



# ECDA Indirect Inspection Tools Close Interval Surveys

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A good coating applied to the pipeline is the primary defense against external corrosion of the metal structure.

Additional protection against corrosion is accomplished with cathodic protection or CP.

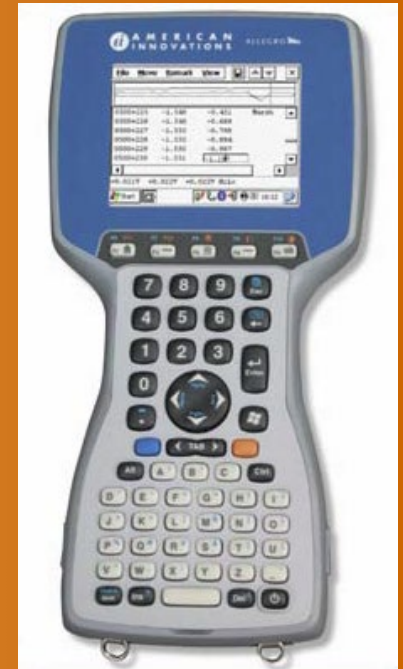
There are two types of CP systems designed to protect steel structures surrounded by conductive electrolyte, such as soil and water:

- Galvanic
- Impressed Current

# Principals of CIS

- A DC structure-to-electrolyte potential is collected during both the CP “on” state and the CP instant “off” state
- Spacing is determined by depth of pipeline and 3 – 5 – 10 foot spacing is common
- All influencing current must be interrupted
- All interrupters must be synchronized
- Sufficient ground contact must be achieved

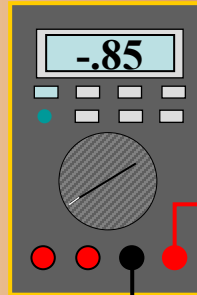
# CIS tools



# What can CIS data tell us?

- It is a macro tool that gives us a relative state of the cathodic protection on the pipeline and can find:
  - Areas of adequate and inadequate protection
  - Large coating defects
  - Possible interference areas
  - Shorted casings

Example voltage reading *note*  
*polarity sign*



Connect voltmeter (positive)  
lead to Steel Structure



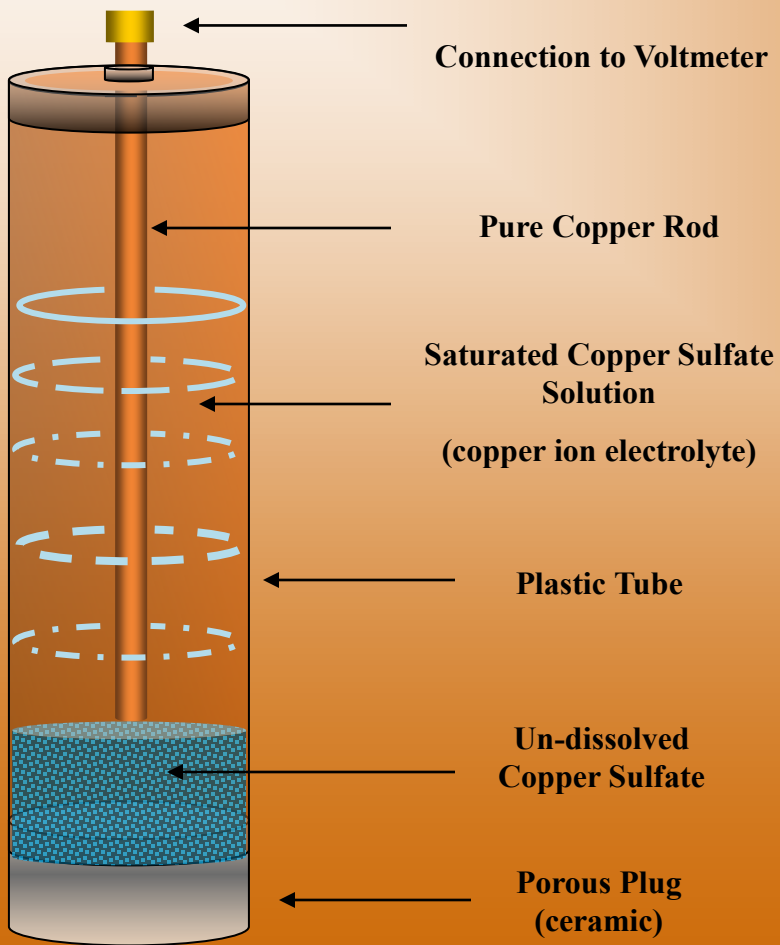
Connect common  
(negative) lead to  
Copper/Copper  
Sulfate Electrode

High Resistance Voltmeter and Cu/SO<sub>4</sub> Reference Electrode



Steel pipe





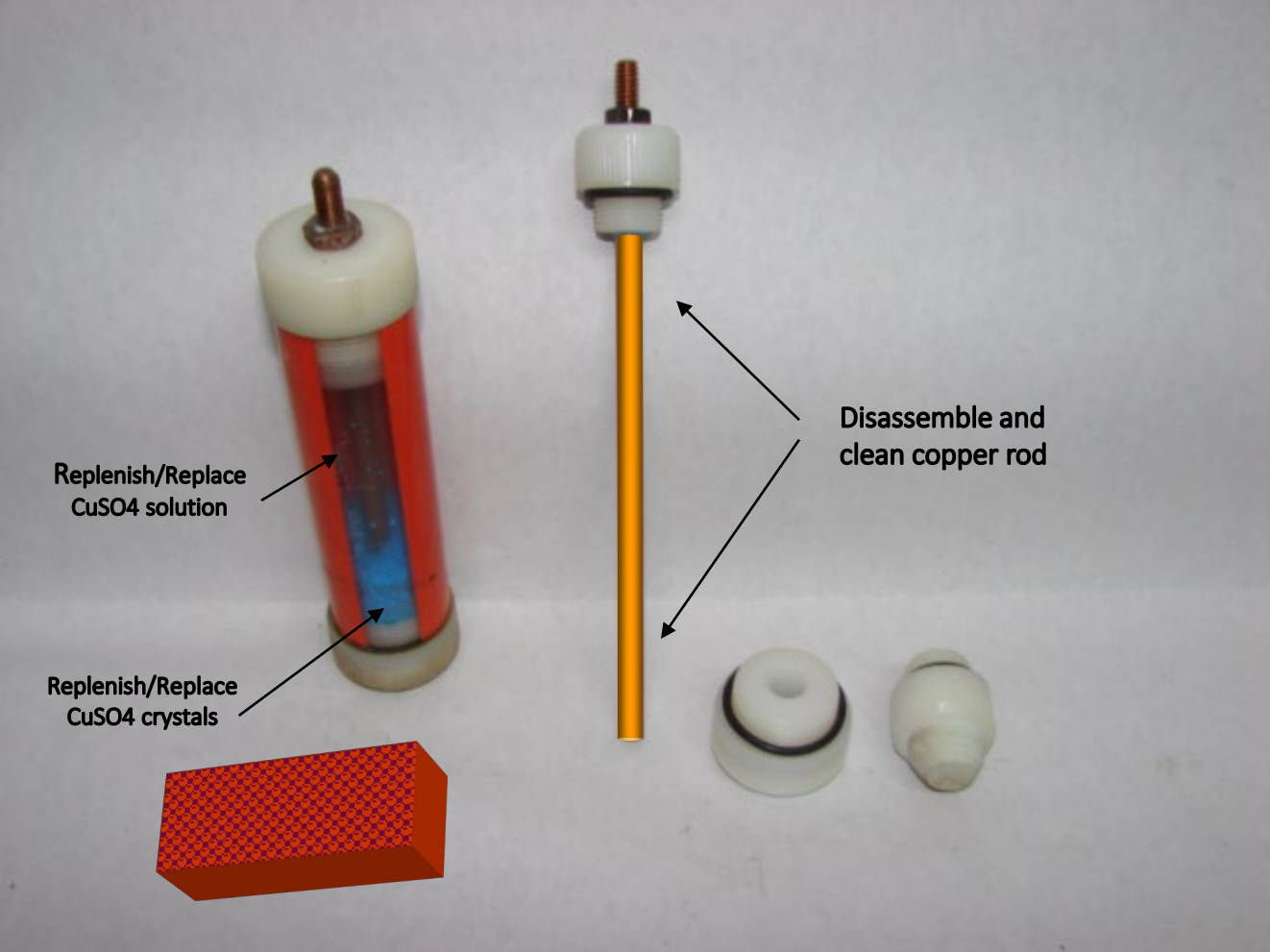
**Standard Reference Half Cell  
(Cu-CuSO<sub>4</sub> Electrode)**



