



Defrosting Performance Validation after Snow Ingestion for Passenger Vehicles

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. To validate the performance of the vehicle defroster system to defrost the interior surface of the windshield when influenced by snow ingestion with and without a heating, ventilating, and/or air conditioning (HVAC) filler (if part of the originally equipped HVAC system). See Figure 1 in 1.3.

1.2 Applicability. For all passenger vehicle defroster systems with and without filter(s).

1.3 Remarks.



Figure 1: Example of Pickup with Snow on Hood and Cowl

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3043	GMW3067	GMW16661
GMW3058	GMW15259	

2.3 Additional References.

- Letraset Ltd. (www.letraset.com)
- Ratnik Industries, Ltd., Victor, NY. (www.ratnik.com or equivalent)
- Test report.
- VTS.

3 Resources

3.1 Facilities. Climatic wind tunnel including a chassis dynamometer with adjusting possibilities for wind speed (to 100 km/h) and ambient temperature ($\leq -20\text{ }^{\circ}\text{C}$). An ability to manufacturing a consistent dry, fluffy, flaky dust type of snow where snow will not packed into a snow ball (it will fall apart) and remains as a powder with a density of $\approx 50\text{ kg/m}^3$ (Appendix B suggests an alternate method to manufacture snow, store it outside of the tunnel, and to add the snow onto the vehicle if needed).

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 Temperature measuring and recording equipment for at least four (4) measuring points.

3.2.2 Equipment to measure, record, and supply power for voltage (0 to 15) V Direct Current and current (0 to 30) A for passenger compartment blower(s) and battery(s).

3.2.3 Measuring and recording equipment for the engine speed.

3.2.4 Engine Oil/Coolant. As released for the engine at the test temperature.

3.2.5 Timing device with stopwatch functions.

3.2.6 Snow guns for making snow

3.2.7 Snow leveling device (see Figure 2).

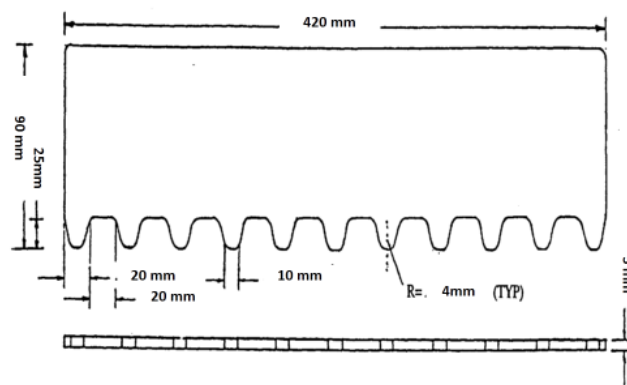


Figure 2: Snow Leveling Device ($\approx$ (3 to 5) mm Acrylic Sheet)

3.2.8 Methyl alcohol or equivalent degreasing agent.

3.2.9 Window cleaning agent (3% to 5% ammonia or equivalent).

3.2.10 Adhesive backed tape (white 3 mm width Letraset Letraline Number 1925 or equivalent).

3.2.11 Lamp to provide the in-vehicle observer with backlighting of the windshield (not to affect wind flow pattern).

3.2.12 Weight measuring equipment to measure the weight of the HVAC filter in grams with an accuracy $\pm 5\%$ and the snow density (3.1) using a box of known volume. Density = weight of snow/volume of the box.

3.2.13 Body cabin pressure measurement with recording equipment (so as to estimate outside air defrost airflow of any major change with a known body airflow leakage airflow curve, GMW3067).

3.3 Test Vehicle/Test Piece. Vehicle equipped with defroster systems with and without filter(s).

3.4 Test Time.

Calendar time: 1 days

Test time: 4 h (2 h increments thereafter if repeating 4.3.1)

Coordination time: 4 h

3.5 Test Required Information. Subjective rating scale according to Appendix C.

3.6 Personnel/Skills. One (1) climatic tunnel operator, one driver.

4 Procedure

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

4.1.1 Fuel. Winter fuel shall be used for all engine applications.

4.1.2 Settings. The vehicle ventilation system controls shall be set to **Full Hot, Heater Mode, Outside Air (OSA)**, and the blower switch set as specified in Table 2 and Table 3. The blower is to be hooked up to an external blower supply for the filter snow catching part of this procedure and to vehicle power during the engine on defog/de-ice part of this procedure. The mode and blower(s) switch position will vary during the test.

The center face outlets shall remain closed and the outboard face vents shall be aimed as much as possible at the center of the mirror patch on the front side windows. This setup is performed regardless of the vehicle having dedicated Side Window Defogger (SWD) Outlets.

4.1.3 Cleaning of the Windows. The inner surfaces of the windows shall be completely degreased with methyl alcohol or an equivalent degreasing agent. After drying, an ammonia solution of (3 to 5)% shall be applied. The surface treated in this manner shall be allowed to dry and then wiped with a dry cotton cloth.

4.1.4 Functional Operation of the System. The functional operation of all switches, controls, blower motor, and fan shall be verified before the test.

4.1.5 Cleaning of the Vehicle. The test vehicle exterior shall be clean. Do not shine or wax the hood.

4.1.6 Windshield Grid Lines. Tape grid lines on windshield exterior in an evenly spaced pattern three (3) squares high and six (6) squares wide (see Data Sheet A1).

4.1.7 Plenum Condition. Check the cowl plenum and air inlet to ensure there is no snow and/or obstructions (especially when repeating this test after any vehicle changes). Any wetness shall be eliminated prior to running test. The snow from any previous testing is to be removed.

4.1.8 Windshield Area Markings. The critical driver view area shall be marked on the glass interior as per the description of areas in Figure C1 in Appendix C.

