TINKER & RASOR

CORROSION MITIGATION INSTRUMENTATION

Portable Copper–Copper Sulfate Reference Electrode Operating & Maintenance Instructions

1. Introduction

Tinker & Rasor Portable Copper–Copper Sulfate ($Cu–CuSO_4$) Reference Electrodes are used for structure-to-electrolyte potential measurements in cathodic protection systems. Proper preparation and maintenance ensure accurate readings and long service life.

This guide provides step-by-step instructions for operating, maintaining, cleaning, and refilling Portable $Cu–CuSO_4$ Reference Electrodes. These electrodes are **user-maintained** and are **not serviced or calibrated** by Tinker & Rasor.

Electrode Models

- **6A / 6B** – Standard portable reference electrodes
- **3A ("Fat Boy")** – High-capacity design for concrete and high-demand environments
- **2A ("Pencil Cell")** – Slim, compact electrode for tight or restricted access locations

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2. Safety Information – WARNING!

Copper sulfate must be handled with care. Avoid contact with skin, eyes, or clothing, and wear gloves and safety glasses when refilling or cleaning the electrode. Refer to the **Tinker & Rasor Copper Sulfate SDS** for safety details. For SDS information, visit www.tinker-rasor.com/sds.

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3. Important Notes

Preventing Leakage

To prevent leaking, ensure that all caps and threaded components of the Portable Copper–Copper Sulfate Reference Electrode are tightened properly. After reassembly, the cap must be secured **finger-tight plus one-quarter turn** to fully compress the O-ring and form a proper seal. Insufficient tightening will result in leakage and loss of copper sulfate solution.

Pretreated Ceramic Tips

All Tinker & Rasor Portable $Cu–CuSO_4$ Reference Electrodes — including **replacement ceramic tips** — are supplied **pretreated with copper sulfate solution**. This ensures rapid wetting and proper performance during first-time use.

High-Impedance Meter Required

Always use a **high-impedance voltmeter (10 MΩ or greater)** when taking measurements. Low-impedance meters can load the circuit and cause inaccurate readings.

4. General Operating Instructions

Before Use

- **Remove the protective cap before taking any measurement.**
- Ensure the ceramic tip is clean, moist, and free of contaminants.
- Rinse the tip with clean tap water.
- Inspect test cables and connectors for damage.
- Always use a **high-impedance voltmeter (10 MΩ or greater)** to prevent loading errors.

Taking a Measurement

1. Remove the protective cap and rinse the ceramic tip.
2. Place the ceramic tip firmly in contact with the electrolyte.
3. Connect the electrode to the **negative (–)** terminal of the voltmeter.
4. Allow the reading to stabilize for 3–10 seconds.
5. Replace the protective cap after use.

Soil Contact Note

In dry conditions, scrape away the surface layer to expose moist soil, or lightly moisten the area with clean water to ensure proper ionic contact.

Avoid contact with grass, weeds, or other vegetation, especially in wet conditions, as organic material can interfere with the measurement and create unstable readings.

Additional Use Notes

- Allow the electrode to reach ambient temperature before use.
- Do not expose the tip or solution to oils or petroleum products.
- Do not allow the electrode or solution to freeze.

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5. Electrode Specifications

Model	Intended Use	Dimensions	Liquid Volume	Copper Sulfate Volume
6A	General CP measurements	1.25” x 6” 3.18 cm x 15.24 cm	1 oz	20 g
6B	General CP measurements	1.25” x 7” 3.18 cm x 17.78 cm	1 oz	20 g
3A (Fat Boy)	Concrete and high-demand environments	3.5” x 5” 7.62 cm x 12.70 cm	6 oz	60 g
2A (Pencil Cell)	Tight spaces / Classrooms	0.375” x 5.75” 0.95 cm x 14.61 cm	0.05 oz	1.5 g

6. Temperature Effects (Cu-$CuSO_4$ Correct Factor)

Copper reference electrodes experience a small temperature-dependent shift relative to their standard potential. These factors apply **only** to Cu–$CuSO_4$ electrodes, other electrodes have different temperature correction factors.

Correction Factors

- **0.05 mV per 1°F** above or below 77°F
- **0.9 mV per 1°C** above or below 25°C

Behavior

- Higher temperatures → reading becomes **more positive**
- Lower temperatures → reading becomes **more negative**

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7. Short-Term Maintenance (After Each Use)

- Rinse the ceramic tip with clean tap water.
- Wipe gently with a soft cloth.
- Replace the protective cap to prevent drying.
- Store tip-down whenever possible.