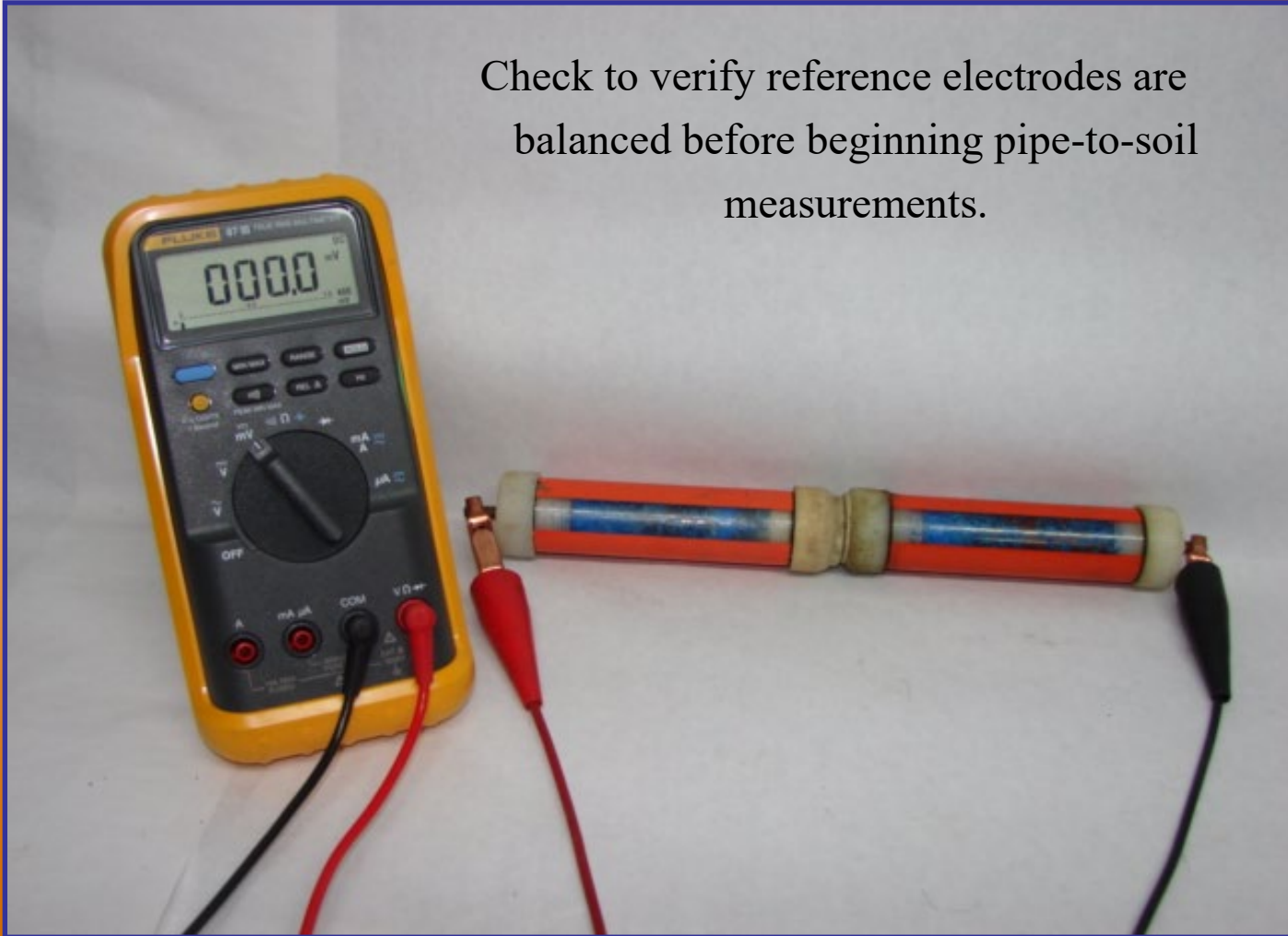


These reference cells will require simple maintenance in order to balance them for reliable use in a CIS survey.

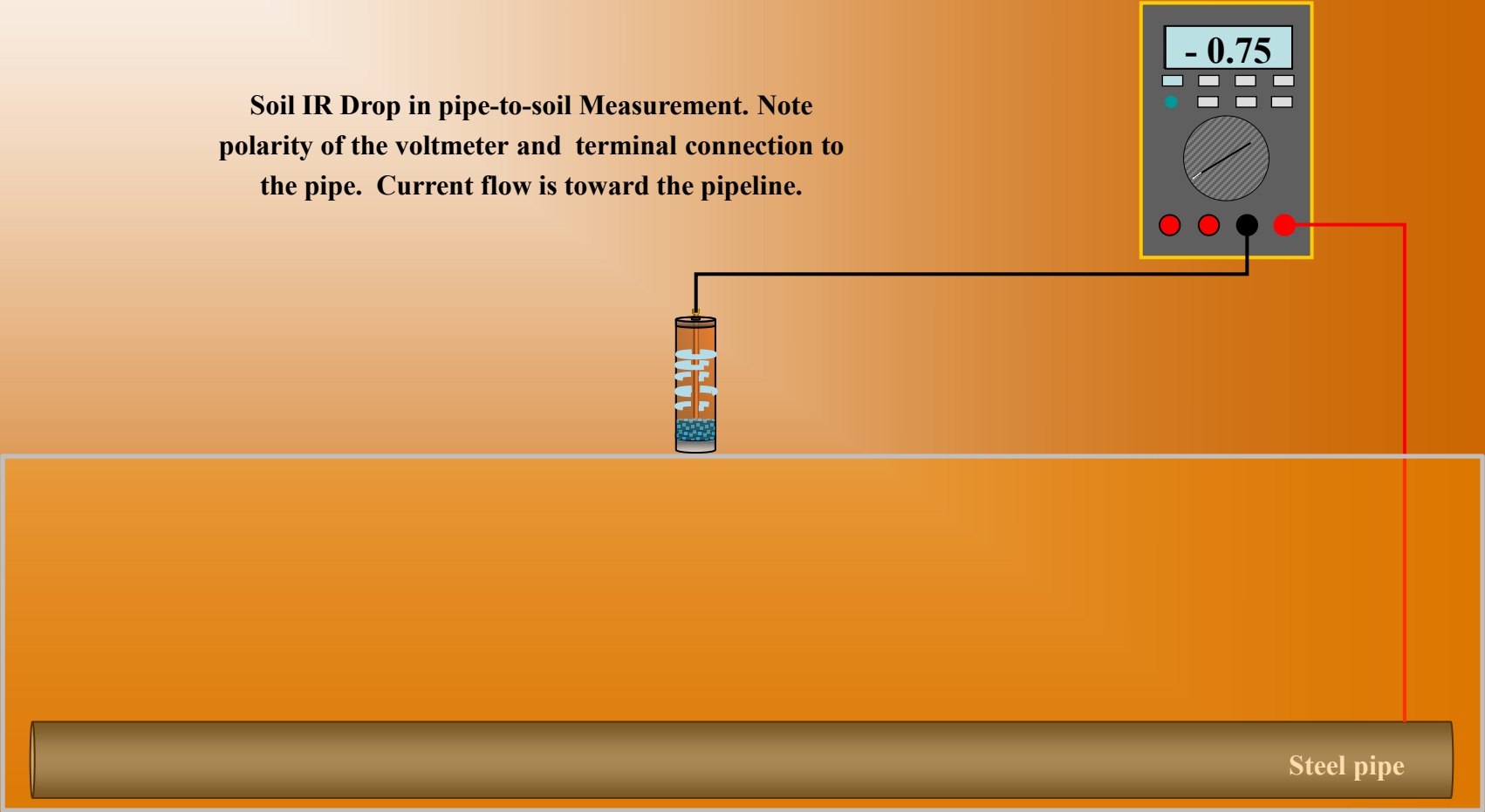




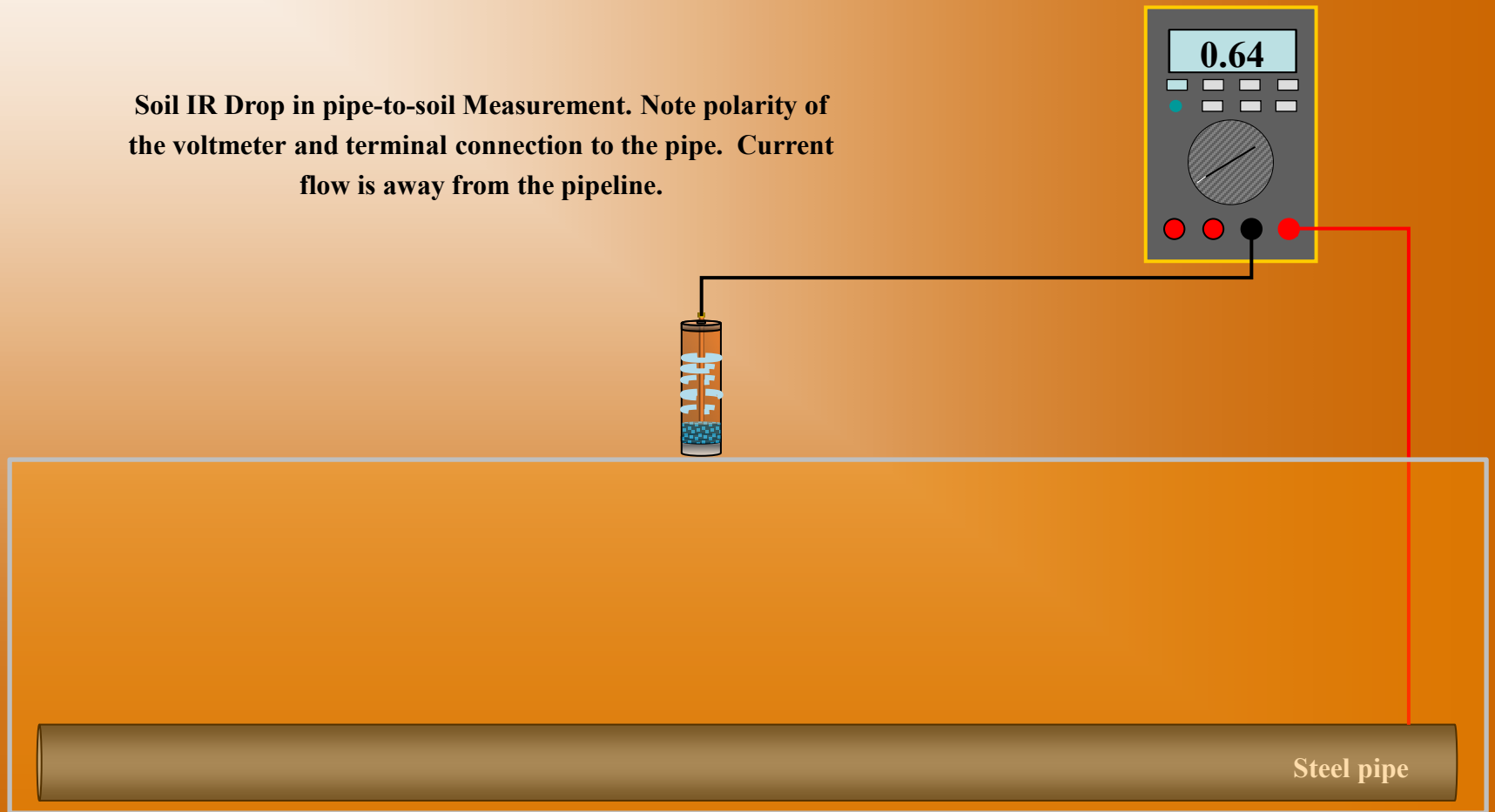
Check to verify reference electrodes are balanced before beginning pipe-to-soil measurements.



