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## Foreword

This standard is drafted in accordance with the rules given in the GB/T 1.1-2009 *Directives for Standardization—Part 1: Rules for the Structure and Drafting of Standardizing Documents*.

This standard was proposed by Research Institute of Standards and Norms of Ministry of Housing and Urban-Rural Development of the People's Republic of China.

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# General technical specification for medium and low speed maglev vehicles

## 1 Scope

This standard specifies the technical specification for medium and low speed maglev vehicles from the following aspects: working conditions, main technical specifications of vehicle, basic requirements, vehicle type and train formation, car body and interior equipment, levitation stock, electrical system, traction system, levitation and guidance system, braking system, air supply system, control and diagnosis system, location and velocity detecting system, air conditioning and ventilation system, communication and passenger information system, safety facilities, test and acceptance, marking, as well as transportation and quality warranty period.

This standard is applicable to the medium and low speed maglev vehicles (hereinafter referred to as the "vehicles").

## 2 Normative references

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

GB 4208 *Degrees of Protection Provided by Enclosure (IP Code)*

GB/T 5599 *Railway Vehicles—Specification for Evaluation the Dynamic Performance and Accreditation Test*

GB/T 10411 *D.C.Traction Power Supply System for Urban Rail Transit*

GB 14892 *Noise Limit and Measurement for Train of Urban Rail Transit*

GB/T 14894 *Rules for Inspecting and Testing of Urban Rail Transit Vehicles after Completion of Construction*

GB 18045 *Safety Glass for Railway Rolling Stock*

GB/T 19842 *Air-Conditioning Units for Railbound Vehicles*

GB/T 21413 *Railway Applications — Electric Equipment for Rolling Stock*

GB/T 21414 *Railway Applications—Rolling Stock—Protective Provisions against Electrical Hazards*

GB/T 21563 *Railway Applications—Rolling Stock Equipment—Shock and Vibration Tests*

GB/T 24338.4 *Railway Applications—Electromagnetic Compatibility—Part 3-2: Rolling Stock—Apparatus*

CJ/T 311 *Technical Specification of Linear Induction Traction Motors for Urban Mass Transit*

TB/T 1451 *Foreside Windscreen for Locomotives and Motor Units*

TB/T 1484.1 *Specification for Cables on Board Rolling Stock—Part 1:Standard Wall Insulation Cables up to AC 3kV*

TB/T 1507 *Railway Applications—Rules for Installation of Cabling on Rolling Stock*

TB/T 1508 *Technical Specification for Locomotive Electrical Cubicle*

TB/T 2437 *Power Converters Installed on Board Rolling Stock— Characteristics and Test Methods*

TB/T 3021 *Railway Applications—Electronic Equipments Used on Railway Vehicles*

### **3 Terms and definitions**

For the purpose of this document, the following terms and definitions apply.

#### **3.1 Medium and low speed maglev vehicle**

The rail transport vehicle of which the normal conductive magnetic levitation technology is adopted to achieve the levitation and guidance, the linear induction motor is used to achieve the traction and electric braking and the maximum running speed is 120km/h.

#### **3.2 Electromagnet for levitation**

The electromagnet that may produce the controllable electromagnetic force under the effect of exciting current to perform the electromagnetic levitation and guidance functions. It mainly consists of the excitation coil, pole plate and iron core.

#### **3.3 Levitation gap**

The vertical distance between the magnetic pole face of electromagnet and the undersurface of F-shaped rail in the levitation state of the vehicle.

#### **3.4 Levitation and guidance control**

By detecting the signals of levitation gap, vertical acceleration of magnet and so on, the feedback control of exciting current of electromagnet for levitation is achieved and the levitation force is adjusted so as to maintain the allowable levitation gap. When the electromagnet for levitation laterally deviates from the F-shaped rail, the lateral component of levitation force can make it return to normal position accordingly.

#### **3.5 Levitation bogie**

The mechanical structural device which is used to support the car body and transmit the levitation, guidance, traction and braking force, and has the function of mechanical decoupling to adapt the track curve and irregular tolerances.

#### **3.6 Forced guidance device**

The adjusting device that makes the electromagnet module for levitation fit to the track curve, and guarantees that the vehicle passes through the curve smoothly.

#### **3.7 Levitation stock**

The part of the vehicle used for performing the functions of levitation, guidance, traction, braking and running of the vehicle.

#### **3.8 Location and velocity detecting device**

The equipment installed on the vehicle which is used for the speed measurement, location and

direction detection, and realize the feedback control and operation control of traction and braking of the train.

### 3.9 Reference

The measurement reference point for controlling the size of every part of vehicle and the relation of the relative positions between the vehicle and track.

### 3.10 Medium and low speed maglev track

The fixed structure used to support and guide the train to run, which includes the F-shaped section of magnetic conductivity structure and induction metal plate on its upper surface. Besides the functions to withstand and transmit the gravity, guidance force, traction force and braking force of train, the fixed structure still has the functions of levitation, guidance, traction, braking and levitation gap measurement by combining with the electromagnet, linear induction motor and sensor equipped on the vehicle to form the electromagnetic loop.

### 3.11 Track gauge

The distance between the centers of levitation magnetic pole face on the two sides of rail.