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8. Long-Term Maintenance & Storage

If the electrode will not be used for one month or longer:

1. Empty the copper sulfate solution.
2. Rinse the tube with **distilled or deionized water** to remove any remaining crystals.
3. Dispose of solution according to local regulations.
4. Before returning to service, perform a full cleaning and refilling procedure.

Store at room temperature with the cap installed.

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9. Cleaning, Inspection & Refilling Procedure

Step 1 — Disassemble

- Unscrew the tube from the upper rod assembly.

Step 2 — Clean the Copper Rod

- Use a non-metallic scouring pad (green 3M pad).
- Clean until the copper rod is bright and metallic.
- Do not use metallic abrasives. Most sandpapers contain metals.

Step 3 — Inspect the O-Ring

- Check for cracks, deformation, or wear.
- Replace if necessary.

Step 4 — Add Copper Sulfate Crystals

Use only high-purity copper sulfate crystals, as impurities can affect the electrode's reference potential. Fill approximately **one-third of the tube** with crystals.

Tinker & Rasor Copper Sulfate Options:

- **049-011**: High-Purity Copper Sulfate Crystals, 1 lb 3 oz — **Models 3A, 6A/B**
- **049-021**: Fine Copper Sulfate Crystals, 4 oz — **Model 2A**

Step 5 — Add Water

Fill with **distilled or deionized water** to approximately **½ inch (13 mm)** below the top.

Step 6 — Reassemble and Saturate

- Reinstall the cap/rod assembly (**finger-tight + ¼ turn**).
- Shake gently to dissolve crystals until the solution becomes deep blue.
- Some undissolved crystals should remain.
- Allow the electrode to rest tip-down for **1–2 hours** to fully wet the ceramic plug.

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10. Low-Temperature Operation

- Water based Copper sulfate solution freezes at 32°F (0°C).
- Freezing may cracks the ceramic plug and cause permanent damage.
- For freezing conditions, use **Tinker & Rasor Antifreeze Solution (049-012)**.
    - This shifts the electrode potential by **approximately +12 mV**.

Allow the electrode to equalize to ambient temperature before use.

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11. Accuracy Verification (Copper-to-Copper Test)

To verify electrode performance:

1. Fill a plastic container with clean tap water (do not use distilled or deionized water)
2. Submerge both electrodes' ceramic tips ensuring no physical contact.
3. Connect:
    - Standard electrode → **Negative (–)**
    - Test electrode → **Positive (+)**
4. A reading of **0 ± 10 mV** indicates the electrode is within tolerance.

Accuracy Note

Cu–$CuSO_4$ electrodes are manufactured to **±5 mV accuracy** relative to Standard. When two Cu–$CuSO_4$ electrodes are compared, the combined tolerance becomes **±10 mV**.

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12. Waterproof Adapter (W-7) Usage

The W-7 Waterproof Adapter allows Portable Cu–$CuSO_4$ Electrodes to be used safely in wet or submerged environments without exposing the electrical connection to water.

Using the W-7 Adapter

1. Thread the W-7 onto the electrode, stopping about **½ turn** before compressing the O-ring.
2. Strip **¼ inch** from #18 AWG wire, slide the small O-ring over the insulation, and insert the wire into the brass hex fitting.
3. Tighten the hex nut firmly.
4. Hand-tighten the adapter to fully compress the large O-ring and seal.
5. Ensure the test lead insulation has no damage in submerged areas.
6. Ensure the **electrode is completely filled** to prevent water intrusion.
7. Fits most **¼-20 threaded** electrodes.

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13. Photoelectric Effect (Sunlight Interference)

Direct sunlight on the voltmeter, test leads, or electrode can create electrical noise due to the photoelectric effect, causing drifting or unstable readings.

To minimize:

- Shade the meter and electrode
- Recheck the reading once shaded
- Avoid direct sunlight when possible

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14. Common Causes of Bad Readings

- Low meter input impedance (**< 10 MΩ**)
- Poor soil contact
- Dirty, contaminated, worn, cracked, or aged ceramic plugs
- Discolored, cloudy, or contaminated copper sulfate solution

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15. Troubleshooting Guide

Issue	Possible Cause	Corrective Action
Unstable readings	Dry or contaminated tip	Rinse and re-wet tip
Low potentials	Weak or contaminated solution	Clean and refill
Slow response	Clogged or aged ceramic plug	Clean or replace
No reading	Cap installed, or bad connection	Remove cap, check leads
Reading drifts	Temperature mismatch	Allow stabilization
Large deviation vs reference	Poor saturation	Refill crystals and water

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16. Product Support

For replacement parts or product assistance, visit www.tinker-rasor.com/portable or contact a Tinker & Rasor representative. Office Hours: **Monday–Friday, 7:30 AM – 4:00 PM (CST)**