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# AUTOMOTIVE VEHICLES – AIR CONDITIONING SYSTEMS THERMAL PERFORMANCE – METHOD OF MEASUREMENT

(*first revision of IS 14618*)



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FOREWORD

(formal clauses will be added later)

This Indian Standard is one in the series of Indian Standards being developed for Automotive Testing of Performance Evaluation.

An increasing number of passenger cars presently being introduced are provided with occupant comfort control systems such as heating, ventilation and air-conditioning systems (HVACS). The manufacturers of automotive air conditioning systems have their own discreet procedure for assessment of the performance of the air conditioning system. This standard aims at standardization of the method for evaluation of air conditioning system performance of different types and categories of vehicles.

This standard was first published in 1999. The revision of this standard has been taken up to update the standard based on latest technologies. In this revision definitions of few terms have been modified and a stationary test has been included for evaluating the performance of air-conditioning system.

## 1 SCOPE

**1.1** This standard covers the procedure for evaluating cabin cooling performance of an automotive air conditioning system and its compatibility with the engine. This standard is applicable to vehicles of $M_1$ and $M_2$ category provided with air conditioning systems based on vapour compression refrigeration cycle drawing power from the vehicle engine.

**1.2** This standard does not apply to such automotive vehicles which are provided with a completely independent prime mover for the air conditioning system.

## 2 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

### 2.1 Accumulator (Receiver) Tank

The hollow tank in the refrigerant flow circuit separate or integrated with condenser catering to the surges of refrigerant flow which occur due to unpredictable changes in compressor speed and heat load variations. This generally incorporates a hygroscopic material for absorbing any moisture in the refrigerant.

**2.2 Air Conditioning System**

The system consisting of a cooling coil, compressor, condensing coil, condenser cooling fan (may or may not be required as condenser coil can also be cooled with radiator fan) blower, accumulator (or receiver) tank, expansion device, associated controls, plumbing and also refrigerant.

**2.3 Blower**

The air delivery pump used to circulate the air from the occupants space or outside atmosphere through the cooling coil.

**2.4 Compressor**

The mechanical pump used to raise the pressure of the refrigerant and maintain flow of the refrigerant in the circuit.

**2.5 Condensing Coil**

The heat exchanger in which the heat from the refrigerant is transferred to the amhient air.

**2.6 Cooling Coil**

The heat exchanger through which the refrigerant absorbs heat from the air in the vehicle occupant’s space and thereby cooling the occupant area.

**2.7 Discharge Pressure**

The pressure of the refrigerant on the discharge side of the circuit.

**2.8 Discharge Side**

The high pressure side of the refrigerant circuit. This is effectively from the exit of the compressor to the inlet of the expansion (or throttling) device.

**2.9 Expansion Device**

The device at which the high pressure refrigerant is isenthalpically throttled down to lower pressure. This may he in the form of a (internally or externally equalised) thermostatic expansion valve or a capillary tube.

**2.10 Refrigerant**

The medium which circulates inside the air conditioning system that is through the cooling coil, compressor, condensing coil and the related plumbing by absorbing heat at the cooling coil and rejecting it at the condensing coil.

NOTE - (The refrigerants generally used are di-chloro di-fluoro methane (also called CFC12 or R12) or 1,1,1,2 tetra fluoro ethylene (also called HFC 134a or R 134a).

**2.11 Suction Pressure**

The pressure of the refrigerant on the suction side of the circuit.

**2.12 Suction Side**

The low pressure side of the refrigerant circuit. This is effectively from the exit of the expansion (or throttling) device up to the inlet of the compressor.

**3 PREPARATION OF THE VEHICLE**

Prior to the start of testing the following shall he ensured.

**3.1** The air conditioning system of the vehicle shall be charged with the refrigerant to the mass specified by vehicle manufacturer.

**3.2** The battery of the vehicle (or any alternate electrical power source) on which the various electrical components of the air conditioning system depend, shall be at rated voltage throughout the test.

