Urban Transportation

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Various Transportation Systems

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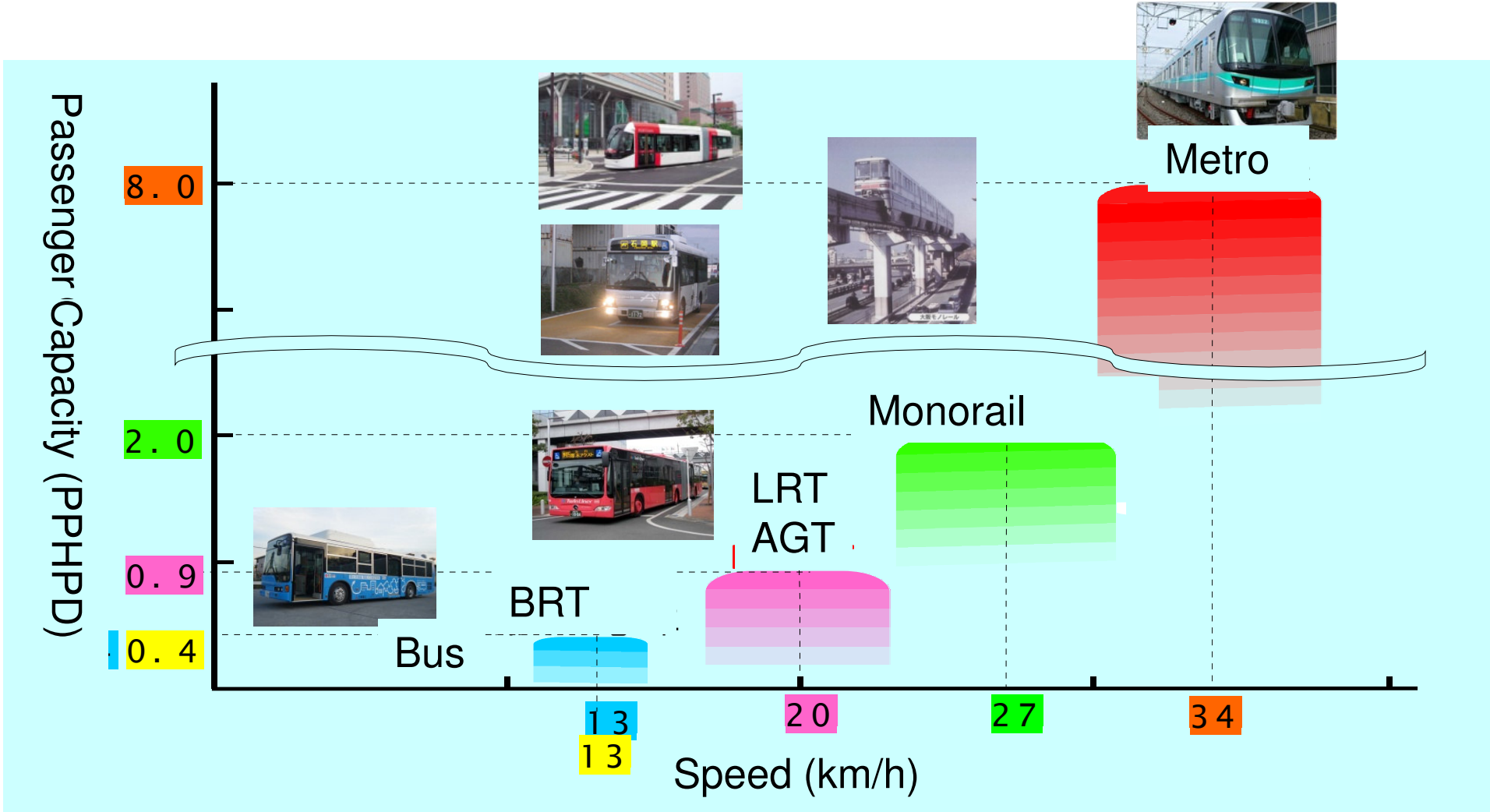
Example of Various Transportation Systems in Japan



