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 Material Flame Retardant Performance

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1 Scope

This document specifies the test methods and evaluation methods for material flame retardant performance of electric vehicle.

This document is applicable to M_1 and N_1 electric vehicles, including those on battery 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/T 4780 Terms for Motor Vehicle Body

GB/T 5169.10 Fire hazard testing for electric and electronic products - Part 10: Glowing/hot-wire based test methods - Glow-wire apparatus and common test procedure

GB 8410 Flammability of Automotive Interior Materials

GB/T 8627 Test Method for Density of Smoke from the Burning or Decomposition of Building Materials

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

3 Terms and Definitions

For the purposes of this document, the terms and definitions given in GB/T 4780, GB/T 5169.10, GB 8410, GB/T 8627 and GB/T 15089 and the following apply.

3.1 ignition

generation of a visible open flame with a combustion time greater than 1 s

4 Test Conditions

4.1 Site and environment

The ambient temperature of the test room is 25°C±10°C, and the relative humidity is ≤ 75%.

4.2 Equipment and facilities

4.2.1 Horizontal combustion test chamber

It complies with the provisions of GB 8410 and is used for open flame combustion test.

4.2.2 Glow-wire apparatus

It complies with the provisions of GB/T 5169.10 and is used for glow-wire test.

4.2.3 Smoke density tester

It complies with the provisions of GB/T 8627 and is used for smoke density test.

4.3 Accuracy of instruments and meters

Unless otherwise specified, the accuracy of instruments and meters shall be controlled as follows:

1) Temperature measuring device: ±0.5ºC;
2) Time measuring device: ±0.1% FS;
3) Length measuring device: ±0.20 mm.

4.4 Measurement process error

The error requirements with the target value are as follows:

1) Temperature: ±2°C;

2) Time: ±1 S;

3) Length: ±1 mm.

5 Test Preparation

5.1 Preparation of test samples

5.1.1 Specimen sampling

The test samples are cut from the vehicle. The sampling positions and dimensions are shown in Table 1 .

Table 1 Sampling Dimensions

S/N	Test Items	Sampling Positions	Test Specimen Dimensions
1	Open flame combustion test	Main carpet (including bottom sponge), trunk carpet, bottom shield and driver's seat cushion fabric	Length 138 mm, 60 mm < width ≤ 100mm, thickness ≤ 13 mm. 5 specimens.
2	Glow-wire test	Main carpet (including bottom sponge), bottom shield	Length 60 mm, width 60 mm, thickness being the actual thickness of the sample. 3 specimens.
3	Smoke density test	Trunk carpet, main carpet (including bottom sponge), bottom shield and driver's seat cushion fabric	Length 25 mm, width 25 mm, thickness ≤ 20 mm. 3 specimens.
Note 1: The sample shall be cut from a flat position as much as possible. When the sample has a curved surface, the sample dimensions shall be calculated according to the length of the curved surface. Note 2: When the sampling position entirely consists of metallic material, testing at this position is not required, and the test results and scores are calculated based on the highest level. Note 3: If the thickness of the specimen is greater than that specified in the table, a mechanical method shall be used to cut it from the non-exposed surface so that the thickness of the specimen including the exposed surface is as specified in the table.			

1 - Driver's seat cushion fabric

2 - Main carpet

3 - Trunk carpet

4 - Bottom shield

Fig. 1 Sampling Position

5.1.2 Specimen preconditioning conditions

Before the test, the sample shall be preconditioned at 23°C±2°C and 50%±5% relative humidity for 24 h.

5.2 Preparation of test system

Before the test, all equipment shall be calibrated in accordance with relevant standards (see 4.2.1~4.2.3).

6 Test Method

6.1 Open flame combustion test

6.1.1 The gas lamp is ignited with the air inlet closed, and the flame is adjusted according to the flame height marking plate to achieve a flame height of 38 mm. Before the first test, the flame shall burn stably in this state for at least 1 min and then go out.

6.1.2 The specimen with surface fuzzing or tufting is placed flat on a flat table, and a metal comb is used to comb twice in the opposite direction of the fuzz on the raised surface. If the sample has no surface fuzzing or tufting, this step can be skipped.

6.1.3 The specimen is installed into the specimen holder with its exposed side facing downward. The specimen is installed so that its both sides and one end are clamped by the U-shaped holder, and its free end is aligned with the opening of the U-shaped holder. Only when the specimen is not wide enough for the U-shaped holder to clamp it securely, or when the soft and flexible free end of the specimen may cause unstable combustion, should the specimen be placed on a specimen holder with heat-resistant metal wire for the combustion test.

6.1.4 The specimen holder is pushed into the combustion chamber, with the specimen placed in the center of the combustion chamber in a horizontal position.

6.1.5 The gas lamp is ignited with the air inlet closed, and the flame height is adjusted to 38 mm. The free end of the specimen is positioned in the flame to ignite for 15 s, after which the flame is extinguished (by closing the valve of the gas lamp).

