1 Scope

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This procedure describes an accelerated laboratory corrosion test method to evaluate assemblies and components. The test procedure provides a combination of cyclic conditions (salt solution, various temperatures, humidity, and ambient environment) to accelerate metallic corrosion. The procedure is effective for evaluating a variety of corrosion mechanisms, such as general, galvanic, crevice, etc. The test exposure/conditions can be individually tailored to achieve any desired level of corrosion exposure. Also, synergistic effects due to temperature, mechanical and electrical cycling, along with other stresses, can be comprehended by this test. See Deviations Section (pages 25 through 27) of this document for typical modifications.

1.2 Foreword. The test method is comprised of 1% (approximate) complex salt mist applications coupled with high temperature and high humidity and high temperature dry off. One (1) test cycle is equal to 24 h. A cycle is made up of the daily events or test inputs illustrated in Figure A1. A cycle normally requires one (1) day to complete. The test exposure is dictated by a targeted coupon mass loss. A target range for the number of cycles necessary to meet the required mass loss is provided in Table A1 for Method 1/2 and Table A2 for Method 3. The coupon mass loss values are used to verify that the correct amount of corrosion has been produced by the test. In addition to meeting mass loss requirements, the test must be conducted such that the number of cycles required to meet coupon mass loss requirements falls within the specified range.

1.3 Applicability. This is a cyclic corrosion test (refer to Figure A1) used for validation testing (cosmetic and/or functional/general durability), development testing, and quality control testing, for all global environmental regions. The basic exposures for cosmetic corrosion are found below in exposures 0, A, B, and C. Exposures D and E are used for functional assessment (refer to Table A1 and Table A2). All corrosion mechanisms are accelerated at different rates on test. Completing the test may not ensure that a component passes the functional requirement. A comprehensive failure mode analysis must be conducted to ensure all failure modes are considered and life expectancy is met.

- Exposure 0: All Areas (0 Year/Initial Delivery (ID)).
- Exposure A: Underbody Components.
- Exposure B: Underhood Components.
- Exposure C: Exterior Components/Panels, Secondary Surfaces, and Interior Components.
- Exposure D/E: All Components (Functional).

Note: For Exposure 0 (0 Year/ID) evaluate parts at two (2) cycles of the defined exposure linked to the associated vehicle area and mounting location as defined in Table A1 for Method 1/2 and Table A2 for Method 3.

Note: Reference the Deviations Section (pages 25 through 27) for optional modifications.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

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March 2013
2.1 External Standards/Specifications.
ASTM D610    ISO 6270-2    ISO 12103-1    SAE 2001-01-0640
ASTM D1193    ISO 8407    SAE 1008-1010    SAE J2329

2.2 GM Standards/Specifications.
GMW14700    GMW15356    GMW15358    GMW16277 (I)
GMW15282    GMW15357    GMW15359

(I) = This is a standard that is distributed only internally within General Motors. This standard cannot be distributed outside of General Motors. Contact the GM lead engineer for any instructions.

2.3 Additional References.
- ACT Test Panels
- Auto Technology Company
- National Exposure Testing
- Powder Technology Incorporated
- Splash Shielding Best Practices: The supplier shall work with the GM responsible engineer to comprehend this requirement.

3 Resources
3.1 Facilities. Laboratory (preferably with controlled ambient conditions).
3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.
3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.
3.2.1 Ambient Stage. The apparatus for the ambient stage shall have the ability to maintain the following environmental conditions:
   - Temperature: 25 °C ± 3 °C.
   - Humidity: 45% ± 10% Relative Humidity (RH).
   - Duration: Approximately 8 h per cycle.

   **Note:** For weekends and holidays, it is acceptable to open the chamber and allow chamber environment to mix with controlled ambient environment.

3.2.2 Humid Stage. The apparatus for the humid stage shall have the ability to ramp to (within 1 h) and maintain (for approximately 7 h) under the following environmental conditions:
   - Temperature: 49 °C ± 2 °C.
   - Humidity: Approximately 100% RH.
   - Duration: Approximately 8 h per cycle.

   The apparatus shall consist of a fog/environmental chamber, suitable water supply conforming to ASTM D1193 Type IV, provisions for heating the chamber, and the necessary means of control.

3.2.2.1 Water Fog. The apparatus shall include provisions for a supply of suitably conditioned compressed air and one or more nozzles for fog generation. The nozzle or nozzles used for the generation of the fog shall be directed or baffled to minimize any direct impingement on the test samples.

   At least two (2) clean fog collectors shall be placed within the exposure zone so that no drops of solution from the test specimens or any other runoff source shall be collected. The collectors shall be placed in the proximity of the test specimens, one nearest to any nozzle and the other farthest from all nozzles. Collection rates for each 80 cm² of horizontal collection area should be in the range of 0.75 mL/h to 1.5 mL/h (on average) for water that is collected in the collectors within the Humid Stage. Fog collection rates may be adjusted within this range as necessary to meet mass loss target rates.
Suitable collecting devices include glass or plastic funnels with the stems inserted through stoppers into graduated cylinders. Funnels with a diameter of 10 cm have an area of about 80 cm². Where samples cannot be read immediately upon completion of the humid stage, closed cell foam balls can be used in combination with the collections funnels (i.e., foam ball in mouth of funnel) to allow moisture to collect while minimizing evaporation.

3.2.2.2 Wet-Bottom. The apparatus shall consist of the chamber design as defined in ISO 6270-2. During wet-bottom generated humidity cycles, the tester must ensure that visible water droplets are found on the samples to verify proper wetness.

3.2.2.3 Steam Generated Humidity. Steam generated humidity may be used provided the source of water used in generating the steam is free of corrosion inhibitors. During steam generated humidity cycles, the tester must ensure that visible water droplets are found on the samples to verify proper wetness.

3.2.3 Dry Off Stage. The apparatus for the dry off stage shall have the ability to ramp to (within 3 h) and maintain (for approximately 5 h) under the following environmental conditions:

- Temperature: 60 °C ± 2 °C.
- Humidity: ≤ 30% RH.
- Duration: Approximately 8 h per cycle.

The apparatus shall also have sufficient air circulation to prevent temperature stratification, and also allow thorough drying of the test samples.

3.2.4 Salt Mist Application. The solution shall be sprayed as an atomized mist, and should be sufficient to rinse away any salt accumulation left from previous sprays. The test samples and coupons shall be thoroughly wet/dripping. Suitable application techniques include using a plastic bottle, or a siphon spray powered by oil-free regulated air to spray the test samples and coupons.

Note: The force/impingement from this salt application should not remove corrosion or damage coatings/paints system of test samples.

