

Cathodic Protection Measurement Basics

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CP Measurements

- Pipe-To-Soil Potentials
- CP Current Flow
- Resistance
- Rectifier Readings

Pipe-To-Soil Potentials

- Voltmeter
 - Digital, Analog, Computerized
 - High Input Impedance
 - Rugged
- Lead Wires
 - Tight Connections
 - Secure To Structure
 - Low Resistance As Possible

Pipe-To-Soil Potentials

- Reference Electrode Types
 - Copper-Copper Sulfate (Most Common)
 - Silver-Silver Chloride (Offshore – Salt Water)
 - Zinc Metal (Rough Conditions)
 - Lead-Lead Chloride (Lead Sheathed Cables)
 - Calomel (Hg-HgCl₂) (Laboratory Use)
 - Hydrogen Cell (Laboratory Use)

Pipe-To-Soil Potentials

- To Maintain Criteria of SP-0169
 - Cu-CuSO₄ (-) 0.850 V
 - Ag-AgCl (Sat KCl) {4.6M} (-) 0.733 V
 - Ag-AgCl (KCl @ 3.5M) (-) 0.739 V
 - Ag-AgCl (KCl @ 1.0M) (-) 0.756 V
 - Ag-AgCl (Seawater) (-) 0.784 V
 - Zinc Metal (+) 0.228 V
- Be Very Careful With Ag-AgCl References.
The KCl Concentrations Shift the Potential

Pipe-To-Soil Potentials

- Cu-CuSO₄ Reference Electrode
 - Temperature Sensitive
 - Copper-Copper Sulfate Ref: 0.5 mV per °F
 - Shift Positive When Colder
 - Contaminant Free
 - Clean Bar and Tip
 - Clear Solution
 - Saturated Solution
 - Distilled Water with Blue Crystals Left Over

Pipe-To-Soil Potentials

- Position
 - Directly Over Structure
 - Closer The Better But Don't Touch Structure
- Good Electrolyte Contact
 - Tip Contact to Ground
 - Thick Layers of Crushed Rock
 - Watch out for Unknowns like:
 - Geoplastic sheets under stone
 - Asphalt layers under concrete pavement (old roads)
 - Paved Over Trolley Tracks (Old Cities)

Pipe-To-Soil Potentials

- Sign Convention

Voltmeter (-) Lug	Voltmeter (+) Lug	Sign Convention
Structure	Half Cell	0.850
Half Cell	Structure	(-) 0.850

CP Current Flow

- Direct Readings
 - Inconvenient
 - Slow
 - Dangerous
 - Meter in Series with Circuit
 - Off Too Long
 - Sway Readings
- Shunt Readings
 - Accurate and Faster
 - Voltmeter Across Known Resistance

