C-AHI

China-Automobile Health Index

No.: CAHI-SM-EEI-A0-2023

Energy Efficiency and Emission Index

Energy Efficiency and Emission Testing and Evaluation Protocol

(Version 2023)

Published by China Automotive Engineering Research Institute Co., Ltd.

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Energy Efficiency and Emission Testing and Evaluation Protocol

1 Scope

This document specifies the relevant tests and evaluation methods for green travel in China-Automobile Health Index.

This document is applicable to M_1 internal combustion engine vehicle, M_1 battery electric passenger cars and M_1 hybrid electric passenger cars with a maximum design gross mass not exceeding 3500 kg, which can be used as a reference for other vehicles.

2 Normative References

The following normative documents contain provisions which, through reference in this text, constitute indispensable provisions of this document. For dated references, only the dated edition applies to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB/T 15089-2001 Classification of Power-driven Vehicles and Trailers

GB 18352.6-2016 Limits and Measurement Methods for Emissions from Light-duty Vehicles (CHINA 6)

GB/T 18386.1-2021 Test Methods for Energy Consumption and Range of Electric Vehicles - Part 1: Light-duty Vehicles

GB/T 19233-2020 Measurement Methods of Fuel Consumption for Light-duty Vehicles

GB 19578-2021 Fuel Consumption Limits for Passenger Cars

GB/T 19596-2017 Terminology of Electric Vehicles

GB/T 19753-2021 Test Methods for Energy Consumption of Light-duty Hybrid Electric Vehicles

GB/T 32694-2021 Plug-in Hybrid Electric Passenger Cars - Specifications

Measures for the Parallel Administration of the Average Fuel Consumption and New Energy Vehicle Credits of Passenger Vehicle Enterprises (2023-07-25)

3 Terms and Definitions

For the purposes of this document, the following terms and definitions and those defined in GB/T 15089-2001 and GB/T 19596-2017 apply.

3.1 internal combustion engine vehicle

passenger cars (including NOVC-HEV) using gasoline or diesel with a maximum design gross mass not exceeding 3500 kg

3.2 plug-in hybrid electric vehicle; PHEV

a HEV that can obtain electric energy from off-board devices under normal operation conditions

3.3 battery electric mini vehicle

M_1 battery electric passenger cars with body length less than 4 m

3.4 battery electric general vehicle

M_1 battery electric passenger cars with body length of 4 m or more

4 Test Method

See Table 1 for each test method of green travel.

Table 1 List of Green Travel Test Methods

No.	Vehicle type	Dimension	Test Scenario	Test method
1	Internal combustion engine vehicle (including NOVC-HEV)	Low-carbon, energy-saving	Energy consumption in congestion scenarios	See Annex A for details.
2			Energy consumption in high temperature scenarios	See Annex B for details.
3			Energy consumption in low temperature scenarios	See Annex C for details.
4			Energy consumption in normal temperature scenarios	GB/T 19233-2020 (announcement evaluation)
5	Plug-in hybrid electric vehicle	Low-carbon, energy-saving	Fuel consumption increase rate with A/C ON at high temperature (CS)	See Annex G for details.
6			Power consumption (CD)	GB/T 19753-2021 (announcement evaluation)
7			Fuel consumption (CS)	
8		Endurance maintenance	Attenuation rate of equivalent all-electric range at high temperature (CD)	See Annex F for details.
9			Attenuation rate of equivalent all-electric range at low temperature (CD)	See Annex F for details.
10	Battery electric passenger car	Low-carbon, energy-saving	Power consumption per 100 km under WLTC at normal temperature	See Annex D for details.
11			Charging time per 100 km	See Annex E for details.
12		Endurance maintenance	Driving range attenuation rate under WLTC at high temperature	See Annex D for details.
13			Driving range attenuation rate under WLTC at low temperature	See Annex D for details.
14			Driving range attenuation rate at a constant speed of 120 km/h at normal temperature	See Annex D for details.
15			Driving range attenuation rate under WLTC at normal temperature	See Annex D for details.

5 Evaluation Method

5.1 Evaluation of Internal Combustion Engine Vehicle

The evaluation of internal combustion engine vehicle (including NOVC-HEV) consists of fuel consumption in congestion scenarios ($FC_{congestion}$), fuel consumption in high temperature scenarios (FC_{HT}), fuel consumption in low temperature scenarios (FC_{LT}) and fuel consumption in normal temperature scenarios (FC_{NT}). See Table 2 for the evaluation of internal combustion engine vehicle.

Table 2 Evaluation of Internal Combustion Engine Vehicle

Vehicle type	Fuel Consumption in Congestion Scenarios ($FC_{congestion}$)	Fuel Consumption in High Temperature Scenarios [2] (FC_{HT})	Fuel Consumption in Low Temperature Scenarios [2] (FC_{LT})	Fuel Consumption in Normal Temperature Scenarios [3] (FC_{NT})	Scoring Criteria S [4] (100-Point System)
Internal combustion engine vehicle (including NOVC-HEV)	$FC_{congestion}$ = 1.40 FC_L	FC_{LT} = 1.40 FC_L	FC_{LT} = 1.40 FC_L	FC_{NT} = 1.00 FC_L	S = 0 point
	$FC_{congestion}$ = 1.10 FC_L	FC_{LT} = 1.10 FC_L	FC_{LT} = 1.10 FC_L	FC_{NT} = 0.85 FC_L	S = 60 points
	$FC_{congestion}$ = 0.80 FC_L	FC_{LT} = 0.80 FC_L	FC_{LT} = 0.80 FC_L	FC_{NT} = 0.70 FC_L	S =100 points

Note 1: FC_L is the fuel consumption limit in GB 19578-2021 of this vehicle type with curb weight.

Note 2: If the vehicle fails to meet the corresponding temperature requirements 15 minutes after being activated during the test, 2 points will be deducted for each additional minute, with a maximum of 10 points.

Note 3: The fuel consumption in normal temperature scenarios is the announced value corresponding to this vehicle type.

Note 4: The specific score is linearly interpolated inward in Area S of the scoring criteria.

5.2 Evaluation of plug-in hybrid electric vehicle

See Table 3 for the evaluation of plug-in hybrid electric vehicle.

Table 3 Evaluation of Plug-in Hybrid Electric Vehicle

Vehicle type	Power consumption (CD mode) [1] (kWh/100km)	Fuel consumption (CS mode) [2] (kWh/100km)	Fuel consumption increase rate with A/C ON at high temperature [3] (CS mode) (%)	Attenuation rate of equivalent all-electric range at low temperature [3] (CD mode) (%)	Attenuation rate of equivalent all-electric range at high temperature [3] (CD mode) (%)	Scoring Criteria S [4] (100-Point System)
Plug-in hybrid electric vehicle	E_{NT} = 1.5E	Y_{NT} = 0.9°C	β_{HT} = 40%	η_{LT} = 55%	η_{HT} = 20%	S = 0 point
	E_{NT} = 1.35E	Y_{NT} = 0.7°C	β_{HT} = 32%	η_{LT} = 45%	η_{HT} = 15 %	S = 60 points
	E_{NT} = 0.8E	Y_{NT} = 0.4°C	β_{HT} = 13%	η_{LT} = 30 %	η_{HT} = 5%	S =100 points

Note 1: According to the *Measures for the Parallel Administration of the Average Fuel Consumption and New Energy Vehicle Credits of Passenger Vehicle Enterprises*, the power consumption of plug-in hybrid electric vehicles in CD mode shall be less than 135% of the limit value of battery electric passenger cars. When M≤1000, E=0.0112M+0.4, when 1000<M≤1600, E=0.0078M+3.8, and when M>1600, E=0.0048M+8.60.

Note 2: According to the *Measures for the Parallel Administration of the Average Fuel Consumption and New Energy Vehicle Credits of Passenger Vehicle Enterprises*, the fuel consumption of plug-in hybrid electric vehicles in CS mode shall be less than 70% of the limit value in GB 19578-2021. When M≤750, C=6.27, when 750<M≤2510, C=0.0042(M-1415) +9.06, and when M>2510, C=13.66.

Note 3: If the vehicle is corrected by WLTC correction during the test, 5 points will be deducted from the score of the corresponding item. If the vehicle fails to meet the corresponding temperature requirements 15 minutes after being activated during the test, 2 points will be deducted for each additional minute, with a maximum of 10 points.

Note 4: The specific score is linearly interpolated inward in Area S of the scoring criteria.

5.3 Evaluation of Battery Electric Passenger Cars

Battery electric passenger car are divided into general vehicles and mini vehicles, and the evaluation is carried out according to Table 4.

Table 4 Evaluation of Battery Electric Passenger Cars

Vehicle type	Driving range attenuation rate under WLTC at normal temperature [1] (%)	Driving range attenuation rate at a constant speed of 120 km/h (%)	Energy consumption rate under WLTC at normal temperature [1, 2] (kWh/100km)	Driving range attenuation rate under WLTC at low temperature [1,3] (%)	Driving range attenuation rate under WLTC at high temperature [1,3] (%)	Charging time per 100 km (min)	Scoring Criteria S [4] (100-Point System)
General vehicle	Y_{NT} = 30%	$Y_{constant\ speed}$ = 55%	E_{NT} = 1.3E	Y_{LT} = 55%	Y_{HT} = 20%	T_{100km}=28min	S = 0 point
	Y_{NT} = 20%	$Y_{constant\ speed}$ = 50%	E_{NT} = 1.2E	Y_{LT} = 45%	Y_{HT} = 13%	T_{100km}=18min	S = 60 points
	Y_{NT} = 10%	$Y_{constant\ speed}$ = 30%	ENT = 0.8E	Y_{LT} = 25%	Y_{HT} = 3%	T_{100km}=10min	S =100 points
Mini vehicle	Y_{NT} = 30%	——	E_{NT} = 1.15E	Y_{LT} = 60%	Y_{HT} = 35%	——	S = 0 point
	Y_{NT} = 20%		E_{NT} = 1.05E	Y_{LT} = 55%	Y_{HT} = 25%		S = 60 points
	Y_{NT} = 5%		E_{NT} = 0.95E	Y_{LT} = 35%	Y_{HT} = 10%		S =100 points

Note 1: If the vehicle is corrected by WLTC correction during the test, 5 points will be deducted from the score of the corresponding item.