## 4 Working conditions

### 4.1 Environmental condition

4.1.1 The normal operating elevation does not exceed 1 200m.

4.1.2 The ambient temperature is  $-25^{\circ}\text{C}$  to  $40^{\circ}\text{C}$ .

4.1.3 The monthly average maximum relative humidity of the month with highest relative humidity is not greater than 90% (the monthly average minimum temperature of the month is  $25^{\circ}\text{C}$ ).

4.1.4 The vehicle shall withstand the inroads of wind, sand, rain, snow, and the corrosion caused by cleaning agent when the vehicle is washed.

4.1.5 In terms of different climatic conditions in different cities and regions, the user and the manufacturer may set down separate provisions for the environmental conditions for use in the contract.

### 4.2 Line condition

4.2.1 The track gauge of line: 2 000mm.

4.2.2 The minimum radius of horizontal curve: main line: 100m, auxiliary line:75m.

4.2.3 The minimum radius of vertical curve: 1 000m.

4.2.4 Maximum gradient: 70‰.

### 4.3 Power supply conditions

4.3.1 Current-collection mode: Current collection of contact rail-current collector.

4.3.2 Power supply system: The voltage of the power supply system is DC 1 500V (the voltage fluctuation range is: DC 1 000V to 1 800V).

4.3.3 The traction substation, contact rail and power supply protective device in the power supply system shall meet the requirements given in GB/T 10411.

## 5 Main technical specifications of vehicle

The main technical specifications of vehicle should be in accordance with those specified in Table 1. When it is needed to adopt other specifications in the project, the user and the supplier may set down separate provisions in the contract.

**Table 1 Main technical specifications of vehicle**

No.	Designation	Type of vehicle	
		End vehicle	Intermediate vehicle
1	Basic length of vehicle <sup>a</sup> /mm	15 600	14 600
2	Basic length of car body/mm	15 000	14 000
3	Basic width of car body/mm	3 000	
4	Maximum height of vehicle <sup>b</sup> /mm	≤ 3 700	
5	Net interior height/mm	≥ 2 100	
6	Height of floor surface/mm	≤ 950	
7	Total seating area /m <sup>2</sup>	10.8	12.3
8	Total standing area /m <sup>2</sup>	20.4	21.8
9	Interior effective area <sup>c</sup> /m <sup>2</sup>	31.2	34.1
10	Seating capacity (person)	24	28
11	Rated passengers <sup>d</sup> /(person/car)	146	159
12	Exceeded passengers <sup>e</sup> /(person/car)	208	224
13	Vehicle readiness weight/t	22.5	21.5
14	Maximum passenger weight of vehicle/t	12.5	13.5
15	Maximum total weight of vehicle/t	35	35
16	Number of door/pair	2 to 3	

<sup>a</sup> Distance between connecting surfaces of two couplers.  
<sup>b</sup> From the top of rail to the vehicle roof.  
<sup>c</sup> Interior effective area = Total seating area + Total standing area.  
<sup>d</sup> Seating capacity + the standing capacity when the standing area occupies 6 person/m<sup>2</sup>.  
<sup>e</sup> Seating capacity + the standing capacity when the standing area occupies 9 person/m<sup>2</sup>

## 6 Basic requirements

**6.1** The vehicle clearance shall conform to the relevant specifications, and the newly-manufactured or innovated vehicle shall be checked with the vehicle clearance.

**6.2** The equipment and subsidiary facilities of the vehicle shall be reasonably arranged, and installed reliably and firmly for the convenience of inspection, repair and maintenance.

**6.3** The design of vehicle shall consider the modularization and lightweight, to improve the usability and guarantee the carrying capacity.

**6.4** The parts with the same model shall have a good interchangeability.

**6.5** The weight of the vehicle in the readiness state shall not exceed 3% of the specified value in the contract.

**6.6** The height from the floor surface of a passenger compartment to the top of the rail shall coordinate with the platform surface of the station, and the height adjustment device of the vehicle shall be able to guarantee that the height of the floor surface of the vehicle does not change significantly when the passenger capacity changes. The height of the floor surface shall not be lower than the height of the platform in any case.

**6.7** The train shall be able to safely pass through the section with minimum radius of horizontal curve at the specified speed, and able to carry out the normal uncoupling and coupling operation of the train on the specified small radius curve.

**6.8** The traction-speed characteristics and braking force-speed characteristics of the train shall meet the requirements of specification in the design document agreed by both the user and the manufacturer.

**6.9** In the normal load condition, on the level and straight track, when the rated voltage is supplied, the average starting acceleration of the train is:

—Not less than  $0.9\text{m/s}^2$  when the speed is accelerated from  $0\text{km/h}$  to  $35\text{km/h}$ ;

—Not less than  $0.5\text{m/s}^2$  when the speed is accelerated from  $0\text{km/h}$  to  $80\text{km/h}$ ;

—The acceleration from  $80\text{km/h}$  to the highest running speed shall meet the requirements of the specification of the design document agreed by both the user and manufacturer.

**6.10** In the normal load condition, on the level and straight track, the average braking deceleration of the train from the highest running speed to stopping, if there are no special requirements, shall be:

—The average service braking deceleration is not less than  $1.1\text{m/s}^2$ ;

—The average emergency braking deceleration is not less than  $1.3\text{m/s}^2$ .

