



Defogging System Maximum Performance Validation of Windshield, Side Windows and Backlight

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. The purpose of this standard is the validation of the performance capability of a defogging system for the windshield, side windows, and the performance of the electrically heated backlight.

1.2 Foreword. Not applicable.

1.3 Applicability. The applicability for this standard is for all passenger vehicle defroster systems and electrically heated backlights.

2 References

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

2.1 External Standards/Specifications.

EU 672/2010

FMVSS 103

FMVSS 104

UN R 43 Annex 18

2.2 GM Standards/Specifications.

GMW15845

2.3 Additional References.

Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities.

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.

3.1.3 Climatic wind tunnel including an adjustable chassis dynamometer.

3.1.4 Capability for a vehicle speed of 100 km/h minimum, a wind speed of 100 km/h minimum, and an ambient temperature of -20 °C minimum.

3.2 Equipment.

3.2.1 Data measuring and recording equipment capable of measuring data described in Appendix C, Table C1, Table C2, Table C3, and Table C4.

3.2.2 Device for operation and adjustment of accelerator pedal to accelerate and maintain vehicle speed.

3.2.3 Battery Charger to maintain battery during cold soak (see 4.2.2.1).

3.2.4 Vapor generator with water capacity adequate for generating $\geq (70 \pm 5)$ g/h water vapor per occupant seating position for ≥ 40 minutes. Vapor generator should be calibrated once per year at a minimum.

3.2.5 Timing device with stopwatch functions.

3.2.6 Means of recording cleared glass area for all tests (Sharpie (a permanent felt-tip marker), camera, etc.)

3.2.7 Degrease window (s) using Klean Strip (a denatured alcohol).

3.2.8 Clean the window(s) using Windex Original (a glass cleaner).

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3.3 Test Vehicle/Test Piece. Test passenger vehicle with defroster systems and electrically heated backlights.

3.4 Test Time.

Calendar time: 1 days

Test time: 4 h

Coordination time: 8 h

3.5 Test Required Information. Blower setting, HVAC mode selection and time of mode change are to be recorded.

3.6 Personnel/Skills. Provide one climate tunnel operator and one in-vehicle observer. For the purpose of consistent and repeatable results, a robot should be used for vehicle acceleration and speed control. If a robot is not available it is acceptable to have a human driver.

4 Procedure

4.1 Preparation. The vehicle shall be prepared for the climatic tunnel and shall be equipped with devices according to 3.2. Instrumentation installed per GMW15845. Instrumentation channels required to be monitored during this test are defined in Appendix C, Table C1, Table C2, Table C3, and Table C4.

4.1.1 Engine Oil, Coolant and Fuel. Ensure that test vehicle contains fluids as released that are appropriate for the test ambient temperature. Winter grade fuel or others fluids may impact the ability for proper engine ignition.

4.1.2 Tire Pressure. Tires to be inflated to the maximum rated pressure.

4.1.3 Battery State of Charge. The vehicles low voltage battery should be of good health with state of charge > 60% prior to start of test. For applicable vehicles with a propulsion or propulsion assist battery, the maximum state of charge should be achieved prior to start of test.

4.1.4 Cleaning of the Windows. The inner surfaces of all vehicle glass (including backlight) shall be completely degreased with Klean Strip (a denatured alcohol). After degreasing agent is completely dry, clean the glass with Windex Original (a glass cleaner). The surface treated in this manner shall be allowed to dry and then wiped with a dry cotton cloth.

4.1.5 Heating, Ventilation and Air Conditioning (HVAC) Settings. Initially the vehicle ventilation system controls shall be set to full hot, Production Outside-Air (P/OSA) and defrost mode with blower set to 75% ($\pm 5\%$) of maximum blower. Vehicles with a rear HVAC system are to have the rear blower turned off during the entirety of this test.

4.1.5.1 The HVAC settings will change during the test at the 10 minute point after engine start. Mode will be changed from defrost to floor. Blower will be reduced from 75% of maximum to 50% ($\pm 5\%$). These blower settings must be defined prior to start of test by the responsible development engineer.

4.1.5.2 Outboard panel outlets to remain in open position with airflow aimed parallel to respective side glass at the height of the occupant shoulder. Inboard panel outlets to remain open and aimed respectively to driver and passenger shoulder area.

4.2 Conditions.

4.2.1 Environmental Conditions.

- Ambient temperature: $(-10 \pm 1)^\circ\text{C}$
- Relative Humidity: $\geq 70\%$
- Accelerated soak: 5°C below test temperature. See 4.2.2.1.1 for detailed instructions

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon with the program thermal lead development engineer and windshield clearing vehicle performance owner. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.2.2.1 Soak. It shall be ensured that the entire vehicle is at a stable temperature which is in the range of $\pm 1^\circ\text{C}$ of the test temperature prior to start of test. Temperatures of the vehicle's coolant, engine oil, and transmission oil should be monitored during the soak. A battery charger is to be applied to the vehicle's low voltage battery during the soak condition.

