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Technical Requirements and Testing Methods for Passenger Car Braking Systems

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Foreword

All provisions of this standard are compulsory.

This standard is not equivalent to ECE Regulation R13-H "Uniform Provisions Concerning the Approval of Passenger Cars with Regard to Braking" in consistency degree. Compared with ECE R 13-H, there are technical differences and main editorial changes as follows:

-- Delete the content relevant to type approval specified in Appendix 1 and Appendix 2 of ECE R 13-H;

-- Integrate Appendix 3, Appendix 4, Appendix 5 and Appendix 6 of ECE R 13-H into the text part of this standard;

-- Considering part of vehicles with lower maximum design speed cannot reach the specified test speed due to limitation in acceleration performance, such vehicles may be applied with Type-0 test for engine disconnected at the maximum speed that they can run;

-- Add the requirements in "vehicle type approval and expansion";

-- Provide complete test methods;

-- Symbols and definitions involved in this standard are summarized as Appendix A;

-- Use Appendix 1 of Annex 3 in ECE R 13-H as Appendix B of this standard;

-- Use Annex 7 in ECE R 13-H as Appendix C of this standard;

-- Use Annex 8 in ECE R 13-H as Appendix D of this standard;

-- Provide the requirements on recommended test report and figures/tables relevant in Appendix E.

Vehicles approved to this standard firstly shall implement this standard on the implementation date of this standard; and the vehicles being manufactured shall implement this standard after 12 months from the implementation date.

Prior to the implementation of the revised edition to GB 12676-1999, vehicles of categories M1 may use one of this Standard and GB 12676-1999.

Appendix A, Appendix B, Appendix C and Appendix D of this standard are normative, and Appendix E is informative.

This standard was proposed by the National Development and Reform Commission.

This standard shall be under the jurisdiction of the National Technical Committee 114 on Road Vehicles of Standardization Administration of China (SAC/TC 114).

Chief Drafting Organizations: China Automotive Technology & Research Center, Dongfeng Honda Motor Co., Ltd., FAW TOYOTA Motor Co., Ltd., Shanghai Volkswagen Motor Co., Ltd., Chery Motor Co., Ltd., Guangzhou Honda Motor Co., Ltd., Beijing Hyundai Motor Co., Ltd., Huachen BMW Auto Co., Ltd.

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Technical Requirements and Testing Methods for Passenger Car Braking Systems

1 Scope

This standard specifies the structure, performance and test methods for braking system of passenger cars (vehicle).

This standard is applicable to vehicles of category M_1 as specified by GB/T 15089.

2 Normative References

The following standards contain the provisions which, through reference in this text, constitute the provisions of this standard. For dated reference, the subsequent amendments (excluding corrigendum) or revisions of these publications do not apply. However, the parties who enter agreement according to these specifications are encouraged to study whether the latest editions of these references are applicable. For undated references, the latest edition of the normative document is applicable to these specifications.

GB 4094 Motor Vehicles-Symbols for Controls, Indicators and Tell-tales [GB 4094-1999, eqv 93/91/EEC (78/316/EEC)]

GB/T 5620 Road vehicles -- Braking of automotive vehicles and their trailers -- Vocabulary (GB/T 5620-2002, idt ISO 611: 1994)

GB 12981 Motor vehicle brake fluids (GB 12981-2003, ISO 4925: 1978, MOD)

GB/T 14168 Motor vehicles -- Graphical symbols to designate brake fluid types (GB/T 14168-1993, eqv ISO 9128: 1987)

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

GB/T 17619 Limits and methods of testing for immunity of electrical / electronic sub-assemblies in vehicles to electromagnetic radiation

GB 18655 Vehicles boats and internal combustion engines -- Radio disturbance characteristics -- Limits and methods of measurement for the protection of on-board receivers (GB 18655-2002, idt IEC/CISPR 25: 1995)

3 Terms and Definitions

For the purposes of this document, the terms and definitions in GB/T 5620 together with the follows apply.

3.1 Basic Terms and Definitions

3.1.1

Vehicle type

A category of vehicles which do not differ in such essential respects as:

-- the maximum total design mass;

-- the distribution of mass among the axles;

-- The highest design speed;

-- The type of braking equipment, with more particular reference to the presence or otherwise of equipment for braking a trailer or any presence of electric braking system;

-- The number of and layout of axles;

-- The type of engine;

-- The gear and speed ratio of transmission;

-- The final drive ratios;

-- The tyre dimensions.

3.1.2

Braking equipment

The combination of parts whose function is progressively to reduce the speed of a moving vehicle or bring it to a halt, or to keep it stationary if it is already halted; the equipment consists of the control device, the transmission device, and the brake proper.

3.1.3

Control device

The part actuated directly by the driver to furnish to the transmission the energy required for braking or controlling it. This energy may be the muscular energy of the driver, or energy from another source controlled by the driver, or a combination of these various kinds of energy.

3.1.4

Transmission device

The combination of components comprised between the control and the brake and linking them functionally. The transmission may be mechanical, hydraulic, pneumatic, electric or mixed. Where the braking power is derived from or assisted by a source of energy independent of the driver, the storage of energy (energy accumulator) in the system is likewise part of the transmission.

The transmission device is divided into two independent functions: the control transmission and the energy transmission. Whenever the term ‘transmission’ is used alone in this Standard, it means both the ‘control transmission’ and the 'energy transmission'.

3.1.4.1

Control transmission device

The combination of the components of the transmission device which control the operation of the brakes, including the control function and the necessary storage(s) of energy.

3.1.4.2

Energy transmission device

The combination of the components which supply to the brakes the necessary energy for their function, including the storage(s) of energy necessary for the operation of the brakes.

3.1.5

Brake

The part in which the forces opposing the movement of the vehicle develop. It may be a friction brake (when the forces are generated by friction between two parts of the vehicle moving relatively to one another); an electrical brake (when the forces are generated by

3.1.15

Actuation

Application and release of the control.

3.1.16

Electric regenerative braking, EBS

A braking system which, during deceleration, provides for the conversion of vehicle kinetic energy into electrical energy.

3.1.16.1

Electric regenerative braking control

A device which modulates the action of the electric regenerative braking system.

3.1.16.2

Electric regenerative braking of category A

An electric regenerative braking system which is not part of the service braking system.

3.1.16.3

Electric regenerative braking of category B

An electric regenerative braking system which is part of the service braking system.

3.1.17

Traction battery; power battery

An assembly of accumulators (batteries) constituting the storage of energy used for powering the traction motor(s) of the vehicle.

3.1.18

Electric state of charge, SOC

The instantaneous ratio of electric quantity of energy stored in the traction battery relative to the maximum quantity of electric energy which could be stored in this battery.

3.1.19

Phased braking

A means which may be used where two or more sources of braking are operated from a common control, whereby one source may be given priority by phasing back the other source(s) so as to make increased control movement necessary before they begin to be brought into operation.

3.1.20

Automatically commanded braking

A function within a complex electronic control system where actuation of the braking system(s) or brakes of certain axles is made for the purpose of generating vehicle retardation with or without a direct action of the driver, resulting from the automatic evaluation of on-board initiated information.

3.1.21

selective braking

A function within a complex electronic control system where actuation of individual brakes is made by automatic means in which vehicle retardation is secondary to vehicle behavior modification.

3.1.22

Nominal value

The reference braking performance gained by assigning the values to the input and

The boundaries of the external physical limits within which the system is able to maintain control.

4 Structure and Function Requirements

4.1 Braking Equipment

4.1.1 General requirements

4.1.1.1 The braking equipment shall be so designed, constructed and fitted as to enable the vehicle in normal use, despite the vibration to which it may be subjected, to comply with the provisions of this Standard.

4.1.1.2 The braking equipment shall be so designed, constructed and fitted as to be able to resist the corroding and ageing phenomena to which it is exposed.

4.1.1.3 Braking friction linings shall not contain asbestos.

4.1.1.4 The effectiveness of the braking equipment shall not be adversely affected by magnetic or electrical fields.

4.1.1.5 Flat or drum type braking bench shall be able to generate maximum stationary brake force.

4.1.1.6 A failure detection signal shall not interrupt momentarily for less than 10ms the demand signal in the control transmission, provided that the braking performance is thereby not reduced.

4.1.2 Functions of braking equipment

4.1.2.1 Service braking system

The service braking system shall make it possible to control the movement of the vehicle and to halt it safely, speedily and effectively, whatever its speed and load, on any up or down gradient. It shall be possible to graduate this braking action. The driver shall be able to achieve this braking action from his driving seat without removing his hands from the steering control.

4.1.2.2 Emergency braking

The emergency braking (emergency braking system) system must make it possible by application of the service brake control to halt the vehicle within a reasonable distance in the event of failure of the service braking system. It must be possible to graduate this braking action. The driver must be able to obtain this braking action from his driving seat without removing his hands from the steering control.

4.1.2.3 Parking braking system

The parking braking system shall make it possible to hold the vehicle stationary on an up or down gradient even in the absence of the driver, the working parts being then held in the locked position by a purely mechanical device. The driver shall be able to achieve this braking action from his driving seat.

4.1.3 The requirements of Appendix D are applied to the safety aspects of all complex electronic vehicle control systems which provide or form part of the control transmission of the braking function including those which utilize the braking system(s) for automatically commanded braking or selective braking.

4.2.2.9 If the service braking force and transmission depend exclusively on the use of an energy reserve, one energy reserve for the transmission is deemed to be sufficient, provided that the prescribed emergency braking is ensured by the action of the driver's muscular energy acting on the service brake control and the requirements of Article 4.2.5 are met.

4.2.2.10 Certain parts, such as the pedal and its bearing, the master cylinder and its piston or pistons, the control valve, the linkage between the pedal and the master cylinder or the control valve, the brake cylinders and their pistons, and the lever-and-cam assemblies of brakes, shall not be regarded as liable to breakage if they are amply dimensioned, are readily accessible for maintenance, and exhibit safety features at least equal to those prescribed for other essential components (such as the steering linkage) of the vehicle. Any such part as aforesaid whose failure would make it impossible to brake the vehicle with a degree of effectiveness at least equal to that prescribed for emergency braking shall be made of metal or of a material with equivalent characteristics and must not undergo notable distortion in normal operation of the braking systems.

4.2.3 The failure of a part of a hydraulic transmission system shall be signalled to the driver by a device comprising a red tell-tale signal lighting up before or upon application of a differential pressure of not more than 15.5 MPa between the active and failed brake equipment, measured at the master cylinder outlet and remaining lit as long as the failure persists and the ignition (start) switch is in the 'on' (run) position. However, a device comprising a red tell-tale signal lighting up when the fluid in the storage is below a certain level specified by the manufacturer is permitted. The tell-tale signal must be visible even by daylight; the satisfactory condition of the signal shall be easily verifiable by the driver from the driver's seat. The failure of a component of the device shall not entail total loss of the braking equipment's effectiveness. Application of the parking brake shall also be indicated to the driver. The same tell-tale signal may be used.

4.2.4 Where use is made of energy other than the muscular energy of the driver, there need not be more than one source of such energy (hydraulic pump, air compressor, etc.), but the means by which the device constituting that source is driven must be as safe as practicable.

4.2.4.1 In the event of failure in any part of the transmission of a braking system, the feed to the part not affected by the failure must continue to be ensured if required for the purpose of halting the vehicle with the degree of effectiveness prescribed for emergency braking. This condition shall be met by means of devices which can easily be actuated when the vehicle is stationary, or by automatic means.

4.2.4.2 Storage devices located down-circuit of this device shall be such that in the case of a failure in the energy supply after four full-stroke actuations of the service brake control, under the conditions prescribed in Article 5.4.1.2 to this Standard, it is still possible to halt the vehicle at the fifth application, with the degree of effectiveness prescribed for emergency braking.

4.2.4.3 For hydraulic braking systems with stored energy, these provisions can be considered to be met provided that the requirements of Article 5.4.1.3 to this Standard, are satisfied.

4.2.5 The requirements of Articles 4.2.2, 4.2.3 and 4.2.4 above shall be met without the use of any automatic device of a kind such that its ineffectiveness might pass unnoticed through the fact that parts normally in a position of rest come into action only in the event of failure in

the braking system.

4.2.6 The service braking system shall act on all wheels of the vehicle and shall distribute its action appropriately among the axles.

4.2.7 In the case of vehicles equipped with electric regenerative braking systems of category B, the braking input from other sources of braking, may be suitably phased to allow the electric regenerative braking system alone to be applied, provided that both the following conditions are met.

4.2.7.1 Intrinsic variations in the torque output of the electrical regenerative braking system (e.g. as a result of changes in the electric state of charge in the traction batteries) are automatically compensated by appropriate variation in the phasing relationship as long as the requirements of one of Article 5.1.3.2 or Article 5.6.3.3 are satisfied.

4.2.7.2 Wherever necessary, to ensure that braking strength remains related to the driver's braking demand, having regard to the available tyre/road adhesion, braking shall automatically be caused to act on all wheels of the vehicle.

4.2.8 The action of the service braking system shall be distributed between the wheels of one and the same axle symmetrically in relation to the longitudinal median plane of the vehicle.

Compensation and functions, such as anti-lock, which may cause deviations from this symmetrical distribution shall be declared.

4.2.8.1 Compensation by the electric control transmission for deterioration or defect within the braking system shall be indicated to the driver by means of the yellow warning signal specified in Article 4.2.21.1.2 below. This requirement shall apply for all conditions of loading when compensation exceeds the following limits.

4.2.8.1.1 A difference in transverse braking pressures on any axle:

a) Adopting 25% of the higher value for vehicle decelerations ≥ 2 m/s^2;

b) Adopting a value corresponding to 25% at 2 m/s^2 for decelerations below 2 m/s^2.

4.2.8.1.2 An individual compensating value on any axle:

a) Adopting 50% of the nominal value for vehicle decelerations ≥ 2 m/s^2;

b) Adopting a value corresponding to 50% of the nominal value at 2 m/s^2 for decelerations below 2 m/s^2.

4.2.8.2 Compensation as defined above, is permitted only when the initial brake application is made at vehicle speeds greater than 10 km/h.

4.2.9 Malfunctions of the electric control transmission shall not apply the brakes contrary to the driver's intentions.

4.2.10 The service, emergency and parking braking systems shall act on braking surfaces connected to the wheels through components of adequate strength.

Where braking torque for a particular axle or axles is provided by both a friction braking system and an electrical regenerative braking system of category B, disconnection of the latter source is permitted, providing that the friction braking source remains permanently connected and able to provide the compensation referred to in Article 4.2.7.1.

In the case of short disconnection transients, incomplete compensation is accepted; but within 1s, this compensation shall have attained at least 75% of its final value.

Nevertheless, in all cases, the permanently connected friction braking source shall ensure that both the service and emergency braking systems continue to operate with the prescribed

running under normal operating conditions and there are no faults in the braking system, as is the case in type approval tests, the alarm device must give no signal except during the time required for charging the energy storage(s) after start-up of the engine. The red warning signal specified in Article 4.2.21.1.1 below shall be used as the optical warning signal.

4.2.14.2 In the case of vehicles which are only considered to comply with the requirements of Article 4.2.4.1 of this Standard by virtue of meeting the requirements of Article 5.4.1.3 to this Standard, the alarm device shall consist of an acoustic signal in addition to an optical signal. These devices need not operate simultaneously, provided that each of them meets the above requirements and the acoustic signal is not actuated before the optical signal. The red warning signal specified in Article 5.2.21.1.1 below shall be used as the optical warning signal.

4.2.14.3 This acoustic device may be rendered inoperative while the parking brake is applied and/or in the case of automatic transmission the selector is in the 'Park' position.

4.2.15 Without prejudice to the requirements of Article 4.1.2.3 above, where an auxiliary source of energy is essential to the functioning of a braking system, the reserve of energy shall be such as to ensure that: if the engine stops or in the event of a failure of the means by which the energy source is driven, the braking performance remains adequate to bring the vehicle to a halt in the prescribed conditions.

In addition, if the muscular effort applied by the driver to the parking braking system is reinforced by a servo device, the actuation of parking braking shall be ensured in the event of a failure of the servo device; if necessary by using a reserve of energy independent of that normally supplying the servo device. This reserve of energy may be that intended for the service braking system.

4.2.16 The pneumatic/hydraulic auxiliary equipment shall be supplied with energy in such a way that during its operation the prescribed deceleration values can be reached and that even in the event of damage to the source of energy the operation of the auxiliary equipment cannot cause the reserves of energy feeding the braking systems to fall below the level indicated in Article 4.2.14 above.

4.2.17 In the case of a motor vehicle equipped to tow a trailer with electric service brakes, the following requirements shall be met:

4.2.17.1 The power supply (generator and battery) of the motor vehicle shall have a sufficient capacity to provide the current for an electric braking system. With the engine running at the idling speed recommended by the manufacturer and all electrical devices supplied by the manufacturer as standard equipment of the vehicle switched on, the voltage in the electrical lines shall at maximum current consumption of the electrical braking system (15A) not fall below the value of 9.6 V measured at the connection. The electrical lines shall not be capable of short circuiting even when overloaded.

4.2.17.2 In the event of a failure in the motor vehicle's service braking system, where that system consists of at least two independent units, the unit or units not affected by the failure shall be capable of partially or fully actuating the brakes of the trailer.

4.2.17.3 The use of the stop-lamp switch and circuit for actuating the electrical braking system is permissible only if the actuating line is connected in parallel with the stop-lamp and the existing stop-lamp switch and circuit are capable of taking the extra load.

4.2.18 Additional requirements for vehicles equipped with electric regenerative braking

systems.

4.2.18.1 As for vehicles fitted with an electric regenerative braking system of category A, its electric regenerative braking shall only be activated by the accelerator control and/or the gear neutral position.

4.2.18.2 Vehicles fitted with an electric regenerative braking system of category B

4.2.18.2.1 It shall not be possible to disconnect, partially or totally, one part of the service braking system other than by automatic means. This should not be construed as a departure from the requirements of Article 4.2.10.

4.2.18.2.2 The service braking system shall have only one control device.

4.2.18.2.3 The service braking system shall not be adversely affected by the disengagement of the motor(s) or by the gear ratio used.

4.2.18.2.4 If the operation of the electric component of braking is ensured by a relation established between information coming from the control of the service brake and the braking force to the wheels which of it results, a failure of this relation leading to the non-respect of the prescriptions of distribution of braking among the axles (5.5 or 5.6, which is applicable) shall be warned to the driver by an optical warning signal at the latest when the control is actuated and having to remain lit as long as this defect exists and that the switch of 'contact' is in the position 'go'.

4.2.18.3 For vehicles fitted with an electric regenerative braking system of either category (A or B), all the relevant prescriptions shall apply except Article 4.2.18.1.1 above. In this case, the electric regenerative braking may be actuated by the accelerator control and/or the gear neutral position. Additionally, the action on the service braking control shall not reduce the above braking effect generated by the release of the accelerator control.

4.2.18.4 The operation of the electric braking must not be adversely affected by magnetic or electric fields, which is verified according to the requirements of GB/T 17619; simultaneously, braking equipment under test shall meet the requirements of GB 18655.

4.2.18.5 For vehicles equipped with an anti-lock device, ABS must control the electric braking system.

4.2.18.6 The state of charge of the traction batteries is determined by the method set out in Appendix B to this Standard [2)].

4.2.19 Special requirements for the parking braking system with electric transmission device

4.2.19.1 In the case of a failure within the electric transmission, any unintended actuation of the parking braking system shall be prevented.