**6.11** Noise:

a) The equivalent continuous sound pressure level in the driver's cab and passenger compartment shall meet the requirements given in GB 14892, and the maximum allowable limit value of equivalent sound pressure level  $L_{\text{eq}}$  of noise of the train is  $75\text{dB(A)}$ .

b) When the train parks on the straight and level track or in open air free sound field, which the auxiliary equipment operates normally, the continuous noise value measured in the place outside the vehicle, which is  $7.5\text{m}$  from the center of the track, and  $1.5\text{m}$  at the height from the rail surface, shall be not greater than  $65\text{dB(A)}$ .

c) When the train runs at the speed of  $60\text{km/h}$  in the open air free sound field of a straight and level railway section, the equivalent continuous noise value measured in the place outside the vehicle, which is  $7.5\text{m}$  from the center of the track and  $1.5\text{m}$  high from the rail surface, shall be no more than  $68\text{dB(A)}$ .



**6.12** The stationarity of the vehicle shall be tested according to GB/T 5599, and the index of the stationarity shall be less than 2.5.

**6.13** When one of the levitation bogies in every vehicle lose its levitation function, the remaining bearing capacity shall guarantee the train move to the next station.

**6.14** A normal load train which loses its 1/3 traction power shall be able to run to the next station.

**6.15** The shock and vibration test of all kinds of equipment of vehicle shall meet the relevant requirements given in GB/T 21563.

**6.16** The longitudinal impact rate of the train shall be not greater than  $1\text{m/s}^3$ .

**6.17** The vehicle and its interior facilities shall be made of non-combustible materials or low-smoke and halogen-free flame retardant materials. And these materials shall meet the requirements of the relevant national fire codes and standards.

### **6.18 Driving mode**

The driving mode of the train should be divided into:

- The manual driving mode;
- The automatic driving mode.

The switching between the manual driving mode and the automatic driving mode shall be carried out on the principle of not affecting the driving safety, and the switching of driving mode shall be recorded and displayed.

**6.19** The manual driving mode shall be that the driver operates the train manually according to the signal indication.

**6.20** The automatic driving mode shall be that the automatic train operation (ATO) subsystem operates the train, and manual intervention should not be applied under normal condition.

**6.21** The requirements for the surface treatment before the coating and the protective coating of the vehicle shall meet the requirements of the relevant national standards.

**6.22** The design and manufacture of the vehicle shall comply with the relevant national standards and the laws and regulations for environmental protection. The limited quantity of harmful substance in the interior materials and indoor air of the vehicle shall meet the requirements given in TB/T 3139.

## **7 Vehicle type and train formation**

### **7.1 Vehicle type**

- End vehicle: the vehicle with the driver's cab;
- Intermediate vehicle: the vehicle without the driver's cab.

### **7.2 Train formation**

**7.2.1** The train should consist of 2 end vehicles and several intermediate vehicles, to form a train.

### 7.3 Coupling device

**7.3.1** Semi-permanent draw bar or tight-lock and semi-automatic coupler shall be provided between the assembled vehicles, and the front end of the driver's cab shall be provided with tight-lock and automatic coupler or tight-lock and semi-automatic coupler and shall enable the driver to identify the coupling and locking state of the coupler.

**7.3.2** The buffer device shall be installed in the coupling device at the front end of the driver's cab, and shall be able to effectively absorb the colliding energy and soften the impact. The maximum impact velocity that the buffers device can bear for fully restoration is 5km/h. If the lower maximum impact velocity is optional in a project, it is allowed that the user and the manufacturer determine the velocity through consultation.

## 8 Car body and interior equipment

### 8.1 Car body

**8.1.1** The same model of the vehicle shall have the unified basic structural form.

**8.1.2** The structural material of car body should be aluminum alloy and composite.

**8.1.3** The car body shall not produce plastic deformation and fatigue damage under the effect of overload capacity during its service period, and shall have sufficient rigidity and can meet the requirements of repair and safe operation.

**8.1.4** When the vehicle in the state of readiness parks(in the landing state) on the straight and level rail and releases the braking, the value of the height of the car body and levitation bogie from the reference surface shall conform to the technical specifications of the product.

**8.1.5** The strength and rigidity of the newly designed car body shall be verified by calculation and test.

**8.1.6** In the car body test, 350kN should be adopted as the longitudinal compression static load when the user and the manufacturer do not have special provisions in the contract.

**8.1.7** The vertical load of the car body test shall be calculated according to Formula (1):

$$L_{vt}=1.1 \times ( W_c+W_{PMAX} ) - ( W_{cb}+W_{et} ) \quad \dots\dots\dots( 1 )$$

Where:  $L_{vt}$ —the vertical load of the car body test;

$W_c$ —the weight of car body when it is in the operation readiness state;

$W_{PMAX}$ —the maximum passenger weight (the weight of the driver,seating and maximum standing passengers);

$W_{cb}$ —the weight of car body structure;

$W_{et}$ —the weight of test equipment.

**Note:** The maximum number of standing passengers (exceeded passengers) is calculated according to 9person/m<sup>2</sup>, and the standing area is that subtracting the area of seats and the area within 0.20m to 0.25m of front edge of seats, and the average weight of one person is calculated according to 60kg.

**8.1.8** The designed life of the main structure of the vehicle (the car body, levitation bogie, etc.) shall be 30 years.

**8.1.9** The sealing performance of the vehicle shall meet the requirements given in GB/T 14894. Rain and snow shall not enter the car body and shells of the various equipment installed on the outside of the car body and all openings, doors, windows and hole's covers. The enclosed type boxes and cabinets shall be sealed well and shall not have seepage and leakage when the mechanical cleaning is carried out.