3.2.5 Corrosion Coupons and Mounting Hardware. Coupons serve to monitor the average general bare steel corrosion produced by the test environment. Coupons consist of 25.4 × 50.8 long × 3.18 mm thick pieces of bare SAE 1008-1010 carbon steel, cold-rolled steel per SAE J2329 CR1E, uncoated, no post-coating treatment, which are stamped with an alphanumeric identification number (reference Figure A2).

The coupons shall be secured to an aluminum or nonmetallic coupon rack with fasteners as shown in Figure A3 and Figure A4. The bolt, nut, and washers shall be made from a non-black plastic material, preferably nylon. Figure A4 shows a completed coupon rack configuration. The number of coupons recommended for different test durations are shown in Table A3.

3.3 Test Vehicle/Test Piece. The test sample (design, surface, and preparation) should be agreed to by the parties concerned (Design Engineer/Materials Engineer/Corrosion Engineer) and should simulate actual production materials and conditions when possible.

The number of test samples selected should be sufficient to ensure that the test results are statistically significant at some predetermined confidence level, unless otherwise specified. Any unusual observations made during sample preparation should be recorded and reported as part of the test results.

Where appropriate, test samples and/or control panels of known performance, should be tested concurrently. These controls can allow the normalization of test conditions during repeated running of the test (supplementing the required mass loss controls) and may also allow comparison of test results from different repeats of the test.

Where actual/representative production samples are available and the in-service orientation is known, test samples should be oriented to simulate these conditions.

When using test panels and/or the in-service orientation is not known, the sample shall, in principle, be oriented such that it is facing upward and at an angle of 20 degrees ± 5 degrees from vertical.

3.3.1. Preconditioning of Test Samples. The gravelometer and/or a scribing tool can be used to provide damage to coating layers prior to testing in order to better represent potential in-service damage when appropriate. The use of either of these preconditioning methods shall be agreed upon by the parties concerned and shall conform to the methods described in GMW14700 and/or GMW15282.
3.4 Test Time. See cycle times in Table A1 or Table A2.
3.5 Test Required Information. Not applicable.
3.6 Personnel/Skills. Not applicable.

4 Procedure
4.1 Preparation.
4.1.1 Salt Solution Preparation. The complex salt solution in percent (%) by mass shall be as specified below:
- Sodium Chloride (NaCl): 0.9%.
- Calcium Chloride (CaCl₂): 0.1%.
- Sodium Bicarbonate (NaHCO₃): 0.075%.
Sodium Chloride must be reagent grade or Morton Culinox 999 Food grade. Calcium Chloride must be reagent grade. Sodium Bicarbonate must be reagent grade (e.g., Arm and Hammer Baking Soda or comparable product is acceptable). Water must meet ASTM D1193 Type IV requirements.
Note: Either CaCl₂ or NaHCO₃ material must be dissolved separately in water and added to the solution of the other materials. If all solid materials are added dry, an insoluble precipitate may result.
Salt solution makeup calculator for the appropriate amount of sodium chloride, calcium chloride, sodium bicarbonate, and water examples are shown in Appendix B, Figures B1 through B6.
Additional contaminants (dust, grit, poultice, and exhaust condensate) called out in the Deviations Section (pages 25 through 27) are defined in Appendices C through Appendix F.
4.1.2 Coupon Preparation. Corrosion coupons should be cleaned with methanol or acetone solution and accurately weighed prior to use. The weight, in grams, shall be recorded and retained for future reference. If coupons are not used immediately, they should be stored such that they are corrosion free at the start of test.
It is critical that all forming or preservation oils/lubes be removed prior to exposure to allow for general/uniform corrosion of the coupon. This process can be aided by using a commercial grade degreaser prior to methanol or acetone clean.
4.1.3 Coupon Rack Preparation. Prior to start of test; prepare the coupon rack with sufficient coupons to monitor the test. The number of coupons recommended for different test durations are shown in Table A3.
The exact location of each coupon on the rack shall be identified and recorded using the pre-stamped numbers for reference as illustrated in Figure A4.
Allow a minimum 5 mm spacing between the coupons and the rack surface. All coupons shall be secured vertically with no more than 15 degree deviation from vertical and must not contact each other.
The coupon rack shall be placed in the general vicinity of the test samples being tested, such that the coupons receive the same environmental exposure as the test samples.
Note: Mass loss coupons are test monitoring devices and are not intended to be exposed to additional stresses which may be added to the base test (i.e., gravelometer, dust, grit, exhaust condensate, thermal exposure, etc.) Additional coupons may be required to monitor special test conditions (refer to Deviations Section, pages 25 through 27).

4.2 Conditions.
4.2.1 Environmental Conditions.
4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions.
4.3.1 Test Execution. See Figure A1 (Flow Diagram) for the steps that comprise the test method. Repeat the cycle daily, as necessary, until the test exposure requirements are met. At the option of the test requestor, the test can be continued throughout weekends to decrease the overall test time provided that the number of cycles and mass loss requirements are met.
4.3.2 Salt Application. For each salt mist application, use the spray apparatus to mist the samples and coupons until all areas are thoroughly wet/dripping. The quantity of spray applied should be sufficient to visibly rinse away salt accumulation left from previous sprays. The first salt mist application occurs at the beginning of the ambient stage. Each subsequent salt mist application, when specified, should occur approximately 1.5 h after the previous application in order to allow adequate time for test samples to dry. A minimum of 1 h spacing between the end of a previous salt application and the subsequent salt application is required.

4.3.3 Test Options. The test may be modified to target specific component applications. Refer to Deviations Section, pages 25 through 27.

4.3.4 Test Monitoring. Corrosion coupons shall be removed and analyzed after a predetermined number of cycles (typically 5) throughout the test to monitor the corrosion (less frequent for longer exposures (i.e., >40 cycles). To analyze coupons, remove one (1) coupon from each end of the rack, clean to prepare for weighing, and an average mass loss determination. Although corrosion rate may vary somewhat during the duration of the test, an assumption of linearity may be useful in predicting the number of cycles to meet future mass loss targets.

4.3.4.1 Before weighing, clean the coupons using a mild sand/bead blast 80 psi ± 10 psi process to remove all corrosion by-products from the coupon surface. Wipe the coupons free of grit and weigh to determine the coupon mass loss using the formula:

\[ \text{Mass Loss} = (\text{Initial Mass}) - (\text{End-of-Exposure Mass}) \]

Note: Although not preferred, corrosion by-product removal by chemical cleaning per ISO 8407 may be used.

4.3.4.2 Compare the actual mass loss to the targeted value. Refer to Table A1 or Table A2 for targeted mass loss values, in grams, for various test exposures as a function of the coupon’s original thickness. Testing should be conducted as necessary to achieve necessary coupon mass loss. The number of cycles required to achieve required mass loss must be a period as defined in Table A1 for Method 1/2 or Table A2 for Method 3.

