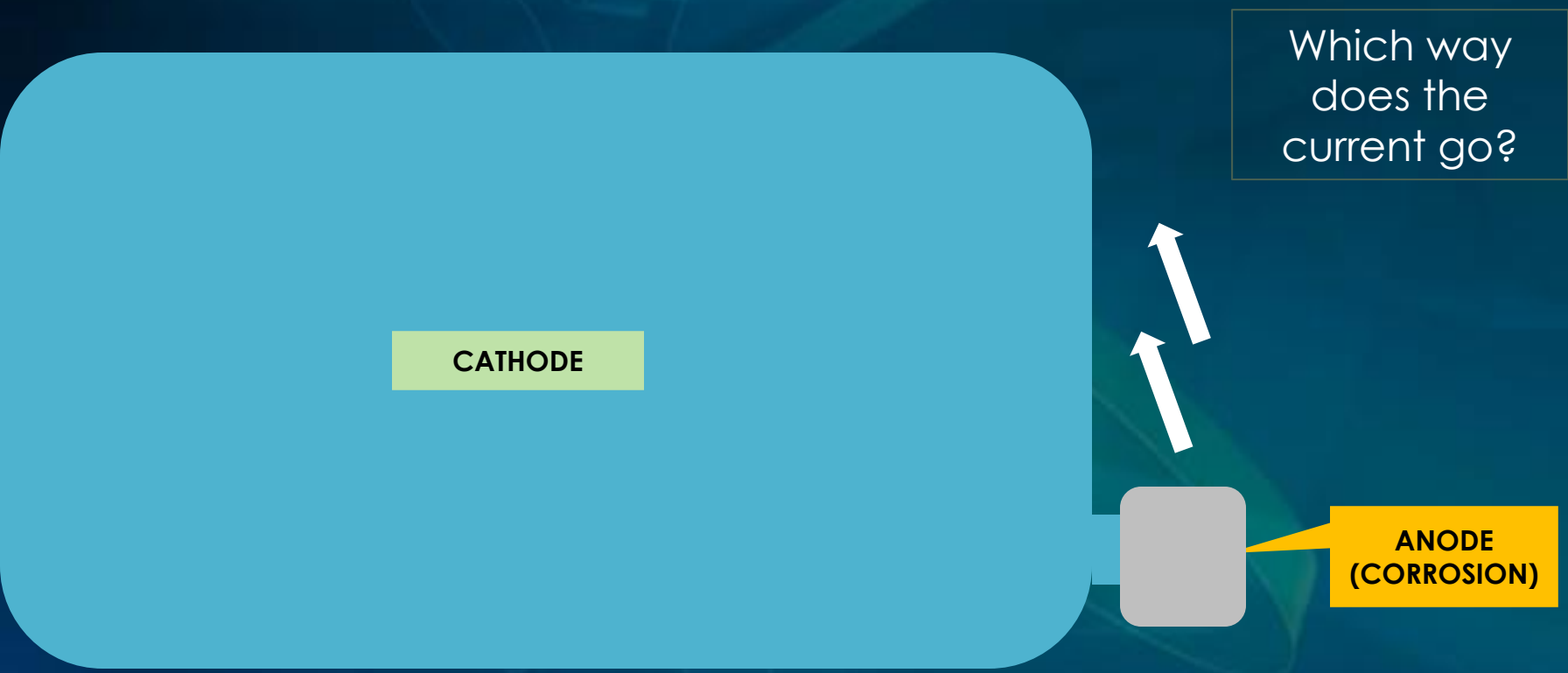
Source: www.corrosionpedia.com

Sacrificial Cathodic Protection

Which way does the current go?