**Soil IR Drop in pipe-to-soil Measurement. Note polarity of the voltmeter and terminal connection to the pipe. Current flow is toward the pipeline.**



**Soil IR Drop in pipe-to-soil Measurement. Note polarity of the voltmeter and terminal connection to the pipe. Current flow is away from the pipeline.**



# CIS – Lateral Measurements

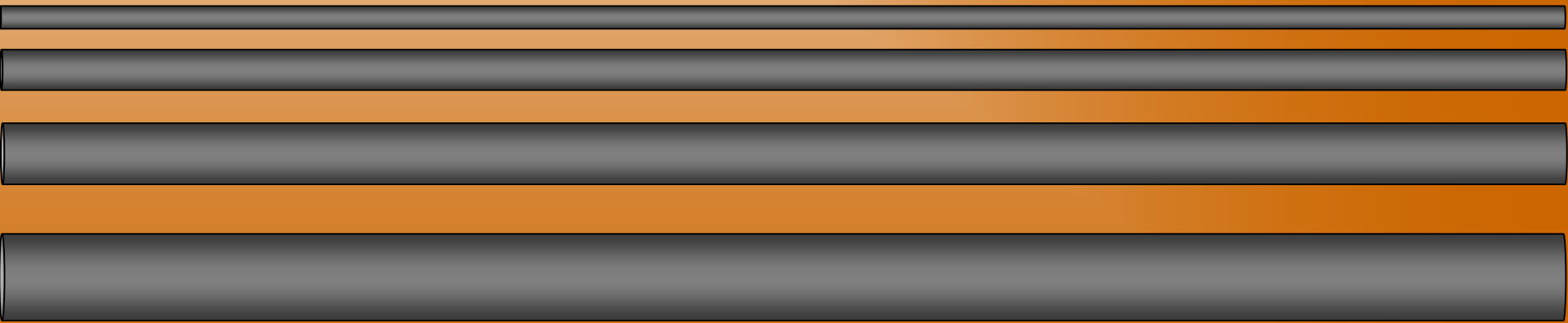
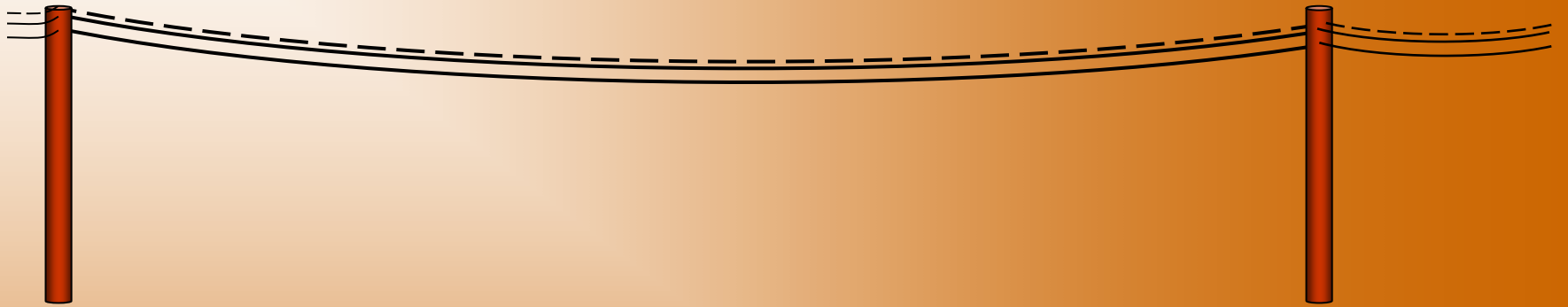
- Lateral potentials are “On” and instant “Off” potentials offset to each side of the pipeline, typically at a distance of 2.5 times the pipeline depth. Lateral potentials are compared with over the pipe potentials.
- Lateral potentials more negative than the potential over the pipeline may indicate current flowing to the pipeline.
- Lateral potentials more positive than the potential over the pipeline may indicate current flowing away from the pipeline.
- Lateral potentials on both sides of the pipeline indicating current flowing to the pipeline is normal in the “On” cycle but if seen in the “Off” cycle could be uninterrupted influencing current.
- Lateral potentials that show current going to the pipeline on one side and away from the pipeline on the opposite side may result from current passing the pipeline as an example in a parallel pipeline.

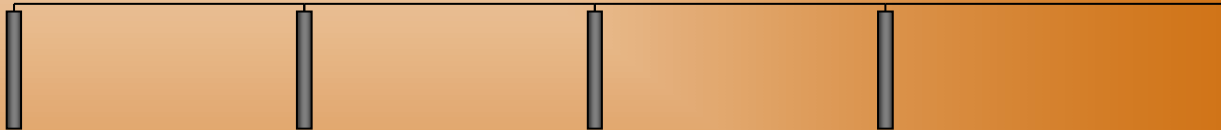
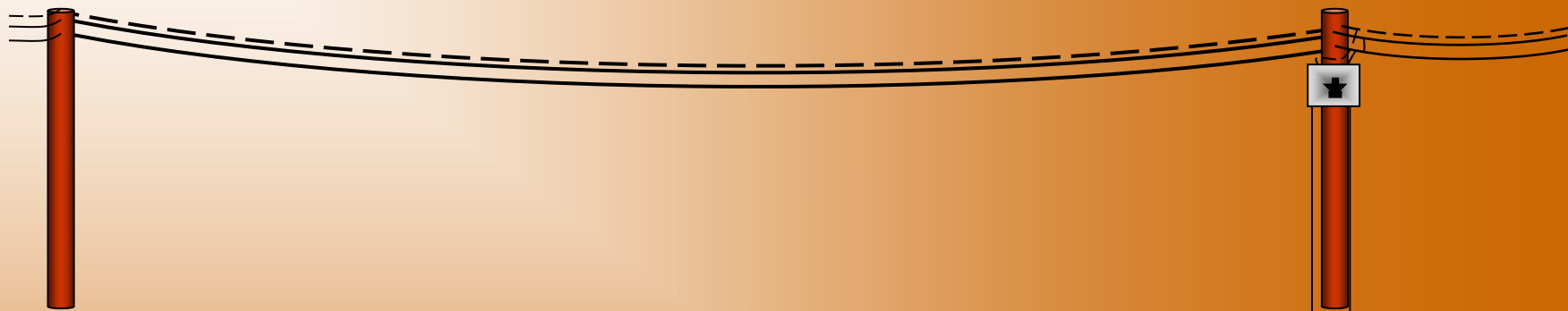


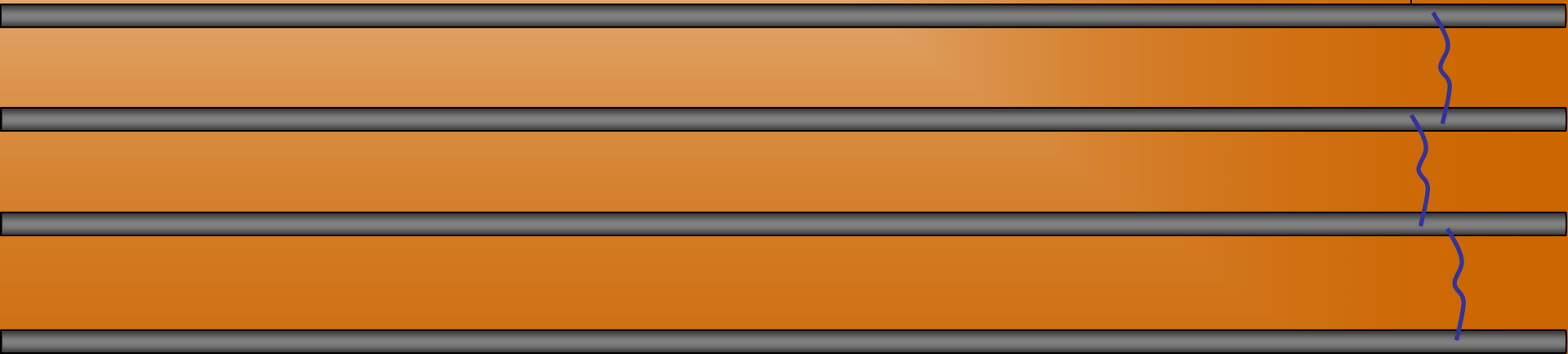
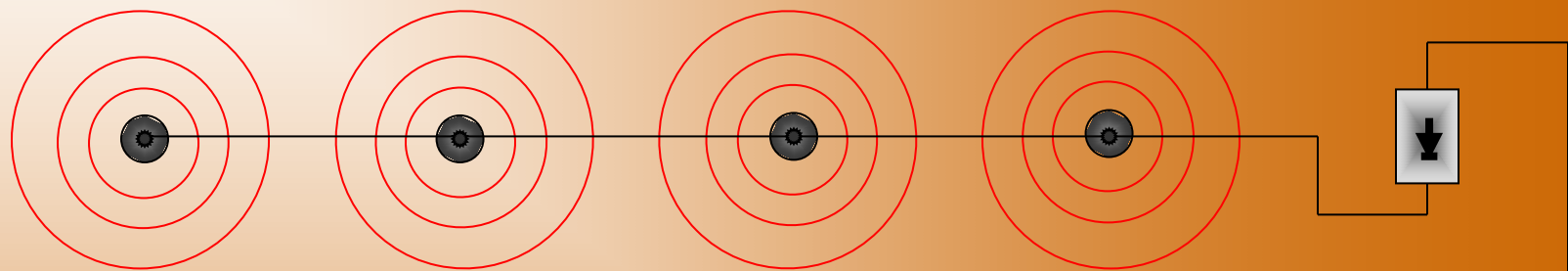