Note: Coupon mass loss targets corresponding to incremental test exposures are not included in Table A1. The processes defined in 4.3.4 and 5.3.1 may be used to check test progress and assure the test is being run correctly. Corrosion mass loss should increase consistently between documented exposure values. If the actual mass loss does not fall within the targeted range for the specified exposure(s) as listed in Table A1 or Table A2, then the test should be repeated. Also, the reasons why the test did not fall within the target range should be investigated and corrected before resuming the test.

4.3.5 Test Acceleration. Temperature and humidity ramp times between the ambient stage and humid stage, and between the humid stage and dry stage, can have a significant effect on test acceleration. (Corrosion rates are highest during these transition periods.) Typically, the time from the ambient stage to the humid stage should be approximately 1 h and the transition time between humid stage and dry stage should be approximately 3 h. These ramp times can be adjusted to increase or decrease test acceleration in order to meet targeted mass loss. Any significant deviation from the ramp time described should be documented with the test results and requires prior approval by the parties concerned. Ramp time is to be included as part of the specified exposure period.

4.3.6 Extended Downtime. For any periods of extended downtime (i.e., greater than four (4) to five (5) days), it is recommended that test parts and associated coupons receive a fresh water rinse prior to the downtime period and are stored in ambient conditions to help minimize corrosive effects during this time. If downtime exceeds or is expected to exceed 17 consecutive days, this condition should be reviewed with test requestor. Additional special measures may be required to control the corrosion behavior of the test samples during this period. Storage in a desiccator, freezer, etc., may be appropriate. Extended downtime periods and any associated special measures should be included in the test documentation.

4.4 Cosmetic Corrosion Inspection. The test sample(s) shall be inspected for corrosion by means of GMW15356, GMW15357, GMW15358, GMW15359, and photographed (as necessary) at the end of predetermined cycles. Samples may be rated in terms of percent corroded area per ASTM D610 or some other comparable standard if agreed upon by test requestor and tester. If test samples containing plastic materials are being tested, any discoloration or degradation and/or adhesive bond failure (delamination) shall be noted and recorded.

If scribing is required, on test samples, follow the method described in GMW15282. This method includes measurement of corrosion creepback from a scribe line. This method should be used when reporting test results unless stated otherwise on drawings or agreed upon by test requestor and tester.
4.5 End-of-Test Functional Inspection. At the end of test, the samples shall be rinsed with fresh tap water and allowed to dry before evaluating. End-of-test functional analysis may involve sectioning, microscopic analysis and/or removal of corrosion product to determine degree and extent of base metal attack.

5 Data

5.1 Calculations.
- Salt Solution: (reference Appendix B).
- Coupon Mass Loss: (reference 4.3.4.1).

5.2 Interpretation of Results. Acceptance criteria shall be specified within engineering documentation which may include: Material Specifications, Vehicle, Subsystem, Component Technical Specifications, Statement of Requirements, Part Drawings, etc.

5.3 Test Documentation.

5.3.1 Coupons. Coupon mass loss values are to be recorded periodically throughout test and included as part of the overall test documentation in order to provide evidence of test control and adherence to specified test targets. This data may be plotted using charts like the examples found in Figure G1 and Figure G2.

5.3.2 Test Reports. Test reports should include a description of the specific test cycle executed, description of test options or special instructions, test deviations and/or extended test downtime periods (including any special measures taken). Test reports should also include (at minimum) targeted and actual number of cycles run, as well as the targeted and actual coupon mass loss associated with the documented data collection points.

5.3.3 Test Equipment Documentation. The information in 5.3.3.1 through 5.3.3.14 shall be recorded and available upon request for each cabinet/exposure location used to conduct test conditions as appropriate.

5.3.3.1 Cabinet Manufacturer/Model.
5.3.3.2 Humidity Profile.
5.3.3.3 Temperature Profile.
5.3.3.4 Humidification Process.
5.3.3.5 Collection Rate.
5.3.3.6 Dehumidification Process.
5.3.3.7 Heating Process.
5.3.3.8 Cooling Process.
5.3.3.9 Air Circulation Process.
5.3.3.10 Capacity.
5.3.3.11 Size.
5.3.3.12 Calibration Process.
5.3.3.13 Frequency of Calibration.
5.3.3.14 Ramp Time between Stages.

Cycle profiles (including typical steady state conditions and the ramp times between steady state conditions) should be maintained and available upon request.

Note: A form for Test Equipment documentation can be found in Appendix H. If information does not change from test to test, documentation of a representative test will be acceptable. All the specified information will be required if test results are in question.

5.3.4 Test Solution. The information in 5.3.4.1 through 5.3.4.5 shall be recorded and available upon request.

5.3.4.1 Frequency of Salt Solution Changes.
5.3.4.2 Method of Salt Application.
5.3.4.3 pH of Solution.
5.3.4.4 Salinity or Conductivity of Solution.
5.3.4.5 Solution Constituents.
Note: The form for Test Solution documentation can be found in Appendix J. All specified information will be required if test results are in question.

6 Safety
This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems 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.

7 Notes
7.1 Glossary. Not applicable.
7.2 Acronyms, Abbreviations, and Symbols.
ASTM ASTM International
DMFC Dry Milled Fire Clay
CR1E Cold Rolled Grade 1 and Type E
EXT Exterior
g Grams
h Hours
ID Initial Delivery (0 year)
INT Interior
I/WS Inside the Weather Strip
ND Not Defined
O/WS Outside the Weather Strip
PS Protected from Splash
RH Relative Humidity
s Seconds
SAE SAE International
sp Salt Sprays
SS Secondary Surface
UB Underbody
UH Underhood

8 Coding System
This standard shall be referenced in other documents, drawings, etc., as follows:
Test to GMW14872
Test to GMW14872, vehicle area including mounting location, method, cosmetic and/or functional test exposure, (0, A, B, C or D) or where the drawing or material specification calls for a specific deviation. This deviation should specify an associated mass loss.

Example 1: For an underbody (UB) component pertaining to a global region specified as Class 3 cosmetic (including 0 year/ID, i.e., two (2) cycles) and functional.
Test to GMW14872, (UB), All, four salt sprays (4 sp), Method 3, Exposures 0, A, and D.

Example 2: For a low, mid, or high underhood (UH) component pertaining to a global region specified as Class 1 or Class 2 cosmetic and functional with splash protection not defined.
Test to GMW14872, UH, All, 4 sp, Method 1/2, Exposures B and D.
Example 3: For a mid-mounted and protected from splash underhood component pertaining to a global region specified in Method 3 cosmetic and functional.
Test to GMW14872, UH, Mid PS, 4 sp, Method 3, Exposures B and D.