Various Transportation Systems

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	LRT	AGT	MONORAIL	SUBWAY
Feature	Steel Wheel on Steel Rail	Rubber Tire on Slab Structure	Rubber Tire on Beam Structure	Steel Wheel on Steel Rail
Application	- Major Circular Public Transportation	- Public Transportation Supporting Trunk Rail Lines	- Public Transportation Supporting Trunk Rail Lines -Access to Airport	- Major Public Transportation

System Capacity and Main Line Alignment

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	LRT	AGT	MONORAIL	SUBWAY
System Capacity Passenger Carrying Capacity in Passenger per Hour per Direction (PPHPD)	2,000 – 12,000 PPHPD	2,000 – 12,000 PPHPD	2,500 – 48,000 PPHPD	6,000 – 60,000 PPHPD
Carrying Capacity / Car	100 passenger/car	80 passenger/car	200 passenger/car	260 passenger/car
Minimum Curve Radius	R=30m	R=30m	R=60m	R=300m
Maximum Grade	i=3.5%	i=6%	i=6%	i=3.5%
Cost	Low	Medium	Medium	High
Landscape	Fair	Fair	Good	Good

Trigger for Developing Monorail

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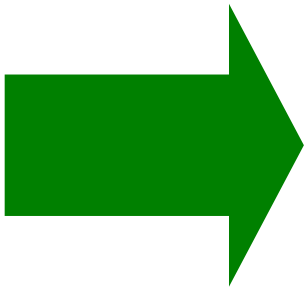
There are 3 Options for Railway Construction



Option 1 ***On Ground (Surface)***	***Surface Railway***	***Land Acquisition of Congested Land Occupancy*** High Cost, legal cases & Time Consuming
Option 2 ***Under Ground***	***Subway***	***Digging hole/tunnels under ground*** VERY VERY EXPENSIVE & Time Consuming
Option 3 ***On Air***	***Monorail***	***Air space is Free for public*** Air is free and no property owner

Feature of Monorail System / Line Alignment

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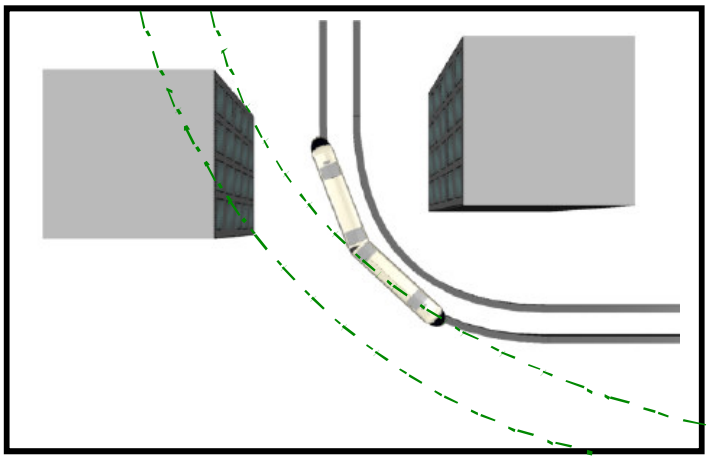
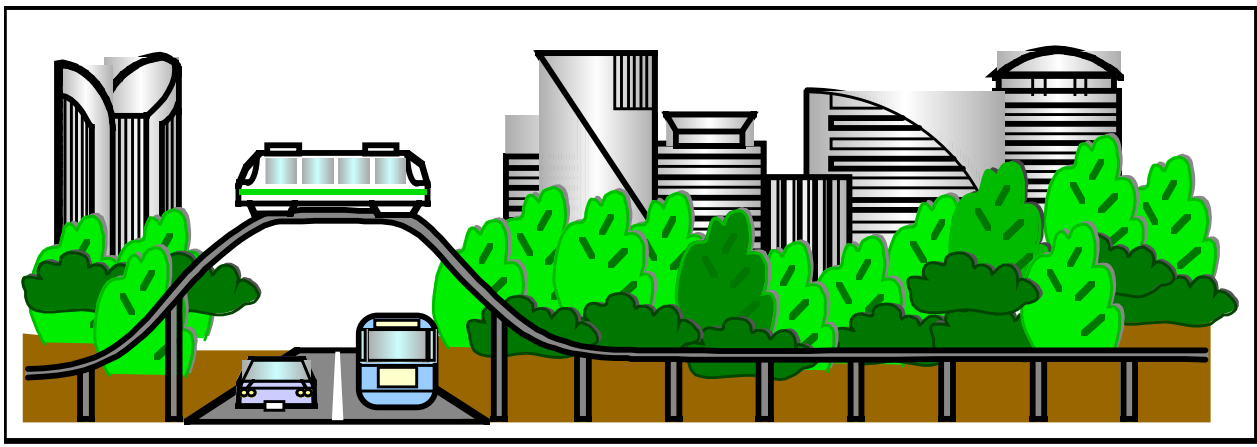
Flexible Line Alignment

