Quality document	Title: Evaluation Standard for Controllability of Auto Air	Number: ASP-T-0301
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1. Purpose

   This is to evaluate the controllability of auto air conditioners under vehicle-installed condition and amenity for passengers in environmental test chamber.

2. Applicable Range

   In this standard, test methods for a controllability of auto air conditioners and amenity that are conducted with an actual vehicle in the environmental chamber are specified and this standard shall be applied to automobiles equipped with auto air conditioners. (Note: Excluding construction vehicles, heavy trucks and open-cars).

   However, the applicable range shall be determined separately when a customer specifies particularly.

3. Meaning of Terms

   Tout: Recognized value of outdoor air temperature by a controller.

   Tin: Recognized value of indoor air temperature by a controller.

   Rsun: Recognized value of solar power by a controller.

   Teva: Recognized value of air temperature after an evaporator by a controller.

   M/A: Motor Actuator.

   rms: Effective Value (root mean square)

   FS: Full Scale

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4. Testing Particulars

As auto air conditioners are used in a wide ranged environment, namely, high or low ambient temperature, with or without solar radiation, etc., auto air conditioning features to maintain amenity for passengers according to such situation is required.

Therefore, an evaluation test of auto air conditioners consists of following 5 particulars and controllability of these 5 particulars is evaluated in every test. A relation between evaluation judgment tests and evaluation test particulars is shown below.

Testing particular that is not able to evaluate functionally shall be excluded.

No.	Evaluation Test Particulars	Evaluation Judgment Test Particulars	
1	Auto cooling-down test	Fan control characteristic	Fan start-up characteristics, fan drop point, fan drop angle, fan hunting.
		Intake door control characteristic	Increase of blowout temperature at intake variation, switching point, intake hunting, discharge pressure and room temperature increase during IDLE.
		Air-mix door control characteristic	Air-mix hunting, mode switching.
		Room temperature amenity	Room temperature control point, sensible evaluation.
2	Auto warming-up test	Fan control characteristic	Fan start-up characteristics, fan drop point, fan hunting.
		Air-mix door control characteristic	Air-mix hunting, mode switching.
		Room temperature amenity	Room temperature control point, sensible evaluation.
3	Set-up temperature change test	Fan control characteristic	Fan hunting.
		Intake door control characteristic	Intake hunting.
		Mode control characteristic	Mode hunting.
		Air-mix door control characteristic	Air-mix hunting, room temperature responsiveness, mode switching.
		Room temperature amenity	Room temperature control point, sensible evaluation.
4	Cooler ON/OFF test	Air-mix door control characteristic	Cooler ON/OFF following capacity.
5	Solar power variation test	Air-mix door control characteristic	Solar ON/OFF following capacity.

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5. Specimen

Selection of specimen: As for specimen that may affect features, select from products that have a median value of specifications. For other air conditioning parts, those shall be a genuine product or final specifications at the developing stage. Also, select specifications of the major model (hot seller), if there are many varieties (vehicle type, engine type) in vehicle model specifications. Details of specimen selection standard are shown below;

(Table) Selection standard of specimen

				Selection standard	Remarks
Air conditioner specifications	Auto air conditioning specifications	Air mix potentio characteristic		Within a range of designed specifications	Characteristic data shall be obtained in advance.
		Auto air conditioning controller			
		Sensor	Engine water temperature sensor		
			Indoor temperature sensor	Within median value of designed specifications ±1%.	Installation position shall be a legitimate or the final position. (Supply sensor included in applied system)
			Outdoor temperature sensor		
			Solar radiation sensor		
		Auto air conditioning amplifier		Control flow logic constant, etc. shall be satisfied.	Design drawing and data shall be obtained in advance.
				With monitor output function.	
	Heater air conditioning specifications	Standard heater unit shall be selected.		Standard unit or major model unit.	Subject to the latest specifications as at when a test is conducted.
		Temperature control characteristic		Data of blowout temperature, discharge temperature difference at both sides and discharge temperature difference at top/bottom in respective modes shall be obtained in advance.	
		Dispersion range of blowout temperature			
		Air volume, air distribution ratio			
	Cycle air conditioning specifications	Compressor		It shall be a final specification as at when a test is conducted.	
		Condenser			
		Piping hoses			
		Evaporator	Core size, fin pitch		
			Expansion valve	It shall be a medial value of design specifications± 1%.	
		Volume of sealed- in refrigerant		It shall be a medial value of design specifications± 5%.	
	Other air conditioner components			These shall be a condition of genuine duct, grill and foot-chamber or the final specification as at when a test is conducted.	
Specimen vehicle specifications	Model	Standard model shall be selected		Major model	Model and engine shall be taken into account.
	Vehicle condition	Body air-tightness		Data shall be obtained. These shall be within a range conforming to design standards.	These shall be a genuine condition or the final specification as at a development stage.
		Vehicle structural parts		Engine heat blow-back	
	Engine	Thermostat		No defect shall be found in specifications shown in the right column.	Valve opening volume, lift volume, and leakage volume.