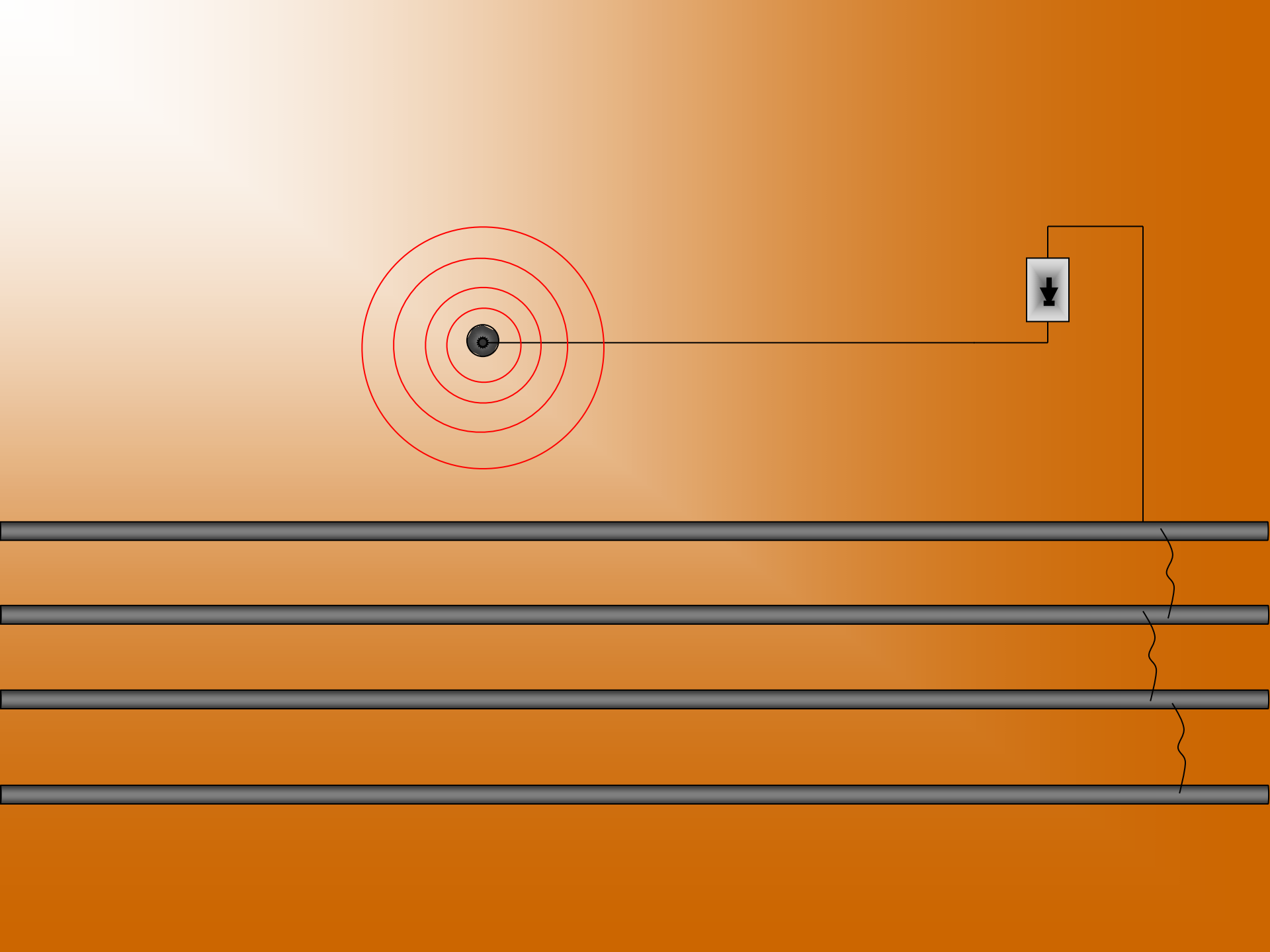
Multiple Gas Mains



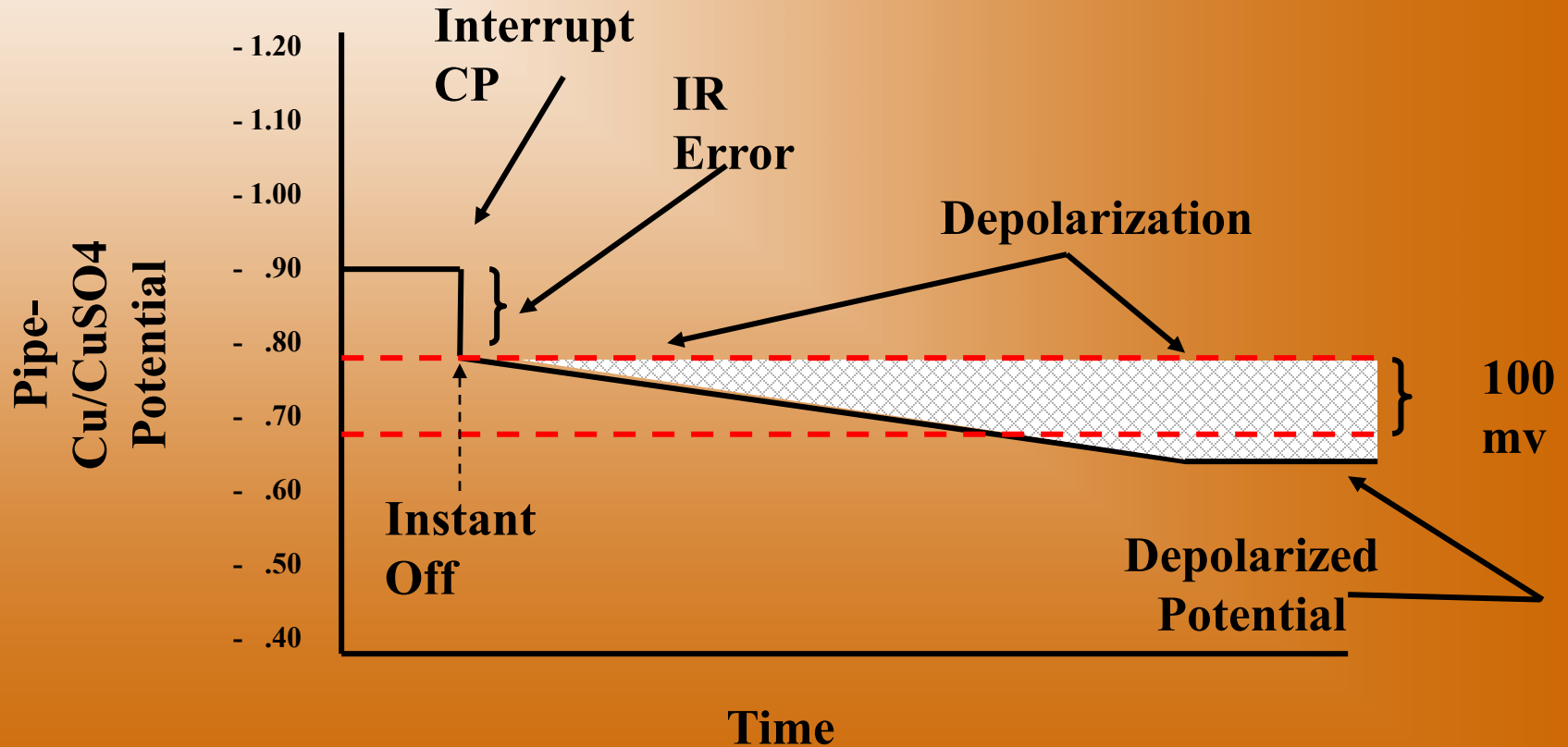




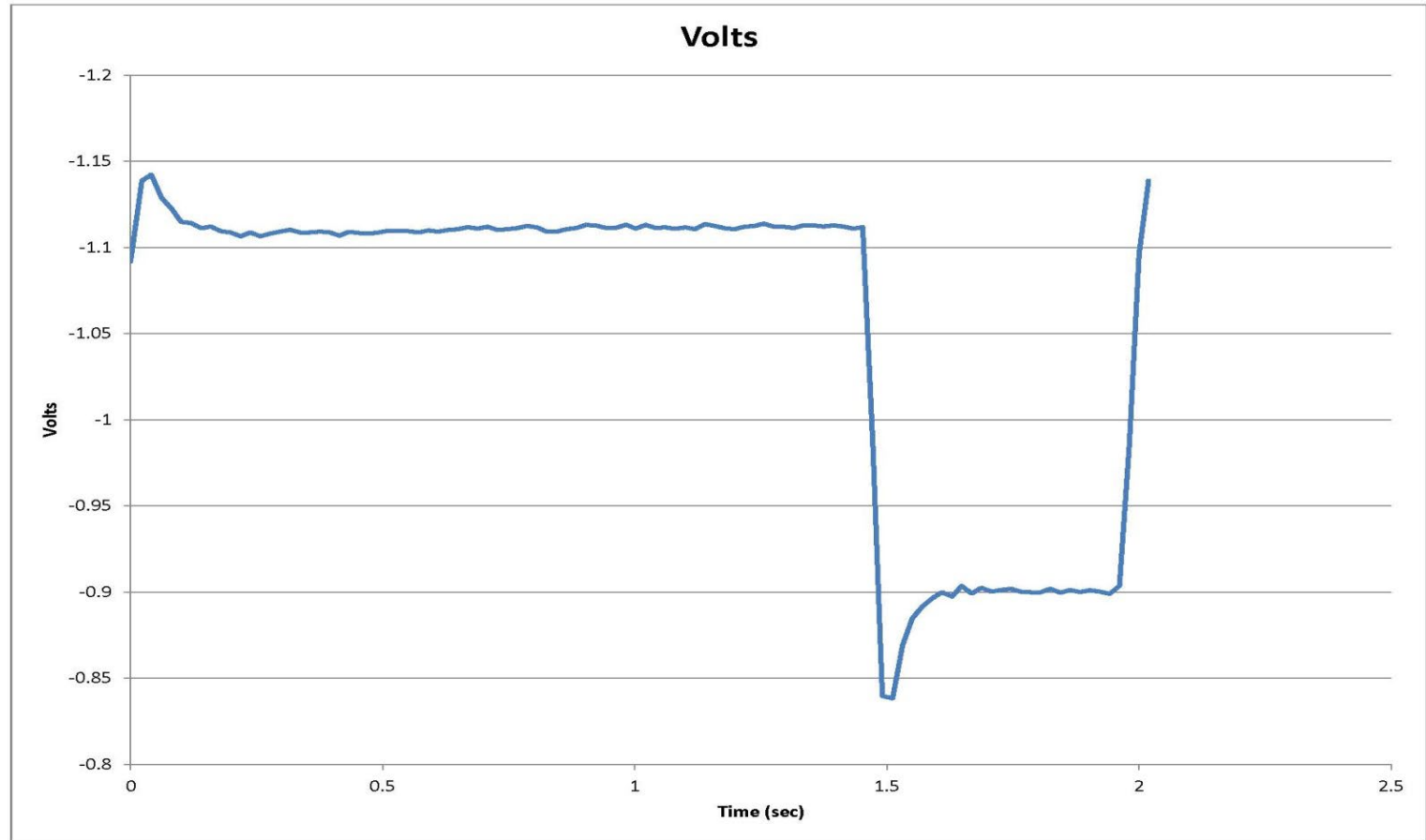


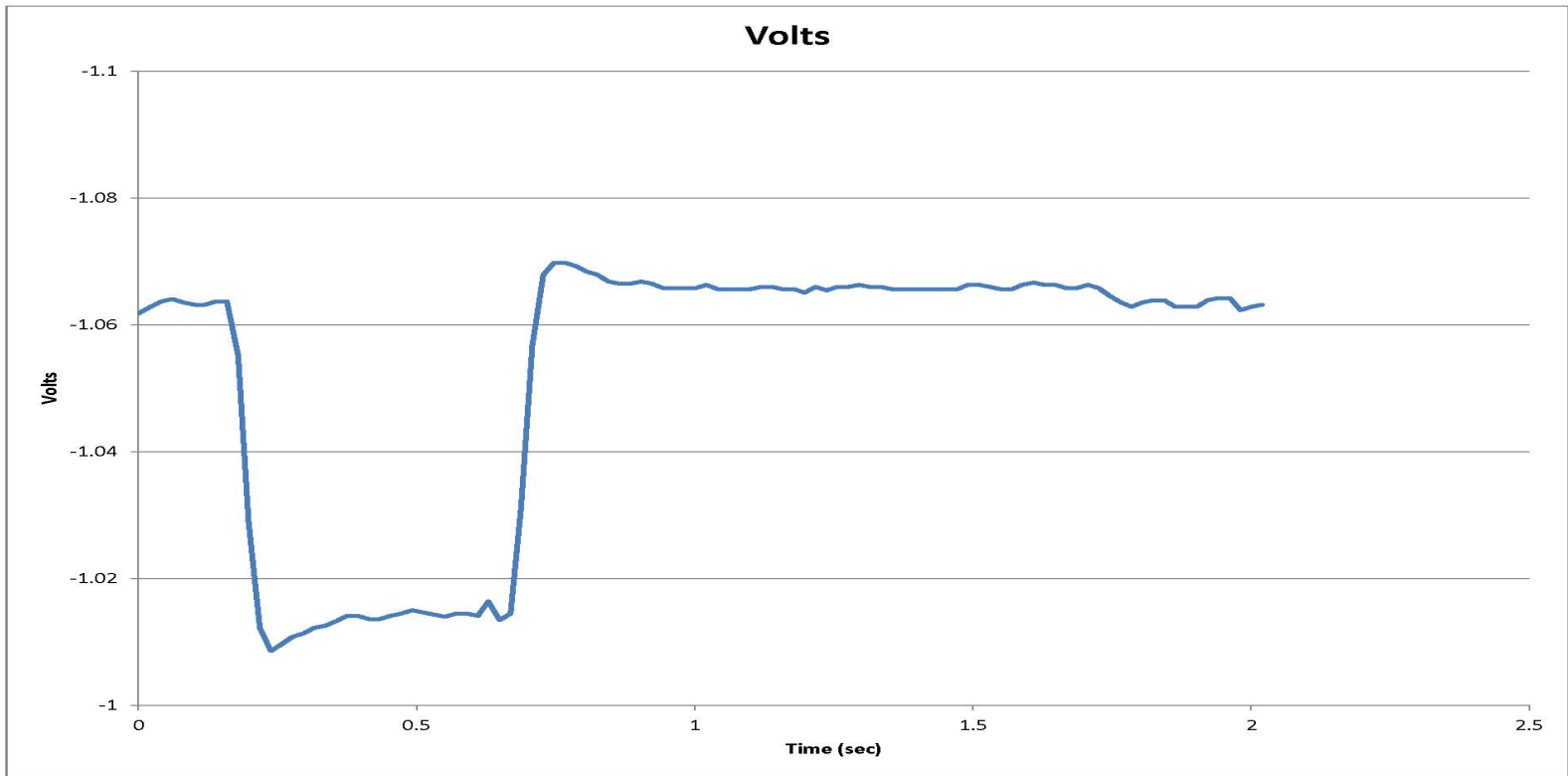


# -850 mV or 100 mV Criteria

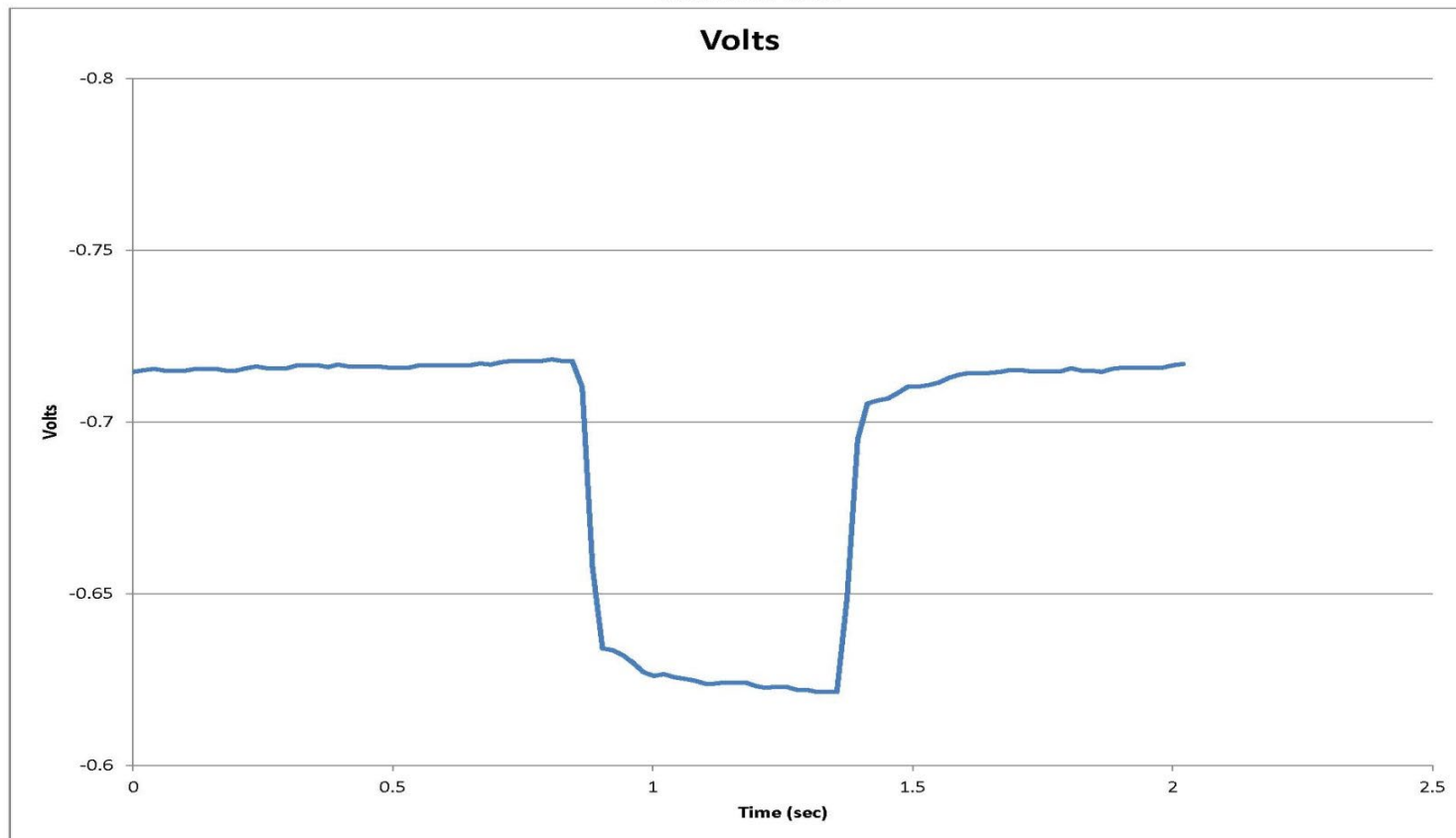