Sacrificial Cathodic Protection

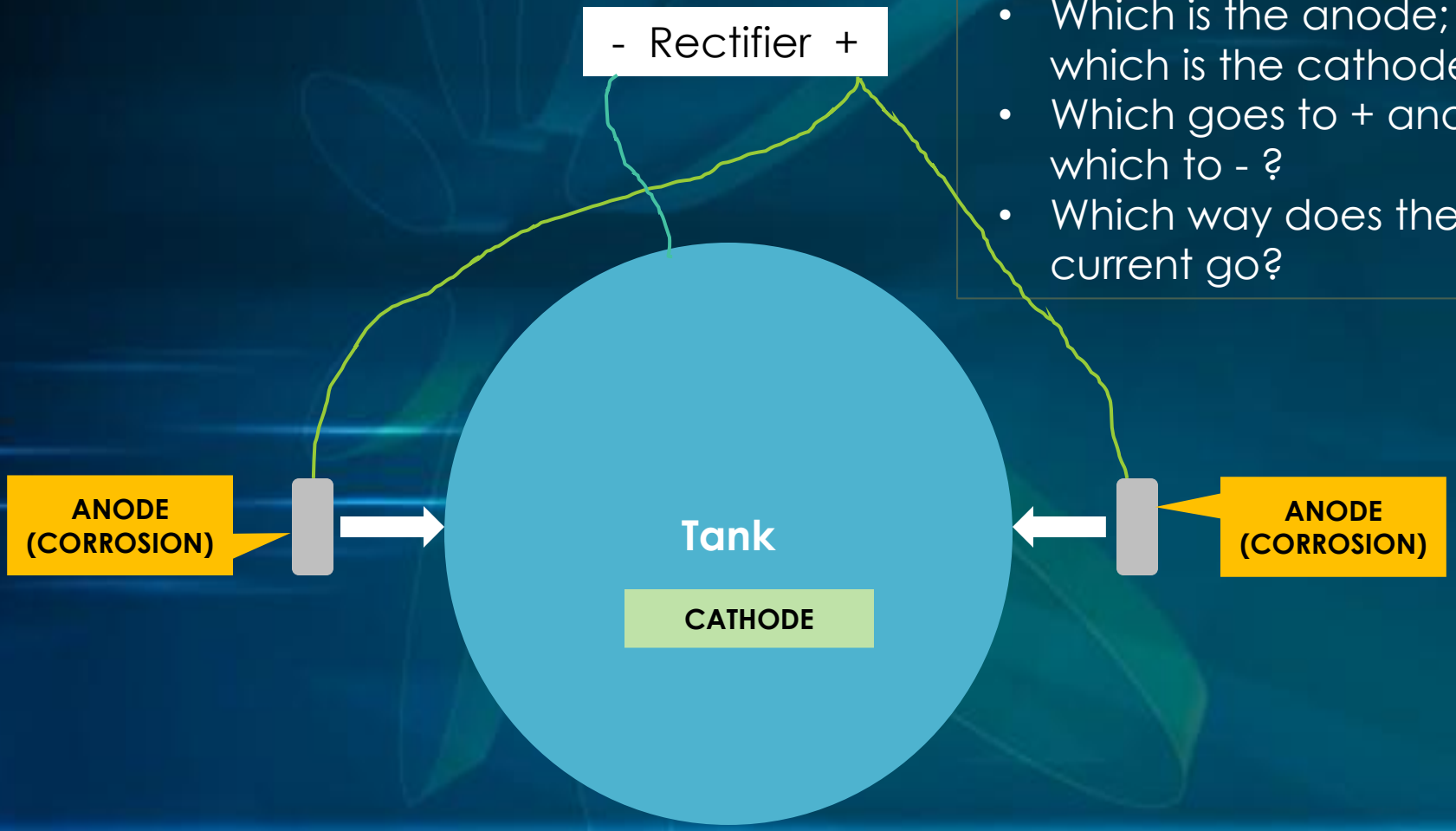


Impressed Current Cathodic Protection

- Rectifier +

- Which is the anode; which is the cathode?
- Which goes to + and which to - ?
- Which way does the current go?

Impressed Current Cathodic Protection



- Which is the anode; which is the cathode?
- Which goes to + and which to - ?
- Which way does the current go?

From the Rule

- 761.700(1)(b) Cathodic protection.

1. Cathodic protection systems shall be installed, operated and maintained to provide continuous corrosion protection to the metal components of those portions of the tank and integral piping in contact with the soil.

2. Inspection and testing requirements.

a. General. Storage tank systems equipped with any type of cathodic protection must be inspected and tested by a Corrosion Professional or a Cathodic Protection Tester within six months of installation or repair and at least every year thereafter in accordance with the criteria contained in NACE International RP-0169-96 and RP-0285-95, as applicable. Factory-installed (galvanic) cathodic protection systems may be tested every three years.

b. Impressed current systems. Storage tank systems with impressed current systems shall be inspected at intervals not exceeding two months. All sources of impressed current shall be inspected. Evidence of proper functioning shall be current output, normal power consumption, a signal indicating normal operation, or satisfactory electrical state of the protected structure. Impressed current systems that are inoperative for a cumulative period exceeding 1440 hours shall be assessed by a Corrosion Professional to ensure that the storage tank system is structurally sound, free of corrosion holes, and operating in accordance with the design criteria.

c. Sacrificial anode systems. Storage tank systems with sacrificial anodes shall either have permanent test stations for soil-to-structure potential measurements or use temporary field test stations for annual testing in accordance with sub-subparagraph 62-761.700(1)(b)2.a., F.A.C.

3. Storage tank systems with cathodic protection systems that cannot achieve or maintain protection levels in accordance with the design criteria shall:

a. Be repaired in accordance with sub-subparagraph 62-761.700(1)(b)2.a., F.A.C., or

b. Be placed out-of-service in accordance with subsection 62-761.800(1), F.A.C.

4. Records of the continuous operation of impressed current systems and all cathodic protection inspection and testing activities shall be maintained in accordance with paragraph 62-761.700(1)(b), F.A.C.

