even if there is wheel friction.

3) However, this need not be the case for the diameters of the wheels of rolling stock traveling spaces in which only rolling stock of a structure that is not easily derailed and turnout of a structure that does not easily cause derailing have been installed.

4) "The wheels of rolling stock of a structure that is not easily derailed" refer to wheels of rolling stock of a structure that is not easily derailed, owing to bogie structure, when passing a switch, even if wheel diameter does not conform to the regulations.

(4) Wheel flange

Wheel flange must conform to the following standards.

1) Wheel flange height shall be from 25mm to 30mm (for gauge 0.762m railways, 22mm to 30mm).

2) It must not possibly damage switches.

3) It must not possible cause marked hunting or the like.

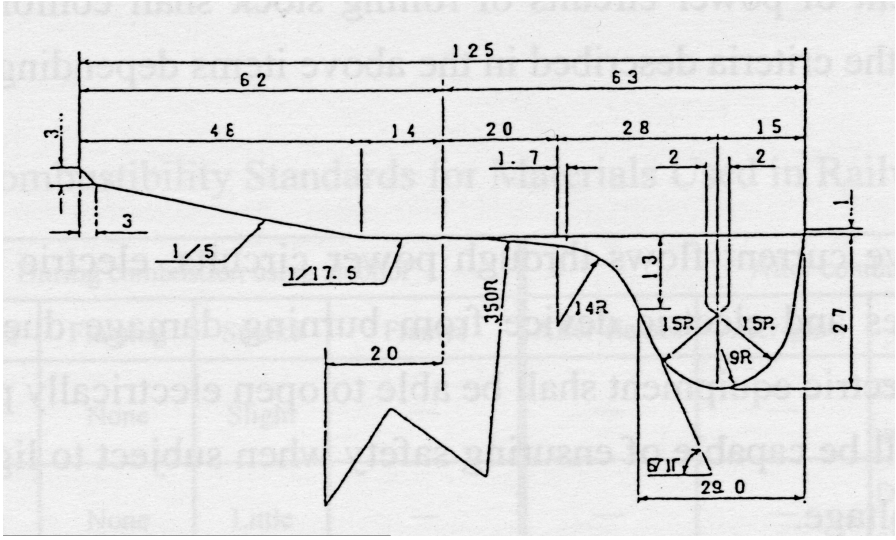


Fig. 5.1.39 Wheel tread of subway rolling stock
Marunouchi Line, TRTA, Tokyo

7.4.3 The suspension mechanism shall have a sufficient buffer capacity and should be capable of securing stable shock absorbing movement against shock from the track.

A suspension mechanism with air springs must conform to the following standards.

(1) The mechanism must be equipped with an air chamber of sufficient capacity.

(2) Even if air leakage occurs that substantially influences spring characteristics, the mechanism must be able to safely support the car body.

7.5 Motive Power Apparatuses

7.5.1 Electric equipment of power circuits of rolling stock shall conform to the following criteria.

(1) Electric equipment shall not cause electric shock and fire accidents when the breakage of electric insulation takes place.

(2) Electric equipment shall not cause any inductive disturbance to other electric circuits.

(3) Current collecting device shall be that which can ensure electric insulation against the car body and which can smoothly follow contact wires while running.

(4) In case of current collecting device being pantographs, they should be able to be simultaneously folded with operation from crew section depending on the purpose of use of each car.

(1) The electric equipment of power circuits of rolling stock shall conform to the following criteria in addition to the criteria described in the above items depending on the electric line voltage.

1) When an excessive current flows through power circuits, electric equipment shall be able to protect wires and electric device from burning damage due to overheating. In addition, the said electric equipment shall be able to open electrically power circuits.

2) Power circuits shall be capable of ensuring safety when subject to lighting voltage or an abnormality high voltage.

3) Rolling stock shall not be able to directly cut off the current by the direct the current collecting device and the direct cutting of the current shall be conducted by electric device other than the current collecting device.

4) Rolling stock shall be able to forcibly interrupt power supply to contact wires at the time of an abnormality.

5) Electric lines

①The parts of electric lines in danger of being damaged by friction or vibration must be protected.

②Electric line protecting tubes and device retracting and protracting openings must not be penetrable by rain.

③Electric lines of different voltages must not be inserted in the same protecting tube. However, this shall not be the case if the electric line in the relevant protecting tube has insulation of the standard for the highest of the voltages applied to the relevant electric lines or when using an electric line that has a similar or greater insulation

effect.

④ Electric lines must be encased in incombustible materials (includes extremely incombustible and nonflammable materials; same hereinafter). However, this shall not be the case if there is no danger of electrical confusion or short-circuiting.

⑤ Regardless of the provisions of the preceding item, electric wires close to devices in danger of generating arcs or heat or electric wires to be connected must be encased in extremely incombustible materials (including nonflammable ones; same hereinafter).

⑥ In the preceding item, "electric wires close to devices in danger of generating arcs or heat or electric wires to be connected" is limited to electric wires that would be influenced by the arcs or heat generated by these devices. In addition, "must be encased in extremely incombustible materials" includes cases in which insulated insulation tubes are used for protection.

6) Combustibility standards for materials used in railway rolling stock

① No flammability, extreme incombustibility, and incombustibility shall be in accordance with the standards for combustibility of materials used in railway rolling stock.

Table 5.1.14 Combustibility Standards for Materials Used in Railway Rolling Stock

Class	During combustion using alcohol				After combustion using alcohol			
	Ignition	Flaming	Smoke	Flames	After-flames	After-glow	Carbonization	Deformation
Nonflammable	None	None	Slight	—	—	—	Discoloration under 100 mm	Surface deformation under 100 mm
Extremely incombustible	None	None	Little	—	—	—	Didn't reach top of test piece	Deformation under 150 mm
	Some	Some	Little	Weak	None	None	Under 30 mm	
Incombustible	Some	Some	Usual	Flames didn't reach top of test piece	None	None	Reached top of test piece	Deformation reached edge; perforations in part

① Dimensions for carbonization and deformation are expressed in terms of the major axis.
② For abnormal smoke emission, the class was lowered by one.
③ Judgment depended on the following test method.

② Test method

a) As shown in Fig. 7.5, in the test method for nonmetal materials for railway rolling stock, the accompanying test material (182 mm x 257 mm) was maintained at a slope of 45°. So that the center of the bottom of the fuel container was 25.4 mm (1 inch) from the bottom, perpendicularly, of the center of the bottom of the accompanying test material, it was placed on a stand made of a material having heat conductivity, like cork. Pure ethyl alcohol (0.5 cc) was added and ignited, and the setup was left alone until the fuel had been all used up.

b)The judgment of combustibility was divided into during and after combustion with alcohol. During combustion, the accompanying test material was observed for the following: ignition, flaming, smoking, condition of smoke, and condition of flames. After combustion, after-flame, afterglow, carbonization and deformation conditions were surveyed.

c)As for how the accompanying test pieces were processed prior to the testing, for moisture-absorbing materials, pieces given the prescribed dimensions were placed in a ventilated room away from direct sunlight, 1m above the floor, and allowed to stand for 5 days.

d)Test room conditions were as follows.

Temperature: 15 °C to 30 °C

Humidity: 60 % to 75 %

There was no airflow.

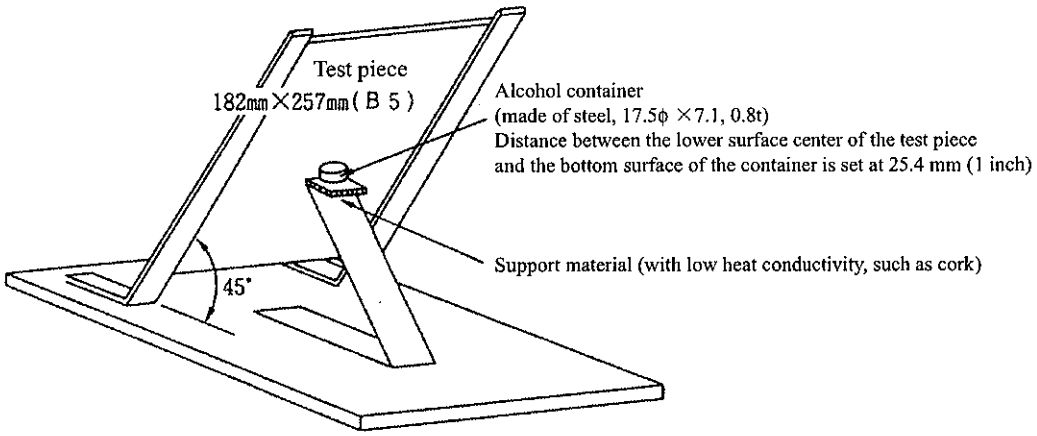


Fig. 5.1.40 Test method

(2) Pantograph

1)A pantograph is a current collecting device that collects current from an aerial single-line electric wire.

2)Although it must be possible to drop the pantograph all at once via operations from the crew's room, in accordance with the rolling stock's usage purpose, when operating a locomotive train, the number of necessary pantographs is low, and in rolling stock where it is possible for crew members to easily raise the pantograph, it is acceptable if it cannot be raised via the mechanical strength of springs.

(3) Devices in danger of generating heat

1)Devices in danger of generating heat must be separated from floors and walls, with nonflammable heat-shielding plates provided in between, as necessary.

2)Among the resistors in the power circuit, devices in danger of generating heat include the main resistors, current-reducing resistors and inductive shunt resistors that generate a comparatively large volume of heat. Not included are voltage meters, wheel slip prevention devices and other such resistors.

(4) Separation from floors and walls, installation of heat-shielding plates and protection of electric wires

1) For passenger cars in subways, etc.

① Electric wiring must not be done within a range encompassed by a plane positioned 150 mm from under the floor and from the side, end and bottom of the power circuit resistor's resistor element. However, for wiring that is unavoidable owing to structure, such as for automatic door closing devices, passenger-room heaters, etc., use heat-resistant encasing. In addition, this shall not be the case for items protected with metal electric wire tubes, the protracting lines and crossovers of power circuit resistors, and items covered with extremely combustible materials.