4.2.19.2 In the case of an electrical failure in the control or a break in the wiring within the electric control transmission between the control and the ECU directly connected with it, excluding the energy supply, it shall remain possible to apply the parking braking system from the driver's seat and thereby be capable of holding the laden vehicle stationary on an 8% up or down gradient. Alternatively, in this case, an automatic actuation of the parking brake is allowed when the vehicle is stationary, provided that the above performance is achieved and, once applied, the parking brake remains engaged independently of the status of the ignition

[2] By agreement with the testing organization, state of charge assessment will not be required for vehicles, which have an on-board energy source for charging the traction batteries and the means for regulating their state of charge (SOC).

braking control in accordance with Article 5.2.2 to this Standard.

4.2.20.4 In the event of a failure of the energy source of the electric control transmission, starting from the nominal value of the energy level, the full control range of the service braking system shall be guaranteed after twenty consecutive full stroke actuations of the service braking control. During the test, the braking control shall be fully applied for 20 seconds and released for 5 seconds on each actuation. It should be understood that during the above test sufficient energy is available in the energy transmission to ensure full actuation of the service braking system. This requirement shall not be construed as a departure from the requirements of Section 5.4.

4.2.20.5 When the battery voltage falls below a value nominated by the manufacturer at which the prescribed service braking performance can no longer be guaranteed and/or which precludes at least two independent service braking circuits from each achieving the prescribed emergency braking performance, the red warning signal specified in Article 4.2.21.1.1 shall be activated. After the warning signal has been activated, it shall be possible to apply the service braking control and obtain at least the secondary performance prescribed in Article 5.2.2 to this Standard. It should be understood that sufficient energy is available in the energy transmission of the service braking system.

4.2.20.6 If auxiliary equipment is supplied with energy from the same reserve as the electric control transmission, it shall be ensured that, with the engine running at a speed not greater than 80% of the maximum power speed, the supply of energy is sufficient to fulfill the prescribed deceleration values by either provision of an energy supply which is able to prevent discharge of this reserve when all auxiliary equipment is functioning or by automatically switching off pre-selected parts of the auxiliary equipment at a voltage above the critical level referred to in Article 4.2.20.5 of this Standard such that further discharge of this reserve is prevented. Compliance may be demonstrated by calculation or by a practical test. This Article does not apply to vehicles where the prescribed deceleration values can be reached without the use of electrical energy.

4.2.20.7 If the auxiliary equipment is supplied with energy from the electric control transmission, the following requirements shall be fulfilled:

4.2.20.7.1 In the event of a failure in the energy source, whilst the vehicle is in motion, the energy in the storage shall be sufficient to actuate the brakes when the control is applied.

4.2.20.7.2 In the event of a failure in the energy source, whilst the vehicle is stationary and the parking braking system applied, the energy in the storage shall be sufficient to actuate the lights (light signalling device) even when the brakes are applied.

4.2.21 The general requirements for optical warning signals whose function is to indicate to the driver certain specified failures (or defects) within the braking equipment of the motor vehicle, are set out in the following articles. Other than as described in Article 4.2.21.5 below, these signals shall be used exclusively for the purposes prescribed by this Standard.

4.2.21.1 Motor vehicles shall be capable of providing optical brake failure and defect warning signals, and alarm signal shall meet the requirements of GB 4094 and this Standard.

4.2.21.1.1 A red warning signal, indicating failures defined elsewhere in this Standard within the vehicle braking equipment which preclude achievement of the prescribed service braking performance and/or which preclude the functioning of at least one of two independent service braking circuits, such as:

a) Failure of service braking circuit;

b) Brake fluid leakage alarming, including alarm of pressure difference and/or low liquid level;

c) Failure of the control device, or break of external wiring electric control unit excluding power supply;

d) Where the voltage of traction battery drops to the level specified by the manufacturer;

e) Parking braking.

4.2.21.1.2 Where applicable, a yellow warning signal indicating an electrically detected defect within the vehicle braking equipment, which is not indicated by the red warning signal described in Article 4.2.21.1.1 above, such as:

a) The compensation on braking system failure or property deterioration made by electric transmission device exceeds the prescribed limit;

b) Braking friction lining needs be replaced;

c) Break of internal wiring of electric transmission, or failure of control device for parking braking system;

d) Circuit or sensor malfunction affecting ABS function and performance requirement;

e) Failure of brake force distribution system (excluding mechanical-type);

f) Failure of electric regenerative braking of category B.

4.2.21.1.3 Acoustic alarm signal shall be adopted if necessary:

a) Braking friction lining needs be replaced;

b) Dynamic braking system that does not satisfy continued energy supply requirements in case of transmission failure.

4.2.21.2 The warning signals shall be visible, even by daylight; the satisfactory condition of the signals shall be easily verifiable by the driver from the driver's seat; the failure of a component of the alarm devices shall not entail any loss of the braking system's performance.

4.2.21.3 Except where stated otherwise, a specified failure or defect shall be signalled to the driver by the above-mentioned warning signal(s) not later than on actuation of the relevant braking control; the warning signal(s) shall remain displayed as long as the failure/defect persists and the ignition (start) switch is in the 'on' (run) position; and the warning signal shall be constant (not flashing).

4.2.21.4 The warning signal(s) mentioned above shall light up when the electrical equipment of the vehicle (and the braking system) is energized. With the vehicle stationary, the braking system shall verify that none of the specified failures or defects is present before extinguishing the signals. Specified failures or defects which should activate the warning signals mentioned above, but which are not detected under static conditions, shall be stored upon detection and be displayed at start-up and at all times when the ignition (start) switch is in the 'on' (run) position, as long as the failure or defect persists.

4.2.21.5 Non specified failures (or defects), or other information concerning the brakes and/or running gear of the power-driven vehicle, may be indicated by the yellow signal specified in Article 4.2.21.1.2 above, provided that all the following conditions are fulfilled:

4.2.21.5.1 The vehicle is stationary;

4.2.21.5.2 After the braking equipment is first energized and the signal has indicated that, following the procedures detailed in Article 4.2.21.4 above, no specified failures (or defects)

maximum design speed of a vehicle is lower than the speed prescribed for a test, the test shall be performed at the vehicle's maximum speed.

5.1.2.3 During the tests, the force applied to the brake control in order to obtain the prescribed performance must not exceed the maximum force laid down.

5.1.2.4 The road must have a surface affording good adhesion, unless specified otherwise.

5.1.2.5 The tests must be performed when there is no wind liable to affect the results.

5.1.2.6 At the start of the tests, the tyres must be cold and at the pressure prescribed for the load actually borne by the wheels when the vehicle is stationary.

5.1.2.7 The prescribed performance must be obtained without locking of the wheels at speeds exceeding 15 km/h, without deviation of the vehicle from a 3.5 m wide lane, without exceeding a yaw angle of 15° and without abnormal vibrations

5.1.2.8 For vehicles powered completely or partially by an electric motor (or motors), permanently connected to the wheels, all tests must be carried out with these motor(s) connected.

5.1.2.9 For vehicles as described in Article 5.1.2.8 above, fitted with an electric regenerative braking system of category A, behavior tests defined in Article 5.1.4.3.1 shall be carried out on a track with a low adhesion coefficient (as defined in Article 5.6.3.2.2).

5.1.2.10 In the tests provided in Articles 5.1.2.9, wheel locking is not allowed. However, steering correction is permitted if the angular rotation of the steering control is within 120 o during the initial 2 seconds and not more than 240° in all.

5.1.2.11 For a vehicle with electrically actuated service brakes powered from traction batteries (or an auxiliary battery) which receive(s) energy only from an independent external charging system, these batteries shall, during braking performance testing, be at an average of not more than 5% above that state of charge at which the brake failure warning prescribed in Article 4.2.20.5 is required to be given.

If this warning is given, the batteries may receive some recharge during the tests, to keep them in the required state of charge range.

5.1.3 Requirements in state of the vehicle during braking

5.1.3.1 In braking tests, and in particular in those at high speed, the general behavior of the vehicle during braking must be checked.

5.1.3.2 Behavior of the vehicle during braking on a road on which adhesion is reduced must meet the relevant requirements of Section 5.5 and Section 5.6 to this Standard.

In the case of a braking system according to Article 4.2.7 where the braking for a particular axle (or axles) is comprised of more than one source of braking torque, and any individual source can be varied with respect to the other(s), the vehicle shall satisfy the requirements of Section 5.5 or Section 5.6 under all relationships permitted by its control strategy [4)].

5.1.4 Type-0 test (ordinary performance test with cold brakes)

5.1.4.1 General requirements

5.1.4.1.1 The average temperature of the service brakes on the hottest axle of the vehicle, measured inside the brake wear linings or on the braking path of the disc or drum, is between 65 and 100 °C prior to any brake application.

[4] The manufacturer shall provide the testing organization with the family of braking curves permitted by the automatic control strategy. These curves (family) may be verified by the testing organization.

5.1.4.1.2 The test shall be carried out under the following conditions:

5.1.4.1.2.1 The vehicle must be laden, the distribution of its mass among the axles being that stated by the manufacturer; where provision is made for several arrangements of the load on the axles, the distribution of the maximum mass among the axles must be such that the mass (load) on each axle is proportional to the maximum design mass (load) for each axle.

5.1.4.1.2.2 Every test must be repeated on the unladen vehicle; there may be, in addition to the driver, a second person on the front seat who is responsible for noting the results of the test.

5.1.4.1.2.3 In the case of a vehicle equipped with an electric regenerative braking system, the requirements depend on the category of this system.

Electric regenerative braking of category A: any separate electric regenerative braking control which is provided, shall not be used during the Type-0 tests.

Electric regenerative braking of category B: the contribution of the electric regenerative braking system to the braking force generated shall not exceed that minimum level guaranteed by the system design. This condition is deemed to be satisfied if the state of charge of the batteries is in one of the following conditions:

a) At the maximum charge level (SOC) recommended by the manufacturer, as listed in the vehicle specification;

b) At a level not less than 95% of the full charge level, where the manufacturer has made no specific recommendation;

c) At a maximum level resulting from automatic charge control on the vehicle.

5.1.4.1.2.4 The limits prescribed for minimum performance, both for tests with the vehicle unladen and for tests with the vehicle laden, shall be those laid down hereunder; the vehicle must satisfy both the prescribed stopping distance and the prescribed mean fully developed deceleration, but it may not be necessary to actually measure both parameters.

5.1.4.1.2.5 The road must be level; unless otherwise specified, each test may comprise up to 6 stops including any needed for familiarization.

5.1.4.2 Type-0 test with engine disconnected, service braking in accordance with the requirements of Item a) in Table 2. The test must be carried out at the speed prescribed, the figures prescribed in this connection being subject to a certain margin of tolerance. The minimum performance prescribed must be attained.

5.1.4.3 Type-0 test with engine connected, service braking in accordance with the requirements of Item b) in Table 2.

5.1.4.3.1 The test shall be carried out with the engine connected, from the speed prescribed in Item b) in Table 2. The minimum performance prescribed shall be attained. This test is not run if the maximum speed of the vehicle is ≤ 125 km/h.

5.1.4.3.2 The maximum practical performance figures shall be measured, and the behaviour of the vehicle shall be in accordance with Article 5.1.3.2. However, if the maximum speed of the vehicle is greater than 200 km/h, the test speed shall be 160 km/h.

5.1.5 Type-I test (fade test and recovery test)

5.1.5.1 Heating procedure

5.1.5.1.1 The service brakes of all vehicles must be tested by successively applying and releasing the brakes a number of times, the vehicle being laden, in the conditions shown in Table 1.

	$S\leq$	$0.1v+0.0067v^2$
	$d_m\geq$	5.76m/s^2
	F	65N~500N

5.2.1.2 In the case of a motor vehicle authorized to tow an unbraked trailer, the minimum Type-0 performance of the combination shall not be less than 5.4 m/s^2 in both the laden and unladen conditions.

The combination performance shall be verified by calculations referring to the maximum braking performance actually achieved by the engine disconnected (laden condition) during the Type-0 test with the engine disconnected, using the following formula (no practical tests with a coupled unbraked trailer are required):

$$d_{M+R} = d_M \times \frac{P_M}{P_M + P_R}$$

5.2.2 Emergency braking

5.2.2.1 The performance of the emergency braking system shall be tested by the Type-0 test with the engine disconnected from an initial vehicle speed of 100 km/h and a force applied to the service braking control device not less than 65N and not exceeding 500N. Vehicles, that cannot make the specified speed due to the limitation of maximum design speed, may be tested at the speed that they can make.

5.2.2.2 The emergency braking system must give a stopping distance not exceeding $0.1\upsilon+0.0158\upsilon^2$ (m), and mean fully developed braking deceleration not less than 2.44 m/s^2 (corresponding to the second term of the braking distance formula).

5.2.2.3 The emergency braking effectiveness test shall be conducted by simulating the actual failure conditions in the service braking system.

5.2.2.4 For vehicles employing electric regenerative braking systems, the braking performance shall additionally be checked under the two following failure conditions:

a) For a total failure of the electric component of the service braking output;

b) In the case where the failure condition causes the electric component to deliver its maximum braking force.

5.2.3 Parking braking system

5.2.3.1 The parking braking system shall be capable of holding the laden vehicle stationary on a 20% up or down gradient.

5.2.3.2 On vehicles to which the coupling of a trailer is authorized, the parking braking system of the motor vehicle must be capable of holding the combination of vehicles stationary on a 12% up or down gradient.

5.2.3.3 If the control device is manual, the force applied to it must not exceed 400N.

5.2.3.4 If it is a foot control device, the force exerted on the control must not exceed 500N.

5.2.3.5 A parking braking system which has to be actuated several times before it attains the prescribed performance is admissible.

5.2.3.6 To check compliance with the requirement specified in Article 4.2.2.4 of this Standard, a Type-0 test must be carried out, with the engine disconnected, at an initial test speed of 30 km/h. The mean fully developed deceleration on application of the control of the parking brake system and the deceleration immediately before the vehicle stops, shall not be less than 1.5 m/s^2. The test shall be carried out with the laden vehicle. The force exerted on

the braking control device shall not exceed the specified values.

5.3 Response Time

5.3.1 Where a vehicle is equipped with a service braking system which is totally or partially dependent on a source of energy other than the muscular effort of the driver, the following requirements must be satisfied:

5.3.1.1 In an emergency braking, the time elapsing between the moment when the control device begins to be actuated and the moment when the braking force on the least favorable placed axle reaches the braking performance specified in Table 2 must not exceed 0.6 seconds.

5.3.1.2 In the case of vehicles fitted with hydraulic braking systems, the requirements of Article 5.3.1.1 above are considered to be satisfied if, in an emergency braking, the deceleration of the vehicle or the pressure at the least favorable brake cylinder, reaches a level corresponding to the prescribed performance within 0.6 seconds.

5.4 Provisions Relating to Energy Sources and Energy Storage Devices (Energy Accumulators) -- Hydraulic Braking Systems with Stored Energy

5.4.1 Capacity of energy storage devices (energy accumulators)

5.4.1.1 General requirements

5.4.1.1.1 Vehicles on which the braking equipment requires the use of stored energy provided by hydraulic fluid under pressure shall be equipped with energy storage devices (energy accumulators) of a capacity meeting the requirements of Articles 5.4.1.2 or 5.4.1.3.

5.4.1.1.2 However, the energy storage devices shall not be required to be of a prescribed capacity if the braking system is such that in the absence of any energy reserve it is possible with the service brake control to achieve a braking performance at least equal to that prescribed for the emergency braking system.

5.4.1.1.3 In verifying compliance with the requirements of Articles 5.4.1.2, 5.4.1.3 and 5.4.2, the brakes shall be adjusted as closely as possible and, for Article 5.4.1.2, the rate of full-stroke actuations must be such as to provide an interval of at least 60 seconds between each actuation.

5.4.1.2 Vehicles equipped with a hydraulic braking system with stored energy shall meet the following requirements:

5.4.1.2.1 After 8 full-stroke actuations of the service brake control, it shall still be possible to achieve, on the 9th application, the performance of the emergency braking system.

5.4.1.2.2 Testing shall be performed in conformity with the following requirements:

a) Testing shall commence at a pressure that may be specified by the manufacturer but is not higher than the cut-in pressure [5)];

b) The energy storage device(s) shall not be fed; in addition, any energy storage device(s) for auxiliary equipment shall be isolated.

5.4.1.3 Vehicles equipped with a hydraulic braking system with stored energy which cannot meet the requirements of Article 4.2.4.1 of this Standard shall be deemed to satisfy that

[5] The initial energy level shall be stated in the type approval document.

the last (second) wheel on the rear axle and the last (second) wheel on the front axle is < 0.1 seconds for vehicle speeds > 30 km/h.

5.5.4.2 Vehicle conditions

a) Vehicle load: Laden and unladen;

b) Transmission position: Engine disconnected.

5.5.4.3 Test conditions and procedures

a) Initial brake temperature: Between 65 °C and 100 °C average on the hottest axle.

b) Test speed: 65 km/h for a braking rate ≤ 0.50;
100 km/h for a braking rate > 0.50.

c) Control force

1) Control force is applied and controlled by a skilled driver or by a mechanical brake pedal actuator;

2) Control force is increased at a linear rate such that the first axle lockup occurs no less than 0.5 second and no more than one and 1.5 seconds after the initial application of the pedal;

3) The pedal is released when the second axle locks, or when the pedal force reaches l kN, or 0.1 seconds after the first lockup, whichever occurs first.

d) Wheel locking: Only wheel lockups above a vehicle speed of 15 km/h are considered.

e) Test road surface: This test is conducted on road test surfaces on which wheel lockup occurs at braking rates between 0.15 and 0.80.

f) Data to be recorded: The following information must be automatically recorded in phase continuously throughout each test run such that values of the variables can be cross referenced in real time.

1) Vehicle speed;

2) Instantaneous vehicle braking rate (e.g. by differentiation of vehicle speed);

3) Brake control force (or hydraulic line pressure);

4) Angular velocity at each wheel.

g) Each test run shall be repeated once to confirm the wheel lockup sequence: if one of these two results indicates a failure to comply, then a third test run under the same conditions will be decisive.

5.5.4.4 Performance requirements

a) Both rear wheels shall not reach a locked condition prior to both front wheels being locked - at vehicle braking rates between 0.15 and 0.8.

b) If, when tested to the procedure specified above, and at vehicle braking rates between 0.15 and 0.8 the vehicle meets one of the following criteria, then it passes this wheel lockup sequence requirement:

1) No wheels lock;

2) Both wheels on the front axle and one or no wheels on the rear axle lock;

3) Both axles simultaneously lock.

c) If wheel lockup commences at a braking rate less than 0.15 or more than 0.8, then the test is invalid and should be repeated on a different road surface.

d) If, either laden or unladen, at a braking rate between 0.15 and 0.8 both wheels on the rear axle and one or no wheels on the front axle lock, then it fails the wheel lockup sequence

test. In this latter case, the vehicle must be submitted to the 'torque wheels' test procedure to determine the objective brake factors for calculation of the adhesion utilization curves.

5.5.5 Torque wheel test

The purpose of this test is to measure the brake factors and thus determine the adhesion utilization of the front and rear axles over a range of braking rates between 0.15 and 0.8.

5.5.5.1 Vehicle conditions

a) Vehicle load: Laden and unladen;

b) Transmission position: Engine disconnected.

5.5.5.2 Test conditions and procedures

a) Initial brake temperature: Between 65 °C and 100 °C average on the hottest axle.

b) Test speeds: 100 km/h and 50 km/h.

c) Control force: control force is increased at a linear rate between 100 and 150 N/s for the 100 km/h test speed, or between 100 and 200 N/s for the 50 km/h test speed, until the first axle locks or until a pedal force of 1 kN is reached, whichever occurs first.

d) Brake cooling: Between brake applications, the vehicle is driven at speeds up to 100 km/h until the initial brake temperature specified in 5.5.5.2 a) is reached.

e) Number of testing runs: With the vehicle unladen, run five stops from a speed of 100 km/h and five stops from a speed of 50 km/h, while alternating between the two test speeds after each stop. With the vehicle laden, repeat the five stops at each test speed while alternating between the two test speeds.

f) Test road surface: This test is conducted on a road test surface affording good adhesion.

g) Data to be recorded: The following information must be automatically recorded in phase continuously throughout each test run such that values of the variables can be cross referenced in real time.

