ASTM INTERNATIONAL

Designation: G 52 – 00

Standard Practice for
Exposing and Evaluating Metals and Alloys in Surface Seawater[1]

This standard is issued under the fixed designation G 52; 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 As contrasted with deep ocean testing (1), this practice covers conditions for the exposure of metals, alloys, and other materials in natural surface seawater such as those typically found in bays, harbors, channels, and so forth (2, 3). This practice covers full immersion, tidal zone and related splash, and spray zone exposures.

1.2 It sets forth general procedures that should be followed in conducting seawater exposure tests so that meaningful comparisons may be made from one location to another, as described, for example, in (2, 3).

1.3 This practice identifies recommended procedures for evaluating the effects of natural surface seawater on the materials exposed.

NOTE 1—Terms relative to this subject matter can be found in Terminology G 15.

1.4 *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 3623 Test Method for Testing Anti-fouling Panels in Shallow Submergence[2]
G 1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens[3]
G 15 Terminology Relating to Corrosion and Corrosion Testing[3]
G 30 Practice for Making and Using U-Bend Stress-Corrosion Test Specimens[3]
G 38 Practice for Making and Using C-Ring Stress-Corrosion Test Specimens[3]
G 39 Practice for Preparation and Use of Bent-Beam Stress-Corrosion Test Specimens[3]
G 46 Guide for Examination and Evaluation of Pitting Corrosion[3]
G 58 Practice for Preparation of Stress-Corrosion Test Specimens for Weldments[3]
G 78 Guide for Crevice Corrosion Testing of Iron Base and Nickel Base Stainless Alloys in Seawater and Other Chloride-Containing Aqueous Environments

3. Significance and Use

3.1 The procedures described herein are recommended for evaluating the corrosion or marine fouling behavior, or both, of materials exposed to quiescent or local tidal flow conditions, or both.

3.1.1 This practice is not intended to cover the influence of high seawater velocity or the behavior of materials in seawater which has been transported from its source.

3.1.2 Some aspects of this practice may be applicable to testing in tanks and troughs which are continuously provided with fresh surface seawater. Additionally, some aspects may also be applicable to deep ocean testing.

NOTE 2—Guide G 78 provides guidance for conducting crevice corrosion tests under controlled seawater test conditions.

3.2 While the duration of testing may be dictated by the test objectives, exposures of more than six months or one year are commonly used to minimize the effects of environmental variables associated with seasonal changes or geographic location, or both.

3.3 The procedures described are applicable for the exposure of simple test panels, welded test panels, or those configured to assess the effects of crevices, or both, such as those described in Guide G 78. In addition, they are useful for testing of actual components and fabricated assemblies.

3.4 It is prudent to include control materials with known resistance to seawater corrosion or fouling, or both, as described in Test Method D 3623.

NOTE 3—Materials which have been included in ASTM Worldwide Seawater Corrosivity Studies include UNS K01501 (carbon steel), UNS C70600 (90/10 CuNi) and UNS A95086 (5086-H116 Al) (2, 3).

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[1] This practice is under the jurisdiction of ASTM Committee G01 on Corrosion of Metals, and is the direct responsibility of Subcommittee G01.09 on Corrosion in Natural Waters.
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[2] *Annual Book of ASTM Standards*, Vol 06.02.
[3] *Annual Book of ASTM Standards*, Vol 03.02.

NOTE 4—In the case of evaluations of aluminum alloys, care should be exercised in the location of specimens near copper or high copper-containing alloys. In some instances, it is not sufficient to simply electrically isolate specimens to prevent bi-metallic (galvanic) corrosion; copper ions from nearby corroding copper or copper-base alloys can deposit on aluminum and accelerate its corrosion.

4. Test Sites

4.1 Test sites should be chosen at locations representative of natural seawater environments where the metals or alloys to be tested may be used. Ideally, a natural seawater test site should have clean, uncontaminated seawater, be in a protected location, and have facilities for such tests as splash, tidal, and full immersion. Reference should be made to tropical versus other conditions, and seasonal variations in temperature and in deposition of marine growth on the test panels with a defined "fouling season."