**8.1.10** The cold-proof, heat-insulated and sound-insulated materials shall be laid between the internal and external wall panels and between the under frame and the floor of the car body structure, and these materials shall have small moisture absorption, low expansion rate and stable performance.

**8.1.11** The jacking support and hoisting base of car body shall be equipped for the vehicle, and the positions allowing for jack up the car body and hoisting shall be marked for the convenience of disassembly, assembly and rescue.

**8.1.12** The impact energy absorption area to prevent the unexpected collision shall be arranged on the vehicles at both ends of the train so as to protect the safety of drivers and passengers.

## **8.2 Driver's cab**

**8.2.1** The driver's cab shall have a wide field of vision to enable the driver to easily and clearly observe the forward signal, interregional line, tunnel and station platform while driving.

**8.2.2** The window glass of front windshield of the cab shall be made of safety glass which will not burst apart or dispersed when any part of the glass is punched through or knocked, and the front window shall be equipped with the windshield wipers and solar shading devices. In cold areas, the electric glass heater and defogger shall be provided, which shall meet the requirements given in TB/T 1451. The penetration resistance and impact resistance of the front window glass shall meet the relevant requirements given in TB/T 1451.

**8.2.3** The side door shall be provided for the driver's cab, the emergency evacuation door shall be equipped at both ends of the train, the connection door shall be equipped between the driver's cab and the passenger compartment, the net width of these doors shall not be less than 550mm, and the net height of these doors shall not be less than 1 800mm.

**8.2.4** The appearance and structure of driver's desk, the layout of various operating devices, information display and driver's seat shall conform to the principles of ergonomic engineering, which shall guarantee that the driver feels comfortable within the limited space, and can observe the information equipment and the line ahead while driving.

**8.2.5** The driver's seat shall be soft or medium-soft, and its height, front and rear positions shall be adjustable. The design of driver's seat shall ensure that the driver can leave the seat quickly if necessary.

**8.2.6** The illuminance of the driver's cab at the center of the floor shall be 3 lx to 5 lx, and the surface of the driver's desk shall be 5 lx to 10 lx. The indicators, on-board signal light and other artificial lighting shall not cause illusions of the driver when he or she observes the train signal. Lighting device shall be equipped to meet the needs of inspection and maintenance of the indoor equipment.

**8.2.7** The display values of the instrument and indicator lamps on the driver's operating platform shall be clearly seen from the distance of 500mm, when the train is in the tunnel or in the sunlight or when lighting in the train is turned off.

## **8.3 Passenger compartment**

**8.3.1** The doors on both sides of the passenger compartment shall be reasonably arranged, and the net opening width of each door shall not be less than 1 300mm, and the height of door shall not be less than 1 800mm.

**8.3.2** The opening and closing of the side door in passenger compartment shall be electrically controlled, and driven by electricity or compressed air. Its transmission and control shall be safe and reliable. The opening and closing of the side door should be controlled uniformly by the driver and may also be controlled by the operation control system; the side door of passenger compartment shall have the electrical interlock device and door blocking device for non-zero velocity automatic door closing, which can guarantee that the door is locked correctly

in the operation. Every single side door shall have system isolation function, and shall be able to be separated from the door control system when malfunction happens, and it shall also have the function of manual-operation unlocking to open and close the door in the passenger compartment; there shall be one door at least on each side of the vehicle, which can be opened and closed by the key from the external side of the door. When it is closed, the side door shall have a cushioning action and shall have protective measures (such as the finger-protective adhesive strips) and a single door reopening and reclosing device so as to avoid the risk of injury of passengers.

**8.3.3** Appropriate number of windows shall be equipped at the two sides of the passenger compartment, the window shall be fixed, and the openable and closable fanlight should be equipped at the upper part of the windows. The safety glass, whose shards will not cause serious injuries to humans when it shatters, shall be used as the glass of doors and windows. The glass can be smashed by violence or sharp-pointed objects during emergency, and the performance of the safety glass shall meet the requirements given in GB 18045.

**8.3.4** Appropriate number of seats for passenger compartment shall be placed in the passenger compartment, and the shape of the seating shall meet the requirements of ergonomic engineering, and the arrangement of the seats shall be in line with the bearing capacity of the vehicle.

**8.3.5** The inner wall panels shall be made of flame retardant materials that are easy to clean and have good decorative effect. The floor shall be wear resistant, anti-skid, waterproof, anti-static and flame-retardant. The seats, decorations and advertisement panels in the passenger compartment shall be made of difficult combustible or highly flame-retardant materials.

**8.3.6** The passenger compartment shall be equipped with a sufficient number of firm and beautiful stanchions, handholds and grab rails, and appropriate number of additional hanging rings should be installed in line with the needs.

**8.3.7** The sufficient lighting of lamplights shall be provided in the passenger compartment, and the average illumination in the place that is 800mm high from the floor shall not be less than 200 lx and its minimum value shall not be less than 150 lx (when there is no illumination outside the vehicle). The compartment shall be equipped with emergency illumination device and its illumination shall not be less than 10 lx.

**8.3.8** Gangway shall be provided between two cars, and the gangway shall be sealed, fireproof, waterproof, heat and sound insulated. The foot plate of the gangway shall be wear-resistant, smooth, anti-skid and anti-clamp, and the sealing material used for gangway shall have sufficient tensile strength, safe and reliable, and anti-ageing and odorless.