Note 2: According to the *Measures for the Parallel Administration of the Average Fuel Consumption and New Energy Vehicle Credits of Passenger Vehicle Enterprises*, when M≤1000, E=0.0112M+0.4; When 1000<M≤1600, E=0.0078M+3.8; When M>1600, E=0.0048M+8.60.

Note 3: If the vehicle fails to meet the corresponding temperature requirements 15 minutes after being activated during the test, 2 points will be deducted for each additional minute, with a maximum of 10 points.

Note 4: The specific score is linearly interpolated inward in Area S of the scoring criteria.

5.4 Calculation method of green travel weighted score

The full score of each test scenario of green travel is 100 points, and the total weighted score of all test scenarios is 100 points. Total weighted points = ∑ (score of each scenario * weight). Refer to Table 5 for details.

Table 5 Calculation Method of Green Travel Weighted Score

No.	Vehicle type	Dimension	Test Scenario	Weight		Score
1	Internal combustion engine vehicle (including NOVC-HEV)	Low-carbon, energy-saving	Energy consumption in congestion scenarios	30%		100
2			Energy consumption in high temperature scenarios	20%		
3			Energy consumption in low temperature scenarios	20%		
4			Energy consumption in normal temperature scenarios	30%		
5	Plug-in hybrid electric vehicle	Low-carbon, energy-saving	Fuel consumption increase rate with A/C ON at high temperature (CS)	25%		100
6			Power consumption (CD)	10%		
7			Fuel consumption (CS)	15%		
8		Endurance maintenance	Attenuation rate of equivalent all-electric range at high temperature (CD)	20%		
9			Attenuation rate of equivalent all-electric range at low temperature (CD)	30%		
10	Battery electric passenger car	Low-carbon, energy-saving	Power consumption per 100 km under WLTC at normal temperature	10%	20%	100
11			Charging time per 100 km	10%	——	
12		Endurance maintenance	Driving range attenuation rate under WLTC at high temperature	15%	30%	
13			Driving range attenuation rate under WLTC at low temperature	20%	30%	
14			Driving range attenuation rate at a constant speed of 120 km/h at normal temperature	20%	——	
15			Driving range attenuation rate under WLTC at normal temperature	25%	20%	
		Model		General vehicle	Mini vehicle	——

5.5 Green travel rating method

A rating shall be given to the corresponding final weighted score (S) according to Table 6.

The rating is 1-star for a vehicle type scoring lower than 50 points, 2-star for one scoring [50, 65) points, 3-star for one scoring [65, 75) points, 4-star for one scoring [75, 85) points, and 5-star for one scoring [85, 100] points.

Table 6 Correspondence between Star Rating and Scores

Star Rating	Score Range	Rating Sign
1-star	S＜50	★
2-star	50≤S＜65	★★
3-star	65≤S＜75	★★★
4-star	75≤S＜85	★★★★
5-star	85≤S≤100	★★★★★

Annex A
(Normative)
Test Method of Fuel Consumption for Internal Combustion Engine Vehicle in Congestion Scenario

This annex describes the test method of fuel consumption for internal combustion engine vehicle in congestion scenario. In view of the commuting scenarios in urban areas concerned consumers, the simulated congestion conditions are composed of low speed section, low speed section, medium speed section and low speed section under the World Harmonized Light Vehicle Test Cycle (WLTC) described in Annex CA in GB 18352.6-2016. The total range of the cycle is 14 km, with a duration of 2200 s and an average speed of 23 km/h.

A.1 Requirements for test conditions

A.1.1 Requirements for test room and equipment

For the requirements for test room and equipment, the relevant provisions in GB 18352.6-2016 shall apply.

A.1.2 Requirements for environmental conditions

The test room environment shall meet the requirements of C.1.2.2 in GB 18352.6-2016.

A.1.3 Vehicle preparation

Vehicle preparation shall be carried out as per 5.2 and 5.3 in GB/T 19233-2020.

A.1.4 Requirements for test fuel

The test fuel shall meet the technical requirements for reference gasoline in Annex K.2.1 or that for reference diesel in Annex K.2.3 in GB 18352.6-2016.

A.2 Test method

A.2.1 Test cycle

The congestion condition test cycle consists of four parts in turn: low speed section (Low), low speed section (Low), medium speed section (Medium) and low speed section (Low) under the WLTC described in Annex CA in GB 18352.6-2016, with a total duration of 2200 s. The duration of the low speed section is 1767 s, and that of the medium speed section is 433 s.

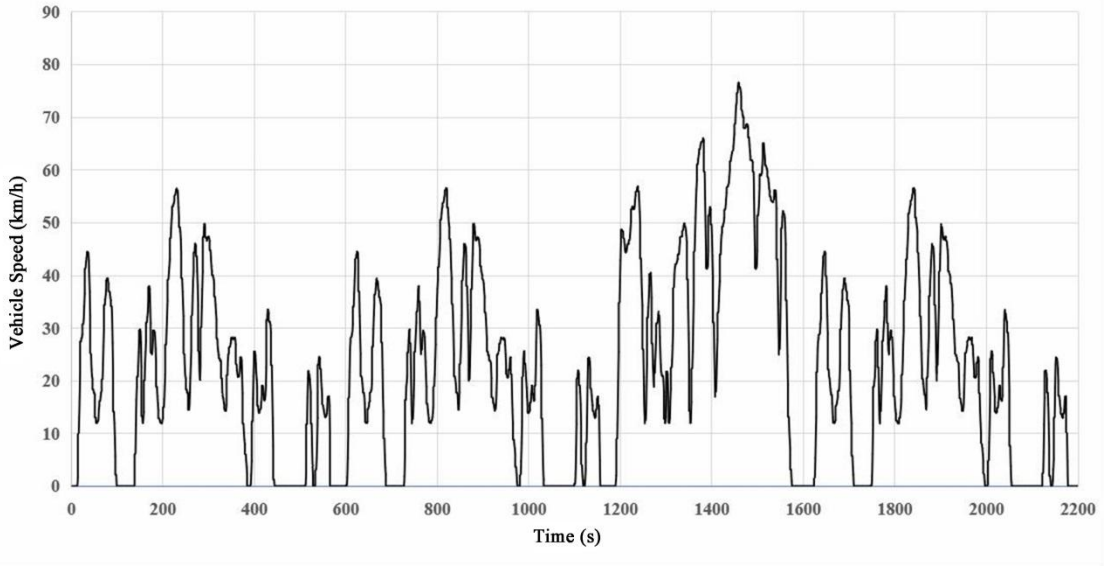

Fig. A.1 Schematic Diagram of Test Cycle in Congestion Scenario

A.2.2 Test preparation

Set the chassis dynamometer as required in 6.2 in GB/T 19233-2020.

For VUT with manual transmission, its gearshift selection and calculation method of gearshift point shall comply with Annex CB in GB 18352.6-2016.

Road load measurement and dynamometer setting shall comply with Annex CC in GB 18352.6-2016. The vehicle road load shall be determined by the coastdown method, which shall be used as an input to the program for simulating road driving resistance by chassis dynamometer in congestion scenario tests.

The test equipment and calibration shall comply with Annex CD in GB 18352.6-2016.

Place the vehicle and connect the exhaust gas sampling system and other test equipment to confirm that the fuel pipeline is free of leakage and fully exhausted.

A.2.3 Preconditioning and soaking

The VUT shall be preconditioned and soaked according to C.1.2.6 and C.1.2.7 in GB 18352.6-2016 respectively.

A.2.4 Determination of emissions

Place the vehicle and connect the exhaust gas sampling system and other test equipment to confirm that the fuel pipeline is free of leakage and fully exhausted.

The ambient temperature shall be set according to the requirements for environmental conditions in A.1.2.

The chassis dynamometer shall be set according to A.2.2.

The test shall be carried out in accordance with the provisions in C.1.2.8 to C.1.2.14 in GB 18352.6-2016.

A.3 Calculation of fuel consumption

The HC, CO and CO_2 emissions shall be obtained according to the method in A.2.4, and then the fuel consumption ($FC_{congestion}$) in congestion scenarios shall be calculated.

Calculate the fuel consumption with Formula (A.1) and Formula (A.2), in L/100 km:

a) For vehicles equipped with gasoline engines:

$$FC_{congestion} = \frac{0.1155}{D}[\ (0.866\times HC) + (0.429\times CO) + (0.273\times CO_2)\ ] \quad \text{(A.1)}$$

b) For vehicles equipped with diesel engines:

$$FC_{congestion} = \frac{0.1156}{D}[\ (0.866\times HC) + (0.429\times CO) + (0.273\times CO_2)\ ] \quad \text{(A.2)}$$

Where,

$FC_{congestion}$ - fuel consumption in congestion scenarios, in L/100 km, rounded to 2 decimal places;

HC - hydrocarbon emission, in g/km;

CO - carbon monoxide emission, in g/km;

CO_2 - carbon dioxide emission, in g/km;

D - density of test fuel at 288 K (15°C), in kg/L.