4.2.2.1.1 Accelerated Soak has a cycle time of (1.5 to 3) h, with procedure as follows. Open all passenger doors. Sand bags should be applied to door hinge area to keep door open through the duration of the soak. Set chamber

temperature to -15 °C and wind speed to 80 km/h. Once engine oil sump temperature reaches -11.5 °C bring the tunnel temperature back to -11 °C and lower wind speed to 15 km/h. Engine oil temperature will increase to -10 °C. Once this occurs, bring tunnel temperature back to -10 °C. Monitor coolant, engine oil, and transmission oil temperatures. When all three are within ± 1 °C of test temperature, the schedule should be started.

4.2.2.2 Defogging Conditions. Vehicle and wind speeds as specified in the measurement program (see Table 1).

4.2.2.3 Electrical Power Supply. Power for all electric driven vehicle components is to be supplied by the vehicle's integrated power supply. Headlights (low beam), backlight defogging system and heated seats (if standard equipment) are switched on (heated seats to maximum performance). If a time out occurs on either the backlight defogging system or heated seats, they are to be turned back on for the duration of the test. External power supplies should be used for the steam generator, vehicle instrumentation, and the accelerator pedal robot.

4.2.2.4 Dynamometer Load. Dynamometer loading is to be set to road load at a vehicle mass of curb weight plus the driver. The acceleration and deceleration rate is shown in Table 1.

4.2.2.5 Gear Steps or Drive Positions. The transmission gear should be Drive for an Automatic Transmission (AT) or the highest possible gear that can maintain the specified vehicle speed for manual transmissions. If excessive gear shifting is required to maintain vehicle speed, the lower transmission gear should be manually selected. Excessively is defined as more than four downshifts/upshifts in 1 km. For manual transmissions, if two gears are possible selections from a typical driver, the more probable gear should be selected.

4.2.2.5.1 The specified dynamometer speeds are driven at road load (on level stretches without acceleration).

4.2.2.5.2 For repeat measurements on vehicles with automatic transmissions, it shall be ensured that same dynamometer speeds are driven at the same lowest engine speeds.

4.2.2.5.3 For manual transmissions, gears shall be changed as follows.

- Shifts at $(3000 \pm 200) \text{ min}^{-1}$ ($(3000 \pm 200) \text{ rpm}$).

4.3 Instructions.

4.3.1 Measuring Values and Data to Record. All data (See Appendix C, Table C1, Table C2, Table C3, and Table C4) shall be recorded at 1 s intervals.

4.3.2 Measuring Program.

Table 1: Windshield and Side Window Defogging/Backlight Defogging

	Temperature	HVAC	Vehicle Speed	Wind Speed	Steam Generator	Duration
1 Soak	-10 °C ^{Note 1}	Blower Off	0 km/h	15 km/h	Prepare and Heat ^{Note 2}	Per 4.2.2.1
2 Fog	-10 °C	Blower Off	0 km/h	< 5 km/h	70 g/h per occupant rating	10 minutes
3 Defog	-10 °C	Full Hot Temperature, Defrost Mode, 75% of Maximum Blower Speed	40 km/h ^{Note 3}	40 km/h	Reduce steam ^{Note 4}	10 minutes
4 Refog	-10 °C	Floor mode, 50% of Maximum Blower speed, Temperature Control to Maintain Breath Level Temperature Between (20 and 24) °C	100 km/h	100 km/h	No change	30 minutes

Note 1: Reference 4.2.2.1.1 for accelerated soak instructions with reduce ambient and increased wind speed.

Note 2: Reference 4.3.3 for steam generator heating instructions.

Note 3: Accelerate vehicle at 3.0 km/h/s until vehicle speed target is reached, then adjust throttle to maintain test speed.

Note 4: Reduce the steam load 70 g/h per the number of occupants riding in test vehicle.

4.3.3 Water Vapor Generation. Proper time should be allotted to adequately heat the vapor generator to the appropriate temperature per instruction and calibration information during the soak portion of this test procedure. Start the vapor generator in the control room with maximum power. When water temp is equal to 90°C move the vapor generator to the test section. Wait 5 minutes, when water temperature is above 98°C switch to max passenger seating level. The hood shall be closed and water vapor shall be generated in the passenger compartment for 10 minutes. The amount of water vapor shall be (70 ± 5) g/h for each passenger seating location. The water vapor generator shall be placed along the centerline of the vehicle, in the center of the vehicle passenger compartment (see Appendix A, Figure A1).

4.3.4 Windshield and Side Window Defogging. After 10 minutes of vapor generation, the observers shall enter the vehicle. When entering the vehicle careful attention should be paid to limit the amount of time the door is open so that cabin humidity is maintained. The door should be closed at a moderate pace, not slammed shut which will push humid air out of the cabin. The water vapor generator output shall be reduced by (70 ± 5) g/h per each observer in the vehicle. Immediately afterwards the engine shall be started ($t = 0$ minutes) and the initial defogging procedure shall be performed at a vehicle and wind speed of 40 km/h.

