



Subjective Performance Validation of Automatic Climate Control

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 comfort capability of an automatic vehicle Heating, Ventilating, Air Conditioning (HVAC) system by a series of road tests.

1.2 Applicability. For all passenger vehicles with an automatic Air Conditioning (A/C) system.

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.

None

2.3 Additional References.

- Vehicle Technical Specification (VTS).

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 This test procedure has been designed to allow usage in a variety of different geographic locations around the world. The locations need to provide for a facility that will allow the temperature deltas required in 4.3.4.

3.2 Equipment.

3.2.1 General.

3.2.1.1 Ambient measuring device.

3.2.1.2 Humidity measuring device.

3.2.1.3 Multiple data sheets.

3.2.1.4 Solar load measuring device.

3.2.1.5 Stop watch.

3.2.1.6 Radio/communication devices for each test vehicle.

3.2.1.7 Other optional equipment (needed for objective data collection on one vehicle for reference only).

3.3 Test Vehicle/Test Piece. Passenger vehicles equipped with an automatic HVAC system.

3.4 Test Time.

Calendar time: See 4.3

Test hours: See 4.3

Coordination hours: See 4.3

3.5 Test Required Information. Test conditions as specified by the procedure.

3.6 Personnel/Skills. For each seating row equipped with a control panel, a minimum of two people are required. Otherwise, a minimum of one person per row is required. The jury members shall be experienced with automatic systems. Changing the set point for comfort reasons is done solely by agreement of the jurors in the row of the impacted control panel.

4 Procedure

4.1 Preparation. The vehicle shall be prepared for the road and shall optionally be equipped with devices according to 3.2 and 4.3.3.

4.2 Conditions. Although the test procedure is written in individual cycles, it is acceptable to combine different portions of the cycles to best suit the geographic and ambient conditions at the time. However, the minimum test conditions for each cycle must still be met. Additionally, a cycle may be temporarily suspended to allow relocation to more suitable road and ambient conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Ambient and Humidity. As described in the testing matrices located in Appendix A, Table A1. The impacted cycles linked to each test matrix shall be conducted for each potential combination of ambient and solar conditions. As it is recognized that time, resources and mother-nature may not allow every combination to be tested, the validation engineer shall determine which combinations may be skipped.

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 – Cycle 1.

4.2.2.1.1 Pre-Conditioning.

- a. Road Speed: (50 to 110) km/h.
- b. Temperature: Within test matrix range.
- c. Humidity: Per test matrix.
- d. Automatic Climate Control (ACC): Full automatic control of all devices (normal settings).
- e. Windows: Closed.
- f. Air Outlet Direction: The jurors will adjust the outlets as required to achieve comfort.
- g. Sun Load: Per test matrix.
- h. Set Point: The jurors will adjust the outlets as required to achieve comfort.
- i. Time: Minimum of 30 minutes or until comfort is achieved.
- j. Data: No data is taken.

4.2.2.1.2 Stabilize Road Load.

- a. Road Speed: (50 to 110) km/h.
- b. Temperature: Within test matrix range.
- c. Humidity: Per test matrix.
- d. ACC: Full automatic control of all devices (normal settings).
- e. Windows: Closed.
- f. Air Outlet Direction: No adjustments allowed during the initial time segment. If required, jurors may re-adjust the system back to comfort during the extended time period. This is the preferred method to re-acquire comfort prior to adjusting the set point.
- g. Sun load: Per test matrix.

- h. Set Point: No adjustments allowed during the initial time segment. If required, jurors may re-adjust the system back to comfort during the extended time period.
- i. Time: Two (2) h minimum. Afterwards, time will be extended an unspecified additional amount if a juror does not maintain comfort. The juror(s) will then make the necessary adjustments to allow them to return to comfort.
- j. Data: The jurors shall mark the appropriate data sheet at the specified intervals.

4.2.2.1.3 Change Set Points.

- a. Road Speed: (50 to 110) km/h.
- b. Temperature: Within test matrix range.
- c. Humidity: Per test matrix.
- d. ACC: Full automatic control of all devices (normal settings).
- e. Windows: Closed.
- f. Air Outlet Direction: Adjust as desired.
- g. Sun Load: Per test matrix.
- h. Set Point: Adjust set point multiple times delaying between adjustments per the time instructions. The adjustments are to be made relative to the set point that achieved comfort. The seven adjustments are:
 - 1. T_{comfort}^{+1} (remain for 15 minutes)
 - 2. T_{comfort}^{-1} (remain for 15 minutes)
 - 3. T_{comfort}^{-3} (remain for 10 minutes)
 - 4. T_{comfort}^{-5} (remain for 5 minutes)
 - 5. T_{comfort} (remain for 30 minutes)
 - 6. T_{comfort}^{+3} (remain for 10 minutes)
 - 7. T_{comfort}^{+5} (remain for 5 minutes)
- i. Data: The jurors shall mark the appropriate data sheet at the specified intervals.

