Day 1 Review

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Appalachian Underground Corrosion Short Course

Mathematics Reminder!

- Any number times itself is always equal to itself!
 - 1 x 18 = 18
 - 235 x 1 = 235
 - 64 x 1 = 64
 - 73526 x 1 = 73526
 - 53 x1 x 1 x 1 x 1 = 53
 - 1 x 348 x 1 x 1 x 1 = 348

UNITS IS EVERYTHING!

- 5280 Feet = 1 Mile
- 1 Dollar = 20 Nickels
- 1 Volt = 1000 millivolts
- 24 Hours = 1 Day



How to Convert

- If we have 15,000 feet that we want to convert to miles;
- We must convert the units

 $15000 feet \times \frac{1 \text{ mile}}{5280 \text{ feet}} = \frac{2.84 \text{ feet} - \text{mile}}{\text{feet}}$

Answer: 15000 feet = 2.84 miles

How to Convert

- If we have 8.62 miles that we want to convert to feet;
- We must convert the units

How to Convert

- If we have Volts to Millivolts [1 Volt = 1000 mV]
- We must convert the units; .084 Volts to millivolts

$$\frac{1 \, Volt}{1000 \, millivolts} = 1 \qquad \frac{1000 \, millivolts}{1 \, Volts} = 1$$

$$.084 \, Volts \times \frac{1000 \, mV}{1 \, Volt} = \frac{840 \, Volt - mV}{Volt}$$

Answer: .084 Volt = 840 mV

Moving the Decimal Point for conversions

Convert		
.857 V	mV	
772 mV	V	
1.357 V	mV	
50 mA	А	
.020 A	mA	

$$\frac{1 \, Volt}{1000 \, millivolts} = 1$$

 $\frac{1000 \text{ millivolts}}{1000 \text{ millivolts}} = 1$ 1 Volts

Electricity Symbols

•Voltage source- Electrical Pressure, usually represented by an "E" or "V"

 Current flowing – Flow of Electrons, usually represented by an "I"

Ε

Resistor- Resistance to the flow of electrons, usually represented by an "R"

Ohm's Law

A potential of 1 volt across a resistance of 1 ohm causes 1 amp of current to flow



Volts = 12 V Resistance = 3.5 Ω Current = ? A	Volts = 6 V Resistance = ? Ω Current = 1.5 A	Volts = ? V Resistance = 5 Ω Current = .4 A
$\frac{12 V}{3.5 \Omega} = 3.42 \text{ A}$	$\frac{6V}{1.5A} = 4\Omega$.4 A × 5 Ω = 2 V









Locating

- An electrical device used to locate underground metallic structures.
- Modes of Operation include:
 - Inductive (indirect)
 - Conductive (direct)
 - Inductive Clamp
 - Passive



Locating

- Choosing the Right Tool; <u>ALWAYS FOLLOW</u> <u>MANUFACTURERS'</u> <u>INSTRUCTIONS</u>!
 - Low Frequency
 - High Frequency
- If in Doubt- Don't Mark it out and Hand Dig



What is Corrosion? The <u>deterioration</u> of a material, due to a <u>reaction with its environment</u>



What is a Corrosion Cell?

Corrosion cannot occur without the **four** components of a corrosion cell;

ANODE CATHODE METALLIC PATH ELECTROLYTE

*Take one of the four away and corrosion will be mitigated.

Galvanic Series

Active (More Electro-Negative)

- High Potential Magnesium (-1.75 v)
- Magnesium Alloy (-1.5 v)
- Zinc (-1.1 v)

Potentials

measured with

respect to

saturated

Cu-CuSO₄ Half Cell

- Aluminum Alloys (-1.05 v)
- Clean Carbon Steel (-0.5 to -0.8 v)
- Rusted Carbon Steel (-0.2 to -0.8 v)
- Lead (-0.5 v)
- Copper (-0.2 v)
- High Silicon Iron (-0.2 v)
- Gold (+0.2V)
- Graphite, Carbon (+0.3v)

Noble (More Electro-Positive)

*Anode is more electro-negative than the cathode

*Cathode is more electro-positive than the anode







Telluric Currents



Cathodic Protection

Galvanic Anode Cathodic Protection

Advantages:

- Seldom cause stray current interference
- Relatively low installation cost
- Self-Powered
- Low Maintenance

Disadvantages:

- Limited on current output- doesn't work in high-resistivity soils
- Not practical for bare or poorly coated pipelines
- Relatively high consumption rate

Sacrificial Anodes

Zinc, Aluminum, and Magnesium

Impressed Current Cathodic Protection

Advantages

- Capable of protecting large structures
- Capable of protecting structures which require greater magnitudes of current (Higher Driving Voltage)
- May be more economical than sacrificial anode systems
- Lower consumption rates than galvanic anodes
- Better in High Soil Resistivity areas

Disadvantages

- Increased maintenance requirements
- Tendency for higher operating costs
- Possibility of contributing to stray current interference on neighboring structures
- Electric power may be needed

Impressed Current Anodes

- Graphite Anode
- High Silicon Cast Iron
- Mixed Metal Oxide Anode
- Platinum
- Scrap Steel Abandoned Structures
- Aluminum
- Lead Silver
- Magnetite