Example 4: For a door hinge mounted outside the weather strip in a global region specified in Method 1/2 functional.
Test to GMW14872, Secondary Surface (SS) Outside the Weather Strip (O/WS), Method 1/2, Deviation Option 1, Duration, 70 cycles.
In addition, the criteria for making pass/fail determinations must be specified (i.e., Vehicle Technical Specification Paragraph Number, etc.)

9 Release and Revisions
This standard was originated in November 2005. It was first approved by the Global Laboratory Corrosion Testing Harmonization Team in August 2006. It was first published in November 2006.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Publication Date</th>
<th>Description (Organization)</th>
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<tr>
<td>1</td>
<td>NOV 2006</td>
<td>Initial publication.</td>
</tr>
<tr>
<td>2</td>
<td>MAR 2010</td>
<td>Added Exposure 0: 0 year/ID to 1.2 and Table A1. Added Notes 1 to 3 to Figure A1. Updated 3.3 and added 3.3.1 Preconditioning of Test Samples. Moved 4.5 Test Monitoring to 4.3.4. Moved 4.4. Test Acceleration to 4.3.5. Added 4.3.6 Extended Downtime. Updated Underhood section of Table A1. Replaced Method SH/SM with Method 1/2 and Method SL with Method 3 in Table A1. Added additional source under Figure A4. Updated Deviations to include coupon exposure and mass loss. (Corrosion Global Subsystem Leadership Team)</td>
</tr>
<tr>
<td>3</td>
<td>MAR 2013</td>
<td>Addressed Internal audit issues around wet and dry time/duration. Added Exposure E. Updated Appendix A Table A1. Modified Notes 2 and 3. Added Table A2. Updated cinders provider. Replaced Appendix I with Appendix J; Appendix I (skipped). (Corrosion Global Subsystem Leadership Team)</td>
</tr>
</tbody>
</table>
Appendix A

Figure A1: Flow Diagram

Note 1: The typical ramp time from the ambient stage to the humid stage is 1 h and is part of the 8 h humid stage.
Note 2: The typical ramp time from the humid stage to the dry stage is 3 h and is part of the 8 h dry stage.
Note 3: For weekends and holidays, it is acceptable to open chamber and allow chamber environment to mix with controlled ambient environment as defined in ambient stage (3.2.1).
Note 4: For extended downtime refer to 4.3.6.
### Table A1: Mass Loss Targets for Method 1/2 \(^\text{Note 1}\) Cosmetic \(^\text{Note 2}\) and Functional \(^\text{Note 3}\)

<table>
<thead>
<tr>
<th>Vehicle Area</th>
<th>Mounting Location of Component</th>
<th>Number of Salt Sprays (sp)</th>
<th>Test Exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underbody (UB)</td>
<td>All</td>
<td>4 per cycle</td>
<td>Exposure A: 0.84 ± 0.14 g (38 ± 6 µm) 6 ± 1 cycles</td>
</tr>
<tr>
<td>Underbody (UB)</td>
<td>All – Splash Protection Not Defined (ND) (^\text{Note 6})</td>
<td>4 per cycle</td>
<td>Exposure B: 1.32 ± 0.13 g (60 ± 6 µm) 9 ± 1 cycles</td>
</tr>
<tr>
<td>Underbody (UB)</td>
<td>Mid – Protected from Splash (PS) (^\text{Note 6})</td>
<td>1 per cycle</td>
<td>Exposure B: 0.88 ± 0.09 g (40 ± 4 µm) 8 ± 1 cycles</td>
</tr>
<tr>
<td>Underbody (UB)</td>
<td>High – Protected from Splash (PS) (^\text{Note 6})</td>
<td>1 per cycle</td>
<td>Exposure B: 0.44 ± 0.4 g (20 ± 2 µm) 4 ± 1 cycles</td>
</tr>
<tr>
<td>Exterior (EXT)</td>
<td>All</td>
<td>4 per cycle</td>
<td>Exposure C: 3.94 ± 0.28 g (179 ± 13 µm) 26 ± 3 cycles</td>
</tr>
<tr>
<td>Secondary Surface (SS)</td>
<td>Outside the Weather Strip (O/WS)</td>
<td>1 per cycle</td>
<td>Exposure C: 1.98 ± 0.14 g (90 ± 6 µm) 18 ± 2 cycles</td>
</tr>
<tr>
<td>Secondary Surface (SS)</td>
<td>Inside the Weather Strip (I/WS) (^\text{Note 7})</td>
<td>1 per 5 cycles</td>
<td>Exposure C: 0.40 ± 0.3 g (18 ± 1 µm) 7 ± 1 cycles</td>
</tr>
<tr>
<td>Interior (INT)</td>
<td>Low (^\text{Note 7})</td>
<td>1 per 5 cycles</td>
<td>Exposure C: 1.30 ± 0.09 g (59 ± 4 µm) 22 ± 3 cycles</td>
</tr>
<tr>
<td>Interior (INT)</td>
<td>Mid, High (^\text{Note 7})</td>
<td>1 per 5 cycles</td>
<td>Exposure C: 0.40 ± 0.03 g (18 ± 1 µm) 7 ± 1 cycles</td>
</tr>
</tbody>
</table>

**Note 1:** Method is called out in material specifications/drawings as defined in Section 8.

**Note 2:** For Exposure 0 (0 Year ID) evaluate parts at two (2) cycles of the defined exposure linked to the associated vehicle area and mounting location.

**Note 3:** Exposures D and E are used for functional assessment. All corrosion mechanisms are accelerated at different rates on test. Completing the test may not ensure that a component passes the functional requirement. A comprehensive failure mode analysis must be conducted to ensure all failure modes are considered and life expectancy is met.

**Note 4:** Penetration factor based on material and dimension is 45.4.

**Note 5:** In addition to mass loss requirements, the test must be conducted such that the number of cycles falls within the specified range.

**Note 6:** In order to be classified as Protected from Splash, the associated vehicle application(s) must effectively employ all Splash Shielding Best Practices and the component must be classified as “Dry” based on the Vehicle Splash Shield Performance Evaluation (GMW16277) procedure.