Explanation of terms

With monitor output function: With output function of control calculated value.

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6. Environmental Load Conditions and Test Methods

Followings are conditions subject to domestic specifications.

As to auto cooling-down and auto warming-up test for North America (including South East Asia, Middle East), following climate conditions shall be applied.

Auto cool-down: outdoor temperature 40±1℃, relative humidity 30±10%RH, solar power 1050W/m^2±5%

Auto warm-up: outdoor temperature -20±1℃.

Conditions \ Testing particulars			Auto cooling-down	Auto warming-up	Stability, manual operability after stabilization, disturbance controllability after stabilization.										
					Set-up temperature change					Cooler ON/OFF			Solar power variation		
Environmental load	Outdoor temperature ±1 [℃]		35	-10	35	20	10	0	-10	20	15	10	20	10	
	Relative humidity±5 [%]		70	Course	70	Course				Course			Course		
	Solar power [W/m^2]±5%	770	○		○	○	○	○					0 → 770 → 0		
		0		○	○	○	○	○	○	○	○	○			
Test Methods	Conditions before soaking	Solar power [W/m^2]	0	N.A	N.A					N.A			N.A		
		Door, window	Full open												
		Front wind [m/s]	Any												
		Air temperature after evaporator	Outdoor temp. ±2℃												
		Engine water temperature	Within outdoor temp. ±5℃												
		Duration [min]	Any												
	Soaking	Solar power [W/m^2]	770	0	N.A					N.A			N.A		
		Door, window	Full open	Full open											
		Front wind [m/s]	0	Any											
		Air temperature after evaporator	Course	Outdoor temp. ±2℃											
		Engine water temperature	Course	Within outdoor temp. ±5℃											
		Duration [min]	60	Any											
	Passenger soak		5 min. before boarding	5 min. before boarding	N.A					N.A			N.A		
	Number of passengers		2 (Note 1)	2 (Note 1)	2 (Note 1)					2 (Note 1)			2(Note 1)		
	Vehicle speed ±3[km/h]		40→100→IDLE	40→100→IDLE	40					40			40		
	Air conditi	Control mode	AUTO	AUTO	AUTO					AUTO→OFF →AUTO			AUTO		
		Set-up temperature	25	25	25→22→28→25					25			25		
		Mode door (Note 3)	AUTO	AUTO	AUTO					(Note3)			AUTO		
		Intake door (Note 5)	AUTO	AUTO	AUTO					AUTO			AUTO		
	Duration	40km/h	Until stabilization (Note 5) or max.60 minutes		Until being stabilized (Note 6) or max. 30 minutes.										
		100km/h	Until being stabilization (Note5) or max.30 minutes												
		IDLE	Until being stabilization (Note 5) or max.30 minutes												

Note 1. During PMV measurement, one passenger is seated at a driving seat and the side-seat shall be reserved for PMV measurement. For a sensible evaluation by a passenger, volume of clothes shall be determined referring to the following table.

⚠1	Outdoor temperature [℃]	40, 35, 30	20	15, 20	0, -10, -20
	Volume of clothes [clo]	0.8	1.0	1.1	1.2
	Clothes (Reference)	Brief, short sleeve singlet, short sleeve shirt, summer slacks, normal socks, flat shoes.	Brief, short sleeve singlet, long sleeve shirt, vest, summer slacks, normal socks, flat shoes.	Brief, long sleeve singlet, long sleeve shirt, vest, winter slacks, normal socks, double-soled shoes.	Brief, long sleeve singlet, long sleeve shirt, sweater, winter slacks, normal socks, double-soled shoes.

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Note 2. If AUTO is not equipped with mode door, set up mode door as shown below.

Outdoor temperature	40, 25, 20			15			10			0			-10			-20		
Set-up temperature	25	22	28	25	22	28	25	22	28	25	22	28	25	22	28	25	22	28
VENT	○	○	○	○	○	○	○	○										
BI-LEVEL									○	○	○	○	○	○				
FOOT															○	○	○	○

Note 3. When outdoor temperature is 20℃: VENT, 15℃: FOOT, 10℃: FOOT.

Note 4. When AUTO is not equipped to the intake door, auto cooling-down test: REC. Other than this case, it shall be FRESH.

Note 5. Stabilization means a situation where variation of average room temperature is within 0.5deg/10minutes, or hunting repeat 2 to 3 cycles with the same range.

Note 6. Using gears during run test are shown below;

	40km/h	100km/h	IDLE
4 speed M/T	Top gear	Top gear	Neutral
5 speed M/T	↑	Top gear	↑
3 speed A/T	D-range	D range	N-range
4 speed A/T	E-range (OD OFF)	D-range (OD OFF)	↑

Note 7. Evaluation around heating area of outdoor air sensor part during IDLE shall be conducted by an actual running test.