



Designation: G52 – 20

Standard Practice for Exposing and Evaluating Metals and Alloys in Surface Seawater¹

This standard is issued under the fixed designation G52; 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 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 as contrasted with deep ocean testing.³ This practice covers full immersion, tidal zone and related splash, and spray zone exposures.^{2,4}

1.2 This practice 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.

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

1.4 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.

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 Kirk, W. W., and Pikul, S. J., *Seawater Corrosivity Around the World: Results from Three Years of Testing, ASTM STP 1086 Corrosion in Natural Waters*, 1990, pp. 3-36.

³ Reinhart, F. M., "Corrosion of Materials in Hydrospace," Technical Report R-304, U.S. Naval Civil Engineering Laboratory, Port Hueneme, CA, December 1966.

⁴ Phull, B. S., Pikul, S. J., and Kain, R. M., *Seawater Corrosivity Around the World: Results from Five Years of Testing, ASTM STP 1300 Corrosion in Natural Waters*, Vol 2, 1997, pp. 34-73.

2. Referenced Documents

2.1 *ASTM Standards*:⁵

D3623 Test Method for Testing Antifouling Panels in Shallow Submergence

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

G30 Practice for Making and Using U-Bend Stress-Corrosion Test Specimens

G38 Practice for Making and Using C-Ring Stress-Corrosion Test Specimens

G39 Practice for Preparation and Use of Bent-Beam Stress-Corrosion Test Specimens

G46 Guide for Examination and Evaluation of Pitting Corrosion

G58 Practice for Preparation of Stress-Corrosion Test Specimens for Weldments

G78 Guide for Crevice Corrosion Testing of Iron-Base and Nickel-Base Stainless Alloys in Seawater and Other Chloride-Containing Aqueous Environments

G193 Terminology and Acronyms Relating to Corrosion

3. Terminology

3.1 Terms relative to this subject matter can be found in Terminology G193.

4. Significance and Use

4.1 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.

4.1.1 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.

4.1.2 Some aspects of this practice may be applicable to testing in tanks and troughs, which are continuously provided with surface seawater pumped directly from the source. Additionally, some aspects may also be applicable to deep ocean testing.

⁵ 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.

NOTE 1—Guide G78 provides guidance for conducting crevice corrosion tests under controlled seawater test conditions.

4.2 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. Refer also to 7.3 for test duration recommendations.

4.3 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 G78. In addition, they are useful for testing of actual components and fabricated assemblies.

4.4 It is prudent to include control materials with known resistance to seawater corrosion or fouling, or both, as described in Test Method D3623.

NOTE 2—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).^{2,4}

NOTE 3—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.

5. Test Sites

5.1 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.”

5.2 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.²

6. Exposure Racks

6.1 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.

6.2 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 4—Bolts used to secure the insulators must be galvanically compatible with the test rack.

6.3 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.

6.4 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.

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

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

6.6 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.

6.6.1 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 5—It should be recognized that barnacles attached to rack support ropes will create potential safety hazards if manual lifting is required.

6.7 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.

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

7. Specimens

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

7.2 Odd shaped samples and assemblies comprising like or dissimilar metals can also be tested. If testing materials in odd shapes (bolts, nuts, pipes, and so forth) 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