1) Vehicle speed;

2) Brake control force;

3) Angular velocity of each wheel;

4) Brake torque at each wheel;

5) Hydraulic line pressure in each brake circuit, including transducers on at least one front wheel and one rear wheel downstream of any operative proportioning or pressure limiting valve(s);

6) Vehicle deceleration.

h) Sampling speed: all the data acquisition and recording equipments shall achieve 40Hz sampling speed at least in all channels.

i) Determination of front versus rear brake pressure: Determine the front versus rear brake pressure relationship over the entire range of line pressures. Unless the vehicle has a variable brake proportioning system, this determination is made by static tests. If the vehicle has a variable brake proportioning system, dynamic tests are run with the vehicle both laden and unladen. Fifteen emergency brakings from 50 km/h are made for each of the two load conditions, using the same initial conditions specified in this appendix.

5.5.5.3 Data reduction

a) The data from each brake application prescribed in Article 5.5.5.2 e) above is filtered using a five-point, on-center moving average for each data channel.

utilization and the wheel-locking sequence of Section 5.5, instead of the adhesion utilization requirements prescribed in Article 5.6.3.2. However, if the relative positions of the adhesion utilization curves do not meet the requirements of Article 5.5.2, a check shall be made to ensure that the wheels on at least one of the rear axles do not lock before those of the front axle or axles under the conditions prescribed in Article 5.5.2, with regard to the braking rate and the load respectively. These requirements may be checked on high-adhesion (about 0.8) and low-adhesion road (0.3 maximum) surfaces by modulating the service braking control force.

5.6.2 General requirements

5.6.2.1 Any electrical failure or sensor anomaly that affects the system with respect to the functional and performance requirements in Section 5.6, including those in the supply of electricity, the external wiring to the controller(s), the controller(s) and the modulator(s) shall be signalled to the driver by a specific optical warning signal. The yellow warning signal specified in Article 4.2.21.1.2 of this Standard shall be used for this purpose.

5.6.2.2 Sensor anomalies, which cannot be detected under static conditions, shall be detected not later than when the vehicle speed exceed 10 km/h [6]. However, to prevent erroneous fault indication when a sensor is not generating a vehicle speed output, due to non-rotation of a wheel, verification may be delayed but detected not later than when the vehicle speed exceeds 15 km/h.

5.6.2.3 When the anti-lock braking system is energized with the vehicle stationary, electrically controlled pneumatic modulator valve(s) shall cycle at least once.

5.6.2.4 In the event of a single electrical functional failure which only affects the anti-lock function, as indicated by the above-mentioned yellow warning signal, the subsequent service braking performance must not be less than 80% of the prescribed performance according to the Type-0 test with the engine disconnected. This corresponds to a stopping distance of $0.1\upsilon + 0.0075\ \upsilon^2$ (m) and a mean fully developed deceleration of 5.15 m/s^2.

5.6.2.5 The operation of the anti-lock system must not be adversely affected by magnetic or electrical fields [7], and it shall be verified according to the requirements of GB/T 17619; simultaneously, the test with braking equipment shall meet the requirements of GB 18655.

5.6.2.6 A manual device may not be provided to disconnect or change the control mode [8] of the anti-lock system.

5.6.3 Special regulations

5.6.3.1 Energy consumption

As for vehicles with ABS, the following tests shall be conducted to verify that service braking system can keep its performance in full travel brake for a long time.

5.6.3.1.1 Testing Conditions

5.6.3.1.1.1 The initial energy level in the energy storage device(s) shall be that specified by the manufacturer. This level shall be at least such as to ensure the efficiency prescribed for

[6] Until uniform test procedures have been agreed, the manufacturers shall provide the testing organization with their test procedures and results.

[7] Until uniform test procedures have been agreed, the manufacturers shall provide the testing organization with their test procedures and results.

[8] It is understood that devices changing the control mode of the anti-lock system are not subject to Article 5.6.2.6 if in the changed control mode condition all requirements to the category of anti-lock systems, with which the vehicle is equipped, are fulfilled.

service braking when the vehicle is laden. The energy storage device(s) for pneumatic auxiliary equipment must be isolated.

5.6.3.1.1.2 From an initial speed of not less than 50 km/h, on a surface with a coefficient of adhesion of 0.3 [9] or less, the brakes of the laden vehicle shall be fully applied for a time t, during which time the energy consumed by the indirectly controlled wheels shall be taken into consideration and all directly controlled wheels must remain under control of the anti-lock system.

5.6.3.1.1.3 The vehicle's engine shall then be stopped or the supply to the energy transmission storage device(s) cut off.

5.6.3.1.1.4 The service braking control shall then be fully actuated 4 times in succession with the vehicle stationary.

5.6.3.1.1.5 When the brakes are applied for the 5th time, it must be possible to brake the vehicle with at least the performance prescribed for emergency braking of the laden vehicle.

5.6.3.1.2 Additional requirements

5.6.3.1.2.1 The coefficient of adhesion of the road surface shall be measured with the vehicle under test, by the method described in Article 5.6.6.1.1.

5.6.3.1.2.2 The braking test shall be conducted with the engine disconnected and idling, and with the vehicle laden.

5.6.3.1.2.3 The braking time, $t = \frac{v_{max}}{7}$, shall not be less than 15s, υ_{max} is 160km/h in maximum.

5.6.3.1.2.4 If the test is conducted in several phases, no fresh energy shall be supplied between the phases of the test. From the second phase, the energy consumption corresponding to the initial brake application may be taken into account, by subtracting one full brake application from the four full applications prescribed in Article 5.6.3.1.1.4 (and 5.6.3.1.1.5 and 5.6.3.1.2.6) for each of the second, third and fourth phases used in the test prescribed in Article 5.6.3.1.1 as applicable.

5.6.3.1.2.5 The performance prescribed in Article 5.6.3.1.1.5 shall be deemed to be satisfied if, at the end of the fourth application, with the vehicle stationary, the energy level in the storage device(s) is at or above that required for emergency braking with the laden vehicle.

5.6.3.2 Utilization ratio of adhesion coefficient

5.6.3.2.1 The utilization of adhesion by the anti-lock system takes into account the actual increase in braking distance beyond the theoretical minimum. The anti-lock system shall be deemed to be satisfactory when the condition $\varepsilon \geq 0.75$ is satisfied, where ε represents the adhesion utilized, as defined in Article 5.6.4.1.2.

5.6.3.2.2 The adhesion utilization ε shall be measured on road surfaces with a coefficient of adhesion of 0.3 (υ) or less, and of about 0.8 (dry road), with an initial speed of 50 km/h. To eliminate the effects of differential brake temperatures it is recommended that z_{AL} be determined prior to the determination of k.

5.6.3.2.3 The test procedure to determine the coefficient of adhesion (k) and the formulae

[9] Until such test surfaces become generally available, tyres at the limit of wear, and higher values up to 0.4 may be used at the discretion of the Technical Service. The actual value obtained and the type of tyres and surface shall be recorded.

for calculation of the adhesion utilization (ε) shall be those laid down in 5.6.4.

5.6.3.2.4 The utilization of adhesion by the anti-lock system shall be checked on complete vehicles equipped with anti- lock systems of categories 1 or 2. In the case of vehicles equipped with category 3 anti-lock systems, only the axle(s) with at least one directly controlled wheel must satisfy this requirement.

5.6.3.2.5 The condition $\varepsilon \geq 0.75$ shall be checked with the vehicle both laden and unladen [10].

The laden test on the high adhesion surface may be omitted if the prescribed force on the control device does not achieve full cycling of the anti-lock system.

For the unladen test, the control force may be increased up to 1000 N if no cycling is achieved with its full force value [11]. If 1000 N is insufficient to make the system cycle, then this test may be omitted.

5.6.3.3 Additional checks

The following additional checks shall be carried out with the engine disconnected, with the vehicle laden and unladen.

5.6.3.3.1 The wheels directly controlled by an anti-lock system must not lock when the full force is suddenly applied on the control device, on the road surfaces specified in Article 5.6.3.2.2, at an initial speed of υ = 40 km/h and at a high initial speed υ = 0.8, $\upsilon_{max} \leq 120$ km/h.

5.6.3.3.2 When an axle passes from a high-adhesion surface (k_H) to a low-adhesion surface (k_L), where $k_H \geq 0{,}5$ and $k_H / k_L \geq 2$ [12], with the full force applied on the control device, the directly controlled wheels must not lock. The running speed and the instant of applying the brakes shall be so calculated that, with the anti-lock system fully cycling on the high-adhesion surface, the passage from one surface to the other is made at high and at low speed, under the conditions laid down in Article 5.6.3.3.1.

5.6.3.3.3 When a vehicle passes from a low-adhesion surface (k_L) to a high-adhesion surface (k_H) where $k_H \geq 0.5$ and $k_H / k_L \geq 2$, with the full force applied on the control device, the deceleration of the vehicle must rise to the appropriate high value within a reasonable time and the vehicle must not deviate from its initial course. The running speed and the instant of applying the brake shall be so calculated that, with the anti-lock system fully cycling on the low-adhesion surface, the passage from one surface to the other occurs at approximately 50 km/h.

5.6.3.3.4 The provisions of this Article shall only apply to vehicles equipped with anti-lock systems of categories 1 or 2. When the right and left wheels of the vehicle are situated on surfaces with differing coefficients of adhesion (k_H and k_L), where $k_H \geq 0.5$ and $k_H / k_L \geq 2$, the directly controlled wheels must not lock when the full force is suddenly applied on the control device at a speed of 50 km/h.

5.6.3.3.5 Furthermore, laden vehicles equipped with anti-lock systems of category 1 shall, under the conditions of Article 5.6.3.3.4 satisfy the prescribed braking rate in 5.6.5.

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[10] Until a uniform test procedure is established, the tests required by this Article may have to be repeated for vehicles equipped with electrical regenerative braking systems, in order to determine the effect of different braking distribution values provided by automatic functions on the vehicle.

[11] 'Full force' means the maximum force laid down in Chapter 5; a higher force may be used if required to activate the anti-lock system.

[12] k_H is the high-adhesion surface coefficient, and k_L is the low-adhesion surface coefficient.

5.6.3.3.6 However, in the tests provided in Articles 5.6.3.3.1~ 5.6.3.3.5, brief periods of wheel-locking shall be allowed. Furthermore, wheel-locking is permitted when the vehicle speed is less than 15 km/h; likewise, locking of indirectly controlled wheels is permitted at any speed, but stability and steerability must not be affected and the vehicle must not exceed a yaw angle of 15° or deviate from a 3.5 m wide lane.

5.6.3.3.7 During the tests provided in Articles 5.6.3.3.4 and 5.6.3.3.5, steering correction is permitted, if the angular rotation of the steering control is within 120° during the initial 2 seconds, and not more than 240° in all. Furthermore, at the beginning of these tests the longitudinal median plane of the vehicle must pass over the boundary between the high- and low-adhesion surfaces and during these tests no part of the outer tyres must cross this boundary.

5.6.4 Utilization ratio of adhesion coefficient

5.6.4.1 Measurement method

5.6.4.1.1 Determination of the coefficient of adhesion (k)

5.6.4.1.1.1 The coefficient of adhesion (k) shall be determined as the quotient of the maximum braking forces without locking the wheels and the corresponding dynamic load on the axle being braked.

5.6.4.1.1.2 The brakes shall be applied on only one axle of the vehicle under test, at an initial speed of 50 km/h. The braking forces shall be distributed between the wheels of the axle to reach maximum performance. The anti-lock system shall be disconnected, or inoperative, between 40 km/h and 20 km/h.

5.6.4.1.1.3 A number of tests at increments of line pressure shall be carried out to determine the maximum braking rate of the vehicle (z_{max}). During each test, a constant input force shall be maintained and the braking rate will be determined by reference to the time taken (t) for the speed to reduce from 40 km/h to 20 km/h using the formula: z=0.566/t.

a) Wheel lock may occur below 20 km/h.

b) Starting from the minimum measured value of t, called t_{min}, then select three values of t comprised within t_{min} and 1.05 t_{min} and calculate their arithmetical mean value t_m (t_m cannot be replaced with t_{min}, where three values of t cannot be gained), and the maximum braking strength is calcualted according to the following formula: $z = \frac{0.566}{t}$. However, the requirements of Article 5.6.4.1.3 shall still apply.

5.6.4.1.1.4 The braking forces shall be calculated from the measured braking rate and the rolling resistance of the unbraked axle which is equal to 0.015 and 0.010 of the static axle load for a driven axle and a non-driven axle, respectively.

5.6.4.1.1.5 The dynamic load on the axle shall be that given by the formulae in Section 5.5.

5.6.4.1.1.6 The value of k shall be rounded to three decimal places.

5.6.4.1.1.7 Then, the test will be repeated for the other axle(s) as defined in Articles 5.6.5.1.1.1 ~ 5.6.4.1.1.6.

5.6.4.1.1.8 For example, in the case of a two-axle rear-wheel drive vehicle, with the front axle (1) being braked, the coefficient of adhesion (k) is given by:

Select vehicles with different suspensions (suspensions of same type and different parts shall be regarded ones of same type).

6.1.4 Axle spacing and wheel spacing

Select vehicles with the minimum axle spacing and the minimum wheel spacing.

6.1.5 Maximum speed

Select vehicles that can reach Type-0 test speed and Type-I fade test required speed of engine connected.

6.1.6 Engine

Select vehicles fitted with the minimum braking action engine.

6.1.7 Transmission system and total transmission rate

Select vehicles fitted with the transmission system device can generate minimal engine braking action.

6.1.8 Braking system

a) Select vehicles with the longest pipeline system (all pipelines);

b) Select vehicles with different brake types;

c) Select vehicles with different brake force transmission and control modes;

d) Select vehicles with different brake circuit layout.

6.1.9 Capacity of energy storage device

a) Select vehicles with the maximal capacity energy storage device in energy storage capacity test;

b) Select vehicles with the minimal capacity energy storage device in other tests.

6.1.10 Energy source

Select vehicles with the minimum energy supply or/and the minimum boosting force.

6.1.11 Tyre

a) Select vehicles with the maximal rolling radius tyre;

b) Select vehicles with minimal tyre-section width.

6.2 Expansion of approved vehicle type

6.2.1 Where the change relevant to braking system is made on approved vehicle type, the expansion approval application shall be carried out.

6.2.2 Where the expansion of the approved vehicle type meets the principles specified in 6.1, the expansion shall be authorized.

6.2.3 Where the expansion of the approved vehicle type exceeds the scope specified in 6.1, new test shall be carried out.

7 Test Methods

This standard specifies that static check shall be carried out firstly and then dynamic test. In dynamic test, it is recommended that unladen test is carried out firstly and then laden test. Type-I test shall be carried out after completing all dynamic tests.

Prior to starting static test and dynamic test, automatic wear compensation device may be regulated manually according to the opinions of the manufacturer; however, it shall not be

regulated manually during dynamic test. Whenever, brake adjustment shall not result in wear or cohesion under non-braking state.

Before the test, vehicle shall run in a grinding-in way as required by the manufacturer. In case the manufacturer takes no specific requirements on grinding-in travel, grinding-in shall run by the following means.

a) Run the vehicle under laden condition at an initial speed of 80% the maximum speed (less than or equal to 120 km/h), and brake at a deceleration of $3m/s^2$; release the pedal when the speed drops to the initial speed, and accelerate the speed to the initial speed; repeat such test.

b) The total number of grinding-in is 200. In case 200 times of continuous grinding-in cannot be achieved due to the condition restriction, the total number of grinding-in may be according to the specific conditions.

7.1 Test Site and Equipment

a) The test site shall provide high-adhesion road surface with about 0.8 adhesion coefficient, and low-adhesion surface with an adhesion coefficient of less than or equal to 0.3. Split road surface and butting road surface shall be set for ABS test;

b) Speed, transient deceleration and control force (or pipeline pressure) may be checked by the driver at any time during the test;

c) The accuracy of control force measuring instrument / sensor is not lower than 2%; arranged the devices testing and recording speed, braking distance (two above shall be accurate to ±1%), deceleration, control force (or pipeline pressure) and time;

d) The accuracy of pipeline pressure gage / sensor is not lower than 2%;

e) Instruments/devices to measure the temperature of the friction lining on brake shall ensure to indicate temperature of the hottest axle brake to driver at least in the test, and the accuracy hereof is not lower than 5%;

f) Mass measurement apparatus, the accuracy is not lower than 2%;

g) Tyre pressure gage, the is not lower than 2%;

h) Time measurement and display devices, the accuracy is not lower than 1s; and the accuracy of the reaction-time measurement device is not lower than 0.01 s;

i) Distance measurement apparatus, the accuracy is not lower than 1%;

j) Engine speed recorder, the accuracy is not lower than 2%;

k) Voltmeter shall be arranged where vehicles fitted with electric transmission device are tested.

7.2 Test Vehicles

It shall be verified that test vehicles meet requirements of Section 6.1.

7.3 Static Inspection

7.3.1 Information and documents inspection

a) Declaration of the manufacturer on the brake linings excluding asbestos;

b) Statement of the manufacturer on the failure simulation and its influence;

It shall be verified that the driver, wearing stationary type safety belt, can actuate the parking braking control device on the driving position; and that the parking braking may be locked by the pure mechanical device and the control devices can completely return to the original positions after the braking is released (such as disconnecting the locking devices).

7.3.4.3 Emergency braking system inspection

As the service braking failure being simulated, it shall be verified that the driver, wearing stationary type safety belt and holding the handwheel with both hands, can actuate the service braking pedal on the driving position.

7.3.5 Bench test

7.3.5.1 Under the laden condition of the vehicle, the energy storage at the normal operation condition will not participate in the wheel fixation of braking action. Gradually increase the control force, pipeline pressure or manipulation amplitude, simulate the necessary "failure" state, test each axle, and inspect each wheel that can obtain the maximum braking force under the conditions permitted by the test bench. Therein, the hydraulic power braking shall be tested under the condition that parking braking is released.

7.3.5.2 It shall be inspected that the service braking and parking braking can be effectively carried out in the back up.

7.3.5.3 As for the vehicle fitted with electric control transmission braking system, verify the energy storage returning to the normal operation condition, loosen the parking braking control device, close the ignition switch or pull out the key to cut off the energy supply to the electric control transmission device, carry out full travel actuation for the service braking, and inspect each wheel reaching the maximum braking force measured in Article 7.3.5.1.

7.3.5.4 It is judged that the service braking action shall be symmetrically distributed and rationally among the axles according to the results of bench test; it is verified that service braking and emergency braking shall be regulative.

7.3.6 Compensation devices

As for the vehicle equipped with antilock braking system or traction force control system that may result in unsymmetrical braking force distribution or the compensation devices that can implement braking action not directly controlled by the driver, the relevant statements made by the manufacturer shall be inspected.

7.3.6.1 It shall be verified that the electric control transmission devices will not compensate where the speed is less than or equal to 10km/h. Under all loading conditions, where the compensation of the electric control transmission to the braking system fault or performance deterioration will cause the following conditions, the yellow alarm signals shall be lightened:

a) Transverse braking pressure difference of axle: shall take 25% of the higher value where the vehicle deceleration $\geq 2m/s^2$; shall take 25% of the value at $2m/s^2$, where the vehicle deceleration $<2m/s^2$.

b) Single compensation value of axle: shall take 50% of the nominal value where the vehicle deceleration $\geq 2m/s^2$; shall take 50% of the nominal value at $2m/s^2$, where the vehicle deceleration $<2m/s^2$.