**Note 7:** Number of salt sprays for one (1) per five (5) cycles should be sprayed at the start-of-test and every five (5) cycles thereafter.
<table>
<thead>
<tr>
<th>Vehicle Area</th>
<th>Mounting Location of Component</th>
<th>Number of Salt Sprays (sp)</th>
<th>Cosmetic Mass Loss Requirements Note 4 and Number of Test Cycles</th>
<th>Functional Mass Loss Requirements (Penetration Note 4) and Number of Test Cycles</th>
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</thead>
<tbody>
<tr>
<td>Underbody (UB)</td>
<td>All</td>
<td>4 per cycle</td>
<td>Exposure A: 0.42 ± 0.07 g (19 ± 3 µm) 3 ± 1 cycles</td>
<td>Exposure D: 4.74 ± 0.19 g (215 ± 8 µm) 32 ± 4 cycles</td>
</tr>
<tr>
<td>Underbody (UB)</td>
<td>All – Splash Protection Not Defined (ND) Note 6</td>
<td>4 per cycle</td>
<td>Exposure B: 0.66 ± 0.07 g (30 ± 3 µm) 4 ± 1 cycles</td>
<td>Exposure D: 3.55 ± 0.14 g (161 ± 6 µm) 24 ± 3 cycles</td>
</tr>
<tr>
<td>Underbody (UB)</td>
<td>Mid – Protected from Splash (PS) Note 6</td>
<td>1 per cycle</td>
<td>Exposure B: 0.44 ± 0.04 g (20 ± 2 µm) 4 ± 1 cycles</td>
<td>Exposure D: 2.38 ± 0.10 g (108 ± 4 µm) 22 ± 3 cycles</td>
</tr>
<tr>
<td>Underbody (UB)</td>
<td>High – Protected from Splash (PS) Note 6</td>
<td>1 per cycle</td>
<td>Exposure B: 0.22 ± 0.02 g (10 ± 1 µm) 2 ± 1 cycles</td>
<td>Exposure D: 1.19 ± 0.05 g (54 ± 2 µm) 11 ± 2 cycles</td>
</tr>
<tr>
<td>Exterior (EXT)</td>
<td>All</td>
<td>4 per cycle</td>
<td>Exposure C: 3.94 ± 0.28 g (179 ± 13 µm) 26 ± 3 cycles</td>
<td>Exposure D: 7.23 ± 0.29 g (328 ± 13 µm) 48 ± 5 cycles</td>
</tr>
<tr>
<td>Secondary Surface (SS)</td>
<td>Outside the Weather Strip (O/WS)</td>
<td>1 per cycle</td>
<td>Exposure C: 1.98 ± 0.14 g (90 ± 6 µm) 18 ± 2 cycles</td>
<td>Exposure D: 3.61 ± 0.14 g (164 ± 7 µm) 33 ± 4 cycles</td>
</tr>
<tr>
<td>Secondary Surface (SS)</td>
<td>Inside the Weather Strip (I/WS) Note 7</td>
<td>1 per 5 cycles</td>
<td>Exposure C: 0.40 ± 0.03 g (18 ± 1 µm) 7 ± 1 cycles</td>
<td>Exposure D: 0.73 ± 0.03 g (33 ± 1 µm) 12 ± 2 cycles</td>
</tr>
<tr>
<td>Interior (INT)</td>
<td>Low Note 7</td>
<td>1 per 5 cycles</td>
<td>Exposure C: 1.30 ± 0.09 g (59 ± 4 µm) 22 ± 3 cycles</td>
<td>Exposure D: 2.38 ± 0.10 g (108 ± 4 µm) 40 ± 4 cycles</td>
</tr>
<tr>
<td>Interior (INT)</td>
<td>Mid, High Note 7</td>
<td>1 per 5 cycles</td>
<td>Exposure C: 0.40 ± 0.03 g (18 ± 1 µm) 7 ± 1 cycles</td>
<td>Exposure D: 0.73 ± 0.03 g (33 ± 1 µm) 12 ± 2 cycles</td>
</tr>
</tbody>
</table>

**Note 1:** Method is called out in material specifications/drawings as defined in Section 8.

**Note 2:** For Exposure 0 (0 Year/ID) evaluate parts at two (2) cycles of the defined exposure linked to the associated vehicle area and mounting location.

**Note 3:** Exposures D and E are used for functional assessment. All corrosion mechanisms are accelerated at different rates on test. Completing the test may not ensure that a component passes the functional requirement. A comprehensive failure mode analysis must be conducted to ensure all failure modes are considered and life expectancy is met.

**Note 4:** Penetration factor based on material and dimension is 45.4.

**Note 5:** In addition to mass loss requirements, the test must be conducted such that the number of cycles falls within the specified range.

**Note 6:** In order to be classified as Protected from Splash, the associated vehicle application(s) must effectively employ all Splash Shielding Best Practices and the component must be classified as “Dry” based on the Vehicle Splash Shield Performance Evaluation (GMW16277) Procedure.

**Note 7:** Number of salt sprays for one (1) per five (5) cycles should be sprayed at the start-of-test and every five (5) cycles thereafter.
Figure A2: Coupon Schematic

Figure A3: Coupon Hardware Illustration
Suitable coupons and/or coupon rack assemblies along with salt solution, dust, grit, poultice, and exhaust condensate can be purchased from the following:

**ACT Test Panels**
273 Industrial Drive
P.O. Box 735
Hillsdale, Michigan 49242
(517) 439-1485

**Auto Technology Company**
20026 Progress Drive
Strongsville, Ohio 44149
(800) 433-8336

**National Exposure Testing**
3545 Silica Road
Suite E
Sylvania, Ohio 43560
(419) 841-1065

---

### Table A3: Recommended Number of Coupons and Removal Frequency

<table>
<thead>
<tr>
<th>Number of Required Cycles</th>
<th>Number of Coupons</th>
<th>Removal Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 10 Cycles</td>
<td>6</td>
<td>5 Cycles</td>
</tr>
<tr>
<td>11 to 20 Cycles</td>
<td>10</td>
<td>5 Cycles</td>
</tr>
<tr>
<td>21 to 30 Cycles</td>
<td>14</td>
<td>5 Cycles</td>
</tr>
<tr>
<td>31 to 40 Cycles</td>
<td>18</td>
<td>5 Cycles</td>
</tr>
<tr>
<td>41 to 80 Cycles</td>
<td>18</td>
<td>10 Cycles</td>
</tr>
</tbody>
</table>

*Note 1: Additional coupons may be required if earlier evaluations must be conducted.*
Appendix B

Figure B1: Salt Solution Calculator for Anhydrous (X=0) Calcium Chloride Based on a Five Gallon Batch Solution

Figure B2: Salt Solution Calculator for One Hydrate (X=1) Calcium Chloride Based on a Five (5) Gallon Batch Solution

Figure B3: Salt Solution Calculator for Dihydrate (X=2) Calcium Chloride Based on a Five (5) Gallon Batch Solution

Note: An electronic copy can be obtained upon request. Contact GMNA Corrosion Engineering.
Figure B4: Salt Solution Calculator for Anhydrous (X=0) Calcium Chloride Based on a Ten (10) Liter Batch Solution

Figure B5: Salt Solution Calculator for One Hydrate (X=1) Calcium Chloride Based on a Ten (10) Liter Batch Solution

Figure B6: Salt Solution Calculator for Dihydrate (X=2) Calcium Chloride Based on a Ten (10) Liter Batch Solution

Note: An electronic copy can be obtained upon request. Contact GMNA Corrosion Engineering.
Appendix C

Dust Type
Arizona Dust conforming to ISO 12103-1, A2 Fine, procured from Powder Technology Incorporated of Burnsville, Minnesota. Dust may also be purchased from ACT Test Panels, Auto Technology Company, and National Exposure Testing.