**3.3** The occupant space shall be thermally insulated appropriately at potential heat entry areas. Locations and material of the insulation shall be as recommended by the manufacturer and they shall also comply with the requirement specified in relevant fire retardant standards.

**3.4** The air flow rate from the cool air outlets shall be as specified by the manufacturer.

**3.5** All cool air outlets shall be adjusted to direct the air flow towards the occupant’s chest/face.

**3.6** The blower shall be operating at its maximum air discharge.

**3.7** Intensity setting provided if any, for the air conditioning system shall be set at its maximum intensity.

**3.8** The fresh air valve, if provided, shall be kept closed during the tests.

## 4 PERFORMANCE EVALUATION

The following tests shall be conducted on the vehicle to assess the cooling performance of the air conditioning system:

a) Stationary test (*see* **4.1**)
b) Cool down test ( *see* **4.2**)
c) Wall test ( s*ee* **4.3**)
d) Lap test ( *see* **4.4**)

The above tests shall be carried out either in controlled ambient in full vehicle test facility or during the hottest period of the day, that is around noon, under a clear sky at a minimum ambient temperature of 30°C

### 4.1 Stationary Test

**4.1.1** This test is carried out to assess the grille ( cold air vent) temp of the air conditioning system

**4.1.2** Sensors such as thermocouples shall be fixed to measure temperatures as all grille levels.

**4.1.3** The vehicle should be parked in shade with bonnet closed. Engine coolant temperature should be same as ambient. All doors and hatchback (if provided) shall be opened.. All AC controls shall be set to its maximum capacity.

**4.1.4** Engine shall be started, AC shall be switched on and engine speed shall be set at 1500rpm. Run the system for 10 min in open door condition and then close all doors and Run the system for further 10minutes

**4.1.5** *Interim Record*

Grille temperature shall be recorded at minimum of 2 min interval from the start of test.

**4.1.6** The average of all grille temperature shall be taken and plotted against time.

### 4.2 Cooldown Test

This test is carried out to obtain the cabin temperature variation under steady state operation of the air conditioning system.

**4.2.1** *Additional Vehicle Preparation*

**4.2.1.1** Sensors, such as thermocouples for recording temperatures at nose levels of all occupant seating positions shall be fitted with recording instruments having an accuracy of $\pm 1\ ^{o}C$.

**4.2.1.2** After the above preparation, the vehicle shall be parked under sunlight, in an open area free from structures which may cast shadows on any part of the vehicle. The vehicle shall be positioned facing the sun in such a way to ensure maximum solar load through windscreen and side window during the entire one hour of soaking. All the doors and windows of the vehicle shall be shut and the fresh air valve (if provided) shall be closed. The vehicle shall be left undisturbed in this position for a minimum duration of one hour and this period shall be considered as the soaking period.

**4.2.1.3** After the soaking period, the testing personnel shall enter the vehicle. The total number of occupants during the test shall be not less than two in case of $M_1$ and three for $M_2$ and in no case exceed the maximum seating capacity of the vehicle. While entering the vehicle, care shall be taken for the following:

a) Occupants shall enter one at a time and each one shall enter quickly and shut the door behind him/her immediately.

b) Not more than one door of the vehicle shall be opened at one time during entry.

**4.2.1.4** *Initial record*

After all the occupants are inside the vehicle, the initial temperatures at all the occupants nose levels shall be recorded.

**4.2.1.5** *Running*

The vehicle shall be started and immediately the air conditioning system shall be switched on at its maximum capacity as at **3.6** to **3.8**. The vehicle shall be driven for one hour at a steady speed of 60 km/h with gear ratio chosen so as to run the compressor at 50 to 80 percent of maximum speed. The start of the test period shall be considered at that instant when the last of the controls is operated to begin the air conditioning system.

**4.2.2** *Interim Record*

During the one hour run, the temperatures at all the occupants' nose levels shall be recorded at intervals not exceeding 5 minutes maximum. The lower limit for the sampling time shall be decided based on the sensitivity and response of the temperature measuring sensor and the capability of the recording equipment.

