Designation: G57 – 20

Standard Test Method for Measurement of Soil Resistivity Using the Wenner Four-Electrode Method[1]

This standard is issued under the fixed designation G57; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the equipment and procedures for the measurement of soil resistivity, both in situ and for samples removed from the ground, for use in assessment and control of corrosion of buried structures.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard. Soil resistivity values are reported in ohm-centimeter.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1193 Specification for Reagent Water

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

G187 Test Method for Measurement of Soil Resistivity Using the Two-Electrode Soil Box Method

G193 Terminology and Acronyms Relating to Corrosion

2.2 *UNS Standards:*[3]

UNS Designation S30400 and S30403

UNS Designation S31600 and S31603

3. Terminology

3.1 *Definitions:*

3.1.1 *four-electrode soil box, n*—a non-conductive container of known internal dimensions with four electrodes for measuring a substance's resistivity.

3.1.2 *saturated soil, n*—soil whose entire soil porosity is filled with water.

3.1.3 *soil resistance meter, n*—an instrument capable of measuring soil resistance.

3.1.4 *soil resistivity, n*—the electrical resistance between opposite faces of a unit cube of material, typically expressed in ohm-meter, ohm-cm, or similar units; the reciprocal of conductivity

3.2 The terminology used herein, if not specifically defined otherwise, shall be in accordance with Terminology G193. Definitions provided herein and not given in Terminology G193 are limited only to this test method.

3.3 *Discussion*—Resistivity measurements indicate the relative ability of a medium to carry electrical currents. When a metallic structure is immersed in a conductive medium, the ability of the medium to carry current will influence the magnitude of galvanic currents and cathodic protection currents. The degree of electrode polarization will also affect the size of such currents.

4. Summary of Test Method

4.1 The Wenner four-electrode method requires that four metal electrodes be placed with equal separation in a straight line in the surface of the soil to a depth not exceeding 5 % of the minimum separation of the electrodes. The electrode

[1] This test method is under the jurisdiction of ASTM Committee G01 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.10 on Corrosion in Soils.

Current edition approved Nov. 1, 2020. Published December 2020. Originally approved in 1978. Last previous edition approved in 2012 as G57–06 (2012). DOI: 10.1520/G0057-20.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] *Metals and Alloys in the Unified Numbering System (UNS)*, 13th Edition, developed jointly by ASTM International, West Conshohocken, PA, and SAE International, Warrendale, PA, 2017.

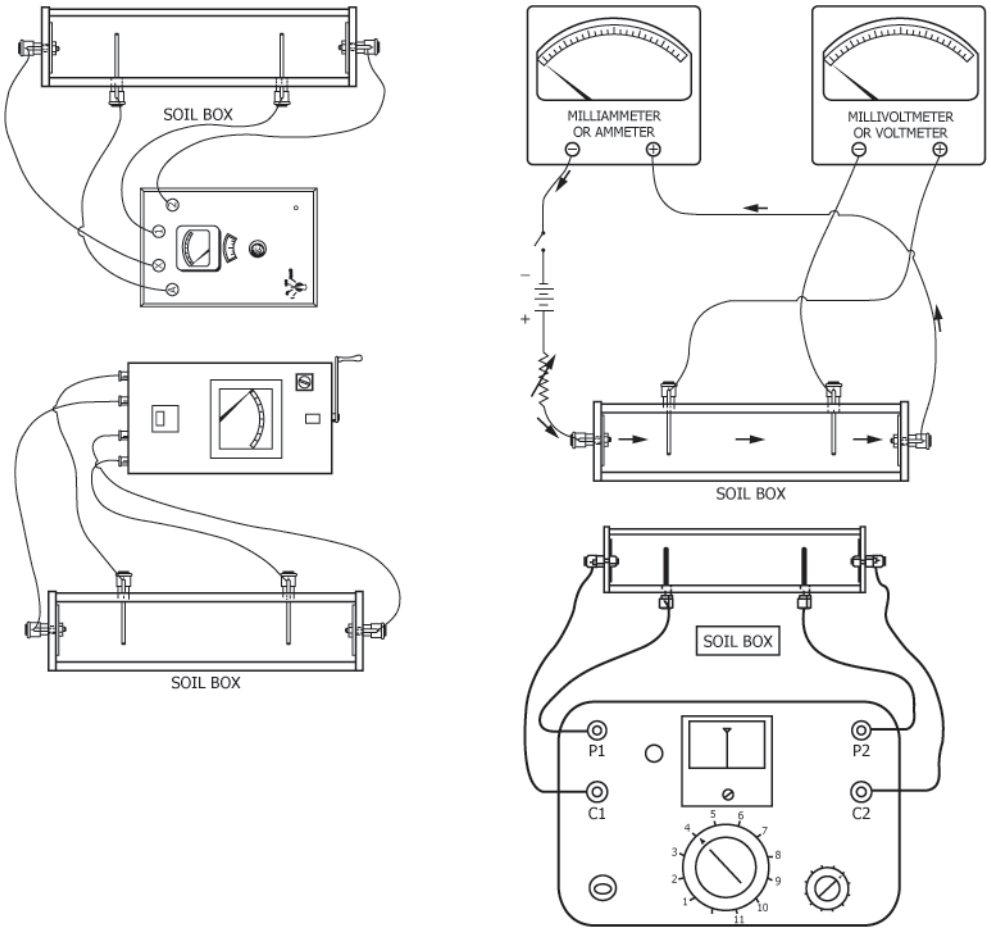

FIG. 1 Typical Connections for Use of Soil Box with Various Types of Instruments

separation should be selected with consideration of the soil strata of interest. The resulting resistivity measurement represents the average resistivity of a hemisphere of soil of a radius equal to the electrode separation.

4.2 A voltage is impressed between the outer electrodes, causing current to flow, and the voltage drop between the inner electrodes is measured using a voltmeter. Alternatively, the resistance can be measured directly using a soil resistance meter. The resistivity, ρ, is then:

$$\rho,\ \Omega\cdot\text{cm} = 2\pi\, aR\ (a \text{ in cm}) \tag{1}$$

$$= 191.5\, aR\ (a \text{ in ft})$$

where:

a = electrode separation, and
R = resistance, Ω.

Using dimensional analysis, the correct unit for resistivity is ohm-centimeter.

4.3 If the current-carrying (outside) electrodes are not spaced at the same interval as the potential-measuring (inside) electrodes, the resistivity, ρ, is:

$$\rho,\ \Omega\cdot\text{cm} = 95.76\,bR\left(1+b/a\right) \tag{2}$$

where:

b = outer electrode spacing, ft,
a = inner electrode spacing, ft, and
R = resistance, Ω.

or:

$$\rho,\ \Omega\cdot\text{cm} = \pi\,bR\left(1+b/a\right) \tag{3}$$

where:

b = outer electrode spacing, cm,
a = inner electrode spacing, cm, and
R = resistance, Ω.

4.4 For soil contained in a soil box similar to the one shown in Fig. 1, the resistivity, ρ, is:

$$\rho,\ \Omega\cdot\text{cm} = R\,A/a \tag{4}$$

where:

R = resistance, Ω,
A = cross sectional area of the container perpendicular to the current flow, cm^2, and
a = inner electrode spacing, cm.

NOTE 1—The spacing between the inner electrodes should be measured from the inner edges of the electrode pins, and not from the center of the electrodes.