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Steering system of motor vehicles -

Basic requirements

汽车转向系 基本要求

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Steering system of motor vehicles - Basic requirements

1 Scope

This Standard specifies the terms and definitions, technical requirements, and test methods of the steering system of motor vehicles.

This Standard applies to categories M, N vehicles and category O trailers specified in GB/T 15089.

This Standard does not apply to:

- Pneumatic transmission steering system;
- Vehicles with autonomous steering system as defined in 3.1.1.5.

2 Normative references

The following documents are indispensable for the application of this document. For the dated references, only the editions with the dates indicated are applicable to this document. For the undated references, the latest edition (including all the amendments) are applicable to this document.

GB/T 3730.1 Motor vehicles and trailers - Types - Terms and definitions

GB/T 3730.2 Road vehicle - Masses - Vocabulary and codes

GB/T 3730.3 Motor vehicles and towed vehicles - Dimensions of vehicles - Terms and definitions

GB/T 5053.3 Road vehicles - Connectors for the electrical connection of towing and towed vehicles - Definitions tests and requirements

GB/T 5563 Rubber and plastics hoses and hose assemblies - Hydrostatic testing

GB/T 7939 Hydraulic fluid power - Hose assemblies - Test methods

GB/T 9574 Rubber and plastics hoses and hose assemblies - Ratios of proof and burst pressure to maximum working pressure

GB/T 12540 Minimum turning circle diameter, minimum turning clearance

Another additional equipment for adjusting the steering quality of the vehicle, which can make the steered wheels and/or the wheels (front and/or rear) on other axles adjust the same or opposite steering angles, in addition to the steering angle provided by the main steering equipment, on categories M and N vehicles.

3.1.3.2 Trailers

3.1.3.2.1

Trailers self-tracking steering equipment

The equipment which changes the steering angle of one or more wheels only when the trailer wheels are subjected to force and/or moment from the ground.

3.1.3.2.2

Articulated steering

The equipment in which the steering movement uses the articulated mechanism between tractors and trailers, to form a relative angle between the longitudinal axis of tractors and trailers, and to change the driving direction of the tractor to generate steering forces, when the vehicle is running.

3.1.3.2.3

Self-steering

The equipment in which the steering movement uses the angle formed by the longitudinal axis of trailer frame or alternative load and the longitudinal axis of draw-bar and turntable frame, to change the driving direction of the tractor to generate steering forces, when the vehicle is running.

3.1.3.2.4

Additional steering equipment

The equipment, independent of the main steering equipment of the tractor, which selectively adjusts the steering angle of one or more axles of the trailer according to different control purposes.

3.1.3.2.5

Full-power steering equipment

The equipment in which the steering forces are completely provided by one or more energy supply components.

3.1.5.4

Hybrid steering transmission

Part of the steering forces are transmitted in one of the above-mentioned ways; while the other part is transmitted in another way.

Note: However, if the mechanical part used for transmission is only for providing the driver's sense of road, and the steering forces transmitted by it can be ignored for the whole system, it shall be regarded as hydraulic or electric steering transmission.

3.1.6

Trailers steering electric control line

The electrical connection part for the steering control function of the trailer.

Note: It includes data communication cables for trailer control, wires and connectors for power supply.

3.2 Terms of functional safety

3.2.1

Functional safety concept

Functional safety requirements and related information needed to achieve safety goals.

Note: For example, safety measures implemented to ensure system integrity and safe operation in fault and non-fault modes.

3.2.2

Unit

The smallest part of a system component which can be identified, analyzed, or replaced as a single entity.

3.2.3

Electronic control system

The combination of a series of units which coordinate the realization of vehicle control functions through electronic data processing.

Note: The system is usually controlled by software; composed of independent functional components such as sensors, controllers and actuators; and connected by

without disassembly. Unless specially designed, any part of the steering transmission equipment shall not limit the maximum steering angle.

4.1.5 The vehicle electrical control system related to the steering of the motor vehicle must not affect the steering function due to electromagnetic interference. And it shall meet the technical requirements in GB 34660.

4.1.6 The adjustable components in the steering transmission system shall be lockable.

4.1.7 The steered wheels of motor vehicles shall not only be the rear wheels.

4.1.8 The steering system can share the same energy supply with other systems. However, if any system that shares the same energy with the steering system fails, the steering system shall still meet the relevant steering functions in the case of fault in 4.3.

4.1.9 The functional safety requirements of the steering electronic control system shall be formulated in accordance with GB/T 34590 (all parts); shall meet the requirements of Appendix B.