Test Results

CATHODIC PROTECTION TEST FORM

FACILITY INFORMATION

JOB # :	8623445	DATE OF TEST :	11/11/2015	TIME OF TEST :	14:45

NAME:	Rainbow Food Mart #5504				
ADDRESS:	8592 49th Street N				
CITY:	Pinellas Park			PHONE # :	
STATE:	FL	ZIP:	CONTACT: JOE	LAT: (N)	
FACILITY ID # :	8623445			LONG: (W)	

CUSTOMER INFORMATION

NAME:					
ADDRESS:					
CITY:				PHONE # :	
STATE:		ZIP:	CONTACT: JOE	FAX # :	

SUMMARY OF TEST

THIS SUMMARY IS NOT COMPLETE WITHOUT THE *SITE SKETCH

RECT.	HR.:	C:	1	F:	3	VOLTAGE:	AMPS:	3.8

TANK #	STRUCTURE CONTACT POINT	REFERENCE CELL POTENTIAL @ END (R1)* ON	END (R1)* OFF	END (R1)* FINAL	END (R1)* DECAY	CENTER (R2)* ON	CENTER (R2)* OFF	CENTER (R2)* FINAL	CENTER (R2)* DECAY	END (R3)* ON	END (R3)* OFF	END (R3)* FINAL	END (R3)* DECAY	STRUCTURE PASSED OR FAILED TO MEET THE MINIMUM NACE STANDARD OUTLINED IN RP0285-95 SECTION 4.2.1.1.
1	STP RISER	-1.199	-1.034	-0.846	0.188	-1.062	-0.961	-0.922	0.039	-2.46	-1.46	-1.389	0.071	PASSED
2	STP RISER	-1.222	-0.869	-0.767	0.102	-0.98	-0.919	-0.9	0.019	-2.61	-1.65	-1.445	0.205	PASSED
3	SHIPON RISER	-0.978	-0.695	-0.573	0.122	-1.197	-49	-0.964	48.036	-2.75	-1.54	-1.363	0.177	PASSED
4														
5														
6														
7														
8														
9														
10														

DISP #	STRUCTURE CONTACT POINT	REFERENCE CELL POTENTIAL ON VOLTAGE	INSTANT OFF	FINAL VOLTAGE	VOLTAGE DECAY	STRUCTURE PASSED OR FAILED TO MEET THE MINIMUM NACE STANDARD OUTLINED IN RP0285-95 SECTION 4.2.1.1.
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						

TESTER NAME:

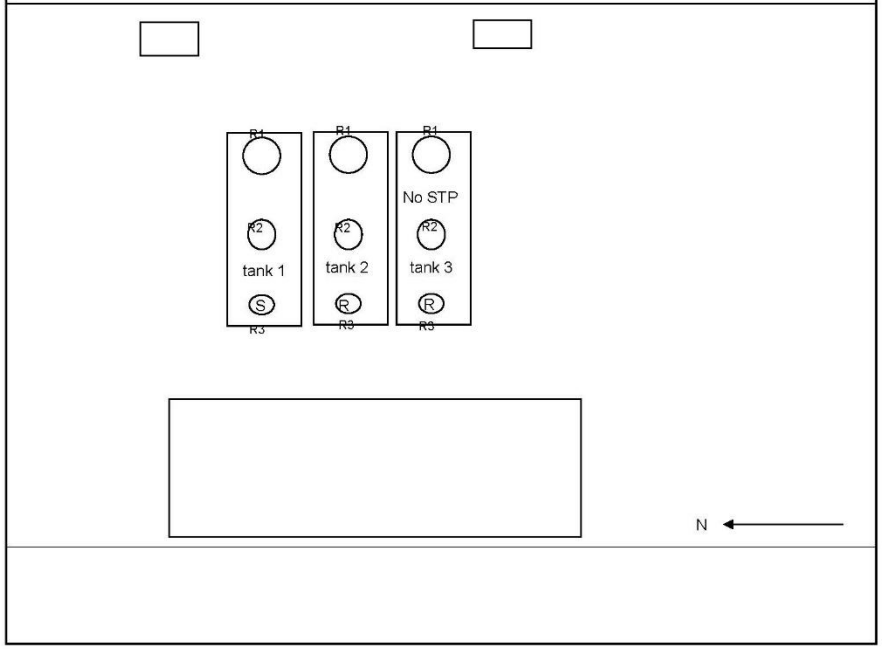
JOB # :	8623445			DATE OF TEST:	11/22/11
FACILITY NAME:	Rainbow Food Mart #5504			FAC. ID # :	8623445

CONTINUITY TEST

TANK #	(1) FILL RISER	(2) TANK BOTTOM	(3) STP RISER	(4) VENT RISER	(5) Sensor Riser	(6)SPARE	CONTINUOUS	ISOLATED
1	-0.698		-0.696	-0.500	-0.378		1,3	4,5
2	-0.698		-0.695	-0.503	-0.617		1,3	4,5
3	-0.698		-0.697	-0.697	-0.608		1,3,4	5
4								
5								
6								
7								
8								
TANK #:	1,2,3		1,2,3	1,2 3	1 2'3		CONTINUOUS ISOLATED	

IN THE SPACE BELOW, SKETCH THE IMPORTANT PARTS OF THE FACILITY SUCH AS TANKS, MAN WAYS, VENTS, ANODES, PUMP ISLANDS AND BUILDINGS. INDICATE REFERENCE CELL LOCATIONS USING LOCATION CODE "R" AND SEQUENTIAL NUMBERS (R1, R2 AND R3).

COMMENTS



Always a bad sign….

Questions?