7.3.6.2 Inspection shall be carried out according to the design documents. It shall be verified that braking force compensation devices (such as electronic braking force distribution system (EBD) or antilock braking system) failure can be indicated to the driver through corresponding alarm signals; failures that result in failing to reach the specified service

braking performance shall be indicated through the red signals specified in Article 4.2.21.1.1; otherwise, they shall be indicated by the yellow signals specified in Article 4.2.21.1.2.

7.3.7 Proportional relation inspection of control force and pipeline pressure

Pipeline pressure / control force shall be inspected by the reasonable amplitude which shall be ensured covering the maximum allowable control force; the date under the mode with assistance and without assistance shall be recorded respectively. As for the assistance system, the pressure of energy storage device shall be regulated to the cut-in pressure at the start of each actuation, the valve shall be adjusted correctly, the pipeline pressure before and after the proportional valve shall be recorded under the unladen condition.

7.3.8 Electric regenerative braking inspection

7.3.8.1 As for the vehicle equipped with electric regenerative braking, the category of electric regenerative braking shall be verified. The electric regenerative braking, a part of service braking system, belongs to category B; the electric regenerative braking, not a part of service braking system, belongs to category A.

7.3.8.2 It shall be inspected that electric regenerative braking of category A can only be started by the accelerator pedal and/or at the neutral gear position; electric regenerative braking of category B can only be started by the service braking pedal. It shall be verified that the braking action of electric regenerative braking will not be degraded by the friction brake.

7.3.8.3 As for the vehicles equipped with electric regenerative braking of category B and those equipped with electric regenerative braking of category A and B, it shall be inspected and verified that the service braking system has only one control device which cannot be partly or completely disconnected by the modes except the automatic mode. If the engine may be disconnected, it shall be further verified that the disconnection will not degrade the service braking efficiency through the dynamic test; moreover, it shall be inspected that the service braking performance has nothing to do with the transmission gear.

It shall be inspected that the electric regenerative braking control device is controlled by the corresponding relationship between the manipulation amplitude of service braking control device and wheel braking force. It shall be verified that where this relationship failure resulting in failing to meet the relevant requirements of Sections 5.5 and 5.6, the failure shall be indicated to the driver through optical alarm signal at the start of control device at the latest; as long as the failure exists and "contact" switch exists in the running position, alarm signals shall be indicated all the time.

7.3.8.4 Test specifications and test results provided by the manufacturer shall be inspected to verify that the electric regenerative braking is free from the adverse effect of electromagnetic field.

7.3.8.5 As for the vehicles equipped with antilock braking systems, it shall be verified that the electric regenerative braking is controlled by the antilock braking system.

7.3.9 Passenger car trailed with electric braking system trailer

7.3.9.1 As for the passenger car trailed with electric braking system trailer, the trailer braking system shall be manipulated under the conditions of engine idling operation and all electrical equipment operative to generate the maximum current (15A) consumption. It shall be verified the voltage of trailer interconnecting link not less than 9.6V. Inspection shall be carried out according to the design document to verify that the braking system circuits will appear short circuit under the overloaded conditions.

information provided by the manufacturer if the failure testing signals can interrupt the electric control transmission command signals. If possible, it shall be verified it is only transient interruption (<10ms) and will not influence the braking performance.

7.3.11.2 Electric control transmission energy failure

It shall be verified that the electric control transmission electric energy level is under the nominal value declared by the manufacturer, which may be regarded as the rated voltage of traction battery. Under the condition of engine running but traction battery not charged, the service braking is actuated 20 times in full travel. During each braking, carry out 20s full travel brake, release 5s, brake one more, and inspect the residual electric energy of transmission device sufficient to actuate the service brake in full travel. As for the braking system where the hydraulic transmission coexists with the electric control transmission, the hydraulic energy failure and energy storage shall be inspected.

7.3.11.3 It shall be inspected that the manufacturer declares the maximum voltage of traction battery which cannot ensure the service braking performance or has at least two independent service braking return circuits failing to reach the emergency braking performance. The voltage of traction battery is gradually decreased by partly discharging the traction battery or replacing the traction battery by bench top power supply, and the actual voltage is recorded when the red alarm signals specified in Article 4.2.21.1.1 are lightened. Bench top power supply, if used, shall be verified having sufficient power; if the existing wires of vehicle are used, power shall be supplied by removing the traction battery terminal and the output voltage shall be detected. Actually-recorded voltage shall not be higher than the rated voltage of traction battery. Moreover, dynamic test shall be carried out under this voltage level to verify the residual electric energy in the service braking electric control transmission device is sufficient to reach the emergency braking performance.

7.3.11.4 If the electric energy of auxiliary equipment or parking braking system comes from the electric control transmission energy storage device of service braking system, the following inspections shall be carried out:

Engine speed shall be able to maintain the electric energy level of electric control transmission but shall not be higher than 80% of the rotational speed at the maximum power; switch on, make all the above auxiliary equipment operative and record the traction battery voltage at the engine running and auxiliary equipment operative. It shall be verified through the dynamic test that the specified service braking performance can still be met at this voltage level (see the following note); after the traction battery (energy storage device) discharges, dynamic test shall be carried out to verify that the specified deceleration can still be reached on the condition without electric energy. It may also be inspected through calculation.

7.3.11.5 If the electric energy of auxiliary equipment comes from the energy storage device of service braking electric control transmission, the vehicle shall be inspected under the parking braking state under the condition of vehicle static, engine running and traction battery uncharged; besides, full travel brake shall be carried out for the service braking to verify the stop light maintaining the indication state and all vehicle lights (including head light, front/rear fog light and turn light) operating normally during the braking period.

7.3.11.6 Inspection shall be carried out by reference to the design documents to verify that the service braking electric control transmission failure will not result in the braking violating the intention of the driver.

7.3.12 Inspection on fluid reservoir/master cylinder

7.3.12.1 Fluid reservoir shall be confirmed to be easy accessible, and that inspection on liquid surface be realized without opening the fluid reservoir through adoption of the transparent material and installment of low liquid level indicator or other ways. If the transparent material is adopted, the liquid in all colors shall be confirmed to be clear and visible.

7.3.12.2 The vehicle equipment shall be confirmed to generate the red warning signal to the driver in the hydraulic transmission failure or when the liquid surface of the fluid reservoir is less than specified level. The warning signal shall be checked to be clear and visible even in daytime in convenience for the inspection on the operation condition of warning signal at driving position. The indication signal for parking brake of vehicle equipment also shall be confirmed.

7.3.12.3 For the inspection on operation condition, service brake failure and brake fluid leakage shall be simulated to confirm that warning signal can indicate at the latest in the function of brake pedal. Parts of warning device shall be checked not to result in the complete loss of brake performance. As long as there is failure or malfunction and the ignition switch is at the position of "on" (operation), the warning device will be lighten all the time.

7.3.12.3.1 As for the pressure difference warning device, the two outlets in the master cylinder shall be separately connected with one pressure gauge / sensor (one is in main brake circuit and the other is in emergency brake circuit). The pressure difference of the two outlets at the lightening of warning signal shall be recorded and confirmed to not exceed 1.55pa in the simulation of a circuit failure. This process shall be repeated in the simulation of another circuit failure.

7.3.12.3.2 As for the liquid surface warning device, the warning signal shall be confirmed to give instruction when the liquid level at any part of the fluid reservoir falls to the specified level by manufacturer.

7.3.12.4 If level indicator is not installed, the lowest capacity of fluid reservoir, namely maximum liquid discharging volume produced by the maximum abrasion of braking friction lining, shall be checked: vehicles shall be made on level road and brake fluid surface shall be confirmed just right in the indicated record level at one side of the fluid reservoir; brake fluid shall be extracted until the liquid surface just covers the input aperture of the master cylinder; the extracted liquid volume shall be measured and its equal to or larger than the lowest calculated total capacity of fluid reservoir shall be checked.

7.3.12.4.1 As for the axle in disc brake, its maximum liquid discharging volume can be gotten in the way that the thickness (thickness of maximum filler block) of completely new friction lining shall minus that of friction lining in complete worn (the declared thickness of minimum filler block by manufacturer), and then plus the maximum allowable worn dimension of brake disc, and times the total area of the piston at one side of the bracket and times the number of cylinders.

7.3.12.4.2 As for the axle in drum brake, maximum liquid discharging volume of single axle can be gotten in the way that the maximum retraction amount of single piston $\Delta x \approx \frac{r \cdot \Delta d}{\sqrt{r^2 - L^2}} + s$ times piston area and the number of cylinders. The lowest total capacity

confirmed that the parts without being affected by the failure not only be able to maintain the current energy level, but also be able to continue supplementing energy, and the energy storage inspection shall be carried out according to 7.3.15.2.3.

7.3.15.2.3 Energy storage inspection under the condition of energy failure

a) Disconnect auxiliary device and its energy storage, regulate the pressure to that specified by the manufacturer, but shall not be higher than the opening pressure.

b) Make the energy supply failed by method such as start the magnetic valve to make the pump output to the fluid reservoir.

c) Carry out 4 times of whole stroke actuation to service braking, record the residual pressure of energy storage; carry out the fifth braking and record the obtainable line pressure. There shall be at least 1min interval between each braking.

7.3.15.3 Dynamic braking system

7.3.15.3.1 Inspect its independent mesh with at least two energy storage devices respectively , which act on at least two wheels respectively; confirm that the parts are not affected by simulating partial failure of transmission device may not only be able to maintain the current pressure, but also may supplement energy, and the energy storage inspection shall be carried out according to 7.3.15.3.2.

7.3.15.3.2 Energy storage inspection under the condition of energy failure

a) Disconnect auxiliary device and its energy storage, regulate the pressure to that specified by the manufacturer, but shall not be higher than the opening pressure.

b) Make the energy supply failed by method such as start the magnetic valve to make the pump output to the fluid reservoir.

c) Carry out 4 times of whole stroke actuation to service braking, record the residual pressure of energy storage; carry out the fifth braking and record the obtainable line pressure. There shall be at least 1min interval between each braking.

7.3.15.4 Energy storage type hydraulic braking system

7.3.15.4.1 Energy storage inspection under the condition of energy failure

a) Disconnect auxiliary device and its energy storage; and regulate the pressure to that specified by the manufacturer, but not be higher than the opening pressure.

b) Carry out 8 times of whole stroke actuation to service braking without supplementing energy; record the residual pressure of energy storage; carry out the ninth braking and record the obtainable line pressure. There shall be at least 1min interval between each braking.

7.3.15.4.2 Vehicle fail to meet the requirements of 7.3.15.2.2 or 7.3.15.3.1 shall simulate the energy storage inspection when the energy failure is caused by pipeline failure

a) Disconnect auxiliary device and its energy storage, regulate the pressure to that specified by the manufacturer, but shall not be higher than the opening pressure.

b) The energy is static or the engine rotates in idle speed.

c) The analogue transmission is failed, carry out 8 times of whole stroke actuation to service braking without supplementing energy; record the residual pressure of energy storage; carry out the ninth braking and record the obtainable line pressure. There shall be at least 1min interval between each braking.

7.3.15.5 Inspection of warning condition for energy storage device

Start the engine, boost the pressure and record the closing pressure (p_1); reduce the pressure gradually and record the opening pressure. If the opening pressure is different from

the minimal pressure specified by the manufacture, then the minimal pressure shall be recorded, and it shall be confirmed that the minimal pressure is not higher than the actually measured opening pressure.

7.3.15.5.1 Inspect the system, and confirm that except pressure gauge, optical or acoustic low-voltage alarm device is also be installed, and the alarm device is connected with each loop permanently, and optical signals meet the requirements of 4.2.21.1.1.

a) Where an engine operates regularly and a braking system is free from any fault, it shall be confirmed that a alarm device shall not give out any signal except the period when a energy storage shall be charged after an engine starts.

b) Consume the energy till the alarm signal is lit, under the condition of not supplementing energy, carry out 4 times of whole stroke actuation to service braking without supplementing energy; record the residual pressure of energy storage; carry out the fifth braking and record the obtainable line pressure.

7.3.15.5.2 As for the vehicle stated in 7.3.15.4.2, confirm that except pressure gauge, optical and acoustic warning signals are equipped, and the optical signal shall give out warning before the acoustic signal, and the optical signal shall meet the requirements of 4.2.21.1.1, which shall maintain lit when the ignition switch is turned on(such as operation condition).

7.3.15.5.3 This acoustic device may be out of service when the parking brake is applied and/or when the control lever of automatic transmission is in the "parking" position.

7.3.16 If vacuum or hydraulic assistance is used to reinforce parking braking action, inspect that parking braking may still be carried out without using assistance, if necessary, stored energy which is not usually used for this purpose (such as used for service braking) may be used.

7.3.17 Energy capacity inspection

7.3.17.1 Supplement energy to the system till the pressure is closed (p_1), stop supplementing energy, and carry out 4 times of whole stroke service braking, and record the residual pressure (p_2).

7.3.17.2 Under the condition of not supplementing energy to the energy storage device, regulate the system pressure to p_2. The engine operates in the maximum power rotation speed or the allowable maximum rotational speed of the overspeed governor, supplement energy to the system, record the time required for the pressure of the most unfavorable energy storage device rising to p_1; inspect that whether the time is equal to or less than 20s or not. Except automatic disconnection, the energy supply device of auxiliary device shall not be disconnected in this test.

7.3.17.3 Stop the engine; start at a pressure specified by the manufacturer but does not exceed the opening pressure, carry out two times of whole stroke actuation to the service braking system, and confirm that the alarm device doesn't give out any signal.

7.3.18 Auxiliary equipment

Inspect and determine the auxiliary equipment supplied by the braking energy storage device; regulate the energy storage device to the cut-in pressure under the uncharged condition, open all the above auxiliary equipment, make them operative, inspect the pressure of braking system energy storage device not falling to the level below the working pressure level of the alarm device.

7.3.19 Parking braking performance

speed and specified speed shall not be greater than ±2%. In the test, the vehicle shall be accelerated 5km above the specified speed, loosening the accelerator pedal, and braked when the speed falls to the specified test speed. If the maximum design speed is lower than the specified test speed, test shall be carried out at the maximum speed that can be continuously maintained by the vehicle.

7.4.1.4 Unless otherwise specified, the braking operation of all dynamic tests shall reach the scheduled control force or pipeline pressure limit within the shortest time.

7.4.1.5 Vehicle shall run along the middle line of the test channel before the braking, shall maintain stable during the braking process (yaw angle shall be less than or equal to 15°), shall not deviate 3.5m wide test channel and shall not appear abnormal vibration.

7.4.2 Vehicle preparation

7.4.2.1 Vehicle shall be loaded as required:

a) Unladen condition refers to such situation: vehicle in the kerb mass state, only one person beside the driver on the front seat recording the test results.

b) Laden condition refers to such situation: with the mass of the driver, test recording personnel and all necessary test equipment, vehicle loaded to the maximum total design mass, mass distribution verified meeting the requirements of the manufacturer. If there are several kinds of different mass distribution plans, the one with the maximum front to rear axle mass distribution ratio shall be adopted.

7.4.2.2 Tyre dimensions and types shall be checked, and the tyre shall be inspected under the recommended pressure of corresponding loads.

7.4.2.3 All test equipment shall be calibrated.

7.4.3 Unladen condition - basic performance test

7.4.3.1 Type-0 test for engine disconnected

7.4.3.1.1 The speed specified in this test is 100km/h. vehicles, that cannot make the specified speed due to the limitation of maximum design speed, may be tested at the speed that they can make. In the test, firstly it shall be verified that the mean temperature of service brake on the hottest axle is 65℃~100℃. On the horizontal surface with good adhesion conditions ($\mu \geq 0.8$), vehicle is accelerated to 5km/h above the specified test speed, disconnecting the gear, and then it is braked when the speed falls to the specified test speed.

As for the electric vehicles whose motors and wheels are in the permanent connection, if free from clutch/neutral gear, all the tests (disconnected or connected test) shall be carried out under the motor connecting conditions.

7.4.3.1.2 Repeat 7.4.3.1.1; verify the optimal braking performance that a vehicle with no wheel locking can meet the requirements; vehicle braking including the familiar one: at most 6 braking in each test, and at most 5 repetitions.

As for the hydraulic power braking vehicle obtaining the critical results at the maximum pressure, further test shall be carried out to verify that the pipeline pressure can reach the minimum performance when the energy storage is charged to the cut-in pressure.

7.4.3.2 Type-0 test for engine connected

This test is only applicable to the vehicle with the maximum speed v_{max}>125km/h, specified test speed v=80%v_{max}≤160km/h; as for the vehicle with the maximum speed v_{max}>200km/h, the test speed shall be 160km/h.

7.4.3.2.1 Firstly it shall be verified that the mean temperature of service brake on the hottest

axle is 65℃~100℃.On the horizontal surface with good adhesion conditions, vehicle is accelerated to 5km/h above the specified test speed, running at the corresponding maximum gear, loosening the accelerator pedal and maintaining the gear, and then braked when the speed falls to the specified test speed. The adopted braking control force (or pipeline pressure) is close to that of type-0 test for engine disconnected in Article 7.4.3.1.1. Braking control force shall be maintained constant during the entire braking process, ensured reaching the maximum braking rate and not causing wheel locking.

7.4.3.2.2 The above tests shall be carried out for electric vehicles equipped with electric regenerative braking of category A with permanent connection of motor and wheel on the low-adhesion surface ($\mu \leq 0.3$).In the test, the vehicle state shall be inspected free from the influence of gear shift, accelerator pedal loosening and other instant states. Steering correction is permitted in the test, but the corner of the handwheel shall not be greater than 120° during the initial 2 seconds and shall not be greater than 240° in all.

7.4.3.2.3 Repeat 7.4.3.2.1; verify the optimal braking performance that a vehicle with no wheel locking can meet the requirements, at most 5 repetitions.

7.4.4 Unladen condition - failure test

By reference to the description made by the manufacturer on failure simulation and static test results, select and simulate in turn corresponding failure conditions, and carry out Type-0 test for engine disconnected according to Articles 7.4.3.1.1 and 7.4.3.1.2.Vehicles, that cannot make the specified speed due to the limitation of maximum design speed, may be tested at the speed that they can make.

7.4.4.1 Simulate one return circuit failure of service braking system, maintain the pipeline pressure of failure return circuit zero in the entire test process, and verify the specified emergency braking performance reachable.

7.4.4.2 As for the vehicles stated in Article 7.3.15.2.1, simulate assisting device failure in turn by consuming the energy stored in the assisting device, disconnect the booster from the energy at the time the energy is totally consumed, immediately carry out Type-0 test for engine disconnected, verify the specified emergency braking performance reachable.

7.4.4.3 As for the vehicles stated in Articles 7.3.15.2.2 and 7.3.15.3.1, simulate each return circuit failure in turn, carry out Type-0 test for engine disconnected under the pipeline pressure measured in the static test, and verify the specified emergency braking performance reachable.

7.4.4.4 As for the vehicles stated in Articles 7.3.15.2.3, 7.3.15.3.2, 7.3.15.4.1 and 7.3.15.5.1, maintain the failure state, carry out Type-0 test for engine disconnected under the pipeline pressure measured in the static test, verify the specified emergency braking performance reachable.

7.4.4.5 As for the vehicles stated in Article 7.3.15.4.2, maintain the failure state, carry out Type-0 test for engine disconnected under the pipeline pressure measured in the static test, and verify the specified emergency braking performance reachable.

7.4.4.6 Charge the auxiliary energy device to the normal working level, stop the engine or disconnect the energy supplied from the engine, carry out Type-0 test for engine disconnected, verify the specified service braking performance reachable.

7.4.4.7 As for vehicle equipped with ABS, disconnect the circuits of power supply, sensor and controller in turn, stop antilock braking system, verify the service braking performance

not less than 80% of the specified performance of Type-0 test for engine disconnected.