**8.3.9** In each train, there shall be at least one reserved location for wheelchair and there shall be provided with handle or fixtures suitable for wheelchair users.

## **9 Levitation stock**

**9.1** The levitation stock shall coordinate with the car body and the rails, and meet the requirement of the non-contact running realized by the electromagnetic force.

**9.2** The frame of levitation bogie should be made of aluminum alloy materials.

**9.3** The forced guidance device shall be equipped between the levitation bogie and the carriage.

**9.4** The levitation bogie shall be provided for the emergency rescue support device, and when the levitation of the vehicle ceases to be effective, the device can guarantee that the train is able to run to the next station and the next vehicle maintenance and repair center after all passengers get off. The support device shall meet the

requirements of wear resistance, impact resistance, and corrosion resistance and so on.

**9.5** The suspension system should be equipped with air spring to support the car body, and shall be equipped with automatic height adjustment valve and anti-overinflating device.

**9.6** The structural strength of the levitation bogie shall guarantee that under the maximum load, the stress of the bogie shall not exceed the allowable stress value of the corresponding material, and at the same time, it is necessary to consider the requirements for the structural fatigue strength.

**9.7** The structural rigidity of the levitation bogie shall guarantee that under the maximum load, the total vertical deflection in the longitudinal range of the main beam of the bogie shall meet the requirements of levitation gap control.

**9.8** It is necessary to install the anti-contact slider, so as to prevent the attracting between the levitation magnet and the F-shaped rail, which will make the vehicle unable to run normally.

**9.9** The lateral stop slipper shall be installed between the levitation bogie and the track. The material of horizontal stop slipper shall be wear-resistant and impact-resistant. Ferromagnetic materials shall not be used.

## **10 Electrical system**

**10.1** The power equipment of the train shall not only meet the requirements of normal running, but also meet the running requirements under malfunction and rescue. The on-board power supply of the train shall have redundancy, and when a failure of one set of power supply occurs in the train, the power supply shall be able to guarantee that the train can stop at the specified stopping point safely and reliably.

**10.2** The vehicle shall have a good electromagnetic compatibility. The electromagnetic compatibility of the electrical equipment shall be able to meet the requirements given in GB/T 24338.4.

**10.3** The electrical system shall have a good insulation protection. All the circuits shall be able to withstand the voltage withstanding test, and the test voltage value is 85% of the lowest value of the test voltage of the electrical equipment in the circuit to be tested. It is necessary to take preventive measures or isolation measures for the electronic devices and electrical instruments so that they do not bear the withstanding voltage of circuit when the test is conducted.

**10.4** All pieces of electrical equipment shall have reliable protection. The setting value, action time and sequence of operation of all kinds of protections shall be correct. The fault protection shall have the self-recovery function. The overcurrent protection of the main circuit shall also coordinate with the overcurrent protection of the traction substation, which shall be able to break reliably in all kinds of short-circuit states, and shall have the fault display and fault removal device in order to maintain the fault running of the train.

**10.5** The protective grounding of every piece of electrical equipment shall be reliable, and the grounding wire shall have sufficient sectional area. It is necessary to guarantee the equipotential bonding of the metal parts, which may be electrified because of failure and all accessible electric conductors. The train shall have the reliable lightning protection grounding, and the grounding impedance of the car body shall not be more than  $0.05\ \Omega$ . The impedance of the grounding conductor between the protection grounding terminal of the electrical equipment and the car body shall not be greater than  $0.1\ \Omega$ .

**10.6** The vehicle shall be equipped with car body electrified protection detection and control device. The vehicle shall be equipped with earth electrode to guarantee that the car body can be grounded reliably when the vehicle is parked in the places having grounding device such as the station, parking garage and maintenance and repair garage of the vehicle depot.

**10.7** The electrical protection of every piece of electrical equipment on the vehicle shall meet the requirements given in GB/T 21414.

**10.8** The insulation of the electric equipment such as the electrical clearance, creepage distance and dielectric strength testing and so on shall meet the requirements given in GB/T 21413.

**10.9** The current collector shall have the good current collection capacity, and the contact pressure of the current collector should be set to 120N to 180N.

**10.10** The levitation power supply of the vehicle is DC power supply, and the levitation power supply system shall be equipped with the corresponding storage battery.

**10.11** The levitation power supply system and the auxiliary converter shall meet the requirements given in TB/T 2437, and their capacity shall be able to meet the needs of use under various operating conditions.

**10.12** The AC power supply on the vehicle should be obtained from the transition of high voltage DC current obtained from the current collector through the inverter.

**10.13** The control power supply is DC power supply, which supplies electricity for the control system. Storage battery group shall be arranged as standby power for the control system, and shall have a certain degree of redundancy.

**10.14** The storage battery with high specific energy and specific power should be used, for its floating charge performance is good. The capacity of the storage battery shall meet the needs of emergency power supply of the vehicle in the condition of failure, including the emergency lighting, the external lighting, and power supply for on-board safety equipment, broadcasting, communications, emergency ventilation, the door open and close one time, etc. The working time of the system shall not be less than 30 minutes, and at the same time, it shall also meet the needs of power consuming in the course of emergency stopping.

**10.15** The electrical equipment exposed outside the vehicle shall have the protective property that is not less than the IP55 level specified in GB 4208.

