中国电动汽车火灾安全指数
CHINA ELECTRIC VEHICLE FIRE SAFETY INDEX

China Electric Vehicles Fire Safety Index

(Version 2026)

Testing and Evaluation Protocol for Vehicle Sealing Performance

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1 Scope

This document specifies the test method and evaluation method of the sealing performance of the passenger compartment of the vehicle in the environment of simulating the external high concentration of particulate matter generated by the thermal runaway of the power battery.

This document applies to Class M_1 and Class N_1 electric vehicles, including pure electric vehicles and hybrid electric vehicles.

This document is not applicable to fuel cell electric 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 3095-2012 Ambient Air Quality Standards

GB/T 18801-2022 Air Cleaner

GB 38031-2025 Electric Vehicles Traction Battery Safety Requirements

3 Terms and Definitions

For the purposes of this document, the terms and definitions given in GB 3095-2012, GB/T 18801-2022, GB 38031-2025 and the following apply.

3.1 Test chamber ambient PM concentration

The concentration of particulate matter surrounding the vehicle under test within the enclosed test chamber.

3.2 PM concentration in the passenger compartment

The concentration of particulate matter with an aerodynamic equivalent diameter less than or equal to 100 μm in the ambient air inside the passenger compartment.

3.3 Half-hour average PM concentration

The arithmetic mean of the time-averaged concentrations at various collection points in the passenger compartment within the specified half-hour test observation period.

3.4 Half-hour max PM concentration

The maximum instantaneous value of particulate matter concentration monitored at all collection points in the passenger compartment within the specified half-hour test observation period.

3.5 Time to exceed PM concentration threshold

The time interval from the data evaluation start time t_0, which is artificially marked by the tester according to specified criteria after the test chamber ambient PM concentration meets the stability requirements, to the time when the particulate matter concentration at any collection point inside the passenger compartment first exceeds the threshold of 1000 μg/m³. This is denoted as t_1.

3.6 Half-hour average ingress PM concentration

The net increase value obtained by deducting the passenger compartment PM concentration at the data evaluation start time t_0 from the half-hour average concentration in the passenger compartment within the specified 30-minute test period. This is denoted as $C_{30min,avg}$.

3.7 Half-hour max ingress PM concentration

The maximum net increase value obtained by deducting the passenger compartment PM

concentration at the data evaluation start time t_0 from the half-hour maximum concentration in the passenger compartment within the specified 30-minute test period. This is denoted as $C_{30min,max}$.

4 Test Conditions

4.1 Site and environment

a) Ambient temperature: Initial test ambient temperature >0 ℃;

b) Ambient humidity: Relative humidity between 10% and 90%;

c) Ambient atmospheric pressure: Atmospheric pressure between 86 kPa and 106 kPa;

d) The test shall be conducted in a test chamber with enclosed space. Internal dimensions of the test chamber: 8m × 4m × 3.5m (Length × Width × Height);

e) Test chamber ambient PM concentration: Particulate matter (particle size ⩽ 100 μm) ⩽ 80 μg/m³ ;

f) The test chamber is equipped with a circulating fan, and the air purification capacity of the test chamber is ≥ 300 m³/h.;

g) The particulate matter generator should comply with the regulations for standard target pollutants in Appendix A.2.2 of GB/T 18801-2022.

4.2 Equipment and facilities

4.2.1 Accuracy of instruments and meters

The range and accuracy of measuring instruments and meters shall not be lower than the following requirements:

a) Temperature measurement device: ±0.5 °C;

b) Humidity measurement device: ±2% RH;

c) Time measurement device: ±1 s;

d) Particulate matter concentration measurement device: ±15% FS;

e) PM concentration measurement device range: test chamber ambient PM concentration measurement range shall cover at least 100000 μ g/m ³ .Passenger compartment PM concentration measurement range shall cover at least 10000 μg/m³.

4.2.2 Measurement process error

The requirements for the error between the control value (actual value) and the target value are as follows:

a) Temperature: ±2 °C;

b) Particulate matter concentration: ±20%;

4.2.3 Data logging

Unless otherwise specified, the recording interval of test data during the test shall be ≤ 1 s.

5 Test Preparation

5.1 Test chamber

According to the site and environment requirements specified in 4.1, control the ambient PM concentration in the test chamber to below 80 μg/m³. At the same time, ventilate or purify the vehicle under test so that the PM concentration inside the passenger compartment is synchronously reduced to below this limit to eliminate the influence of residual pollutants.

5.2 Particulate matter generation device

The source of particulate matter generation is cigarette smoke, with a tar content of 8 mg.

5.3 Vehicle preparation

a) The vehicle is normal with no fault alarms.

b) The vehicle is powered on, with the gear in "P" (Park).

c) During the test, all doors, windows and sunroof are closed and locked,and flush door handles are in the retracted state.

d) The air conditioning system is in the internal circulation mode and turned off, and the in-vehicle air purification function is in deactivated (off).

e) Except for test requirements, no non-original items shall be placed inside the vehicle.