7.4.4.8 Disconnect the control connection of variable braking force distribution system, determine the possible distribution failure mode, adjust the mode to the worst state, carry out Type-0 test for engine disconnected, verify MFDD of vehicle not less than 3.86 m/s^2. If the braking force distribution failure may result in the complete braking of the controlled axle, the braking stability shall be inspected.

Load sensing proportion valve, electronic braking force distribution system (EBD) and other devices controlling the braking force distribution (such as G valve or reducing valve) shall be tested by reference to this article.

7.4.4.9 As for the vehicles with electric control transmission service braking system, the following additional tests shall be carried out:

7.4.4.9.1 Simulate the persistent failure of service braking electric control transmission by disconnecting the wires, carry out Type-0 test for engine disconnected, verify the vehicle can reach the specified emergency braking performance, and lighten corresponding alarm signals according to the requirements of Article 4.2.21.1.1 (lighten the red alarm signal when failing to meet the service braking performance, lighten the yellow alarm signal in other cases).

7.4.4.9.2 Regulate the traction battery voltage to SOC determined in Article 7.3.11.3, prevent charging the traction battery, inspect the traction battery not charging the non-crucial auxiliary equipment (including the exterior lighting device), and verify the specified emergency braking performance reachable.

7.4.4.10 As for the electric vehicles whose service braking systems have electric components, the following additional tests shall be carried out:

7.4.4.10.1 Simulate the service braking electric component failure by disconnecting the power supply, carry out Type-0 test for engine disconnected, and verify the vehicle can reach the specified emergency braking performance.

7.4.4.10.2 If the service braking electric component failure will result in the complete function of brake, one failure switch which can operate safety during the vehicle running shall be installed. Simulate the electric control transmission device failure by disconnecting the wires, manipulate the failure switch to carry out Type-0 test for engine disconnected, and verify the vehicle can reach the specified emergency braking performance.

7.4.5 Unladen condition - ABS test

7.4.5.1 Determination of adhesion coefficient use ratio on low-adhesion surface

The tests shall be carried out on the low-adhesion surface with adhesion coefficient less than or equal to 0.3.

In order to eliminate the influence of different brake temperature, it is suggested to determine z_{AL} before k.

7.4.5.1.1 As for the vehicles equipped with antilock braking system of category 1 and category 2, all wheels shall be braked to determine the maximum braking rate z_{AL}; as for the vehicles equipped with antilock braking system of category 3, each axle which has at least one directly controlled wheel shall be respectively determined by its z_{AL}.

Connect the antilock braking system, step on the brake pedal, and verify each brake in the normal operation.

Brake at the initial speed of 55km/h, determine the time required for the speed to fall from 45km/h to 15km/h, ensure the full cycling of antilock braking system during the braking

category 2, adhesion coefficient use ratio $\varepsilon = \frac{Z_{AL}}{k_M}$.

7.4.5.1.3.2 As for the vehicles equipped with antilock braking system of category 3, each axle which has at least one directly controlled wheel shall be respectively determined for its ε. For example: as for the double-axle vehicle driven by rear wheel whose antilock braking system only acts on the rear axle, the adhesion coefficient use ratio:

$$\varepsilon_2 = \frac{z_{AL} \times P \times g - 0.010F_1}{k_2\left(F_2 - \frac{h}{E} \times z_{AL} \times P \times g\right)}.$$

7.4.5.1.4 Round off ε to 2 decimal places, inspect ε≥0.75; if ε>1.00, the adhesion coefficient shall be re-measured with the allowable error 10%.

7.4.5.2 Determination of adhesion coefficient use ratio on high-adhesion surface

Tests shall be carried out on the road surface with adhesion coefficient about 0.8 (dry surface) by reference to Articles 7.4.5.1.1, 7.4.5.1.2 and 7.4.5.1.3.

If full cycling cannot be realized during the full braking, the control force may be increased to 1000N; if full cycling of system cannot be realized where the control force is greater than 1000N, this test shall not be carried out any more.

7.4.5.3 Additional inspection

The purpose of this test is to verify wheel un-locking and vehicle stable, therefore it is unnecessary to brake until the vehicle stops running.

7.4.5.3.1 Single surface test

On such two kinds of surfaces where the adhesion coefficient is less than or equal to 0.3 and about 0.8 (dry surface), carry out rapid full braking at the initial speed of 40km/h and $0.8v_{max}$≤120km/h. In the test, the wheels directly controlled by the antilock braking system shall not be locking.

7.4.5.3.2 Butt joint surface test (k_H≥0.5, k_H/k_L≥2)

7.4.5.3.2.1 High-adhesion surface (k_H) to low-adhesion surface (k_L)

Where the test axle runs from the high-adhesion surface to the low-adhesion surface, carry out rapid full braking and inspect the directly controlled wheel unlocking. Running speed and braking occasion shall ensure that the vehicles run from the high-adhesion surface to the low-adhesion surface at the high and low speed specified in Article 7.4.5.3.1, and the antilock braking system shall be made full cycling on the high-adhesion surface

7.4.5.3.2.2 Low-adhesion surface (k_L) to high-adhesion surface (k_H)

Where the vehicle runs from the low-adhesion surface to the high-adhesion surface, carry out rapid full braking, inspect the vehicle deceleration with obvious increase within the appropriate time and the vehicle does not deviate the set running route. Running speed and braking occasion shall ensure that the vehicles run from the low-adhesion surface to the high-adhesion surface at about 50km/h, and the antilock braking system shall be made full cycling on the low-adhesion surface.

7.4.5.3.3 Split surface test (k_H≥0.5, k_H/k_L≥2)

This test is applicable to the vehicles equipped with antilock braking system of category 1 and category 2.

condition $d_{M+R} = d_M \dfrac{P_M}{P_M + P_R} m/s^2$, verify d_{M+R} not less than 5.4m/s^2.

Where,

d_M -- In the Type-0 test for engine disconnected, MFDD of passenger car under the laden condition, m/s^2;

P_M -- Laden mass of passenger car, kg;

P_R -- Laden mass of non-braking trailer that may be trailed, kg.

7.4.7.2 Parking braking in the running vehicle

By reference to Article 7.4.3.1, parking braking shall be applied at the initial speed of 30km/h to carry out Type-0 test for engine disconnected. Control force shall not be greater than 400n (500N in the foot control) and shall be maintained constant during the braking process. It shall be verified that MFDD and the transient deceleration before the vehicle stop not less than 1.5 m/s^2. As long as one test result can reach the specified performance, it shall be regarded meeting the requirements.

7.4.7.3 Response test

As for the vehicles equipped with assistance braking system and which cannot reach the service braking performance without the assistance, they shall be equipped with deceleration recording equipment and the service braking shall be carried out at the running speed not greater than 20km/h. According to the recorded deceleration, it shall be verified that the time from starting actuating the pedal to reaching the specified service braking deceleration not greater than 0.6s.Service braking control force is not restricted in this test.

7.4.7.4 Type-I test

7.4.7.4.1 Heating process

7.4.7.4.1.1 Type-0 test for engine disconnected shall be carried out twice at the initial speed v_1=80%v_{max}≤120km/h and at the maximum gear; the control force or pipeline pressure required for the vehicle to generate 3m/s^2 deceleration under the laden condition shall be determined. Moreover, is shall also be verified that the speed can fall from v_1 to v_2 within the specified time (Δt=45s); Δt is the time from the start of one braking operation to the start of the next braking operation.

7.4.7.4.1.2 Adopt the maximum gear, determine the control force or pipeline pressure according to Article 7.4.7.4.1.1, carry out the service braking from speed v_1, make the vehicle generating a mean deceleration of 3m/s^2; release the braking when the speed falls to v_2, select the optimal gear to recover the speed to v_1, maintain this speed at least 10s at the maximum gear, carry out braking again, determine the time interval between the start of two braking Δt. The time measuring device shall be started or re-set at the first braking operation.

7.4.7.4.1.3 Repeat the procedures of Article 7.4.7.4.1.2 until the total braking times are 15. The control force of each braking operation shall be ensured to generate a mean deceleration of 3m/s^2.

7.4.7.4.1.4 Cycling time may be difference due to the vehicles and test return circuits. As for the cycle period change caused by insufficient vehicle performance, the time interval Δt between the braking operation shall be increased to the shortest time required to reach the speed v_1, and 10s shall be set aside to stabilize the speed. If the cycle period change is caused by the risk or characteristics (such as steering or downslope) of the test return circuit, the full

cycle time of 4 continuous braking shall meet the relevant requirements. Moreover, the whole period of all the 15 braking shall be corresponding to the time consume for each braking operation in the correct interval.

7.4.7.4.1.5 As for the electric vehicle that cannot reach the specified speed within the cycle period, the first braking shall be carried out at the specified speed, and the subsequent braking shall be carried out at the speed reached after accelerated 45s immediately within the shortest time.

7.4.7.4.2 Hot performance

7.4.7.4.2.1 At the end of the last braking, accelerate to the Type-0 test speed immediately within the shortest time, carry out Type-0 test for engine disconnected; the used mean control force shall not be greater than the actually used control force in the Type-0 test under the laden condition; it shall be verified that the vehicle under the wheel unlocking state can at least reach 60% of the actual performance in the laden condition Type-0 test and 75% of the specified performance in the Type-0 test. If the vehicle under the control force of Type-0 test can reach 60% of the actual performance in the Type-0 test but not reach 75% of the specified performance, further test may be carried out by higher control force not greater than 500N. The results of the two tests shall be recorded in the test report.

7.4.7.4.2.2 As for the electric vehicles that cannot reach the specified speed within the cycle period (Δt), hot performance test shall be carried out at the maximum speed that may be reached after the heating cycle. For comparison, Type-0 test under the cold state and laden condition shall be carried out at the same speed after the recovery test.

For vehicles equipped with an electric regenerative braking of category A, during the hot performance test, the highest gear must be continuously engaged and the separate electric braking control, if any, not used.

7.4.7.4.3 Recovery process

Immediately after the hot performance test, accelerate to 50km/h immediately within the shortest time, adopt the maximum gear appropriate to the speed, and carry out service braking at a mean deceleration of 3m/s^2. At the end of the braking, accelerate to 50km/h immediately within the shortest time and maintain this speed, and carry out braking at a mean deceleration of 3m/s^2 again at the position 1.5km away from the last braking start point. Repeat this process until the total braking times are 4. The time measuring device shall be started or re-set at the first braking operation.

7.4.7.4.4 Recovery performance

At the end of the last braking, accelerate to Type-0 test speed immediately within the shortest time, carry out Type-0 test for engine disconnected, and verify the vehicle under the wheel unlocking state can reach 70% of the actual performance in the laden condition Type-0 test, not greater than 150%. This test is free from the restriction of brake temperature requirements, but the used mean control force shall not exceed the actually used control force in the laden condition Type-0 test.

7.4.7.4.5 Cold inspection

Cool down the brake to the ambient temperature and verify the brake unbonding. As for the vehicle equipped with automatic wear compensation device, the wheel shall be inspected if it can rotate freely where the hottest brake cools down to 100℃.

7.4.7.5 Additional laden Type-0 test shall be carried out for the electric vehicle stated in

Article 7.4.7.4.2.2. Firstly, several braking operation shall be carried out according to the requirements of Type-0 test to recover the brake linings; then, Type-0 test for engine disconnected shall be carried out at the same speed as the hot performance test to verify the vehicle can at least reach 60% of the actual performance of cold braking and 75% of the specified performance of the Type-0 test corresponding to the used speed.

7.4.7.6 Additional test for vehicles equipped with electric regenerative braking of category B

7.4.7.6.1 As for the vehicles equipped with electric regenerative braking of category B (or with category A and category B), the following additional tests shall be carried out after the static inspection specified in Article 7.3.8.2.

Under the condition of motor connected, the service braking shall be carried out by moderate control force from about 100km/h speed. During the braking period, the connection with the motor shall be disconnected to inspect the braking force generated by the service braking system if it is reduced. Motor connected braking test shall be carried out in turn at each gear with the similar test speed to verify the service braking force has nothing to do with the adopted gear.

7.4.7.6.2 As for the electric regenerative braking of category A and category B started by loosening the accelerator pedal, the following additional inspection shall be carried out after those in Article 7.3.8.1.

Under the condition of motor connected, electric regenerative braking is started by loosening the accelerator pedal from about 100km/h speed, and service braking is applied slightly to verify that the electric regenerative braking action is not reduced.

7.4.7.7 Additional inspection for the service braking system of electric control transmission

7.4.7.7.1 As for the vehicle whose auxiliary equipment or parking braking system is supplied power by the traction battery of service braking system electric control transmission device, if additional inspection is required as shown in the static test of Article 7.3.11.4, all the above auxiliary equipment shall be made operative to carry out Type-0 test for engine disconnected. If necessary, the discharged may be controlled by selecting the auxiliary equipment, the traction battery voltage before the braking shall be made in the level recorded in Article 7.3.11.4, and the vehicle shall be verified reaching the specified service braking performance. If the test in Article 7.3.11.4 results in the discharge of traction battery (energy storage device), the above Type-0 test for engine disconnected shall be carried out under this condition.

7.4.7.7.2 As for the vehicle whose auxiliary equipment is supplied power by the traction battery of service braking system electric control transmission device, the service braking shall be carried out under the charging state of battery and not greater than 20km/h speed, and it shall be verified that the service braking system can completely brake.

7.4.8 Laden condition - failure test

By reference to the requirements of Article 7.4.4, select in turn and simulate corresponding failure conditions under the laden conditions, carry out Type-0 test for engine disconnected, and verify the vehicle can reach the specified emergency braking performance under each failure condition.

7.4.9 Braking force distribution inspection among axles

The vehicle shall be inspected to see if it meets the braking force distribution

the vehicle, it is recommended to test before installing the torque wheel.

7.4.9.2.1.2 The speed specified in this test is 100km/h. In the test, driving the vehicle at the speed 5km/h higher than the test speed, and act the brake pedal at a linear speed of 100N/s~150N/s. The braking shall be released where the first axle locking (no matter which axle first locks) or the braking control force reaching 1kN.

A series of braking may be required in advance in this test to determine the braking operating speed; if necessary, mechanical-type braking control force motivation device may be required, by regulating which to provide the required braking operating speed. The adopted pipeline pressure range shall be sufficient to reach the braking strength (z) of 0.15~0.8.

7.4.9.2.1.3 Make the vehicle run at the maximum speed of 100km/h, cool down the brake until its temperature is within the specified range.

7.4.9.2.1.4 Tests shall be carried out at a speed of 50km/h and a braking operating speed of 100N/s~200N/s in accordance with Articles 7.4.9.2.1.2 and 7.4.9.2.1.3.

7.4.9.2.1.5 Tests shall be carried out alternatively at the test speed of 100km/h and 50km/h, and 5 braking operation shall be carried out respectively at the speed of 100km/h and 50km/h, respectively in accordance with the requirements of Articles 7.4.9.2.1.2 and 7.4.9.2.1.3. Brake cooling running shall be carried out between the braking; and the brake temperature shall be ensured within the range of limit in each braking.

7.4.9.2.2 Laden test

Laden test shall be carried out in accordance with Articles 7.4.9.2.1.1~7.4.9.2.1.5.

7.4.9.2.3 Data reduction

7.4.9.2.3.1 The test data from 20 times of braking (5 times of running braking shall be carried out respectively under two kinds of load conditions and two kinds of test speed) shall be screened by 5-point central translation method in each data channel.

7.4.9.2.3.2 The braking torque and pipeline pressure data of each wheel determined and screened from each test shall be treated by the method of least squares; only the data among 0.15g~0.8g of vehicle deceleration shall be adopted; the gradient (external factor of brake) and intercept (brake release/maintain pressure) shall be determined according to the results of regression analysis.

7.4.9.2.3.3 Front axle results (unladen condition and laden condition) shall be selected from the complete test results obtained from Article 7.4.9.2.3.2 and averaged; average external factor and release pressure of the front axle brake in each braking shall be calculated.

7.4.9.2.3.4 Repeat the procedures in Article 7.4.9.2.3.3, select the rear axle results and calculate the external factor and release pressure of the rear axle brake in each braking.

7.4.9.2.3.5 The braking force of the front axle corresponding to the given front axle pipeline pressure within the range of the entire pipeline pressure shall be calculated according to the external factor & release pressure of the front axle brake and the dynamic rolling radius of the wheel; different data shall be adopted respectively under the laden and unladen conditions.

7.4.9.2.3.6 Repeat the procedures in Article 7.4.9.2.3.5 for the rear axle; the braking rate of the rear axle corresponding to the given front axle pipeline pressure within the range of the entire pipeline pressure shall be calculated according to the front and rear pipeline pressure relationship; different data shall be adopted respectively under the laden and unladen conditions.

7.4.9.2.3.7 As for unladen condition and laden condition, calculate the braking rate of the

Appendix A

(Normative)

Symbols and Definitions

The following symbols are applicable to this standard.

No.	Symbol	Name and description
1	d_m	Mean fully developed braking deceleration, MFDD
2	d_M	Maximum value of MFDD of passenger car in the Type-0 test for engine disconnected, m/s^2
3	d_{M+R}	Calculated MFDD of passenger car trailed non-braking trailer, m/s^2
4	Δd	The thickness of brand new friction lining (maximum friction lining thickness) minus the thickness of completely worn friction lining (minimum friction lining thickness declared by the manufacturer)
5	Δt	braking cycle period, namely the duration from the start of one braking operation to the start of the next braking operation
6	Δx	maximum retraction amount of piston, $\Delta x \approx \frac{r \cdot \Delta d}{\sqrt{r^2 - L^2}} + s$
7	E	Wheelbase
8	ε	The adhesion utilized of the vehicle: quotient of the maximum braking rate with the antilock braking system operative (z_{AL}) and the theoretical coefficient of adhesion (k)
9	ε_i	The ε-value measured on axle i (in the case of a motor vehicle with a category 3 antilock braking system)
10	ε_H	The ε - value on the high-adhesion surface
11	ε_L	The ε - value on the low-adhesion surface
12	f	Control force
13	f_i	Coefficient of adhesion utilized by axle i, $f_i=T_i/N_i$[14)]
14	F	Force (N)
15	F_{dyn}	Normal reaction of road surface under dynamic conditions with the antilock braking system operative
16	F_{idyn}	F_{dyn} on axle i in case of power-driven vehicles
17	F_i	Normal reaction of road surface on axle i under static conditions
18	F_M	Total normal static reaction of road surface on all wheels of power-driven vehicle
19	F_{Mnd}[15)]	Total normal static reaction of road surface on the unbraked and non-driven axles of the power-driven vehicle
20	F_{Md}	Total normal static reaction of road surface on the unbraked and driven axles of the power-driven vehicle
21	F_{WM}	0.01 F_{Mnd}+0.015 F_{Md}
22	g	Gravity acceleration, g=9.81m/s^2; in the wheel-lock sequence test, it may take g=10m/s^2
23	h	Height of center of gravity specified by the manufacturer and agreed by the Technical Service conducting the approval test
24	i	Axle number (For front axle, i=1; for rear axle, i=2)
25	J	Deceleration of vehicle, m/s^2
26	k	Coefficient of adhesion between tyre and road

electro-magnetic action between two parts of the vehicle moving relatively to, but not in contact with one another); a fluid brake (when the forces are generated by the action of a fluid situated between two parts of the vehicle moving relatively to one another); or an engine brake (when the forces are derived from an artificial increase in the braking action, transmitted to the wheels, of the engine).

3.1.6

Different types of braking equipment

Equipment which differ in such essential respects as:

-- Components having different characteristics;

-- A component made of materials having different characteristics, or a component differing in shape or size;

-- A different assembly of the components.

3.1.7

Component of the braking equipment

One of the individual parts which, when assembled, constitutes the braking equipment.

3.1.8

Progressive and graduated braking / modulatable braking

Braking during which, within the normal operating range of the device, and during actuation of the brakes, whose the braking force varies proportionally as the action on the control (monotonic function) and can be easily regulated with sufficient precision;

3.1.9

Unladen condition

The mass of a complete vehicle, adding with 110 kg.

