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Foreword

This standard is drafted in accordance with the rules given in the GB/T 1.1-2009.

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

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Technical specification for medium and low speed maglev turnout

1 Scope

This standard specifies the terms and definitions, types of turnout, requirements, test methods, inspection rules, safety and environmental protection, marking, packaging, transportation and storage, warranty period for medium and low speed maglev transit turnout.

This standard is applicable to the manufacture and acceptance of medium and low speed maglev transit turnout, with the straight speed of not more than 120km/h and the lateral speed of not more than 25km/h.

2 Normative references

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

- GB/T 191 *Packaging—Pictorial Marking for Handling of Goods*
- GB/T 699 *Quality Carbon Structural Steels*
- GB/T 700 *Carbon Structural Steels*
- GB/T 985.1 *Recommended Joint Preparation for Gas Welding, Manual Metal Arc Welding, Gas-shield Arc Welding and Beam Welding*
- GB/T 985.2 *Recommended Joint Preparation for Submerged Arc Welding*
- GB/T 1591 *High Strength Low Alloy Structural Steels*
- GB/T 1184 *Geometrical Tolerancing—Geometrical Tolerance for Features without Individual Tolerance Indications*
- GB/T 1801 *Geometrical Product Specifications (GPS)—Limits and Fits—Selection of Tolerance Zones and Fits*
- GB/T 1804 *General Tolerances—Tolerances for Linear and Angular Dimensions without Individual Tolerance Indications*
- GB/T 3323 *Radiographic Examination of Fusion Welded Joints in Metallic Materials*
- GB/T 4162 *Forged and Rolled Steel Bars—Method for Ultrasonic Testing*
- GB 4824 *Industrial, Scientific and Medical Equipment—Radio-Frequency Disturbance Characteristics—Limits and Methods of Measurement*
- GB/T 5117 *Covered Electrodes for Manual Metal Arc Welding of Non-alloy and Fine Grain Steels*
- GB/T 5118 *Covered Electrodes for Manual Metal Arc Welding of Creep-resisting Steels*
- GB/T 5777 *Seamless Steel Pipe and Tubing Methods for Ultrasonic Testing*
- GB/T 6417.1 *Classification and Explanation of Imperfections in Fusion Welded Joints*
- GB 7251.1-2005 *Low-voltage Switchgear and Controlgear Assemblies—Part 1: Type-tested and Partially Type-tested Assemblies*
- GB/T 7417 *AX Series Relays for Railway Signaling*
- GB/T 8923.1 *Preparation of Steel Substrates before Application of Paints and Related Products—Visual Assessment of Surface Cleanliness—Part 1: Rust Grades and Preparation Grades of Uncoated Steel Substrates and*

of Steel Substrates after Overall Removal of Previous Coatings

GB/T 11352 *Carbon Steel Castings for General Engineering Purpose*

GB/T 13306 *Plates*

GB/T 13384 *General Specifications for Packing of Mechanical and Electrical Product*

GB/T 17626.2 *Electromagnetic Compatibility-Testing and Measurement Techniques-Electrostatic Discharge Immunity Test*

GB/T 17626.3 *Electromagnetic Compatibility-Testing and Measurement Techniques-Radiated, Radio-Frequency, Electromagnetic Field Immunity Test*

GB/T 17626.4 *Electromagnetic Compatibility-Testing and Measurement Techniques-Electrical Fast Transient/Burst Immunity Test*

GB/T 17626.5 *Electromagnetic Compatibility-Testing and Measurement Techniques-Surge Immunity Test*

JB 4730.4 *Nondestructive Testing of Pressure Equipments-Part 4: Magnetic Particle Testing*

JB 4730.5 *Nondestructive Testing of Pressure Equipments-Part 5: Penetrant Testing*

JB/T 8468 *Magnetic Particle Testing for Steel Forgings*

JB/T 8854.2 *Curved Tooth Coupling GII CL GII CLZ*

JB/T 9050.1 *Cylindrical Reduction Gear Units-Part 1: General Technical Requirement*

JGJ 82 *Technical Specification for High Strength Bolt Connections of Steel Structures*

TB/T 1527 *The Protection Coating Anti-corrosion and Specification for the Supply of Paints for Railway Steel Bridge*

TB/T 1774 *Technical Condition for Centralized Relay Electric Interlock*

TB/T 2615 *Fail-safe Principle of Railway Signalling*

TB 10002.1 *Fundamental Code for Design on Railway Bridge and Culvert*

3 Terms and definitions

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

3.1

Main body of structure

The main stressed components of the turnout, including the turnout beam, trolley, hinged connection rod, connection device at movable end, connection device for F-typed rail, F-typed rail, which support the maglev vehicles and participate in the turning of turnout.

3.2

Medium and low speed maglev turnout

The line switching equipment of medium and low speed maglev line which consists of the main body of structure, driving, locking, control and signaling systems, etc., and is classified into the simple turnout, three-throw turnout, bilateral turnout, single crossover and scissors crossover according to the structural composition and the line state after switching.

3.3

Switch time for turnout

The duration needed from the time the turnout control system receives the switching command to the time the turnout completes the switching and sends out the position indication signal.

3.4

Fixed end of turnout

The stationary end of the turnout in the process of switching.

3.5**Active end of turnout**

The moving end of the turnout in the process of the switching.

3.6**Center of turning**

The three central points on which the three turnout beams turn respectively, and they are ordered as the first, the second and the third center of turning in the direction from the fixed end to the active end.

3.7**Reference line of turnout**

The tangent line of fitting circular curve of turnout at the first center of turning.

3.8**Radius of turnout**

The circumradius of the polyline formed by the center lines of all the sections of tracks on the turnout.

3.9**Switch distance of turnout**

The distance between the terminal point of active end and the reference line of turnout after the switching of turnout.

3.10**Track structure of turnout**

The structural part carrying the vehicle above the infrastructure, which consists of the induction plate, guide rail and rotatable steel girder.

3.11**Center of turnout**

The point of intersection between the center line of the track at the active end and the reference line when the turnout is in the working position, which coincides with the third center of turning.

3.12**Switch angle for turnout**

The included angle between the center line of the track at the active end and the reference line when the turnout is in the working position, and the point of intersection is in the center of turnout.

3.13**Rotary railway**

The track which can rotate to serve as the transition in the scissors crossover.

3.14**Allowable speed at straight line location of turnout**

The maximum speed at which the train is allowed to pass when the track is in a straight line.

3.15**Allowable speed at branch line location of turnout**

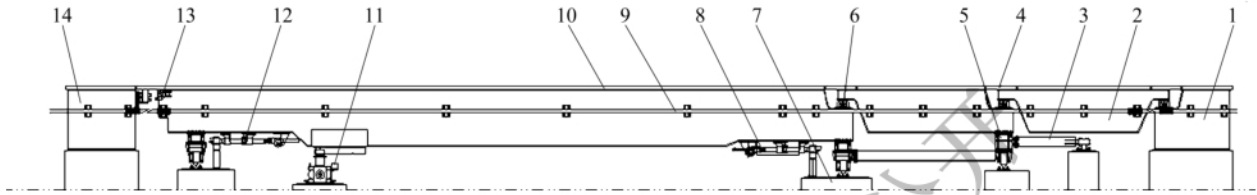
The maximum speed at which the train is allowed to pass when the track is in a branch line.