② The closest crossbeam, leaving 500 mm or more, in the lengthwise direction of the rolling stock, from the power circuit resistor's resistor element, (for rolling stock that does not have crossbeams, a position 500 mm from the resistor element, in the lengthwise direction of the rolling stock) and electrical wiring under the floor between the relevant resistor elements must be protected using metal electric wire tubes, or sealed ducts. However, this shall not be the case if protracting lines from control devices or the like make this method difficult. In such cases, a protracting line within 200 mm of the limits of the range of item "a.," and within 250 mm under the floor must be covered in an extremely inflammable electric insulation material.

③ The sealed duct in the previous item shall not obstruct the ventilation around the power circuit resistor. In addition, the part facing the power circuit resistor within 200 mm of the limits of the range of item "a.," its interior, and its exterior must be covered with a nonflammable heat-insulating material.

④ At the top of the power circuit resistor, at a point 250 mm or more under the floor, provide a nonflammable heat-shielding plate 6mm or more thick and containing heat-insulating material. This heat-shielding plate must not put heat generated from the power circuit resistor under the floor or on the electric wire tubes, ducts, or electric wiring. However, this shall not be the case when a structure with similar or superior effects and dimensions is possible.

2) Passenger cars other than those for subways, etc.

① Electric wiring done within a range encompassed by a plane positioned 350 mm under the floor and from the side and end of the power circuit resistor's resistor element and 150 mm from its bottom, must be protected with metal electric wire tubes or sealed ducts. However, this shall not be the case if this method is made difficult by the power circuit resistor's protracting lines and crossovers.

② The power circuit resistor should be as far as possible from under the floor. At its top there should be a nonflammable heat-shielding plate. This heat-shielding plate must not put heat generated from the power circuit resistor under the floor or on the electric wire tubes, ducts, or electric wiring.

③ Power circuit resistor of the forced ventilation and cooling system

Wiring shall be prohibited inside the ventilation duct (excluding power circuit resistor wiring). Wiring of parts subjected to the hot air from around the nozzle and the use of vinyl chloride electric wire tubes should be avoided to the utmost. When absolutely unavoidable, metal must be used for protection. However, heat-shielding plates will not be necessary.

(5) Electric locomotives

1) In the power circuit for an electric locomotive, a two-way switch and automatic breaker must be provided at a position near the current collecting device. However, this shall not be the case for rolling stock that is supplied with power through the relevant circuit, provided with two-way switch and automatic breaker, of other rolling stock. Here, "a position near the current collecting device" does not refer to a physically close position but an electrically close one. Thus, it does not necessary mean the rooftop.

2) Regardless of the provisions of the preceding item, in electric locomotives operating in spaces with train lines of alternating current, the two-way switch can be omitted.

3) In the power circuit of an electric locomotive that has a pantograph, in addition to the provisions of item "(1)," the following devices must be provided at a position near the pantograph. In this item, "a position near the pantograph" does not refer to a physically close position but an electrically close one. Thus, it does not necessarily mean the rooftop.

① Lightning arrester

② A device that cannot drop the pantograph without the power circuit being cut off (limited to operation in spaces with train lines of alternating current).

③ A protecting contact switch (limited to operation in spaces with train lines of alternating current).

④ When penetrating electrical systems or spaces in which train lines have different standard voltage, equipment that protects electrical devices (limited to electric systems

or operation in spaces in which train lines have different standard voltage).

(6) Release of power circuit

When the power circuit, owing to control device trouble, makes an abnormal closed circuit, other than the regular closed circuit inside it (because the part that generates electric power is included within the relevant circuit, this is a circuit in danger of letting a current larger than the regulations stipulate continue to flow), it must have a device that detects the abnormal closed circuit and automatically opens the relevant circuit.

(7) Induction motor design policy

1) Ensure strength

Aim to make the motor small and lightweight. For the bogie mounting part and mounting bolt, the condition of the rails on the route to be traveled and travel speed should be determined and sufficient strength secured.

2) Set the capacity.

Although capacity can be computed based on rolling stock performance and load conditions on the route used, interchangeability with other routes must also be considered.

3) Consider maintenance.

Determining the actual status of inspections and repairs at the maintenance work site, give maintenance thorough consideration.

4) Select the type of insulation.

As recovery operation at peak load time is the most severe condition, consider the temperature rise at that time and decide the type of insulation in kind.

5) Decide upon the size.

When the bogie's air spring goes flat, the car body will be lowered. Taking this into consideration, determine the size, making sure that the under surface of the rolling stock will not interfere with the traction motor.

(8) Control Design Policies

1) Rail car performance

Rail cars must run properly at full load, and also be capable of, in the event of a failure, ascending the steepest grade in its fully loaded condition as it pushes all the way any other full-load car that may become disabled to start due to the failure.

2) Control of power factor (acceleration) and braking shall not lessen the train's riding quality, and shall improve, insofar as possible, the train's adhesive coefficient and regenerative braking factor. The maximum current of the train, when coupled with cars, shall be within the limits prescribed in contracts with other companies who share the

railway.

3) High-speed circuit breakers and line breakers

High-speed circuit breakers and line breakers shall be designed to provide better maintainability. Their ratings shall be determined by calculations based on car performance and load condition, and shall allow for thermal changes that may occur when they are used continuously over extended periods of time.

4) Filter constant

The constant of the harmonic-suppressor filter provided in the power circuit shall be of such resonant frequency that it will properly suppress the current in case of a failure, and ensure stable control throughout operation, without affecting the signal and communications facilities.

5) Redundancy of the control circuit

The control circuit shall be so configured that it minimizes the reduction of the car performance at the occurrence of a failure.

6) Interchangeability

Where many cars are to be procured from different manufacturers, precautions shall be used to ensure, as much as possible, interchangeability of the control equipment components to improve maintainability.

7) Safeguards

The selection of fuse and non-fuse breaker (NFB) capacities shall be based not only on the current in the control circuit but also on effective protection of the entire system commensurate with other protective devices used within the system.

(9) Series Wound Motor

1) Reasons for selecting this motor type

① Easier to control torque and speed.

② Highly efficient throughout the range of speeds.

2) Maintenance work

① Daily inspection

Daily inspection shall primarily consist of checking if brushes are in good condition and not worn beyond the acceptable level and other inspections to ensure proper brush functioning as they are held in their retainers, as well as cleaning of the insulating support between the brush retainer and the fixed motor frame (yoke) to keep the insulation in good condition.

② Measuring the roundness of commutator profile

The commutator profile shall be measured regularly and corrected if the profile deviates 50 μ meter or more from its concentric location.

③ Brush material management

The brush selected should have good commutation performance, operability, and long life. As for the brush hardness, your selection should be based in particular on the relationship between the commutation performance and brush longevity.

(10) The VVVF Inverter Control System

1) Background

In Europe research focused on the application of AC motors to rail cars partly because their DC motor commutators for trains were less dependable than those of Japanese motors. In 1903, German engineers attained a speed of 210 km/h with their 3-phase alternating current train having 3 pantographs. In Italy a laboratory train driven by an AC locomotive was developed, which was good and nearly usable in actual operation. In the 1960s, DC electric locomotives were modified to employ Thyristor, which resulted in the development of AC motor control systems both in England and Soviet Union. In 1972, the E120Type Electric Locomotive was developed in West Germany. It was a high-output, yet compact, 4-axis driven electric locomotive of 5,600 kW capacity, utilizing 3-phase induction motors and piezoelectric type PWM control inverters. This locomotive was mass-produced. In Japan, JR Kamotsu developed and purchased high-output electric locomotives (6,000 kW) EF200 Type and EF210 Type with VVVF inverter control, and also electric diesel locomotive DF200 Type. Through use of the VVVF inverters in these locomotives, highly adhesive control has been realized in a limited available space with resulting better performance and maintainability.

2) Maintaining the VVVF inverter control system

① Maintenance techniques

The VVVF inverter control system is easy to document the maintenance techniques as compared with DC motor control and therefore is more likely to provide consistent inspection/correction procedures, irrespective of the maintainers' experience and dexterity.

②Reliability

With the increased reliability and standardization of the equipment, the VVVF inverter control system has acquired such additional abilities as the phase-conversion control of induction motors and the slip frequency control. As a result, the system eliminates reversers, accelerators, brake converters, and other high-voltage conversion devices that are used in DC motor control systems. In other words, the system can now be available in the form of static units. This has accelerated the development of unit-by-unit configurations and furthered the improvement of system reliability.

③ Generalization of parts

Mechanical parts are becoming more and more generalized and standardized. Consequently, replacement work has been simplified and maintenance work improved.

4) Program rewriting

Control is digitized. This means that one can edit data (e.g. control algorithm modification or setting of constants) just by modifying the software (rewriting the ROM).

3) Performance

① Trend toward a unit with higher output, more compact in size and lighter in weight

By using an induction motor that requires no commutator for the main motor, it becomes possible to increase rotational speed and maximum RPM. The induction motor does not need to meet the commutation limits or over-current limits at braking as in the DC motor. The only requirements the induction motor must to comply with are ventilation cooling capacity and the structural stiffness of the rotor. The output is the product of torque multiplied by speed. Therefore, the output of the induction motor is greater than that of DC motor of the same size. The induction motor can be smaller in size and lighter in weight than DC motor of the same output.

Table 5.1.15 Comparison of RPM of Traction Motors

Item	DC motor	AC motor	Ratio
Rated rpm	1,550	1,860	1.2
Maximum allowable rpm	4,700	6,320	1.3

② Lower energy consumption and higher regenerative efficiency

The ＶＶＶＦ inverter reduces power consumed by the main register at the time of starting and acceleration of the DC motor control. In addition, its regenerative brake used in association with the high-speed response torque control gives it high efficiency and effectiveness even in areas of low speed due to its high adherence, with resultant advantages of increased regenerative efficiency and reduced energy needs.

③ High adherence and reduced ＭＴ ratio

The combination of the high self-adhesiveness of the induction motor and the computer control over such adhesiveness has resulted in a high adhesive coefficient that is not attainable by conventional control methods. The self-adhesiveness

refers to the phenomena that when wheels are idling at acceleration, the slip factor reduces to reduce automatically the acceleration torque, while when wheels run at braking, the slip factor decreases to cause an automatic reduction of the brake torque. Thanks to the ＶＶＶＦ inverter, the main AC motor is no longer restricted by the switching control used to change the DC motor to series connection at low speed running or switching to parallel connection at high speed running. The AC main motor can remain connected in parallel regardless of motor speed, enabling the train system to be designed more freely than before. It is now possible to change the train formation of electric cars and trailer cars.