4.2.2.1.4 Pre-Conditioning for City Traffic.

- a. Road Speed: (50 to 110) km/h.
- b. Temperature: Within test matrix range.
- c. Humidity: Per test matrix.
- d. ACC: Full automatic control of all devices (normal settings).
- e. Windows: Closed.
- f. Air Outlet Direction: Jurors may adjust to achieve comfort.
- g. Sun Load: Per test matrix.
- h. Set Point: Jurors may adjust to achieve comfort.
- i. Time: Minimum of 30 minutes or until comfort is achieved.
- j. Data: No data is taken.

4.2.2.1.5 City Traffic.

- a. Road Speed: (0 to 50) km/h with stops.
- b. Temperature: Within test matrix range.
- c. Humidity: Per test matrix.
- d. ACC: Full automatic control of all devices (normal settings).
- e. Windows: Closed.
- f. Air Outlet Direction: No adjustments are allowed.
- g. Sun Load: Per test matrix.
- h. Set Point: No adjustments are allowed.
- i. Time: Minimum of 20 minutes; numerous stops with a minimum of 5 stops > 1 minute in duration.
- j. Data: The jurors shall mark the appropriate data sheet at the specified intervals.

4.2.2.2 Vehicle Conditioning – Cycle 2.**4.2.2.2.1 Pre-Conditioning.**

- a. Road Speed: (80 ± 10) km/h.
- b. Temperature: Within test matrix range.
- c. Humidity: Per test matrix.
- d. ACC: Full automatic control of all devices (normal settings).
- e. Windows: Closed.
- f. Air Outlet Direction: Adjusted at juror's discretion to achieve comfort.
- g. Sun Load: Per test matrix.
- h. Set Point: Adjusted at juror's discretion to achieve comfort.
- i. Time: Minimum of 30 minutes or until comfort is achieved.
- j. Data: No data is taken.

4.2.2.2.2 Soak.

- a. Road Speed: 0 km/h, engine off.
- b. Temperature: Within test matrix range.
- c. Humidity: Per test matrix.
- d. Windows: Closed.
- e. Sun Load: Per test matrix.
- f. Time: Varies (5 minutes first time).
- g. Data: No data is taken.

4.2.2.2.3 Dynamic Highway.

- a. Road Speed: Speed > 80 km/h.
- b. Temperature: Within test matrix range.
- c. Humidity: Per test matrix.
- d. ACC: Full automatic control of all devices (normal settings).
- e. Windows: Closed.
- f. Air Outlet Direction: Adjust as desired.
- g. Sun Load: Per test matrix.
- h. Set Point: No adjustments are allowed.
- i. Time: Run until all jurors achieve comfort or 60 minutes, whichever comes first.
- j. Data: The jurors shall mark the appropriate data sheet at the specified intervals.

4.2.2.2.4 Repeating Soaks.

- a. Repeat entire cycle multiple times modifying the soak time each time until 15 minutes, 30 minutes, 1 h and 3+ h have been completed.

4.2.2.3 Vehicle Conditioning – Cycle 3.**4.2.2.3.1 Pre-Conditioning.**

- a. Road Speed: (80 ± 10) km/h.
- b. Temperature: Within test matrix range.
- c. Humidity: Per test matrix.
- d. ACC: Full automatic control of all devices (normal settings).
- e. Windows: Closed.
- f. Air Outlet Direction: Adjusted at juror's discretion to achieve comfort.
- g. Sun Load: Per test matrix.
- h. Set Point: Adjusted at juror's discretion to achieve comfort.
- i. Time: Minimum of 30 minutes or until comfort is achieved.

- j. Data: No data is taken.

4.2.2.3.2 Soak.

- a. Road Speed: 0 km/h, engine off.
- b. Temperature: Within test matrix range.
- c. Humidity: Per test matrix.
- d. Windows: Closed.
- e. Sun Load: Per test matrix.
- f. Time: Varies (5 minutes first time).
- g. Data: No data is taken.

4.2.2.3.3 Dynamic City Traffic.

- a. Road Speed: (0 to 50) km/h, multiple stops.
- b. Temperature: Within test matrix range.
- c. Humidity: Per test matrix.
- d. ACC: Full automatic control of all devices (normal settings).
- e. Windows: Closed.
- f. Air Outlet Direction: Adjust as desired.
- g. Sun Load: Per test matrix.
- h. Set Point: No adjustments allowed.
- i. Time: Minimum of 20 minutes; numerous stops with a minimum of five stops > 1 minute in duration.
- j. Data: The jurors shall mark the appropriate data sheet at the specified intervals.