Annex B
(Normative)
Test Method of Fuel Consumption for Internal Combustion Engine Vehicle in Low Temperature Scenario

B.1 Requirements for test conditions

B.1.1 Requirements for test room and equipment

For the requirements for test room and equipment, the relevant provisions in GB 18352.6-2016 shall apply.

B.1.2 Requirements for environmental conditions

The average temperature in the environment shall be set to (-7±3)°C, with the instantaneous temperature neither being lower than -13°C nor higher than -1°C, and the temperature not being lower than -10°C or higher than -4°C for 3 consecutive minutes. The air humidity shall be low enough to prevent condensation of water vapor on the chassis dynamometer.

During the test, the test room temperature shall be monitored and measured at the outlet of the cooling fan. The ambient temperature shall be the arithmetic mean of test room temperatures measured at a regular interval of not more than 1 min.

B.1.3 Vehicle preparation

Vehicle preparation shall be carried out as per 5.2 and 5.3 in GB/T 19233-2020.

B.1.4 Requirements for test fuel

The test fuel shall meet the technical requirements for reference gasoline in Annex K.2.1 or that for reference diesel in Annex K.2.3 in GB 18352.6-2016.

B.2 Setting of heating device

B.2.1 General requirements

During the test, close all windows and set the A/C to the external circulation and foot mode to make the average temperature of in-vehicle temperature measuring points reach above 20°C as soon as possible. Afterwards, the average temperature shall be kept within the range of 20°C~22°C as far as possible until the end of the test. Whether to turn on the defrosting and demisting device shall be determined as required by the automobile manufacturers. If it is turned on, the duration shall also be set as required by the automobile manufacturer.

Temperature measuring point of passenger compartment: Arrange temperature measuring points for each front-row passenger seat. For longitudinally adjustable seats, keep them locked in the middle position of their travel or the rearward position closest to the middle position. For seats whose height can be adjusted separately, adjust them to the position designed by the manufacturer or the lowest position. The backrest of the seat shall be adjusted to the angle designed by the manufacturer or 25 ° backward from the vertical plane. The positions of temperature measuring points are shown in Fig. B.1.

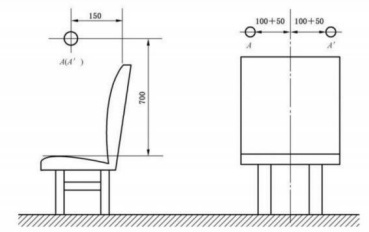

Fig. B.1 Location of Temperature Measuring Point (Point A or Point A')

B.2.2 Heating device of automatic control system

a) For an automatic A/C with forced preset mode, set the temperature to the highest value according to the preset settings of the A/C itself. If the requirements cannot be met, switch to the manual mode for control. When the temperature inside the vehicle reaches 21°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (20~22)°C.

b) For an automatic A/C without forced preset mode, select "Auto", set the temperature to the highest value, and select external circulation and foot mode. When the temperature inside the vehicle reaches 21°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (20~22)°C, and keep the air volume at the middle level.

B.2.3 Heating device of manual control system

For a manual A/C, set the temperature adjustment switch to the maximum heating mode position, set the air volume adjustment switch to the maximum position, and set the air circulation switch to the external circulation and foot mode. After the temperature inside the vehicle reaches 21°C, put the air volume adjustment switch to the middle position and adjust the temperature knob to keep the average temperature of in-vehicle temperature measuring points within the range of 20°C~22°C as far as possible.

B.2.4 Heating device with middle and rear air outlets

For vehicles with middle and rear air outlets, close or seal the outlets. Set the front vents to the maximum opening position, with their direction facing the middle position.

B.3 Test method

B.3.1 Test cycle

The test shall be carried out on the chassis dynamometer according to the WLTC described in Annex CA in GB 18352.6-2016, including low speed section (Low), medium speed section (Medium), high speed section (High) and extra high speed section (Extra High), with a total duration of 1800 s.

B.3.2 Preconditioning

Set the ambient temperature for preconditioning according to C.1.2.2 in GB 18352.6-2016.

Set the chassis dynamometer as required in 6.1.1 in GB/T 18368.1-2021. According to Annex H.2.2.1 in GB 18352.6-2016 and based on the vehicle road load determined according to Annex CC in GB 18352.6-2016, obtain the resistance by reducing the coastdown time by 10% and use it as an input to the program for simulating road driving resistance by chassis dynamometer during the low temperature test at -7°C.

One preconditioning shall be carried out via the test cycle specified in B.3.1.

B.3.3 Soaking

Shut down the engine within 10 min after preconditioning and move the vehicle to the soaking workshop. If the vehicle passes through a zone at other temperatures during this period, the duration shall not exceed 10 min. The vehicle shall be soaked in the environment specified in B.1.2 for 12 h~15 h with all windows closed. During vehicle soaking, keep the average ambient temperature per hour within the range of (-7±3)°C, keep the instantaneous temperature within the range of (-7±6)°C and never let the temperature exceed (-7±3)°C for continuous 3 min.

If the soaking zone is not the same facility as the formal test environment chamber, the vehicle shall be moved to the formal test environment chamber as soon as possible after the soaking is completed. If the vehicle passes through a zone at other temperatures, the duration shall not exceed 10 min. Start the test within 20 min after entering the environment chamber.

B.3.4 Determination of emissions

Place the vehicle and connect the exhaust gas sampling system and other test equipment to confirm that the fuel pipeline is free of leakage and fully exhausted.

The ambient temperature shall be set according to the requirements for environmental conditions in B.1.2.

The chassis dynamometer shall be set according to B.3.2.

The vehicle A/C shall be turned on and set according to setting of heating device in B.2.

The test shall be carried out in accordance with the provisions in C.1.2.8 to C.1.2.14 in GB 18352.6-2016.

B.4 Test results

The emissions of HC, CO and CO_2 are obtained by the method in B.3.4, and the fuel consumption in low temperature (FC_{LT}) is calculated according to the method in A.3.

Annex C
(Normative)
Test Method of Fuel Consumption for Internal Combustion Engine Vehicle in Low Temperature Scenario

C.1 Requirements for test conditions

C.1.1 Requirements for lighting system

The full spectrum shall be adopted.

The radiation area shall not be smaller than 6 m × 2.5 m.

The maximum radiation intensity shall not be less than 1000 W/m^2.

The error of radiation intensity shall not be greater than ±45 W/m^2.

The radiation uniformity shall not exceed 10%.

C.1.2 Technical requirements for cooling fan

The nozzle section of fan shall not be less than the area of air inlet grille.

The maximum speed of fan shall not be less than 120 km/h.

The nozzle of fan shall be not more than 1 m away from the front edge of vehicle.

C.1.3 Other technical requirements

The error of ambient temperature shall not be more than ±2.0°C.

The error of relative humidity of the environment shall not be more than ±5%.

For other unspecified test equipment and test room requirements, the relevant provisions of GB 18352.6-2016 shall apply.

C.1.4 Requirements for environmental conditions

The ambient temperature shall be (35±2)°C. The ambient relative humidity shall be (50±5)%.

The solar radiation intensity shall be (1000±45) W/m^2 during vehicle soaking and fuel consumption test with A/C for cooling, and there shall be no solar radiation during the rest of the test. The solar radiation intensity shall be set based on the plane position of the highest point of the vehicle body.

C.1.5 Vehicle preparation

Vehicle preparation shall be carried out as per 5.2 and 5.3 in GB/T 19233-2020.

For the vehicle with an idling start-stop system, the idling start-stop system shall be switched off or deactivated by appropriate means.

C.1.6 Test fuel preparation

The test fuel shall meet the technical requirements for reference gasoline in Annex K.2.1 or that for reference diesel in Annex K.2.3 in GB 18352.6-2016.

C.2 Setting of A/C for cooling

For an automatic A/C with forced preset mode, set the temperature to the lowest value according to the preset settings of the A/C itself. If the requirements cannot be met, switch to the manual mode for control. When the temperature inside the vehicle reaches 24°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (23~25)°C.

For an automatic A/C without forced preset mode, select "Auto", set the temperature to the lowest value, and select internal circulation and face mode. When the temperature inside the vehicle

reaches 24°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (23~25)°C, and keep the air volume at the middle level.

For a manual A/C, select the maximum cooling mode, maximum air volume, internal circulation and face mode. When the temperature inside the vehicle reaches 24°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (23~25)°C, and keep the air volume at the middle level.

For vehicles with middle and rear air outlets, close or seal the outlets. Set the front vents to the maximum opening position, with their direction facing the middle position.

See B.2.1 and Fig. B.1 for the temperature measuring points of passenger compartment.

C.3 Test method

C.3.1 Test cycle

The test shall be carried out on the chassis dynamometer according to the WLTC described in Annex CA in GB 18352.6-2016, including low speed section (Low), medium speed section (Medium), high speed section (High) and extra high speed section (Extra High), with a total duration of 1800 s.

C.3.2 Preconditioning

Set the ambient temperature and humidity according to C.1.4.

Set the chassis dynamometer as required in 6.2 in GB/T 19233-2020. The vehicle road load shall be determined by the coastdown method, which shall be used as an input to the program for simulating road driving resistance by chassis dynamometer in congestion scenario tests.