4) Motor type

① Synchronous Motor

The synchronous motor is a DC motor which runs synchronously with the frequency of power supply within a certain range of loads. Its rotational speed can be expressed as:

$$Ns = 120\ f/p\ (rpm) \quad \text{---------- (7.5.1.a)}$$

Where;
Ns：rotation per minute
ｆ：frequency (Hz)
ｐ：number of poles

② Induction Motor

The induction motor is an AC motor with windings around its rotor and stator wherein a rotational field is generated by causing an AC current to flow through the primary winding (the winding around the stator). The resulted action of the electromagnetic induction supplies energy to the rotor (the secondary winding) to rotate the rotor. Unlike the DC motor, the AC motor requires no commutator and no brush at its secondary winding; the start of the winding is connected to its end, thus forming a closing circuit, which makes it impossible to energize the rotor coil externally.

In normal operating condition, the rotor runs at a speed slightly lower than the synchronous speed that is dependent on the number of poles and the frequency of the alternating current. There are two types of rotors: Squirrel-cage rotor and wound rotor. The squirrel-cage induction motor is made up of the rotor with a core around which a copper or aluminum bar or wire is wound. The wound rotor induction motor has a slip ring and a brush to use their resistance to control the rotor current, namely, the torque. The wound rotor induction motor has been used on

the Yungfrau railway in Switzerland.

The RPM of the induction motor can be expressed by an equation similar to one used for the synchronous motor but with the use of 6 poles in electric locomotives and 4 poles in trams in most cases. The rotor speed is slightly lower than the field speed of the stator, and this difference is called the "slip." Slip is generally in the range of 2 to 6 Hz.

5) Methods of controlling the VVVF inverter induction motor

Power conversion involves the conversion of voltage, current, frequency, phase, and other factors. A converter or inverter is used mainly to accomplish power conversion; the converter is a device that converts the alternating current into direct current, and the inverter is a device used to convert the direct current into alternating current.

① Voltage-control-type system

This type of system supplies a pulsed wave voltage to the induction motor to wave the current.

a) Advantages are that you can put all components in a single system, the elimination of torque pulsation regardless of the speed used, and the better and easier control of multiple motors.

b) Disadvantages are higher count of semiconductors used in the main and auxiliary circuits, use of a main filter and a commutating condenser and, therefore, increased weight and reduced reliability of the system. The need for an auxiliary inductance also increases commutation loss.

② Current-control-type system

This type of system supplies a pulsed wave to the induction motor to wave the voltage.

a) One advantage is that you can protect the system easily. Other advantages include that the system can incorporate the slow-switching Thyristors, and that the power circuit can be simplified.

b) Disadvantages are that the system is a chopper-inverter hybrid and, therefore, a complicated system, larger torque pulsation at low speed, and the need for high control technology to obtain stable control.

6) Methods of cooling the switching devices

① Heat pipe cooling

② Cooling by dip boiling

③ Cooling by non-dip boiling

7) Unit of power circuit controls

① Concentrated car control in 2 groups

The use of IGBT switching technology results in a design that controls with

(2) A doorway for the crew shall be an inward opening door or sliding door when located on the side of a car. If a door indicator is attached, however, the door may open outward. When the door is opened outward, the distance between the door and the clearance limit shall be 75 mm or more.

7.9.2 The front and sides of the crew section shall provide the field of view required for operation by the crew in accordance with the operating conditions.

Providing the necessary field of view in accordance with the operating conditions means to give the crew a necessary sight under any weather conditions, such as rain and snow.

7.10 Structure of Passenger Doorway

7.10.1 Passenger doorway will have a structure, which ensures the safe and smooth boarding and alighting of passengers, and there shall be no danger of passengers stumbling.

Door for aged and physically handicapped passengers

On-board indicator

An on-board indicator above door shall display the destination, next, and arriving station names, with a sound from the door opening or closing side.

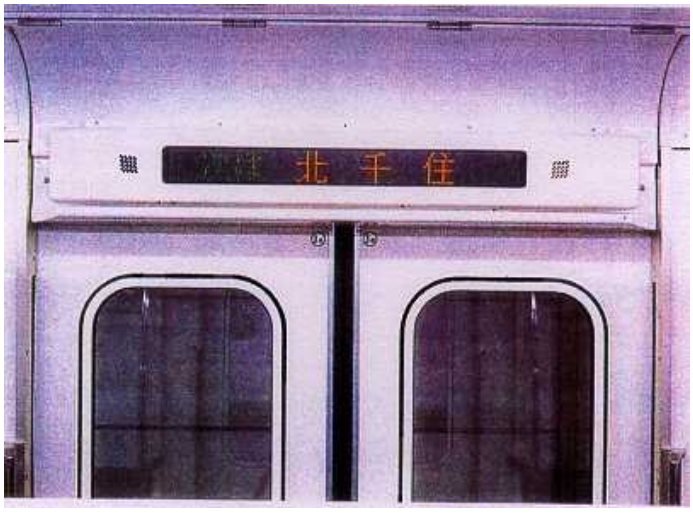


Fig. 5.1.42 Passenger Doorway

7.10.2 The level difference between the doorway and the platform shall be as small as possible.

Passenger doorway

(1) A passenger car shall have a gateway on each side.

(2) A passenger doorway shall conform to the following criteria:

1) The effective width shall be 660 mm or more.
   ① The effective width shall preferably be 1,000 mm or more for a train mainly used by commuters or students in a large cities or in their suburbs.
   ② The effective width of a doorway section higher than 1,700 mm may be reduced within the range not affecting boarding or alighting.
2) The effective height shall be 1,800 mm or more.
   ① Effective height means the height from the floor, excluding that of the sliding door rail.
3) A passenger car door shall satisfy the following requirements:
   ① The door shall slide or open inward.
   ② The door shall be equipped with an automatic door-closing device.
4) The level difference between the passenger car floor or footstep and the platform shall be minimized. In this case, the floor or footstep shall be higher than the platform if the passenger safety or smooth boarding/alighting is not disturbed.
5) A car requires a footstep of 380 mm/step max in height and 260 mm min in effective width for the doorway if the floor is more than 380 mm higher than the platform when the car is empty.
6) The footstep requires anti-slipping measures.
7) A passenger doorway with a footstep requires a handle for safe boarding and alighting.

(3) The automatic door-closing device shall conform to the following criteria:
1) The device shall work safely and securely.
   ① Safe working includes slowdown of the closing speed immediately before the passenger door closes to the full.
2) A train shall have a structure that permits departure only after doors are closed, excluding ones on passenger cars.
   For departure after door closing, an internal-combustion engine train blocks the power transmission system and an electric train blocks the main circuit.
3) Even when cars are connected, the doors shall permit simultaneous opening and closing.
4) A train shall have an operating device to lock the doors electrically or mechanically.
5) The automatic door closing device shall work normally even if the electric or mechanical locking is released and the operating device is set to the unlock position when the train is in motion.
   "In motion" means that the train is running at 10 km/h or higher speed but the preferable speed is about 5 km/h.
6) The automatic door-closing device shall work normally even when the main power supply fails.

(4) A passenger car with a passenger doorway shall have a lamp that automatically lights when the door is opened.

(5) The lamp shall conform to the following criteria:

1) Located at an upper part on each side of the car

2) Lit in red

3) Easy to distinguish from other lamps

4) Not disabled even when the main power supply fails

7.11 Structure of Passenger Doorway and Gangway

A passage doorway and gangway shall have a structure, which allows the safe and smooth passage of passengers and endures the evacuation of passengers to other connected cars at the time of an abnormality.

Passenger doorway and gangway

(1) A passenger car shall have one or more doorways and gangways, except when the car mainly runs alone.

(2) Irrespective of (1), a passenger car for subway shall have doorways and gangways two each (one each for a car at the head or tail of a train or mainly connected to an engine). The first or last car of a train running on a third-rail track, however, shall have two doorways and one gangway.

(3) A doorway shall conform to the following criteria:

1) The effective width shall be 550 mm or more but may be 400 mm for a car running on a track whose gage is 0.762 meter.

2) The effective height shall be 1,800 mm or more.

3) A doorway at the front of the first car of a train or at the rear of the last car requires a door.

4) A door at a doorway shall be of the sliding type (including a plug door). The door prescribed in 3) can always be closed securely and held open on the connected side.

(4) A gangway shall satisfy the following criteria:

1) The effective width shall be equal to or more than that of doorway.

2) The effective height shall be 1,800 mm or more.

3) A remarkable level difference or any other traffic disturbing factors shall be permitted.

4) A hood and gangplank shall be prepared to ensure smooth passage without falling or tripping due to vibration or shock.

① A hood shall include handrails to ensure smooth passage through a connected section when the train is running. In this case, a door shall be prepared at the doorway with an emergency passage sign and kept closed for easy opening in an emergency case only.

(5) A hood for a doorway of a subway passenger car shall be made of a fire-resistant material.

(6) A doorway for aged or physically handicapped passengers shall conform to the following criterion:

The door width between cars shall be extended from 800 to 900 mm for the easy passage of a wheeled passenger in case of emergency.

Fig. 5.1.43 Gangway

7.12 Structure of a Passenger Car

The structure of a passenger car shall not hamper safe use by passengers and shall conform to the following criteria:

(1) A passenger room shall be safe and comfortable to use.

(2) A passenger room with a ventilator shall be ventilated even when the power supply from the overhead trolley fails.

1) For natural ventilation, the total area of passenger room windows shall be 1/20 or more of the floor area of the car.

2) The ventilating capacity of the ventilator shall be for double the seating capacity of the car on the assumption that the hourly ventilation per passenger is 13 m^3. If the car does not accept passengers beyond the seating capacity, the necessary ventilating capacity just for the seating capacity is enough.

(3) A sunshade shall be made of a flame-resistant material.

