



Air Conditioning System Maximum Performance Validation for Passenger Vehicles

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. Provide validation of the maximum performance capability of a vehicle Air Conditioning (AC) system by reproducible measurements in a climatic wind tunnel.

1.2 Foreword. Not applicable.

1.3 Applicability. Apply for all passenger vehicles with an AC system.

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

2.3 Additional References.

None

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 a chassis dynamometer with adjusting possibilities for a vehicle speed of 110 km/h minimum, a wind speed of 110 km/h minimum, an ambient temperature of +50 °C minimum and a relative humidity of 80% minimum.

3.1.4 Capability of solar radiation simulation with a power of $\geq 1100 \text{ W/m}^2$.

3.2 Equipment.

3.2.1 General.

3.2.1.1 Temperature, pressure, speed, humidity, voltage and current measuring and recording equipment as described in Appendix A.

3.2.1.2 Device for operation and adjustment of accelerator pedal.

3.2.1.3 Battery charger to maintain battery during warm-up may be required (see 4.2.2.1.1).

3.3 Test Vehicle/Test Piece. Passenger vehicle equipped with an AC system.

3.3.1 Exterior Color. A dark exterior color produces more solar load than a light exterior color. Use engineering judgment to select a worst case consumer experience using a dark exterior hue. Black exterior color is not a test requirement. White exterior color is not acceptable.

3.3.2 Vehicle Camouflage. Camouflage used to disguise the vehicle during development can impact both solar loading and grille airflow. Engineering judgment should be used to make a decision to test with or without camouflage.

3.3.3 Vehicle Condenser Radiator and Fan Module (CRFM). The vehicle CRFM and powertrain configuration impact AC performance. Use engineering judgment to select a representative mainstream customer configuration.

3.4 Test Time. Preparation time; plus five hours for each Cycle 1, three hours for each Cycle 2 and four hours for each Cycle 3 (See 4.3.2).

3.5 Test Required Information. Test conditions are as specified in this procedure unless specified by the Vehicle Technical Specification (VTS).

3.5.1 Dynamometer Load. The United States Environmental Protection Agency (EPA) test weight shall be used to determine the road load dynamometer setting for the various roll speeds as required.

3.5.2 Acceleration and Deceleration.

3.5.2.1 Accelerate: 50 km/h to 100 km/h Acceleration 3.0 km/h/s.

3.5.2.2 Decelerate: 100 km/h to 0 km/h Deceleration 2.0 km/h/s.

3.6 Personnel/Skills. Require one climatic tunnel operator and one driver (if necessary).

4 Procedure

4.1 Preparation. The vehicle shall be prepared for the climatic tunnel and shall be equipped with devices according to 3.2 and 4.3.3. Automatic systems may require additional equipment to override air inlet selection. GMW15845 - Test Vehicle Instrumentation Procedure shall be utilized to define specific instrumentation methods.

4.1.1 Settings. For automatic and manual systems, the vehicle ventilation front (and rear, if equipped) system controls shall be set to AC outlet mode, maximum cold temperature and maximum blower speed. Deviations are described in the following paragraphs.

4.1.1.1 Sunroofs are to remain closed at all times and sun shades (if equipped) deployed to minimize the cabin solar load (this is the expected customer hot weather operating mode).

4.1.1.2 All ventilation outlets are to remain open and the panel vent nozzles shall be adjusted in such a way that the main air flow of each nozzle is directed towards the closest occupant shoulder horizontally and vertically to a line 200 mm below breath temperature sensors. Rear cooling outlets, if present, positioned to deliver airflow 200 mm directly below the breath temperature sensor. Vents shall not be adjusted during the remainder of the test.

4.1.1.3 Chillers for battery and/or power electronics cooling shall be set to operate as expected for appropriate ambient operation.

Note: Automatic systems are operated like manual systems. Be sure the air inlet mode can be switched during the Cycle 1 test to full Outside Air (OSA) mode (0 percent recirculation). Some vehicles provide partial recirculation of airflow in the customer selectable OSA mode or Production Outside Air Mode (P/OSA), which is not acceptable for this test. Full OSA mode data collection is used for refrigeration system sizing. Rear climate systems shall be operated as expected for all passenger seats occupied.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Ambient.

- Test Temperature: $+38 \pm 1$ °C for Cycle 1 and Cycle 2, and $+50 \pm 1$ °C for Cycle 3.
- Relative Humidity: 40% for Cycle 1 and Cycle 2, and 20% for Cycle 3.
- Sun Load: 1000 W/m² (measured in the center of vehicle roof).

Note: Different conditions may be described in the corresponding VTS.

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 Conditioning.

4.2.2.1.1 Warm-up. Warm-up is not necessary if the temperature of the body mass (seat rail) is within 15 °C of the test temperature (See GMW15845 regarding seat rail thermocouple location).

4.2.2.1.1.1 The engine shall be idling (running) in Park or Neutral. The AC compressor is not to run. The Heating, Ventilation and Air Conditioning (HVAC) module must be at a full cold temperature setting.

Note: If an automatic control system forces the AC compressor on or moves the temperature door travel away from full cold, the engine shall remain off.

Table 1: Warm-up

Wind Speed	Optional
Temperature	38 °C Cycle 1 and 2, 50 °C Cycle 3
Engine	On, (see 4.2.2.1.1.1)
Front Blower	Customer selectable speed closest to 8 V
Battery	Connected to charger if engine remains off, (see 4.2.2.1.1.1)
Windows	Optional down
HVAC Mode	A/C Panel Mode, Air Inlet P/OSA
HVAC Temperature	Full cold, AC off
Sun Load	Optional
Time	Until the temperature of the body mass (e.g., seat rail) is within 10 °C of the test ambient temperature.

Table 2: Pre-Soak

Wind Speed	50 km/h
Temperature	38 °C Cycle 1 and 2, 50 °C Cycle 3
Humidity	40% RH Cycle 1 and 2, 20% RH Cycle 3
Engine	On, (see 4.2.2.1.1.1)
Compressor	Off
Front Blower	See Table 1
Windows	Open
HVAC Mode	A/C Panel Mode (see Note), Air Inlet P/OSA
HVAC Temperature	Full cold, AC off
Sun Load	Off
Time	30 minutes

Note: Cycle through defrost and heater mode to purge the HVAC module of conditioned air prior to the selection of AC panel mode. It may be necessary to move the ignition to “run” to obtain the needed change in air inlet door mode during this or any future mode change when the vehicle is otherwise not running.

Table 3: Solar Soak Conditions

Wind Speed	As required to maintain test conditions (e.g., 5 to 8 km/h)
Temperature	38 °C Cycle 1 and 2, 50 °C Cycle 3
Humidity	40% RH Cycle 1 and 2, 20% RH Cycle 3
Engine	Off
Front Blower	Off
Windows	Closed
HVAC Mode	A/C Panel Mode
Air Inlet mode	Production Recirculation Mode (P/R)
Sun Load	On (see 4.2.1.1)
Time	60 minutes (see Note)

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