3.16**Buttress girder**

The fixed steel beam that connects the concrete beam and the turnout beam, and supports the vehicle after the F-typed rail is installed on it.

4 Types of turnout

4.1 The simple turnout, see Figure 1 and Figure 2.



Key:

- | | |
|--|-----------------------------------|
| 1—connection beam at fixed end; | 8—locking device; |
| 2—turnout beam; | 9—conductor rail support; |
| 3—hinged connection rod; | 10—F-typed rail; |
| 4—connecting device of F-typed rail; | 11—driving system; |
| 5—trolley; | 12—electrical system; |
| 6—vertical connecting device between the rail beams; | 13—assembly at active end; |
| 7—foundation; | 14—connection beam at active end. |

Note: The simple turnout is the equipment to connect the straight line and branch line.

Figure 1

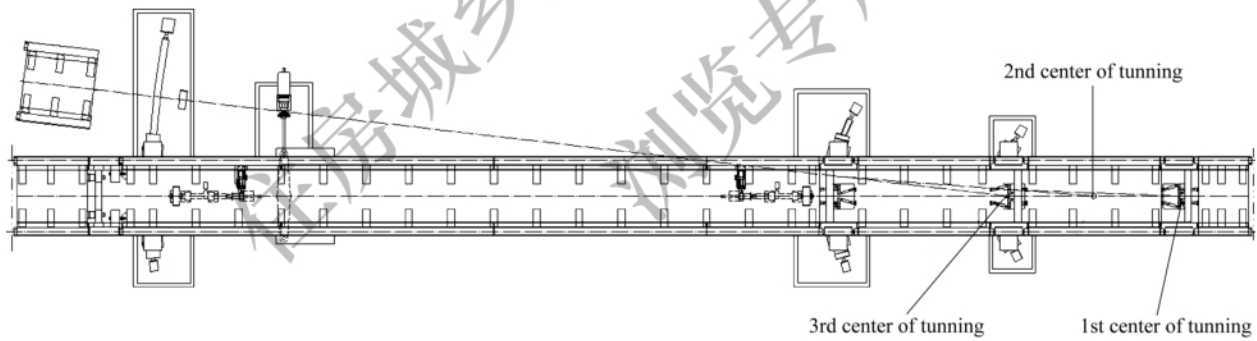
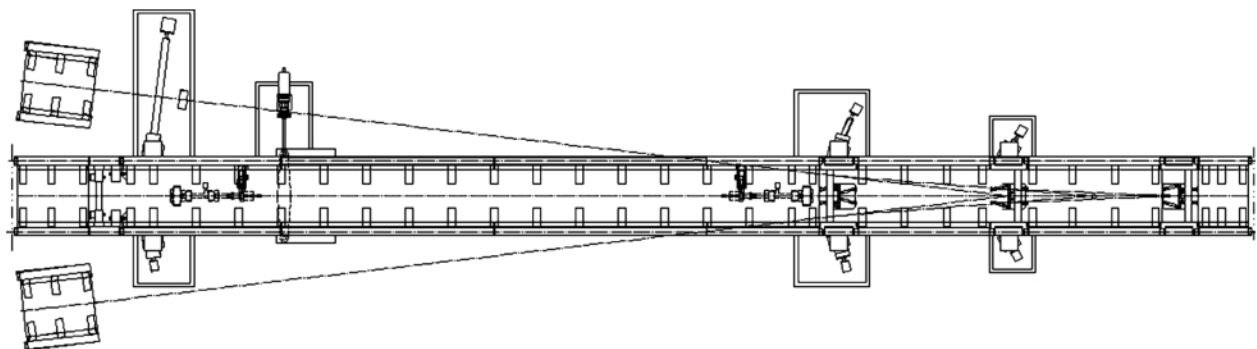


Figure 2

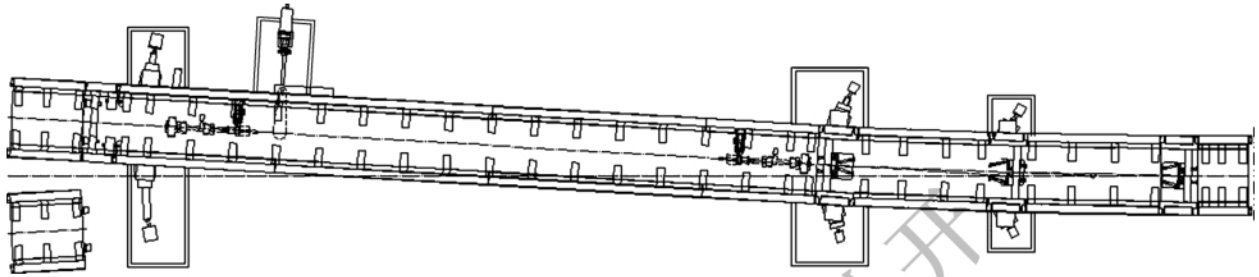
4.2 The three-throw turnout, see Figure 3.



Note: The three-throw turnout is the equipment to connect the straight line and the branch lines at the two sides.

Figure 3

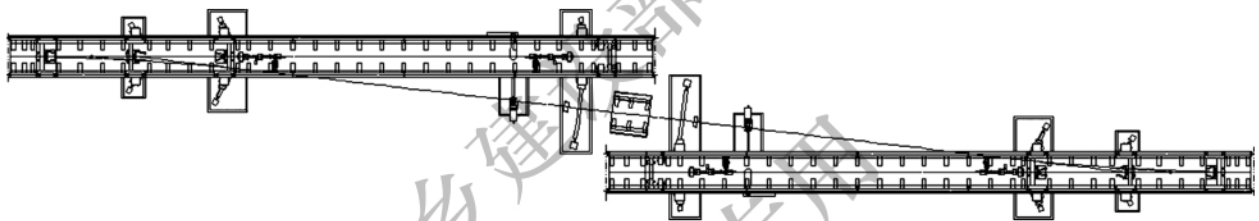
4.3 The bilateral turnout, see Figure 4.



Note: The bilateral turnout is the equipment to connect two zygomorphic lines.

Figure 4

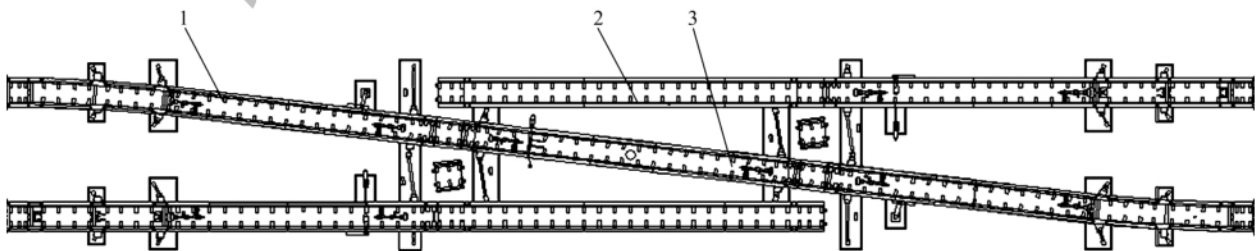
4.4 The single crossover, see Figure 5.