(4) A passenger room shall be equipped with a transmitter for an emergency alarm and an operating device for an emergency stop, except when the car has a driver or conductor

section and a passenger can easily notify of the conductor.

(5) A passenger room shall have a receiver for an on-board broadcasting system, except when the car mainly runs alone.

(6) When necessary, a passenger room shall have heating or cooling equipment.

(7) Aisle

1) A passenger car requires an aisle from a doorway to seats, except when passengers can take seats directly from the doorway.

2) An isle shall conform to the following criteria:

① The isle shall be safe and easy to pass.

② The effective width shall be 550 mm (450 mm for a section not higher than 800 mm from the floor) or more.

③ The effective height shall be 1,800 mm or more.

Fig. 5.1.44 Passenger room cooling equipment

7.12.1 When open, the windows shall not contact any ground facility nor pose any danger of passengers falling off.

(1) A window shall conform to the above criterion if the car runs on a track where the interval between the clearance limit and the rolling stock gage is 400 mm on one side of the car. If the interval is less than 400 mm but 200 mm or more, the car shall have a structure that prevents a passenger from leaning out of a window.

(2) A window shall satisfy the following criteria:

1) The window shall open outward.

2) The lower edge of a passenger opening section shall be 800 mm or more from the floor

face for a window beside or behind a seat but 1,200 mm or more for a window on the aisle.

7.12.2 Windows shall have sufficient strength.

A window shall have a safety glass pane or a pane of an equivalent or higher strength.

7.12.3 The passenger room shall have lighting equipment required at night or when running through tunnels, and shall be maintained bright enough to endure safety at the time of an abnormality.

A passenger room shall have appropriate spare lighting equipment that lights automatically in case passenger room lighting equipment fails even when the main power supply fails.

(1) A passenger room lighting equipment failure means that the main power supply fails.

(2) Appropriate spare lighting equipment shall have a lighting intensity of two 10W incandescent lamps per 10 m of rolling stock. If the main power supply fails, the spare lighting equipment is expected to be lit for 30 minutes or more when the emergency equipment is in operation.

7.12.4 Toilets shall be provided depending on the usage and operation distance of rolling stock.

As a rule, a toilet shall be of the tank type.

(1) “As a rule” means that the railroad operator shall be guided by considering the installation status of wastewater disposal facilities and the conditions along the railroad tracks.

(2) A tank-type toilet is not open.

7.12.5 At least one car of the passenger train shall be provided with a space to accommodate wheelchairs.

(1) Passenger seat

1) A passenger car shall have an appropriate number of passenger seats, except special cars.

2) Passenger seats shall be covered and padded with flame-resistant materials.

3) Standing room may be prepared at floor space other than that reserved for seats.

4) Standing room shall be equipped with hand straps, handrails, and other items to ensure the passenger safety.

Fig. 5.1.45 Wheel chair space

(2) Wheelchair space

Fig.5.1.45 shows a wheelchair space prepared in the second car from the beginning. For emergency contact with the conductor, an emergency verbal communication device is at hand.

7.13 Structure of Emergency Exit

Rolling stock shall have emergency exits through which escape can be easily made in an assured manner if the structure of rolling stock makes emergency escape difficult and this emergency exit shall have a mechanism to verify its state of opening or closure.

(1) It is difficult to make emergency escape if the car has only one emergency exit.

Fig. 5.1.46 Emergency Excite under Quarterly Inspection
06 series of subway rolling stock, Chiyoda Line, TRTA, Tokyo

(2) An emergency exit shall conform to the following criteria:

1) The emergency exit ensures easy escape.

For easy escape, there shall be no disturbing level difference or projection at or near the exit.

2) The effective width shall be 400 mm or more.

3) The effective height shall be 1,200 mm or more.

4) The door shall satisfy the following requirements:

① An inward-opening or sliding door shall be used.

② The door shall always be closed securely.

③ In case of emergency, the emergency exit can be opened manually from inside or outside the car and does not close again by the self weight.

The emergency exit may be opened manually from outside the car with the crew intervention but can be opened easily from inside without a key or any other special tool.

5) At or near an emergency exit, the location and handling instructions shall be indicated at an easy-to-see form for passengers.

6) Indications of the location and handling instructions of an emergency exit shall conform to the following criteria.

① If a lamp indicates the location of an emergency exit, the color of a lamp shall be g reen.

② A lamp shall be not disabled even when the main power supply fails

7) A passenger car with an emergency exit shall have a lamp that automatically lights when the emergency exit door is opened.

8) The lamp shall be attached to an upper part on each side of the car.

9) The lamp shall be easy to distinguish from other lamps.

10) The lamp shall be not disabled even when the main power supply fails.

11) A lamp doubled as another lamp shall be easy to distinguish from other lamps by the lamp form or with an indicator in the driver or conductor section.

7.14 Coupling Device

The device required to connect rolling stock shall be solid with sufficient strength and shall be capable of connecting the cars securely withstanding vibrations and impacts.

Coupling device

(1) A coupling device shall conform to the following criteria:

1) The device shall have a sufficient strength to endure operations.

2) Cars can be interconnected securely and shall not be released even under vibration or shock.

3) Contacting a car shall connect its coupling device automatically, except when the coupling device is for an engine, securely connected car, or relief.

4) A coupling device shall have a buffering function, except when the coupling device is for an engine or relief.

① A coupling device with a buffering function mitigates a connection shock.

② An air tube coupling device shall interconnect rolling stock air tubes securely to prevent vibration or shock form causing an air leakage.

③ An electric wire coupling device shall interconnect rolling stock electric wires securely to prevent rainwater from leaking in or vibration or shock from causing contamination or short circuit.

7.15 Structure of Rolling Stock for Transport of Special Cargo

Tankers and other freight cars for the transportation of special cargo shall have a structure to prevent disasters originating from the said cargo.

(1) Tanker

1) A tanker shall have a tank securely attached to the chassis frame with sufficient spaces between the front and rear ends of the tank and those of the chassis frame.

2) A tank for transporting a hazardous liquid (inflammable, acidic, corrosive, or volatile) shall conform to the following criteria:

① A copper plate shall be 9 mm or thicker and a mirror plate 12 mm or thicker. Manhole and inlet lids shall be 6 mm or thicker steel plates or have the equivalent or higher strength and durability.

② Protective devices shall be attached to projecting valves and inlet accessories.

③ A tank for transporting a hazardous liquid shall have a grounding device if static electricity is anticipated to cause a disaster.

(2) Automobile carrier

Open automobile-carrying rolling stock for an AC overhead trolley section shall have devices to connect the automobiles and the rolling stock electrically.

7.16 Equipment of Driver Section

The driver section, which is used to operate rolling stock, shall be equipped with such devices and equipment as acceleration and deceleration control and others required for operation in accordance with the usage of rolling stock.

(1) The driver section in the first car of a train or in an engine used only to operate rolling stock shall be equipped with the following devices and facilities:

1) Control facility operating device

2) Control device for normal brake equipment

3) Transmitter and receiver for a sign or verbal communication device if the rolling stock has such a device

4) Speedometer

A speedometer shall be lit, self-illuminated, or coated with a luminous paint on the dial and needles.

5) On-board signal display if the rolling stock that runs on a track where on-board sign

equipment is necessary

6) Equipment status display if the rolling stock runs on a track with automatic train stop, control, or run equipment, and on-board equipment release switches

① The release switches shall be difficult to access from the driver at the regular position.

② "Difficult to access" means that the switches are located where the driver cannot operate from the regular position or covered with protective materials.

7) Device to lower pantographs if the rolling stock has pantographs

8) Protective grounding switch if the rolling stock has a protective grounding device

9) Transmitter and receiver for safety communications facilities if the rolling stock has such facilities

10) Alarm buzzer and transmitter for alarming facilities if the rolling stock runs on a track equipped with such facilities. The driver section of an engine used only to operate rolling stock, however, may not have these devices.

11) Blower blasting device

12) Pressure gage indicating the pressure of the source tank tube

① A pressure gage shall be lit, self-illuminated, or coated with a luminous paint on the dial and needles.

② A pressure gage shall indicate the upper and lower limit pressures of a pressure regulator, except a digital pressure gage indicates differently when the pressure becomes lower than the lower limit pressure or higher than the higher one (Pressure-gage indicating the pressure intermittently at fixed intervals).

13) Front beacon light control device

14) Wiper control device

(2) In addition to the devices above, the driver section in the first car of a passenger train (including a train containing a passenger car) shall be equipped with the devices listed below, except when the driver section is on an engine.

1) Device indicating the operating status of a receiver for emergency verbal communication device or an emergency stop device

2) Device indicating the status of emergency doors

This device shall include a sound-alarming device. The sound alarm, however, shall be easy to distinguish from other sound alarms.

3) Device indicating the status of passenger doorways

① This device shall enable a crew member to confirm that all passenger doorways are closed.

② When a doorway is closed, the opening between the door edges shall be 30 mm or less. If the doorway has a single door, this rule applies to the opening between the door edge and the doorstop of the car.

7.17 Automatic Door Control Device

7.17.1 The automatic door control device installed at the doors of passenger doorway shall be capable of securing the safety of passengers while the rolling stock is running and shall allow the simultaneous opening or closing of all doors and verification of the door status of opening or closure by a crew member.

7.17.2 The doors equipped with an automatic door control device (hereinafter referred to as "automatic doors") shall allow their manual opening at the time of an emergency.

(1) Rolling stock shall have internal and external emergency devices to allow manual door opening in case of emergency. The internal devices shall be easy for passengers to use, except when the rolling stock runs on a third-rail track.
   1) The location and the way of handling an internal device shall be indicated where passengers can see easily but shall not if the rolling stock runs on a third-rail track.
   2) The indicated contents shall be identifiable even when the main power supply fails.
   3) A door shall have a handrail at the center height inside and at the lower position outside. A folding door, however, may not have the external handrail.
   4) A sliding door may be a so-called plug door that opens and closes by sliding outward.
   5) An emergency manual door-opening device refers to a door opening cock if the automatic door-closing device is driven by an air pressure.
   6) An internal device for emergency manual door opening shall be easy for passengers to use. The position, size, and color of indication shall be designed to make not a small number of passengers see the location and handling instructions even when the car is crowded. Emergency instructions shall also be given to make passengers notify the crew of emergency and follow the crew because it is dangerous to go out of the car disorderly.