3.1.10

Laden condition

Except where otherwise stated, a vehicle so laden as to attain its ‘maximum design total mass’.

3.1.11

The distribution of mass among the axles

The distribution of the effect of the gravity on the mass of the vehicle and/or its contents among the axles.

3.1.12

Wheel/axle load

The vertical static reactive (force) of the road surface in the contact area on the wheel/wheels of the axle.

3.1.13

Maximum stationary wheel/axle load

The stationary wheel/axle load achieved under the condition of the laden vehicle.

3.1.14

Hydraulic braking equipment with stored energy

A braking equipment where energy is supplied by a hydraulic fluid under pressure, stored in one or more accumulator(s) fed from one or more pressure pump(s), each fitted with a means of limiting the pressure to a maximum value. This value shall be specified by the manufacturer.

Systems or functions, which use the braking system as the means of achieving a higher level objective, are subject to Appendix D only insofar as they have a direct effect on the braking system. If such systems are provided, they must not be deactivated during testing of the braking system.

4.2 Characteristics of Braking Systems

4.2.1 The set of braking systems with which a vehicle is equipped shall satisfy the requirements laid down for service, emergency and parking braking systems.

4.2.2 The systems providing service, emergency and parking braking may have common components so long as they fulfill the following conditions:

4.2.2.1 There shall be at least two controls, independent of each other and readily accessible to the driver from his normal driving position. Every brake control shall be designed such that it returns to the fully off position when released. This requirement shall not apply to a parking brake control when it is mechanically locked in an applied position.

4.2.2.2 The control of the service braking system shall be independent of the control of the parking braking system.

4.2.2.3 The effectiveness of the linkage between the control of the service braking system and the different components of the transmission systems shall not be liable to diminish after a certain period of use.

4.2.2.4 The parking braking system shall be so designed that it can be actuated when the vehicle is in motion. This requirement may be met by the actuation of the vehicle's service braking system, even partially, by means of an auxiliary control device.

4.2.2.5 Without prejudice to the requirements of Article 4.1.2.3 of this Standard, the service braking system and the parking braking system may use common components in their transmission(s), provided that in the event of a failure in any part of the transmission(s) the requirements for emergency braking are still ensured.

4.2.2.6 In the event of breakage of any component other than the brakes and the components referred to in Article 4.2.2.10, or of any other failure of the service braking system (malfunction, partial or total exhaustion of an energy reserve), that part of the service braking system which is not affected by the failure, must be able to bring the vehicle to a halt in the conditions prescribed for emergency braking.

4.2.2.7 If service braking is ensured by the action of the driver's muscular energy assisted by one or more energy reserves, emergency braking must, in the event of failure of that assistance, be capable of being ensured by the driver's muscular energy assisted by the energy reserves, if any, which are unaffected by the failure, the force applied to the service brake control not exceeding the prescribed maximum.

4.2.2.8 If the service braking force and transmission depend exclusively on the use, controlled by the driver, of an energy reserve, there shall be at least two completely independent energy reserves, each provided with its own transmission, likewise independent; each of them may act on the brakes of only two or more wheels so selected as to be capable of ensuring by themselves the prescribed degree of emergency braking without endangering the stability of the vehicle during braking; in addition, each of the aforesaid energy reserves shall be equipped with an alarm device as defined in Article 4.2.14 below.

degree of effectiveness.

Disconnection of the braking surfaces of the parking braking system shall be permitted only on condition that the disconnection is controlled exclusively by the driver from his driving seat, by a system incapable of being brought into action by a leak.

4.2.11 Wear of the brakes shall be capable of being easily taken up by means of a system of manual or automatic adjustment. In addition, the control and the components of the transmission and of the brakes must possess a reserve of travel and, if necessary, suitable means of compensation such that, when the brakes become heated, or the brake linings have reached a certain degree of wear, effective braking is ensured without immediate gap adjustment being necessary.

4.2.11.1 Adjustment shall be automatic for the service brakes. Automatic adjustment devices shall be such that after heating followed by cooling of the brakes, effective braking is still ensured. In particular the vehicle shall remain capable of normal running after the tests conducted in accordance with Article 5.1.5 (Type-I test).

4.2.11.2 It shall be possible to easily assess this abrasion of braking friction lining for service braking system from the outside or underside of the vehicle, without the removal of the wheels, by the provision of normal vehicle tool or equipment appropriate inspection holes or by some other means. During the inspection, wheel can be dismantled; or an acoustic or optical alarm device will warn the driver at his driving position when lining replacement is necessary; or the yellow warning signal specified in Article 4.2.21.1.2 below may be used.

4.2.12 In hydraulic-transmission braking systems, the filling ports of the fluid storages shall be readily accessible; in addition, the receptacles containing the reserve fluid shall be so designed and constructed that the level of the reserve fluid can be easily checked without the receptacles having to be opened, and the minimum total storage capacity is equivalent to the fluid displacement resulting when all the wheel cylinders or calliper pistons serviced by the storages move from a new lining, fully retracted position to a fully worn, fully applied position. If these latter conditions are not fulfilled, the red warning signal specified in Article 4.2.21.1.1 below shall draw the driver's attention to any fall in the level of reserve fluid liable to cause a failure of the braking system.

4.2.13 The fluid to be used in hydraulic transmission braking systems shall be in accordance with marking and graphical symbol of corresponding brake fluid grade stated in GB 12981 and GB/T 14168. The symbol and the marking must be affixed in a visible position in indelible form within 100 mm of the filling ports of the fluid storages; additional information may be provided by the manufacturer.

4.2.14 Alarm Devices

4.2.14.1 Any vehicle fitted with a service brake actuated from an energy storage shall, where the prescribed emergency braking performance cannot be obtained by means of this brake without the use of the stored energy, be provided with an alarm device, giving an optical or acoustic signal when the stored energy, in any part of the system, falls to a value at which without re- charging of the storage and irrespective of the load conditions of the vehicle, it is possible to apply the service brake control a fifth time after four full-stroke actuations and obtain the prescribed emergency braking performance (without faults in the service brake transmission device and with the brakes adjusted as closely as possible). This alarm device must be directly and permanently connected to the circuit. When the engine is

(start) switch. In this alternative, the parking brake shall be automatically released as soon as the driver starts to set the vehicle in motion again. The engine/manual transmission or the automatic transmission (park position) or its auxiliary device may be used to achieve or assist in achieving the above performance. If necessary, parking braking may be released by driver tool or auxiliary equipment.

4.2.19.2.1 A break in the wiring within the electrical transmission, or an electrical failure in the control of the parking braking system shall be signalled to the driver by the yellow warning signal specified in Article 4.2.21.1.2. When caused by a break in the wiring within the electrical control transmission of the parking braking system, this yellow warning signal shall be signalled as soon as the break occurs.

4.2.19.2.2 An electrical failure in the control or break in the wiring external to the electronic control unit(s) and excluding the energy supply shall be signalled to the driver by flashing the red warning signal specified in Article 4.2.21.1.1 as long as the ignition (start) switch is in the 'on' (run) position including a period of not less than 10 seconds thereafter and the control is in the 'on' (activated) position. Where actuation of the parking brake is normally indicated by a separate red warning signal, satisfying all the requirements of Article 4.2.21.2, this signal (parking brake), to indicate the failure above shall be used to replace flash signal.

4.2.19.3 Auxiliary equipment may be supplied with energy from the electric transmission of the parking braking system provided that the supply of energy is sufficient to allow the actuation of the parking braking system in addition to the vehicle electrical load under non-fault conditions. Where the energy reserve is also used by the service braking system, the requirements of Article 4.2.20.6 shall apply.

4.2.19.4 After the ignition/start switch which controls the electrical energy for the braking equipment has been switched off and/or the key removed, it shall remain possible to apply the parking braking system, whereas releasing shall be prevented.

4.2.20 Special requirements for service braking systems with electric control transmission

4.2.20.1 With the parking brake released, the service braking system shall be able to generate a static total braking force at least equivalent to that required by the prescribed Type-0 test, even when the ignition/start switch has been switched off and/or the key has been removed. It should be understood that sufficient energy is available in the energy transmission of the service braking system.

4.2.20.2 In the case of a single temporary failure (<40ms) within the electric control transmission, excluding its energy supply, (e.g. non-transmitted signal or data error) there shall be no distinguishable effect on the service braking performance.

4.2.20.3 A failure within the electric control transmission [3)], not including its energy reserve, that affects the function and performance of systems addressed in this Standard shall be indicated to the driver by the red or yellow warning signal specified in Articles 4.2.21.1.1 and 4.2.21.1.2, respectively, as appropriate. When the prescribed service braking performance can no longer be achieved (red warning signal), failures resulting from a loss of electrical continuity (e.g. breakage, disconnection) shall be signalled to the driver as soon as they occur, and the prescribed emergency braking performance shall be fulfilled by operating the service

[3] Until uniform test procedures have been agreed, the manufacturer shall provide the testing organization with an analysis of potential failures within the control transmission and their effects. This information shall be subject to discussion and agreement between the testing organization and the manufacturer.

Table 1 Conditions of Heating Test

v_1/(km/h)	v_2/(km/h)	Δt/s	N/time
$80\%v_{max} \leq 120$	$\frac{1}{2} v_1$	45	15

5.1.5.1.2 If the characteristics of the vehicle make it impossible to abide by the duration prescribed for Δ_t, the duration may be increased; in any event, in addition to the time necessary for braking and accelerating the vehicle, a period of 10 seconds must be allowed in each cycle for stabilizing the speed v_1.

5.1.5.1.3 In these tests, the force applied to the control must be so adjusted as to attain a mean deceleration of 3 m/s^2 during every brake application; two preliminary tests may be carried out to determine the appropriate control force.

5.1.5.1.4 During brake applications, the highest gear ratio of the transmission (excluding overdrive) must be continuously engaged.

5.1.5.1.5 For regaining speed after braking, the gearbox must be used in such a way as to attain the speed v_1 in the shortest possible time (maximum acceleration allowed by the engine and gearbox).

5.1.5.1.6 For vehicles not having sufficient autonomy to carry out the cycles of heating of the brakes, the tests shall be carried out by achieving the prescribed speed before the first braking application and thereafter by using the maximum acceleration available to regain speed and then braking successively at the speed reached at the end of each 45s cycle duration.

5.1.5.1.7 For vehicles equipped with an electric regenerative braking system of category B, the condition of the vehicle batteries at the start of the test, shall be such that the braking force contribution provided by the electric regenerative braking system does not exceed the minimum guaranteed by the system design. This requirement is deemed to be satisfied if the batteries are at one of the state of charge conditions as listed in Article 5.1.4.1.2.3.

5.1.5.2 Hot state performance

5.1.5.2.1 At the end of the Type-I test, the hot performance of the service braking system must be measured in the same conditions (and in particular at a mean control force no greater than the mean force actually used) as for the Type-0 test with the engine disconnected (the temperature conditions may be different).

5.1.5.2.2 This hot performance must not be less than 75% (This corresponds to a stopping distance of $0.1\upsilon + 0.0080\ \upsilon^2$ and a mean fully developed deceleration of 4.82 m/s^2) of that prescribed, nor less than 60% of the figure recorded in the Type-0 test with the engine disconnected.

5.1.5.2.3 For vehicles fitted with an electric regenerative braking system of category A, during brake applications, the highest gear must be continuously engaged and the separate electric braking control, if any, not used.

5.1.5.2.4 In the case of vehicles equipped with an electric regenerative braking system of category B, having carried out the heating cycles according to Article 5.1.5.1.6, the hot performance test shall be carried out at the maximum speed which can be reached by the vehicle at the end of the brake heating cycles, unless the speed specified in Article a) in Table 2 can be reached.

For comparison, a later Type-0 test with cold brakes shall be repeated from this same

Article if the following requirements are met.

5.4.1.3.1 After any single transmission failure it shall still be possible after 8 full-stroke actuations of the service brake control, to achieve, at the 9th application, at least the performance of the emergency braking system.

5.4.1.3.2 Testing shall be performed in conformity with the following requirements:

a) With the energy source stationary or operating at a speed corresponding to the engine idling speed, any transmission failure may be induced. Before inducing such a failure, the energy storage device(s) shall be at a pressure that may be specified by the manufacturer but not exceeding the cut-in pressure.

b) The auxiliary equipment and its energy storage devices, if any, shall be isolated.

5.4.2 Capacity of hydraulic fluid energy sources

5.4.2.1 Conditions of measurement

During the tests to determine the time $t_{0\text{-}1}$, the feed rate of the energy source shall be that obtained when the engine is running at the speed corresponding to its maximum power or at the speed allowed by the over-speed governor.

During the test to determine the time $t_{0\text{-}1}$, energy storage device(s) for auxiliary equipment shall not be isolated other than automatically.

5.4.2.2 Interpretation of results

In the case of all vehicles, the time $t_{0\text{-}1}$ shall not exceed 20 seconds.

5.4.3 Characteristics of alarm devices

With the engine stationary and commencing at a pressure that may be specified by the manufacturer but does not exceed the cut-in pressure, the alarm device shall not operate following 2 full-stroke actuations of the service brake control.

5.5 Distribution of Braking among the Axles of Vehicles

Vehicles which are not equipped with an anti-lock system shall meet all the requirements of this article. If a special device is used, this must operate automatically.

5.5.1 The manufacturer shall draw out adhesion coefficient utilization curves of front axle and rear axle under laden and unladen conditions according to the following formula:

Front axle: $$f_1 = \frac{T_1}{N_1} = \frac{T_1}{P_1 + Z \times \frac{h}{E} \times P \times g}$$

Rear axle: $$f_2 = \frac{T_2}{N_2} = \frac{T_2}{P_2 - Z \times \frac{h}{E} \times P \times g}$$

5.5.1.1 Unladen condition refers to necessary substance and driver in running order; laden condition, where provision is made for several possibilities of load distribution, and the one whereby the front axle is the most heavily laden shall be the one considered.

5.5.1.2 For vehicles fitted with an electric regenerative braking system of category B, where the electric regenerative braking capacity is influenced by the electric state of charge, the curves shall be plotted by taking account of the electric braking component under the minimal and maximum conditions of delivered braking force. This requirement is not applicable if the vehicle is equipped with an anti-lock device which controls the wheels connected to the

b) For each brake application prescribed in Article 5.5.5.2 e), determine the slope (external brake factor) and pressure axis intercept (brake hold-off pressure) of the linear least squares equation best describing the measured torque output at each braked wheel as a function of measured line pressure applied at the same wheel. Only torque output values obtained from data collected when the vehicle deceleration is within the range of 0.15 g to 0.80 g are used in the regression analysis.

c) Average the results of Article 5.5.5.3b) above to calculate the average brake factor and brake hold-off pressure for all brake applications for the front axle.

d) Average the results of Article 5.5.5.3b) above to calculate the average brake factor and brake hold-off pressure for all brake applications for the rear axle.

e) Using the relationship between front and rear brake line pressure determined in Article 5.5.5.2 i) above and the dynamic tyre rolling radius, calculate the braking force at each axle as a function of front brake line pressure.

f) Calculate the braking rate of the vehicle as a function of the front brake line pressure using the following equation.

$$z = \frac{T_1 + T_2}{P \times g}$$

Where,

z -- Braking rate at a given front brake line pressure;

T_1, T_2 -- Braking forces at the front and rear axles respectively, corresponding to the same front brake line pressure;

P -- Vehicle mass.

g) Calculate the adhesion utilized at each axle as a function of braking rate using the following formulae.

$$f_1 = \frac{T_1}{P_1 + \frac{z \times h \times P \times g}{E}} \qquad f_2 = \frac{T_2}{P_2 - \frac{z \times h \times P \times g}{E}}$$

h) Plot f_1 and f_2 as a function of z, for both laden and unladen load conditions, e.g. adhesion coefficient utilization curve of the vehicle, shall meet the requirements of Article 5.5.2.

5.6 Test Requirements for Vehicles Fitted with Anti-Lock Systems (ABS)

5.6.1 Types of anti-lock systems

a) Category 1 ABS

A vehicle equipped with a category 1 ABS shall meet all the requirements of Section 5.6.

b) Category 2 ABS

A vehicle equipped with a category 2 ABS shall meet all the requirements of Section 5.6, except those of Article 5.6.3.3.5.

c) Category 3 ABS

A vehicle equipped with a category 3 anti-lock system shall meet all the requirements, except those of Articles 5.6.3.3.4 and 5.6.3.3.5. On such vehicles, any individual axle which does not include at least one directly controlled wheel must fulfill the conditions of adhesion

$$k_1 = \frac{z_m \times P \times g - 0.015 \times F_2}{F_1 + \frac{h}{E} \times z_m \times P \times g}$$

5.6.4.1.1.9 One coefficient will be determined for the front axle k_f and one for the rear axle k_r.

5.6.4.1.2 Determination of the adhesion utilization (ε)

5.6.4.1.2.1 The adhesion utilized (ε) is defined as the quotient of the maximum braking rate with the anti-lock system operative (z_{AL}) and the coefficient of adhesion (k_M).

5.6.4.1.2.2 From an initial vehicle speed of 55 km/h, the maximum braking rate (z_{AL}) shall be measured with full cycling of the anti-lock braking system and based on the average value of three tests, as in Article 5.6.4.1.1.3 of this appendix, using the time taken for the speed to reduce from 45 km/h to 15 km/h, according to the following formula:

$$z_{RAL} = \frac{0.849}{t_m}$$

5.6.4.1.2.3 The coefficient of adhesion k_M shall be determined by weighting with the dynamic axle loads:

$$k_M = \frac{k_f \times F_{fdyn} + k_r \times F_{rdyn}}{P \times g}$$

Where, $F_{fdyn} = F_f + \frac{h}{E} \times z_{AL} \times P \times g$ $\qquad$ $F_{rdyn} = F_r - \frac{h}{E} \times z_{AL} \times P \times g$

5.6.4.1.2.4 In the case of a vehicle equipped with an anti-lock system of categories 1 or 2, the value of z_{AL} will be based on the whole vehicle, with the anti-lock system in operation, and the adhesion utilized (ε) is given by the same formula quoted in Article 5.6.4.1.2.1.

5.6.4.1.2.5 In the case of a vehicle equipped with an anti-lock system of category 3, the value of z_{AL} will be measured on each axle which has at least one directly controlled wheel. For example, for a two-axle rear-wheel drive vehicle with an anti-lock system acting only on the rear axle (2), the adhesion utilized (ε) is given by:

$$\varepsilon_2 = \frac{z_{AL} \times P \times g - 0.010 F_1}{k_2 \left(F_2 - \frac{h}{E} \times z_{AL} \times P \times g \right)}$$

This calculation shall be made for each axle having at least one directly controlled wheel

5.6.4.1.3 Value ε shall be rounded to 2 decimal places. If ε>1.00, the measurements of coefficients of adhesion shall be repeated. A tolerance of 10 % is accepted.

5.6.5 Braking performance on differing adhesion surfaces

5.6.5.1 The prescribed braking rate referred to in Article 5.6.3.3.5 may be calculated by reference to the measured coefficient of adhesion of the two surfaces on which this test is carried out. These two surfaces must satisfy the conditions prescribed in Article 5.6.3.3.4.

5.6.5.2 The coefficient of adhesion (k_H and k_L) of the high- and low-adhesion surfaces, respectively, shall be determined in accordance with the provisions in Article 5.6.4.1.1.

5.6.5.3 The braking rate (z_{MALS}) for laden vehicles shall be:

c) Statement of the manufacturer on the aspect of complex electronic vehicle control system;

d) Other information related to the requirements of this standard.

7.3.2 Component inspection

7.3.2.1 During the appearance inspection for the braking system, it shall be verified that the connection efficiency between the service braking pedal and transmission component will not degrade as time goes on.