With all windows open, the A/C shall be set to external circulation mode and the air volume adjusting switch shall be set at the middle position (rounded to the next higher position). During the process, the compressor shall stay off.

The vehicle shall run at a constant speed of (90±2) km/h for 20 min.

C.3.3 Soaking

The vehicle shall be soaked in the environment specified in C.1.4 for at least 0.5 h with the engine and all windows closed.

C.3.4 Determination of emissions

Place the vehicle and connect the exhaust gas sampling system and other test equipment to confirm that the fuel pipeline is free of leakage and fully exhausted.

The environmental conditions shall be set according to the requirements for environmental conditions in C.1.4.

The vehicle A/C shall be turned on and set according to C.2.

The test shall be conducted according to the requirements of Chapter 6 in GB/T 19233-2020.

C.4 Test results

The emissions of HC, CO and CO_2 are obtained by the method in C.3.4, and the fuel consumption in high temperature (FC_{HT}) is calculated according to the method in A.3.

Annex D
(Normative)
Test Methods of Range and Energy Consumption for Battery Electric Passenger Cars

D.1 Scope

This method is applicable to M_1 battery electric passenger cars.

D.2 Test conditions

D.2.1 Environmental conditions

The temperature of high temperature environment shall be set to (35±2)°C, the air humidity to (50±5)%RH and the illumination intensity to (1000±45) W/m^2. The solar radiation intensity shall be set based on the plane position of the highest point of the vehicle body.

The temperature of normal temperature environment shall be set to (23±2)°C.

The temperature of low temperature environment shall be set to (-7±3)°C.

During the test, the test room temperature shall be monitored and measured at the outlet of the cooling fan. The ambient temperature in the report shall be the arithmetic mean of test room temperatures measured at a regular interval of not more than 1 min.

D.2.2 Vehicle conditions

All components of the vehicle shall meet the requirements for mass production.

The vehicle may be subject to running-in according to the needs of the automobile manufacturer or its authorized agent, and the mechanical condition shall be ensured to be good; in addition, the running-in distance shall be 1000 km with the original traction battery. The original traction battery shall be subjected to at least one course from the fully charged state to the minimum value of state of charge (SOC).

The lubricant specified by the automobile manufacturer shall be used.

Except for the ones used for driving purpose, all energy storage systems shall be charged to the maximum values (electric energy, hydraulic pressure, air pressure, etc.) specified by the automobile manufacturer.

The starting of the vehicle power system shall be carried out as required by the automobile manufacturer.

According to C.1.2.4.4 in GB 18352.6-2016, confirm that the settings of vehicle control and powertrain are the same as those of mass-produced models.

According to C.1.2.4.5 in GB 18352.6-2016, confirm that the vehicle tire model is consistent with the regulations of the automobile manufacturer.

D.2.3 Chassis dynamometer conditions

According to C.1.2.4.2 in GB 18352.6-2016, determine the operation of the vehicle on the dynamometer.

The test mass of the vehicle shall be defined with reference to 3.9 and Annex CC in GB 18352.6-2016, equivalent to the sum of the reference mass, the mass of optional equipment and the mass representative of the vehicle load.

The road load measurement and dynamometer setting of the vehicle shall refer to the provisions of Annex CC in GB 18352.6-2016, and the vehicle road load shall be determined by the coastdown method, which shall be used as an input to the program for simulating road driving resistance by chassis dynamometer in normal and high temperature tests. For the low temperature test, according to Annex H.2.2.1 in GB 18352.6-2016 and based on the vehicle road load

determined according to Annex CC in GB 18352.6-2016, obtain the resistance by reducing the coastdown time by 10% and use it as an input to the program for simulating road driving resistance by chassis dynamometer during the low temperature test at -7°C.

D.2.4 Driving mode and transmission gear settings

The driving mode and transmission gear shall be set with reference to Annex C in GB/T 18386.1-2021, and enable the VUT to follow the driving cycle specified in D.2.6.

D.2.5 A/C setting conditions

Arrange temperature measuring points for each front-row passenger seat in this document. See B.2.1 and Fig. B.1 for front seat adjustment and location of temperature measuring points.

For the A/C settings in high temperature test, make sure that the A/C start time coincides with the test start time. Set the front air outlets to the maximum opening, and turn the direction of the air outlets to the middle position. Close the middle and rear air outlets.

a) For an automatic A/C with forced preset mode, set the temperature to the lowest value according to the preset settings of the A/C itself. If the requirements cannot be met, switch to the manual mode for control. When the temperature inside the vehicle reaches 24°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (23~25)°C.

b) For an automatic A/C without forced preset mode, select "Auto", set the temperature to the lowest value, and select internal circulation and face mode. When the temperature inside the vehicle reaches 24°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (23~25)°C, and keep the air volume at the middle level.

c) For a manual A/C, select the maximum cooling mode, maximum air volume, internal circulation and face mode. When the temperature inside the vehicle reaches 24°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (23~25)°C, and keep the air volume at the middle level.

A/C setting for normal temperature test: turn off the A/C.

For the A/C settings in low temperature test, make sure that the A/C start time coincides with the test start time. Set the front air outlets to the maximum opening, and turn the direction of the air outlets to the middle position. Close the middle and rear air outlets.

a) For an automatic A/C with forced preset mode, set the temperature to the highest value according to the preset settings of the A/C itself. If the requirements cannot be met, switch to the manual mode for control. When the temperature inside the vehicle reaches 21°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (20~22)°C.

b) For an automatic A/C without forced preset mode, select "Auto", set the temperature to the highest value, and select external circulation and foot mode. When the temperature inside the vehicle reaches 21°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (20~22)°C, and keep the air volume at the middle level.

c) For a manual A/C, select the maximum heating mode, maximum air volume, external circulation and foot mode. When the temperature inside the vehicle reaches 21°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (20~22)°C, and keep the air volume at the middle level.

D.2.6 Test cycle

For mini vehicles, the WLTC described in Annex CA in GB 18352.6-2016 shall be executed, which includes low speed section, medium speed section and high speed section.

For general vehicles, the test shall be carried out according to the driving cycle method and the constant speed method respectively. The driving cycle method shall be based on the WLTC described in Annex CA in GB 18352.6-2016, including low speed section, medium speed section, high speed section and extra high speed section. The constant speed method tests at a high speed of (120±2) km/h.

D.2.7 Test cycle cut-off conditions

Cut-off conditions of test cycle at a constant speed of (120±2) km/h: When the actual speed cannot meet the lower limit requirement of speed tolerance for 4 s consecutively.

Cut-off conditions of WLTC: When the actual speed cannot maintain the tolerance requirements specified in Annex C.1.2.6.6 in GB 18352.6-2016. When the cut-off conditions of the test are met, keep the vehicle coasting to the minimum stable speed or 5 km/h while keeping the vehicle's gear and driving mode unchanged, and then depress the brake pedal to stop the vehicle.

D.2.8 Traction battery charging and discharging conditions

D.2.8.1 Traction battery discharging cut-off conditions

The vehicle runs at a constant speed of 70% ± 5% of the maximum speed for 30 min to discharge the traction battery. The traction battery discharge cut-off condition is satisfied when the speed cannot maintain 65% of the maximum speed for 30 min.

D.2.8.2 Normal charging of traction battery

The vehicle shall be charged routinely within 0.5 h after the driving range test, and the charging power shall not be higher than 42 kW.

a) If there are multiple AC charging modes (such as conductive charging and inductive charging), the conductive charging mode shall be used. If there are multiple levels of conductive charging power available, the highest charging power shall be used. A lower charging power may be selected if recommended by the automobile manufacturer.

b) If the vehicle only has a DC charging mode, or if it is recommended by the automobile manufacturer and confirmed by the testing organization, the DC charging mode can be selected.

In case the AC charging mode is adopted, the electric charge measuring equipment shall be installed between the vehicle plug and the power supply equipment. If the vehicle only has a DC charging mode, or the DC charging mode is selected as recommended by the automobile manufacturer and confirmed by the testing organization, the electric charge measuring equipment shall be installed between the power supply equipment and the power grid. The electric charge measured by the electric charge measuring equipment is expressed in kWh, and the measured value shall be rounded to 2 decimal places.

Charging shall be carried out continuously. In case of power failure during charging, it shall be recorded in the test report and the reason explained. Charging is completed when the on-board or external instrument indicates that the traction battery has been fully charged. In case the on-board or external instrument sends an obvious signal indicating that the traction battery is not fully charged, the longest charging time is 3× traction battery energy (kWh)/ charging power (kW) specified by the automobile manufacturer.

If the vehicle needs to be moved before and after charging, it is not allowed to move the vehicle by using the power provided on the vehicle, and the regenerative braking system is required to be ineffective.

D.3 Test methods for energy consumption and range in heating state with heating device ON

in low temperature environment

D.3.1 Preconditioning

The vehicle status shall be confirmed according to D.2.2.

The chassis dynamometer setting and road load simulation shall be confirmed according to D.2.3.

The traction battery shall be charged regularly to full state according to the requirements of D.2.8.2.

D.3.2 Soaking

The vehicle shall be soaked in the low temperature test environment specified in D.2.1 for 12 h with all windows closed, the engine hood closed, and all doors closed.

If the vehicle soaking area and the environment chamber for the formal test are not in the same facility, the vehicle shall be moved to the environment chamber for the formal test as soon as possible after soaking. If the vehicle passes through a zone at other temperatures during moving, the duration shall not exceed 10 min. The power on the vehicle shall not be used, and the regenerative braking system shall be ineffective.