**10.16** The wiring of electrical equipment of the vehicle shall meet the requirements given in TB/T 1507; the wiring of electrical screening cabinets in the vehicle shall also meet the requirements given in TB/T 1508.

**10.17** The low-smoke halogen-free wires and cables used for the vehicle shall be adopted as the connecting wires of electrical equipment of all the circuits. The electrical voltage withstanding grade, electrical conductivity and flame retardant property shall meet the requirements given in TB/T 1484.1. The materials used for the cables shall not produce harmful and dangerous smoke during combustion and thermal decomposition. The use of optical cables and communication cables shall meet the requirements of current national standards of products.

## 11 Traction system

**11.1** On-board alternating current (AC) transmission system with variable frequency and speed shall be adopted for the traction of vehicle.

**11.2** The linear induction motor shall be adopted as the traction motor and it should be unilateral and short primary.

**11.3** The secondary induction plate of the linear induction motor shall be aluminum plate or other conductive materials or structure, which is laid on the F-shaped rail. The copper plate or other conductive materials should be adopted in the areas having the large slopes and requiring the greater traction force. The induction plate shall have good electrical conductivity, and the thickness of the induction plate shall be reasonably matched with the clearance of motor and the primary parameters.

**11.4** In the condition of meeting the requirements of traction, when an inverter supplies the electricity to several traction linear induction motors in parallel, the current equilibrium between the motors shall be considered.

**11.5** There shall be sufficient connection strength between the induction plate and the F-shaped rail, and after the induction plate is fixed on the F-shaped rail, the clearance between the surface of induction plate and the surface of F-shaped rail shall not be greater than 1.0mm, and the surface unevenness degree of the induction plate within 1m length range shall be less than 5% of the rated mechanical clearance of the motor.

**11.6** The traction system shall be able to meet the requirements for the traction force or electrical braking force in various running conditions of the train, fully play the role of the electrical braking force. The electric braking system shall coordinate with the mechanical braking system to achieve the smooth transition between the electrical braking and the mechanical braking.

**11.7** In the condition of power supply as specified in Article 4.3.2, the output power of the inverter shall meet the requirements of rated traction.

**11.8** The traction system shall have fault detection and protection functions.

**11.9** The normal force between the primary and secondary traction linear induction motor shall be controlled within a certain range and shall not exceed the bearing capacity of the levitation system when the maximum load is reached.

**11.10** The traction system shall be able to automatically adjust the traction force or electrical braking force according to the conditions of the vehicle such as the loading capacity of the vehicle and so on and shall have the anti-impulse control measures that can respond timely.

**11.11** The traction motor shall meet the requirements given in CJ/T 311, the traction electrical equipment shall meet the requirements in GB/T 21413, the electronic equipment shall meet the requirements in TB/T 3021, and the traction inverter shall meet the requirements in TB/T 2437.

**11.12** The characteristics of the traction motor shall meet the requirements of traction and braking characteristics of the vehicle traction system.

**11.13** The overall dimension, installing dimension and electrical performance of the primary assembly of the on-board traction motor shall be consistent to meet the interchange requirements.

## 12 Levitation and guidance system

**12.1** The quantity, working voltage and current of the levitation electromagnet shall be calculated and determined on the basis of comprehensive consideration of the demand of the vehicle, and shall meet the requirements for the redundancy.

**12.2** The levitation controller shall have the functions of stabilized levitation and guidance for the maglev train and shall be able to adapt to all of the running conditions of the vehicles. The working states of the levitation controllers and levitation electromagnets shall be able to send to the control and diagnosis system of the vehicles, and have the fault-tolerant control function.

**12.3** The levitation sensor shall have the function of clearance measurement and vertical acceleration measurement, and the measurement accuracy shall meet the requirements of levitation control. The sensor shall work normally at the temperature of  $-30^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ . The maximum linearity error within the measuring range shall not exceed 1%. The annual stability is not greater than 1%. The redundancy setting shall be adopted for the sensors to guarantee that the failure of the single sensor does not affect the performance of the levitation system.

## 13 Braking system

**13.1** The braking system controlled by computer shall be adopted for the train, which shall have two braking modes: the electric braking mode and the air (or hydraulic) braking mode. The air (or hydraulic) braking shall have the relatively independent braking capacity and that it can be put into use in the condition of interruption of traction power supply or the failure of electrical braking. The air (or hydraulic) braking shall be able to ensure the safe stopping of the train.

**13.2** The braking system shall have common braking and emergency braking functions, and shall have the function of the braking force adjustment according to the vehicle load. When the train implements emergency braking on the straight track, it shall be able to park within the specified distance.

**13.3** The electric braking and the air (or hydraulic) braking shall be able to coordinate with each other, and the commonly used braking shall make full use of electric braking function and have impulse restriction. When the electric braking is used, priority shall be given to the use of the regenerative brake, and the electric braking and air (or hydraulic) braking shall be able to convert smoothly. When the electrical braking force is insufficient, the air (hydraulic) braking shall be able to supplement the insufficient braking force according to the requirements of the total braking force.

**13.4** The train shall have parking brake devices to guarantee that the train with maximum load and maximum slope can park without slipping away when the brake applied. Its braking force shall be generated and transmitted only by mechanical means.

**13.5** When the train is accidentally separated, the emergency braking shall be able to be carried out immediately to guarantee the automatic braking of the separated train, and to enable the driver to identify it.