(2) Automatic doors shall have a mechanism to prevent the start of a train before their closure. This requirement shall not apply, however, if the station facilities and rolling stock have devices to confirm the safety of passengers on the platform.

7.18 Air Compressor and Accessories

The air compressor (source of compressed air) shall be capable of preventing abnormal rise of the compression pressure and functional decline due to the water produced by air compression.

Internal pressure vessel and accessories

A rolling stock internal pressure vessel and its accessories shall conform to the following criteria, except a vessel (for other than brake equipment) to accumulate a non-compressed

gas whose pressure at the working temperature (gage pressure) is 2 kg/cm^2 or more, internal diameter is less than 200 mm, length less than 1,000 mm, and capacity is less than 40 liters.

(1) A source air tank shall have a drain cock (including a water drain cock if the tank receives an air supply from an air compressor with a dehumidifier) or an automatic drainage system.
A drain cock shall be protected if its damage by foreign matter is anticipated.

(2) An internal pressure vessel shall be installed at an easy-to-inspect place.

(3) An internal pressure vessel and piping shall be installed carefully to prevent damage by vibration or shock.

(4) A safety valve shall prepared on a source air tank or near the connection of the tank and its piping.

1) A safety valve shall work within 0.5 to 1.0 kg/m^2 of the maximum working pressure of the source air tank and have an appropriate blowout rate.

2) Even when there are several source air tanks, there may be only one safety valve at the nearest tank to the air compressor or the piping between the nearest air tank and the next one.

(5) An air compressor shall have a pressure regulator.
If a train has two or more air compressors linked through air piping, a pressure regulator is not necessary for each air compressor.

7.19 On-Board Devices
On-board devices shall conform to the following criteria.

(1) Emergency stop device

1) An emergency stop device shall conform to the following criteria:

① At or near an emergency stop device, the location and handling instructions of its operating device shall be indicated clearly for passengers.

② The indicated contents shall be identifiable even when the main power supply fails.

③ The function shall permit manual release.
The receiver cannot release the function easily at his or her own discretion if the function does not permit manual release.

④ The function shall work even when the main power supply fails.

2) A passenger car equipped with emergency stop devices shall have lamps that automatically light if the devices are used, except when a used emergency stop device can be located with a indicator in the driver and conductor sections.

3) The above lamp shall conform to the following criteria:

① Located at an upper part on each side of the car

② Easy to distinguish from other lamps

③ Not disabled even when the main power supply fails

4) The passenger room of a car running on a third-rail track shall not have an emergency

stop device.

(2) Front beacon light

1) A car with a driver section shall have front beacon lights.

2) A front beacon light shall conform to the following criteria:

① Easy to confirm from ahead of the train at night

② Lit in white

③ Attached symmetrically at the center of the car

④ Permitting dimmering and downward lighting

3) The front of a train shall be free of lights easy to be taken as rear beacon lights.

(3) Rear beacon light

1) A rear beacon light shall conform to the following criteria:

① Easy to confirm from rear of the train at night

② Lit in red

③ Not disabled even when the main power supply fails

2) The rear of a train shall be free of lights easy to be taken as front beacon lights.

(4) Electric circuit other than the main one

A rolling stock electric circuit other than the main one shall have the following devices on the power supply side

1) Fuse (including an item of the equivalent or higher performance), except when the car receives power supply from another car through a circuit with a fuse

"Item of the equivalent or higher performance" refers to a non-fuse breaker.

2) Switch for the power supply circuit of an electric generator, a power converter for static inverter, or an air compressor motor, except that of an air compressor motor that receives power from a power converter with a switch

A switch shall permit manual operations.

(5) Fire alarm

A sleeping car shall be equipped with fire alarms (only of the type that detects a fire automatically by sensing heat or smoke).

7.19.1 Rolling stock shall be equipped with device, which allows verbal communication or the exchange of signs between crewmembers or between a crewmember and ground staff, depending on the facility conditions.

(1) The conductor section of rolling stock shall be equipped with the following devices:

1) Control device for normal brake equipment (only of the type to stop a train quickly)

2) Transmitter and receiver for a sign or verbal communication device if the rolling stock has such a device

(2) In addition to the devices above, the conductor section of a passenger train shall be equipped with the following devices:

1) Transmitter for on-board broadcasting system
2) Control device for the automatic closing device of passenger doorways
3) Device indicating the operating status of a receiver for emergency verbal communication device or an emergency stop device
4) Device indicating the status of passenger doorways
The function shall not be disabled even when the main power supply fails.

(3) The devices prescribed in 1 and 2 above shall be easy for the conductor to operate or confirm.

(4) Sign device
1) A car where the conductor issues a departure sign shall have a sign device, except when a sign device at each station is used to issue a departure sign.
2) A sign device shall conform to the following criteria:
① Transmission and reception shall be permitted only between crewmembers.
② The function shall not allow manual release.
The receiver cannot release the function easily at his or her own discretion if the function does not permit manual release.
③ The function shall not be disabled even when the main power supply fails.

(5) Verbal communication device
1) A passenger car shall have a verbal communication device (including a portable device), except when the car mainly runs alone.
2) A verbal communication device shall conform to the following criteria:
① Transmission and reception shall be permitted only between crewmembers, except when normal communication between crewmembers can be ensured.
Normal communication means that even a verbal communication device with a function for other communication gives priority to communication between crew members for no communication problems.
② The function shall not allow manual release.
The receiver cannot release the function easily at his or her own discretion if the function does not permit manual release.
③ The function shall not be disabled even when the main power supply fails.

(6) On-board broadcasting system
1) A passenger car shall have an on-board broadcasting system, except when the car mainly runs alone.
2) An on-board broadcasting system shall conform to the following criteria:
① The system permits broadcasting to all passenger rooms.
② The function shall not be disabled even when the main power supply fails.

(7) Emergency notifying device
1) A passenger car shall have an emergency notifying device, except when the car has an

emergency stop device or runs alone or with one more car only.

2) An emergency notifying device shall conform to the following criteria:

① At or near an emergency notifying device, the location and handling instructions shall be indicated in an easy-to-see form for passengers.

② The indicated contents shall be identifiable even when the main power supply fails.

③ The function shall not allow manual release.

The receiver cannot release the function easily at his or her own discretion if the function does not permit manual release.

④ The function shall not be disabled even when the main power supply fails.

3) A passenger car equipped with emergency notifying device shall have lamps that automatically light if the devices are used, except when a used emergency notifying device can be located with a receiver in the driver and conductor sections.

"Receiver" includes one supporting verbal communication with the transmitter prescribed in (4).

4) "Lamp" prescribed in (3) shall conform to the following criteria:

① Located at an upper part on each side of a car

② Easy to distinguish from other lamps

③ The function shall not be disabled even when the main power supply fails.

Fig. 5.1.47 Emergency notifying device

7.19.2 The car at the front end of the train shall have a device capable of warning of danger by means of a whistle at its front end.

(1) Whistle

1) A car with a driver section shall have a whistle.

2) A whistle shall conform to the following criteria:

① The whistle shall have a sufficient volume to warn of a danger.

② The function shall not be disabled even when the main power supply fails.

(2) Car of a train without a conductor

1) Device of the driver section

① The driver section in the first car of a train shall have a device to stop the train quickly if the driver cannot continue driving, except when the train runs automatically on an underground or elevated track.

The device shall work if the driver becomes sick during work and can no longer drive the train.

② The device to stop the train quickly if the driver cannot continue driving shall conform to the following criteria:

a) For a subway passenger car, the device shall automatically notify the depot or commanding center of the device activation.

b) The function shall not allow manual release.

c) The function shall not be disabled even when the main power supply fails.

③ The driver section in the first car of a train shall have a transmitter for the on-board broadcasting system and a device to control the automatic door closing devices for passenger doorways. These devices shall be easy for the driver to operate at the regular position.

The regular position is where the driver checks passenger boarding and alighting.

2) On-board facilities for safety communication

① The first car of a train shall have on-board facilities for safety communications, except when ground communication facilities.

When telephone a along a track is used, ground communication facilities shall have a telephone unit (connection terminal if a portable telephone is mounted on the train) at the depot and every 500 m along the track.

② On-board facilities for safety communication shall conform to the following criteria:

a) Transmission and reception shall be permitted between the train and the depot or commanding center.

b) The device shall not be used both for on-board broadcasting and emergency alarming.

c) The function shall not allow manual release.

d) The function shall not be disabled even when the main power supply fails.

3) Emergency notifying device

Passenger cars of a train without a conductor shall have emergency notifying device, except when the train has an emergency stop device or mainly runes alone.

7.20 Marking on Rolling Stock

Rolling stock shall have a marking, which allows the identification of individual cars.

(1) A symbol number shall be marked on an engine.

A symbol number identifies a car.

(2) The following items shall be marked on a passenger or freight car:

1) Symbol number

2) Tare weight of the car

The tare weight shall be up to the first decimal place (unit: ton) with fractions discarded.

3) Passenger capacity and maximum load

① The total number of passengers seated and standing shall not exceed the passenger capacity.

② The passenger capacity of a sleeping car or any other special car shall be determined according to the car structure.

(3) A special car shall have a marking of tare weight.

7.21 Fire Prevention and Control Measures for Rolling Stock

7.21.1 Fire prevention and control measures for the wires and equipment on-board rolling stock shall conform to the following criteria.

(1) On-board wires shall not cause fire or spreading of fire even in the presence of anticipated heat generating sources.

(2) On-board heat generating equipment shall not adversely affect other sections of rolling stock.

Anti-fire measures on an internal-combustion engine

(1) When the smokestack of exhaust piping is relocated or the car body is altered near the smokestack, thermal insulation between the smokestack and the car body shall be strengthened.

(2) Fire alarm devices shall be installed if the rolling stock is new and the crew cannot find a fire easily at or around the internal-combustion engine due to the number of cars connected and the placement of crew.

(3) Automatic fir extinguishers shall be installed on new sleeping cars and power supply cars mainly used with sleeping cars.