D.3.3 Measurement of energy consumption and range in low temperature environment

The ambient temperature shall be set according to the low temperature test requirements in D.2.1.

The vehicle status shall be confirmed according to D.2.2.

The chassis dynamometer setting and road load simulation shall be confirmed according to D.2.3.

The driving mode and transmission gear shall be set according to D.2.4.

The vehicle shall be tested continuously on a chassis dynamometer as per the WLTC specified in D.2.6. At the same time as the test starts, carry out the A/C operation for the low temperature test according to D.2.5, and stop the test when the running speed of the vehicle meets the requirements specified in D.2.7. The vehicle can be stopped for 10 min every 4 WLTCs. During vehicle stopping, make sure that the start button of the vehicle is at the "OFF" position, the engine hood closed, the fan for the test bench turned off, and the brake pedal released, and do not use any external power source for charging.

When the test ends and the vehicle stops, record the distance D traveled by the vehicle, in km, rounded to the nearest integer, which is deemed as the driving range in low temperature environment.

After the end of the driving range test, the vehicle shall be normally charged according to the requirements of D.2.8.2 within 2 h.

D.4 Test methods for energy consumption and range with cooling mode of A/C ON in high temperature environment

D.4.1 Preconditioning

The vehicle status shall be confirmed according to D.2.2.

The chassis dynamometer setting and road load simulation shall be confirmed according to D.2.3.

The traction battery shall be charged regularly to full state according to the requirements of D.2.8.2.

D.4.2 Soaking

The vehicle shall be soaked in the high temperature test environment specified in D.2.1 for 2 h with all windows opened, and the engine hood and all doors closed.

If the vehicle soaking area and the environment chamber for the formal test are not in the same facility, the vehicle shall be moved to the environment chamber for the formal test as soon as possible after soaking. If the vehicle passes through a zone at other temperatures during moving, the duration shall not exceed 10 min. The power on the vehicle shall not be used, and the regenerative braking system shall be ineffective.

D.4.3 Measurement of energy consumption and range in high temperature environment

The ambient temperature shall be set according to the high temperature test requirements in D.2.1.

The vehicle status shall be confirmed according to D.2.2.

The chassis dynamometer setting and road load simulation shall be confirmed according to D.2.3.

The driving mode and transmission gear shall be set according to D.2.4.

The vehicle shall be tested continuously on a chassis dynamometer as per the WLTC specified in D.2.6. At the same time as the test starts, carry out the A/C operation for the high temperature test according to D.2.5, and stop the test when the running speed of the vehicle meets the requirements specified in D.2.7. The vehicle can be stopped for 10 min every 4 WLTCs. During vehicle stopping, make sure that the start button of the vehicle is at the "OFF" position, the engine hood closed, the fan for the test bench turned off, and the brake pedal released, and do not use any external power source for charging.

When the test ends and the vehicle stops, record the distance D traveled by the vehicle, in km, rounded to the nearest integer, which is deemed as the driving range in high temperature environment.

After the end of the driving range test, the vehicle shall be normally charged according to the requirements of D.2.8.2 within 2 h.

D.5 Test methods for energy consumption and range in normal temperature environment

D.5.1 Preconditioning

The vehicle status shall be confirmed according to D.2.2.

The chassis dynamometer setting and road load simulation shall be confirmed according to D.2.3.

The traction battery shall be charged regularly to full state according to the requirements of D.2.8.2.

D.5.2 Soaking

The vehicle shall be soaked in the normal temperature test environment specified in D.2.1 for 12 h with all windows closed.

If the vehicle soaking area and the environment chamber for the formal test are not in the same facility, the vehicle shall be moved to the environment chamber for the formal test as soon as possible after soaking. If the vehicle passes through a zone at other temperatures during moving, the duration shall not exceed 10 min. The power on the vehicle shall not be used, and the regenerative braking system shall be ineffective.

D.5.3 Measurement of energy consumption and range in normal temperature environment

The ambient temperature shall be set according to the normal temperature test requirements in D.2.1.

The vehicle status shall be confirmed according to D.2.2.

The chassis dynamometer setting and road load simulation shall be confirmed according to D.2.3.

The driving mode and transmission gear shall be set according to D.2.4.

The vehicle shall be tested continuously on a chassis dynamometer as per the WLTC specified in D.2.6. At the same time as the test starts, carry out the A/C operation for the normal temperature test according to D.2.5, and stop the test when the running speed of the vehicle meets the requirements specified in D.2.7. The vehicle can be stopped for 10 min every 4 WLTCs. During vehicle stopping, make sure that the start button of the vehicle is at the "OFF" position, the engine hood closed, the fan for the test bench turned off, and the brake pedal released, and do not use any external power source for charging.

When the test ends and the vehicle stops, record the distance D traveled by the vehicle, in km, rounded to the nearest integer, which is deemed as the driving range in normal temperature environment.

After the end of the driving range test, the vehicle shall be normally charged according to the requirements of D.2.8.2 within 2 h.

D.6 Test methods for energy consumption and range at constant speed in normal temperature environment

D.6.1 Preconditioning

The vehicle status shall be confirmed according to D.2.2.

The chassis dynamometer setting and road load simulation shall be confirmed according to D.2.3.

The traction battery shall be charged regularly to full state according to the requirements of D.2.8.2.

D.6.2 Soaking

The vehicle shall be soaked in the normal temperature test environment specified in D.2.1 for 12 h with all windows closed.

If the vehicle soaking area and the environment chamber for the formal test are not in the same facility, the vehicle shall be moved to the environment chamber for the formal test as soon as possible after soaking. If the vehicle passes through a zone at other temperatures during moving, the duration shall not exceed 10 min. The power on the vehicle shall not be used, and the regenerative braking system shall be ineffective.

D.6.3 Measurement of energy consumption and range at constant speed in normal temperature environment

The ambient temperature shall be set according to the normal temperature test requirements in D.2.1.

The vehicle status shall be confirmed according to D.2.2.

The chassis dynamometer setting and road load simulation shall be confirmed according to D.2.3.

The driving mode and transmission gear shall be set according to D.2.4.

The vehicle shall be tested continuously on a chassis dynamometer at a constant speed of (120±2) km/h as specified in D.2.6, and the vehicle shall be accelerated to the target vehicle speed stably within 1 min. At the same time as the test starts, carry out the A/C operation for the normal temperature test according to D.2.5, and stop the test when the running speed of the vehicle meets

the requirements specified in D.2.7. In the testing process, the vehicle can be stopped twice with a separate duration not exceeding 2 min. During vehicle stopping, make sure that the start button of the vehicle is at the "OFF" position, the engine hood closed, the fan for the test bench turned off, and the brake pedal released, and do not use any external power source for charging.

When the test ends and the vehicle stops, record the distance D traveled by the vehicle, in km, rounded to the nearest integer, which is deemed as the driving range at constant speed in normal temperature environment.

After the end of the driving range test, the vehicle shall be normally charged according to the requirements of D.2.8.2 within 2 h.

D.7 Indicator calculation

D.7.1 Calculation of range attenuation rate

Calculate the driving range attenuation rate at low temperature according to Formula (D.1), at high temperature according to Formula (D.2), at constant speed according to Formula (D.3), and at normal temperature according to Formula (D.4):

$$N_{LT} = \frac{D_{NT} - D_{LT}}{D_{NT}} \times 100\% \quad \text{(D.1)}$$

$$N_{HT} = \frac{D_{NT} - D_{HT}}{D_{NT}} \times 100\% \quad \text{(D.2)}$$

$$N_{\text{constant speed 120}} = \frac{D_A - D_{\text{constant speed 120}}}{D_A} \times 100\% \quad \text{(D.3)}$$

$$N_{NT} = \frac{D_A - D_{NT}}{D_A} \times 100\% \quad \text{(D.4)}$$

Where,

N_{LT} - driving range attenuation rate at low temperature, in %, rounded to 1 decimal place;

N_{HT} - driving range attenuation rate at high temperature, in %, rounded to 1 decimal place;

$N_{\text{constant speed 120}}$ - driving range attenuation rate at a constant speed of 120 km/h, in %, rounded to 1 decimal place;

N_{HT} - driving range attenuation rate at high temperature, in %, rounded to 1 decimal place;

D_{NT} - driving range under WLTC at normal temperature, in km, rounded to the nearest integer;

D_{HT} - driving range under WLTC at high temperature, in km, rounded to the nearest integer;

D_{LT} - driving range under WLTC at low temperature, in km, rounded to the nearest integer;

D_A - driving range announced in the *Announcement on Road Motor Vehicle Manufacturing Enterprises and Products*, in km, rounded to the nearest integer.

D.7.2 Calculation of energy consumption (under WLTC at normal temperature)

Calculate the energy consumption under WLTC at normal temperature of D.5 according to Formula (D.4):

$$C = 100 \times \frac{E_{PG}}{D} \quad \text{(D.4)}$$

Where,

C - energy consumption under WLTC at normal temperature, in kWh/100 km and rounded to 1 decimal place;

E_{PG} - energy from the power grid during charging according to D.2.8.2, in kWh, rounded to 2 decimal places;

D - driving range under WLTC at normal temperature in D.5, in km, rounded to the nearest integer.

Annex E
(Normative)
Test Methods of Charging Time for Battery Electric Passenger Cars per 100 km

E.1 Scope

This method is applicable to M_1 battery electric passenger cars.

E.2 Requirements for test conditions

E.2.1 Environmental conditions

The temperature shall be set to (23±2)°C.