CP Current Flow

- Shunt Readings Rated in Ohms

0.001 Ohm: 1 mV = 1 Amp 25 Amp Max

0.01 Ohm: 1 mV = 0.1 Amp 8 Amp Max

0.1 Ohm: 1 mV = 0.01 Amp 2 Amp Max

- Shunt Readings By Proportion

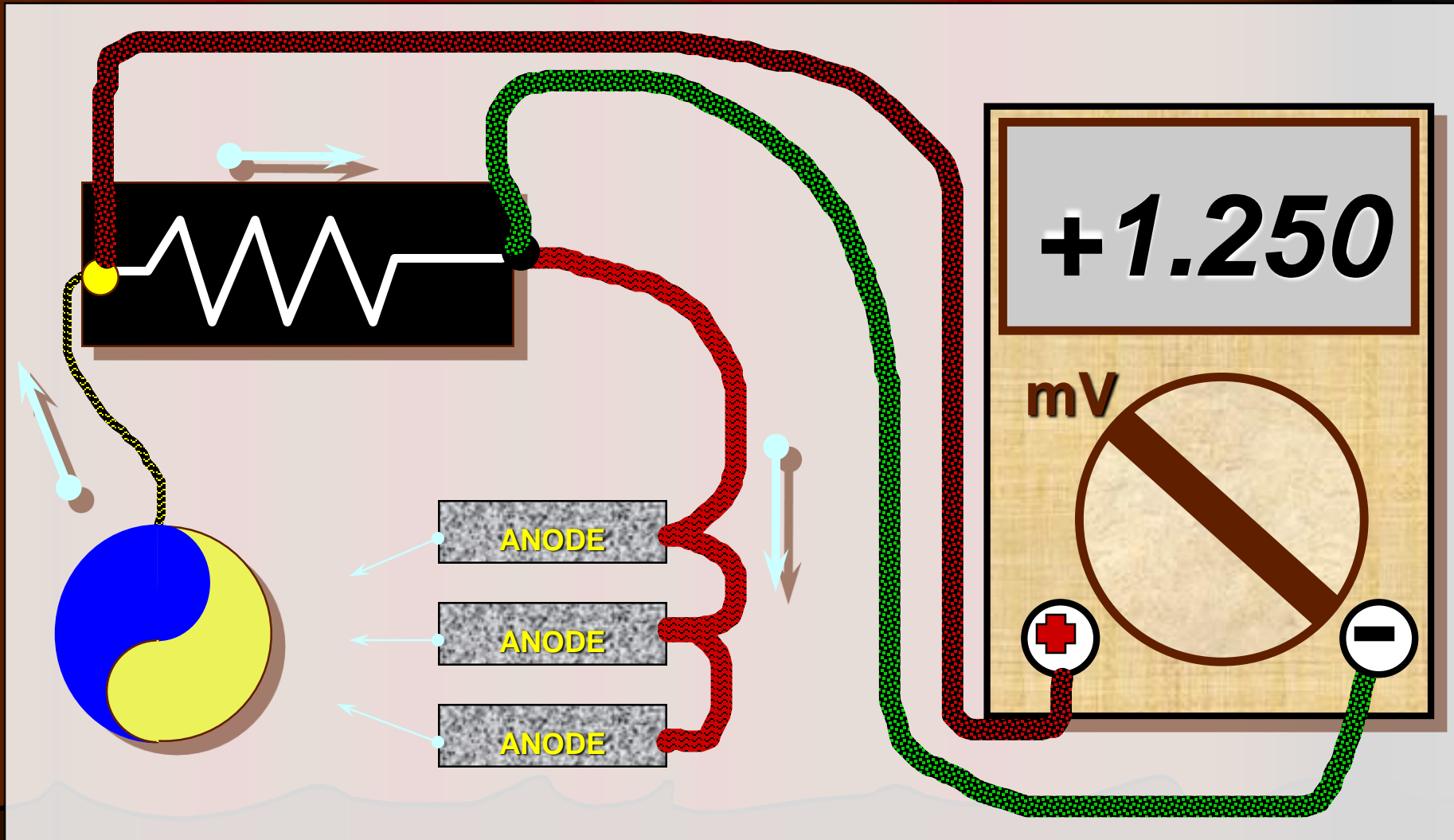
50 mV = 50 Amps 1 mV = 1 Amp

50 mV = 100 Amps 1 mV = 2 Amps

100 mV = 100 Amps 1 mV = 1 Amp

50 mV = 60 Amp 1 mV = 1.2 Amps

CP Current Flow



Resistance

- Direct Readings
 - Isolate Circuit
 - Turn Off Power
- Calculated
 - Known V & Known I
 - Calculate: $R = V / I$
- Other Method
 - B3 Series Meter

Rectifier Readings

- AC Input
 - Voltage at Disconnect or Behind Breaker
 - Current by Clamp-On Ammeter
 - Power = $(3600 \times Kh \times N) / T$
- AC Throughput
 - Voltage Across Main Lugs of Taps
- DC Output
 - Voltage Across the Output Lugs
 - Current: Voltage Across the Shunt
- Efficiency
 - Power Out / Power In