(4) When altering the exhaust piping, the rolling stock new or existing shall have an oil sump and a drain plug shall be attached to the bottom of the silencer if the exhaust

piping may be overheated because the rolling stock should be kept idling for a long time and run on a long gradient track.

7.21.2 Fire prevention and control measures for passenger cars shall conform to the following criterion:
Fireproof materials shall be used for the inside of rolling stock.

The body of a passenger car shall conform to the following criteria:

(1) The roof shall be made of a metal or another material of the equivalent or higher flame resistance.
"Roof" refers to the part of car body higher than the gutter or drain.

(2) The roof of a passenger car running in a DC overhead trolley section shall conform to the following criteria:
1) The rooftop shall be covered with a noncombustible insulating material.
2) Equipment and metal things on the rooftop shall be insulated from the car body at the attached sections and covered with a noncombustible insulating material.
3) The floor shall have a structure that does not let smoke or fire through easily.
4) The floor bottom face shall be covered with a noncombustible material or a metal plate.
5) In addition to the above, the body of a subway passenger car shall conform to the following criteria:
① A heat-insulating or soundproof material shall not be combustible.
② The padding under the floor covering shall not be combustible.
Padding means what is padded under the floor of a keystone structure, including hard boards and waterproof plywood boards between the metals or the metal and floor covering.
③ The floor plate shall be made of a metal or another material of the equivalent or higher flame resistance.
④ The surface coating of the floor bottom face shall not be combustible.
a) "Surface coating" means the top layer coating and does not include the base layer of double coating.
b) If a metal plate is attached under the floor to prevent hot air from the underfloor equipment, the metal plate is regarded as the floor bottom face.
⑤ An underfloor equipment box shall not be combustible. However, a combustible material may be used if insulation is necessary or there is any other due reason.
"Equipment box" shall not include relay or other covers.

7.22 Continued Functioning of Some Devices during Power Interruption

Devices designed to ensure the safety of train operation and passengers, and devices required for passenger evacuation shall be capable of continuing their function for a specific period of time when their main power supply is cut off.

(1) When the brake operation involves electrical circuits, the brake must be operable in the event of a primary power supply failure (no supply of electricity other than from batteries due to cutting off of the supply from the train line or damage to equipment such as motor generator).

(2) If an electric circuit is used for safety brake equipment, braking shall be ensured even when the main power supply fails.

(3) Electric brake equipment (including one for suppressing the speed only) shall satisfy one of the following requirements, except when the equipment works normally without the main power supply:

1) Other power-operated brake equipment replaces the electric brake equipment automatically in case the main power supply fails.

2) Notified of a main power supply failure in the driver section, the driver can activate other power-operated brake equipment.

(4) The automatic door-closing device shall work normally even when the main power supply fails.

(5) A lamp that automatically lights when the door is opened, is not disabled even when the main power supply fails.

(6) The function of emergency stop device shall work even when the main power supply fails. The indicated contents for the location and handling instructions of its operating device shall be identifiable even when the main power supply fails. Lamps that automatically light if the devices are used, are not disabled even when the main power supply fails.

(7) Rear beacon lights are not disabled even when the main power supply fails.

(8) The lamp that automatically lights when the emergency exit door is opened shall be not disabled even when the main power supply fails.

(9) The function of sign device shall not be disabled even when the main power supply fails.

(10) The function of verbal communication device shall not be disabled even when the main power supply fails.

(11) The function of on-board broadcasting system shall not be disabled even when the main power supply fails.

(12) The function of emergency notifying device shall not be disabled even when the main power supply fails. The function of lamps that automatically light if the devices are used, shall not be disabled even when the main power supply fails. The indicated contents, which are the location and handling instructions, shall be identifiable even when the main

power supply fails.

(13) The function of whistle shall not be disabled even when the main power supply fails.

(14) The function of the device to stop the train quickly if the driver cannot continue driving when a train is operated without a conductor, shall not be disabled even when the main power supply fails.

(15) The function of on-board facilities for safety communication shall not be disabled even when the main power supply fails.

Chapter 8 Maintenance of Facilities and Rolling Stock

8.1 Maintenance of Railway Facilities and Rolling Stock

8.2 Inspection and Trial Operation of New Facilities and Rolling Stock, etc.

8.3 Patrolling, etc. When There is Threat of Disaster

8.4 Regular Inspection, etc. of Railway Facilities and Rolling Stock

8.4.1 In regard to the regular inspection of railway facilities and rolling stock, the interval, subject sections and method of inspection shall be stipulated in correspondence with the type, structure and conditions of use, etc. of such railway facilities and rolling stock.

8.4.2 When the regular inspection of railway facilities and rolling stock is conducted, the inspection data, location and contents shall be recorded and stored.

Concerning lines, power facilities, operation safety facilities and rolling stock, periodic inspections shall be carried out at intervals no longer than those indicated below.

(1) Line

1)	Tracks	1 year
2)	Bridges, tunnels and other structures	2 years

(2) Power Facilities

1)	Contact lines, main transformers, feeder side breakers and other important power facilities	1 year

2) Other power facilities 2 years

(3) Operation Safety Facilities

1) Block devices, signals, interlocking devices and other important operation safety facilities 1 year

2) Other operation safety facilities 2 years

(4) Rolling Stock

1) Periodic inspections of rolling stock conditions and functions 3 months

2) Periodic inspections of important parts of motors, running gear, brake devices and other important devices

3 years (new rolling stock is 4 years) or travel distance of 600,000 km (whichever is the shorter period).

3) Periodic inspections on rolling stock in general except for important parts

6 years (7 years for new rolling stock)

Chapter 9 Train Operation

9.1 Boundary of Stations

The boundary of a station shall be the position at which the home signal or home marker is located.

Internal and external station boundaries are indicated in the following drawing.

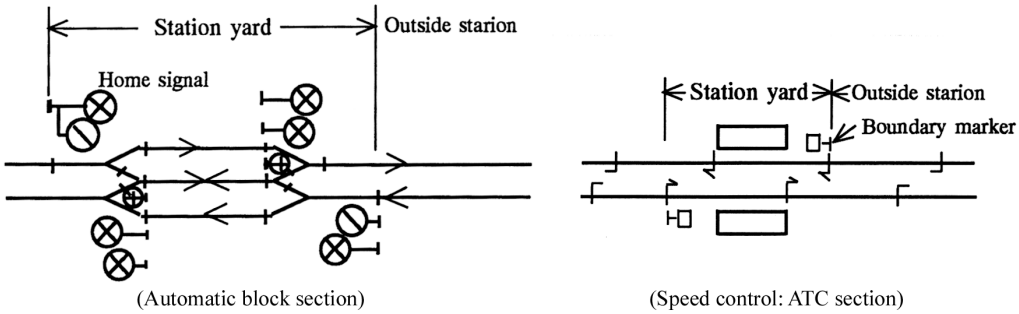


Fig. 5.1.48 Station Internal and External Boundaries

9.2 Train Composition

9.2.1 The maximum number of connected cars of a train shall be determined based on the facility conditions and the performance, structure and strength of the cars.

9.2.2 The integrated braking force of a train shall be that which is suitable for the track conditions and operating speed.

9.2.3 The details of the brake test for a train and the method of verifying its operation status shall be stipulated separately.

Train Composition

The maximum number of connected cars of a train shall be determined with consideration given to the effective length of line and rolling stock performance, etc.

(1) Relationship with effective length of line (locomotive-hauled passenger and freight trains)

Number of connected cars = (effective length of line) - (locomotive length + distance allowance)/(1 virtual car length)

Note: 1 virtual car length needs to be set according to actual conditions.

(2) Size of train formations in urban transport (electric railcar trains)

Although this differs according to the transport system, trains are generally made up of between 3-10 car units. As for the relationship between transportation volume and number of trains, there is no definitive relational expression, but it is clear that the number of trains is proportional to the passing transportation volume. Moreover, the rate of increase in the number of trains is smaller than the rate of increase in transportation volume. In particular, the minimum train headway is determined based on comprehensive consideration.

$$Y=aX+b\sqrt{X}+c$$

y: number of trains (number in one direction)
X: transportation volume (passengers traveling in one direction)
a, b, c: constants

There is a limit to the number of trains depending on the operating system, etc. Even if ATC is introduced, the minimum headway is no less than 1.5-2.0 minutes (40-30 trains/hour).

Transportation capacity is obtained by the following expression: boarding capacity x number of cars x boarding efficiency x number of trains. On urban transport lines, transportation capacity is set assuming boarding efficiency of roughly 150%.

9.3 Emergency Braking Distance, etc. of Trains

9.3.1 The emergency braking distance shall be stipulated separately.

9.3.2 The braking mechanism of a train shall be continuous braking.

9.3.3 The ratio of brake axles to the total number of axles of the train shall be stipulated separately.

(1) Emergency Braking Distance of Trains

Generally speaking, concerning the braking distance of trains, a set figure is determined based on assumption of problems such as emergency stopping on railway crossings, etc. An example is given below.

On railways in Japan, trains shall have an emergency braking distance of 600 m or less, and in cases where this exceeds 600 m, maximum speed shall be limited.

Since the emergency braking distance is set at 600 m or less, it is necessary for trains to stop at 600 m or less in cases of emergencies on railway crossings. Therefore, the maximum operating speed of trains shall be set at 130 km/h based on this brake performance. Maximum speed is set at 160 km/h on sections which have no railway crossings.

(2) Train Brake Devices

There shall be three types of brake device: pneumatic brakes, electric brakes and electromagnetic track brakes, and these shall function so that brakes on all cars are activated at the same time (continuous brakes).

(3) Brake Shaft Ratio

The ratio of shafts to all axles in a train formation is set at 100% as a rule, however, in cases where the ratio of brake shafts decreases due to rolling stock breakdown, etc., it is necessary to determine speed restrictions, etc. in advance.

9.4 Train Operation

9.4.1 A main line outside a station shall only be used for train operation.

9.4.2 Departure, passing and/or arrival times at a station shall be pre-determined for train operation.

9.4.3 “Keep-right” or “Keep-left” shall be stipulated separately for double-track sections where trains are operated.

9.4.4 In principle, a train shall not engage in reverse operation, etc. However, this does not apply to trains engaged in the repair work of tracks and other facilities, relief trains and trains in trial operation.

