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Standard Guide for Laboratory Cyclic Corrosion Testing of Automotive Painted Steel[1]

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1. Scope

1.1 This guide is designed to assist in determining the appropriate corrosion test methods for automotive painted steel.

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 requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B117 Practice for Operating Salt Spray (Fog) Apparatus
D16 Terminology for Paint, Related Coatings, Materials, and Applications
D609 Practice for Preparation of Cold-Rolled Steel Panels for Testing Paint, Varnish, Conversion Coatings, and Related Coating Products
D823 Practices for Producing Films of Uniform Thickness of Paint, Varnish, and Related Products on Test Panels
D870 Practice for Testing Water Resistance of Coatings Using Water Immersion
D1193 Specification for Reagent Water
D1654 Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
D1735 Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
D2247 Practice for Testing Water Resistance of Coatings in 100 % Relative Humidity
D3170 Test Method for Chipping Resistance of Coatings
D6675 Practice for Salt-Accelerated Outdoor Cosmetic Corrosion Testing of Organic Coatings on Automotive Sheet Steel
G1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens
G15 Terminology Relating to Corrosion and Corrosion Testing
G16 Guide for Applying Statistics to Analysis of Corrosion Data
G113 Terminology Relating to Natural and Artificial Weathering Tests of Nonmetallic Materials

NOTE 1—Practice D6675 describes an outdoor accelerated cosmetic corrosion test that uses periodic application of an electrolyte solution to materials exposed at 45 degrees to the horizontal and facing the equator.

2.2 *SAE Publications:*

SAE J1563 Guidelines for Laboratory Cyclic Corrosion Test Procedures for Painted Automotive Parts[3]
SAE J2334 Cosmetic Corrosion Lab Test[3]

2.3 *Other Standards:*

GM 9540P General Motors Accelerated Corrosion Test
JASO M610 Cosmetic Corrosion Test Method for Automotive Parts
JIS Z 2371 Methods of Neutral Salt Spray Testing

3. Terminology

3.1 *Definitions*—For definition of terms used in this standard, refer to Terminologies D16, G15, and G113.

4. Significance and Use

4.1 When a laboratory-accelerated test simulates the changing conditions to which automotive finishes are exposed, more realistic corrosion failures are produced.

4.2 Cyclic corrosion tests are effective for evaluating a variety of corrosion mechanisms, such as general, galvanic, crevice, etc. The cyclic corrosion tests make use of many types of environments, such as salt fog (Practice B117), humidity (Practice D2247 or Practice D1735) and dry conditions to accelerate metallic corrosion. In cyclic corrosion testing, specimens can be exposed to many different types of environmental conditions and cycled from one environment to another.

4.3 In all tests it is imperative to expose control specimens with an established corrosion performance together with the test specimens to make a comparison possible of the corrosion performance of the two sets.

[1] This guide is under the jurisdiction of ASTM Committee D01 on Paint and Related Coatings, Materials, and Applications and is the direct responsibility of Subcommittee D01.27 on Accelerated Testing.

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[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] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

4.4 Guidelines are included for those who evaluate the corrosion performance of painted metal parts in cyclic corrosion tests. These guidelines are intended to help ensure that the results of the tests can be used to reach conclusions concerning the variables under study, without being affected by the test procedure itself. The guidelines are also intended to assist users of this type of test in obtaining good inter-laboratory agreement of results.

4.5 This guide is not intended to be a substitute for the described cyclic corrosion test standard. In all cases, the laboratory should obtain the most recent published standard for complete details. The published standard supersedes this guide.

5. Apparatus

5.1 Depending upon the test cycle chosen, some or all of the following may be required.

5.1.1 *Salt Spray (Fog) Chamber*, as described in Practices B117 and D1735.

5.1.2 *Humidity Test Chamber*, as described in Practice D2247.

5.1.3 *Stone Chip Tester*, as described in Test Method D3170.

5.1.4 *Scribing Tool*, as described in Test Method D1654.

5.1.5 *Immersion Tank*, as described in Practice D870.