Min. Curve Radius	60m at main line 50m at depot
Max. Gradient	6% at main line 6% at depot

Avoidance of territorial Infringement onto the existing building and property





Environmental Impact (P1/2)

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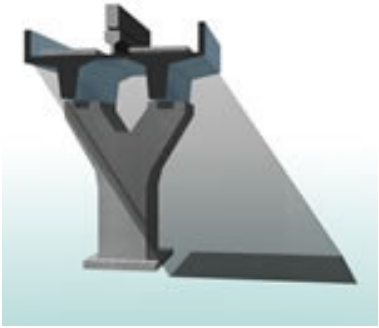
No.	Items	Monorail	BRT, VLT
1	Obstruction on Sun-shine (see attached)	**Less Impacted** The monorail guideway consist of Simple beam structure, and makes Narrow shadow only  It is easy to grow plants under the guideway	**Impacted** The slab guideway makes a wide Shadow and obstructs sunshine  It is difficult to grow plants under The guideway
2	Hazardous Material CO2/Nox	**None** Clean energy by electricity	**Hazardous** CO2/NOx generated by Combustion engine
3	Noise, Vibration	**Negligible** By using rubber tires, impact of noise and vibration is negligible	**Noisy** Engine noise and Steel wheel-steel rail, squeaky noise and vibration at rail gap are large

Environmental Impact (P2/2)

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Visual Quality

Monorail can provide Visual Quality to the urban city planning.

Make the City
Different from other cities

Carrying Capacity (P1/2)

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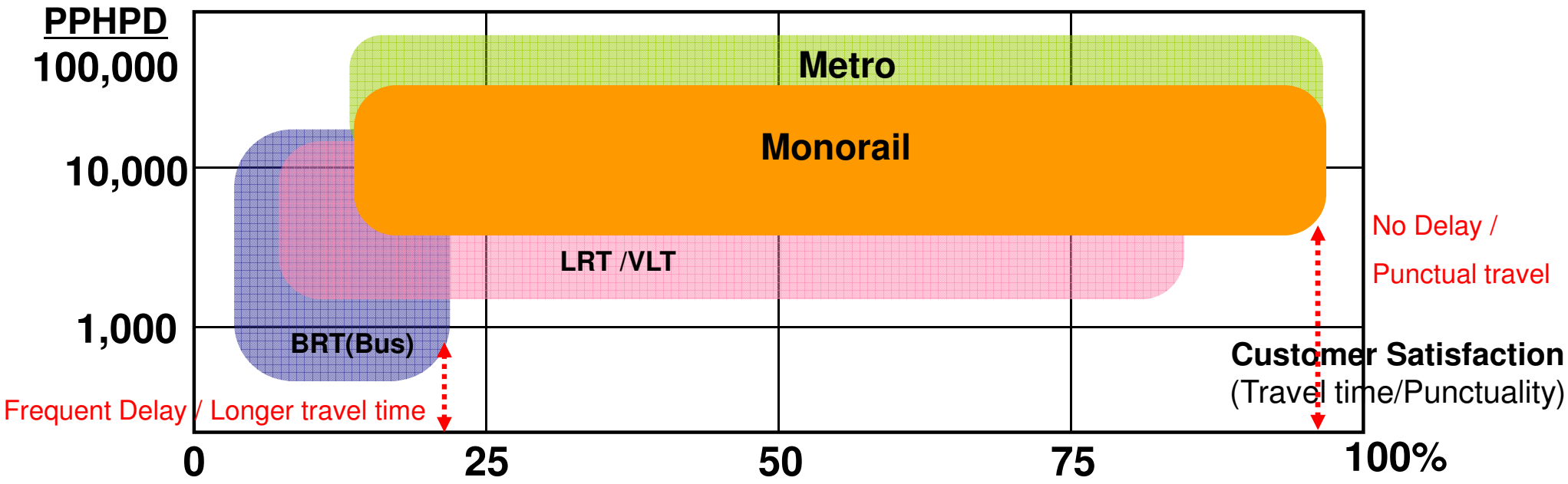
No.	Items	Monorail	BRT, VLT
1	Technology - Technical Maturity - System Safety - System Reliability	**Proven** **Recent** Japanese monorail technology uses the same parts / components, RAMS guideline, EMC, regulation and railway standard & code as Conventional **METRO** technology uses and Japanese monorail service has started since 1964 over 45 years without any single accident Including human injury and fatal incident in operational history.	
2	System Carrying Capacity	5000 – 70,000pphpd (pphpd : Passenger Per Hour Per Direction)	2000 –20,000pphd