4.2 Periodic observations of critical water parameters should be made and reported; depending on the experiment, these might include water temperature, salinity, conductivity, pH, oxygen content, and tidal flow (velocity). If there is concern about the quality of water at the test site, it is suggested that ammonia, hydrogen sulfide, and carbon dioxide be determined periodically using analytical chemistry procedures.[4]

5. Exposure Racks

5.1 Test racks should be constructed of a material that will remain intact for the entire proposed period of exposure. Nickel-copper alloy 400 (UNS No. N04400) has been found to be an excellent material, but is not recommended for holding aluminum specimens. Coated aluminum racks (6061-T6 or 5086-H32) also have given satisfactory service. Nonmetallic racks made from reinforced plastic or treated wood might also be used.

5.2 Specimens must be insulated from the test racks. Mounting devices made of porcelain and other non-metallic materials are commonly used. It should be recognized that the specimen contact areas with mounting devices may produce crevice corrosion of some susceptible materials, for example, some stainless steel and aluminum alloys.

NOTE 5—Bolts used to secure the insulators must be galvanically compatible with the test rack.

5.3 Spacing of the mounted specimens can be important. It is desirable to have sufficient space between surfaces of test specimens to ensure that adequate water flows between them and that with long exposures the accumulated fouling will not block off the surface to the presence of the seawater environment.

5.4 Specimen location maps or charts should be prepared and maintained to ensure positive identification at the conclusion of testing. Pre-exposure photographs of assembled test racks are useful.

5.5 Racks may be suspended by such materials as nylon, polyester, or polypropylene rope depending on prevailing conditions. Steel wire rope should be avoided.

5.5.1 For multiple year exposures, it is recommended that the rack support rope be resistant to degradation by seawater as well as ultraviolet light.

5.6 Exposure racks should be suspended so that attached specimens will be oriented vertically and subjected to the full effects of the seawater but free of galvanic contact with other specimens and with minimal sedimentation of silt and debris on the specimen.

5.6.1 It should be recognized that in time some support ropes may stretch due to the added mass of marine fouling. In shallow waters, this should be taken into account to avoid unwanted contact with the sea bed or bottom. In some cases, the added mass will also make test rack removal more difficult.

NOTE 6—It should be recognized that barnacles attached to rack support ropes will create potential hazards if manual lifting is required.

5.7 If periodic removals are envisioned, it is recommended that different racks be utilized to support specimens for each test period. Otherwise, marine fouling and corrosion products on other specimens may be disturbed and possibly affect subsequent behavior of the test material.

5.7.1 It is prudent to check the security of support ropes and the presence of the test racks from time-to-time.

6. Specimens

6.1 When the material to be tested is in sheet form, a nominal specimen size of 100 by 300 mm (approximately 4 by 12 in.) is recommended. Specimens may be larger or smaller to suit a particular test.

6.2 Odd shaped samples and assemblies comprising like or dissimilar metals can also be tested. If testing materials in odd shapes (bolts, nuts, pipes, etc.) is desired, a means of supporting them in the test racks must be devised. It is important that the specimens be electrically insulated from their respective supports and from each other to prevent formation of galvanic corrosion cells. In some instances it is not sufficient to isolate specimens electrically to prevent corrosion of one material. For example, great care must be exercised with aluminum specimens or racks so that they will not be contaminated by copper, which will cause accelerated corrosion of the aluminum. A galvanic couple is not necessary to accelerate the corrosion of aluminum by copper. Copper or alloys containing copper physically located in the vicinity of aluminum may corrode sufficiently so that accelerated corrosion of the aluminum may be caused by copper deposition on the aluminum. (See Note 4.) Again, appropriate insulating supports are required.

6.2.1 Some specimen configurations for evaluating resistance to crevice corrosion or stress corrosion cracking may be tested under this practice. Examples are provided in Guide G 78, Practices G 30, G 38, G 39, and G 58.

6.3 The total number of test specimens required should be determined from a knowledge of the duration of the test and the planned removals of the specimens for intermediate evaluations. For reliable results, a sufficient number of replicate specimens should be used for removal at each exposure period. Triplicate specimens for each exposure period will usually satisfy this requirement. A suitable removal schedule might be 0.5, 1, 2, 5, 10, and 20 years. In case of uncertainty as to an

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[4] *Annual Book of ASTM Standards*, Vols 11.01 and 11.02.