## 14 Air supply system

**14.1** The train shall have two or more sets of independent air compressor units, and when one set fails, the performance, air exchange volume, air supply quality and the volume of air storage cylinder of the remaining air compressor units shall be able to meet the air supply requirements of the whole train; the air compressor unit shall be equipped with dryer and automatic drainage device; the operating threshold value of pressure regulator and the safety valve shall be accurate and reliable. The air storage volume of the air storage cylinder shall also meet the requirements for the air quantity used for emergency braking and rescue of the train air.

**14.2** The air-tightness of the air supply system shall meet the requirements given in GB/T 14894, and the decrease of pressure value of the system (the main air cylinder, brake pipeline, air operated valve, air levitation device, electric air device, etc.) within 5 minutes after closing the air passage shall not exceed 20kPa; the decreased value of the pressure of the brake cylinder and auxiliary air cylinder after 3 minutes shall not exceed 10kPa.

**14.3** The compressed air pipeline should be made of stainless steel or copper materials, and the anti-rust, anti-corrosion and cleaning treatment shall be done before the installation of the pipeline and air storage cylinder.

**14.4** The compressed air distribution device of the air spring suspension shall be able to discharge the compressed air in the corresponding air spring suspension according to the instructions of the levitation system.

## 15 Control and diagnosis system

**15.1** The train should be controlled through a communications network. When the network control is adopted, the function related to safety may be provided with other redundancy methods. The parts related to safety shall also have redundancy.

**15.2** The data communication shall have the following basic functions:

- The train control and diagnosis system communicates with the vehicle subsystem through the network and the intelligent terminal.
- The information of failures of the network-connected subsystem shall be downloaded through the standard service interface on the network.
- The online testing of the main microcomputer control subsystem can be carried out through the standard service interface on the network.

**15.3** The train control and diagnosis system shall be mainly composed of the following devices.

- Terminal device (input and output units). The main function is to collect the data of the main parts and equipment of the vehicle, and transmit the monitoring and control information to the information processing center through the input and output interfaces.
- Central device (the information processing center). Its main function is to collect the data of the main parts and equipment of the whole train, and shall be equipped with the interfaces connected with the peripheral equipment (such as personal computer).
- Driver's cab monitor. Its main function is to enter the man-machine dialogue through the Liquid Crystal

Display(LCD).

—Reading out device. Its main function is to complete the reading of recorded data of the monitoring system, so as to carry out the analysis and inspection of the condition or failure of the train equipment.

**15.4** The diagnosis system of the train shall be able to receive the state information and fault information of the subsystem of the train, and can analyze and store the information, and shall display the information on the display screen of the driver's cab.

**15.5** The main subsystems of the train shall have the self-diagnosis and monitoring functions.

**15.6** The train control diagnosis system shall have the function of recording the operational event.

**15.7** The function of the key parts in the train network control system shall be redundant.

## **16 Location and velocity detecting system**

**16.1** Non-contact measurement and testing mode shall be used for the location and velocity detecting system so that the exact position of the train on the line, the train running speed and the train running direction information in real time can be obtained.

**16.2** The data range, precision and transmission rate measured by the location and velocity detecting system shall be able to meet the requirements of automatic train control and traction control.

**16.3** The location and velocity detecting system shall include two parts: the absolute positioning and relative positioning.

**16.4** The location and velocity detecting system shall have the fault tolerance and redundancy functions.

## **17 Air conditioning and ventilation system**

**17.1** The vehicle air conditioning system shall be able to meet the requirements for the temperature in the vehicle not being higher than  $28^{\circ}\text{C} \pm 1^{\circ}\text{C}$  and the relative humidity not exceeding 65% when the ambient temperature is  $33^{\circ}\text{C}$ . The different areas may also specify the additional temperature requirements in the contract according to the local climatic conditions.

**17.2** The air conditioning device should adopt the centralized control mode, use the synchronous instruction to control, start in sequence.

**17.3** The air conditioning system should be turned on and off in any single carriage, or turn on and off overall by the whole train at the same time.

**17.4** The air conditioning unit shall meet the requirements given in GB/T 19842.

**17.5** The installation of the fresh air inlet and air channel of the air conditioning system shall ensure the cooling effect and the comfort of passengers, and fresh air volume per capita in the passenger compartment shall not be less than  $10\text{m}^3/\text{h}$  (which is calculated according to the rated passenger load). When the passenger compartment is only equipped with mechanical ventilation devices, the air supply volume per capita shall not be less than  $20\text{m}^3/\text{h}$  (which is calculated according to the rated passenger load).

**17.6** The air conditioner shall provide with emergency ventilation function, and when emergency ventilation happens, the fresh air volume per capita shall not be less than  $10\text{m}^3/\text{h}$  (which is calculated according to the rated passenger load).

**17.7** When the air conditioner is provided in the driver's cab, the fresh air volume per capita shall not be less than  $30\text{m}^3/\text{h}$ . When there are special needs in different regions, they may be specified separately in the contract.

**17.8** The vehicles used in the cold areas in winter shall have heating function, and when the vehicle is running, the temperature in driver's cab shall be maintained at the temperature of not less than  $14^\circ\text{C}$ .

**17.9** The air conditioner and heating equipment shall have the corresponding electrical protection function.

## **18 Communication and passenger information system**

**18.1** The train shall have the function of carrying out two-way communication between the driver and the running control and dispatching center, and the communication between the front and rear cab.