4.3.4.1 At the commencement of the test, the compartment blower is set to 75% of maximum. The headlights (low beam), the backlight defogging system and the heated seats (if standard equipment) are switched on.

4.3.4.2 The defogged areas of the windshield and the side windows shall be marked by the observers at 2 minute intervals until time $t = 10$ minutes. After $t = 10$ minutes, windshield and side window patterns are to be marked at 5 minute intervals until $t = 40$ minutes.

4.3.4.3 At time $t = 10$ minutes, the system shall be switched to floor and HVAC blower to 50% of maximum. The breath level temperature shall be maintained between $(20 \text{ and } 22)^\circ\text{C}$, by modulating the temperature control. If a time out occurs on either the backlight defogging system or heated seats, they are to be turned back on for the duration of the test.

Note: At: $t = 40$ minutes, the test is terminated.

4.3.5 Backlight Defogging. This test may be run individually or concurrent with the procedure defined in 4.3.4. Both procedure utilize the same test condition outlined in Table 1. After 10 minutes of vapor generation, the observers shall enter the vehicle and the water vapor generator output shall be reduced by (70 ± 5) g/h per each observer in the vehicle. Immediately afterwards the engine shall be started ($t = 0$ minutes) and the defogging procedure shall be performed at a vehicle and wind speed of 40 km/h for the first 10 minutes and 100 km/h for the remaining test cycle.

4.3.5.1 The compartment blower is set to 75% of maximum. The headlights (low beam), the backlight defogging system and the heated seats (if standard equipment) are switched on. The defogged areas of the backlight shall be photographed by the observer(s) at intervals of five (5) minutes or less.

4.3.5.2 At time $t = 10$ minutes, the system shall be switched to floor and HVAC blower to 50% of maximum. The breath level temperature shall be maintained between $(20 \text{ and } 22)^\circ\text{C}$, by modulating the temperature control. If a time out occurs on either the backlight defogging system or heated seats, they are to be turned back on for the duration of the test.

Note: At: $t = 20$ minutes, the test is terminated.

Note: The steps per 4.3.4 and 4.3.5 may be performed at the same time, if possible.

4.3.6 Measuring Values and Data to Record. All data (See Appendix C, Table C1, Table C2, Table C3, and Table C4) shall be recorded at 1 s intervals.

4.3.6.1 Defogged Areas. At the completion of the test the defogged areas shall be determined.

4.3.6.2 Further Data.

- Vehicle Data, Mileage, Engine/Transmission calibration and Description of the System to Validate
- Test Number and Date
- Name of the Observer(s) and the Person in Charge of the Test
- List of Calibrated Test Equipment

5 Data

5.1 Calculations. The defogged areas shall be calculated according to the windshield areas defined in Appendix B.

There are three methods employed to calculate the area cleared vs. time.

5.1.1 Method One (1): Calculating Areas Cleared or Refogged; Using the Computer Aided Drawing (CAD) System.

5.1.1.1 Transfer the defrosted pattern from the vehicle windshield to tracing paper.

5.1.1.2 Scan the traced lines from the tracing paper to Math CAD using a two dimensional stylus.

5.1.1.3 Using a CAD system, overlay a windshield critical area template with the test result file and calculate areas cleared using the built-in functions in the CAD system. (This requires a template of the windshield areas to be generated in Math data and saved as a template).

5.1.2 Method 2: Calculating Areas Cleared or Refogged; Using Mass of Tracing Paper.

5.1.2.1 Transfer the defrosted pattern from the vehicle windshield to tracing paper.

5.1.2.2 Transfer the windshield critical area template onto the tracing paper containing the defroster patterns.

5.1.2.3 Cut out the driver's side clearing area template (Critical Vision Area (CVA) per Appendix B, B1), and the windshield clearing area template and weigh using a calibrated scale with an accuracy of ± 0.01 g.

5.1.2.4 Cut out the defrosted areas at the times set out in the VTS and weigh to determine mass of cleared areas.

5.1.2.5 Calculate percentage of the areas cleared using the mass of the entire template area and the defrosted areas.

5.1.3 Method 3: Calculating Areas Cleared or Refogged; Using Planimeter.

5.1.3.1 Follow the instrument manufacturer's instructions for proper usage to determine areas.

5.2 Interpretation of Results. The targets are defined by the VTS.

5.3 Test Documentation. With reference to this test procedure the results of the measurements shall be presented in a test report.

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

7 Notes

7.1 Glossary.

Defog: HVAC mode whereby airflow is directed towards both the foot and windshield, also referred to as blend mode.

Defogging: With the engine running, the output of the vapor generator shall be reduced according to the number of persons sitting in the passenger compartment; the defogging procedure shall be performed at a defined vehicle and wind speed.

Soak: Allow vehicle to cool down with hood open.

Water Vapor Generation: With the hood closed, the vehicle passenger compartment shall be fogged up with water vapor using a vapor generator. The quantity of water vapor depends on the number of seats.

7.2 Acronyms, Abbreviations, and Symbols.

°C	Degree Celsius
A	Ampere
AT	Automatic Transmission
CAD	Computer Aided Drawing

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