4.2 Requirements for trailers

4.2.1 When the tractor-trailer combination goes straight ahead, the trailer shall be in the same driving direction as the tractor. If the trailer cannot automatically maintain a straight-line driving, it shall be equipped with corresponding adjustment devices.

4.2.2 The rear wheels of the semi-trailer may be steered wheels.

4.2.3 The tractor is driving straight on a level road. Within the maximum design speed range, when the driver has no steering correction behavior, and the steering system has no abnormal vibration, the trailer shall not affect the straight-line driving performance of the vehicle due to its steering system.

4.2.4 At a uniform speed of (25 ± 1) km/h and 5 km/h, the tractor-trailer combination performs steady-state turning along a turning circle with a radius of 25 m. Measure the radius of the trajectory circle traversed by the rearmost outer edge of the trailer, respectively. The difference between the trajectory circle radius at the speed of (25 ± 1) km/h and 5 km/h shall not be more than 0.7 m.

4.2.5 When the tractor-trailer combination leaves a turning circle with a radius of 25 m at a speed of 25 km/h, the tractor is within 40 m of the tangent line from the leaving starting point as the tangency point (calculated to the end of the trailer). The projection of any part of the trailer on the ground must not exceed

4.3.3.2 When the control transmission device fails, except for those components listed in 4.1.4, for the complete steering system, the vehicle can still steer according to the performance requirements of 4.1 and 4.2 when the steering system is intact.

4.3.3.3 If the energy source fails, under the premise that the energy storage level meets the requirements of 4.3.3.5, the vehicle speed is 10 km/h, and the turning radius is 20 m, it shall be able to complete at least 24 figure-8 turning operations. During the period, the steering control force shall meet the requirements of Table 1 for an intact system.

4.3.3.4 If there is a fault in the energy transmission, except for the components listed in 4.3.1.1, the steering angle cannot change significantly. For a faulty system, under the premise that the energy storage level meets the requirements of 4.3.3.5, as long as the vehicle can drive at a speed of 10 km/h, it shall perform at least 25 figure-8 turns at this speed. The turning radius each time is 20 m. During which the steering control force shall still meet the requirements of Table 2.

4.3.3.5 For the energy storage level at the beginning of the tests described in 4.3.3.3 and 4.3.3.4, it shall be the energy storage state when the driver receives a warning of insufficient energy storage.

The steering electronic control system needs to meet the functional safety requirements of Appendix B. This energy storage level shall be the worst case described in the documentation, submitted by the manufacturer in accordance with Appendix B. The impact of temperature and aging on battery performance shall also be considered.

4.4 Alarm signals

4.4.1 General provisions

4.4.1.1 The steering system shall, through the motor vehicle, clearly warn the driver of any non-mechanical fault that impairs the steering function. Despite the requirements of 4.1.2, the abnormal vibration of the steering system can be used as an additional reminder signal of system fault. The sudden increase in the steering control force of the motor vehicle is also an alarm signal. As for the trailer, the use of mechanical alarm devices is allowed.

4.4.1.2 The visual alarm signal shall work reliably; shall be visible even in the daytime. And it shall be easily recognized by the driver. The fault of the alarm device components shall not affect the performance of the steering system.

4.4.1.3 The audible alarm signal shall be a continuous or intermittent sound signal or voice message, which is easy for the driver to recognize. If voice

In the process of measuring the steering control force, the steering control force, whose duration is shorter than 0.2 s, is ignored.

5.2.4 Measurement of steering control force when the steering system of motor vehicles is intact

5.2.4.1 At a speed of 10 km/h, the motor vehicle enters a steering state from a straight-line driving. Test the steering control force of the steering wheel on the nominal radius of steering control. When the motor vehicle's turning radius reaches the turning circle shown in Table 1, its steering time and the applied steering control force shall meet the requirements of Table 1. Record input of the steering control force. The measurement of steering control force shall be done once on the left and the right, respectively.

5.2.4.2 For categories M₃ and N₃ vehicles, if the turning circle radius cannot be less than 12 m, the maximum turning angle of the steered wheels is used. After the position is locked, perform the test of steering control force.

5.2.5 Measurement of steering control force when the steering system of motor vehicles fails

5.2.5.1 The maximum steering control force, steering time, and steering radius when testing the steering process, and the minimum requirements for steering control force are listed in Table 2. For steering systems with power assist, at least the measurement of steering control force when the power assist fails shall be included. For steering systems without power assist, the manufacturer shall provide steering system failure modes. For the steering system that has failed, repeat the test process of 5.2.4.