9.4.5 When an abnormality occurs during train operation, the train shall be immediately stopped, and measures for train protection shall be taken. Measures for train protection (measures for promptly stopping other trains approaching the site) shall be stipulated separately.

9.4.6 In principle, works on track facilities and electrical equipment shall be conducted as “Work which requires closure of tracks”.

Train Operation

(1) Trains on mainlines outside of stations shall be operated according to set train markers, guard duties and block systems.

(2) When trains carry out push operation or reverse operation due to line breakdowns, etc., it is necessary to separately stipulate the handling of drivers and dispatchers, etc.

(3) Line closure work is maintenance work carried out following completion of administrative procedures between officials such as the revision of related signals, etc. to stop signals preventing trains, etc. from operating on designated sections (see section 9-10 Track Closure).

9.5 Shunting of Rolling Stock

The shunting of rolling stock shall be conducted using cab signals, shunting signals, guiding signals and/or shunting markers, etc. and other requirements shall be stipulated separately.

Shunting of Rolling Stock

In railway compounds installed with power points, rolling stock shall be shunted using shunting signals or shunting markers, etc.

(1) Operation by shunting signals

Drivers operate cars upon confirming signal aspects.

(2) Operation by shunting markers

Drivers shall operate cars upon confirming shunting marker displays and using shunting signs by means of hand flags, lights or radio.

(3) Operation by shunting signs

Same as above.

9.6 Operation Speed

9.6.1 The maximum operation speed of a train shall be determined taking the tracks, electrical lines and structure of the rolling stock into consideration.

9.6.2 Should reverse operation be required, the speed of operation shall be stipulated separately.

9.6.3 Speed limit, shunting speed, etc. which are indicated by signals shall be stipulated separately.

9.7 Safety between Trains

9.7.1 A train shall be operated by means of employment of the block system.

9.7.2 The substitute block system shall be stipulated separately.

9.7.3 The method of operation solely relying on the driver’s judgment shall be stipulated separately.

Operation Speed

(1) Train operation speed

Train operation speed shall be determined according to section and train with consideration given to line conditions and rolling stock performance, etc. (see the section on emergency braking distance).

(2) Rolling stock operation speed

The operation speed of rolling stock is generally set at 25-45 km/h.

(3) Operation speed at abnormal times

Operation speed when trains are conducting push operation, reverse operation or operation based on the driver's wits is generally set at a maximum of 15 km/h.

9.8 Railway Signals and Operation

A train or rolling stock shall be operated in accordance with the conditions indicated by the railway signals.

Railway Signals

The meanings of railway signals (operating conditions) is as shown below (example).

(1) Wayside signals

Call-on signals:	15 km/h or less
Warning signals:	25 km/h or less
Caution signals:	45 km/h (high performance trains are 55 km/h or less)
Deceleration signals:	65 km/h (high performance trains are 75 km/h or less)
Proceed signals:	Maximum designated speed or less on each section in question

(2) Cab signals

Stop signals:	⊗ (no entry or stop immediately)
Ditto:	ⓘ (stop by the end of that route)
Proceed signals:	⑨⓪, etc. (can proceed at 90 km/h or less)

9.9 Train Protection

9.9.1 The types and methods of train protection shall be stipulated separately.

(1) Train Protection

As emergency measures to deal with cases where operating accidents, etc. occur, it is necessary to carry out stop arrangements by train protection.

(2) Train Protection Methods

Train protection methods include protection radio, fusees and rail clamp shunts, and it is necessary to stipulate the method in advance. (An example is given below in relation to the emergency braking distance of trains).

(3) Methods of Emergency Stop Arrangement

1) From wayside

Portable fusees

Rail clamp shunts (automatic block sections, etc.)

Protection switches

Protection radio

Obstruction warning devices for level crossings

2) From moving trains

Rolling stock fusees

Protection radio

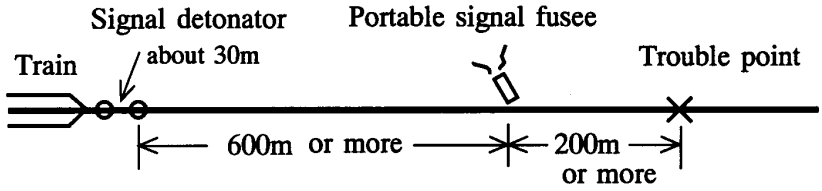


Fig. 5.1.49 Train Protection Methods (example)

9.10 Track Closure

9.10.1 The procedure for the designation, commencement and ending of track closure shall be stipulated separately.

(1) Track Closure

Track closure is a method of securing time and train operation safety in cases where works are carried out, contact lines are out of power, or trolley operation is conducted during train operating time zones.

When conducting track closure in order to perform maintenance work, it is necessary to stipulate procedures such as the securing of advance permission from train dispatchers, etc.

(2) Track Closure Works Methods

1) Preparation of track closure works ledgers

It is necessary to stipulate the format, discussion and method of issue of ledgers in advance.

2) Implementation of track closure works

① Line closure work is maintenance work carried out following completion of administrative procedures between officials such as the revision of related signals, etc. to stop signals preventing trains, etc. from operating on designated sections.

② When it comes to commencing and finishing track closure works on works sites, it is essential that the end of related train operations, etc. be confirmed and that sure communications be carried out with dispatchers, etc.

③ After taking steps to prevent trains from entering closed sections, dispatchers, etc. need to confirm the start of track closure works and so on.

On CTC sections, etc., in order to prevent handling errors, measures are taken such as the provision of track closure keys on centralized control panels.

9.11 Response to Natural Disaster

The procedure to be taken when there is a hazard vis-a-vis train safety due to meteorological conditions (rain, wind or earthquake, etc.) shall be stipulated separately.

In order to minimize damage caused by accidents originating in natural disasters such as rain and wind, etc., operating restrictions with respect to rainfall and wind velocity shall be adopted.

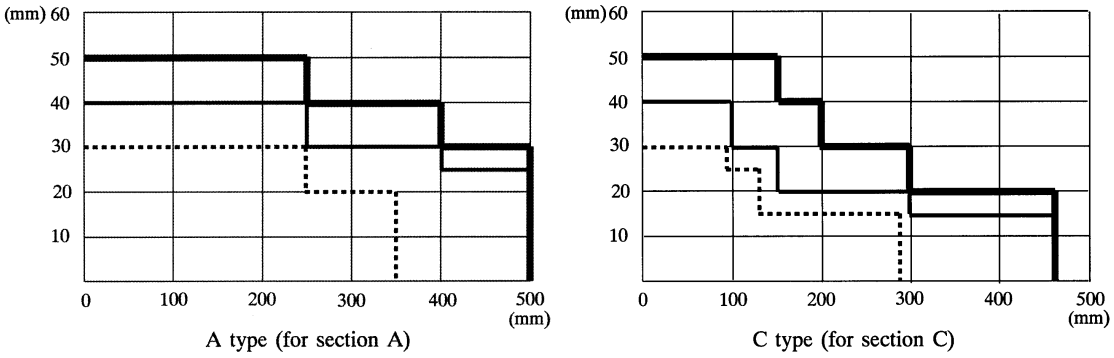
(1) Rain

In operation restrictions based on rainfall, train speed restrictions, etc. are enforced according to hourly rainfall and continuous rainfall based on district-based data of past rainfall and equipment breakdowns, etc.

An example of rainfall restrictions is given in the following table and figure.

Table 5.1.17 Warning Displays and Speed Restrictions, etc.

Type	Warning Display	A Section	B Section	C Section
Security alarm	White light and buzzer	Security	Security	Security
Caution alarm	Yellow light and buzzer	45 km/h or less	35 km/h or less	25 km/h or less
Warning alarm	Red light and buzzer	35 km/h or less	25 km/h or less	Stop operation



Note 1: Vertical axis shows hourly rainfall, horizontal axis shows continuous rainfall.
2: ⋯ shows security, — shows caution, and ━ shows warning alarm.

Fig. 5.1.50 Types and Settings of Rainfall Alarms

(2) Wind

Train speed restrictions are enforced based on wind velocity (20 m/sec, 25 m/sec, etc.).

An example of wind restrictions is given in the following table.

Table 5.1.18 Warning Displays and Speed Restrictions of Wind Velocity Alarm

Wind Velocity	Warning Type	Speed Restriction
20-24 m/sec	Warning alarm	25 km/h or less
25 m/sec or more	Stop alarm	Train operation suspension

(3) Earthquake

Seismometers are installed in necessary places and train speed restrictions are enforced according to measured gal values (seismic acceleration rate).

An example of earthquake operation restrictions is given in the following table.

Table 5.1.19 Warning Displays and Speed Restrictions of Earthquake Alarm

Acceleration Rate	Warning Type	Warning Display	Speed Restriction
40-80 gal (equivalent to 4 on Japanese scale of seismic force)	Alarm sounding	White light and buzzer	25 km/h or less
80 gal or more (equivalent to 5 on Japanese scale of seismic force)	Stop sounding	Yellow light and buzzer	Train operation suspension

Chapter 10 Reporting of Railway Accidents

10.1 Objective

The objective of the provisions of Chapter 10 is the prompt reporting and dealing with railway operation accidents and incidents which impede railway operation in an assured manner.

10.2 Scope of Application

The method to report and deal with a railway operation accident of one's own company or such an accident of another company which is related to the staff and/or rolling stock of one's own company shall be stipulated separately.

10.3 Terminology

Such terms as "skilled person" and "an injured person", etc. shall be stipulated separately.

10.4 Stipulations Regarding Railway Operation Accidents, etc.

10.4.1 Accidents shall be classified into railway operation accidents and incidents disrupting railway operation.

10.4.2 A railway operation accident shall be an accident which entails casualties and/or material damage resulting from the operation of a train, etc.

10.4.3 An incident which disrupts railway operation shall be a minor accident which involves casualties and/or material damage due to the operation of a train, etc. and which does not fall in the category of a train operation accident. The scope of such an incident shall be stipulated separately.

10.5 Responsible Accidents

Railway operation accidents and incidents disrupting railway operation caused by the errors of railway staff are defined as responsible accidents.

