SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE STANDARD

SAE J2334

ISSUED JUN98

Issued 1998-06

Submitted for recognition as an American National Standard

Cosmetic Corrosion Lab Test

Foreword—This cosmetic corrosion lab test procedure is based on field correlated lab test procedure parameters as determined by a Design of Experiment process conducted by the SAE Automotive Corrosion and Prevention Committee (SAE/ACAP) and the Auto/Steel Partnership (A/SP) Corrosion Task Force. Results from this test will provide excellent correlation to severe corrosive field environments with respect to cosmetic corrosion performance. For historical information on the development of this test, refer to 2.1.4.

A typical automotive paint system was used to develop this test. See 2.1.4, 1 to 5. If a different type of coating system is used, field correlation must be determined.

1. Scope—The SAE J2334 lab test procedure should be used when determining cosmetic corrosion performance for a particular coating system, substrate, process, or design. Since it is a field correlated test, it can be used as a validation tool as well as a development tool. If corrosion mechanisms other than cosmetic or general corrosion are to be examined using this test, field correlation must be established.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J1563—Guidelines for Laboratory Cyclic Corrosion Test Procedures for Painted Automotive Parts

2.1.2 ASTM Publications—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 1193—Specification for Reagent Water
ASTM D 1654—Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D 1735—Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
ASTM D 2247—Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM E 70-90—Test Method for pH of Aqueous Solutions with the Glass Electrode
ASTM G 1—Recommended Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-8512 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER; (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS http://www.sae.org

2.1.3 GENERAL MOTORS PUBLICATIONS—Available from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112.

GM 9540P

2.1.4 OTHER PUBLICATIONS

1. Townsend, H. E., "Development of an Improved Laboratory Corrosion Test by the Automotive and Steel Industries," in Advanced Coatings Technology, Proceedings of the fourth Annual ESD Advanced Coatings Conference, The Engineering Society, Ann Arbor, MI, 1994, pp. 29-49.
2. Roudabush, L.A., Townsend, H.E., and McCune, D.C., "Update on the Development of an Improved Cosmetic Corrosion Test by the Automotive and Steel Industries," Automotive Corrosion and Prevention Conference Proceedings, P-268, Society of Automotive Engineers, Warrendale, PA, 1993, pp. 53-63.
3. Townsend, H.E., "Accelerated Corrosion Testing: A Cooperative Effort by the Automotive and Steel Industries, " Proceedings of the Symposium on Corrosion-Resistant Automotive Sheet Steels, ASM Materials Congress, ASM International, Metals Park, OH, 1988, pp. 55-67.
4. Townsend, H.E., "Status of a Cooperative Effort by the Automotive and Steel Industries to Develop a Standard Accelerated Corrosion Test," Automotive Corrosion and Prevention Conference Proceedings, P-228, Society of Automotive Engineers, Warrendale, PA, 1989, pp. 133-145.
5. Townsend, H.E., Granata, R.D., McCune, D.C., Schumacher, W.A., and Neville, R.J., "Progress by the Automotive and Steel Industries Toward an Improved Laboratory Cosmetic Corrosion Test," Automotive Corrosion and Prevention Conference Proceedings, P-250, Society of Automotive Engineers, Warrendale, PA, 1991, pp. 73-97.
6. Stephens, M.L., "SAE ACAP Division 3 Project: Evaluation of Corrosion Test Methods," Automotive Corrosion and Prevention Conference Proceedings, P-228, Society of Automotive Engineers, Warrendale, PA, 1989, pp. 157-164.
7. Lutze, F.W., and Shaffer, R.J., "Accelerated Atmospheric Corrosion Testing of AISI Panels," Automotive Corrosion and Prevention Conference Proceedings, P-250, Society of Automotive Engineers, Warrendale, PA, 1991, pp. 115-127.
8. Petschel, M., "Statistical Evaluation of Accelerated Corrosion Tests and Correlation with Two-Year On-Vehicle Tests," Automotive Corrosion and Prevention Conference Proceedings, P-250, Society of Automotive Engineers, Warrendale, PA, 1991, pp. 179-203.
9. Davidson, D.D. and Schumacher, W.A., "An Evaluation and Analysis of Commonly Used Accelerated Cosmetic Corrosion Tests Using Direct Comparison with Actual Field Exposure," Automotive Corrosion and Prevention Conference Proceedings, P-250, Society of Automotive Engineers, Warrendale, PA, 1991, pp. 205-219.
10. Ostermiller, M.R., and Townsend, H.E., "On-Vehicle Cosmetic Corrosion Testing of Coated and Cold-Rolled Steel Sheet," Automotive Corrosion and Prevention Conference Proceedings, P-268, Society of Automotive Engineers, Warrendale, PA, 1993, pp. 65-83.
11. Granata, R.D. and Moussavi-Madani, M., "Characterization of Corrosion Products and Corrosion Mechanisms on Automotive Coated Steels Subjected to Field and Laboratory Exposure Tests," Leigh University Report to the ASP Corrosion Task Force, January 10, 1996.
12. ASTM E 691-92, "Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method," Annual Book of Standards, American Society for Testing and Materials, West Conshohocken, PA.
13. ASTM E 177-90a, "Standard Practice for Use of the Terms Precision and Bias in ASTM Test Methods," Annual Book of Standards, American Society for Testing and Materials, West Conshohocken, PA.
14. Townsend, H.E. and McCune D.C., "Round-Robin Evaluation of a New Standard Laboratory Test for Cosmetic Corrosion," Automotive Corrosion and Prevention Conference Proceedings, SP-1265, Society of Automotive Engineers, Warrendale ,PA, 1997, pp. 53-68.