Fig. 2 Schematic of Open flame combustion Test

6.1.6 The flame burns forward from the free end of the specimen, and timing starts at the moment when the root of the propagating flame passes through the first marking line. Attention shall be paid on the flame propagation on the side burning faster. Timing shall be based on the side with faster flame propagation.

6.1.7 Timing shall be stopped when the flame reaches the other end of the sample (where timing is determined by the side with faster flame propagation) or is extinguished . If the flame goes out before reaching the other end of the sample, the combustion distance is measured from the first marking line to the point where the flame goes out. The combustion distance refers to the length of the burnt part on the surface or inside of the specimen.

Note 1: If the non-exposed side of the specimen is cut, timing shall be based on the flame propagation rate of the exposed side.

Note 2: If the specimen burns slowly for a long time since timing starts, the test may be stopped when the test timing reaches 20 min, and the combustion time and combustion distance shall be recorded.

Note 3: When a series of tests or repeated tests are carried out, the maximum temperature inside the combustion chamber and of the specimen holder shall not exceed 30°C before the next test.

6.1.8 Combustion rate calculation

The combustion rate V is calculated using Formula 1, and the maximum combustion rate of 5 samples measured is taken as the test result.

$$V = (L/T)\times 60 \quad (1)$$

Where,

V - combustion rate, in mm/min

L - damage length, in mm

T - time, in s

6.2 Glow-wire test

6.2.1 The glow-wire is heated to a specified temperature, which is measured by a calibrated temperature measurement system. Before the tip of the glow-wire contacts the specimen, care shall be taken to ensure that:

(1) The temperature change is kept within 5 K for at least 60 s.

(2) Thermocouple holes in the glow-wire are free of contaminants and have suitable thermocouples connected to the glow-wire. A suitable connection can be achieved by gently pushing the thermocouple to the full depth of the thermocouple hole.

(3) By providing a distance of at least 5 cm between the specimen and the glow-wire or using appropriate shielding, the specimen is not affected by thermal radiation during this period.

(4) Before the test is completed, the heating current will no longer be adjusted.

6.2.2 The specimen is fixed vertically in the glow-wire tester so that the top of the glow wire can be approximately applied to the center of the specimen surface plane.

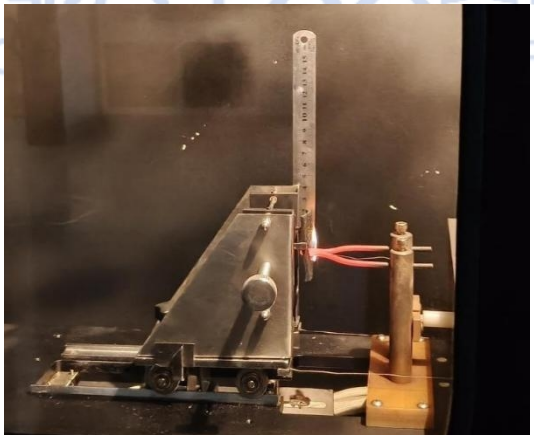

Fig. 3 Schematic of Glow-wire Test

6.2.3 The glow-wire temperature is set to 550°C, and the glow-wire is steadily brought into contact with the specimen, with the tip of the glow-wire contacting the specimen at a pressure of 1.0 N for 30 s±1 s. When the material melts away from the glow-wire, the glow-wire shall not continue to contact the specimen, and the depth that the tip of the glow-wire enters and penetrates the specimen shall be limited to 7 mm±0.5 mm.

6.2.4 After the application time is up, the glow-wire and the specimen are slowly separated to avoid further heating of the specimen and to prevent any air flow from affecting the test results.

6.2.5 During the application of the glow-wire and within 30 s thereafter, an observation shall be made to determine whether the specimen surface ignites. If the specimen ignites, the test ends.

6.2.6 If the specimen does not ignite when the glow wire temperature is 550°C, the glow wire temperature shall be raised to 650°C and the above test repeated, to observe whether the specimen surface ignites. If the specimen ignites, the test ends.

6.2.7 If the specimen does not ignite when the glow wire temperature is 650°C, the glow wire temperature shall be raised to 750°C and the above test repeated, to observe whether the specimen surface ignites. If the specimen ignites, the test ends.

6.3 Smoke density test

6.3.1 The specimen is placed horizontally on the holder so that the flame is just below the specimen when the igniter is in place. The timer is set to zero.

Fig. 4 Schematic of Smoke Density Rating Test

6.3.2 The exhaust fan is turned off, the smoke box door closed, the igniter moved under the specimen and the timer started.

Note: If under the smoke hood, the exhaust fan and smoke hood door shall be closed.

6.3.3 The light absorption rate is recorded at intervals of 15 s, with the total time being 4 min.

6.3.4 After the test is completed, the smoke exhaust box is opened to release the smoke.

Note: If inside the smoke hood, the exhaust fan shall be activated immediately before opening the hood door to clear the smoke.

6.3.5 The smoke box door is opened and detergent and water is used to remove combustion deposits from the photometer, emergency exit signs, and glass doors. The residue from the sieve is removed or the sieve is replaced with another one for the next test.