7.3.2.2 Components (such as connecting piece, wheel cylinder and its piston, brake lever cam assembly) between brake pedal and its support, master cylinder and its, control valve, brake pedal and master cylinder or control valve shall be verified having sufficient strength and convenient for maintenance.

7.3.2.3 Service braking shall be verified acting on all the wheels. The inspected system is double circuit whose realization mode shall be recorded; the fluid reservoir of hydraulic circuit shall be verified independent.

7.3.2.4 It is verified that service brake, emergency brake and parking brake surface shall be in permanent connection with the wheel. If they may be disconnected, it shall be verified that they only disconnect temporarily in the case of gear shift. Disconnection of the parking braking system shall be permitted only on condition that the disconnection is controlled exclusively by the driver from his driving seat, by a system incapable of being brought into action by a leak.

If the service braking or emergency brake may be disconnected, it shall be verified during the dynamic test that the specified performance can be reached in case of disconnection.

7.3.3 Brake wear and regulation inspection

7.3.3.1 It shall be verified the service brake in accordance with the requirements of automatic wear regulating. Emergency braking system and parking braking system, if adopting separate components, shall have manual or automatic wear regulation device. The manual regulation shall be inspected convenient for maintenance and capable of regulation needless to be dismantled. Foot pedal lever ratio shall be inspected appropriate to the pedal travel; it shall be verified all brakes adjusted tightly.

7.3.3.2 It shall be verified that the wear of service braking system brake linings is convenient to be inspected by proper inspection hole or, with other tools/equipment normally installed on the vehicle from the outside or bottom of the vehicle. During the inspection, the wheels may be dismantled, but any component of the braking system shall not be dismantled. Acoustic or optical alarm devices indicating to the drivers may be installed where the friction linings shall be replaced, or the yellow signals specified in Article 4.2.21.1.2 may be adopted.

7.3.4 Structure inspection of braking system

7.3.4.1 Service braking system inspection

It shall be verified that the driver, wearing stationary type safety belt and holding the handwheel with both hands, can actuate the service braking pedal on the driving position; it shall be verified that the service braking and parking braking control devices are mutually independent; service braking control devices can completely return to the original positions after the braking is released.

7.3.4.2 Parking braking system inspection

7.3.9.2 It shall be verified that the effective part can still make the trailer electric braking system operative in the case of passenger car brake circuit failure.

7.3.9.3 As for the trailer electric braking system started by the stop lamp switch, it shall be inspected that the start circuit and stop lamp switch are in the parallel connection as well as the stop lamp switch and circuit can bear the additional loads.

7.3.10 Parking braking system adopting the electric control transmission

The following articles are applicable to the parking braking system which realizes the function connection between control device and brake through electric control transmission, and the situation where electric control transmission coexist with other transmission modes.

7.3.10.1 It shall be verified by disconnecting the signal wire that the electric control transmission failure will not result in the misoperation of parking braking system.

7.3.10.2 It shall be verified by disconnecting the cable that the parking braking may be carried out on the driving position in the case of electric control transmission line damage to make the vehicle maintain static on the specified gradient; if the above requirements cannot be met, the specified performance may be reached by the parking gear of engine and manual transmission / automatic transmission.

7.3.10.3 It shall be verified by disconnecting relevant cables that the electric control transmission device power supply loss or circuit damage will be indicated by the yellow alarm signals specified in Article 4.2.21.1.2.

7.3.10.4 As for the vehicle whose auxiliary equipment is supplied by the parking braking electric control transmission device, switch on, make all auxiliary equipment operative, verify the parking braking feasible and release.

7.3.10.5 After the ignition/start switch which controls the power supply of braking equipment has been switched off (if necessary, the keys shall be pulled out), it shall remain be able to apply the parking braking, but shall not release the braking.

7.3.11 Service braking system with electric control transmission device

The following articles are applicable to the service braking system which realizes the function connection between control device and brake through electric control transmission, and the situation where electric control transmission coexist with other transmission modes.

7.3.11.1 Potential failure effect analysis of electric control transmission device

It shall be verified that the manufacturer provides the potential failure effect analysis information of electric control transmission device; special inspection are carried out for single transient failure (time <40ms) and persistent failure (time ≥40ms); it shall be verified that the analysis results can prove that:

a) Single transient failure (not transmission signal or data error) will not obviously influence the service braking performance.

b) That the persistent failure results in the specified service braking performance cannot be reached will be indicated to the driver by the red alarm signals specified in Article 4.2.21.1.1.Failure caused by the electric control transmission interruption shall be immediately indicated by the alarm signals.

c) That the persistent failure does not prevent the specified service braking performance being reached will be indicated to the driver by the yellow alarm signals specified in Article 4.2.21.1.2.

d) It is inspected by reference to the design documents or judged according to the

of fluid reservoir shall be calculated according to the maximum liquid discharging volume of two axles.

7.3.13 Warning signal and vehicle self-checking

7.3.13.1 The red or (the specified in 4.2.21.1.2) yellow (if it is applicable) warning signal shall be lightened when the vehicle power installation is charging. The warning signal shall be extinguished automatically in standstill of vehicles and without checked malfunction.

7.3.13.2 As for the vehicles equipped with ABS, the installation of a special yellow warning signal device shall be checked to make this signal clear and visible even in daytime and warn the driver when the ABS fails.

Warning signal will be lightened in the standstill of vehicles and the electricity of ABS. The system is self-checking, if without malfunction, warning signal will be extinguished. In the checking process, pressure regulator valve in electric control shall be cycled once at least. As for the sensors abnormality that can't be checked in static conditions shall be checked before the speed is more than 10km/h. However, as the wheel doesn't rotate in static conditions, sensors can't produce vehicle speed signals. In order to prevent wrong warning signal, the checking may be put off but sensors shall be confirmed to be in working order before the speed is more than 15 km /h.

7.3.13.3 Lightening signal of stop lamp

7.3.13.3.1 Activation of the service braking system by the driver shall generate a signal that will be used to illuminate the stop lamps.

7.3.13.3.2 Activation of the service braking system by ‘automatically commanded braking’ shall generate the signal mentioned above. However, when the produced deceleration is less than 0.7 m/s^2, the signal may not be generated.

7.3.13.3.3 Activation of part of the service braking system by ‘selective braking’ shall not generate the signal mentioned above.

7.3.13.3.4 Electric regenerative braking systems, which produce a retarding force upon the release of the accelerator pedal, shall not generate a signal mentioned above.

7.3.13.4 The control mode for the inspection on ABS can't be cut off or changed with hand appliance.

7.3.14 It shall be confirmed that the designator of brake fluid meet the requirements of GB 12981and GB/T 14168, and be fixed in the mode of difficult to erase on the position within 100mm near the filling point of fluid reservoir, which is convenient for observation.

7.3.15 Energy storage and energy supply inspection

7.3.15.1 Inspect the Energy resources device of assistant braking system and dynamic braking system to confirm its working is safe and reliable.

7.3.15.2 Assistant braking system

Determine whether the specified of the emergency braking performance may be reached only by the physical effort of the driver according to the information provided by the manufacturer.

7.3.15.2.1 As for the vehicle may reach the emergency braking performance only by the physical effort of the driver , the dynamic test shall be carried out by simulating assistance failure.

7.3.15.2.2 As for vehicle which must be in virtue of other energy to reach the emergency braking performance, partial failure of transmission device shall be simulated. It shall be

7.3.19.1 Make the vehicle static on the 20% ramp and maintain the downslope state by the service braking, apply the parking braking and maintain at least 5 min, record the maximum control force, release the service braking, and verify the measured maximum control force not greater than 400N (manual control) or 500N (foot control) on this condition. In this test, it is allowed to manipulate the parking braking for several times to reach the specified parking braking retention, but the control force of each manipulation shall be controlled within the specified range.

7.3.19.2 Maintain the upslope state on the 20% ramp and repeat the procedures in Article 7.3.19.1.

7.3.19.3 As for the vehicles whose parking braking systems adopt the electric control transmission, disconnect the electric control transmission of parking braking system and repeat the procedures in Articles 7.3.19.1 and 7.3.19.2. If the parking braking system cannot operate in this case, additional inspection shall be carried out:

a) As for the vehicles of manual transmission, under the condition of engine static and clutch locking, the vehicle may be maintained on the up/down ramp only by adopting the appropriate gears (such as the minimum gear).

b) As for the vehicles of automatic transmission, it shall be verified that the vehicles can be parked on the up/down ramp where the transmission is at the "parking" gear.

7.3.19.4 As for the passenger car that may be trailed with the trailer: additional tests may be carried out by the following methods to verify the train may be maintained static on the 12% up/down ramp only by the parking braking of passenger car.

7.3.19.4.1 Real vehicle method (recommended method)

Make the train reach the maximum design total mass by trailing the appropriate trailer, test on the 12% ramp according to the procedures in Articles 7.3.19.1 and 7.3.19.2, verify the parking braking control force within the specified range, and inspect the train may be maintained static on the up/down ramp only by the parking braking of traction vehicle.

7.3.19.4.2 Simulation method

If the vehicle cannot be loaded to GTM, the passenger car train may be replaced by the passenger car to calculate the parking braking performance of GTM on 12% gradient. The gradient required in the simulation test $=\frac{\text{GTM}\times 12}{\text{GVM}}\%$ .If the ramp meeting the calculation result cannot be provided; the steeper ramp close to the gradient shall be selected to carry out the test according to Articles 7.3.19.1 and 7.3.19.2.

7.3.19.5 If there is no appropriate surface for the test specified in Articles 7.3.19.1 and 7.3.19.4, the ramp parking braking may be simulated through the traction test on the horizontal surface to inspect the parking braking performance.

7.4 Dynamic Test

7.4.1 General

7.4.1.1 Dynamic test shall be performed where the wind force will not affect the test results.

7.4.1.2 Unless otherwise specified, at the beginning of the test, the mean temperature of service brake on the hottest axle is 65℃~100℃.

7.4.1.3 Test shall be carried out at the specified speed (v). The error between the actual test

cycle time of 4 continuous braking shall meet the relevant requirements. Moreover, the whole period of all the 15 braking shall be corresponding to the time consume for each braking operation in the correct interval.

7.4.7.4.1.5 As for the electric vehicle that cannot reach the specified speed within the cycle period, the first braking shall be carried out at the specified speed, and the subsequent braking shall be carried out at the speed reached after accelerated 45s immediately within the shortest time.

7.4.7.4.2 Hot performance

7.4.7.4.2.1 At the end of the last braking, accelerate to the Type-0 test speed immediately within the shortest time, carry out Type-0 test for engine disconnected; the used mean control force shall not be greater than the actually used control force in the Type-0 test under the laden condition; it shall be verified that the vehicle under the wheel unlocking state can at least reach 60% of the actual performance in the laden condition Type-0 test and 75% of the specified performance in the Type-0 test. If the vehicle under the control force of Type-0 test can reach 60% of the actual performance in the Type-0 test but not reach 75% of the specified performance, further test may be carried out by higher control force not greater than 500N. The results of the two tests shall be recorded in the test report.

7.4.7.4.2.2 As for the electric vehicles that cannot reach the specified speed within the cycle period (Δt), hot performance test shall be carried out at the maximum speed that may be reached after the heating cycle. For comparison, Type-0 test under the cold state and laden condition shall be carried out at the same speed after the recovery test.

For vehicles equipped with an electric regenerative braking of category A, during the hot performance test, the highest gear must be continuously engaged and the separate electric braking control, if any, not used.

7.4.7.4.3 Recovery process

Immediately after the hot performance test, accelerate to 50km/h immediately within the shortest time, adopt the maximum gear appropriate to the speed, and carry out service braking at a mean deceleration of 3m/s^2. At the end of the braking, accelerate to 50km/h immediately within the shortest time and maintain this speed, and carry out braking at a mean deceleration of 3m/s^2 again at the position 1.5km away from the last braking start point. Repeat this process until the total braking times are 4. The time measuring device shall be started or re-set at the first braking operation.

7.4.7.4.4 Recovery performance

At the end of the last braking, accelerate to Type-0 test speed immediately within the shortest time, carry out Type-0 test for engine disconnected, and verify the vehicle under the wheel unlocking state can reach 70% of the actual performance in the laden condition Type-0 test, not greater than 150%. This test is free from the restriction of brake temperature requirements, but the used mean control force shall not exceed the actually used control force in the laden condition Type-0 test.

7.4.7.4.5 Cold inspection

Cool down the brake to the ambient temperature and verify the brake unbonding. As for the vehicle equipped with automatic wear compensation device, the wheel shall be inspected if it can rotate freely where the hottest brake cools down to 100℃.

7.4.7.5 Additional laden Type-0 test shall be carried out for the electric vehicle stated in

requirements through the wheel-lock sequence test or torque wheel test if necessary.

7.4.9.1 Wheel-lock sequence test

The test road shall ensure that it can result in wheel locking at the braking rate of 0.15~0.80. The test equipment shall be able to record the entire test process in an automatic, continuous and synchronous way, for the purpose of real time cross reference for the variable such as speed, transient braking rate obtained through speed differentiation, braking control force (or pipeline pressure) and angular speed of each wheel.

7.4.9.1.1 Laden test

7.4.9.1.1.1 Make the vehicle run on low-μ surface at the speed of 65km/h, gradually apply the braking force at the linear speed, make the first wheel locking within 0.5s~1.5s after the braking operation, release the braking where the second axle locking, control force reaching 1000N, or the locking time of the first axle reaching 0.1s (no matter which axle first locks).

7.4.9.1.1.2 A series of braking may be required in advance in this test to determine the braking operating speed; if necessary, mechanical-type braking control force motivation device may be required, by regulating which to provide the required braking operating speed.

7.4.9.1.1.3 Each test run shall be repeated once to confirm the wheel-lock sequence; if one of these test results indicates a failure to comply, then a third test run under the same conditions will be decisive.

7.4.9.1.1.4 Procedures in Articles 7.4.9.1.1.1~7.4.9.1.1.3 shall be repeated on high-μ surface, test speed being 100km/h.

7.4.9.1.1.5 In the test, if the wheel start to lock where the braking rate is less than 0.15 or greater than 0.80, the test is invalid and test shall be carried out again on another surface; if one of the following conditions is met where the braking rate is 0.15~0.80, the vehicle shall be regarded meeting the wheel-lock sequence requirements.

a) No wheel lock;

b) Both wheels on the front axle and one or no wheels on the rear axle lock;

c) Both axles simultaneously lock.

7.4.9.1.2 Unladen test

Test shall be carried out by unladen vehicle by reference to Article 7.4.9.1.1.

7.4.9.1.3 If the test proves that the front wheel locks in front of the rear wheel or locks at the same time with the rear wheel, the vehicle shall be regarded meeting the adhesion coefficient utilization requirements. Otherwise, the wheel-lock sequence test shall be carried out again, or the torque wheel test shall be carried out to determine the external factors of the brake which generates the adhesion coefficient utilization curve.

7.4.9.2 Torque wheel test

7.4.9.2.1 Unladen condition test

7.4.9.2.1.1 As for the vehicle not equipped with dynamic braking proportional valve or pressure limiting valve, static controlling force and pipeline pressure relationship test shall be carried out within the range of the entire pipeline pressure to determine the relationship between the front/rear braking pressure, and this test is unnecessary. As for the vehicle equipped with dynamic braking proportional valve or pressure limiting valve, 15 times of emergency braking shall be carried out within the range of the entire pipeline pressure at a speed of 50km/h to determine the relationship between the front/rear braking pressure. In order to make the mass distribution and non-suspended mass the same as the normal state of

Appendix A

(Normative)

Symbols and Definitions

The following symbols are applicable to this standard.

No.	Symbol	Name and description
1	d_m	Mean fully developed braking deceleration, MFDD
2	d_M	Maximum value of MFDD of passenger car in the Type-0 test for engine disconnected, m/s^2
3	d_{M+R}	Calculated MFDD of passenger car trailed non-braking trailer, m/s^2
4	Δd	The thickness of brand new friction lining (maximum friction lining thickness) minus the thickness of completely worn friction lining (minimum friction lining thickness declared by the manufacturer)
5	Δt	braking cycle period, namely the duration from the start of one braking operation to the start of the next braking operation
6	Δx	maximum retraction amount of piston, $\Delta x \approx \frac{r \cdot \Delta d}{\sqrt{r^2 - L^2}} + s$
7	E	Wheelbase
8	ε	The adhesion utilized of the vehicle: quotient of the maximum braking rate with the antilock braking system operative (z_{AL}) and the theoretical coefficient of adhesion (k)
9	ε_i	The ε-value measured on axle i (in the case of a motor vehicle with a category 3 antilock braking system)
10	ε_H	The ε - value on the high-adhesion surface
11	ε_L	The ε - value on the low-adhesion surface
12	f	Control force
13	f_i	Coefficient of adhesion utilized by axle i, $f_i=T_i/N_i$[14)]
14	F	Force (N)
15	F_{dyn}	Normal reaction of road surface under dynamic conditions with the antilock braking system operative
16	F_{idyn}	F_{dyn} on axle i in case of power-driven vehicles
17	F_i	Normal reaction of road surface on axle i under static conditions
18	F_M	Total normal static reaction of road surface on all wheels of power-driven vehicle
19	F_{Mnd}[15)]	Total normal static reaction of road surface on the unbraked and non-driven axles of the power-driven vehicle
20	F_{Md}	Total normal static reaction of road surface on the unbraked and driven axles of the power-driven vehicle
21	F_{WM}	0.01 F_{Mnd}+0.015 F_{Md}
22	g	Gravity acceleration, g=9.81m/s^2; in the wheel-lock sequence test, it may take g=10m/s^2
23	h	Height of center of gravity specified by the manufacturer and agreed by the Technical Service conducting the approval test
24	i	Axle number (For front axle, i=1; for rear axle, i=2)
25	J	Deceleration of vehicle, m/s^2
26	k	Coefficient of adhesion between tyre and road

Appendix C

(Normative)

Inertia Dynamometer Test Method for Brake Linings

C.1 General

The alternative types of brake linings shall be checked on the inertia dynamometer by comparing their performance with that obtained from the brake linings with which the vehicle was equipped. If necessary, road test may also be carried out.

C.2 Test equipment

C.2.1 A dynamometer having the following characteristics shall be used for the tests:

C.2.1.1 It shall be capable of generating the inertia required by Article C.3.1 and have the capacity to meet the requirements prescribed by Article 5.1.5 with respect to the Type-I fade test.

C.2.1.2 The brakes fitted shall be identical with those of the original vehicle type concerned.

C.2.1.3 Air cooling, if provided, shall be in accordance with Article C.3.4.

C.2.2 The instrumentation for the test shall be capable of providing at least the following data:

C.2.2.1 A continuous recording of disc or drum rotational speed;

C.2.2.2 Number of revolutions completed during a braking process, resolution not greater than one eighth of a revolution;

C.2.2.3 Braking time;

C.2.2.4 A continuous recording of the temperature measured in the center of the path swept by the lining or at mid- thickness of the disc or drum or lining;

C.2.2.5 A continuous recording of brake application control line pressure or force;

C.2.2.6 A continuous recording of brake output torque.

C.3 Test conditions

C.3.1 The dynamometer shall be set as close as possible, with ± 5% tolerance, to the rotary inertia equivalent to that part of the total inertia of the vehicle braked by the appropriate wheel(s) according to the following formula:

$$I=MR^2$$

Where,

I -- rotational inertia ($kg \cdot m^2$);

R -- Dynamic tyre rolling radius (m);

M -- That part of the maximum mass of the vehicle braked by the appropriate wheel(s). In the case of a single- ended dynamometer, this part shall be calculated from the design braking distribution when deceleration corresponds to the appropriate value given in Table 2 Item a).