2.1.4.1 Reproducibility and Repeatability information concerning this test method is discussed in SAE Paper 970734. See Reference 14.

3. *Definitions*

3.1 **Cosmetic corrosion—**Corrosion that occurs as a result of the breakdown or damage to a coating system. Typically, this type of corrosion does not impact function but does compromise appearance.

3.2 **General corrosion—**Corrosion of a component that is typically bare (no organic coating). Corrosive attack is uniform in nature and distributed over “large” areas.

3.3 **Scribe creepback—**Coating creepback resulting from corrosion and undercutting from the scribe line. A scribe is a controlled simulated damage site designed to represent a scratch or chip.

3.4 **Corrosion coupons—**Cold-rolled steel samples used to control and correlate corrosion lab tests by means of mass loss data.

3.5 **Test controls—**Components (i.e., test panels, coupons, parts, etc.) which have been previously tested and/or correlated. They can be used to control the test conduct and compare the test results (also assist in evaluating reproducibility and repeatability).

4. *Equipment and Test Materials*

4.1 **Test Cabinets—**Test cabinet(s) with the ability to obtain and maintain the following environmental conditions (Reference SAE J1563, ASTM D 1735, and ASTM D 2247):

a. 50 °C ± 2 °C and 100% Humidity (water fog/condensing)—Water fog/condensing humidity can be obtained by using atomized water, steam (vapor) generator, etc. The test samples and controls are required to be visibly moist/wet.
b. 60 °C ± 2 °C and 50% Relative Humidity ±5%. Additional equipment will be required to maintain the 50% relative humidity condition.

Air circulation must be sufficient to prevent temperature stratification and allow drying of test parts during the dry-off portion of the test cycle.

Air circulation can be obtained through the use of a fan or forced air.

4.2 **Salt Solution—**The salt solution is a complex mixture involving 3 salts on a weight percent basis as follows:

0.5% NaCl
0.1% $CaCl_2$
0.075% $NaHCO_3$

NOTE 1—Either the $CaCl_2$ or $NaHCO_3$ material must be dissolved separately in DI water (Reference ASTM D 1193 Type IV) and then added to the solution of other materials. If all solid materials are added at the same time in a “dry” state, an insoluble precipitate may result. If a slight precipitate still forms and a spray application is used to apply the solution, it will be necessary to remove the precipitate to avoid clogging of nozzles (i.e., filter or siphon solution). Do not attempt to dissolve the precipitate by adding acid.

