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**Defect analysis methods for battery electric vehicles fire
accidents**

纯电动汽车火灾缺陷分析方法

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Foreword

This document was drafted in accordance with the provisions of GB/T 1.1-2020 *“Directives for standardization - Part 1: Rules for the structure and drafting of standardizing documents”*.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The issuing authority of this document shall not be held responsible for identifying any or all such patent rights.

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Defect analysis methods for battery electric vehicles fire accidents

1 Scope

This document establishes the analysis procedure for defect analysis of battery electric vehicle fire accidents, and describes the in-depth analysis method for battery electric vehicle fire accident information, batch vehicle information analysis method, defect engineering analysis and test method, defect identification and judgment, and defect analysis report content.

This document applies to the defect analysis of battery electric vehicle fire accidents. It is used as a reference for the defect analysis of other types of electric vehicle fire accidents.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 5907.1 Fire protection vocabulary - Part 1: General terms

GB/T 19596 Terminology of electric vehicles

GB/T 34402 Safety of motor vehicle product - Guidelines for risk assessment and risk control

GB 38031 Electric vehicles traction battery safety requirements

GB/T 43387 Product recall - Vocabulary

GB/T 43388 Judgment guidelines for serious safety-related fault of household automobile

XF/T 812 Guide for fire cause investigation

3 Terms and definitions

For the purpose of this document, the terms and definitions defined in GB/T 5907.1, GB/T 19596, GB 38031, GB/T 43387 and GB/T 43388 and the following apply.

6 In-depth analysis of fire accident information

6.1 General

Based on the on-site investigation of one or more fire accidents of battery electric vehicles of the same model and batch, collect basic information on battery electric vehicle fire accidents, accident vehicle data information, accident scene investigation information, accident evidence analysis information and other relevant information, comprehensively analyze the fault mode, and identify the fire failure cause.

6.2 Fire accident information collection

6.2.1 Basic accident information

Basic accident information generally includes but is not limited to:

- accident information: accident time, accident location, accident vehicle status and driving conditions, accident vehicle power, casualties, accident vehicle storage location, accident scene video, etc.;
- accident process information: information of processes such as vehicle fire accident occurrence, discovery, firefighting;
- accident disposal information: storage, towing and disposal of accident vehicles after fire extinguishing, etc.;
- fire investigation information: information obtained through investigation in accordance with the requirements of XF/T 812, such as other traffic accidents that occurred before the fire accident, chassis collision, wading, soaking in water, battery replacement or repair, vehicle modification and installation, etc., preliminary analysis and judgment of the cause of the fire accident, etc.;
- accident vehicle dealer information: dealer registration name, contact number, mailing address, accident vehicle sales date, etc.

6.2.2 Accident vehicle data information

Accident vehicle data information generally includes but is not limited to:

- accident vehicle information: electrical system layout of the accident vehicle, power battery layout, maintenance record of the accident vehicle, vehicle operation data and operation cycle data 7 days before the accident, etc.;
- accident vehicle operation cycle data analysis information: analysis of vehicle usage such as fast charging ratio, maximum charging current, daily mileage, total mileage, insulation changes, historical alarm information, battery abuse, etc. of the

accident vehicle, as well as safety parameter correlation analysis, consistency analysis, etc.;

- accident vehicle power battery information: location, manufacturer, nominal total capacity, nominal total voltage, total weight, charging power, system thermal management form, series-parallel type, number and layout of voltage and temperature sensors of the power battery; manufacturer, specification and model, nominal capacity, cell weight, maximum sustainable charge and discharge power, maximum sustainable charge and discharge current, battery electrochemical system, positive electrode material type of the battery cell; module location, module manufacturer, software manufacturer, hardware manufacturer, etc. of the battery management system.

6.2.3 Accident scene investigation information

Accident scene investigation information generally includes but is not limited to:

- accident data pre-analysis information: safety parameter correlation analysis of vehicle operating total voltage, total current, battery temperature, insulation resistance, and background monitoring fault information 7 days before the accident, as well as parameter consistency analysis of battery cell voltage, temperature probe monitoring value, etc.;
- accident investigation information: analysis of burn damage and residual traces of accident vehicle body, power compartment, trunk, chassis, passenger compartment, main parts such as battery, motor, electronic control, and charging socket, data analysis of charging piles of accident vehicles in charging state, fire spread trend and fire location judgment, etc.;
- accident vehicle fault mode and accident cause analysis information: accident vehicle fault mode identification process, fire cause.