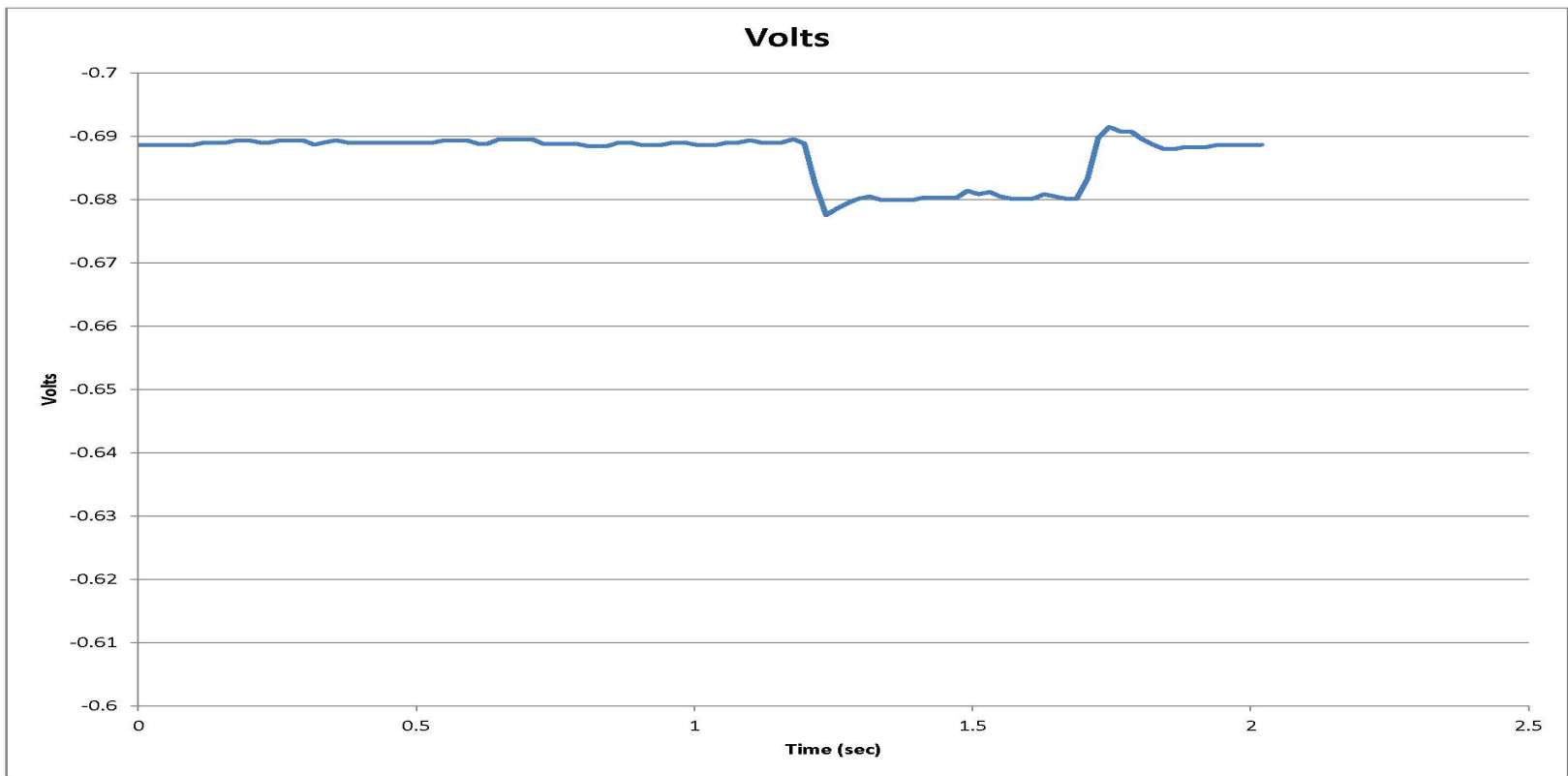
# Wave Prints



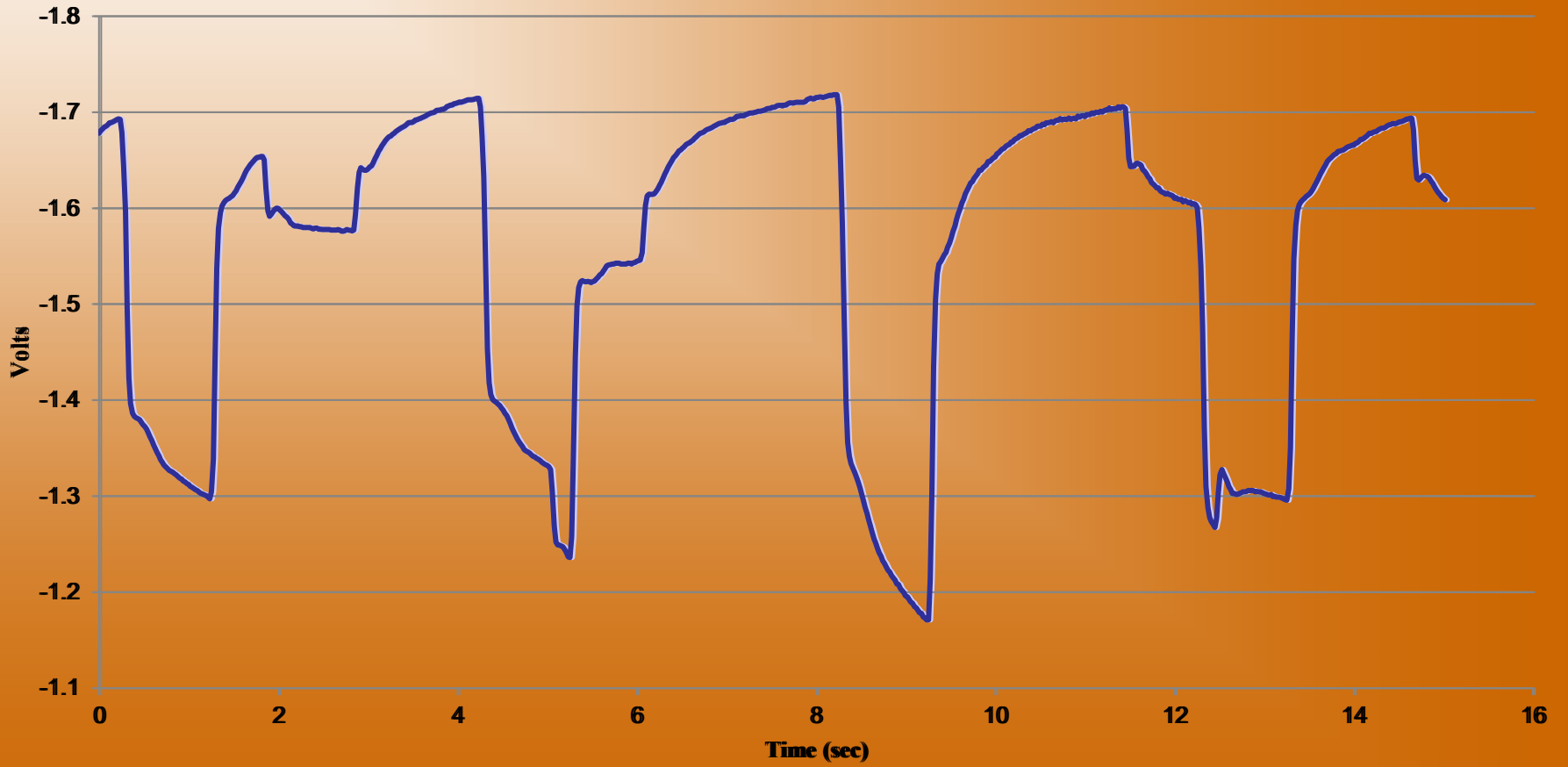








# Volts



# CIS – The Classics

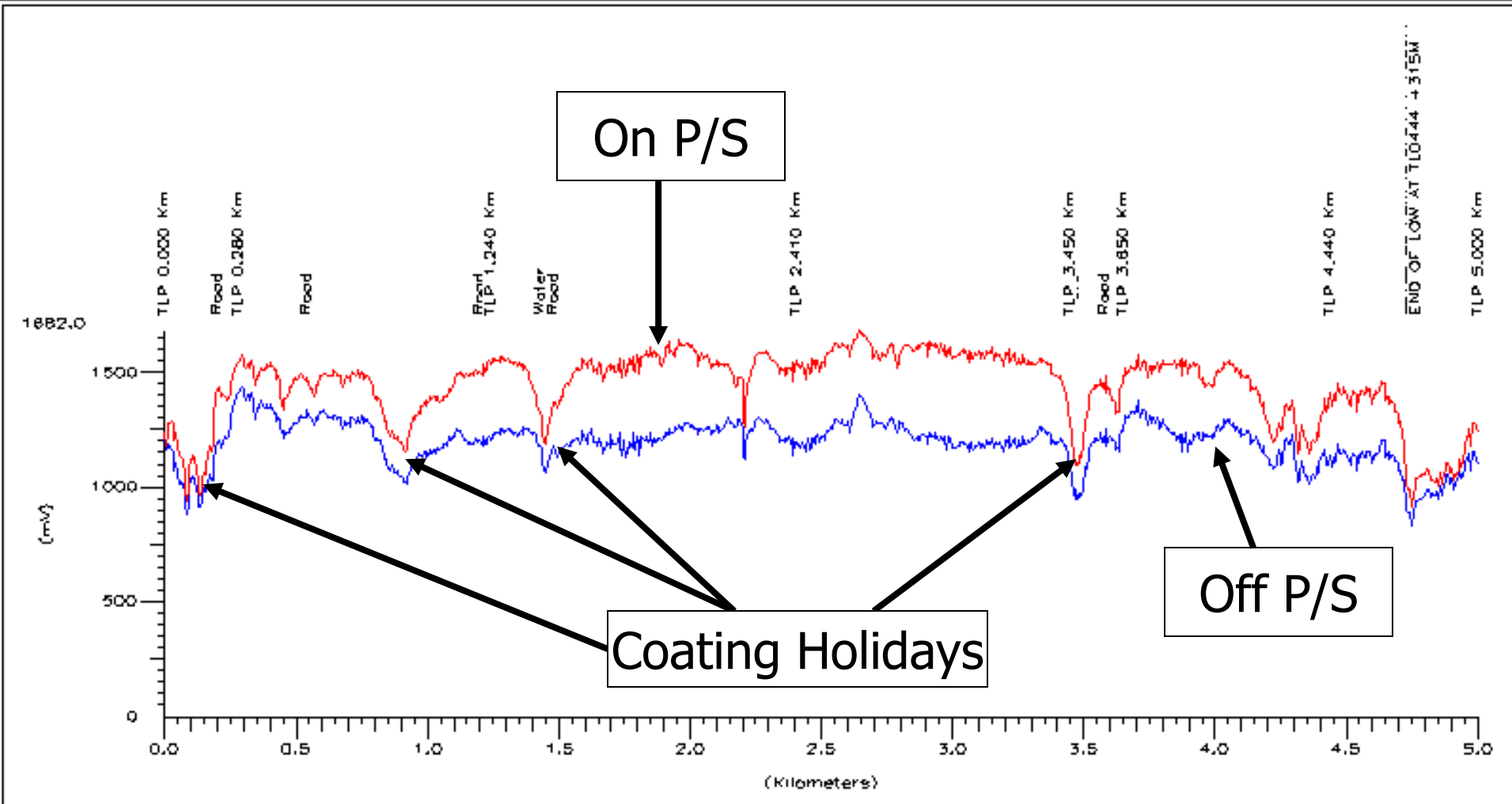
- Large Dip in the On and Off measurements
- Dip in the On measurement but not in the Off measurement
- Large Rise in both the On and Off measurements
- High Off measurement

# CIS – The Not So Classics

- Off measurement higher than the On
- Reasonable On measurement with very low Off measurement
- Reasonable On measurement with very high Off measurement
- Positive measurements

