



Validation of HVAC Airflow at Zero Interior Body Pressure

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. Determine statically the total airflow available from the Heating, Ventilation, Air Conditioning (HVAC) system, as installed in a vehicle under various operating modes. The vehicle interior itself is used as the collection chamber in order to collect and measure air from the HVAC system. This is accomplished by extracting air out of the vehicle interior by an external blower in order to maintain a zero body pressure with the HVAC system in outside air blowing air into the interior.

1.2 Applicability. For all passenger vehicles with HVAC systems that blow outside air into the vehicle.

1.3 Remarks. Not applicable.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15845

GMW17625

2.3 Additional References.

- Subsystem Technical Specification (SSTS).
- Vehicle Technical Specification (VTS).

3 Resources

3.1 Facilities. Any area able to contain the vehicle to be tested and the necessary test equipment. A still air room is desirable.

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 Regulated power supply capable of ≥ 18 V and ≥ 40 A.

3.2.2 One laboratory voltmeter capable of measuring (0 to 20) V.

3.2.3 One laboratory ammeter capable of measuring (0 to 50) A.

3.2.4 One laboratory tachometer capable of measuring (0 to 5000) rpm.

3.2.5 One laboratory temperature measuring instrument capable of measuring (0 to +50) °C.

3.2.6 One laboratory pump for vacuum operated HVAC systems mode selection (not required for most HVAC systems). System vacuum level shall be maintained at 50 kPa minimum.

3.2.7 One laboratory pressure measurement device capable of measuring ± 200 Pa body pressure.

3.2.8 One laboratory pressure measurement device capable of measuring ± 1250 Pa for HVAC module pressure.

3.2.9 One laboratory pressure measurement device capable of measuring (0 to 110) kPa atmospheric pressure.

3.2.10 One airflow measurement device capable of measuring and producing ≥ 215 L/s.

3.2.11 Flexible tubing with diameters of: 100 mm minimum for airflow equipment and 7 mm minimum for pressure measurement.

3.2.12 Interior pressure tap (suggested design shown in GMW15845) for measuring interior body pressure.

3.2.13 HVAC module pressure tap (suggested design shown in GMW15845) for measuring HVAC module case pressure (location shall be documented on Data Sheet B1 in Appendix B).

Note: For manual systems, this pressure tap is only necessary for dynamic and recirculation airflow measurement according to GMW15845. For Brushless Direct Current (BLDC) blower motors, the Development Engineer is to create a case pressure vs. Pulse Width Modulation (PWM) output to correctly select the required airflow for heater tests and defrost tests.

3.2.14 A cardboard side window insert shall be made with openings for the flexible tubes noted in 3.2.7 through 3.2.13 and all necessary wiring to the HVAC module.

3.3 Test Vehicle/Test Piece. Passenger vehicle with HVAC system.

3.4 Test Time. Sixty (60) minutes per HVAC operation mode to be tested.

Calendar time: 1 day

Test hours: 4 h

Coordination hours: 4 h

3.5 Test Required Information. Vehicle Technical Specification and/or list of modes to be tested.

3.6 Personnel/Skills. One technician.

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 Power supply, voltmeter, ammeter and tachometer shall be connected to the compartment blower motor. For vehicles with BLDCs and integrated PWM controllers, the appropriate computer equipment shall be utilized to change the blower speed.

4.1.2 One of the vehicle front windows shall be opened, a cardboard window insert shall be made and sealed into the window opening. The hood is to be closed during testing to account for any cowl pressure restriction.

4.1.3 A flexible tube with a minimum Inner Diameter (ID) of 100 mm shall be installed from airflow machine through the front side of the cardboard window insert and the tube shall be sealed at the insert opening.

4.1.4 The interior pressure tap shall be installed in an area where the pressure tap is not influenced by airflow (the location shall be documented on Data Sheet B1 in Appendix B). A flexible tube with a 7 mm ID shall be installed from the interior pressure tap through the window insert and sealed at the insert opening. The tubing shall be connected to the body pressure sensing device (interior body pressure).