Note: The single crossover is the equipment to realize the one-way switching between the adjacent lines.

Figure 5

4.5 The double crossover see Figure 6, the rotatable track see Figure 7.



Key:

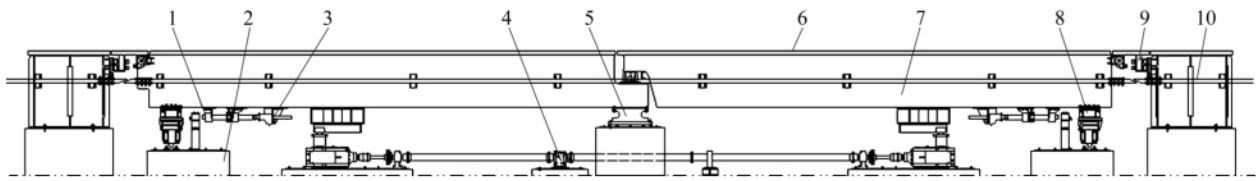
- 1—simple turnout;
- 2—fixed track;
- 3—rotary track.

Note: The double crossover is the equipment to realize the two-way switching between the adjacent lines.

Figure 6

4.6 Parameters of turnout

See Table 1 for the overall dimension, the track gauge, the branch speed, the switching time of adjacent turnout positions and the schematic diagrams of various types of turnouts.



Key:

- 1—locking device;
- 2—foundation;
- 3—electrical system;
- 4—driving device;
- 5—middle hinge shaft;
- 6—F-shaped rail;
- 7—rotary track;
- 8—trolley;
- 9—assembly at active end;
- 10—conductor rail support.

Note: The front view of rotatable track.

Figure 7

Table 1 Parameters of turnout

Type	Length including connection beam/mm	Track gauge of F-shaped rail of turnout/mm	Allowable speed of turnout	Switching time of adjacent turnout positions/s	Schematic diagram/mm
Simple turnout	34 764	2 000	When the branch speed is less than or equal to 25km/h or the turnout is in the position of straight line, it meets the requirements of maximum speed of line	≤ 15	
Bilateral turnout	34 764	2 000	The branch speed is less than or equal to 25km/h	≤ 15	
Multi-throw turnout	34 764	2 000	When the branch speed is less than or equal to 25km/h or the turnout is in the position of straight line, it meets the requirements of maximum speed of line	≤ 15	

Continued

Type	Length including connection beam/mm	Track gauge of F-shaped rail of turnout/mm	Allowable speed of turnout	Switching time of adjacent turnout positions/s	Schematic diagram/mm
Single crossover	67 167	2 000	When the branch speed is less than or equal to 25km/h or the turnout is in the position of straight line, it meets the requirements of maximum speed of line	$\cong 15$	
Double crossover	94 937	2 000	When the branch speed is less than or equal to 25km/h or the turnout is in the position of straight line, it meets the requirements of maximum speed of line	$\cong 15$	

5 Requirements

5.1 General technical conditions

5.1.1 The turnout shall be manufactured in accordance with the approved drawings and this document.

5.1.2 The turnout should not be installed on slopes.

5.1.3 The turnout shall be structured to facilitate operation, maintenance, repair, lubrication and part's replacement.

5.1.4 The maximum of vertical deflection of turnout beam caused by the static live load shall not be more than $L/3\ 800$; Under the action of the train's swaying force, centrifugal force and wind power, the transverse deflection of turnout beam shall not be more than $L/2\ 600$, and the transverse deflection is calculated without considering the influence of temperature load, where L is the span of turnout beam.

5.1.5 The natural frequency of turnout shall be less than 10Hz.

5.1.6 The turnout shall be powered by a dual power supply. Generally, the power supply of turnout is the three-phase five-wire AC power supply with the voltage of AC 380V (fluctuation range: AC 360V to AC 400V) and the frequency of $50\text{Hz} \pm 0.5\text{Hz}$.

5.1.7 The turnout shall be grounded reliably and be provided with the effective lightning protection, and the turnout and the control system shall be connected to the integrated grounding grid separately, and the grounding

resistance at the access to integrated grounding grid shall be less than 1 Ω.

5.1.8 The running track for the turnout trolley shall be installed on the integral base of turnout.

5.1.9 The turnout shall be equipped with the drainage facilities.

5.1.10 The switch distance of turnout shall be calculated according to Formula (1), the safety clearance shall be equal to or greater than 200mm, and not less than 100mm in the difficult condition:

$$L=A+\frac{1}{2}B+C \quad \dots\dots\dots (1)$$

Where,

L—switching distance of turnout, mm;

A—equipment gauge, mm;

B—turnout section width, mm;

C—safety clearance, mm.

5.1.11 The turnout control system shall meet the requirements given in TB/T 2615, and the electrical equipment used in the turnout control circuit shall meet the requirements given in GB/T 7417.

5.1.12 The related turnout position indication circuit in the turnout control circuit shall meet the requirements given in TB/T 1774.

5.1.13 The turnout control system shall ensure that turnout position indication is consistent with the actual position of turnout.

5.1.14 The turnout control system shall provide the automatic train control system with the necessary interface information such as the indication signal and fault information that are consistent with the actual position. The point-to-point hardwire connection mode is used for the interface between the automatic train control system and the turnout control system, which shall conform to the double-circuit and double-break principle, and its voltage grade is DC 24V. The interface circuit shall comply with the control rules for the turnout by the automatic train control system.

5.1.15 The turnout control system shall be designed with lightning protection, no-voltage protection, phase sequence detection, open-phase protection and over current protection.

5.1.16 The turnout control system shall be designed with switching control, authorization control, state monitoring and fault alarm.

5.1.17 In the centralized control mode, the turnout control system shall ensure that the turnout is not switched until the automatic train control system sends out the switching command.

5.1.18 The local turnout control system shall not function until it has been authorized by and sent acknowledgement to automatic train control system and shall return authorization after local control operation is completed.

5.1.19 All the components, complete sets of electric control cabinets and wires and cables shall meet the requirements given in GB 7251.1 and other relevant national standards, and the cables and wires shall be flame retardant, low smoke and halogen free.

5.2 Environmental conditions

5.2.1 The altitude at which turnout and electric equipment are installed shall not be more than 1 400m.

5.2.2 The maximum relative humidity in the electrical control cabinets of turnout shall be less than or equal to 90%, without condensation.

5.2.3 The turnout system shall withstand the erosion of wind, sand, rain, snow and the corrosion effect caused by cleaning agent.

5.2.4 The wind load intensity the turnout bears under natural environment is calculated as specified in TB 10002.1.

5.2.5 The normal operating temperature of turnout shall be within the range of -25°C to $+75^{\circ}\text{C}$, and the mean temperature in 24 hours shall not exceed 45°C .

5.2.6 There shall be no flammable, explosive and corrosive gases in the working environment.

5.2.7 As the climate varies with region, the operating environmental conditions may be otherwise specified in the contract by the user and the manufacturer.

5.3 Materials of main components

5.3.1 The selection of steel structure materials for main components of turnout shall meet the requirements given in GB/T 700 for structural carbon steel or the requirements given in GB/T 1591 for structural low alloy steel.