E.2.2 Traction battery discharge

The vehicle runs at a constant speed of 70% ± 5% of the maximum speed for 30 min to discharge the traction battery. The traction battery discharge cut-off condition is satisfied when the speed cannot maintain 65% of the maximum speed for 30 min.

E.3 Test method

In the normal temperature environment described in E.2.1, make the traction battery meet the discharge cut-off condition according to E.2.2.

Quickly charge the vehicle with a 120 kW charging pile within 0.5 h after the traction battery reaches the discharging cut-off condition. Start to time when the charging pile has current input until the traction battery indicator shows that it is fully charged. Record the charging time (n min) from the time when the charging pile has current to the end of 80% SOC. Read the energy $E_{\text{n min}}$ from the power grid during charging of the 120kW charging pile. Calculate the fast charging time required for driving 100 km according to Formula (E.1):

$$T_{100\text{km}} = \frac{100 \times C_1}{\frac{1}{n} \times E_{\text{n min}}} \quad \text{..... (E.1)}$$

Where,

$T_{100\ \text{km}}$ - fast charging time required for driving 100 km in the pure electric mode, in min, rounded to the nearest integer;

n - charging time from charging pile having current to the end of 80% SOC, in min, rounded to the nearest integer;

$E_{\text{n min}}$ - the energy from the power grid read during charging of the 120 kW charging pile, in Wh, rounded to the nearest integer;

C_1 - energy consumption calculated by Formula (D.4) (under WLTC at normal temperature), in Wh/km, rounded to the nearest integer.

If the vehicle needs to be moved before charging, it is not allowed to use the power on the vehicle, and the regenerative braking system shall be ineffective.

In case of power outage of the power grid during charging, the charging time may be appropriately adjusted according to the duration of power failure and the charging effectiveness shall be confirmed.

Annex F
(Normative)
Test Methods of Range and Energy Consumption for Plug-in Hybrid Electric Vehicle

F.1 Test conditions

F.1.1 Environmental requirements

According to Annex A.2.1.3 in GB/T 19233-2020, the ambient temperature for the low temperature test shall be (-7±3)°C.

According to Annex B.2.2 in GB/T 19233-2020, the ambient temperature for high temperature test shall be (35±2)°C, the air humidity be (50±5)%RH, and the solar radiation intensity be (1000±45) W/m^2. The solar radiation intensity shall be set based on the plane position of the highest point of the vehicle body.

During the test, the test room temperature shall be monitored and measured at the outlet of the cooling fan. The ambient temperature in the report shall be the arithmetic mean of test room temperatures measured at a regular interval of not more than 1 min.

F.1.2 Requirements for test equipment

The test equipment shall comply with Annex CD in GB 18352.6-2016.

See Table F.1 for the requirements of other relevant parameters.

Table F. 1 Unit, Accuracy and Resolution of Relevant Measurement Parameters

Parameters	Unit	Accuracy	Resolution
Electric energy	Wh	±1%	1
Current	A	±1%	0.1
Voltage	V	±1%	0.1

F.1.3 Test fuel

The reference fuel that meets the requirements in Annex K in GB 18352.6-2016 shall be adopted according to the lowest grade recommended by the automobile manufacturer, and it is forbidden to add oxygenate to the fuel.

F.1.4 VUT

All components of the VUT shall meet the requirements for mass production.

The VUT may be subjected to running-in according to the needs of the automobile manufacturer or its authorized agent, and the mechanical condition shall be ensured to be good, with a running-in range of not more than 15000 km.

The lubricant specified by the automobile manufacturer shall be used.

Other settings for the VUT shall be completed in accordance with the relevant provisions in Annex C.1.2.4.2~C.1.2.4.5 and C.1.2.4.7 in GB 18352.6-2016.

F.1.5 A/C operation of VUT

Arrange temperature measuring points for each front-row passenger seat in this document. See B.2.1 and Fig. B.1 for the front seat adjustment and location of temperature measuring points.

For the high temperature test, make sure that the A/C start time coincides with the test start time. Set the front air outlets to the maximum opening, and turn the direction of the air outlets to the middle position. Close the middle and rear air outlets.

a) For an automatic A/C with forced preset mode, set the temperature to the lowest value according to the preset settings of the A/C itself. If the requirements cannot be met, switch

to the manual mode for control. When the temperature inside the vehicle reaches 24°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (23~25)°C.

b) For an automatic A/C without forced preset mode, select "Auto", set the temperature to the lowest value, and select internal circulation and face mode. When the temperature inside the vehicle reaches 24°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (23~25)°C, and keep the air volume at the middle level.

c) For a manual A/C, select the maximum cooling mode, maximum air volume, internal circulation and face mode. When the temperature inside the vehicle reaches 24°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (23~25)°C, and keep the air volume at the middle level.

Turn off the A/C during normal temperature test.

For the low temperature test, make sure that the A/C start time coincides with the test start time. Set the front air outlets to the maximum opening, and turn the direction of the air outlets to the middle position. Close the middle and rear air outlets.

a) For an automatic A/C with forced preset mode, set the temperature to the highest value according to the preset settings of the A/C itself. If the requirements cannot be met, switch to the manual mode for control. When the temperature inside the vehicle reaches 21°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (20~22)°C.

b) For an automatic A/C without forced preset mode, select "Auto", set the temperature to the highest value, and select external circulation and foot mode. When the temperature inside the vehicle reaches 21°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (20~22)°C, and keep the air volume at the middle level.

c) For a manual A/C, select the maximum heating mode, maximum air volume, external circulation and foot mode. When the temperature inside the vehicle reaches 21°C, turn the temperature knob to maintain the average temperature of in-vehicle temperature measuring points at (20~22)°C, and keep the air volume at the middle level.

F.1.6 Test cycle

The test cycle shall be based on the WLTC described in Annex CA in GB 18352.6-2016, including low speed section, medium speed section, high speed section and extra high speed section.

F.1.7 Test-related parameters and accuracy

Relevant parameters and accuracy of the test results shall meet the requirements of Table F.2. Unless otherwise specified, the process data shall not be rounded off during the calculation of other parameters.

Table F. 2 Relevant Parameters and Accuracy of Test Results

Parameters	Unit	Accuracy of Test Results
Driving range related parameters (EAER, R_{CDC})	km	Round to an integer
Fuel consumption related parameters (FC_{CS}, FC_{CD})	L/100km	Round to 2 decimal places
Power consumption related parameters ($EC_{AC, CD}$)	Wh/km	Round to an integer
Charged energy E_{AC}	Wh	Round to an integer

F.2 Test procedure

F.2.1 General requirements for test

Road load measurement and dynamometer setting shall be carried out in accordance with Annex CC in GB 18352.6-2016.

The starting of the vehicle power system shall be carried out as required by the automobile manufacturer.

The vehicle shall be tested in accordance with the test cycle specified in F.1.6.

For a vehicle equipped with manual transmission, the vehicle shall be driven in accordance with the requirements in the user manual for mass-produced vehicles provided by the automobile manufacturer, and the driver assistant shall remind the driver of the shifting moment during driving.

The vehicle speed shall be properly controlled to track the test cycle curve accurately. The speed tolerance of each test cycle shall meet the requirements in Annex C.1.2.6.6 in GB 18352.6-2016.

If the operating temperature of REESS is higher than the normal range, the tester must make the temperature of REESS return to the normal range according to the procedure recommended by the automobile manufacturer. The automobile manufacturer shall submit the certificate proving that the thermal management system of the REESS does not fail or attenuate.

CO_2, CO and HC exhaust sampling and charge-depleting tests shall be carried out at the beginning of the test and be stopped after the end of the test. The exhaust sampling shall be carried out according to the relevant provisions in C.1.2.9 and C.1.2.12~C.1.2.14 of Annex in GB 18352.6-2016.

The exhaust sampling analysis shall be performed separately for each speed section.

Special requirements for test results: If the test cycle has been corrected according to the provisions in Annex CA.5 in GB 18352.6-2016, the maximum vehicle speed shall be stated in the test report.

During the vehicle soaking, the forced cooling specified in Annex C.1.2.7.2 in GB 18352.6-2016 is applicable.

F.2.2 Validity determination of OVC-HEV charge-sustaining mode test

This document specifies the procedure for correcting the OVC-HEV charge-sustaining mode test based on the REESS electric energy variation.

F.2.2.1 Calculation of $\Delta E_{REESS, CS}$

It is necessary to correct the fuel consumption for the OVC-HEV charge-sustaining mode test that meets certain requirements. The correction process involves the calculation of $\Delta E_{REESS, CS}$ and the cycle correction criterion c.

