



Evaluation of Condensation on Interior Components

1 Introduction

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. Condensation will form on the outside of the Heating Ventilation and Air Conditioning (HVAC) Module, related air ducts, portions of the Instrument Panel (IP) and/or the floor console (if applicable) when operated in hot humid environmental conditions. This procedure can be used to observe/re-create customer satisfaction concerns. This test procedure is not inclusive of all situations that cause condensation to form on HVAC components. The only certainty is that condensate will form on components when the surface temperature is below the dew point of the surrounding air. The quantity of condensation generated is determined by many factors and too numerous to cite in this document.

1.2 Applicability. All vehicles with Air Conditioning (A/C) systems. This procedure should not be used as a definitive pass/fail criteria for condensation handling. This procedure recreates a rare user profile and will generate a significant amount of condensation. The duration of this procedure is 2 h, but even more condensation will be created if the duration of the test is extended.

1.3 Remarks. Condensate formed outside HVAC module, HVAC ducts, HVAC outlets, or the IP can drip on top of or enter other components producing improper function or undesirable damp conditions. Condensate may also drip onto passengers' lower legs or feet unexpectedly, dissatisfying the occupant.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3055 GMW15845

2.3 Additional References.

- Vehicle Technical Specifications (VTS)

3 Resources

3.1 Facilities. Climatic wind tunnel or test chamber with the possibility to create an ambient temperature of +32 °C minimum and a relative humidity (RH) of 85% minimum.

Note: If the condensate pattern found during climatic tunnel evaluation is judged to be influenced by dynamic vehicle maneuvers such as vehicle turning or braking, then reference GMW3055: Parking Area Analysis with U-turns. Simply run Test II as described in 4.1.2 prior to beginning the Parking Area Analysis with U-turns. Deviate from GMW3055 by leaving the windows open and HVAC mode and temperature settings as stated within this test specification for Test II.

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. See GMW15845 regarding detailed instrumentation guidance.

3.2.1 Temperature measuring and recording equipment are listed and outlined in Appendix B, Table B1.

3.2.2 Pressure measuring and recording equipment for listed measurements are outlined in Appendix B, Table B1.

3.2.3 Measuring and recording equipment for listed measurements are outlined in Appendix B, Table B1.

3.2.4 Measuring and recording equipment for relative humidity as outlined in Appendix B, Table B1.

3.2.5 Device for operation and adjustment of accelerator pedal.

3.2.6 External blower for engine coolant stabilization (if necessary).

3.2.7 A kraft paper mat for each foot well to record condensate dripping onto the vehicle floor. This paper should be replaced with a dry kraft paper mat for each test.

3.2.8 Equipment for viewing the condensate formation on components (flashlight, mirror, camera, etc.)

3.3 Test Vehicle/Test Piece. This procedure applies to front and rear air conditioning modules installed in a vehicle. The HVAC module's evaporator cannot have any instrumentation on or near the evaporator surface such as a thermocouple grid, thermocouples, etc.

HVAC modules and ducts made from plastic (polypropylene and polyethylene) are best suited for this test procedure. Parts from rapid prototyping and Three Dimensional (3D) printing will not exhibit the same level of exterior condensation generation due to their material properties. HVAC modules made with rapid prototyping material can be used to understand condensate handling within the module, but test results may be misleading with respect to seam/joint integrity.

3.4 Test Time. 150 minutes. See 4.3.1.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. One climatic tunnel or test chamber operator.

4 Procedure

4.1 Preparation. The vehicle shall be prepared for the test facility and shall be equipped with devices according to 3.2 and 4.3.2.

4.1.1 Test I. Remove parts which obstruct the visibility of the HVAC module and related ducts.

Note: Removal of hush panels, glove boxes or other interior parts (to improve the visibility of the HVAC module) will enhance the air circulation around the cold interior components causing two effects:

- Increase the available moisture for condensation formation and,
- Warming the ducts which may reduce condensation.

For these reasons, Test II is essential to pass judgment on system performance.

4.1.2 Test II. All Interior trim parts such as the IP, hush panel, glove box and floor console (if applicable) shall remain in the original position.

For Test I and Test II, if the heater system is equipped with a coolant shut off valve (water valve), the valve shall be closed during the test.

4.2 Conditions.

4.2.1 Environmental Conditions.

Temperature : +32 °C minimum

Relative Humidity (RH) : 85% minimum

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.

4.2.2.1 Engine. Idling at a speed of 1500 rpm $\pm$ 200 rpm in test chamber or equivalent road speed in climatic tunnel with appropriate wind speed.

4.2.2.2 HVAC Control Setting.

4.2.2.2.1 Fixed Roof Vehicles. Maximum cold, vent mode, Production Recirculation Mode (P/R), minimum blower speed.

4.2.2.2.2 Open Roof Vehicles. Shall be tested in three configurations:

- Roof Closed:** Maximum cold, vent mode, Production Recirculation Mode (P/R), minimum blower speed.

b. **Roof Open:** Maximum cold, heater mode, Production Recirculation Mode (P/R), minimum blower speed.

c. **Roof Open:** Maximum cold, vent mode, Production Recirculation Mode (P/R), minimum blower speed.

4.2.2.3 Side Windows. Side windows shall be open unless fixed in position.

4.2.2.4 Open Roof Vehicles. Vehicles shall be tested in both roof closed and roof open configurations according to 4.2.2.2.

4.3 Instructions.

4.3.1 Measurement Program.

4.3.1.1 Test I. For two (2) hours the vehicle shall be operated under the conditions described in 4.2. After the test, a visual inspection shall take place and the condensation on all interior parts and dripping spots shall be documented and photographed.

4.3.1.2 Test II. For two (2) hours the vehicle shall be operated under the conditions described in 4.2. After the test, a visual inspection shall take place using the knowledge of dripping events determined in Test I. Condensation on all electronic components in the IP, drips on paper floor mats, and drips on the floor console surfaces shall be documented and photographed.

4.3.1.3 When significant areas of condensate dripping or patterns of condensate are observed, judgment by evaluation of dynamic road testing may be conducted to determine if the condensate formed will drip onto vulnerable components or onto vehicle occupants during dynamic maneuvers such as left or right hand turns, heavy braking or rapid acceleration. Obtain ambient conditions that are defined in 3.1.

4.3.2 Measuring Values and Data to be Recorded. Instrumentation shall follow methods as described in GMW15845. Data capture rate shall be 1 Hz or faster.

4.3.2.1 Temperatures in °C.

- Ambient.
- IP center outlet.
- Rear A/C outlets (rear systems only).
- Engine coolant.

4.3.2.2 Pressure in kPa.

- Low side pressure at service port.
- High side pressure at service port.

4.3.2.3 Further Specific Measuring Values.

- Engine speed in rpm.
- Relative humidity in %.

4.3.2.4 Further Data.

- Vehicle mileage and description of the system to be validated.
- Test number and date.
- Name of the person in charge of the test.
- List of calibrated test equipment.
- Photographs and descriptions of all condensate drip points.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. Condensate formed outside HVAC module, HVAC ducts, HVAC outlets, or the IP can drip on top of or enter other components producing improper function or undesirable damp conditions. Condensate may also drip onto passengers' lower legs or feet unexpectedly, dissatisfying the occupant.

5.3 Test Documentation. With reference to this standard, the results of the test shall be presented in a test report which includes the raw data formatted as shown on Data Sheet A1 in Appendix A.