5.3.2 All the outsourced materials and parts shall be accompanied with the quality certificate(certificate of conformity) provided by the supplier, the quality certificate shall conform to the specifications of national standard. They shall not be put into use until they pass the re-inspection of the mechanical properties and chemical composition carried out by the manufacturer.

5.3.3 The index of mechanical properties of materials of shafts shall not be inferior to 45 steel specified in GB/T 699.

5.3.4 The mechanical properties of cast materials shall not be inferior to ZG340-640 specified in GB/T 11352; the mechanical properties of forging materials shall not be inferior to 45 steel specified in GB/T 699, and that of the forgings with the diameter of more than 400mm shall not be inferior to 55 steel.

5.3.5 The steel castings shall be subjected to annealing or ageing.

5.4 Bolting and welding

5.4.1 When the components are connected with the high strength bolt, all the requirements shall conform to the specifications given in JGJ 82.

5.4.2 The electrodes, welding wires and flux used for the welded components shall be compatible with the materials of the parts to be welded.

5.4.3 The electrode shall meet the requirements given in GB/T 5117 and GB/T 5118.

5.4.4 The type and size of welded joint shall meet the requirements given in GB/T 985.1 and GB/T 985.2.

5.4.5 There shall be no obvious defects when visual inspecting the welds and the external defects of welded seam shall meet the requirements given in GB/T 6417.1.

5.4.6 The penetration welds of main stressed components (turnout beam, trolley crossbeam, trolley frame, hinged connection rod and so on) shall be subjected to 100% UT in accordance with GB 11345, which shall reach quality evaluation Level I. The main fillet welds shall be subjected to 100% UT in accordance with TB 10212, which shall reach acceptance quality evaluation Level II .

5.4.7 When the overlapping form is adopted between the turnout beams, before installing the lower cover plate, butt welds at the root shall be subjected to 100% NDT in accordance with GB/T 3323, which shall reach the testing level B and quality evaluation Level II .

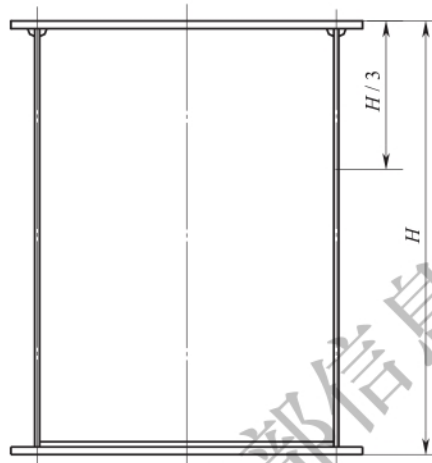
5.4.8 The fillet welds on installation plate of F-shaped rail shall be subjected to 100% NDT in accordance with JB 4730.4 and JB 4730.5, which shall reach acceptance Level I .

5.5 The turnout beam and connecting device between the beams

5.5.1 The effect of dead weight shall be considered for the driving beam of turnout, and the process camber may

be set in the process of manufacture so that no camber exists on the dead weight condition.

5.5.2 With regard to checking of local flatness of web plate of main girder, the flatness shall not be more than 2mm/m within $H/3$ away from the upper flange plate in the pressure area, the flatness in other areas shall not be more than 3mm/m, the flatness in the full length range shall not be more than 6mm/20m, see in Figure 8.

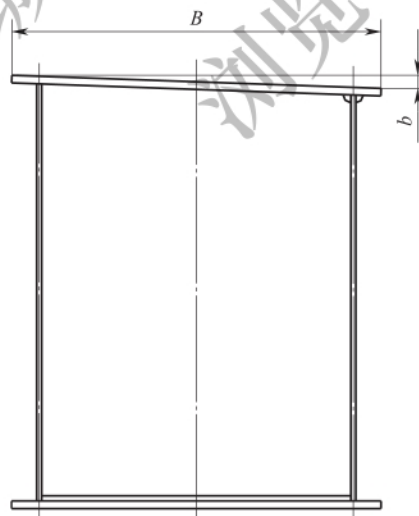


Key:

H —height between the upper and lower cover plates.

Figure 8

5.5.3 See Figure 9 for the checking of upper flange plate of the turnout beam.



Key:

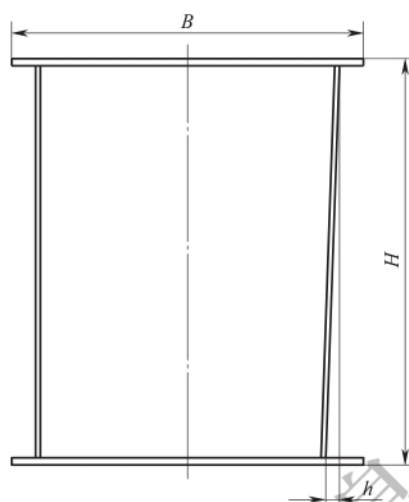
B —width of upper cover plate;

b —angle of inclination.

Note: The horizontal inclination of upper flange plate of the turnout beam: $b \leq 2\text{mm}$.

Figure 9

5.5.4 The vertical deflection of web plate of turnout beam: $h \leq 2\text{mm}$, this value shall be measured at the large diaphragm, see Figure 10.



Key:

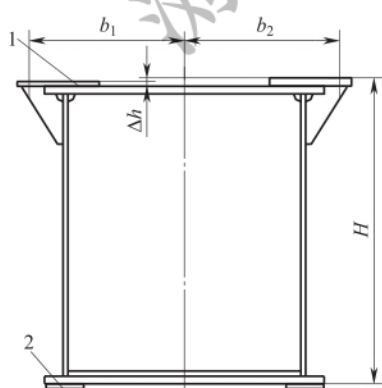
B —width of upper cover plate;

H —height between the upper and lower cover plates;

h —lateral inclination of web plate.

Figure 10

5.5.5 The limit deviation of height H from the installation plate of F-shaped rail to the lower surface of installation plate of the trolley is $\pm 0.5\text{mm}$, the limit deviation of height between the installation plates of left and right F-shaped rails in the same section is $\Delta h \pm 0.5\text{mm}$, and the limit deviation of the distance from the bolt holes of installation plates of F-shaped rails on both sides to the center line of beam is $\pm 0.5\text{mm}$, see Figure 11.



Key:

1—installation plate of F-shaped rail;

2—installation plate of trolley;

b_1 —distance from the center line of hole of installation plate of F-shaped rail to the center line of turnout beam (left);

b_2 —distance from the center line of hole of installation plate of F-shaped rail to the center line of turnout beam (right);

H —height of F-shaped rail;

Δh —deviation of height between the installation plates of left and right F-shaped rails in the same section.

Note: This figure shows the deviation of height between the installation plate of F-shaped rail and the installation plate of trolley.

Figure 11

5.5.6 The flatness of installation plate of F-shaped rail in the full length range (including the connection beam) shall not be greater than 1mm.

5.5.7 The vertical connecting device between the beams shall have enough strength and shall be convenient for lubrication or selflubrication.