Spray Apparatus
A simple garden duster is suitable for dust application (refer to Figure C1 for example).

Dust Application
Dust should be applied such that a semi-transparent layer is applied to the entire part or focal area of the part. Keep the applicator agitated to ensure proper dust application (agitate/shake duster between applications).

Figure C1: Garden Duster Example

Note: For bulk supply use suppliers defined above. Smaller quantities may be purchased from ACT Test Panels, Auto Technology Company, and National Exposure Testing (refer to Appendix A for contact information).
Appendix D

Grit Specification

Grit Trough Solution Mix: (Typical recipe to be mixed with 18.9 L of water (5 gal) – total solution amount can be increased or decreased by multiplying or dividing as necessary).

Solid Contaminants:
- Fire Clay – 900 g
- Cinders – 900 g
- Sand – 900 g
- Ottawa Lakes Screening – 1080 g

1% Complex Salt Mix:
- NaCl (sodium chloride) – 170.37 g
- CaCl$_2$ $\cdot$ 2H$_2$O (calcium chloride dihydrate) – 25.07 g (18.93 g – anhydrous)

**Note 1:** It is permissible to use hydrated salts.
- NaHCO$_3$ (sodium bicarbonate) – 14.2 g (baking soda is also suitable and can be purchased at a grocery store).

Mixing Instructions:
Add 18.9 L (5 gal) of the 1% complex salt solution to the premix bag of solid ingredients (or if you do not have pre-mixed bags, weigh out the materials, put them in a container able to hold at least 22.7 L (6 gal) and then add the water). Thoroughly mix liquid and solids together with moderate agitation. If spraying the solution, immediately after agitation or during agitation, siphon solution from the top half of the mix for use in spraying on test samples. An alternative method would be to build an automatic spray system incorporating a pumping device that either prescreened the coarse solids or drew liquid from the top half of the solution. In the case of a test where a part is to be submerged in the solution and then cycled/stroked, make sure that the part stays in the top ¾ of the solution to avoid ingestion or damage due to large particles that fall out of solution and reside in the bottom of the mix.

**Note:** Be sure to pour/douse the grit solution on all areas of the part that would potentially experience splash in the field. Depending on number of samples, level of contamination, and exposure of test, it may be appropriate to collect and reuse grit solution. A fresh batch of grit solution should be made at minimum once a month for the duration of the test.

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Supplier</th>
<th>Address</th>
<th>Phone/Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cinders</td>
<td>Brooklyn Cinder Sales</td>
<td>20400 Sheldon Road, Brook Park, Ohio</td>
<td>(440) 243-1661</td>
</tr>
<tr>
<td></td>
<td>Limestone and Sand Inc.</td>
<td>44142</td>
<td></td>
</tr>
<tr>
<td>Dry Milled Fire Clay (DMFC) – 20 Mesh sacked</td>
<td>Harbison Walker</td>
<td>28777 Goddard Road, Romulus, MI</td>
<td>(734) 955-6025</td>
</tr>
<tr>
<td>Sand – unwashed play sand or 2NS</td>
<td>Local Hardware</td>
<td>Milford Proving Ground – Corrosion</td>
<td>(248) 431-9789</td>
</tr>
<tr>
<td>Ottawa Lakes Screening</td>
<td>Stoneco Michigan</td>
<td>15203 S. Telegraph Road, Monroe, MI</td>
<td>(734) 241-8966</td>
</tr>
</tbody>
</table>

**Note 1:** For bulk supply use suppliers defined. Smaller quantities may be purchased from ACT Test Panels, Auto Technology Company, and National Exposure Testing (refer to Appendix A for contact information).
Appendix E

Poultice Specification

Solid Contaminants: Fire Clay – 22.5% by weight
Sand – 72.5% by weight
Calcium Chloride – 5% of the combined Fire Clay and Sand weight

Mixing Instructions:
Combine fire clay and sand. Add 5% Calcium Chloride to the combined weight of the fire clay and sand. Next, distilled or deionized water per ASTM D1193 Type IV is added to the solid ingredients in small amounts until desired poultice consistency. Poultice is to be packed (approximately 6.35 mm (¼ in) thick) on test specimens.

Example: (100 g batch)
Mix 22.5 g of fire clay and 72.5 g of sand. Add 5 g of Calcium Chloride to the fire clay and sand mixture. Thoroughly mix solid constituents together. Add small amounts of water at a time while thoroughly mixing liquid and solid constituents until it creates a thick and moist poultice consistency. Apply poultice to test specimen packing the poultice to approximately 6.35 mm (¼ in) thick.

Note: For bulk supply use suppliers defined in Table D1. Smaller quantities may be purchased from ACT Test Panels, Auto Technology Company, and National Exposure Testing (refer to Appendix A for contact information).
Appendix F

Table F1: Exhaust Condensate Specification (Reference SAE 2001-01-0640)

<table>
<thead>
<tr>
<th>Number</th>
<th>Ingredients</th>
<th>Level (Weight Percent)</th>
<th>Amount per 113.56 L (30 gal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Activated Carbon</td>
<td>0.5%</td>
<td>571.5 g</td>
</tr>
<tr>
<td>2</td>
<td>Ammonia (as Ammonium Hydroxide, 29.7%)</td>
<td>0.25%</td>
<td>959.0 g</td>
</tr>
<tr>
<td>3</td>
<td>Sulfate (as Ammonium Sulfate)</td>
<td>0.125%</td>
<td>195.2 g</td>
</tr>
<tr>
<td>4</td>
<td>Acetate (as Ammonium Acetate)</td>
<td>0.04%</td>
<td>59.3 g</td>
</tr>
<tr>
<td>5</td>
<td>Sulfite (as Ammonium Sulfite)</td>
<td>0.025%</td>
<td>47.5 g</td>
</tr>
<tr>
<td>6</td>
<td>Formaldehyde (37%)</td>
<td>0.025%</td>
<td>76.7 g</td>
</tr>
<tr>
<td>7</td>
<td>Nitrate (as Ammonium Nitrate)</td>
<td>0.012%</td>
<td>17.6 g</td>
</tr>
<tr>
<td>8</td>
<td>Formic Acid (88%)</td>
<td>0.01%</td>
<td>13.2 g</td>
</tr>
<tr>
<td>9</td>
<td>Chloride (as Ammonium Chloride)</td>
<td>0.005%</td>
<td>8.5 g</td>
</tr>
<tr>
<td>10</td>
<td>Water</td>
<td>Balance</td>
<td></td>
</tr>
</tbody>
</table>

Note: Total for nitrite and nitrate.