NOTE 2—Measure and record pH of the salt solution prior to the start of test and on a weekly basis thereafter (Reference ASTM E 70-90). Do not attempt to adjust the pH with any form of buffers.

Test specimens are to be immersed in the salt solution for a 15-min interval each test cycle. Other methods of applying the salt, such as hand spraying or direct application by a mist within the test chamber may be adequate but this variable has not been analyzed with respect to correlation, repeatability, or reproducibility impact. A spray that completely wets the part with solution for the 15 min (continuously) should be adequate. However, avoid a high intensity (pressure) spray (with respect to impact on the test specimen). If a spray or mist application of the salt solution is used instead of an immersion application, results must be demonstrated to be equivalent to immersion or they are only valid for relative A:B comparisons. Further research regarding spray versus immersion salt application techniques are underway. Results will be used to update this procedure as they become available.

It is recommended that the test solution be changed weekly and that agitation/stirring of the solution be done prior to the salt solution application.

5. Test Procedure

5.1 Test Cycle—The test cycle is outlined in Figure 1 (5 day/week – manual operation) and Figure 2 (7 day/week - automatic operation). It consists of three basic stages:

1. Humid Stage—50 °C and 100% Humidity, 6 h in duration,
2. Salt Application Stage—15 min duration conducted at ambient conditions
3. Dry Stage—60 °C and 50% RH, 17 h and 45 min in duration

The test cycle is repeated daily. Fully automatic cabinets have the option of running during the weekends or programming in a dry stage soak for the weekends (typically it would be desired to run on weekends and holidays to complete the test sooner). An exception to this rule would be if comparisons to other laboratories who do not have fully automatic capabilities is desired (for manual operations, the weekend exposure is typically maintained at dry stage conditions unless 7 day operations are available). Total test duration and weekend conditions must be documented in the test results. If two or more laboratories will be conducting tests on similar parts, it is recommended that a constant/common weekend condition be defined before testing begins.

Ramp time between the salt application stage (2) and dry stage (3) are part of the dry stage time. Similarly, ramp time between the dry stage (3) and humid stage (1) are part of the humid stage. Ramp times should be documented for each test set-up.

For cosmetic corrosion evaluations of coatings susceptible to damage, test samples will be scribed prior to exposure (Reference ASTM D 1654). Scribe length should be a minimum of 2 in. Scribe creepback measurements are to be taken at predetermined intervals depending on the level of corrosion resistance desired. Scribe orientation, on the specimen, must be specified and documented (for typical flat panel specimens, it is recommended that panels be oriented 15 degrees from the vertical such that no one panel shadows another and that the scribe line be made in a diagonal across the panel face).

5.2 Test Duration—Typically, SAE J2334 is conducted for a minimum of 60 cycles when evaluating coated products. Longer durations may be required to observe performance differences in the heavier weight metallic precoats. Different test durations may be appropriate based on other materials, corrosion mechanisms of interest, or past history.