5.6 Turnout trolley

5.6.1 The dimensional tolerance of wheel tread diameter shall not be less than h9 specified in GB/T 1801, and the dimensional tolerance unmarked shall conform to the specifications given in GB/T 1804. The dimensional tolerance of wheel shaft hole shall not be less than H7; the radial and end surface circular runout of the reference end surface of the wheel (lathe the V-shaped groove of 1.5mm on it as the mark) relative to the shaft hole line shall not be inferior to grade 8 specified in GB/T 1184.

5.6.2 After heat treatment, the wheel shall conform to the specification of Table 2.

Table 2 Hardness of wheel tread

Diameter of wheel/mm	Hardness of wheel tread HBS10/3 000/10	Layer depth of hardness 260 HBS10/3 000/10/mm
≤ 400	300-380	≥ 15
>400	300-380	≥ 20

5.6.3 The metallographic inspection of the wheels shall be carried out before the trolley designed for each group of lines is put into production. One wheel is taken for the metallographic inspection, and a slice of 20mm thick is taken in the radius direction, and in case that the material is 45 steel or 55 steel, the metallographic structure is tempered troostite; in case that the material is ZG340-640, the metallographic structure is tempered troostite, and there can not be residual as-cast structure in the core (non-quenched layer).

5.6.4 The difference of wall thickness of wheel rim or wheel hub of less than or equal to 500mm in diameter shall not be more than 3mm, or the difference of wall thickness of wheel rim or wheel hub of more than 500mm in diameter shall not be more than 5mm.

5.6.5 After a part is machined to its basic size, the defects on the machined surface such as sand holes, pores, etc. shall be treated as follows.

- a) The repair welding shall not be carried out in the shaft hole. The slight shrinkage shall not exceed 10% of total area, the defects shall not be more than the value specified in Table 3, and the defect edges shall be blunted.

Table 3 Allowable values of defects such as sand hole and pores

Diameter of wheel D /mm	Area of single defect/mm ²	Depth/mm	Quantity/piece	Distance between defects/mm
≤ 500	25	4	2	≥ 50
>500	25	6	3	≥ 60

- b) In other positions except the wheel tread and shaft hole, the area after the defects are removed shall not be more than 300mm², the depth shall not exceed 20% of the nominal wall thickness and shall not be more than 7mm, and the quantity of defects shall not exceed 3 at the same machined surface, the repair

welding is allowed, and heat treatment is not needed after repair welding, but it needs to be blunted to keep smooth.

- c) The diameter of pock on the wheel tread is not more than 1mm, the depth is not more than 2mm and the total number of pocks is not more than 5. In addition, neither other defects nor the repair welding shall be allowed.
- d) If the defects do not meet the above-mentioned requirements or there is a crack, the wheel shall be scrapped.

5.6.6 The flaw detection of wheel shall meet the requirements given in GB/T 5777.

5.6.7 The assembled wheel shall rotate flexibly by hand. Its rotation shall be agile.

5.6.8 The roughcast of angle bearing box shall be annealed.

5.6.9 After the angle bearing box of trolley is machined to its basic size, the defects at the machined surface such as sand holes, pores, etc. shall be treated as follows.

- a) The repair welding shall not be made in the shaft hole. For a single defect, its area shall not exceed 25mm^2 , its maximum size shall not exceed 8mm, and its depth shall not exceed 3mm; the number of defects shall not exceed: 1 for the bore diameter of no more than 150mm, 2 for the bore diameter of more than 150mm; when the distance between the defects is not less than 100mm, the defect edge shall be blunted.
- b) The defects at other machined surfaces: the area where the defects are removed to expose good metal shall not be more than 200mm^2 , and the depth shall neither exceed 20% of the nominal wall thickness nor 7mm. The number of defects does not exceed 2 at the same machined surface, the repair welding is allowed, and heat treatment is not needed after repair welding, but it shall be blunted to keep smooth.
- c) If the defects do not meet the above-mentioned requirements or there is a crack, it shall be scrapped.

5.7 Hinged connecting rod mechanism of turnout

5.7.1 Its positioning shall be accurate, and its rotation shall be agile.

5.7.2 The roughcasts of bearing pedestal and angle bearing box shall be annealed.

5.7.3 After the bearing pedestal of hinged connecting rod is machined to its basic size, the defects at the machined surface such as sand holes, pores, etc. shall be treated as follows.

- a) The repair welding shall not be made in the shaft hole. For a single defect, its area shall not exceed 25mm^2 , its maximum size shall not exceed 8mm, and its depth shall not exceed 3mm; the number of defects shall not exceed: 1 for the bore diameter of no more than 150mm, 2 for the bore diameter of more than 150mm; when the distance between the defects is not less than 100mm, the defect edge shall be blunted.
- b) The defects on other machined surfaces: After the defects are removed to expose good metal, the area shall not be more than 200mm^2 , the depth shall not exceed 20% of the nominal wall thickness and shall not exceed 7mm, and the quantity of defects does not exceed 2 on the same machined surface, the repair welding is allowed, and heat treatment is not needed after repair welding, but it needs to be blunted to keep smooth.
- c) If the defects do not meet the above-mentioned requirements or there is a crack, it shall be scrapped.

5.8 Driving device

5.8.1 The driving part of turnout shall be equipped with the safety clutch device, and the limit moment shall be

1.25 times of rated rotating moment.

5.8.2 The friction discs of friction clutch shall be contacted evenly, and the contact area shall not be less than 75%.

5.8.3 The drum gear coupling should be used, which shall meet the requirements given in JB/T 8854.2.

5.8.4 The selection of speed reducer shall meet the requirements given in JB/T 9050.1.

5.8.5 The driving roller shall conform to the followings:

- a) Roller should be forged with steel 45 or 40Cr.
- b) The hardness of roller after heat treatment is (280-320) HBS10/3 000/10.
- c) The assembled roller shall be rotated flexibly by hand.

5.8.6 The guiding groove structure should be made of the same material as turnout beam, and be installed on the turnout beam with the high strength bolts. The area on the side of guiding groove, which is contacted with the roller, shall be equipped with the wear resisting plate, and whose mechanical properties of the material shall not be inferior to 45 steel, and the hardness after heat treatment is (320-350) HBS10/3 000/10.

5.9 Locking device

5.9.1 The locking device structure shall be designed safely and reliably, and its positioning is accurate and the locking is firm, and it shall meet the requirements for the strength and rigidity to resist the centrifugal force and impact force produced when the vehicle passes.

5.9.2 All the requirements of locking roller are the same as those of driving roller.

5.9.3 The mechanical properties of lockpin material shall not be inferior to that of 45 steel, the hardness after heat treatment is (240-280) HBS10/3 000/10, and the surface is chromeplated.

5.9.4 After the heat treatment of lockpin shafts, the ultrasonic flaw detection and magnetic particle inspection should be carried out to them one by one, and the ultrasonic flaw detection shall meet the requirements given in GB/T 4162, the quality grade is Grade AA, and the magnetic particle inspection shall meet the requirements given in JB/T 8468, the surface shall be free of longitudinal and transverse capillary cracks.

5.10 The angle bisection device of F-shaped rail between the beams

5.10.1 The angle bisection device of F-shaped rail between the beams shall have the function of bisecting the angle between F-shaped rails of adjacent turnout beams, and shall be flexible in rotation without getting stuck.

5.10.2 The shot blasting shall be carried out at the root of overlapped position of angle bisection device of F-shaped rail, in order to increase the fatigue strength.