5.2.5.2 For categories M₃ and N₃ vehicles, the dual-steering axle or multi-steering axle non-articulated vehicle except for the motor vehicle's self-tracking steering equipment is 500 N.

5.3 Tests for trailers

5.3.1 Straight-line driving and abnormal vibration test of tractor-trailer combination: When the tractor is driving in a straight line on a horizontal road at 80 km/h (according to the maximum speed of product design when the maximum speed is lower than 80 km/h), the trailer shall not have large directional deviation (caused by the steering system) or abnormal vibration in the steering system.

5.3.2 According to the requirements of 4.2.4, the tractor-trailer combination is subjected to the turning circle test during steady-state steering at different speeds. The difference of the turning circle shall meet the requirements of 4.2.4.

Appendix A

(Normative)

Supplementary regulations for vehicles equipped with auxiliary steering equipment (ASE)

A.1 General provisions

In addition to meeting the requirements of the text of this Standard, vehicles equipped with auxiliary steering equipment shall also comply with the requirements of this appendix.

A.2 Special regulations

A.2.1 Transmission equipment

A.2.1.1 Purely mechanical steering transmission equipment

The purely mechanical steering transmission equipment shall meet the requirements of 4.3.1.1.

A.2.1.2 Purely hydraulic steering transmission equipment

The purely hydraulic transmission equipment shall prevent its pressure from exceeding the maximum allowable pressure.

A.2.1.3 Purely electric steering transmission equipment

The purely electric steering transmission equipment is not allowed to be overloaded.

A.2.1.4 Hybrid transmission equipment

A hybrid transmission equipment composed of mechanical, hydraulic and electric, etc. shall meet the requirements of A.2.1.1, A.2.1.2 and A.2.1.3 above respectively.

A.2.2 Test requirements after fault

A.2.2.1 General requirements

Failure or fault of any component of ASE (except the components that are not prone to fault as specified in 4.3.1.1) shall not cause sudden and obvious changes in the driving state of the vehicle. The requirements of 5.2 shall still be

Appendix B

(Normative)

Functional safety requirements

B.1 General

When the vehicle safety-related electronic and electrical systems malfunction, it will lead to potentially hazardous events (for example, during the normal driving of the vehicle, unexpected autonomous steering occurs, resulting in a vehicle collision). GB/T 34590 (all parts) clarifies the functional safety requirements, which the vehicle safety-related electrical and electronic systems shall meet during the safety life cycle; to avoid or reduce the risks caused by system faults.

This appendix specifies the documentation, safety strategy, and verification and validation requirements of the steering electronic control system in terms of functional safety.

This appendix is not aimed at the nominal performance of the steering electronic control system; nor is it used as a specific guide for the functional safety development of the steering electronic control system. Rather, it stipulates the methods to be followed during the design process, and the information that shall be available for system verification and validation; to prove that, the system can realize the functional concept and functional safety concept under normal operation and fault conditions; and, meets all applicable performance requirements specified in this Standard.

B.2 Documentation

B.2.1 Requirements

Corresponding documentation shall be available; to explain the functional concept of the steering electronic control system, and the functional safety concept, safety strategy, development process and method formulated to achieve the safety goal; to prove that the system:

- The design ensures that, in both non-fault and fault conditions, the system can realize the functional concept and functional safety concept.
- Under non-fault and fault conditions, meet the performance requirements specified in this Standard.

- Switch to an independent backup system. If the backup system is selected to achieve the safety goal, the principle of the switching mechanism, the logic and level of redundancy, and the inspection characteristics of the backup system shall be explained. The effect of the backup system shall be defined.
- Enter the safe state by turning off the upper-layer function. If the upper-layer function is turned off, all corresponding output control signals related to the function shall be prohibited, to limit the propagation of interference.
- By warning the driver, the risk exposure time is reduced to an acceptable time interval.

B.2.5.3 It shall explain the architecture overview of the software in the steering electronic control system, the logic in the design and development process, and the design methods and tools used.

B.2.5.4 When the safety-related functions of the steering electronic control system fail, the driver shall be warned by means of warning signals or prompt messages, etc.