**4.2.3** *Cabin Temperature Variation*

The average of all nose level temperatures shall be taken and plotted against time.

**4.3 Wall Test**

**4.3.1** The test is intended to simulate the behaviour of the vehicles engine cooling system when the air conditioning system is operational and the vehicle is being driven on d hot, bright day in

bumper to bumper traffic conditions. This test is only required for vehicles in which the condensing coil of the air conditioning system is located in the vicinity of the vehicle's radiator. This test may be carried out either independently or immediately after the cooldown test.

**4.3.2** *Additional Vehicle Preparation*

**4.3.2.1** Sensor, such as thermocouple, for temperature recording of engine water shall be fitted. It shall be ensured that there shall be no leakage through engine coolant circulation system. Pressure gauges for recording air conditioning system pressures shall also be fitted. The pressure gauges used shall have an accuracy of' $\pm$ 1 kPa.

**4.3.2.2** The coolant in the engines coolant circuit shall be as specified by the vehicle and/or engine manufacturer.

**4.3.3** The vehicle shall be parked under the sun, in front of a wall at a distance of one meter from it. This distance shall he measure from the front grill of the vehicle. No air shall he flowing across the vehicle. In case there is significant (>1.5 m/s) crosswind, then rigid barriers shall be positioned on both sides, at least 2 metres away from the vehicle, over the entire length of the vehicle. With the vehicle parked thus, all the doors and windows of the vehicle shall be opened fully and the engine allowed to idle at its rated idling speed. The air conditioning system controls shall be set as at **3.6** to **3.8**. The engine coolant temperature and the discharge pressure of the air conditioning system shall be monitored at intervals of not more than 5 minutes. The test period shall be considered from the instant the air conditioning system is made operative.

**4.3.4** The test shall he continued till the engine coolant temperature has stabilized for a period of 10 minutes.

**4.3.5** The teat shall be discontinued if the engine temperature reaches its limit as specified by vehicle manufacturer or the air conditioning system reaches a high pressure limit specified by the vehicle manufacturer.

**4.4 Lap Test**

**4.4.1** The test is intended to simulate the behaviour of the engines cooling system under severe acceleration of' the vehicle, as in overtaking on the highway, with the air conditioning system operating. This test also may he carried out either independently or immediately after cooldown test.

**4.4.2** All air conditioning system controls shall be as at **3.6** to **3.8**. A11 windows of the vehicle shall he kept open to ensure maximum heat load on the air conditioning system. The vehicle shall be driven off from stationary condition and accelerated as quickly as possible through to its maximum speed. This speed shall be maintained for 10 seconds and then the vehicle shall be decelerated to 30 km/h, as quickly as possible. This shall be treated as one lap and the vehicle shall be driven continuously through ten such laps or until the engine coolant temperature stabilizes for 3 consecutive laps. The second and subsequent laps shall be started from 30 km/h

and not from stationary condition. The engine coolant temperature shall be recorded just before the deceleration phase.

**4.4.3** The test shall be discontinued if the engine coolant temperature reaches its limit as specified by vehicle manufacturer at any given instant.

## 5 ADDITIONAL MEASUREMENTS FOR DIAGNOSTICS

During the testing, the following additional parameters may also be monitored.

### 5.1 Air Conditioning System Cut-in/Cut-off

The cycling of the air conditioning system cut-in/cutoff shall be monitored and can be analyzed for identifying the cause of the system tripping. The arrangement used for monitoring this shall be such that it does not interfere electrically or otherwise, with the normal functioning of the air conditioning system.

### 5.2 Air Temperatures at Outlets and Inlets

Additional temperature sensors may be used at all the air outlets to study the availability of cool air and any imbalance in the temperature distribution among the outlets. These, in addition to the temperatures at the blower inlets, would help in identifying sources of external air infiltration.

**5.2.1** *Frosting of the Cooling Coil*

Any frost formation on the cooling coil would result in reduced air How through the air outlets. This may be assessed subjectively and the causes of frosting identified from the system operating pressures.