**18.2** The train shall have the device for the driver to broadcast stops or have automatic station reporting device. The passenger compartment shall be equipped with speakers used for announcing the coming station and shall be equipped with the passenger information facilities such as the lines, station guide signs and so on.

**18.3** The passenger compartment shall be equipped with the manual alarm device for the passengers and the intercommunicating device between the driver and passengers, and in emergency, the passengers shall be able to send alarm to the driver, and the driver shall be able to immediately identify the vehicle from which the alarm is sent out.

**18.4** The driver's cabs at two ends of the train may be equipped with display devices to display the train number and block section information.

## **19 Safety facilities**

**19.1** The driver's desk shall be equipped with emergency stop control device and emergency alarm button.

**19.2** The driver's cab shall be equipped with the device to display opening and closing information of all side doors of passenger compartments as well as on-board signal display devices. These devices shall be easily observed by the driver.

**19.3** The train shall have automatic train protection system (ATP) or automatic train protection system (ATP) and automatic train operation system (ATO) as well as the communication and liaison devices to ensure train running safety.

**19.4** The front end of the driver's cab shall be equipped with head lights that may switch between low-beam light and high-beam light. The illumination of the head light shall not be less than  $2\text{ lx}$  at the place within the emergency stop distance. The outer wall of the rear end of the train shall be equipped with red protective light with sufficient visual distance.

**19.5** The train shall be equipped with train horn.

**19.6** There shall be a variety of warning signs in the vehicle, including the warning signs for emergency braking device, charged high-voltage equipment, firefighting equipment and the operation instructions in the electrical equipment box. The warning sign of time of discharge after cutting off electricity shall be marked on the high voltage equipment with capacitors.

**19.7** The passenger compartment and the driver's cab shall be equipped with fire extinguishing apparatus suitable for electric device and oils, and the place used for the fire extinguishing apparatus shall be clearly marked and convenient for use. The gas produced by the fire extinguishing materials used in firefighting shall not be detrimental to human bodies.

**19.8** The train shall have the capacity to evacuate passengers in emergency.

## **20 Test and acceptance**

**20.1** After the completion of general assembly, the vehicle shall be tested according to the current national standards and then can be put in use. Acceptance process may only be carried out after all tests are passed.

**20.2** The manufacturer may make adjustments to the vehicle before conducting the type test. Necessary modifications and line test run may also be carried out during the adjustment process. The mileage of running shall be determined by the user and the manufacturer through consultation in accordance with the maximum running speed of the vehicle and the condition of adopting the new equipment and new technologies. For vehicles to which the type test is carried out, the mileage of test run of the vehicle should not be less than 5 000km when it is not specified in the contract.

**20.3** When the vehicle is in one of the following conditions, the type tests shall be carried out.

- a) It is newly designed and manufactured.
- b) Major technological innovation is implemented for the vehicles in mass production, and the performance, construction, materials, and parts have changed greatly.
- c) Samples are selected for testing when it is necessary to reconfirm the performance after a certain number of vehicles are manufactured in mass production.
- d) A model of vehicle is produced by the manufacturer for the first time.
- e) The national quality supervision agency puts forward the requirements.

**20.4** The contents of type test shall include at least the testing of performance of train levitation, traction and braking, train control function, vehicle and train network, the electromagnetic compatibility as well as the train power supply.

**20.5** The ancillary equipment and main parts of the vehicle shall be installed on the vehicle only after they are qualified in inspection.

**20.6** The routine test shall be carried out for all vehicles that are put into mass production.

**20.7** The vehicles formally submitted for acceptance shall have the quality certificate of product, type test report, routine test reports, instructions for use and maintenance and vehicle record book, etc.

**20.8** When delivering the vehicle to user, the manufacturer shall provide the relevant technical documents, drawings for maintenance, on-board tool kits and spare parts.

**20.9** The research tests shall be carried out when there is specification in the contract between the user and the manufacturer.

## **21 Marking**

- a) The relevant information of the vehicle shall be marked in the obvious position of the vehicle, and its marking method shall conform to the specifications in relevant standards. The manufacturer shall provide complete information and the content of the marks shall at least include the following contents:
- Model identification;
  - Name of manufacturer;
  - The rated passenger carrying capacity;
  - The serial number or identifier code;
  - The manufacturing date.
- b) The marking shall be clear, easy to read and not easy to wear.

## **22 Transportation and quality warranty period**

**22.1** The vehicle shall be properly packed, stored, transported and protected by the manufacturer in accordance with the relevant standards until it arrives at the place of delivery specified in the contract, and special tools for the hoisting of the car body shall be provided.

**22.2** The manufacturer shall clearly specify the warranty period of the vehicle and its main parts (it is generally not less than one year after the acceptance and delivery of the vehicle). While the user follows the maintenance instructions, the failure or damage still occurs due to poor manufacturing quality of the vehicle or its main parts within the warranty period, the manufacturer, therefore, shall be responsible for repairing or replacing the parts, installing and commissioning and restoring operation in a free and timely manner.

**22.3** For projects that need to be rectified because of the design or process defects, the warranty period shall be reestablished for the relevant parts from the date when completing this rectification of this vehicle.

### Bibliography

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  - [ 2 ] JIS E 7106: 2006 *Rolling Stock—General Requirements of Car Body Structures for Passenger Car*
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