Procedure:
Dissolve each of ingredients, number two (2) through number nine (9) in distilled water and add while stirring one by one to the prepared container. Add rest of water and number one (1) (activated carbon). Mix thoroughly. Keep in tightly closed container.
Appendix G

Figure G1: Underbody (UB) Mass Loss Target Chart for Method 1/2

Figure G2: Underbody (UB) Mass Loss Target Chart for Method 3

Note: An electronic copy for both corrosion severities (i.e., Method 1/2 and Method 3) and all of the vehicle component areas (i.e., underbody, underhood, exterior, and secondary surface and interior) can be obtained upon request. Contact GMNA Corrosion Engineering.
Appendix H: Test Equipment Documentation Form (Page 1 of 2)

<table>
<thead>
<tr>
<th>General Information</th>
<th><strong>Description of any test interruptions (fill in table below):</strong></th>
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<tbody>
<tr>
<td>Date</td>
<td>Description of Test Interruption</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Operation (Manual (5 days)/Automatic (5 or 7 days)):</th>
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</table>

<table>
<thead>
<tr>
<th>Average Temperature (Lab or Operating Environment) (Range) (°C):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Humidity (Lab or Operating Environment) (Range) (% RH):</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are coupons placed In the location as test samples within the chamber (Yes/No)?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are samples and coupons rotated within the chamber during the exposure (Yes/No)?</td>
</tr>
<tr>
<td>If yes, frequency:</td>
</tr>
<tr>
<td>□ [Chart or data (temperature and humidity) documenting at least 1 weekend (include date(s))]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ambient Stage</th>
<th><strong>Cabinet Identification (Name/Number):</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabinet Manufacturer:</td>
<td>Cabinet Model:</td>
</tr>
<tr>
<td>Cabinet Serial Number:</td>
<td>Air Movement (high/moderate/low and units):</td>
</tr>
<tr>
<td>Cabinet Size:</td>
<td>Cabinet Capacity:</td>
</tr>
<tr>
<td>Last Calibration (Date):</td>
<td>Next Calibration (Due Date):</td>
</tr>
<tr>
<td>Average Temperature (Range) (°C):</td>
<td></td>
</tr>
<tr>
<td>Heating Process:</td>
<td></td>
</tr>
<tr>
<td>Cooling Process:</td>
<td></td>
</tr>
<tr>
<td>Average Humidity (Range) (% RH):</td>
<td></td>
</tr>
</tbody>
</table>

| Typical Time (minutes) to Dry Between Sprays for Standard Test Sample (Paint Panel): |
| Duration Of Individual Salt Applications (s): |
| Time Between Individual Salt Applications (minutes): |

| Ramp Time For Humidity To Return To Specified Ambient Humidity Following Salt Spray (minutes): |
| □ [Chart or data (temperature and humidity) documenting at least 1 cycle of this stage (include date(s))] |
### Appendix H: Test Equipment Documentation Form (Page 2 of 2)

#### Humidity Stage

<table>
<thead>
<tr>
<th>Cabinet Identification (Name/Number):</th>
<th>Cabinet Model:</th>
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<tbody>
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<td>Cabinet Manufacturer:</td>
<td>Cabinet Model:</td>
</tr>
<tr>
<td>Cabinet Serial Number:</td>
<td>Cabinet Model:</td>
</tr>
<tr>
<td>Last Calibration (Date):</td>
<td>Next Calibration (Due Date):</td>
</tr>
<tr>
<td>Ramp Time (Ambient to Humidity Stage):</td>
<td>Next Calibration (Due Date):</td>
</tr>
<tr>
<td>Average Temperature (°C):</td>
<td>Average Temperature (°C):</td>
</tr>
<tr>
<td>Heating Process:</td>
<td>Heating Process:</td>
</tr>
<tr>
<td>Average Humidity (Range) (% RH):</td>
<td>Average Humidity (Range) (% RH):</td>
</tr>
<tr>
<td>Humidification Process:</td>
<td>Humidification Process:</td>
</tr>
</tbody>
</table>

- Chart or data (temperature and humidity) documenting at least one (1) cycle of this stage (include date(s))

#### Collection Rate (fill in table):

<table>
<thead>
<tr>
<th>Sample Cycle Period</th>
<th>Actual Number of Cycles</th>
<th>Collection Rate (mL/h/80 cm² per 8 h exposure)</th>
<th>Date of Collection</th>
<th>Moisture Visible on Samples (Yes/No)</th>
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<tbody>
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</tr>
</tbody>
</table>

#### Dry off Stage

<table>
<thead>
<tr>
<th>Cabinet Identification (Name/Number):</th>
<th>Cabinet Model:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabinet Manufacturer:</td>
<td>Cabinet Model:</td>
</tr>
<tr>
<td>Cabinet Serial Number:</td>
<td>Cabinet Model:</td>
</tr>
<tr>
<td>Cabinet Size:</td>
<td>Cabinet Capacity:</td>
</tr>
<tr>
<td>Last Calibration (Date):</td>
<td>Next Calibration (Due Date):</td>
</tr>
<tr>
<td>Ramp Time (Humidity to Dry off Stage):</td>
<td>Next Calibration (Due Date):</td>
</tr>
<tr>
<td>Average Temperature (°C):</td>
<td>Average Temperature (°C):</td>
</tr>
<tr>
<td>Heating Process:</td>
<td>Heating Process:</td>
</tr>
<tr>
<td>Average Humidity (Range) (% RH):</td>
<td>Average Humidity (Range) (% RH):</td>
</tr>
<tr>
<td>Dehumidification Process:</td>
<td>Dehumidification Process:</td>
</tr>
</tbody>
</table>

- Chart or data (temperature and humidity) documenting at least one (1) cycle of this stage (include date(s))

March 2013

Page 22 of 27
Appendix I: Skipped in this document.
### Appendix J: Test Solution Documentation Form

