



Designation: G116 – 99 (Reapproved 2020)^{ε1}

Standard Practice for Conducting Wire-on-Bolt Test for Atmospheric Galvanic Corrosion¹

This standard is issued under the fixed designation G116; 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.

^{ε1} NOTE—Replaced Terminology G15 with Terminology G193, and other editorial changes made throughout in Dec. 2020.

1. Scope

1.1 This practice covers the evaluation of atmospheric galvanic corrosion of any anodic material that can be made into a wire when in contact with a cathodic material that can be made into a threaded rod.

1.2 When certain materials are used for the anode and cathode, this practice has been used to rate the corrosivity of atmospheres.

1.3 The wire-on-bolt test was first described in 1955 (1),² and has since been used extensively with standard materials to determine corrosivity of atmospheres under the names CLIMAT Test (Classify Industrial and Marine Atmospheres) (2-5) and ATCORR (Atmospheric Corrosivity) (6-9).

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *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.*

1.6 *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.*

¹ This practice is under the jurisdiction of ASTM Committee G01 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.04 on Corrosion of Metals in Natural Atmospheric and Aqueous Environments.

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² The boldface numbers in parentheses refer to the list of references at the end of this standard.

2. Referenced Documents

2.1 *ASTM Standards*:³

G1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens

G3 Practice for Conventions Applicable to Electrochemical Measurements in Corrosion Testing

G16 Guide for Applying Statistics to Analysis of Corrosion Data

G50 Practice for Conducting Atmospheric Corrosion Tests on Metals

G82 Guide for Development and Use of a Galvanic Series for Predicting Galvanic Corrosion Performance

G84 Practice for Measurement of Time-of-Wetness on Surfaces Exposed to Wetting Conditions as in Atmospheric Corrosion Testing

G91 Practice for Monitoring Atmospheric SO₂ Deposition Rate for Atmospheric Corrosivity Evaluation

G92 Practice for Characterization of Atmospheric Test Sites

G104 Test Method for Assessing Galvanic Corrosion Caused by the Atmosphere (Withdrawn 1998)⁴

G193 Terminology and Acronyms Relating to Corrosion

3. Terminology

3.1 For definitions of terms used in this practice, refer to Terminology G193. For conventions related to this method, refer to Practice G3.

4. Summary of Practice

4.1 The practice consists of wrapping a wire of the anode material around the threads of a bolt or threaded rod of the cathode material, exposing the assembly to atmosphere, and

³ 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.

⁴ The last approved version of this historical standard is referenced on www.astm.org.

determining mass loss of the anode wire after exposure. Reference specimens of the anode wire on a threaded, non-conductive, non-porous rod are used to separate general and crevice corrosion effects from galvanic corrosion effects.

5. Significance and Use

5.1 The small size of the wire compared to the short galvanic interaction distance in atmospheric exposures gives a large cathode-to-anode area ratio which accelerates the galvanic attack. The area between the wire and the threads creates a long, tight crevice, also accelerating the corrosion. For these reasons, this practice, with a typical exposure period of 90 days, is the most rapid atmospheric galvanic corrosion test, particularly compared to Test Method G104. The short duration of this test means that seasonal atmospheric variability can be evaluated. (If average performance over a 1-year period is desired, several staggered exposures are required with this technique.) Reproducibility of this practice is somewhat better than other atmospheric galvanic corrosion tests.

5.2 The major disadvantage of this test is that the anode material must be available in wire form and the cathodic material must be available in the form of a threaded rod. This should be compared to Test Method G104 where plate or sheet material is used exclusively.

5.3 An additional limitation is that the more anodic material of the pair must be known beforehand (from information such as in Guide G82) or assemblies must be made with the material combinations reversed.

5.4 The morphology of the corrosion attack or its effect on mechanical properties of the base materials cannot be assessed by this practice. Test Method G104 is preferable for this purpose.

5.5 This test has been used under the names CLIMAT and ATCORR to determine atmospheric corrosivity by exposing identical specimens made from 1100 aluminum (UNS A91100) wire wrapped around threaded rods of nylon, 1010 mild steel (UNS G10100 or G10080), and CA110 copper (UNS C11000). Atmospheric corrosivity is a function of the material that is corroding, however. The relative corrosivity of atmospheres could be quite different if a different combination of materials is chosen.

6. Interferences

6.1 The manufacturing process used to make the wire and rod may affect their corrosion potentials and polarization behavior. Material in these forms may not behave galvanically the same as material in the form of interest, such as fasteners in sheet roofing for example. Although unlikely, this may even lead to a situation where reversing the materials may also reverse their anode-cathode relationship, resulting in attack during service of a material which was resistant during testing as a wire.