4.2 Conditions.

4.2.1 Environmental Conditions. Ambient temperature: $(-20 \pm 1) ^\circ\text{C}$.

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 Vehicle and Wind Speeds. Vehicle and wind speeds as specified in the tunnel schedule (see 4.3.1).

4.2.2.2 Electrical Power Supply. All electrical systems are supplied by the internal vehicle power supply.

4.2.2.3 Dynamometer Load. Dynamometer loading to be set to road load at a vehicle mass of curb weight plus driver. Gear Steps/Drive Positions are given by Table 1.

Table 1: Gear Steps or Drive Positions

Transmission	Speed	
	40 km/h	Idle
MT4	3	Neutral
MT5 WR ^{Note 1}	3	Neutral
MT5 CR ^{Note 2}	3	Neutral
MT6	3	Neutral
AT	Highest Drive Gear	Neutral

Note 1: 5th gear = Overdrive.

Note 2: 5th gear = 1:1 gear ratio.

AT Automatic Transmission

CR Close Ratio

MT Manual Transmission

WR Wide Ratio

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

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

4.3 Instructions.

4.3.1 Climatic Tunnel Schedule. See Table 2 for testing to see how much snow can be collected. See Table 3 to see the effect on Defroster performance (either by airflow restriction, caused by significant amounts of snow being collected on the filter, or by snow being collected inside the HVAC module without a filter).

Table 2: Climatic Tunnel Schedule for Weighing the Snow Ingested

Action	Tunnel Temperature and Humidity	HVAC	Vehicle Condition	Wind Speed	Duration
1. Install snow guns and prepare vehicle with external power supply to blower; see 3.2.2 and 4.3.3.1 for zero body airflow voltage	> 0 °C	Vent, Full cold, Full blower, Out Side Air	0 km/h	0 km/h	30 minutes (to dry out plenum and filter if needed)
2. Weigh filter and reinstall	> 0 °C	Blower Off	0 km/h	0 km/h	< 5 minutes
3. Cold soak vehicle (permissible to run in separate cold chamber to speed testing); see 4.3.3.1	≤ -20 °C and < 70%	Blower Off	0 km/h	30 km/h	Soak vehicle until engine oil reaches < -18 °C
4. Make snow to produce 25 mm of snow on hood and horizontal vehicle surfaces; rake the snow with the 3.2.7 snow leveling device; brush snow off the windshield to side and avoid pushing any into the cowl area; see 4.3.3.1	≤ -20 °C and < 70%	Blower Off	0 km/h	30 km/h	(30 to 60) minutes
5. Start blower and begin test.	≤ -20 °C and < 70%	Defrost, Full hot, Full blower, Out Side Air	Engine off	0 km/h	2 minutes
6. Test	≤ -20 °C and < 70%	Full Hot (F/H), Defrost, FS maximum	Engine off	10 km/h	2 minutes
7. Test	≤ -20 °C and < 70%	F/H, Defrost, FS maximum	Engine off	20 km/h	2 minutes
8. Test	≤ -20 °C and < 70%	F/H, Defrost, FS maximum	Engine off	80 km/h	2 minutes
9. Test	≤ -20 °C and < 70%	F/H, Defrost, FS maximum	Engine off	100 km/h	2 minutes
10. Turn blower off and weight Filter	≤ -20 °C and < 70%	Blower Off	Engine off	0 km/h	< 1 minute

FS Functional Step

Table 3: Climatic Tunnel Schedule for Visibility Evaluation

Action	Tunnel Temperature and Humidity	HVAC	Vehicle/ Dynamometer Speed	Wind Speed	Duration
1. Install snow guns and prepare vehicle; see 4.3.3.1	> 0 °C	Vent, Full cold, Full blower, Out Side Air	0 km/h	0 km/h	30 minutes (to dry out plenum and filter if needed)
2. Remove filter	> 0 °C	Blower Off	0 km/h	0 km/h	5 minutes<
3. Cold soak vehicle; see 4.3.3.1	-20 °C and < 70%	Blower Off	0 km/h	30 km/h	Soak vehicle until engine oil reaches - 20 °C
4. Make snow to produce 25mm of snow on hood and horizontal vehicle surfaces; rake the snow with the 3.2.7 snow leveling device; Brush snow off the windshield to side and avoid pushing any into the cowl area; see 4.3.3.1	-20 °C and < 70%	Blower Off	0 km/h	-5 km/h	(30 to 60) minutes
5. Start vehicle and begin test; See 4.3.3.2	-20 °C and < 70%	Heater, Full hot, Low blower, Out Side Air	Idle	10 km/h	30 s
6. See 4.3.3.2, mark frost/fog line in Critical Viewing Area (CVA) on windshield, and record data (Appendix A); see Figure C2 Effect of Icing Due to Breath	-20 °C and < 70%	Heater, Full hot, Low blower, Out Side Air	40 km/h	20 km/h	Until critical area reaches 80% clear with 20% being covered with a medium breath fog/frost (Appendix C) or heater water temperature reaches 35 °C
7. See 4.3.3.2 (turn on any supplemental heat if base equipment and manually operated)	-20 °C and < 70%	Defrost, Full hot, Full blower, Out Side Air	40 km/h	20 km/h	30 s
8. See 4.3.3.2 and record data (Appendix A); see Figure C3 Sudden Fogging Due to Snow Contacting Heater Core	-20 °C and < 70%	Defrost, Full hot, Full blower, Out Side Air	80 km/h	80 km/h	Sooner of: 20 minutes after breakthrough or 90% of total windshield vision is clear
9. Turn engine off and record data (Appendix A)	-20 °C and < 70%	Blower Off	Engine off	0 km/h	10 minutes <

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