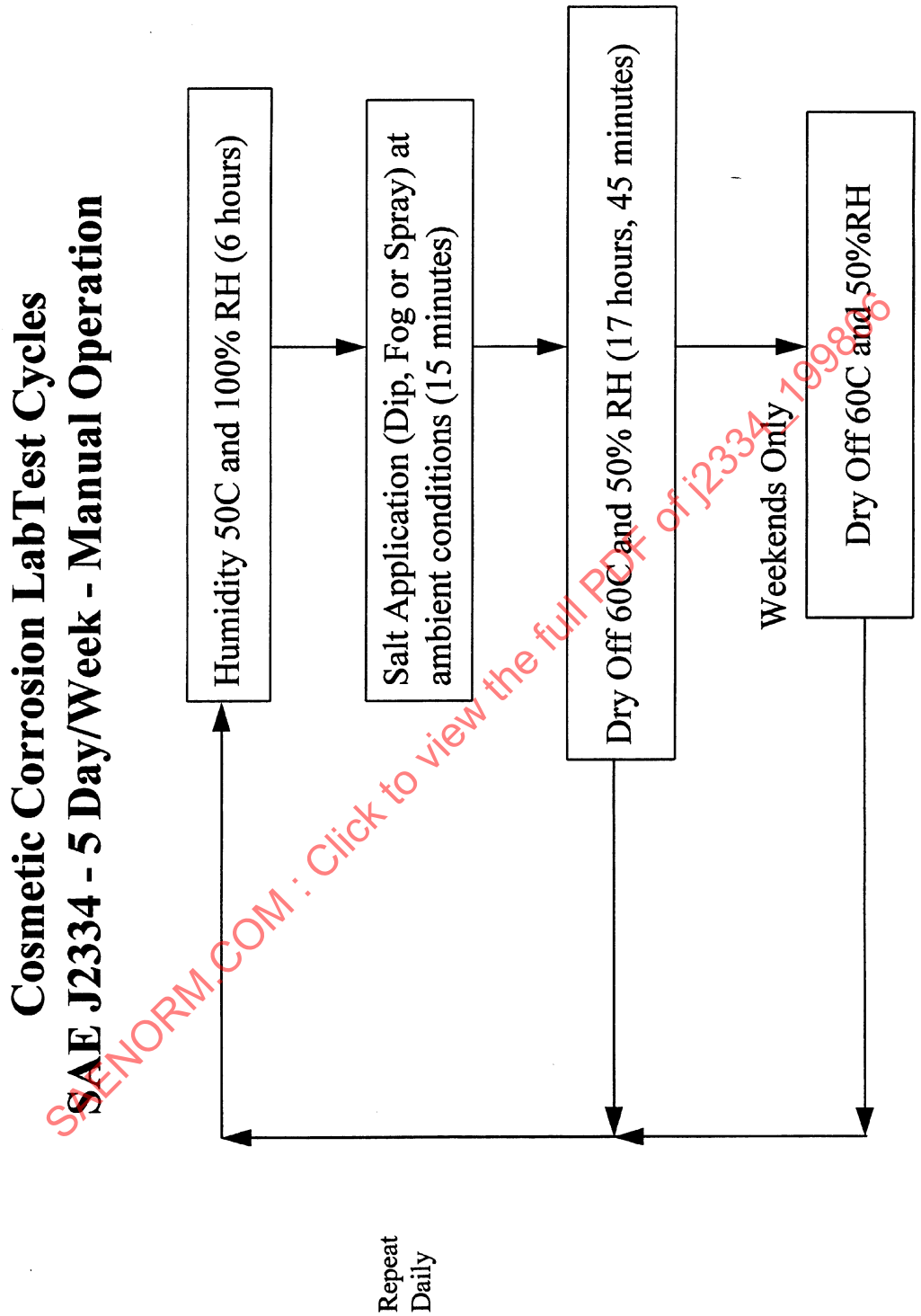

FIGURE 1—COSMETIC CORROSION LAB TEST CYCLES—5 DAY/WEEK—MANUAL OPERATION

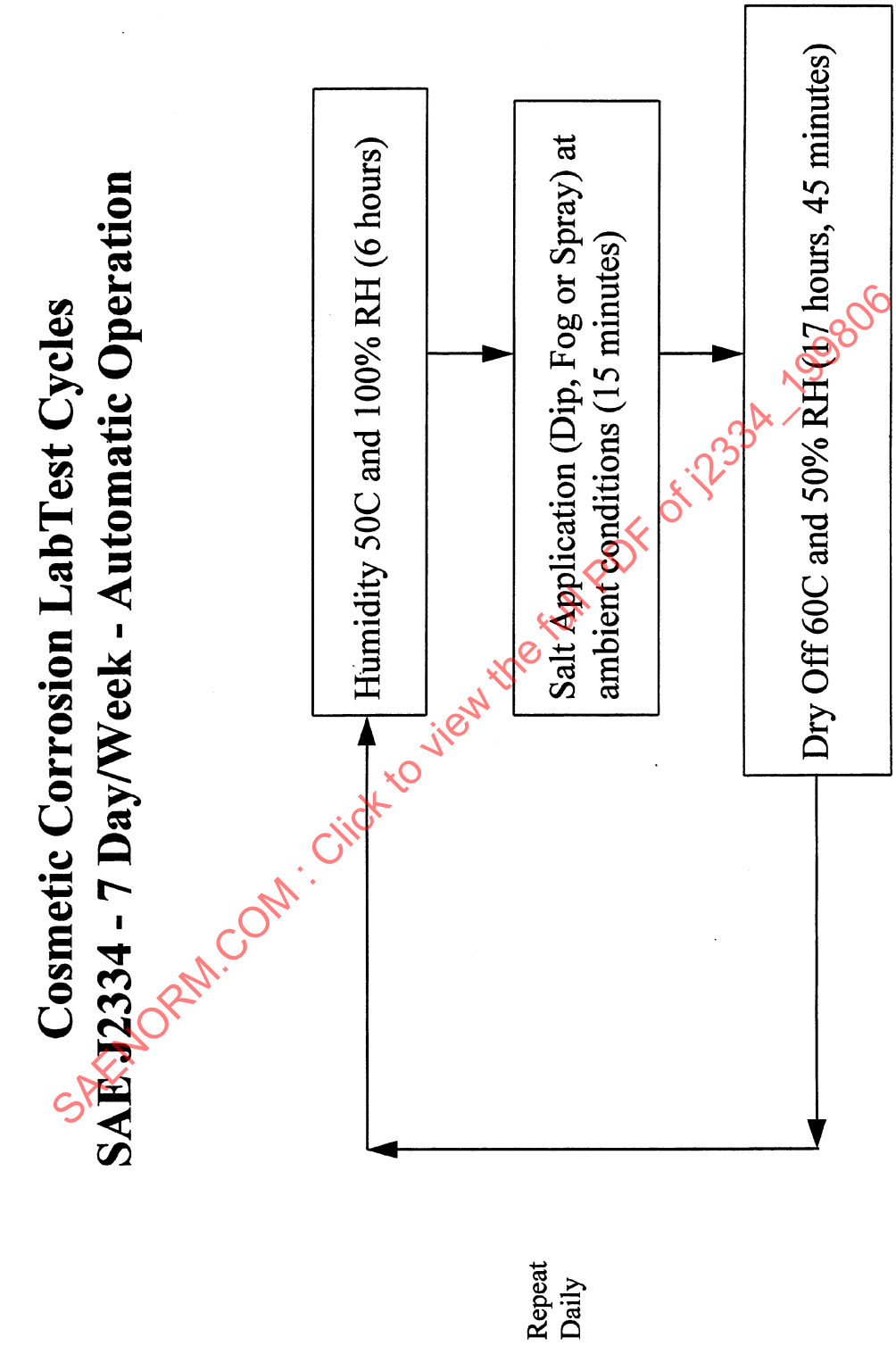

FIGURE 2—COSMETIC CORROSION LAB TEST CYCLES—7 DAY/WEEK—AUTOMATIC OPERATION

5.3 Coupon Monitoring—The testing process will be monitored with bare steel corrosion coupons.

a. Corrosion coupons consist of 25.4 mm wide × 50.8 mm long pieces of bare AISI 1006-1010 steel. The coupons serve to monitor the average general bare steel corrosion produced by the test environment.
b. Each coupon shall be permanently identified by stamping a number onto the surface.
c. Corrosion coupons shall be thoroughly cleaned to remove all forming and storage oils/lubes with a commercially available degreaser followed by a methanol rinse. Then the mass in milligrams shall be recorded and retained for future reference.
d. The coupons shall be secured to an aluminum or nonmetallic coupon rack. The coupons shall be electrically isolated from the rack by using fasteners and washers made from a non-black plastic material, preferably nylon.
e. Allow a minimum 5 mm spacing between the coupons and the rack surface. All coupons shall be secured at a maximum 15 degrees from vertical and must not contact each other.
f. The coupon rack shall be placed in the general vicinity of the samples being tested, such that the coupons receive the same environmental exposure.
g. Coupons shall be removed and analyzed after a predetermined number of cycles throughout the test to monitor corrosion. To analyze coupons, remove 1 coupon from each end of the rack and prepare for weighing and mass loss determination. Insure enough coupons are exposed in the test so monitoring frequency can be accomplished. Additional unexposed coupons can be added throughout the test to obtain interval data in addition to cumulative data.