6.2.4 Accident evidence analysis information

Accident evidence analysis information generally includes but is not limited to:

- electrical short circuit trace analysis information: analysis of melting marks caused by vehicle high-voltage wiring harness, low-voltage wiring harness and its connectors, and analysis of melting marks of charging piles and wiring harnesses;
- fire trace analysis information: analysis of melting marks caused by fire on vehicle wiring harnesses, plastic parts, etc.;
- battery pack burn analysis information: analysis of battery pack shell, battery pack internal parts and wiring harness burn conditions, analysis of mechanical deformation and arcing of structural parts, modules or cells in battery packs,

production date, vehicle registration date, vehicle nature, vehicle category, power type, chassis type; production and manufacturing data, operation cycle data, fault and maintenance information of some vehicles;

- power battery information: battery cell supplier, module supplier, battery pack supplier, battery management system software/hardware supplier, battery cell shape, battery cell model, battery cell type, battery cell positive and negative electrode materials, battery cell electrolyte composition, battery cell charge and discharge power/current limit table, battery pack internal module series-parallel mode, battery pack internal high and low voltage layout diagram, battery pack internal module and battery cell layout diagram, battery pack internal temperature and voltage sensor quantity and location, battery pack tray material, battery pack waterproof design, battery system cooling form, battery system flame retardant coefficient, battery system fuse curve, production and manufacturing process data of some batteries and battery systems;
- motor system information: motor type, rated voltage, no-load current, rated current, starting current, maximum continuous current, rated power, maximum output power, rated speed, no-load speed, maximum speed, rated torque, maximum torque;
- electric control system information: software/hardware supplier, rated voltage, rated current.

7.1.2 Production and manufacturing data, operation cycle data, fault and maintenance information of some vehicles, and production and manufacturing process data of some battery cells and battery systems should be randomly sampled from batches of vehicles with similar operating conditions to the accident vehicle. The specific sampling quantity is determined based on the results of the previous in-depth investigation and analysis of the accident and the proposed analysis method to ensure the scientificity and rationality of the analysis.

7.2 Batch vehicle data analysis

Systematically research the batch vehicle information collected in 7.1, by referring to the analysis methods given in Annex A, analyze the vehicle operation cycle data through the data platform to identify the common fault modes existing in vehicles of the same model, same batch or using the same parts. The batch vehicle data analysis process is shown in Figure 3.

- vehicle parts of the same model and batch: parts disassembled from vehicles of the same model, same parts configuration, same vehicle production batch and parts production batch, and same vehicle three-electric system software version as the accident vehicle, including but not limited to the hardware and software of major parts such as batteries, motors, and electronic controls.

8.3 Defect engineering analysis and test

8.3.1 Accident vehicle wreckage test analysis

The accident vehicle wreckage test analysis shall analyze and disassemble wreckage parts such as battery, motor, electronic control, high and low voltage wiring harness of the accident vehicle, and refer to the analysis methods given in Annex B to measure, test, sample, and analyze the abnormal parts.

8.3.2 Analysis of in-use vehicles adjacent to the accident vehicle

Select 5 in-use vehicles from the same batch as the fire fault parts of the accident vehicle and before and after the vehicle was produced, and perform test, analysis, and disassembly on vehicle parts of the same model. Refer to the analysis methods given in Annex B to measure, test, sample, and analyze the abnormal parts found.

8.3.3 New vehicle comparative analysis

The new vehicle comparative analysis shall be performed on the latest vehicles or parts of the same model as the accident vehicle for assembly inspection, performance test and analysis, fault injection test, disassembly analysis, etc., and refer to the analysis methods given in Annex B to measure, test, sample and analyze the abnormal parts found.

8.4 Identify failure cause

Combining the analysis results of 6.3, 7.2 and 8.3, identify the failure cause:

- if the failure cause can be identified, it should carry out defect identification and judgement in accordance with the requirements of Clause 9;
- if the failure cause cannot be identified, terminate the defect analysis, form a complete defect analysis report, and it should repeat the identification in accordance with the method described in Clause 6.

9 Defect identification and judgement

During the defect identification and judgement process, it is necessary to determine whether the failure of battery electric vehicle fire is related to the design, manufacturing or labeling, etc. of the product itself:

Annex C

(informative)

Battery electric vehicle fire defect analysis report (template)

C.1 Overview of defect analysis

Including but not limited to the reasons for defect analysis, dimensions of analysis, etc.

C.2 Basic information of defect analysis objects

Including but not limited to fire accident information, batch vehicle information, etc.

C.3 In-depth analysis of fire accident information

Including but not limited to the analysis process and content of basic information of battery electric vehicle fire accidents, accident vehicle data information, accident scene investigation information, accident evidence analysis information and other related information, and the identified fault modes.

C.4 Batch vehicle information analysis

Including but not limited to the selected analysis method, production and manufacturing data analysis results, maintenance data analysis results, operation data analysis results of vehicles of the same batch and model, and the identified common fault modes.

C.5 Defect engineering analysis and test

Including but not limited to test plan, test method, test process and test results, and analyzed failure causes.

C.6 Summary of defect analysis work and related suggestions

Including but not limited to the fault modes and failure causes summarized through in-depth analysis of fire accident information, batch vehicle information analysis and defect engineering analysis and test results, and relevant solutions or suggestions.

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