Carrying Capacity (P2/2)

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Verification table of Monorail carrying capacity :

More additional car is feasible to increase

Condition			Loading capacity (Passenger Per Hour)		
*Density (passneger/m2)	Headway (Sec)	No. of Train (trains per hour)	2-car/train	4-car/train	6-car/train
6 (200 Passengers per car)	90	40	16,000	32,000	48,000
	180	20	8,000	16,000	24,000
8 (260 Passengers per car)	90	40	20,800	41,600	62,400
	180	20	10,400	20,800	31,200

Note* 6 passengers/m2 : For the purpose of defining operational capacity
* 8 passengers /m2 : For defining fully loaded capacity
* (10 passengers/m2: For defining physical structural endurance)

Traveling Time & Safety

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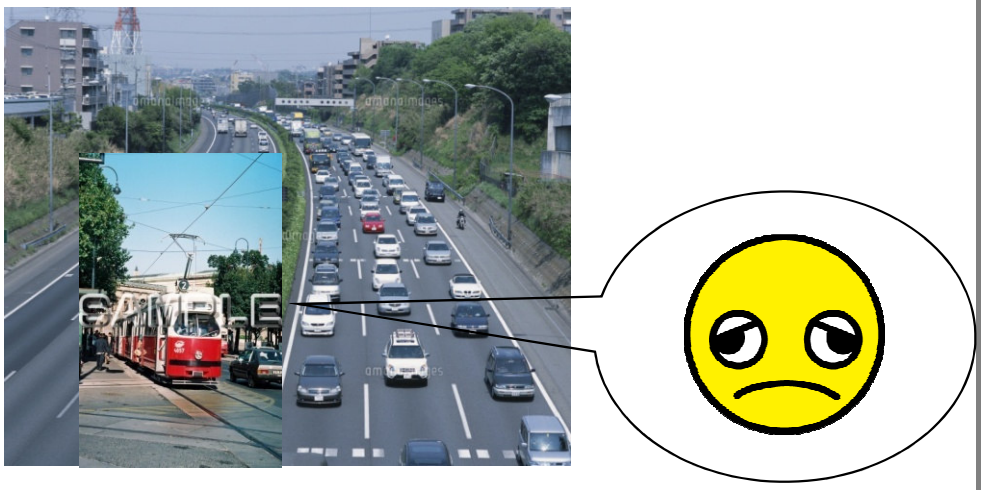
BRT, LRT



Traveling time: 50 – 140 min

- Frequent Delay with traffic Jam
  Far longer travelling time
-Disturbed by road condition