7. Procedure

7.1 Components:

7.1.1 The components used to construct the specimen assemblies for this test are shown in Fig. 1.

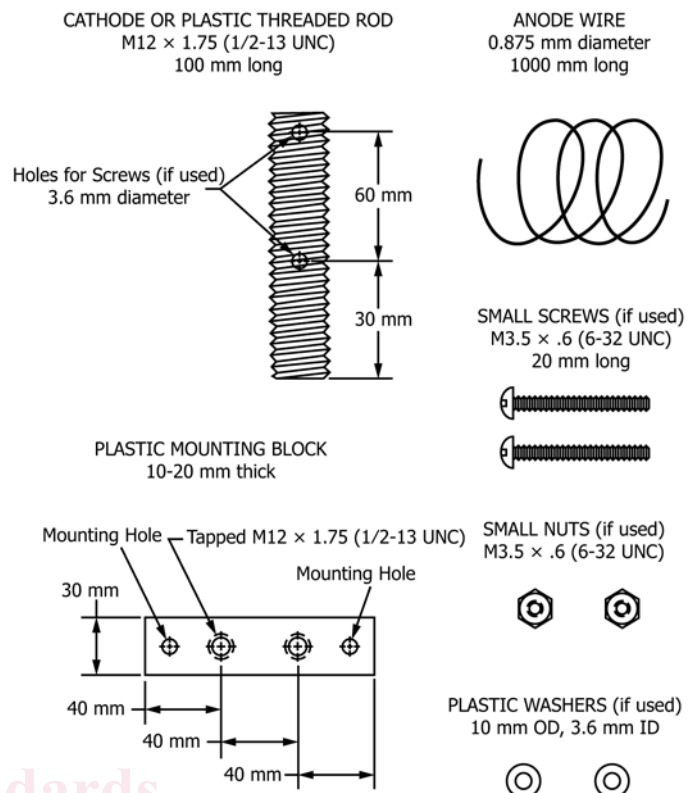


FIG. 1 Components for Making Wire-on-Bolt Exposure Assemblies

7.1.2 Prepare a 1 m length of 0.875 mm + 0.002 mm diameter wire of the anode material for each assembly. Other diameters may be used, however, the diameter of the wire may affect the test results, so that tests may only be compared if they use wire of similar diameters. In selecting material for the wire, consider the cold work and heat treatment of a wire may be significantly different than for the component that the exposure is modeling.

7.1.3 Make the cathode material into M12 x 1.75 (1/2-13-UNC threaded rods or bolts, 100 mm long. Either metric or English threads may be used, but results may only be compared between assemblies with similar thread types.

7.2 Making the Assemblies:

7.2.1 Thoroughly clean and degrease all parts before assembly in accordance with Practice G1.

7.2.2 Determine the mass of the wire to the nearest 0.0001 g.

7.2.3 Secure one end of the wire to a threaded rod using small screws and nuts of the rod material, if possible, or of nylon, stainless steel insulated with nylon, acetal resin, or TFE-fluorocarbon. Plastic washers are usually used under the heads of the screws. The wire may instead be secured to the rod by means of a tight O-ring wrapped around the threaded rod and the wire together.

7.2.4 Wrap the wire tightly around the rod so that it lies inside the threads using a jig such as that shown in Fig. 2. This jig is used to keep constant tension on the wire while it is being wound. While using this jig, wear clean cotton gloves to prevent contamination of the surfaces of the wire or rod. If it is

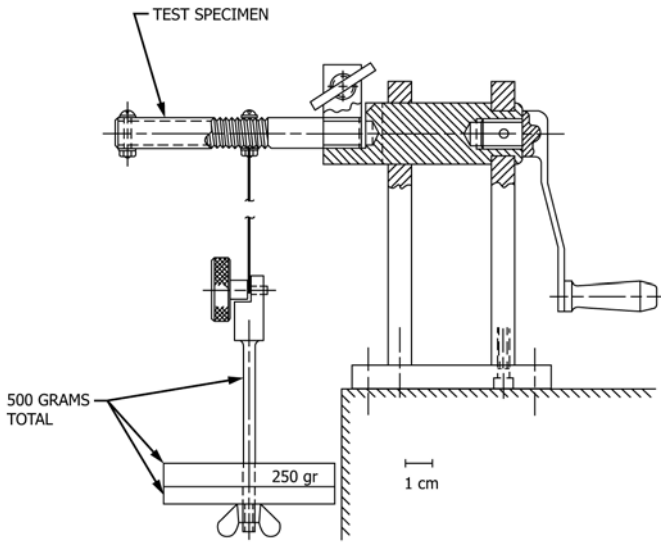


FIG. 2 Constant Tension Coil Winder for Wrapping Wire or Threaded Rods

felt that the wire tension is not critical for the particular application being tested, replace the use of the jig with hand-winding.

