



Standard Practice for Verification of Algorithm and Equipment for Electrochemical Impedance Measurements¹

This standard is issued under the fixed designation G 106; 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 practice describes an experimental procedure which can be used to check one's instrumentation and technique for collecting and presenting electrochemical impedance data. If followed, this practice provides a standard material, electrolyte, and procedure for collecting electrochemical impedance data at the open circuit or corrosion potential that should reproduce data determined by others at different times and in different laboratories. This practice may not be appropriate for collecting impedance information for all materials or in all environments.

1.2 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

D 1193 Specification for Reagent Water²

G 3 Practice for Conventions Applicable to Electrochemical Measurements in Corrosion Testing³

G 5 Reference Test Method for Making Potentiostatic and Potentiodynamic Anodic Polarization Measurements³

G 15 Terminology Relating to Corrosion and Corrosion Testing³

G 59 Practice for Conducting Potentiodynamic Polarization Resistance Measurements³

3. Terminology

3.1 **Definitions**—For definitions of corrosion related terms, see Terminology G 15.

3.2 Symbols:

C = capacitance (farad-cm⁻²)

E' = real component of voltage (volts)

E'' = imaginary component of voltage (volts)

E = complex voltage (volts)

f = frequency (s⁻¹)

I' = real component of current (amp-cm⁻²)

I'' = imaginary component of current (amp-cm⁻²)

I = complex current (amp-cm⁻²)

j = $\sqrt{-1}$

L = inductance (henry – cm²)

R_s = solution resistance (ohm-cm²)

R_p = polarization resistance (ohm-cm²)

R_t = charge transfer resistance (ohm-cm²)

Z' = real component of impedance (ohm-cm²)

Z'' = imaginary component of impedance (ohm-cm²)

Z = complex impedance (ohm-cm²)

α = phenomenological coefficients caused by depression of the Nyquist plot below the real axis, α is the exponent and τ is the time constant(s).

θ = phase angle (deg)

ω = frequency (radians-s⁻¹)

Subscripts:

x = in-phase component

y = out-of-phase component

4. Summary of Practice

4.1 Reference impedance plots in both Nyquist and Bode format are included. These reference plots are derived from the results from nine different laboratories that used a standard dummy cell and followed the standard procedure using a specific ferritic type alloy UNS-S43000⁴ in 0.005 M H₂SO₄ and 0.495 M Na₂SO₄. The plots for the reference material are presented as an envelope that surrounds all of the data with and without inclusion of the uncompensated resistance. Plots for one data set from one laboratory are presented as well. Since the results from the dummy cell are independent of laboratory, only one set of results is presented.

4.2 A discussion of the electrochemical impedance technique, the physics that underlies it, and some methods of interpreting the data are given in the Appendix X1-Appendix X6. These sections are included to aid the individual in understanding the electrochemical impedance technique and

¹ This practice is under the jurisdiction of ASTM Committee G-1 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.11 on Electrochemical Measurements in Corrosion Testing.

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² Annual Book of ASTM Standards, Vol 11.01.

³ Annual Book of ASTM Standards, Vol 03.02.

⁴ These standard samples are available from ASTM Headquarters. Generally, one sample can be repolished and reused for many runs. This procedure is suggested to conserve the available material. Order PCN 12-700050-00.