6. Test Specimens

6.1 The type of specimen and necessary surface preparations shall be specified in the applicable documents, or be agreed upon in advance by the parties involved and should simulate normal production materials and conditions. The number of test specimens selected must be sufficient to ensure that the test results are statistically significant at some predetermined confidence level. Any unusual observations made during specimen preparation shall be recorded and reported as part of the test results.

6.2 In addition to the test specimens, control specimens (panels of known performance in the test conducted) should be tested concurrently. The controls may be used to compare the performance of the test materials with that of a control material having already-established corrosion performance and allow comparisons of test results from repeat exposures to the same test conditions.

7. Preparation of Test Specimens

7.1 Coat the steel panels or product specimens with the material under test in accordance with the procedure agreed upon between interested parties. If no prior agreement takes precedence, Practices D609 and D823 may be appropriate.

7.2 Use a suitable coating that is stable under the conditions of exposure to protect any uncoated backs, cut edges, or areas of the specimen that contain identification marks. Protecting the uncoated back of test panels prevents an unrealistic relationship of cathode to anode in corrosion cells on the test surface.

7.3 Specimens may be submitted to the test scribed, chipped or undamaged, as agreed upon between interested parties. Usually the stone chip test or a scribing tool is used to provide damage prior to cyclic corrosion testing.

7.3.1 When a stone chip test is used, the procedure shown in Test Method D3170 shall be followed to assure consistent results, unless otherwise agreed upon between purchaser and seller. A typical test parameter is one pint road gravel at 70 psi within 5 to 10 s.

7.3.2 The procedure to scribe test specimens, including the scribing tool, shall be agreed upon between purchaser and seller. Unless otherwise specified, the scribe shall be made in accordance with Test Method D1654.

8. General Guidelines

8.1 *Test Conditions*:

8.1.1 *Chamber Conditions*—Cycling between different environments may be performed in one chamber or may require physically moving the test specimens from one chamber to another. Unless otherwise indicated in the test specification, test chamber conditions shall be held within the following limits to achieve consistent results—temperature ±2°C and relative humidity ±5 % RH. Each set point and its tolerance represents an operational control point for equilibrium conditions at a single location in the cabinet which may not necessarily represent the uniformity of conditions throughout the cabinet.

NOTE 2—Under existing calibration methods, it may be difficult to measure temperature tolerance within 2°C. Committees D01 and G03 are expanding tolerances to reflect actual operating conditions and measurement uncertainty. Refer to the currently published document for clarification.

8.1.2 *Chamber Uniformity*—To assure consistency of results, the uniformity of the test conditions should be established on a periodic basis by placing identical test panels at various locations in the test equipment. If unacceptable repeatability of results is observed, ensure that the equipment is operating in accordance with the relevant test methods and these guidelines. Guide G16 offers accepted methods of statistical analyses which are commonly-used in the interpretation of corrosion test results.

8.2 *Racking*—Specimens shall be mounted so that there is no metal-to-metal contact. The racks used in any of the cycles shall be constructed of non-metallic materials that are not conductive. The angle of exposure and the panel orientation specified in the test must be followed for consistency and repeatability of test results. Periodic inspection of the sample racks may be necessary to assure that any protective coating has not been damaged or removed, exposing a metal surface.

8.3 *Sample Placement*—To assist in obtaining good repeatability, equipment must be loaded evenly to maintain good airflow during the test. In order to assure uniformity of exposure conditions, samples should be rotated on a regular basis. For test methods which include a salt fog cycle, care must be taken to assure that salt solution does not drip from one specimen to another.

8.4 *Test Interruptions*—In situations where the test cycle is interrupted, the test specimens should be stored under the least corrosive conditions, either a dry or freeze cycle. Preferably, test interruptions should not exceed more than 25 % of the total test time, but all interruptions should be noted.

8.5 *Ramp Time*—The time needed to adjust the temperature and humidity to the new exposure conditions is considered ramp time. Depending upon the type of equipment used and the