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-$HgCl_2$) (Laboratory Use)
  - Hydrogen Cell (Laboratory Use)

Pipe-To-Soil Potentials

- To Maintain Criteria of SP-0169
  - $Cu\text{-}CuSO_4$ (-) 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-$CuSO_4$ Reference Electrode
  - Temperature Sensitive
    - Copper-Copper Sulfate Ref: 0.5 mV per ^{o}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

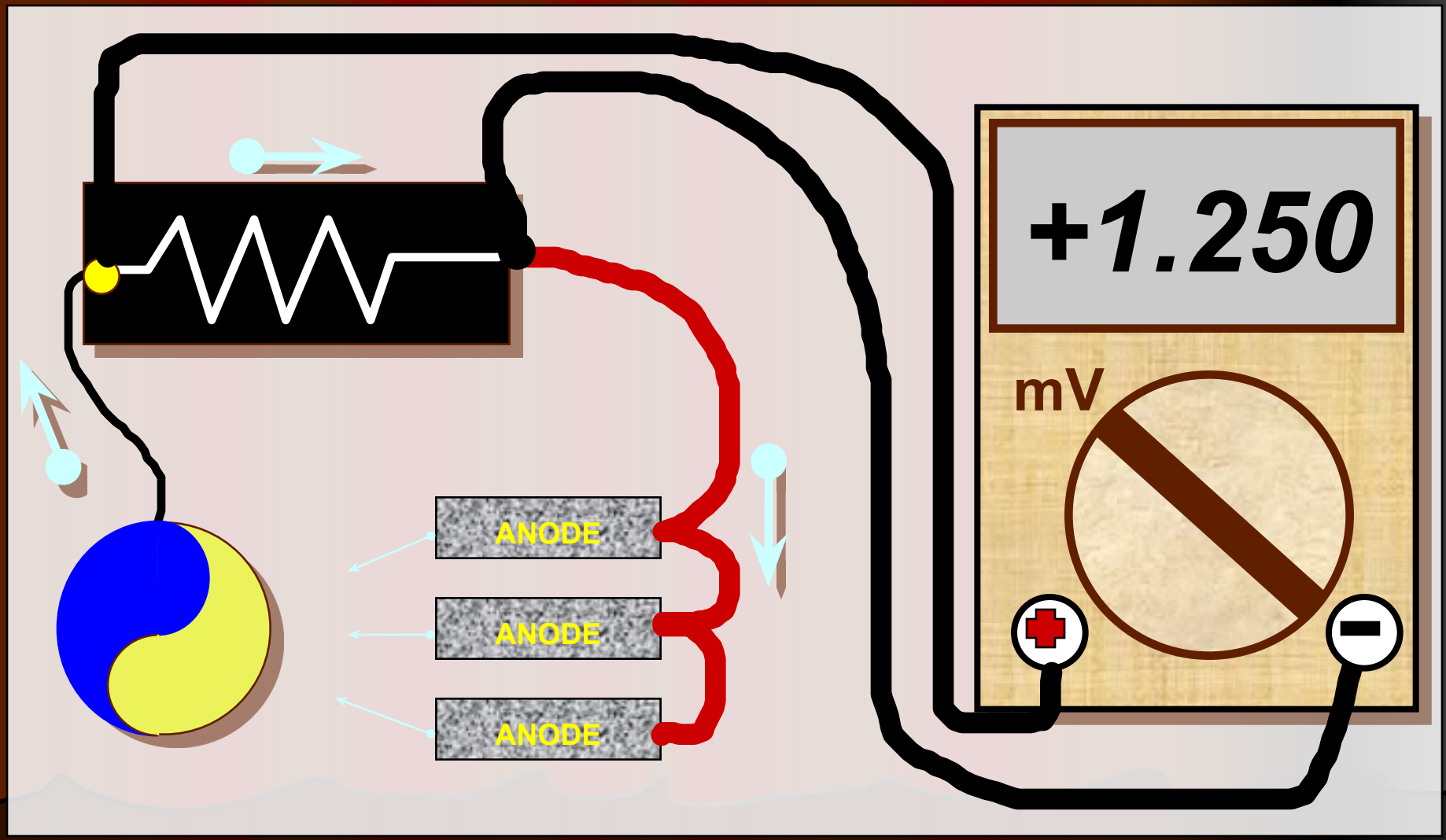
  50 mV = 50 Amps 1 mV = 1 Amp

  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 x Kh x 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