Frequent Accident

- High risk against car accident
  (At-grade with other travels)

Monorail

Traveling time: 20 min

- No Delay / Traveling on Time
  Quick traveling time
-Regardless of road condition

No Accident

- No risk against car accident
  (Grade-separated)

Cost & Delivery (P1/2)

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No.	Items	Monorail	BRT, VGT
1	Guideway structure (Visual Quality Impact)	**Beam Structure**  It is easy to construct.	**Slab structure**  It is difficult to achieve short Construction period
2	Construction Cost	**Less costly** **70 point**	**Costly** **100 point**
3	Fast track delivery	**Fast** **18** months required for 10km Guideway structure	**Longer** **24** months required for 10km Guideway structure

Cost & Delivery (P2/2)

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No.	Items	Monorail	BRT, VGT
4	Disruption to traffic flow on Public road during construction period (often leading to legal case)	**Less Risky** - Guideway beam to be pre-fabricated at temporary casting yard - At site, only using the night time to launch the beam onto column (Public road at site is not occupied, thus no traffic jam)	**Risky** - Because of large components of of work at site, it is required to keep the public road occupied through out the construction period both in rush peak time and off peak time -It causes heavy traffic jam on public road
5	Footage on ground	**Small** Since the track structure is simple, Ground space and pier size are Simple, Ground space and pier size are small	**Large** Since the track structure is large, Ground space and pier size are also large

Right–of–Way Requirement

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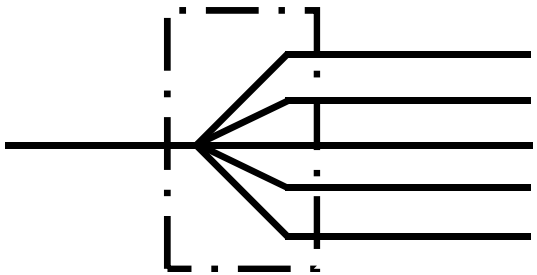
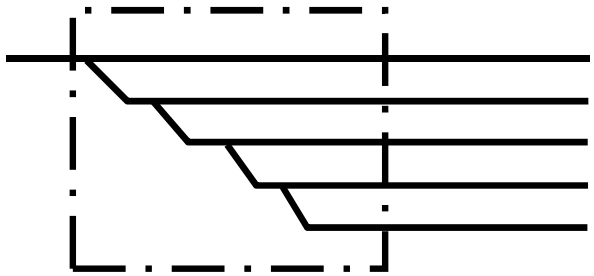
No.	Items	Monorail	VLT
1	Mainline alignment		
	● Horizontal Configuration (Min. Curve Radius)	R= 50m	R= 60m
	● Vertical Configuration (Max. Grade)	6%	3%
	● Station Length (Platform length)	60 ~ 90m	60 ~ 90m
2	Space for parking and depot area	**Small** Special 5-point switch make Space reduction possible 	**Large** Combination of 4-sets of 2-point Switch requires large space 

Operation & Maintenance

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No.	Items	Monorail	Metro,VLT
1	Maintenance work procedure Interval / Frequency	**Equivalent** Japanese monorail technology uses the same parts / components, and availability / maintainability guideline as conventional METRO Technology uses, such as less- maintenance system like latest type IGBT inverter drive, regenerative braking and so on. In this regard, no special effort or technique is required.	
2	Energy consumption for Operation (see Note below) - Annual Service performance - Energy consumption rate	Field data shows: Tama Monorail 221,581,000/ passenger-km @ 45Wh/passenger-km	Field data shows: Sendai LRT 294,352,000/ passenger-km @ 48Wh/passenger-km
3	Wheel maintenance	Average interval of replacement Is at 3~ 4 years but the unit cost of tire is cheap	Average interval of replacement is at least 6~ 8 years but the unit of steel wheel is higher
4	Running surface of Guideway maintenance	**Nothing required** No treatment is required at all	**Iron rails grind and wear** It requires regular inspection and care

Note: Energy consumed by not only train but also all sub-systems are rated by service performance figure.

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