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Limitations of
Laboratory Cyclic
Corrosion Test
Procedures for
Exterior, Painted,
Automotive Body
Panels**

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GUIDELINES AND LIMITATIONS OF
LABORATORY CYCLIC CORROSION
TEST PROCEDURES FOR EXTERIOR,
PAINTED, AUTOMOTIVE BODY PANELS

1. These guidelines and limitations are intended for those engineers and scientists who evaluate the corrosion performance of exterior, painted, automotive body panels in laboratory cyclic tests. They are not an endorsement of any particular cyclic test but, rather, a statement of precautions which should be followed in order to achieve consistent results from a particular test. The precautions are intended to help ensure that the results of the tests can be used to reach conclusions concerning the variables under study without their being confounded by the test procedure itself. The guidelines also serve as a means to assist users of this type of test in obtaining good inter-laboratory agreement of results.
2. INTRODUCTION: In cyclic corrosion testing, test specimens are exposed to at least two different types of environmental conditions and cycled from one environment to the other. Intentional paint film damage prior to testing, such as scribing or exposure to gravelometer, is usually an essential part of the test procedure. The Cyclic tests make use of many types of environments, such as ASTM B-117 salt spray, immersion in a 5% salt solution, or an exposure to dry and/or cold conditions. A humid environment or water immersion of the test specimens is included in most tests. In other cases, a thin layer of clay is applied to the specimen surfaces.

ASTM D2933-74 is an example of a cyclic test. This test consists of only two types of environments:

- A. ASTM B-117 salt spray and
- B. ASTM D-2247 Humidity

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3. HISTORY: In 1914, Mr. J. A. Capp proposed the use of neutral salt spray for the corrosion evaluation of protective coatings on ferrous surfaces. Over the last 70 years, this neutral salt spray test has been cited in numerous specifications, and it has become accepted as a standard method for testing painted automotive body panels. Although there have been many modifications and refinements to this test over the years, there still exists considerable controversy about the ability of this test to predict "real world" corrosion. As the demand for improved corrosion protection increased, engineers and scientists have developed cyclic testing procedures that more accurately predict the corrosion of materials used on the exterior of vehicle bodies.
4. SAMPLE PREPARATION: The type of specimen surface and the panel preparation should be, prior to testing, agreed to by personnel involved, and they should duplicate closely the industrial usage under evaluation. The number of test specimens selected should be sufficient to ensure that the test results are statistically significant at some predetermined confidence level. Any unusual observations made during panel preparation should be recorded and reported as part of the test results.
5. PAINT FILM DAMAGE: The gravelometer or scribing tool is used to provide film damage in cyclic testing. To assure good, consistent results, the procedure shown in SAE J400 should be followed when a gravelometer test is used. Scribing of test specimens should conform to ASTM Method D-1654.

It has been noted that a variance in scribe depth can affect the results of cyclic testing. This variation of test results due to scribe differences can be significant for galvanized surfaces. A microscopic investigation of scribe depth can be used to characterize the scribe.
6. TEST EQUIPMENT VARIABLES AND PRECAUTIONS: Different environments are commonly used in cyclic testing:
 - A. Salt Environment
 - B. Ambient Environment
 - C. High Humidity Environment
 - D. High Temperature Environment
 - E. Low Temperature Environment
 - F. Water Immersion
 - G. Surface Contamination

- 6.1 Salt Environment: When a cyclic test procedure uses salt spray as one step in the cycle, ASTM Method B-117 should be followed.

When immersion in a sodium chloride solution is used, the following conditions should be followed:

Salt Concentration: $5\% \pm 1\%$

pH: 6 to 7

Temperature: $\pm 3^{\circ}\text{C}$ of temperature stated in cycle

This immersion solution will become contaminated with use or the physical contents may change. To assure consistent results, the solution should be monitored and changed on a regular basis.

- 6.2 Ambient Environment:

The ambient conditions used should be:

Temperature: $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$

Relative
Humidity: 50%

This ambient exposure condition should consist of an environment which is free of corrosive vapors, for example, acidic and alkaline fumes. Air movement should not be excessive.

- 6.3 High Humidity Environment: This step of the cyclic test procedure should be held to the following tolerances to achieve consistent results:

Temperature: $\pm 1^{\circ}\text{C}$

Relative
Humidity: $\pm 2\%$

The temperature and relative humidity should be monitored, and it is suggested that automatic control systems be used.

- 6.4 High Temperature Environment: The temperature should be controlled to $\pm 2^{\circ}\text{C}$. The relative humidity in this step should be less than 20%.

- 6.5 Low Temperature Environment: The temperature should be controlled to $\pm 2^{\circ}\text{C}$.

- 6.6 Water Immersion: Freshly distilled water or deionized water should be used as make-up in this step (see ASTM D-1193). The container should be made of inert material. The immersion bath should be controlled to:

pH: 6 to 8

Temperature: $24^{\circ}\text{C} \pm 3^{\circ}\text{C}$

Conductivity: 50 $\mu\text{mho/cm}$ at 25°C

- 6.7 Surface Contamination: When surface contamination of the painted test surface is used, care should be taken to assure that clay contamination conforms to predetermined standards. Kaolin clay is suitable as a surface contaminant.

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 poor repeatability of results is observed, the test equipment should be brought up to the specifications cited in the test procedure.

7. TEST PROCEDURE - PRECAUTIONS:

Racking: Panels should be racked so that there is no metal-to-metal contact between them. The racks used in any of the cycles should be constructed of non-conductive materials. See ASTM B-117 for additional details.

Loading Level: To assist in obtaining good repeatability, test equipment should be loaded evenly to maintain good air flow during the test.

Test Interruptions: In situations where the test cycle has to be interrupted due to equipment malfunction, the test panels should be allowed to remain at the ambient conditions. Test interruptions should not exceed five days and all interruptions should be reported.

8. RATING/REPORTING: Panels should be rated within 15 min of the completion of the test. Prior to their rating, the corroded areas of the panel should be rinsed with DI water ($38^{\circ}\text{C} + 5^{\circ}\text{C}$), and poorly adhering paint should be removed. This can be accomplished with either high-pressure air or with tape, or the paint can be scraped off with a dull knife or spatula. This type of procedure is described in ASTM D-1654. Variations from previously agreed to test conditions should be recorded and reported.

The rating system used to report the corrosion which occurs in a cycle test should be agreed upon prior to testing. ASTM D-1654 is an example of a possible system to be used. Corrosion within 6 mm of a cut edge should be disregarded unless otherwise agreed upon.

RATIONALE:

Not applicable.

RELATIONSHIP OF SAE STANDARD TO ISO STANDARD:

Not applicable.

REFERENCE SECTION:

SAE J400 JAN85, Test for Chip Resistance of Surface Coatings.

ASTM B-117

ASTM D-1193

ASTM D-1654

ASTM D-2247

ASTM D-2933-74

APPLICATION:

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