# CIS – The Ugly

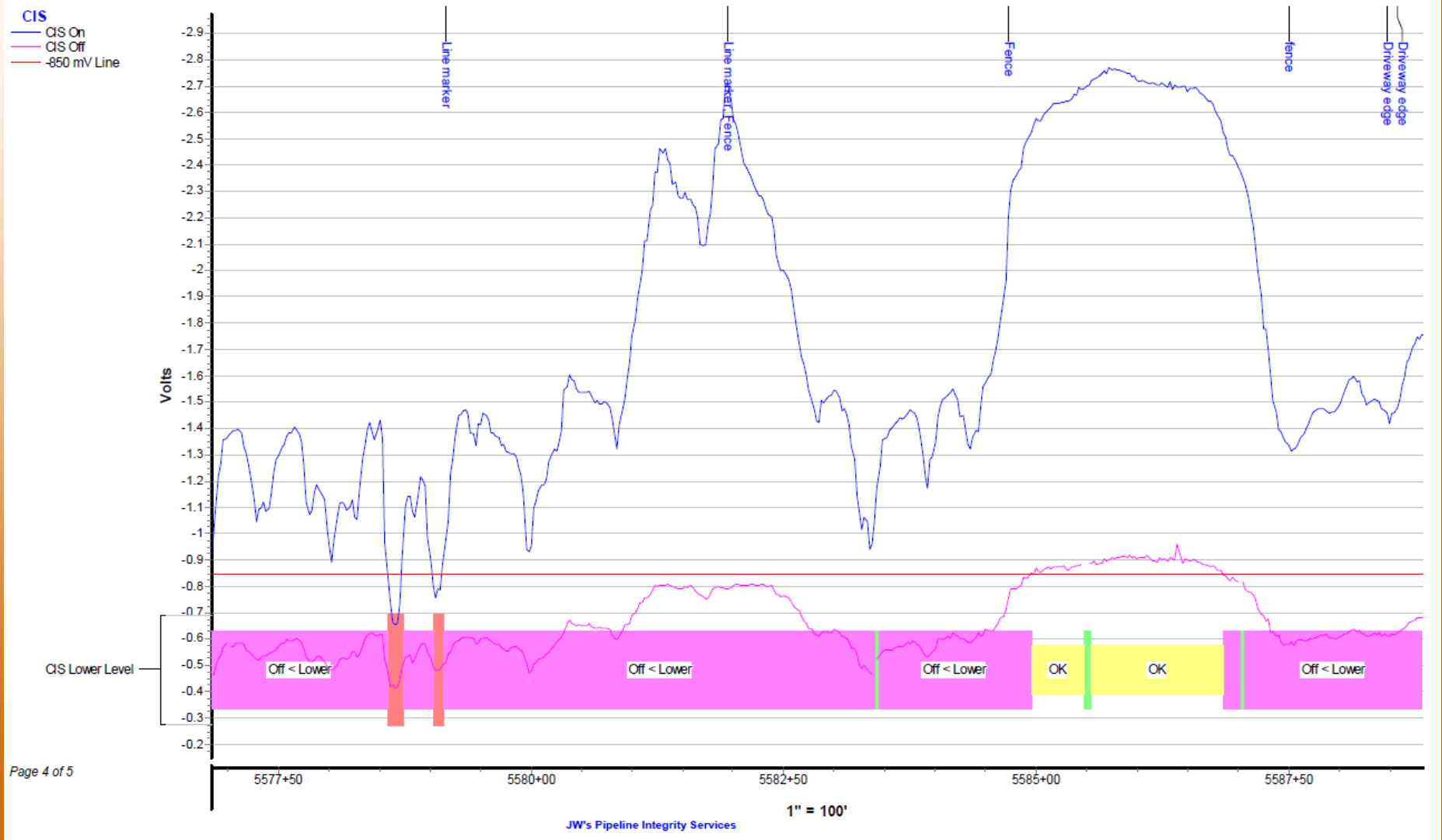
- Scatter
- Spikes
- Flat Line
- Gaps



UNTITLED		Date:		ABC Pipeline	
1 Low		Drawn:		Special	
2 High		Approved:		Dublin, Ohio	
		Data File: 12070005.021		Date: 00/08/30 Spacing ~ 8 meter(s)	

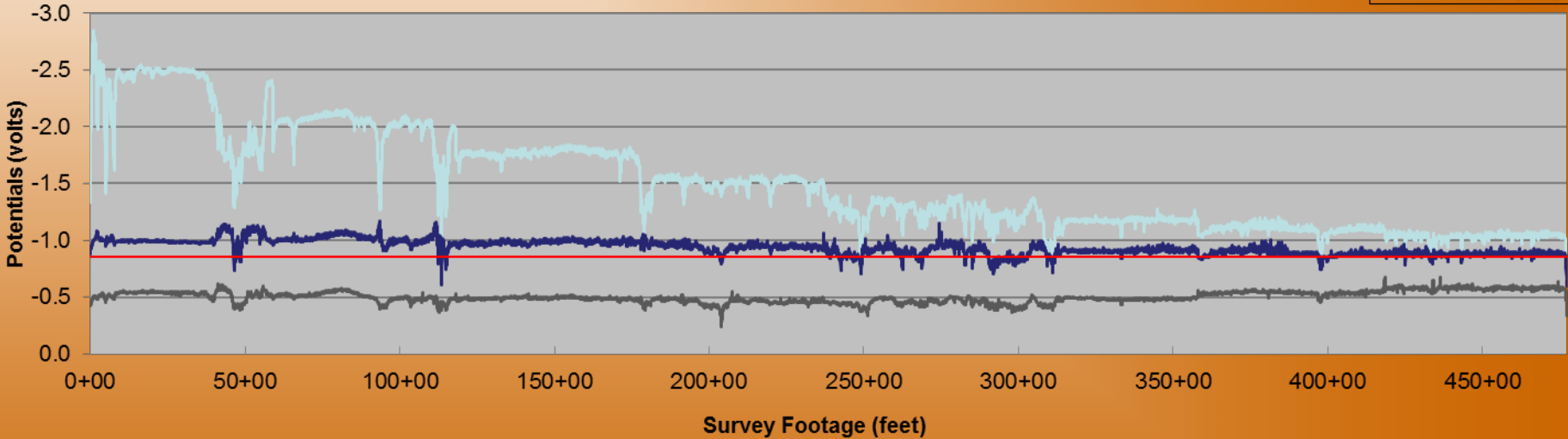




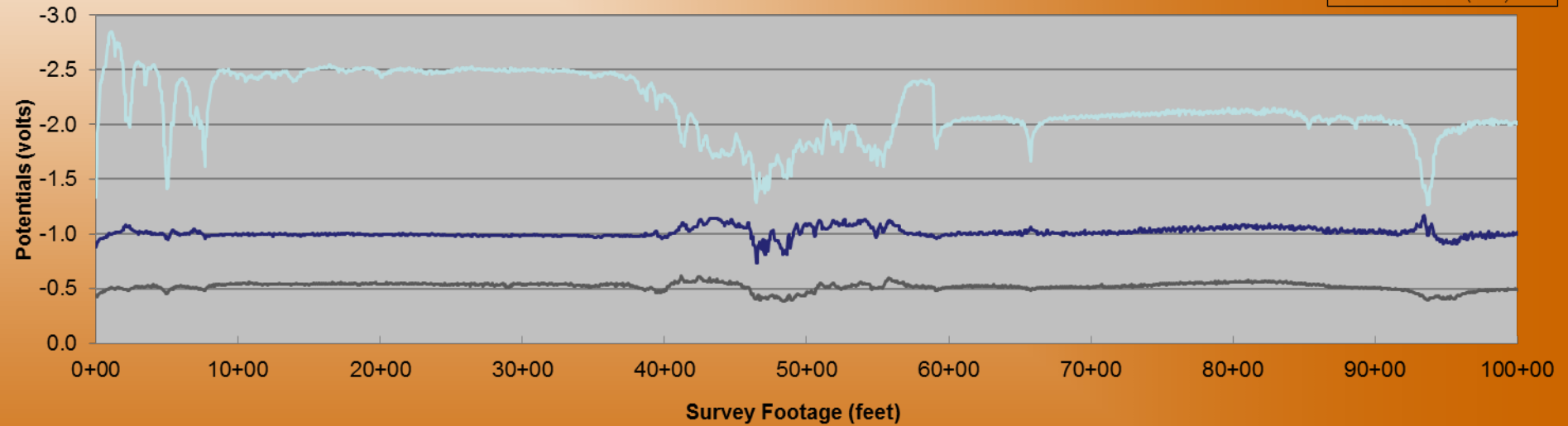
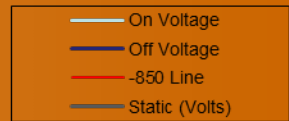


### Line XYZ 12inch - Interrupted CIS Survey with Static Potential - June 2014

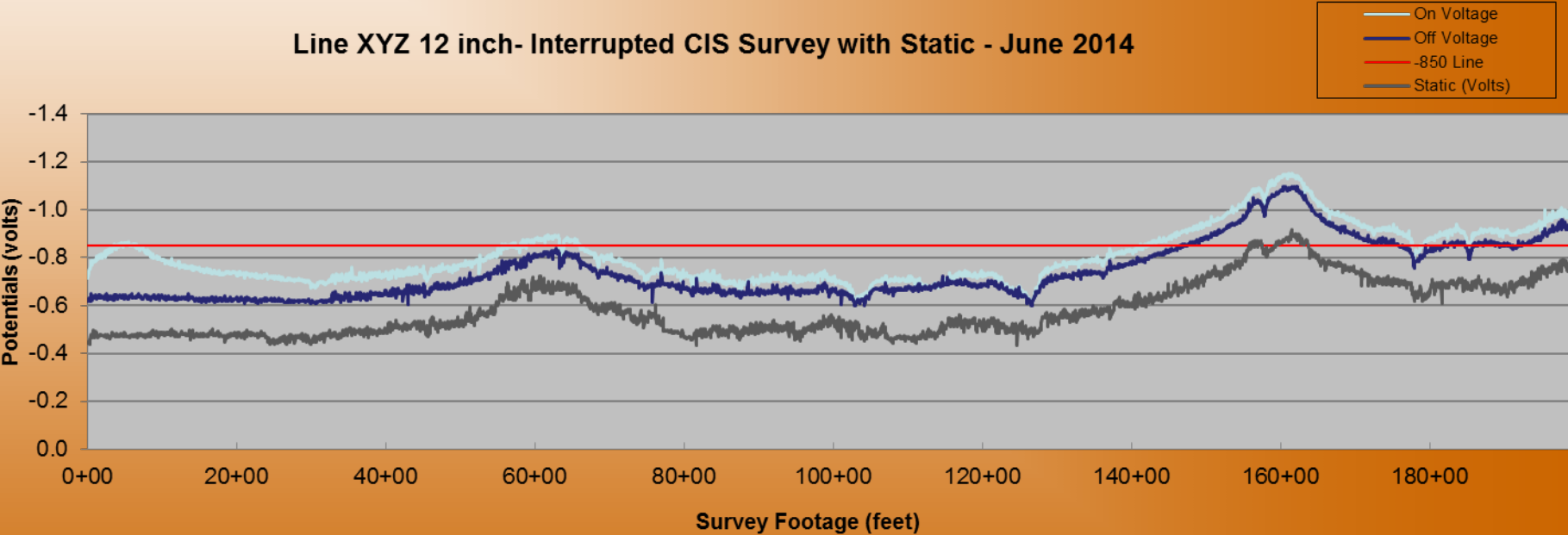
- On Voltage
- Off Voltage
- 850 Line
- Static (Volts)



