GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW3202

Air Conditioner and Heater Subjective and Objective Performance Validation for Passenger Vehicles at City Traffic Conditions

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. Validation of the performance capability of a vehicle's air conditioning (A/C) system by reproducible measurements in a climatic wind tunnel for city traffic, and road load conditions. This test evaluates objective and subjective data.

1.2 Applicability. All passenger vehicles with an Air Conditioning 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.

GMW14555 GMW15754 GMW15845

2.3 Additional References.

- CG2311 HVAC Comfort Data Collection GMW3202
- Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities.

- Climatic wind tunnel including a chassis dynamometer with adjusting capability. Optionally, this test may additionally (not instead) be run at an appropriate Road Test facility. Specific additional requirements for the Road Test facility are defined in GMW14555.
- Air Conditioning Evaluation: Capability for a vehicle speed of 110 km/h minimum, a wind speed of 110 km/h minimum, an ambient temperature range of -20 °C to +50 °C minimum, and a relative humidity of 80% minimum.
- Capability of solar radiation simulation with a power of ≥ 1100 W/m^2.

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 General.

3.2.1.1 Temperature measuring and recording equipment as described in CG2311 and detailed in GMW15845.

3.2.1.2 Pressure measuring and recording equipment as described in CG2311 and detailed in GMW15845.

3.2.1.3 Measuring and recording equipment for the engine speed as detailed in GMW15845.

3.2.1.4 Measuring and recording equipment for voltage and current for compartment blower(s), battery(ies), and engine cooling fans (if applicable) as detailed in GMW15845.

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Note: Capable of measuring frequency per 4.3.3.

3.2.1.5 Device for operation and adjustment of accelerator pedal.

3.2.1.6 Battery Charger to maintain battery during warm-up (see Table 1).

3.2.1.7 Clipboard and Subjective Data table (Data Sheet in CG2311) for each occupant. Each clipboard is to have the number digits one (1) through nine (9) on the back where the number digits are 25 mm in height or larger to facilitate non-verbal comfort data communication from the driver to the front passenger.

3.3 Test Vehicle/Test Piece. Passenger vehicles equipped with an A/C and Heater system.

3.3.1 Exterior Color. A dark exterior color produces more vehicle interior solar load than a light exterior color. Use engineering judgment to select a worst case consumer experience using a dark exterior hue for final validation. Black exterior color is not a test requirement. White exterior color is to be avoided for requirement validation, and shall be noted in the report if white or a light hue was used.

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 A/C performance. Use engineering judgment to select a representative mainstream customer configuration.

3.4 Test Time. See Table 1, Table 2 and Table 3.

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. Curb weight plus one passenger (68 kg) is the weight used to determine the load.

3.5.2 Acceleration and Deceleration. Unless otherwise specified, the acceleration and deceleration rates should be as specified ± 1 km/h/s.

3.5.2.1 City Traffic Acceleration 2.7 km/h/s.

3.5.2.2 City Traffic Deceleration 4.0 km/h/s.

3.5.2.3 City Traffic Acceleration/Deceleration (rounding corner) 1.5 km/h/s.

3.5.2.4 Other Acceleration: 50 km/h to 100 km/h, 3.0 km/h/s.

3.5.2.5 Other Deceleration: 100 km/h to 0 km/h, 2.0 km/h/s.

3.6 Personnel/Skills. 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 measurement devices according to 3.2. Automatic systems may require additional equipment to manually control the system to a customer achievable maximum A/C performance setting unless only Cycle Two will be tested. For example, to test a vehicle with automatic climate control on Cycle One in a hot environment; the climate control would be manually set to high blower, panel (ventilation) air delivery mode, the coldest temperature set point where the air inlet valve is not fixed into Production/Recirculation (P/R) air inlet mode, and then set the air inlet valve to P/R or Production Outside Air (P/OSA) as appropriate for the test condition as defined in 4.3.4 and 4.3.5.

4.1.1 Settings. For automatic and manual systems, the vehicle ventilation front (and rear, if equipped) system controls shall be set to A/C outlet mode, maximum cold temperature and maximum blower speed unless Cycle 2 or Cycle 3 only are to be selected. 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). Side window sunshades (if equipped) are not to be deployed.