5.4 Data acquisition system

a) Install one PM concentration sensor each at 10 cm in front of the headrests of the driver's seat, front passenger's seat, and rear side seats in the passenger compartment. If the vehicle has a third row of seats, add one PM concentration sensor each at 10 cm in front of the headrests of the third-row side seats.

b) Place one PM concentration sensor each at the midpoint of the left and right sides of the vehicle body, at a distance of 0.5 m from the vehicle body and a height of 1 m, to record the test chamber ambient concentration in real-time.

c) Install one camera each in the front and rear rows of the passenger compartment to observe the front and rear areas. If the vehicle has a third row of seats, add one camera in the third row to observe the third-row area.

6 Test Method

6.1 Calibration of test chamber ambient PM concentration

Record the test chamber ambient PM concentration and passenger compartment PM concentration for 5 minutes. If the test chamber ambient PM concentration or passenger compartment PM concentration exceeds 80 μg/m³, open the vehicle doors for ventilation or turn on the test chamber air purification function for purification until both the test chamber ambient PM concentration and passenger compartment PM concentration do not exceed 80 μg/m³.

6.2 Adjust test chamber ambient PM concentration

6.2.1 Close the test chamber.

6.2.2 Turn on the particulate matter generator to transport smoke into the test chamber.

6.2.3 Turn on the circulation fan to make the smoke quickly and uniformly within the test chamber.

6.2.4 Record the test chamber ambient PM concentration and passenger compartment PM concentration in real-time.

6.2.5 When the arithmetic mean of the test chamber ambient PM concentration is within the range of 30000 ± 6000 μg/m³ and is maintained for at least 5 minutes, stop the operation of the particulate matter generator and close the particulate matter delivery pipeline.

6.3 Ingress test

6.3.1 When the test chamber ambient PM concentration is stable, the starting time of data evaluation is t_0=0 min.

6.3.2 Continuously monitor the test chamber ambient PM concentration, Passenger compartment PM concentration and the video footage for half an hour, and the sampling frequency is not less than 1 Hz.

6.3.3 When the test chamber ambient PM concentration is lower than 24000 μg/m^3, turn on the particulate matter generator to continue to transport the smoke to ensure that the test chamber ambient PM concentration is maintained within the range of 30000±6000 μg/m^3.

6.3.4 Record the particulate matter concentration threshold breakthrough time t_1.

6.4 Test End

6.4.1 Turn on the air purification function of the test chamber.

6.4.2 After the test chamber ambient PM concentration drops to the safe range, personnel can enter the test chamber.

6.4.3 Personnel can enter the vehicle only after the concentration of particulate matter in the passenger compartment is reduced to the safe range.

6.4.4 Save test data.

6.4.5 Process the test data and calculate the half-hour maximum ingress PM concentration and half-hour average PM intrusion concentration.

7 Evaluation Methods

7.1 Testing and evaluation items and indicators

The test shall be conducted according to Chapter 6 of this document, and the sealing performance shall be scored according to Table 1.

Table 1 Detailed Rules for Comprehensive Scoring

Level-I Indicator	Evaluation content	Score	Max Score	weight
Time to exceed PM concentration threshold t_1（min）	$t_1 \geq 30$	100	100	40%
	$20 \leq t_1 < 30$	75		
	$10 \leq t_1 < 20$	50		
	$5 \leq t_1 < 10$	25		
	$0 \leq t_1 < 5$	0		
Half-hour max ingress PM concentration $C_{30min,max}$（μg/m^3）	$C_{30min,max} \leq 100$	100	100	30%
	$100 < C_{30min,max} \leq 200$	80		
	$200 < C_{30min,max} \leq 400$	60		
	$400 < C_{30min,max} \leq 600$	40		
	$600 < C_{30min,max} \leq 800$	20		
	$800 < C_{30min,max} \leq 1000$	10		
	$C_{30min,max} > 1000$	0		
Half-hour average ingress PM concentration $C_{30min,avg}$（μg/m^3）	$C_{30min,avg} \leq 100$	100	100	30%
	$100 < C_{30min,avg} \leq 200$	80		
	$200 < C_{30min,avg} \leq 300$	60		
	$300 < C_{30min,avg} \leq 400$	40		
	$400 < C_{30min,avg} \leq 500$	20		
	$C_{30min,avg} > 500$	0		

7.2 Score calculation method

The comprehensive score is the weighted sum of the scores of 3 testing and evaluation

dimensions: Time to exceed PM concentration threshold, half-hour max ingress PM concentration, and half-hour average ingress PM concentration, represented by S_5.

$$S_5 = \sum_{1}^{3} (s_i \times w_i)$$

Where,

S_5 - comprehensive score;

s_i - score of the i^{th} item;

w_i - weight of the i^{th} item.

7.3 Evaluation results

The evaluation results are divided into five grades, as detailed in Table 2.

Table 2 Evaluation Results and Score Distribution

Evaluation results	Score
★★★★★	S≥90
★★★★	80≤S＜90
★★★	70≤S＜80
★★	60≤S＜70
★	S＜60