B.2.6 Safety analysis

B.2.6.1 Safety analysis shall be used; to explain on the whole the effective identification and treatment of the hazards and faults, which affect vehicle motion control and safety goals; in order to support the above-mentioned documentation. Safety analysis shall include but not limited to:

- a) Safety analysis at the complete-vehicle level confirms the following:
 - Interaction with other systems of the vehicle;
 - Functional abnormalities;
 - Safety risks under non-fault conditions.
- b) For system-level safety analysis, potential failure mode and effects analysis (FMEA), fault tree analysis (FTA), or other similar methods suitable for system safety analysis can be used.
- c) Check the validation plan and validation results. The validation shall be based on hardware-in-loop (HIL) testing, real-vehicle road testing, or other appropriate methods.

B.2.6.2 The parameters monitored by the system shall be listed. At the same time, for each fault situation defined in B.2.6.1, it shall list the warning signals to the driver, maintenance personnel, and personnel of the testing organization.

Manufacturer name: _____

Vehicle type: _____ VIN: _____

B.4.2.2 Documentation information provided by the manufacturer

Documentation number: _____

Release time of the original version: _____

Release time of the final version: _____

B.4.2.3 Description of steering electronic control system

Overall description: _____

Description of all control functions of the system and operation methods:

Description of associated components and diagrams in the system: _____

B.4.3 Functional safety concept

Description of signal flow, operating data and priority: _____

Manufacturer's declaration (for example: The manufacturer shall ensure that, the safety strategy, selected to achieve the safety goal, will not affect the safe operation of the vehicle under fault conditions and non-fault conditions):

Architecture overview of the software and the design methods and tools used:

Design description of the system under fault conditions: _____

Safety analysis documentation of the system for hazards and faults: _____

Description of the measures for environmental conditions: _____

B.4.4 Verification and validation

Results of functional concept verification and validation (see B.3.2 for requirements): _____

Results of functional safety concept verification and validation (see B.3.3 for requirements): _____

Test date: _____

Appendix D

(Normative)

Special requirements for power supply of steering system of tractor-trailer combination

D.1 General provisions

This appendix applies to tractors and trailers for which the tractor in the tractor-trailer combination provides electrical energy to the steering system of the trailer. If the trailer steering system uses hydraulic transmission to control the steering, it shall also meet the requirements of Appendix C.

D.2 Requirements for tractors

D.2.1 Power supply

D.2.1.1 When the tractor is running normally, it shall have the ability to provide the trailer with the power supply current as defined in D.2.3.2.

D.2.1.2 The driver's operating manual shall state the information of the electrical energy, which can be provided to the steering system of the trailer. And when the trailer is marked with its required current exceeding the current available from the tractor, the electrical interface must not be connected.

D.2.1.3 The electrical energy provided by the connector defined in D.2.3 shall be used for the power supply of the trailer steering system. However, the provisions of D.3.1.3 apply at any time.

D.2.2 Electrical system protection

When supplying power to the steering system of the trailer, the electrical system of the tractor shall be able to prevent the tractor from being overloaded or short-circuited.

D.2.3 Wiring and connector

D.2.3.1 The cable used to provide trailer electrical energy shall have a conductor cross-sectional area, which is suitable for meeting the maximum continuous current defined in D.2.3.2.

D.2.3.2 The connector used by the tractor to connect to the trailer shall meet the following requirements:

- The pin shall have a current-carrying capacity compatible with the maximum continuous current;
- The environmental protection function of the connector shall meet the requirements set out in B.2 Documentation of Appendix B;
- The connector must not be interchanged with the existing electrical connector currently used on the tractor (i.e. GB/T 20716.1, GB/T 20718, etc.).

D.3.4 Identification

A trailer, equipped with a connector used to provide electrical energy to the steering system of the trailer, shall be marked with the following information:

- The trailer shall be marked with the maximum use current requirement of the trailer steering system defined in D.3.1;
- The functions of the trailer steering system, including the effect on the mobility of the trailer when the connector is connected and disconnected.

The mark shall be in an indelible form. It shall be ensured that, the mark is visible after the electrical connector described in D.3.3.2 is connected.

D.3.5 Fault warning

The driver shall be able to be intuitively warned of the electrical control transmission fault of the steering system.

D.3.6 Simulation and verification of steering system fault

D.3.6.1 The trailer steering system shall meet the relevant performance and functional requirements in this Standard.

D.3.6.2 The fault mode is generally verified under the following two conditions:

a) Steady-state conditions

If the trailer is connected to a tractor without power supply to the trailer steering system; or the power supply of the trailer steering system is interrupted; or the electric control line transmission fails, the trailer steering control system shall meet all relevant requirements of the intact system in 4.2.

b) Transient conditions

When the steering system has a transmission fault of the electric control

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