# NACE International
# Standard Test Method

# Durability Test for Copper/Copper Sulfate Permanent Reference Electrodes for Direct Burial Applications

**Contents**

## Section 1: General

1.1 This standard describes a test method to measure specific physical properties and the relative stability of $Cu/CuSO_4$ PREs when they are subjected to specific environmental stresses. These reference electrodes, while "permanent" in the physical sense (they are not commonly removed), do exhibit a finite service life. This test method is intended to provide a measure of the relative durability that may be expected. The test method specifically focuses on the ability of the $Cu/CuSO_4$ PRE to (1) resist migration of $CuSO_4$ from within the PRE into its surrounding environment and (2) to resist the migration of chloride from its surrounding environment into the PRE.

1.2 Unique field conditions may alter the durability of $Cu/CuSO_4$ PREs. Factors such as temperature, sunlight, and soil contaminants can significantly affect PRE durability. Although consideration of these parameters is outside the scope of this standard, they may require consideration in certain field applications.

1.3 Environmental factors must be accounted for while performing durability testing. Articles have been written indicating possible factors resulting in erroneous potential measurements from a half-cell and their relevance to PREs.[1,2] Variables that usually affect portable $Cu/CuSO_4$ reference electrodes are temperature and sunlight variations. Both cited articles indicate that potential measurements can vary by 0.9 mV/°C (0.5 mV/°F), and that exposure to direct sunlight can cause variations in potential up to +20 mV. However, because PREs are typically used in locations with no direct sunlight exposure and limited temperature variations, such effects should be minimal.[1] Another environmental factor that can cause a change in potential is chloride contamination. This is generally only a problem with prolonged exposure to chloride-rich environments (e.g., seawater, brackish water, or chloride-rich soil). As the chloride contamination increases, the potential shifts further away from its reference potential (potential with no chlorides present) and can reach a value of –123 mV in a 60,000 ppm chloride solution.[2] The chloride variations have been confirmed to some degree through laboratory testing.[3] All of these factors must be considered when $Cu/CuSO_4$ PRE durability tests are performed.

1.4 Long-term failure of PREs has been attributed to a dried-out PRE, which is a particular problem in dry soils. Consequently, PREs are often installed prepotted in a moisture-retaining backfill. The tendency for PREs to dry out is not addressed by this test method.

1.5 The natural tendency for the potential of a $Cu/CuSO_4$ PRE to vary must also be considered. Some of this variation may occur as a result of the age of the PRE and/or differences in manufacturing. As a result, PREs are listed as being repeatable to ±6 mV.[4]

1.6 The tests described herein are relative tests that should only be used to compare PREs that are tested concurrently. Users should not attempt to draw meaningful conclusions from the results of tests performed at different times because the variations may be the result of uncontrolled differences between the two tests rather than the differences in the PREs themselves. The tests are intended to provide comparative data on $Cu/CuSO_4$ PREs tested concurrently; therefore, no pass/fail criteria are established by this standard.

1.7 The tests described herein are relatively short in duration and there are insufficient data to show a correlation between proper short-duration tests and expected service life. However, it would be reasonable to conclude that if one PRE lasts longer than another in these tests, similar relative durability could be expected in actual applications.

## Section 2: Test Equipment and Reagents

2.1 High-impedance voltmeter or data logging device (a minimum input impedance of 100 MΩ, unless it can be shown that a meter with lower input impedance is sufficient) as required to ensure accurate measurements in a high-resistivity (deionized [DI] water) environment. The voltmeter shall have an accuracy of ± 2.0 mV or better in the range being measured;

2.2 Deionized water in accordance with ASTM[(2)] D1193,[5] Type IV (resistivity of 200,000 Ω·cm);

2.3 A known $Cu/CuSO_4$ standard electrode;

[(2)] ASTM International (ASTM), 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959.