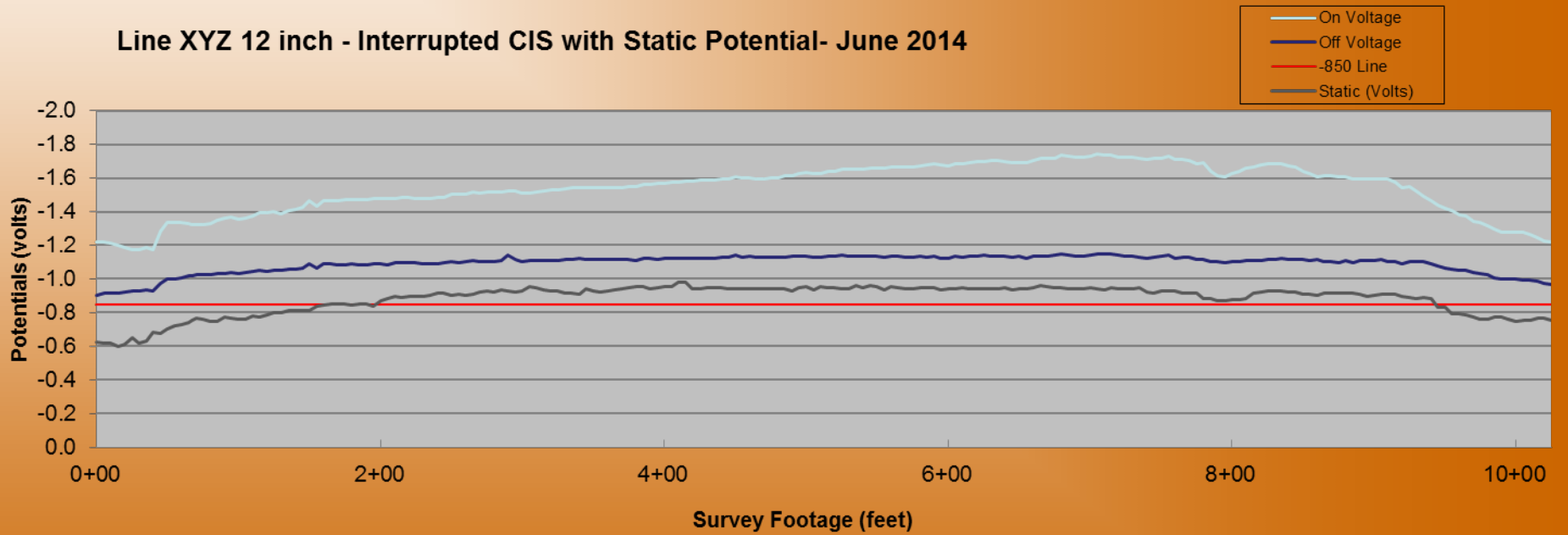
### Line XYZ 12inch - Interrupted CIS Survey with Static Potential - June 2014



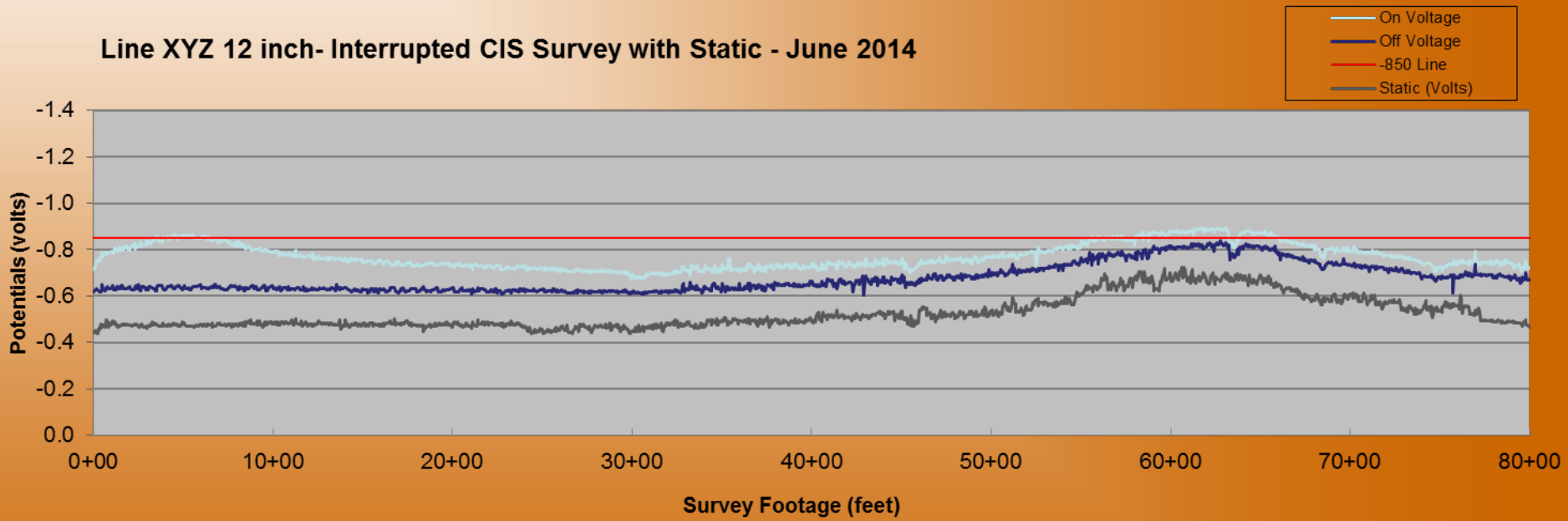
### Line XYZ 12 inch- Interrupted CIS Survey with Static - June 2014



### Line XYZ 12 inch - Interrupted CIS with Static Potential- June 2014



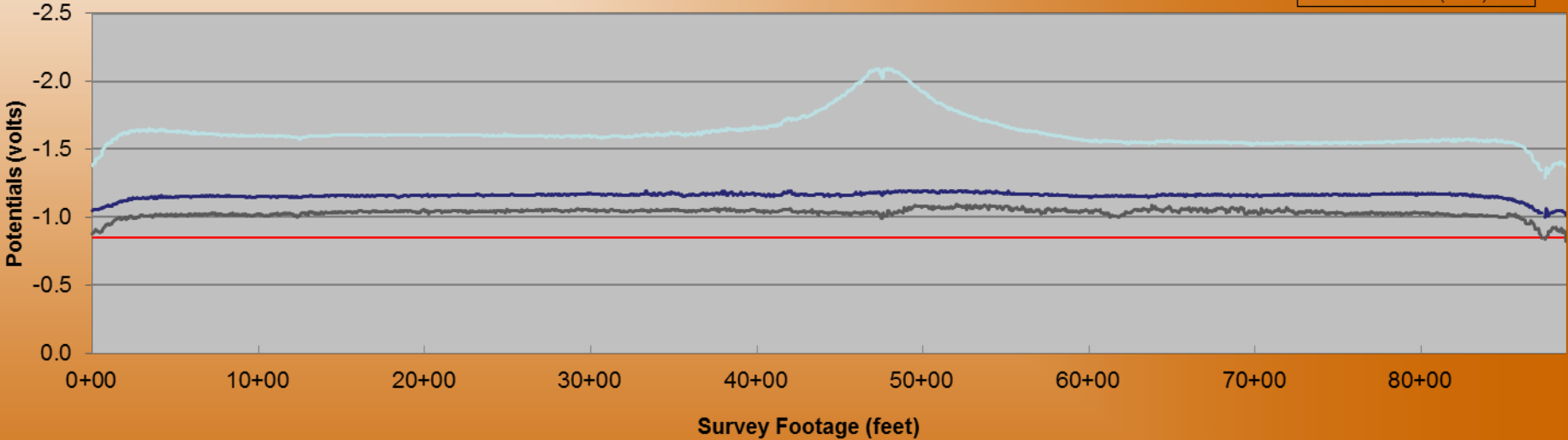
# Line XYZ 12 inch- Interrupted CIS Survey with Static - June 2014





### Line XYZ 12 inch - Interrupted CIS Survey with Static - June 2014

- On Voltage
- Off Voltage
- 850 Line
- Static (Volts)



# CIS – Far Ground Near Ground

- A Far Ground Potential is measured directly over the pipeline away from the electrical connection to the pipeline.
- A Near Ground Potential is measured directly over the pipeline at the spot of the electrical connection to the pipeline.
- During the “On” measurement, it is expected that the Far Ground and Near Ground Potentials will be different indicating different amounts of current and/or direction at the two locations.
- During the “Off” measurement, it is expected that the Far Ground and Near Ground Potentials be very similar indicating no current on the pipeline. If it is not, it would be desirable to locate and determine what additional influencing current should be interrupted.

# CIS – Metal IR

- Goal of Interrupted CIS (Zero on the Off)
- Negative mV On measurement
- Negative mV Off measurement
- Positive On or Off measurement
- High On measurement
- High Off measurement
- Positive On and Negative Off
- Increasing measurements between two test stations

# CIS – Casings

- Difference between the Pipe On measurements and Casing On measurements
- Difference between the Off measurements
- Difference in the amount of Shift between Pipe to Soil measurements and Casing to Soil measurements
- Shorted casings
- Electrolytic Coupling

# Interference?



# CIS data collection solutions

- Fluctuating voltages due to interfering sources of dc including foreign rectified systems, dc rail, welding shops, deep mines, HVDC, and others.
  - Conduct survey at less interfering times (i.e. nighttime).
  - Use stationary data logger to record voltage measurements that can be correlated with mobile CIS data and adjusted accordingly.
- AC shock hazard in electrical transmission ROW.
  - Follow all safety precautions including long sleeves and safety gloves when picking up wire.
- AC meter interference.
  - Use a meter with better interference rejection capabilities.

# What data is most important?

- IT DEPENDS!
  - What is the history of the line?
    - Leaks, Stray Current, TPI, dis-bondment, soils, CP, etc.
  - Are there shorts or bonds in the system?
  - Is there new coating followed by old coating?
  - Are there paved or very rocky areas?
  - How many rectifiers are in the system to be surveyed?
  - How many foreign crossings are there?
  - And the list goes on...



# What data is most important?

## (cont.)

- Multiple applicable tools are key to having a good ECDA indirect inspection survey.
- While the rule only requires two inspection techniques it is almost always required at some locations to have a minimum of three.
- Knowing where your holidays are AND the cathodic protection state are key in making informed decisions about External Corrosion.
- Soils can also be of added value where the tools need supplemental data for support.
- Of course, all Pre-Assessment data is crucial to success.



# Summary

- Combining data and tools are crucial to proper identification of possible external corrosion.
- Other items in the indirect inspections such as depth of cover and foreign crossings should be included in the analysis at indications to look for Third Party Damage.
- If one tool shows an indication and the others do not, it should be verified as to why this occurred and not ignored.
- Coating is not perfect. Therefore, if you find nothing you need to find out why the tools didn't work, resolve the issues and resurvey where necessary.
- All local conditions must be considered before deciding what indications are monitored, scheduled and immediate.



# Questions

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