$\Delta E_{REESS, CS}$ shall be calculated according to Formula (F.1) and Formula (F.2):

$$\Delta E_{\mathrm{REESS},c} = \sum_{g=1}^{m} \Delta E_{\mathrm{REESS},g,c} \quad \text{(F.1)}$$

Where,

g - REESS number;

m - total number of REESSs;

$\triangle E_{\mathrm{REESS},g,c}$ - the electric energy variation of REESS numbered g within the time range of the c^{th} test cycle, in Wh, calculated according to the Formula (F.2):

$$\Delta E_{\mathrm{REESS},g,c} = \frac{1}{3600} \times \int_{t_0}^{t_{\mathrm{end}}} U(t)_{\mathrm{REESS},g,c} \times I(t)_{g,c} dt \quad \text{..... (F.2)}$$

Where,

t_0 - the start time of the c^{th} test cycle, in s;

t_{end} - the end time of the c^{th} test cycle, in s;

$U(t)_{REESS,g,c}$ - the voltage of REESS numbered g at the time t in the time range of the c^{th} test cycle, in V;

$I(t)_{g,c}$ - current of the REESS numbered g at the time t within the time range of the c^{th} test cycle, in A;

F.2.2.2 Calculation of cycle correction criterion c

The cycle correction criterion c is calculated according to Formula (F.3) and Formula (F.4):

$$c = \frac{\left|\Delta E_{\mathrm{REESS,CS}}\right|}{E_{\mathrm{fuel,CS}}} \quad \text{..... (F.3)}$$

Where,

$\Delta E_{REESS, CS}$ - the electric energy variation of REESS in charge-sustaining mode test, in Wh;

$E_{fuel, CS}$ - equivalent of fuel energy consumed in the charge-sustaining mode test, in Wh, calculated according to Formula (F.4):

$$E_{\mathrm{fuel,CS}} = 10 \times \mathrm{HV} \times \mathrm{FC}_{\mathrm{CS,nb}} \times d_{\mathrm{CS}} \quad \text{..... (F.4)}$$

Where,

10 - unit conversion factor;

HV - calorific value of fuel of gasoline 8.92 or diesel 9.85, in kWh/L;

d_{CS} - actual driving range of the vehicle in the charge-sustaining mode test, in km;

$FC_{CS, nb}$ - fuel consumption of the whole cycle without correction, in L/100 km, calculated by the carbon balance method.

F.2.2.3 Validity determination of OVC-HEV charge-sustaining mode test

If $\Delta E_{REESS, CS}$ calculated according to Formula (F.1) and Formula (F.2) is negative (i.e., REESS is in discharge) and the cycle correction criterion c is greater than 0.01, the test result is invalid.

When the automobile manufacturer fails to prove to the testing organization through the test that $\Delta E_{REESS, CS}$ is independent of the fuel consumption in the charge-sustaining mode test, if $\Delta E_{REESS, CS}$ obtained according to Formula (F.1) and Formula (F.2) is negative and the cycle correction criterion c>0.005, correction is required.

If one of the following conditions is met, no correction is required:

a) $\Delta E_{REESS, CS}$ is positive, and the cycle correction criterion c>0.005;

b) Cycle correction criterion c≤0.005;

c) Automobile manufacturers can prove to testing organization through tests that $\Delta E_{REESS,CS}$ is not relevant with fuel consumption in charge-sustaining mode test.

F.2.2.4 Procedure for determining correction factor K_{fuel} and calculation of correction value of fuel consumption

This document involves the fuel consumption calculation process of the OVC-HEV charge-sustaining mode test. If the correction factor K_{fuel} is required for the calculation correction of fuel consumption, please refer to Annex A.2 in GB/T 19753-2021 for details.

F.2.3 Test procedures of OVC-HEV charge-depleting mode

F.2.3.1 Preconditioning

Drive or push the vehicle onto the chassis dynamometer. The vehicle shall run at least one test cycle to complete the preconditioning. During preconditioning, the electrical balance of the REESS shall be measured simultaneously. When the relative electric energy variation $REE_c<0.04$ is met, the charge-depleting mode test meets the termination judgment conditions, and the preconditioning shall be terminated at the end of the test cycle.

F.2.3.2 Vehicle soaking and normal charging

Set the environment chamber to meet the environmental requirements in F.1.1. In the low temperature environment, the vehicle shall be soaked for 12 h with all windows closed, the engine hood closed and all doors opened. In the high temperature environment, the vehicle shall be soaked for 2 h with all windows opened, the engine hood and all doors closed.

If the environment chamber meets the charging conditions, the REESS can be charged normally according to Annex C.2.3 in GB/T 19753-2021 during soaking. If the environment chamber does not have charging conditions, the vehicle can be moved to the chassis dynamometer for soaking after normal charging at normal temperature according to the requirements of Annex C.2.3 in GB/T 19753-2021.

F.2.3.3 Selection of driving mode in the test process

For vehicles with selectable driving modes, the driving mode in the charge-depleting mode test shall be selected according to Annex D.2 in GB/T 19753-2021.

F.2.3.4 Conditions for termination of charge-depleting mode test

A termination judgment shall be made for each test cycle of the charge-depleting mode.

The termination judgment condition for the charge-depleting mode test is met when the relative electric energy variation $REEC_c$ is less than 0.04. Calculate $REEC_c$ according to Formula (F.5):

$$\mathrm{REEC}_c = \frac{\left|\Delta E_{\mathrm{REESS},c}\right|}{E_{\mathrm{cycle}} \times \frac{1}{3600}} \quad \text{(F.5)}$$

Where,

$REEC_c$ - relative electric energy variation in the c^{th} test cycle during the charge-depleting mode test;

c - serial number of test cycle;

E_{cycle} - cycle energy demand, calculated according to Annex CE.5 in GB 18352.6-2016, in Ws;

1/3600 - conversion factor of cycle energy demand;

$\Delta E_{REESS,\,c}$ - electric energy variation of all REESSs in the c^{th} test cycle of the charge-depleting mode test, in Wh, calculated according to Formula (F.1) and Formula (F.2).

F.2.3.5 Charge-depleting mode test procedure

The vehicle shall be tested in accordance with the provisions of Annexes C.1.2.8.1~C.1.2.8.3.1 and C.1.2.8.5 in GB 18352.6-2016.

The charge-depleting mode test procedure shall include multiple continuous test cycles, with the soaking duration between test cycles being less than 30 min, and the test cycles shall be repeated until the termination judgment condition of charge-depleting mode test is met.

The powertrain shall be switched off during soaking between cycles and the REESS shall not be charged. The current and voltage of REESS shall be continuously collected during test cycles and soaking between the test cycles.

When the relative electric energy variation $REEC_c < 0.04$ is met for the first time, the charge-depleting mode test ends. At this moment, the serial number of the test cycle is recorded as n+1.

The n^{th} cycle is defined as the transition cycle; after n cycles, the number of speed sections the vehicle has traveled is n_p. The charge-depleting mode test consists of n test cycles.

The $(n+1)^{th}$ cycle is defined as the confirmation cycle.

For a vehicle that fails to complete the cycle test in the charge-depleting mode, the charge-depleting mode test ends when the standard on-board dashboard indicates parking, or the vehicle continuously deviates from the prescribed driving tolerance for 4 s. At this time, release the accelerator pedal and depress the brake pedal to stop the vehicle within 60 s.

F.2.3.6 Charging of REESS and electric quantity measurement

After the charge-depleting mode test, the vehicle shall be charged according to the provisions of Annexes C.2.3.1 ~ C2.3.2 in GB/T 19753-2021 within 120 min. The charging method shall be consistent with that before the test, and the charging time and electric quantity EAC charged from the external power grid shall be measured. When the requirements of Annex C.2.3.3 in GB/T 19753-2021 are met, the REESS charging ends.

F.2.4 Test procedures of OVC-HEV charge-sustaining mode

F.2.4.1 Preconditioning

Drive or push the vehicle onto the chassis dynamometer. The vehicle shall run at least one test cycle to complete the preconditioning. During preconditioning, the electrical balance of the REESS shall be measured simultaneously. When the relative electric energy variation $REESS_c<0.04$ is met, the charge-depleting mode test meets the termination judgment conditions, and the preconditioning shall be terminated at the end of the test cycle.

F.2.4.2 Vehicle soaking and normal charging

Set the environment chamber to meet the environmental requirements in F.1.1. In the low temperature environment, the vehicle shall be soaked for 12 h with all windows closed, the engine hood closed and all doors opened. In the high temperature environment, the vehicle shall be soaked for 2 h with all windows opened, the engine hood and all doors closed.

F.2.4.3 Selection of driving mode in the test process

For vehicles equipped with selectable driving modes, the driving mode in the charge-sustaining mode test shall be selected according to Annex D.3 in GB/T 19753-2021.

F.2.4.4 Charge-sustaining mode test procedure

The vehicle shall be tested in accordance with the provisions of Annexes C.1.2.8.1~C.1.2.8.3.1 and C.1.2.8.5 in GB 18352.6-2016.

If the $\Delta E_{REESS,\,CS}$ is negative (i.e., REESS is in discharge) and the cycle correction criterion c is greater than 0.01, the test result is invalid. Continuous tests shall be performed with reference to the

provisions of Annexes C.1.2.8.1~C.1.2.8.3.1 and C.1.2.8.5 in GB 18352.6-2016 until the valid test results described in C.2.2.3 appear, and the fuel consumption results shall be corrected according to F.2.2.4.

F.3 Calculation of test results

F.3.1 Calculation of fuel consumption

F.3.1.1 Calculation of fuel consumption in OVC-HEV charge-depleting mode test

With reference to GB 18352.6-2016, calculate the fuel consumption $FC_{CD,c}$ of each test cycle according to the carbon balance method. Calculate the fuel consumption in OVC-HEV charge-depleting mode test according to Formula (F.6):

$$FC_{CD} = \frac{\sum_{c=1}^{n}\left(UF_c \times FC_{CD,c}\right)}{\sum_{c=1}^{n} UF_c} \quad \text{..... (F.6)}$$

Where,

FC_{CD} - fuel consumption in the charge-depleting mode test, in L/100 km;

c - serial number of test cycle;

n - the number of cycles completed at the end of the transition cycle determined according to C.2.3.5;

UF_c - pure electric utilization factor of the c^{th} test cycle, calculated according to Annex F in GB/T 19753-2021;

$FC_{CD,c}$ - the fuel consumption of each test cycle calculated according to the carbon balance method with reference to GB 18352.6-2016.