5.11 Turnout control

5.11.1 Switch control

The switch control shall have two modes: the centralized control and the local control. These two control modes shall switch to each other conveniently by the switcher, and the operation is simple, and the indication is clear.

5.11.1.1 Centralized control

The automatic train control system shall be used to realize the switching of turnout, the automatic train control system sends out the switching command to the turnout control system, and then the turnout control system automatically completes the switching of the position of turnout, and sends out the position indication signal to the operation control system to complete the switching of the position of turnout.

5.11.1.2 Local control

The local control mode includes the local linkage control, local single action control, local emergency control and local manual control.

- a) Local linkage control: After obtaining the authorization for the local operation, the operating personnel gives the switching command of the turnout locally, and then the turnout control system automatically completes the linkage switching of turnout and gives the feedback of the position indication signal to the operation control system to complete the switching of the position of turnout.
- b) Local single action control: After obtaining the authorization for the local operation, the operating personnel gives the single action command of the turnout locally, and then the turnout control system carries out the one-step operation of every operating mechanism of turnout. It is mainly used for maintenance and commissioning, and the turnout control system shall individually operate every motor.
- c) The local emergency control: When there is the failure in the centralized control, local linkage control and local single action control of turnout and it is needed to carry out the switching of the position of turnout, after obtaining the authorization for the local operation, the operating personnel directly operate the motor to realize the switching of the position of turnout. The control loop of this operation shall be independent of the control loop of the above control mode.
- d) Local manual control: After obtaining the authorization for the local operation, the power supply is cut off, and the operating personnel manually operates the motor to complete the switching of the position of turnout.

5.11.2 Authorization control

The turnout shall be under centralized control and also may be under the local control, and the uniqueness and security of control mode shall be guaranteed at any time.

5.11.3 Monitoring and fault alarm

In order to guarantee the safety of driving and equipment, the turnout control system shall carry out the real-time monitoring for the key components and working process of the system, and can send out the alarm signal in time. The monitoring and fault shall include the followings at least:

- a) Main components and working state to be monitored;
 - command relay;
 - locking in-place relay;
 - output relay;
 - unlocking in-place relay;
 - motor switch and thermal relay;
 - main relay of control loop;
 - driving in-place position switch;
 - locking in-place position switch;
 - unlocking in-place position switch;
 - state and time of unlocking action;
 - state and time of locking action;
 - state and time of switching action;
 - state and time of turnout position switching.

b) Fault alarm

In case a certain control unit or component in the control system is abnormal, there shall be the fault display, the control circuit shall be cut off, and the alarm shall be sent out to the operation control system, and alarm shall be given for the following faults:

- switch motor fault;
- locking motor fault;
- given fault;
- output fault;
- switch limit fault
- locking limit fault;
- unlocking limit fault.

5.12 Power supply of turnout

5.12.1 The power load of turnout equipment shall be the first class load.

5.12.2 The turnout control system shall be equipped with the corresponding alternating current power supply and direct current power supply according to the different use types.

5.12.3 The power supply used for position indication, local state, centralized state and fault signal shall be the uninterruptable DC24V power supply provided by the operation control system.

5.13 Infrastructure of turnout

5.13.1 Besides meeting the requirements of the static load, the turnout foundation shall resist the dynamic load and impact load.

5.13.2 In the turnout area, there shall be the safety ancillary facilities, safety isolation facilities and adequate maintenance space as well as the safe passage; the turnout area shall be equipped with the lightening, power supply for maintenance and fire fighting facilities.

5.13.3 The limit deviation of installation height of installed foundation embedded plate is controlled within $\pm 3\text{mm}$.

5.13.4 The trolley running rail connected with the embedded foundation plate should be standard rail, and the installation height deviation is $+0.5\text{mm}$ and -1.5mm , and the rail joint shall not be set, and the stop iron shall be installed at the end of trolley running rail.

5.13.5 The limit deviation of bending radius of trolley running rail is $\pm 3\text{mm}$.

5.14 Corrosion protection of turnout

5.14.1 The anticorrosion treatment shall be carried out at the surface of turnout, and the applied top coat shall be uniform, fine, bright, complete, color consistent, and shall not have the defects such as roughness, missing painting, wrong painting, wrinkles, pin holes and serious sagging.

5.14.2 Before the materials of important metal structural parts are coated, the surface shall be de-rusted by shot blasting to Sa $2\frac{1}{2}$ as specified in GB/T 8923.1, and other components shall reach the de-rusting grade of Sa2 or St3.

5.14.3 When coating, the top coat shall meet the requirements of the sixth coating system given in TB/T 1527; the joint face of high strength bolt shall meet the requirements of the third coating system given in TB/T 1527; when the internal surface of turnout beam is in enclosed spaces, the coating may not be carried out on it. When the internal surface is in open space, it shall meet the requirements of sixth coating system given in TB/T 1527.

5.14.4 The anticorrosive treatment shall be carried out at the exposed metal machined surface.

5.14.5 The anticorrosive treatment such as the chromeplating should be carried out at the surface of locking roller and lockpin.

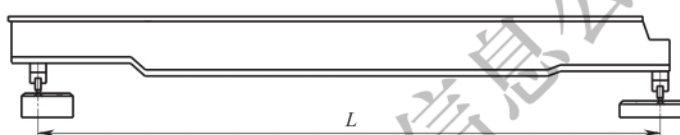
5.14.6 The anticorrosive treatment shall be carried out on all connecting bolts.

5.15 Assembly

5.15.1 In the non-braking state, every assembled mechanism shall rotate flexibly, without getting stuck.

5.15.2 The limit deviation ΔL of span L of turnout beam measured at the diaphragm above two trolleys at both ends (see Figure 12) shall conform to the followings:

- a) If the span $L \leq 10\text{m}$, $\Delta L = \pm 3\text{mm}$;
- b) If the span $L > 10\text{m}$, $\Delta L = \pm 5\text{mm}$.



Key:

L —span of turnout beam.

Figure 12

5.15.3 The position tolerance of wheel under the same trolley frame shall not be more than 1mm, the position tolerance of wheel of different trolley groups under the same cross beam shall not be more than 3mm, see Figure 13.

5.15.4 The clearance L between two adjacent segments of F-shaped rails in the straight line position shall not be more than 40mm. When the turnout is switched to the branch line position, the maximum clearance L of F-shaped rails shall not be more than 55mm, and its minimum clearance shall not be less than 2mm. The limit deviation of track gauge is $\Delta S \leq \pm 1\text{mm}$, see Figure 14.