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 test.

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

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Note: Automatic systems are operated like manual systems during Cycle 1. Rear climate systems shall be operated as expected for all passenger seats occupied. See 4.3.4.6 and 4.3.4.7.

4.1.1.4 Cycle 2 may require a special calibration for the vehicle solar sensor. The vehicle solar sensor calibration shall properly comprehend the 1000 W/m^2 Solar spectrum from the test facility lamps; so that the vehicle behaves as if the solar load is from a true sunlight solar spectrum of 1000 W/m^2.

4.1.1.5 A/C Economy Mode (Eco) and Powertrain Start Stop at idle features shall use Automatic Cycle 2 or Automatic Cycle 3 (if applicable) for subjective and objective data. Test results shall be compared to a baseline condition with Eco and Powertrain Start Stop disabled, and reported with Eco and baseline differential values. Alternate ambient conditions shall be considered for evaluation per VTS 3.2.1.3.1.4.11 Objective Performance –Warm up and Cool Down for Alternate Vehicles.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Ambient.

- Test Temperature: +38 ± 1 °C for Cycle 1 and Cycle 2, and +46 ± 1 °C for Cycle 3.
- Relative Humidity: 40% for Cycle 1 and Cycle 2, and 20% for Cycle 3.
- Sun Load: 1000 W/m^2 (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. Additional details regarding the vehicle velocity profile can be found in CG2311. The vehicle starting battery (if equipped) shall be at full charge at the start of the test (see 4.2.4).

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 A/C compressor is not to run. The Heating, Ventilation, Air Conditioning (HVAC) module must be at a full cold temperature setting.

Note: If an automatic control system forces the A/C 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, 46 °C Cycle 3
Engine	On, (see 4.2.2.1.1.1)
Front Blower	Customer selectable speed closest to 3/4th (75%) of high blower airflow
Rear Blower	Where equipped, customer selectable speed closest to 3/4th (75%) of high blower airflow
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, A/C off
Sun Load	Optional
Time	Until the temperature of the body mass (e.g., seat rail) reaches a minimum of 10 °C below the test ambient temperature.

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Table 2: Pre-Soak

Wind Speed	50 km/h
Temperature	38 °C Cycle 1 and 2, 46 °C Cycle 3
Humidity	40% Relative Humidity (RH) Cycle 1 and 2, 20% RH Cycle 3
Engine	On, (see 4.2.2.1.1.1)
Compressor	Off
Blower	See Table 1
Windows	Open
HVAC Mode	A/C Panel Mode (see Note), Air Inlet P/OSA
HVAC Temperature	Full Cold, A/C 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 A/C 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. All panel outlet to be open.

Table 3: Solar Soak Conditions

Wind Speed	As required to maintain test conditions (e.g., 5 km/h)
Temperature	38 °C Cycle 1 and 2, 46 °C Cycle 3
Humidity	40% RH Cycle 1 and 2, 20% RH Cycle 3
Engine	Off
Blower(s)	Off
Windows	Closed
HVAC Mode	A/C panel with all outlets open (Cycle One) Automatic with all outlets open (Cycle Two and Three)
Air Inlet mode	P/R (Cycle One) Automatic (Cycle Two)
Sun load	On (see 4.2.1.1)
Time	60 minutes (see Note)

Note: Time: Depending on the installed sun simulation equipment, the time shall be defined as the equivalent period, ≥ 50 minutes, to reach the same soak average breath temperature results as obtained with natural sun load of 1 h at 1000 W/m^2 (or as specified by the corresponding VTS) at the same test temperature. In the absence of natural sun data, 60 minutes shall be used.

4.2.3 Idle Conditions. The wind speed in front of the radiator intake is described in the stop descriptions as shown in 4.3.4.10 of this document.

4.2.4 Electrical Power Supply. All electrical systems are supplied by the internal vehicle power supply. The battery shall be fully charged before the test with an allowable exception to maintain an agreed upon desired State of Charge (SOC) on a hybrid propulsion system. The blower speed (voltage) shall be on high throughout the test for Cycle One and set to Automatic control for Cycle Two and Three.

4.3 Instructions.

4.3.1 Gear Step or Drive Positions.

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