



HVAC Performance Validation for Passenger Vehicles at Idle - Engine and Compressor Off 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. Multiple ambient condition validation of the objective performance capability of a vehicle's Heating, Ventilation and Air Conditioning (HVAC) system in city traffic start and stop conditions, by reproducible measurements in a climatic wind tunnel (CWT). In addition to low speed HVAC performance under a variety of ambient conditions; the frequency of stabilized engine off idle (for vehicles with engine off idle) is measured. The test data is used to evaluate customer comfort and compressor logic for both conventional idle and engine off idle vehicles. This enables the evaluation of city traffic Air Conditioning (A/C) and compressor control (regarding the risk of ice formation). The protocol can optionally be used for subjective data.

1.2 Applicability. GM passenger vehicles with a Heating Ventilation and Air Conditioning (HVAC) System. See 3.3.3 for limitations.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3202

GMW14555

GMW15845

GMW17738 (ID)

(ID) = This document is limited to internal use within General Motors and shall not be accessed outside this company. Contact the GM Lead Engineer for further instructions.

2.3 Additional References.

- CG2311
- CG4732
- Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities.

- Climatic wind tunnel (CWT) including a chassis dynamometer with adjusting capability. Optionally for GM vehicles, 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. **Note:** See 3.3.3 regarding testing a vehicle with a solar sensor.
- HVAC Evaluation: Capability for a vehicle speed of 90 km/h minimum, a wind speed of 90 km/h minimum, an ambient temperature range of -10 °C to +45 °C minimum, and a relative humidity (RH) of 80% minimum.
- Capability of solar radiation simulation with a power of $\geq 900 \text{ W/m}^2$.

Note: The test facility lamp "solar spectrum" impacts the availability of vehicle autostops compared to real world usage. This impact is due to the difference in the vehicle solar measurement frequency (type of sensor). The offset between the strength of the test lamp at the measurement frequency of the vehicle sensor, and actual sun shall be understood to enable a special calibration to correct vehicle behavior to represent real world usage.

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February 2018

Page 1 of 10



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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. The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.

3.2.1.2 Pressure measuring and recording equipment as described in CG2311 and detailed in GMW15845. The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.

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.

Note: Recording equipment shall be capable of measuring frequency.

3.2.1.5 Device for operation and adjustment of accelerator and brake pedal. Engine off operation may be dependent on brake pedal usage.

3.2.1.6 Charger to maintain battery during blowdown (see Table 1).

3.3 Test Vehicle/Test Piece. Passenger vehicles equipped with an A/C and Heater system. The climate control software calibrations shall be mature if automatic controls are used.

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

3.3.2 Vehicle Condenser Radiator and Fan Module (CRFM). The vehicle CRFM and powertrain configuration impact Heating, Ventilation, and Air Conditioning (HVAC) performance. Use engineering judgment to select a representative mainstream customer configuration.

3.3.3 Vehicle Solar Sensor Controls. See 3.1. A vehicle that uses a solar sensor for climate control, requires special solar sensor calibration to obtain valid results.

3.3.3.1 The vehicle measurement of the solar sensor is typically incorrect in a CWT. The vehicle sensor measures a subset of the solar frequency; the CWT lamps and real sun may have different spectrums at the same total solar load (wattage). The different content at specific sensor measurement frequency cause incorrect vehicle response. A correction of the climate control software is required to correlate with real world performance, particularly at 400 Watts/m² and 800 Watts/m² solar conditions. A Vspy or similar Assembly Line Diagnostic Link (ALDL) interfacing device may be required.

3.3.3.2 Global Positioning System (GPS) software may not correctly interpret the sun location in a CWT with distributed solar lamps. Ensure solar calculation are correct in the CWT environment by disabling vehicle GPS corrections.

Note: When solar sensor correction on a Benchmark or GM vehicle, testing should be completed on a road test facility and not a CWT with incorrect solar frequency. Vehicle performance in the absence of proper solar response is of limited value and needs to be clearly reported as invalid results.

3.4 Test Time. See Table 5, each of the seven (7) ambient conditions will each require 2 h of testing once the ambient condition is stabilized. Three CWT shifts is the expected minimum for one vehicle configuration.

3.5 Test Required Information. Test conditions are as specified in this procedure unless specified by the VTS or GMW17738 Vehicle Performance Requirement.

3.5.1 Dynamometer Load. Curb weight plus one passenger (68 kg) is the weight used to determine the level road 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.

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February 2018

Page 2 of 10

3.5.2.4 Other Acceleration: 0 km/h to 80 km/h, 3.0 km/h/s.

3.5.2.5 Other Deceleration: 80 km/h to 0 km/h, 2.0 km/h/s.

3.6 Personnel/Skills. One CWT operator and one driver (if necessary).

4 Procedure

4.1 Preparation. The vehicle shall be prepared for the CWT and shall be equipped with measurement devices according to 3.2.

4.1.1 Settings. The vehicle ventilation system in front (and rear, if equipped) controls shall be set to the airflow distribution, blower speed and temperature as shown in Table 5. A deviations is described in 4.1.1.6.

Note: An automatic climate control calibration must be mature to ensure valid results. In the absence of a mature automatic climate control calibration, override settings like a manual climate control as shown in Table 5 and 4.1.1.6 may offer value to show the capability of the system hardware.

4.1.1.1 Blower speeds referenced are based on a control with eight customer selectable blower speeds. For other numerical speed controls;

- Speed 8 is to be high speed (example: speed 4 of 4)
- Speed 6 is to be at a speed of 75% of the control travel (example: speed 3 of 4)
- Speed 4 is to be a speed of 50% of the control travel (example: speed 2 of 4)
- Speed 3 is to be at a speed of 30% of the control travel (example: speed 1 of 4)

4.1.1.2 Sunroofs are to remain closed at all times. Sunroof sun shades (if equipped) shall be closed. Side or rear window sunshades (if equipped) are not to be deployed.

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

4.1.1.4 Chillers for battery and/or power electronics cooling shall be set to operate as expected for appropriate ambient and cold vehicle operation. Specific preconditioning of batteries and electronics may be required to represent a specific customer usage condition, consult with the program HVAC Lead Development Engineer post Vehicle Program Initiation (VPI) or Lead System Architect (post VPI) for proper test protocol.

Note: Rear climate systems shall be operated as expected for all passenger seats occupied. See 4.3.4.6 and 4.3.4.7.

4.1.1.5 A/C Economy Mode (Eco) and Powertrain autostop at idle features shall use the Automatic Cycle for objective data where available. Test results may be compared to a baseline condition with Eco and Powertrain autostop disabled, and reported with Eco and baseline differential values.

4.1.1.6 Temperature door settings on manual systems require a calibration process for conditions in Table 5. The temperature door is to be tuned to maintain a 21 °C to 23 °C breath temperature.

4.1.1.6.1 Recommended process is to prep with the Table 5 conditions, without the "Soak Breath" requirement.

4.1.1.6.2 Set the temperature control to full cold and accelerate to 80 km/h road load conditions.

4.1.1.6.3 Modulate the temperature door once a 22 °C left front breath temperature is achieved to maintain this breath temperature for 5 minutes.

Note: When a breath temperature of 22 °C cannot be reached in 10 minutes, modify the blower speed (up or down) one setting to achieve the correct temperature door position to obtain a 22 °C breath temperature. Place a note in the test files to record the modified blower speed.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Ambient. See Table 5.

Note: Different conditions may be described in the corresponding program VTS or GMW17738 Requirement Documentation.

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.

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Page 3 of 10



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