6.3.6 The light absorption data of three samples in each group is averaged every 15 s, and a curve of the average values versus time is plotted.

6.3.7 The light absorption rate at the highest point of the curve is taken as the maximum smoke density.

6.3.8 Smoke density rating calculation

The smoke density rating SDR is calculated using Formula 2,The average smoke density of three samples is taken as the test result.

$$SDR=（S_1/S_0）\times 100\% \quad (2)$$

Where,

SDR - smoke density rating

S_1 - total smoke production, which is the area enclosed by the curve and the coordinate axis below .

S_0 - the total area of the curve – (0~100)% of the total light absorption area within (0~4) min.

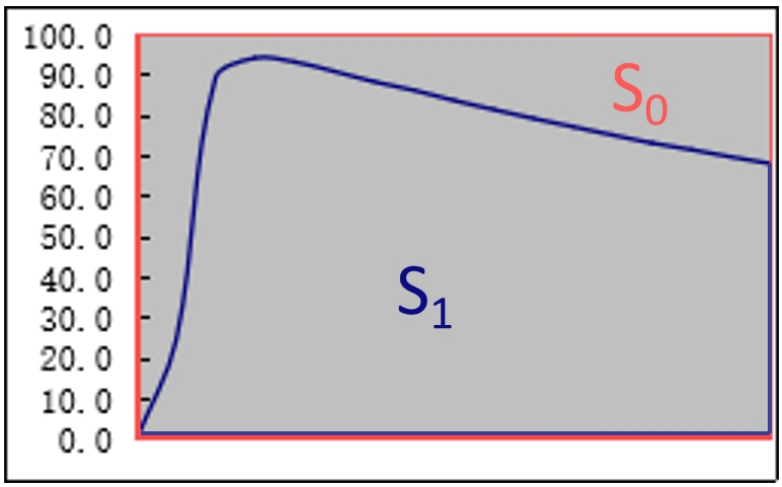

Fig. 5 Schematic of Smoke Density Rating Calculation

7 Evaluation Methods

7.1 Testing and evaluation items and indicators

The material flame retardant performance is tested, and the comprehensive score is calculated according to Table 2.

Table 2 Detailed Rules for Comprehensive Scoring

Level-I Indicator	Level-II Indicator	Evaluation Content	Score	Full Score	Weight
Open flame combustion	Main carpet (including bottom sponge) combustion rate V_1	$V_1 \leq 60$ mm/min	25	25	40%
		$60 < V_1 < 80$mm/min	17.5		
		$V_1 \geq 80$ mm/min	12.5		
	Trunk carpet combustion rate V_2	$V_2 \leq 60$ mm/min	25	25	
		$60 < V_2 < 80$mm/min	17.5		
		$V_2 \geq 80$ mm/min	12.5		
	Bottom shield combustion rate V_3	$V_3 \leq 60$ mm/min	25	25	
		$60 < V_3 < 80$mm/min	17.5		
		$V_3 \geq 80$ mm/min	12.5		
	Driver's seat cushion fabric combustion rate V_4	$V_4 \leq 60$ mm/min	25	25	
		$60 < V_4 < 80$mm/min	17.5		
		$V_4 \geq 80$ mm/min	12.5		
Ignition characteristics	Main carpet (including bottom sponge) temperature without open flame T_1	$T_1 \geq 750$ ℃	50	50	20%
		750 ℃ > $T_1 \geq 650$ ℃	30		
		650 ℃ > $T_1 \geq 550$ ℃	15		
		$T_1 < 550$ ℃	0		
	Bottom shield temperature without open flame T_2	$T_2 \geq 750$ ℃	50	50	
		750 ℃ > $T_2 \geq 650$ ℃	30		
		650 ℃ > $T_2 \geq 550$ ℃	15		
		$T_2 < 550$ ℃	0		
Smoke generation characteristics	Main carpet (including bottom sponge) SDR_1	$SDR_1 \leq 60$	25	25	40%
		$60 < SDR_1 < 70$	12.5		
		$SDR_1 \geq 70$	0		
	Trunk carpet combustion rate SDR_2	$SDR_2 \leq 60$	25	25	
		$60 < SDR_2 < 70$	12.5		
		$SDR_2 \geq 70$	0		
	Bottom shield combustion rate SDR_3	$SDR_3 \leq 60$	25	25	
		$60 < SDR_3 < 70$	12.5		
		$SDR_3 \geq 70$	0		
	Driver's seat cushion fabric combustion rate SDR_4	$SDR_4 \leq 60$	25	25	
		$60 < SDR_4 < 70$	12.5		
		$SDR_4 \geq 70$	0		

7.2 Score calculation method

The comprehensive score is the weighted sum of the scores of 3 testing and evaluation dimensions: combustion rate, ignition characteristics and smoke generation characteristics, expressed as S_4.

$$S_4 = \sum_{1}^{3} (s_i \times w_i)$$

Where,

S_4 - 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 levels.

Table 3 Assessment Results and Score Distribution

Assessment Results	Score
★★★★★	S≥90
★★★★	80≤S<90
★★★	70≤S<80
★★	60≤S<70
★	S<60