h. Before weighing, clean the coupons using a mild “sand blast” (preferably glass beads) to remove all corrosion by-products from the coupon surface. An alternative/equivalent cleaning method, using a chemical process, is described in ASTM G1. Once clean, wipe the coupons with methanol and weigh to determine the coupon mass loss using Equation 1:

$$\text{Mass Loss} = (\text{Initial Mass}) - (\text{End-of-Exposure Mass}) \qquad \text{(Eq. 1)}$$

6. Data Reporting

6.1 Coupons—Coupon mass loss values are to be recorded after each set of a predetermined number of cycles (typically, every 20 cycles). This will be a cumulative value. Additional unexposed coupons can be installed and removed after the next set of cycles to obtain interval coupon data if desired.

6.2 Test Samples—The test samples will have scribe creepback values or corrosion rate measurements recorded at predetermined intervals (typically, 20 cycles – in a rinsed only condition). At end-of-test two sets of creepback values will be recorded (if coated samples are to be evaluated) one set in a rinsed only condition and one set after the scrape and tape process (Reference 1989 SAE Automotive Corrosion and Prevention Conference P228, pages 144-5, see 2.1.4 (4)).

As a guideline, scribe creepback measurements of average, maximum, and minimum (total width) will be recorded.

6.2.1 BY DEFINITION:

