

ICS 43.120
CCS T 47



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 45417-2025

**Guidelines for defect analysis of vehicle regenerative braking
function**

汽车再生制动功能缺陷分析指南

Issued on: February 28, 2025

Implemented on: February 28, 2025

**Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC**

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1 Scope

This document provides guidance on the analysis of defects in regenerative braking function that may cause safety issues during vehicle operation, including the basic process of defect analysis, collection of defect clues, analysis of the correlation between defect clues and regenerative braking function, risk assessment and defect determination, and disposal measures.

This document is applicable to M and N vehicles with regenerative braking function.

2 Normative references

GB/T 13594

GB/T 15089

GB/T 19596

GB 21670

GB/T 34402

GB/T 43387

3 Terms and definitions

For the purposes of this document, the terms and definitions defined in GB/T 13594, GB/T 15089, GB/T 19596, GB 21670, GB/T 34402, GB/T 43387 as well as the followings apply.

3.1 Regenerative braking function

The function of converting vehicle kinetic energy into electrical energy during processes such as coasting, deceleration, or downhill driving.

3.2 Regenerative braking system

Hardware and software systems for implementing regenerative braking function.

3.2.1 Regenerative braking system of category A

A regenerative braking system that does not belong to the service braking system.

[Source. GB 21670-2008, 3.1.16.2, modified]

3.2.2 Regenerative braking system of category B

The regenerative braking system that belongs to the service braking system.

[Source. GB 21670-2008, 3.1.16.3, modified]

3.3 Defect

The common occurrence of situations in the same batch, model, or category of automotive products that do not comply with national or industry standards for safeguarding personal and property safety, or other unreasonable dangers that endanger personal and property safety.

[Source. GB/T 43387-2023, 3.1, modified]

3.4 Defect clue

Information about possible defects in the product.

NOTE. Including accident investigation, consumer complaints, online public opinion, and overseas recall information.

[Source. GB/T 43387-2023, 5.3, modified]

3.5 Defect analysis

Technical analysis activities conducted by producers, recall authorities, or recall technical institutions on the presence of defects in products.

3.6 Risk assessment

The process of determining the comprehensive level of severity and likelihood of occurrence of a hazardous event or situation.

[Source. GB/T 43387-2023, 5.13]

5 Defect clue collection

The main ways to collect defect clues include (but are not limited to).

- a) Accident investigation;
- b) Consumer complaints;
- c) Online public opinion;
- d) Overseas recall;
- e) Quality supervision information.

6 Correlation analysis between defect clues and regenerative

braking function

6.1 Analysis of defect clue characteristics

Conduct defect clue feature analysis based on the defect clues collected in Chapter 5. The analysis mainly includes.

- a) Vehicle characteristics, such as vehicle type, usage mode, regenerative braking type, regenerative braking intensity, vehicle braking control software version, etc.;
- b) Scene features, such as traffic conditions, road environment conditions, weather conditions, etc.;
- c) Driver characteristics, such as driving experience, driver age, etc.

6.2 Characteristic analysis of regenerative braking function

Analyze the characteristics of regenerative braking function for vehicle regenerative braking system. The analysis mainly includes.

- a) Control mode, default state, actual state distribution, adjustment method, reminder situation, vehicle speed correlation logic, relationship with charge state, and relationship with service braking strategy of regenerative braking function;
- b) Hardware information and control strategies related to regenerative braking function, such as vehicle controller, drive motor and controller, battery state of charge, accelerator pedal status, brake pedal status, etc.

6.3 Association analysis

Compare and analyze the correlation between the comprehensive defect clue characteristics and the regenerative braking function characteristics. The analysis methods mainly include. big data analysis, expert analysis, accident scene reproduction, closed road testing, driving simulator testing, virtual simulation testing, etc.

If there is a correlation between the defect clue characteristics and the regenerative braking function characteristics, such as a high accident rate in a specific regenerative braking function mode or a high accident rate in a specific scenario, it is advisable to conduct risk assessment work according to Chapter 7. If there is no correlation, the analysis should be terminated.

7.1 Overview

Risk assessment is an important component of the analysis of defects in regenerative braking function. This mainly includes identifying hazardous events or situations, analyzing the severity of hazardous events or situations, conducting likelihood analysis, and forming a comprehensive risk level rating. Based on the comprehensive risk level rating results, further defect determination can be carried out.

7.2 Identification of hazardous events or situations

According to vehicle malfunctions and accident manifestations, the main hazardous events or situations caused by the regenerative braking function of the vehicle and their analysis methods are shown in Table 1. Other possible hazardous events or situations can also be comprehensively analyzed through on-board data, images, experimental reproduction, and expert demonstration.

When conducting analysis, the main hazardous events or situations can be identified among multiple hazardous events or situations. Conduct risk assessments for major hazardous events or situations. If it is difficult to distinguish between primary and secondary dangerous events or situations, any danger can be set first. The event or situation is a major hazardous event or situation, and a risk assessment is conducted for it.