10.6 Reporting of Railway Operation Accidents and Other Matters

10.6.1 A railway operator shall promptly inform the DOTC of a railway operation accident, etc. and shall submit the relevant document(s) within one week of the said accident.

10.6.2 The reporting standards on railway operation accidents and so forth shall be stipulated separately.

An example of contents in Japan is given below.

(1) Terminology

1) Fatalities refer to persons who dies immediately or within 24 hours as a result of injuries incurred in an accident.

2) Injuries refer to persons who suffer harms which require treatment by a doctor, or which require treatment at a later date. Injuries which require 30 days or more of treatment are classified as serious injuries, while those which require less than 30 days treatment are classified as minor injuries.

(2) Railway Operating Accidents

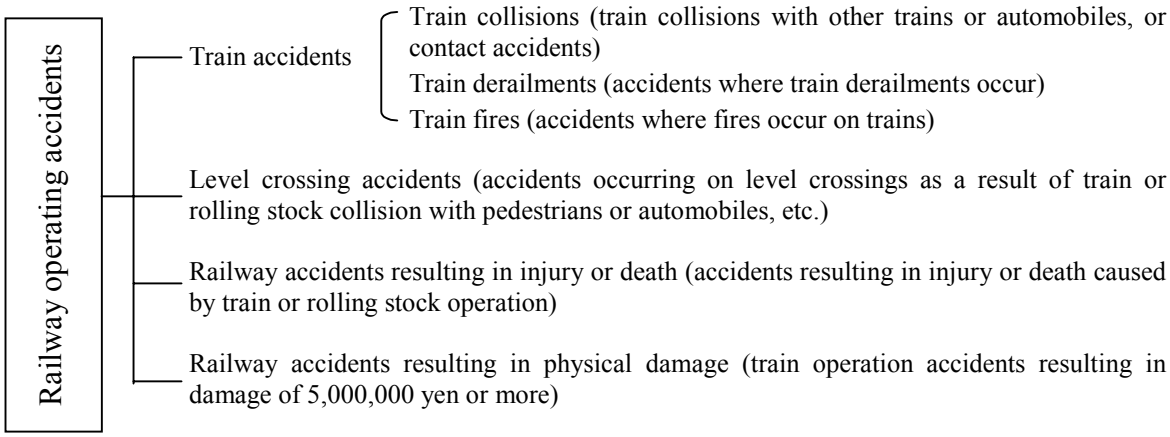


Fig. 5.1.51 Operating Accidents

(3) Operation Obstruction Accidents

Operation obstruction accidents refer to accidents which hinder the operation of trains or rolling stock, and accidents which are not classified as railway operating accidents but which result in physical damage or human death or injury because of train operation. These accidents are classified in the following way.

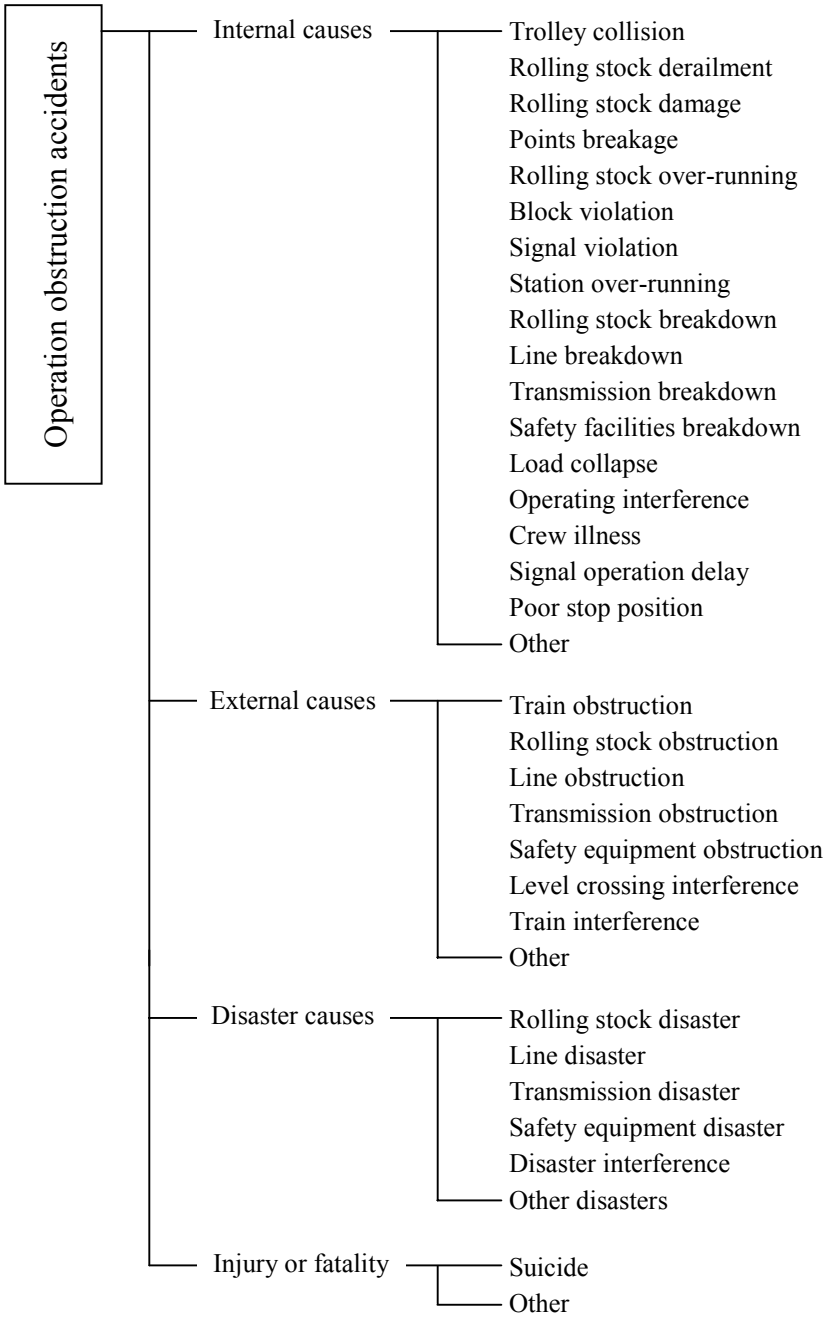


Fig. 5.1.52 Operation Obstructions

(4) Responsible Accidents

Responsible accidents refer to railway operation accidents and operation obstructions arising from employee handling error, and these can be classified as follows:

1) Incidents which escalate into railway operation accidents

2) Incidents where human injuries or fatalities occur as a result of the accident

3) Incidents where damage to property is 500,000 yen or more

4) Incidents which hinder transportation:

① Incidents where train services were suspended
② Incidents where train delays of 30 minutes or more were caused

5) Incidents arising from alcohol consumption or other malicious causes

6) Other major incidents

(5) Semi-accidents

Semi-accidents refer to cases of regulation violations linked to the occurrence of accidents, but which didn't cause any actual harm to train operation, etc.

(6) Reporting Criteria

In cases where railway operating accidents or operation obstruction accidents occur, it is necessary for a telephone or oral report to be immediately made to the manager of the nearest agency related to the Ministry of Transportation concerning the time and place of accident occurrence, outline and cause of the accident, emergency measures, restoration measures, scheduled restoration data, and so on.

1) Accidents where fatalities occurred among train passengers

2) Accidents where five or more fatalities or injuries occurred

3) Accidents where mainline obstruction for six hours or more is recognized

4) Accidents considered to be special incidents

Chapter 11 Environment

11.1 Prevention of Loud Noise

Railway operators should strive to prevent loud noise due to train operation, by promoting such measures as the introduction of track and rolling stock structure which considers noise alleviation.

(1) Prevention of Extreme noise

As measures to reduce extreme noise which arises in line with train running, soundproof walls and sound absorption materials shall be installed, long rails shall be adopted, and flat tires shall be corrected.

(2) Target Noise Levels

The Environment Agency of Japan adopts the following figures as target noise levels on newly constructed conventional line sections.

1) Noise level (new lines)

As equivalent noise levels (L Aeq), 60 dB (A) shall be adopted during daytime (07.00-22.00) and 55 dB (A) during nighttime (22.00-07.00). Moreover, effort shall be made to achieve further reduction of the noise level in residential districts and other areas where the living environment should be protected.

2) Measurement method and evaluation

① The measurement method as a rule targets all trains which use the line in question (both upward and downward directions). The frequency correction circuit is matched with the A characteristics and the single shot noise exposure level (LAE) is measured for each train. However, it is possible to appropriately reduce the number of measured trains and carry out weighted calculation while paying attention to variations in the noise level according to the line in question (upward and downward), type of rolling stock, traveling time zone (train speeds are slower in the rush hour), and so on.

② Calculation of the equivalent noise level (L Aeq) from the LAE is done as follows:

$$L\,Aeq = 10\log_{10}\left[\left(\sum_{i=1}^{n} 10^{LAEi/10}\right)/T\right]$$

T: targeted time of Laeq (sec.)
07.00-22.00: T = 54,000 22.00-07.00: T = 32,400

③ In carrying out measurement, periods when the disparity with background noise (not train noise) is 10 dB (A) or more shall be measured. Moreover, in cases where disparity with background noise cannot be sufficiently obtained, it is appropriate to use slow movement characteristics on the noise meter in the following proximate expression to compute LAE from the measured peak noise level (LAmax).

$L\,AE \quad L\,Amax + 10\log_{10}t$ bt: train passing time (sec.)

However, in the case of freight trains, since a large peak is measured at the front car (locomotive), actual LAE is smaller than the LAE measured with this expression.

3) Selection of Measurement Points

From outdoor sites beyond railway (including track) land which is considered to be representative of the local noise, areas which satisfy the following conditions shall be selected.

① Select sites which are a level distance of 12.5 m away from the center line of adjacent sidings. Moreover, in cases where measurement points cannot be secured outside of railway land, positions located as close to the line as possible shall be selected.

② Height shall be 1.2 m above ground.

③ Points located at least 3.5 m away from windows or outside walls shall as a rule be selected. Moreover, when measuring close to windows or outside walls, the noise level increases by around 3 dB (A) due to sound reflection.