a. Total Width Creepback—A measurement of the distance between the unaffected paint film areas, in millimeters, on each side of the scribed line (measured across and perpendicular to the scribe line). (Loss of adhesion between paint film and substrate).
b. Average—The mean of a set of measurements of Total Width Creepback, at points spaced equidistant apart centered on the scribed line.
c. Maximum—A measurement of the Total Width Creepback at the point with the most extensive adhesion loss, discounting the areas at the ends of the scribed line.
d. Minimum—A measurement of the Total Width Creepback at the point with the least extensive adhesion loss, discounting the areas at the ends of the scribed line.

6.3 Test Equipment—Test equipment used shall be documented and include the following information:

If multiple cabinets are used to conduct the test, the following information must be recorded for each cabinet.

a. Cabinet Manufacturer/Model
b. Humidity
c. Temperature
d. Humidification Process
e. De-humidification Process
f. Heating Process
g. Cooling Process
h. Air Circulation Process
i. Size
j. Capacity
k. Calibration Process
l. Frequency of Calibration
m. Ramp Time Between Stages

6.3.1 SOLUTION INFORMATION:

a. Frequency of Salt Solution Changes (recommend weekly or sooner if contamination is a suspected concern)
b. Method of Salt Application
c. pH Measurement Method

If a recorder is in use, cycle profiles should be submitted with test sample data. If a recorder is not in use, written documentation should be provided indicating typical steady-state conditions and the ramp times between steady-state conditions.

PREPARED BY THE SAE AUTOMOTIVE CORROSION AND PREVENTION COMMITTEE