C.3.2 The initial rotational speed of the inertia dynamometer shall correspond to the linear speed of the vehicle as prescribed in Table 2 Item a) and shall be based on the dynamic rolling radius of the tyre.

C.3.3 Brake linings shall be at least 80% bedded and shall not have exceeded a temperature of 180 °C during the bedding procedure, or alternatively, at the vehicle manufacturer's request, be bedded in accordance with his recommendations.

C.3.4 Cooling air may be used, flowing over the brake in a direction perpendicular to its axis of rotation. The velocity of the cooling air flowing over the brake shall be not greater than 10 km/h. The temperature of the cooling air shall be the ambient temperature.

C.4 Test procedure

C.4.1 Five sample sets of the brake lining shall be subjected to the comparison test; they shall be compared with five sets of linings conforming to the original components identified in the information document concerning the first approval of the vehicle type concerned.

C.4.2 Brake lining equivalence shall be based on a comparison of the results achieved using the test procedures prescribed in this appendix and in accordance with the following requirements.

C.4.3 Type-0 cold performance test

C.4.3.1 Three brake applications shall be made when the initial temperature is below 100 °C. The temperature shall be measured in accordance with the requirements of C.2.2.4.

C.4.3.2 Brake applications shall be made from an initial rotational speed equivalent to that given in Table 2 Item a), and the brake shall be applied to achieve a mean torque equivalent to the deceleration prescribed in this article. In addition, tests shall also be carried out at several rotational speeds, the lowest being equivalent to 30% of the maximum speed of the vehicle and the highest being equivalent to 80% of that speed.

C.4.3.3 The mean braking torque recorded during the above cold performance tests on the linings being tested for the purpose of comparison shall, for the same input measurement, be within the test limits ± 15% of the mean braking torque recorded with the brake linings conforming to the component identified in the relevant application for vehicle type approval.

C.4.4 Type-I test (fade test)

C.4.4.1 Heating procedure

Brake linings shall be tested according to the procedure given in Article 5.1.5.1.

C.4.4.2 Hot performance

C.4.4.2.1 On completion of the tests required under Article C.4.4.1, the hot braking performance test specified in Article 5.1.5.2 shall be carried out.

C.4.4.2.2 The mean braking torque recorded during the above hot performance tests on the linings being tested for the purpose of comparison shall, for the same input measurement, be within the test limits ± 15% of the mean braking torque recorded with the brake linings conforming to the component identified in the relevant application for vehicle type approval.

C.5 Inspection of brake linings

Brake linings shall be visually inspected on completion of the above tests to check that they are in satisfactory condition for continued use in normal service.

Appendix D

(Normative)

Special Requirements to be Applied to the Safety Aspects of Complex Electronic Vehicle Control Systems

D.1 General

This appendix defines the special requirements for documentation, fault strategy and verification with respect to the safety aspects of Complex Electronic Vehicle Control Systems as far as this standard is concerned. This appendix may also be called, by special clauses in this standard, for safety related functions which are controlled by electronic system(s).

This appendix does not specify the performance criteria for 'The System' but covers the methodology applied to the design process and the information which must be disclosed to the Technical Service, for type approval purposes. This information shall show that 'The System' respects, under normal and fault conditions, all the appropriate performance requirements specified elsewhere in this standard.

D.2 Documentation

D.2.1 Requirements

The manufacturer shall provide a documentation package which gives access to the basic design of 'The System' and the means by which it is linked to other vehicle systems or by which it directly controls output variables. The function(s) of 'The System' and the safety concept, as laid down by the manufacturer, shall be explained. For periodic technical inspections, the documentation shall describe how the current operational status of 'The System' can be checked. Documentation shall be brief, yet provide evidence that the design and development has had the benefit of expertise from all the system fields which are involved.

D.2.1.1 Documentation shall be made available in 2 parts:

a) The formal documentation package for the approval, containing the material listed in Section D.2 (with the exception of that of Article D.2.4.4) which shall be supplied to the technical service at the time of submission of the type approval application. This will be taken as the basic reference for the verification process set out in Section D.3.

b) Additional material and analysis data of Article D.2.4.4, which shall be retained by the manufacturer, but made open for inspection at the time of type approval.

D.2.2 Description of the functions of 'The System'

A description shall be provided which gives a simple explanation of all the control functions of 'The System' and the methods employed to achieve the objectives, including a statement of the mechanism(s) by which control is exercised.

D.2.2.1 A list of all input and sensed variables shall be provided and the working range of these defined.

D.2.2.2 A list of all output variables which are controlled by 'The System' shall be provided and an indication given, in each case, of whether the control is direct or via another vehicle

conditions. Possible design provisions for failure in 'The System' are for example:

a) Fall-back to operation using a partial system;

b) Change-over to a separate back-up system;

c) Removal of the high level function.

In case of a failure, the driver shall be warned for example by warning signal or message display. When the system is not deactivated by the driver, e.g. by turning the Ignition (run) switch to 'off', or by switching off that particular function if a special switch is provided for that purpose, the warning shall be present as long as the fault condition persists.

D.2.4.3.1 If the chosen provision selects a partial performance mode of operation under certain fault conditions, then these conditions shall be stated and the resulting limits of effectiveness defined.

D.2.4.3.2 If the chosen provision selects a second (back-up) means to realize the vehicle control system objective, the principles of the change-over mechanism, the logic and level of redundancy and any built in back-up checking features shall be explained and the resulting limits of back-up effectiveness defined.

D.2.4.3.3 If the chosen provision selects the removal of the higher level function, all the corresponding output control signals associated with this function shall be inhibited, and in such a manner as to limit the transition disturbance.

D.2.4.4 The documentation shall be supported, by an analysis which shows, in overall terms, how the system will behave on the occurrence of any one of those specified faults which will have a bearing on vehicle control performance or safety.

This may be based on a Failure Mode and Effect Analysis (FMEA), a Fault Tree Analysis (FTA) or any similar process appropriate to system safety considerations.

The chosen analytical approach(es) shall be established and maintained by the manufacturer and shall be made open for inspection by the technical service at the time of the type approval.

This documentation shall itemize the parameters being monitored and shall set out, for each fault condition of the type defined above, the warning signal to be given to the driver and/or to service/ technical inspection personnel.

D.3 Verification and test

D.3.1 The functional operation of 'The System', as laid out in the documents required in Section D.2, shall be tested as follows:

D.3.1.1 Verification of the function of 'The System'

As the means of establishing the normal operational levels, verification of the performance of the vehicle system under non-fault conditions shall be conducted against the manufacturer's basic benchmark specification unless this is subject to a specified performance test as part of the approval procedure of this or another standard.

D.3.1.2 Verification of the safety concept of Article D.2.4

The reaction of 'The System' shall, at the discretion of the type approval authority, be checked under the influence of a failure in any individual unit by applying corresponding output signals to electrical units or mechanical elements in order to simulate the effects of internal faults within the unit.

The verification results shall correspond with the documented summary of the failure analysis, to a level of overall effect such that the safety concept and execution are confirmed

Appendix E

(Informative)

Test Reports and Relevant Diagrams Requirements

E.1 Vehicle parameter and test data treatment

E.1.1 Vehicle parameter

Item	Treatment mode
Maximum speed / (km/h)	Integral value
Mass/kg	Integral value
Tyre pressure /kPa	Integral value
Wheelbase/mm	Integral value
Height of mass center (unladen condition/laden condition)/mm	Integral value
Brake dimension /mm	Integral value

E.1.2 Test data

Item	Treatment mode
Braking initial speed / (km/h)	One decimal place
Braking distance /m	One decimal place
Braking distance limit	S=Correction braking distance, m; S_a=Measured braking distance, m; v_s=Rated braking initial speed, km/h; v_a=Measured braking initial speed, km/h; One decimal place
MFDD / (m/s^2)	Two decimal places
Deceleration / (m/s^2)	One decimal place
Control force	Taking integral values with 5N as the unit
Traction force	Taking integral values with 100N as the unit
Braking rate z_p (Individual vehicle)	$z_p=T_P/P_U$; z_p=Braking rate; T_p=Traction force; P_u=10× (Total vehicle mass) (N); Two decimal places
Braking rate z_p (Train)	$z_p=T_P/P_U$; z_p=Braking rate; T_p=Traction force; P_u=10× (Train mass) (N); Two decimal places
Response time /s	One decimal place
Conversion between braking pressure and braking force	$B=P\cdot\pi\cdot D_w^2\cdot BEF\cdot r/(4\cdot R)$;

Tested vehicle state (□Engine shutdown □Energy driving device shutdown)

Specified speed/ (km/h)	Test speed / (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
		Measured value/m	Limit/m			Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration

E.3.1.1.4 Type-I test (fade test and recovery test)

Table E.4-1 Heating procedure

Rated speed		Braking interval / (s or m)
Initial speed / (km/h)	Final speed / (km/h)	

Table E.4-2 Hot performance

Specified speed/ (km/h)	Test times	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
			Measured value/m	Limit /m			Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration
	1									
	2									
60% of required value: stop distance _____m and MFDD_____m/s^2. 75% of required value: stop distance_____m and MFDD above 4.82m/s^2.										

Table E.4-3 Recovery process

Specified speed/ (km/h)

Table E.4-4 Recovery performance test

Specified speed/ (km/h)	Test times	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
			Measured value/m	Limit /m			Wheel locking at the speed	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration

							greater than 15km/h			
	1									
	2									
Stop distance range: _____m~_____m or MFDD range: _____m/s^2~_____m/s^2.										

Table E.4-5 Brake linings and running mode inspection after Type-I test

Brake linings:	□Adhering □Un-adhering;
Running mode of tested vehicle:	□Conformity □Inconformity

E.3.1.2 Failure test

E.3.1.2.1 Brake fluid leakage test

Table E.5 Brake fluid leakage test

(Failure state: □Left front wheel □Right front wheel □Left rear wheel □Right rear wheel)

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
			Measured value/m	Limit/m			Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration
Laden condition										
Unladen condition										

E.3.1.2.2 Energy failure test

Table E.6-1 Energy failure test (Assistance brake system capable of emergency braking without assistance)

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
			Measured value/m	Limit/m			Wheel locking at the speed greater than	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration

condition	speed/ (km/h)	(km/h)	Measured value/m	Limit/m		force/N	Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration
Laden condition										
Unladen condition										

E.3.1.2.3 Variable braking force distribution system failure test

Table E.7 Braking force distribution system failure test

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
			Measured value/m	Limit/m			Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration
Laden condition										
Unladen condition										

E.3.1.3 Alarm signal test

E.3.1.3.1 Brake fluid leakage alarm test

Table E.8-1 Brake fluid leakage alarm test

Alarm signal color	Alarm signal position	Response

E.3.1.3.2 Energy failure alarm test

Table E.8-2 Energy failure alarm test

Optical alarm signal			Acoustic alarm signal	
Alarm signal color	Alarm signal position	Response	Volume	Response

E.3.1.3.3 Variable braking force distribution system alarm test

Table E.8-3 Variable braking force distribution system alarm test

Alarm signal color	Alarm signal position	Response

E.3.1.4 Parking braking test

E.3.1.4.1 Static test

Table E.9-1 Parking braking ramp test (upslope/downslope)

Gradient	Control force/N	Halted state
%		
%		

Table E.9-2 Parking braking traction test (forward/backward)

Control force/N	Traction force /N	Braking rate z_p	
		Individual vehicle	Train

E.3.1.4.2 Dynamic test

Table E.10 Parking braking dynamic test

Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Instantaneous deceleration before vehicle stop/ (m/s^2)	Control force/N
		Measured value/m	Limit/m			

E.3.1.4.3 Parking braking alarm test

Table E.11 Parking braking alarm test

Alarm signal position	Response

E.3.1.5 Response time test

E.3.1.5.1 Brake cylinder (air chamber) or pneumatic control hydraulic booster

Table E.12-1 Brake cylinder (air chamber) or pneumatic control hydraulic booster

E.3.1.8 Equipment electric control transmission device parking braking test

Table E.15-1 Electric control transmission braking system line (fault) test (upslope/downslope)

Gradient	Fault state	Control force/N	Halted state	Parking braking release
	Line damage			
	Control device failure			
	Line damage			
	Control device failure			

Table E.15-2 Equipment electric control transmission device parking braking system alarm device inspection

Electric control transmission device damage or control device failure		
Alarm signal color	Alarm signal position	Response
Electric control device external line damage except the control device and energy supply failure		
Alarm signal color	Alarm signal position	Response

E.3.1.9 External device energy supply test

E.3.1.9.1 Static test

Table E.16-1 Ramp test method (upslope/downslope)

Gradient	Control force/N	Halted state
%		
%		

Table E.16-2 Traction test (advance and back)

Control force/N	Traction force /N	Braking rate z_p	
		Passenger car individual vehicle	Passenger car train

E.3.1.9.2 Dynamic test

Table E.17 Dynamic test

Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD / (m/s^2)	Instantaneous deceleration before vehicle stop/ (m/s^2)	Control force/N
		Measured value/m	Limit/m			

E.3.1.9.3 Ignition switch shut down or key pull out test

Table E.18-1 Static test (upslope/downslope)

Gradient	Control force/N	Halted state
%		
%		

Table E.18-2 Parking braking function test

Working state of parking braking system after test: □Conformity □Inconformity

E.3.1.10 Service braking system test of equipment electric control transmission device

E.3.1.10.1 Ignition switch shut down or key pull out test

Table E.19 Ignition switch shut down or key pull out test

Control force/N	Braking pressure/MPa	Braking force /N	Braking force obtained from Type-0 test /N

E.3.1.10.2 Electric control transmission device failure test

Table E.20-1 Electric control transmission device failure test

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
			Measured value/m	Limit/m			Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration
Laden condition										
Unladen condition										

Table E.20-2 Alarm device test in case of continuous failure of electric control transmission device

Alarm signal color	Alarm signal position	Response

Table E.22-2 Critical voltage confirmation (electric energy interrupt test)

Motor speed/ (r/min)	Control force/N	Braking pressure/MPa	Braking force/N	Braking force obtained from Type-0 test/N

E.3.1.10.5 Energy storage capacity inspection

Table E.23-1 Energy failure test of running vehicle

Motor speed/ (r/min)	Control force/N	Braking pressure/MPa	Braking force /N	Braking force obtained from Type-0 test/N

Table E.23-2 Energy failure test of static vehicle (upslope/downslope)

Gradient	Control force/N	Halted state	Stop light response
%			
%			

E.3.1.11 Additional requirements for equipment electric regenerative braking vehicle

E.3.1.11.1 Type-0 test for engine connected

Table E.24-1 Dynamic inspection for vehicle on low-adhesion surface

Load condition	Specified speed/ (km/h)	Control force/ N	Handwheel corner	Vehicle state
				Wheel locking
Laden condition				
Unladen condition				

E.3.1.11.2 Type-I test (fade test and recovery test)

Table E.25-1 Braking test of heating/cooling electric regenerative braking of category B

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
			Measured value/m	Limit/m			Wheel locking at the speed greater than	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration

							15km/h			

Table E.25-2 Redetermination in hot performance test in case of speed failing to meet the specified value

Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
		Measured value/m	Limit/m			Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration

E.3.1.11.3 Braking system test in case of all electric component failure

Table E.26 Braking system test in case of all electric component failure

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
			Measured value/m	Limit/m			Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration
Laden condition										
Unladen condition										

E.3.1.11.4 Test in case of maximum braking force generated by failure

Table E.27 Test in case of maximum braking force generated by failure

Load	Specified	Test speed/	Braking distance	MFDD/ (m/s^2)	Control	Vehicle state

					Transmission With car stop
					Transmission With car stop
					Transmission With car stop
					Transmission With car stop
					Transmission With car stop

E.3.2 Energy supply and energy storage device inspection

E.3.2.1 Energy storage device capacity test

Table E.30 Energy storage device capacity test

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
			Measured value/m	Limit/m			Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration
Laden condition										
Unladen condition										

E.3.2.2 Transmission device failure test

Table E.31 Transmission device failure test

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
			Measured value/m	Limit/m			Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration
Laden										

condition										
Unladen condition										

E.3.2.3 Hydraulic energy capacity test

Time required for pipeline pressure to reach cut-out pressure after 4 times of actuation _____.

E.3.2.4 Alarm device confirmation test in case of energy failure

Table E.32 Energy failure alarm inspection

Optical alarm signal			Acoustic alarm signal	
Alarm signal color	Alarm signal position	Response	Volume	Response

E.3.3 Braking force distribution inspection

E.3.3.1 Wheel-lock sequence test

Table E.33-1 High-adhesion surface test

Specified speed/ (km/h)	Test speed/ (km/h)	Control force/N	Locking sequence	Locking state
			□Without locking □Front axle locking □Simultaneous locking	
			□Without locking □Front axle locking □Simultaneous locking	
			□Without locking □Front axle locking □Simultaneous locking	

Table E.33-2 Low-adhesion surface test

Specified speed/ (km/h)	Test speed/ (km/h)	Control force/N	Locking sequence	Locking state
			□Without locking □Front axle locking □Simultaneous locking	
			□Without locking □Front axle locking □Simultaneous locking	
			□Without locking □Front axle locking □Simultaneous locking	

E.3.3.2 Braking test in case of variable braking force distribution system (without ABS)

E.3.4.1 ABS alarm device confirmation test

Table E.35 ABS alarm device confirmation test

Alarm signal color	Alarm signal position	Response

E.3.4.2 Braking performance test in case of ABS failure

Table E.36 Braking performance test in case of ABS failure

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
			Measured value/m	Limit/m			Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration
Laden condition										
Unladen condition										

E.3.4.3 Energy consumption test

Table E.37 Energy consumption test

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Braking distance		MFDD/ (m/s^2)	Control force/N	Vehicle state			
			Measured value/m	Limit/m			Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration
Laden condition										

E.3.4.4 z_{AL} determination

Table E.38-1 High-adhesion surface test

Load condition	Test times	Time required to reduce the speed from 45km/h to 15km/h/s	Control force/N	t_m	z_{AL}	ε
Laden condition						
Unladen condition						

Table E.38-2 Low-adhesion surface test

Load condition	Test times	Time required to reduce the speed from 45km/h to 15km/h/s	Control force/N	t_m	z_{AL}	ε
Laden condition						
Unladen condition						

Table E.38-3 z_{MALS} determination

Test times	Time required to reduce the speed from 45km/h to 15km/h/S	Control force/N	t_m	z_{MALS}	Vehicle state			
					Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°	Abnormal vibration
z_{MALS}=_____≥0.75 ($4k_L+k_H$)/5=0.75 (4×____+____)/5= (____) z_{MALS}=_____≥k_L=_____								

E.3.4.5 *k* value test

Table E.39-1 High-adhesion surface test

Load condition	Braking axle	Test times	Time required to reduce the speed from 40km/h to 20km/h/s	t_m	z_m	k_f or k_r	k_M
Laden condition	Front axle						
	Rear axle						

condition	speed/ (km/h)	(km/h)	force/N	Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°
Laden condition						
Unladen condition						

Table E.40-3 Butt joint road surface test (from high-adhesion surface to low-adhesion surface)

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Control force/N	Vehicle state		
				Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°
Laden condition						
Unladen condition						

Table E.40-4 Butt joint road surface test (from low-adhesion surface to high-adhesion surface)

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Control force/N	Acceleration increase	Vehicle state		
					Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°
Laden condition							
Unladen condition							

Table E.40-5 Split surface test

Load condition	Specified speed/ (km/h)	Test speed/ (km/h)	Control force/N	Handwheel increase	Vehicle state		
					Wheel locking at the speed greater than 15km/h	Channel greater than 3.5m	Yaw angle greater than 15°
Laden condition							
Unladen condition							

E.3.5 Inertia dynamometer test for brake linings

E.3.5.1 Test vehicle

Vehicle type: _____Brake linings type: _____Friction lining consistency confirmation: _____

E.3.5.2 Test equipment

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------ The End ------