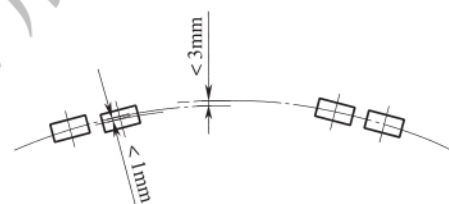
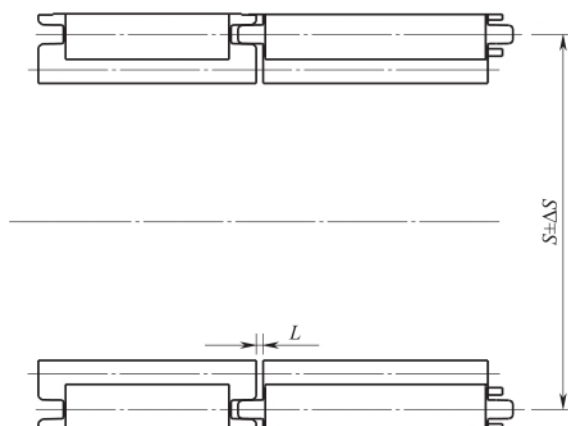


Figure 13



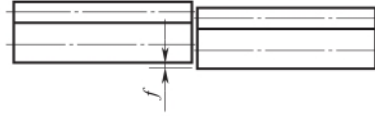
Key:

L —clearance between two adjacent segments of F-shaped rails in the straight line position;

S —minimum clearance.

Figure 14

5.15.5 The misalignment f of the outer edges at the joint between adjacent F-shaped rails shall be less than 0.5mm, see Figure 15.

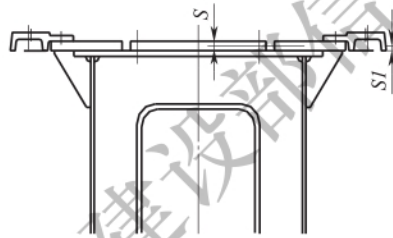


Key:

f —misalignment value of outer edges at the joint.

Figure 15

5.15.6 The difference of height S of magnetic pole faces of F-shaped rails on the same section shall not be more than 0.5mm, and the difference of height SI shall be less than 0.3mm, see Figure 16.



Key:

S —difference of height of magnetic pole faces of F-shaped rails on the same section;

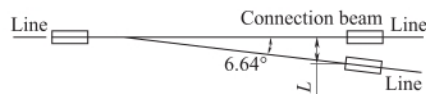
SI —difference of height.

Figure 16

5.15.7 The straightness of the side of F-shaped rail is measured at 50mm high above magnetic pole face, and shall not be more than 1mm/3m or 3mm/total length.

5.15.8 The flatness of magnetic pole face of F-shaped rail in the total length range of turnout area shall not be more than 1.5mm and shall not be more than 0.6mm in 3m range.

5.15.9 The limit deviation of switch distance L at active end of main beam shall not be more than ± 1.5 mm, see Figure 17.



Key:

L —deviation of switch distance.

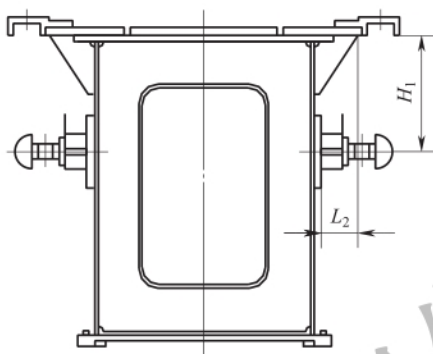
Figure 17

5.15.10 The standard limit deviation of expansion distance of locking rod shall not be more than ± 4 mm.

5.15.11 The return limit deviation of repeated swing of the driving swing arm shall not be more than $\pm 3^\circ$.

5.15.12 The limit deviation of longitudinal spacing of installation plate of power supply rail shall not be more than ± 2 mm, the limit cumulative error shall not be more than 5mm, the limit deviation of the distance H_1 from the installation seat of power supply rail to the top face of the installation seat of F-shaped rail is ± 2 mm, and

the limit deviation of the distance L_2 from the installation seat of power supply rail to the outermost side of the installation seat of F-shaped rail is 6mm to -2mm. See Figure 18.



Key:

H_1 —distance from the installation seat of power supply rail to the top face of the installation seat of F-shaped rail;

L_2 —distance from the installation seat of power supply rail to the outermost side of the installation seat of F-shaped rail.

Figure 18

6 Test methods

6.1 On-line operation test of turnout

6.1.1 Content of test: Inspect the operation performance of turnout and the flexibility of rotation of all the components of turnout, and test the function of control system, and observe whether two control modes are normal in action and accurate in positioning, and whether all the displays are correct.

6.1.2 Test methods: Continuously switch the turnout for 3 000 times. The time interval of each switch is 15s, and at the same time, test the starting current, operation current, switch time, and visually examine the switch action and location display.

6.1.3 Test evaluation: The test passes if there is no failure during the operation, and the operation of driving device and locking device is normal; the driving is smooth and steady; the locking is in place accurately; each driving gear box has no noise and no abnormal temperature rise; the electric control system is stable; the starting current of each phase of motor is within the normal working range; in the case of local linkage, the time required for switching meets the requirements of design, and every action tallies with the display.

6.2 Static load test

6.2.1 Content of test

- a) Inspect the rigidity of turnout structure.
- b) Inspect the bearing capacity of each turnout components.

6.2.2 Test method

The test load is applied on the turnout, and the test load is 1.25 times of rated load, and when loading, it shall be to have no impact:

- a) Visually inspect whether there is obvious deformation or crack on the turnout beam, trolley and turnout baseplate under load;

- b) Place three dial indicators on every section of turnout beam respectively, and the placed position is: on the baseplate of the turnout beam that are 500mm from the center lines of front trolley and rear trolley and in the middle of turnout beam;
- c) Record the downwarping value of turnout beam.

6.2.3 Test evaluation

The test passes if no cracks, permanent deformation, paint peeling or damages affecting the performance and safety of turnout are observed, and the recorded data of dial indicators is within the allowable range of downwarping of turnout.

6.3 Dynamic loading test

6.3.1 Content of test

- a) Inspect the strength of turnout under dynamic load;
- b) Inspect the stability of the vehicle passing through the turnout;
- c) Inspect the vibration characteristics of turnout beam and trolley;
- d) Inspect the reliability and positioning accuracy of positioning system after dynamic loading.

6.3.2 Test methods

6.3.2.1 Park the turnout in the working position on the straight line, and enable the locking device, and the test load that is 1.1 times of rated load, passes through the turnout at the specified speed:

- a) Visually inspect whether the turnout beam, connection device of F-shaped rail and trolley has the unstable action, the swaying after locked, the lubricating oil overflows, the displacement of paint alignment lines of fastener or the cracking of adhesive tape marks;
- b) Before and after the load passes through the turnouts, use the total station to check the precision of interface of the turnout beam and the concrete beam, and record the data;
- c) The dynamic testing equipment is adopted to check the vibration characteristics, acceleration and acceleration time-varying rate of the vehicle, the vibration characteristics of the turnout beam, and the output data are analyzed by software;
- d) Put three dial indicators respectively on each section of turnout beam, and the placed position is as follows: on the baseplate of the turnout beam, which is 500mm from the center lines of the front trolley and rear trolley and in the center of turnout beam, and then record the downwarping value of turnout beam.

6.3.2.2 Transform the turnout to the working position on the branch line, make the locking device in the locked state, and the test load passes through the turnout at the specified speed:

- a) Visually inspect whether the turnout beam, connection device of F-shaped rail and trolley has the unstable action, the swaying after locked, the lubricating oil overflows, the displacement of paint alignment lines of fastener or the cracking of adhesive tape marks;
- b) The dynamic testing equipment is adopted to check the vibration characteristics, acceleration and acceleration time-varying rate of the vehicle, the vibration characteristics of the turnout beam, and the output data are analyzed by software;
- c) Before and after the load passes through the turnouts, adopt the total station to check the precision of interface of the turnout beam and the concrete beam.