<table>
<thead>
<tr>
<th>Water Type (refer to ASTM D1193):</th>
<th></th>
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<tbody>
<tr>
<td>Volume of Batch liters or gallons (L or gal):</td>
<td></td>
</tr>
<tr>
<td>Sodium Chloride (NaCl) grams (g):</td>
<td></td>
</tr>
<tr>
<td>Sodium Bicarbonate (NaHCO3) grams (g):</td>
<td></td>
</tr>
<tr>
<td>Calcium Chloride (CaCl₂ X H₂O) grams (g):</td>
<td>X =</td>
</tr>
</tbody>
</table>

#### Test Solution Monitoring (fill in table for each test solution batch):

<table>
<thead>
<tr>
<th>Test Solution</th>
<th>Date of Initial Use</th>
<th>Initial pH</th>
<th>Initial Conductivity (µS at 25 °C)</th>
<th>Date of Last Use</th>
<th>Total Number of Test Cycles</th>
<th>Final pH</th>
<th>Final Conductivity (µS at 25 °C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Spray Pressure (units):</th>
<th>Spray Flow (units):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Deviations
The following procedure deviations are based on field knowledge combined with engineering judgment to enhance the test’s ability to predict field performance. Prior to making additional modifications or to assist in determining the appropriateness of one of the following options, contact GMNA Corrosion Engineering.

Deviations are generally made during the ambient stage to include additional test inputs such as dust applications, grit sprays, poultice applications, dynamic cycling, electrical cycling, thermal inputs, gravometer, exhaust condensate spray, and acid rain spray.

The test inputs associated with deviations apply only to the test parts. Mass loss coupons are test monitoring devices and should not be exposed to additional inputs that deviate from the base test cycle (refer to Table A1 or Table A2).

If corrosion rate monitoring is required to cover both the base test cycle and the deviation conditions, an additional set of coupons will be required and should see the same test conditions as the samples.

Option 1: Dust Application and Fresh Water Rinse Addition.
Modification to Ambient Stage:
Number of salt sprays per cycle as defined in Table A1.
- One (1) dust application every 5 cycles starting with the 1st cycle (dust should be applied immediately following the last daily salt spray application to test parts only) (refer to Appendix C for dust specification).
- One (1) fresh water rinse applied to test parts only and allowed to dry prior to the salt application on days when dust is applied.

A list of component examples for dust and fresh water rinse addition is provided below:
- Side Door Latches.
- Hood Latches (assume no weather seal protection).
- Door Cavity Hardware.

Note: Coupons only receive the salt sprays defined in Table A1 or Table A2. The dust application and fresh water rinse should only be applied to the test parts.

A list of component examples for dust addition is provided as follows:
- Door Hinges, Hood Hinges, Fuel Filler Door Hardware, Decklid Hinges (assume no weather seal protection), Door Detent (assume no weather seal protection), and Windshield Wiper System.

Test duration to evaluate functional corrosion is 70 cycles with a minimum mass loss of 10.5 g (applicable for test conditions that require four (4) salt sprays per cycle), 7.7 g (applicable for test conditions that require one (1) salt spray per cycle), or 4.2 g (applicable for test conditions that require one (1) salt spray per five (5) cycles).

Option 2: Air Conditioning Compressor Addition.
Modifications to Ambient Stage:
- One (1) salt spray every five (5) cycles starting with the 1st cycle – compressor running.
- One (1) grit spray every five (5) cycles starting with the 4th cycle – compressor static (refer to Appendix D for grit solution).
- Compressor run time of 1.5 h (cycling 12 s on and 3 s off).

Note: Coupons only receive the salt sprays defined in Option 2. The grit application should only be applied to the test parts.
Test duration to evaluate functional corrosion is 70 cycles with a minimum mass loss of 4.2 g.

**Option 3: Key Cylinder Addition.**

**Modification to Ambient Stage:**
- One (1) hose salt spray per cycle (approximately 10 s application, 1.9 cm (0.75 in) to 2.5 cm (1 in) hose, 22.7 L (6 gal) per minute supply).
- One (1) dust application (both sides of test sample in fixture) every five (5) cycles starting with the 1st cycle (dust should be applied immediately following the salt spray application) (refer to Appendix C for dust specification).
- One (1) fresh water rinse applied and allowed to dry prior to the salt application on days when dust is applied.

**Note:** Coupons only receive the salt spray defined in Option 3. The dust application and fresh water rinse should only be applied to the test parts.

Test duration to evaluate functional corrosion is 70 cycles with a minimum mass loss of 7.7 g.

**Option 4: Thermal Soak Addition.**

**Modification to Ambient Stage:**
Oven Soak (number of hours) followed by 25 °C ± 3 °C, 45% ± 10% RH (number of hours).

**Note:** When thermal soak is 4 h in duration and four (4) sprays per cycle are required, perform 1st and 2nd salt spray prior to oven soak with remaining two (2) salt sprays spaced 1 h apart. When thermal soak is 2 h in duration and four (4) sprays per cycles are required, perform 1st salt spray prior to oven soak with remaining three (3) salt sprays spaced 1 h apart. When thermal soak is used in conjunction with a test that specifies one (1) salt spray per cycle or one (1) salt spray per five (5) cycles, then that salt spray shall occur prior to oven soak.

A list of component examples for thermal soak addition is provided below:
- Transmission Oil Cooler Line: 121 °C ± 2 °C (2 h).
- Muffler and Tailpipe: 204 °C to 260 °C (4 h).
- Exhaust Manifold, Flex Coupling: 482 °C ± 2 °C (4 h).

**Note:** Coupons only receive the salt spray defined in Table A1 or Table A2. The thermal soak should only be applied to the test parts.

Test duration to evaluate functional corrosion is 70 cycles with a minimum mass loss of 10.5 g (applicable for test conditions that require four (4) salt sprays per cycle), 7.7 g (applicable for test conditions that require one (1) salt spray per cycle), or 4.2 g (applicable for test conditions that require one (1) salt spray per five (5) cycles).

**Option 5: Exhaust Condensate Addition.**

**Modification to Ambient Stage:**
- Three (3) salt sprays per cycle spaced 1.5 h apart (for test parts and four (4) salt sprays for coupons).
- One (1) exhaust condensate spray 1.5 h after last salt spray (for test parts only; refer to Table F1 Exhaust Condensate).
A component example for exhaust condensate addition is provided below:

- Rear Bumper and Exhaust Tip.

**Note:** Coupons should receive the salt sprays defined in Table A1 or Table A2. The exhaust condensate should only be applied to the test parts.

Test duration to evaluate functional corrosion is 70 cycles with a minimum mass loss of 10.5 g.

Additional options can be customized to specific components or subsystems to increase the ability to conduct validation or development testing. General guidelines defined in Table A1 may be used as a building block for customizing a test. Prior to making additional modifications or to assist in determining the appropriateness of one of the options, contact GMNA Corrosion Engineering.