4.2.2.3.4 Repeating Soaks.

- a. Repeat entire cycle multiple times modifying the soak time each time until 15 minutes, 30 minutes, 1 h and 3+ h have been completed.

4.2.2.4 Vehicle Conditioning – Cycle 4.

4.2.2.4.1 Pre-conditioning.

- a. Road Speed: (80 ± 10) km/h.
- b. Temperature: Within test matrix range.
- c. Humidity: Per test matrix.
- d. ACC: Full automatic control of all devices (normal settings).
- e. Windows: Closed.
- f. Air Outlet Direction: Adjusted at juror's discretion to achieve comfort.
- g. Sun Load: Per test matrix.
- h. Set Point: Adjusted at juror's discretion to achieve comfort.
- i. Time: Minimum of 30 minutes or until comfort is achieved.
- j. Data: No data is taken.

4.2.2.4.2 Soak.

- a. Road Speed: 0 km/h, engine off, garaged vehicle.
- b. Garage Temperature: > 10 degree delta from hot ambient temperature, > 15 degree delta from cold ambient temperature.
- c. Temperature: Outside ambient shall be a minimum of 30 °C for hot portion of the test. The ambient shall be a minimum of -10 °C for the cold portion of the test.
- d. Humidity: Not applicable.
- e. Windows: Closed.
- f. Road Speed: Variable speed.
- g. Temperature: Within test matrix range.
- h. Humidity: Per test matrix.

- i. ACC: Full automatic control of all devices (normal settings).
- j. Windows: Closed.
- k. Air Outlet Direction: No adjustments allowed.
- l. Sun Load: Per test matrix.
- m. Set Point: No adjustments allowed.
- n. Time: Run until all jurors achieve comfort or 60 minutes, whichever comes first.
- o. Data: The jurors shall mark the appropriate data sheet at the specified intervals.

4.2.2.5 Optional Tests. This section is for optional tests to be conducted per the test coordinator's discretion for evaluation of other system feature effects (manual operation, customizations, etc.)

Note: Specific data sheets and cycles may need to be created that are not currently supported in the test procedure documentation.

4.2.2.6 Gear Step or Drive Position. See Table 1.

Table 1: Gears Step or Drive Positions

Transmission	40 km/h	50 km/h	60 km/h	80 km/h	Idle
Manual Transmission – 4 Speed	3	4	4	4	neutral
Manual Transmission – 5 Speed – Wide Ratio ^{Note 1}	3	4	4	5	neutral
Manual Transmission – 5 Speed – Close Ratio ^{Note 2}	3	4	4	4	neutral
Automatic Transmission	Note 3	Note 3	Note 3	Note 3	Note 3

Note 1: 5th Gear = Over Drive

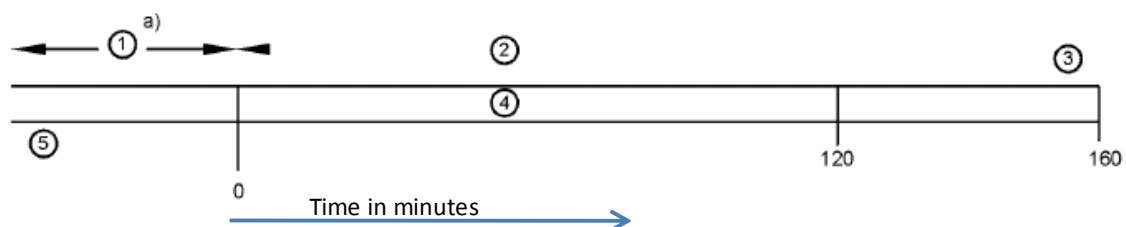
Note 2: 5th Gear = 1:1 Gear Ratio

Note 3: Highest Drive Gear

Note: The specified vehicle speeds are driven at road load (in a normal customer manner per the variability of the public roads).

4.3 Instructions.

4.3.1 Climate Cycle 1. See Figure 1.



Note 1: Pre-Conditioning

Note 2: Stabilized Road Load

Note 3: City Traffic

Note 4: Selected Road Speed (value chosen between (30 to 110) km/h)

Note 5: 30 minutes

Figure 1: Climate Cycle One (1)

- a. Pre-Conditioning.
- b. Stabilized Road Load.
- c. Extended Road Load (if necessary).

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