F.3.1.2 Calculation of fuel consumption in OVC-HEV charge-sustaining mode test

With reference to GB 18352.6-2016, calculate the fuel consumption in the OVC-HEV charge-sustaining mode test according to the carbon balance method.

If the test results meet the conditions of F.2.2.3 and no correction is required, determine the fuel consumption in the OVC-HEV charge-sustaining mode test according to Formula (F.7):

$$FC_{CS} = FC_{CS,c,nb} \quad \text{..... (F.7)}$$

Where,

FC_{CS} - fuel consumption in the OVC-HEV charge-sustaining mode test, in L/100 km;

$FC_{CS,c,nb}$ - fuel consumption in uncorrected cycle, in L/100 km.

If the test result meets the conditions of F.2.2.3 and needs to be corrected, it shall be corrected according to 7.1.1.2.3 in GB/T 19753-2021.

F.3.2 Calculation of power consumption (in OVC-HEV charge-depleting mode test)

According to the provisions of F.2.3.6, calculate the power consumption in the OVC-HEV charge-depleting mode test according to Formulas (F.8), (F.9) and (F.10):

$$EC_{AC,CD} = \frac{\sum_{c=1}^{n}\left(UF_c \times EC_{AC,CD,c}\right)}{\sum_{c=1}^{n} UF_c} \quad \text{..... (F.8)}$$

Where,

$EC_{AC,CD}$ - consumption of power from the external power grid in the charge-depleting mode test, in Wh/km;

$EC_{AC,CD,c}$ - consumption of power from the external power grid of the c^{th} test cycle in the charge-depleting mode test, in Wh/km, calculated according to Formula (F.9):

$$EC_{AC,CD,c}=EC_{DC,CD,c}\times\frac{E_{AC}}{\sum_{c=1}^{n}\Delta E_{REESS,c}} \quad \text{(F.9)}$$

Where,

E_{AC} - electricity from external power grid measured according to F.2.3.6, in Wh;

$\Delta E_{REESS,c}$ - electric energy variation of all REESSs in the c^{th} test cycle calculated according to Formula (F.1), in Wh;

$EC_{DC,CD,c}$ - power consumption of the c^{th} test cycle based on electric energy variation of REESS, in Wh/km, calculated according to Formula (F.10):

$$EC_{DC,CD,c}=\frac{\Delta E_{REESS,c}}{d_c} \quad \text{(F.10)}$$

Where,

d_c - range of the vehicle in the c^{th} test cycle, in km;

F.3.3 Calculation of equivalent all-electric range (EAER) (in OVC-HEV charge-depleting mode test)

Calculate the equivalent all-electric range (EAER) according to Formula (F.11) and Formula (F.12):

$$EAER=\frac{FC_{CS}-FC_{CD,avg}}{FC_{CS}}\times R_{CDC} \quad \text{(F.11)}$$

Where,

EAER - equivalent full electric range, in km;

FC_{CS} - fuel consumption in the OVC-HEV charge-sustaining mode test determined in F.3.1.2, in L/100 km;

R_{CDC} - charge-depleting cycle range determined according to the test procedures in F.2.3.1~F.2.3.5, which is the distance traveled by the vehicle from the beginning of the test to the end of the transition cycle (the n^{th} cycle), in km;

$FC_{CD,avg}$ - weighted average of fuel consumption in the charge-depleting mode test, in L/100 km, calculated according to Formula (F.12):

$$FC_{CD,avg}=\frac{\sum_{c=1}^{n}\left(FC_{CD,c}\times d_c\right)}{\sum_{c=1}^{n}d_c} \quad \text{(F.12)}$$

Where,

c - serial number of test cycle;

n - the number of cycles completed at the end of the transition cycle determined according to F.2.3.5;

$FC_{CD,c}$ - fuel consumption of the c^{th} test cycle, in L/100 km;

d_c - range of the vehicle in the c^{th} test cycle, in km;

F.3.4 Calculation of attenuation rate of equivalent all-electric range (EAER)

Calculate the EAER attenuation rate in the high temperature test or low temperature test according to Formula (F.13):

$$\eta = \frac{EAER_{announced} - EAER_{measured}}{EAER_{announced}} \times 100\% \quad \text{..... (F.13)}$$

Where,

η - attenuation rate of equivalent all-electric range (EAER), in %, rounded to 1 decimal place;

$EAER_{measured}$ - the measured EAER value in the high temperature or low temperature test determined according to Formula (F.11), in km;

$EAER_{announced}$ - equivalent all-electric range (EAER) of the vehicle in the product official announcement, in km.

Annex G
(Normative)
Test Methods of Fuel Consumption Increase Rate for Plug-in Hybrid Electric Vehicle with Cooling Mode of A/C ON

G.1 Test conditions

G.1.1 Environmental conditions

The environmental conditions shall meet the requirements for high temperature test in F.1.1.

G.1.2 Requirements for test equipment

The test equipment shall meet the requirements of F.1.2.

G.1.3 Test fuel

The test fuel shall meet the requirements of F.1.3.

G.1.4 VUT

The VUT shall meet the requirements of F.1.4.

G.1.5 A/C operation of VUT

Arrange temperature measuring points for each front-row passenger seat according to F.1.5, and set the A/C operation in a high temperature environment according to the method in F.1.5 in the test process.

G.2 Test protocol

G.2.1 Test preparation

Set the test conditions according to G.1. Refer to F.2.1 for other test preparation conditions.

G.2.2 Determination of fuel consumption with A/C ON (FC_{ON})

G.2.2.1 Preconditioning

The purpose of preconditioning is to set the charge-sustaining mode of the vehicle.

Drive or push the vehicle onto the chassis dynamometer. The vehicle shall run at least one test cycle to complete the preconditioning. During preconditioning, the electrical balance of the REESS shall be measured simultaneously. When the relative electric energy variation $REESS_c<0.04$ is met, the charge-depleting mode test meets the termination judgment conditions, and the preconditioning shall be terminated at the end of the test cycle.

G.2.2.2 Soaking

The vehicle shall be soaked for 2 h with the powertrain turned off, the engine hood and all doors closed, and all windows opened after the solar radiation intensity is set in the high temperature environment specified in G.1.1.

G.2.2.3 Selection of driving mode in the test process

For vehicles equipped with selectable driving modes, the driving mode in the charge-sustaining mode test shall be selected according to Annex G.3 in GB/T 19753-2021.

G.2.2.4 Test with A/C ON

After turning on and setting the vehicle A/C according to the requirements of G.1.5, immediately carry out the charge-sustaining mode test with the A/C ON according to F.2.4.4. Calculate the fuel consumption in the charge-sustaining mode with the A/C ON according to the requirements of F.3.1.2.

During the test, the temperature changes of the temperature measuring points required by G.1.5

are recorded continuously in real-time at an acquisition frequency of not less than 1 Hz. When the test proceeds for 10 min, the average temperature of the temperature measuring point shall not be greater than 25°C; otherwise, suspend the test, and redo the test following the sequence of G.2.2~G.2.4 after resetting the A/C according to G.1.5. From the 10th min to the end of the test, the accumulated time of the evaluation temperature of the temperature measuring point above 25°C shall not exceed 10 s; otherwise, the test is invalid. Redo the test following the sequence of G.2.2~G.2.4 after resetting the A/C according to G.1.5.

G.2.3 Measurement of fuel consumption with A/C OFF (FC_{OFF})

The declared combined value of fuel consumption in charge-sustaining mode in the mandatory test report in GB/T 19753-2021 is taken as the vehicle fuel consumption with A/C OFF (FC_{OFF}).

G.2.4 Repeatability test

Take G.2.2.1 and G.2.2.4 as a group of tests, and carry out 3 groups of tests in total. Repeatability tests shall be performed on the results of A/C-ON as per G.2.4.1: If the results of A/C-ON test pass the repeatability test, the mean value of fuel consumption obtained from 3 tests shall be calculated and noted as FC_{ON}; if the results fail the repeatability test, the mean value of 2 highest fuel consumption obtained shall be noted as FC_{ON}.

G.2.4.1 Method for determining repeatability test

The standard deviation σ of the 95th percentile distribution for the results of 3 tests shall be calculated by Formula (G.1), and the difference ($\triangle Q_{max}$) between the maximum fuel consumption and the minimum fuel consumption among the results of 3 tests shall be compared with the σ value:

a) If ΔQ_{max} is not greater than σ, the test results are deemed to pass the repeatability test;

b) If ΔQ_{max} is greater than σ, the test results are deemed to fail in the repeatability test.

$$\sigma=0.063\times\overline{Q} \quad \text{..... (G.1)}$$

Where,

σ - standard deviation of the 95th percentile distribution, in L/100 km;

$\overline{Q}$- arithmetic mean of fuel consumption obtained from 3 tests, in L/100 km.

G.3 Calculation of fuel consumption increase rate with cooling mode of A/C ON

Calculate the fuel consumption increase rate in the OVC-HEV charge-sustaining mode with cooling mode of A/C ON according to Formula (G.2):

$$\beta = \frac{FC_{ON}\text{-}FC_{OFF}}{FC_{OFF}} \times 100\% \quad \text{..... (G.2)}$$

Where,

β - fuel consumption increase rate with cooling mode of A/C ON, in %, rounded to 1 decimal place;

FC_{ON} - fuel consumption with cooling mode of A/C ON, in L/100 km;

FC_{OFF} - fuel consumption with cooling mode of A/C OFF, in L/100 km.