6.3.3 Test evaluation

The test passes if the bolt connection and welding area of turnout are not loose or damaged, without abnormal swaying, and after the vehicle passes, the precision of the interface of each part shall conform to the requirements

as specified in 5.15.4 to 5.15.12; the natural vibration frequency of the turnout is not more than 10Hz.

6.4 Electromagnetic compatibility (EMC) test

6.4.1 When the design of turnout control equipment conforms to the following requirements specified in 7.10.2 of GB/T 7251.1-1999, the immunity test or emission test may not be performed on the final complete set of equipment:

- a) The combined devices and components designed according to the specified environment conform to the current relevant national product standards or general EMC standards;
- b) The internal installation and wiring is carried out according to the directions of the device manufacturer (regarding interaction, cable shielding and grounding and etc.).

6.4.2 Purpose of test

Inspect and evaluate the electromagnetic compatibility (EMC) performance of turnout control equipment.

6.4.3 Content of test

- a) Immunity test

The following tests are used to verify the anti-interference performance, see Table 4.

Table 4 Requirements of immunity test

Type test item	Required test grade
Surge 1.2/50 μ s to 8/20 μ s	2kV (line-PE)
GB/T 17626.5	1kV (line-line)
Fast transient impact	2kV
GB/T 17626.4	10V/m
Electromagnetic field	-
GB/T 17626.3	-
Electrostatic discharge	8kV/air discharge
GB/T 17626.2	-

- b) Emission test

The Emission limit shall be verified according to Grade A of standard CISPR 11.

6.4.4 Test methods

The testing is carried out according to the methods specified in GB/T 17626 and GB 4824.

6.4.5 Test evaluation

It shall conform to the specification of 5.15.4 to 5.15.12, and all the functions are normal, the performance is not degraded.

7 Inspection rules

7.1 Delivery inspection

7.1.1 The delivery inspection shall be carried out for every group of turnout, and the contents of delivery inspection include all the items required in 5.5 to 5.10 and 5.14 to 5.15 as well as the requirements of design drawings.

7.1.2 In the factory, the preassembly of every group of turnout shall be carried out, so that the integrity of components and the correctness of geometric dimensions are inspected, and there shall be provided with preassembly marks.

7.1.3 The operation test of every group of turnout shall be carried out in the factory, the frequency of tests shall not be less than 50 times.

7.1.4 The technical inspection department shall inspect the product item by item according to the product drawings and this standard, and acceptance of the product only after it is qualified in the inspection, and then *Certificate of Conformity* shall be issued to users.

7.2 Type inspection

7.2.1 The type inspection is to inspect the quality characteristic of the turnout according to the items and results of content of test in Clause 6.

7.2.2 In any of the following cases, the type inspection shall be carried out.

- a) The design appraisal of trial manufacture of new products or improved old products;
- b) After the normal production, there are the great changes in the design, process, production equipment and management, which may affect the usage performance of product;
- c) The production resumes after it is suspended for two years and above;
- d) When delivery inspection result is significantly different from that of the previous type test;
- e) The national quality supervision department puts forward the requirement of type test or inspection.

7.3 Test of electric control performance

7.3.1 The test of electric control performance is carried out to inspect control performance according to the provisions specified in 5.11.

7.3.2 In any of the following cases, the electric control performance test shall be carried out.

- a) The design appraisal of trial-manufacture of new products or improved old products;
- b) The national quality supervision department puts forward the requirement of type test or inspection.

8 Safety and environmental protection

8.1 Safety

8.1.1 The safety of turnout control system shall meet the requirements given in TB/T 2615.

8.1.2 The materials, apparatuses and elements adopted for the turnout equipment shall meet the requirements for the manufacture and acceptance of electromechanical products and metal materials products of related standards, and the protection level of electrical elements and electrical cabinets is IP55.

8.1.3 The buffers shall be provided at both ends of the trolley.

8.1.4 The transmission part shall be equipped with the torque limiter, and its comprehensive error shall not be more than $\pm 10\%$.

8.1.5 The exposed moving components shall be equipped with protective facilities.

8.1.6 The turnout shall be equipped with lightning protection facilities.

8.1.7 Non authorized personnel shall be forbidden to enter the turnout area.

8.1.8 The turnout area shall have enough maintenance space, access, the installation condition for the auxiliary facilities and the safe isolation facilities. The turnout area shall have lighting facilities, their illuminance shall

not be less than 50 lx to 100 lx, and the turnout area shall be equipped with the power supply facilities for the maintenance.

8.1.9 The turnout area shall be equipped with monitoring facilities, and the location and quantity shall be determined according to operational needs.

8.2 Environmental protection

8.2.1 Specific preventive measures shall be proposed and implemented for possible environmental destruction and adverse impacts due to construction activities according to design requirements and taking into account the project specific circumstances. After the construction is completed, the construction waste shall be cleared up in time as required by good practice.

8.2.2 The planning and construction of temporary works such as the construction access roads, construction sites and so on shall meet the requirements of local environmental protection.

8.2.3 While the installed turnouts are repaired with paint or the lubricating oil of electromechanical products on the turnout is changed, it shall be take measures to avoid leakage, so as to prevent polluting the water quality and land.

8.2.4 While measuring the noise in the place that is 3.5m from the turnout sound source and 1.2m in height from the ground without other reflecting objects, the turnout noise shall be less than 70dB(A).

9 Marking, packaging, transportation and storage

9.1 The marking, packaging, transportation and storage of the turnout shall meet the requirements given in GB/T 191.

9.2 Marking

9.2.1 Label making

Nameplates shall be produced in accordance with GB/T 13306.

9.2.2 Location and content of label

For the general turnout, it is necessary to put the label in the obvious position in the middle of the driving beam and the contents of label shall include:

- a) Turnout designation, factory logo;
- b) Performance parameters of turnout;
- c) Model or mark of turnout;
- d) Production date or serial number;
- e) Name of manufacturer.

9.3 The packaging of electromechanical products shall meet the requirements given in GB/T 13384.

9.4 Hoisting of the turnout beam shall avoid bending, collision, etc., two places shall be bundled when lifting, and the binding places shall be provided with meet the requirements cushions, and the lifting point is located in the connection place near the trolley.

9.5 When handling the turnout, place the turnout beam, trolley and hinged connecting rod on the flat car for towing, and it is prohibited to drag them directly on the ground.

9.6 The turnout shall be placed stably when storing, put wooden cushions under the turnout and the ground shall be solid.

9.7 The turnout shall be covered and protected properly when placed in the open air.

9.8 The documentation provided with the turnout product include:

- a) Certificate of conformity;
- b) The directions for use and maintenance (including the directions provided with the outsourced equipment);
- c) List of equipment;
- d) Installation drawing;
- e) List of wearing parts;
- f) Other related technical documents.

10 Warranty period

The warranty period is 18 months starting from the day of putting into service after installation provided that the turnout is stored, installed and used correctly, and shall not exceed 24 months starting from the day of delivery.

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