Note: The pressure relief valve may be blocked, if required by the test engineer. This is not required if the system is set to Outside Air (OSA), but the pressure relief valves should be tapped if the system is being tested in Production Recirculation (P/R).

4.1.5 A HVAC module pressure tap shall be installed (refer to GMW15845). The recommended placement of the case static HVAC module pressure tap is on the vertical surface of the HVAC module just downstream of the blower scroll. A flexible 7 mm ID tube shall be installed from the HVAC module pressure tap through the window insert and sealed at the insert opening. The tubing shall be connected to the case pressure sensing device (module case pressure).

4.1.6 On those systems utilizing vacuum for system mode selection, the vacuum pump shall be connected to the system source line. During testing the system vacuum level shall be adjusted to maintain 50 kPa or 380 mm Hg. If vacuum source line is routed through window insert, this line shall be sealed at insert opening.

4.1.7 The air discharge location shall be checked for mode verification and the temperature lever shall be located as specified in 4.2.2. All outlet vanes shall be set full open and the outlets positioned to deliver airflow in a horizontal and rearward trajectory.

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4.1.8 Functional Operation of the System. The functional operation of all switches, controls, blower motor, and HVAC system mode doors shall be verified.

4.2 Conditions.

4.2.1 Environmental Conditions. Temperature: (+10 to +30) °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 Electrical Power Supply. The compartment blower is to be supplied by the external regulated power supply. The voltage is specified by the Vehicle Technical Specification (VTS) and the HVAC module Subsystem Technical Specification (SSTS). Additional voltages on request of the test engineer.

4.2.2.2 Settings. The HVAC system controls shall be set to the modes specified by the HVAC module SSTS. Additional modes on request of the test engineer.

4.3 Instructions.

4.3.1 Test Method. Insure that all vehicle doors and windows are closed.

4.3.1.1 Twelve (12) V shall be provided to the blower motor and the compartment blower shall be run for ≥ 15 minutes to stabilize the blower motor temperature.

4.3.1.2 The external power supply shall be adjusted so that the voltage at the blower motor is set to the specified voltage in the HVAC module SSTS. The body pressure shall be referenced and the air machine shall be adjusted until the body pressure is zero. The data shall be recorded as described in 4.3.2.

4.3.2 Measuring Values and Data to be Recorded. Reference Data Sheet A1, Appendix A.

4.3.2.1 Temperatures in Celsius (°C). Ambient (room conditions).

4.3.2.2 Voltage in Volts (V), Current in Ampere (A) and Blower Motor Speed in rpm Compartment blower motor. On systems with BLDCs, the blower duty cycle shall be measured.

4.3.2.3 Pressures in Pascal (Pa).

- Atmospheric.
- Interior.
- HVAC module case.

4.3.2.4 Airflow in Liters per second (L/s). Airflow at test conditions.

4.3.2.5 Relative Humidity in Percent (%). Relative Humidity (RH) at test conditions.

4.3.2.6 Further Data.

- Vehicle data, mileage and description of the system to be validated.
- Test number and date.
- Name of the person in charge of the test.
- Pulse Width Modulation (PWM) in percent (%).
- List of test equipment traceable (Data Sheet B1, Appendix B).

5 Data

5.1 Calculations.

5.1.1 Ambient Air Density (ρ_{amb}) in kilograms per cubic meter (kg/m^3).

$$\rho_{amb} = \rho_{std} \frac{\rho_{amb} (T_{std} + 273.15)}{\rho_{std} (T_{amb} + 273.15)}$$

Where:

T_{std} = 25 °C (Standard Lab Temperature - National Bureau of Standards (NBS)).

P_{std} = 100 kPa (Standard Barometric (Baro) Pressure - NBS).

ρ_{std} = 1.168 kg/m^3 (Standard Air Density - NBS).

T_{amb} = Ambient Air Temperature in degrees Centigrade (°C).