7.2.5 Wind the wire until it is in contact with roughly an axial distance of 50 mm of threaded rod.

7.2.6 Secure the free wire end to the rod by means of small screws and nuts made of the rod material, if possible, or of nylon, stainless steel insulated with nylon, acetal resin, or TFE-fluorocarbon. Plastic washers are usually used under the heads of screws. The wire may instead be secured to the rod by means of a tight O-ring wrapped around the threaded rod and the wire together.

7.2.7 Clip off the excess wire, if any, and determine the mass of the removed piece.

7.2.8 Prepare a minimum of 3 test assemblies using rods of the cathode material and 3 reference assemblies using a nonconductive (nylon) rod for each material combination to be studied.

7.3 Mounting and Exposure:

7.3.1 Hold the assemblies vertically by screwing the rod ends furthest from the wire into plastic plates. Fig. 3 shows a

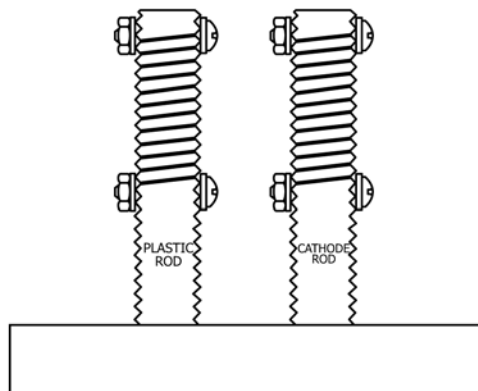


FIG. 3 Schematic Completed Wire-on-Bolt Assemblies Mounted for Exposure

schematic of a completed assembly, and Fig. 4 is a photograph of an actual completed assembly just before exposure.

7.3.2 Mount the plates horizontally on racks such as described in Practice G50.

7.3.3 Expose the assemblies for roughly 90 days in the atmospheric site of interest.

8. Measurements

8.1 It is desirable to characterize or monitor the atmospheric site during test by using one or more of the following Practices G84, G91, or G92.

8.2 After exposure visually inspect the specimens and note the condition of the wires. If any sections of wire are sufficiently corroded to have dropped out of the assembly, then the test is invalid and a shorter duration of exposure should be chosen for a retest.

8.3 Remove and clean the specimens according to the procedures specified in Practice G1 for the material involved.

8.4 Determine the final mass of the wires.

9. Calculation and Interpretation of Results

9.1 The wires exposed on the nonconductive rods are used for reference since they will have experienced no galvanic effects, while the test wires on the cathode rods will have experienced additional galvanic action. It is the difference between the mass loss of the wires on the cathode rods and those on the plastic rods which is an indication of galvanic corrosion.

9.2 Since the length of wire actually exposed will be slightly different for each assembly, the length differences must be corrected for. The mass loss of the wire is corrected to that for a standard 1 m length by using the mass of the wire removed as in 9.3.

9.3 Calculate the mass loss per unit length of wire for each test and reference assembly as follows:

$$\begin{aligned} \text{initial mass} &= \text{original wire mass} - \text{excess wire mass removed} \\ \text{mass loss} &= \text{initial mass} - \text{final mass (after exposure)} \\ \text{mass loss/m} &= \text{mass loss} \times \text{original wire mass}/\text{initial mass} \end{aligned}$$

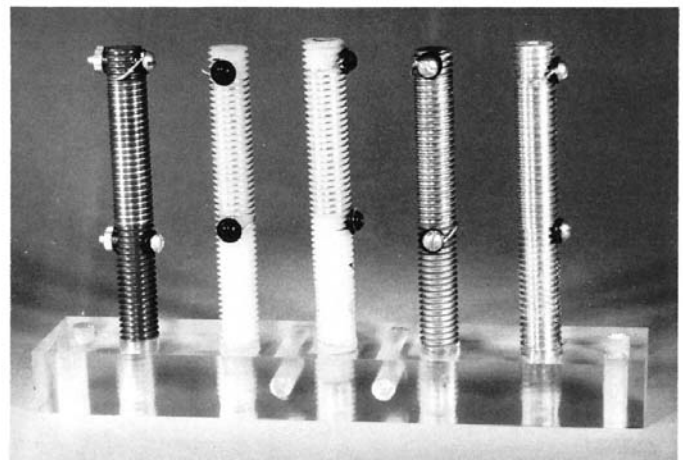


FIG. 4 Completed Wire-on-Bolt Assemblies Ready for Exposure