APPENDIX 6.4-1

Outline of Alternatives

Item		Alternative I	Alternative II	Alternative III
Safety; Reliability; Speed-Up	Commercial, Transportation, Management	• Establishment of advance ticket booking and sales system • Establishment of cargo information system • Transportation management; analysis of train accidents; guidance and training • Strengthening of central management functions in relation to above issues		
	Track; Stations	Track: 43 kg/m rails (25m)	Track: 43 kg/m rails (25m)	Tracks: 43 kg/m rails (25m)
		Long rails (R > 600m)	Long rails (for 80 km/hr sections)	Long rails (for 80 - 110 km/hr sections)
		Improved RC sleepers: 1,660 per km	Existing RC sleepers and improved RC sleepers (for newly laid section): 1,660 per km	Improved RC sleepers: 1,660 per km
		Improvement of fasteners	Improvement of fasteners	Improvement of fasteners
		Ballast: 250 mm or more	Ballast: 200 - 250 mm (for 80 km/hr sections)	Ballast: 200 - 250 mm (for 80 - 110 km/hr sections)
		Replacement of turnouts: High speed turnouts (80 - 110 km/h) Improved turnouts (≤ 80 km/hr) Ordinary turnouts (≤ 70 km/hr)	Replacement of turnouts: Ordinary turnouts (≤70 km/hr)	Replacement of turnouts (same as Alternative I)
		Improvement of paving at all level crossings	Improvement of paving of level crossings (about half number of alternative I)	Improvement of paving at all level crossings
		Construction of 4 new signal stations	Construction of one new signal station	Construction of two new signal stations
		Increase of storage siding	Increase of storage siding	Increase of storage siding
	Subgrade Improvement	Those sites posing a problem for train operation or maintenance	Half the number of Alternative I	Same as Alternative I
	Cant; Transition Curve	Adoption of appropriate cant and prolongment of transition curve in response to degree of speed-up to be adopted		
	Maintenance Facilities	High speed track inspection car; MTT; stone crushing facilities; track maintenance tools and equipment		
	Station Square	At Hanoi, Vinh, Hue, Da Nang, Nha Tran and Ho Chi Minh		

Item		Alternative I	Alternative II	Alternative III
Safety: Reliability: Speed-Up	Bridges; Tunnels	• All slow speed sections to be eradicated • Sites with safety hazards to be improved • Bridges longer than 20m, which are to be improved, to be raised avoiding flooding	• Slow speed sections of less than 40 km/hr to be eradicated • Sites with safety hazards to be improved • Bridges longer than 20m, which are to be improved, to be raised avoiding flooding	• Slow speed sections at tunnels to be eradicated • Sites with safety hazards to be improved • Slow speed sections of less than 40 km/hr at bridges to be eradicated • All slow speed sections where 110 km/hr operation is feasible because of good alignment to be eradicated, except some 18 bridge sections • Bridges longer than 20m, which are to be improved, to be raised avoiding flooding
	Signalling System	Token-less block system (to be completed in December, 1995) Introduction of colour-light signals and electric power supply unit at all stations Introduction of ATS at all stations Introduction of interlock devices Class 1 relay: 10 stations Class 2 relay: all others Approaching train warning system at 200 level crossings	Token-less block system (to be completed in December, 1995) Introduction of colour-light signals and electric power supply unit at all stations Introduction of ATS at all stations Introduction of interlock devices Class 1 relay: 3 stations Class 2 relay: all others Approaching train warning system at 57 level crossings	Same as Alternative II
	Communication	Underground cable to replace overground open wire line (8C + 30P) Introduction of optical transmission system (180 CH) Creation of telephone exchange network (14 switchboards and 16 sub-switchboards) New installation of data communication system Improvement of terminal facilities (centralised telephone system and yard telephone, etc. at all stations)	Underground cable to replace overground open wire line (4C + 20P) (120 CH) Creation of telephone exchange network (8 switchboards and 16 sub-switchboards) New installation of data communication system Improvement of terminal facilities (centralised telephone system and yard telephone, etc. at major stations)	Same as Alternative II

Item		Alternative I	Alternative II	Alternative III
Safety; Reliability; Speed-Up	Rolling Stock			
	Limited Express Passenger Service	New high speed trains (axial load: 11 tons)	Rehabilitation of present engines and addition of new locomotives (D18E); rehabilitation of PCs (for air-conditioning) and addition of new PCs	New high speed trains (axial load: 11 tons)
	Inter-Regional Express Passenger Service	New high speed trains (axial load: 11 tons)	Rehabilitation of present DELs and addition of new DELs (18E); rehabilitation of PCs (for air-conditioning) and addition of new cars	Rehabilitation of present DELs and addition of new DELs (18E); rehabilitation of PCs (for air-conditioning)
	Local Passenger Service	Rehabilitation of present engines and addition of new engines (D12E)	Rehabilitation of present DELs and addition of new DELs (D12E)	Rehabilitation of present DELs and addition of new DELs (D12E); addition of new PCs
	Through Cargo Service	Rehabilitation of present DELs and addition of new DELs (D18E); addition of new wagons (roller bearing)	Rehabilitation of present DELs and addition of new DELs (D18E); addition of new wagons (roller bearing)	Rehabilitation of present DELs and addition of new DELs (D18E); addition of new wagons (roller bearing)
	Inter-Regional Cargo Service	Rehabilitation of present DELs and addition of new DELs (D18E); addition of new wagons (roller bearing)	Rehabilitation of present DELs and addition of new DELs (D18E); addition of new wagons (roller bearing)	Rehabilitation of present DELs and addition of new DELs (D18E); addition of new wagons (roller bearing)
	Local Cargo Service	Rehabilitation of present DELs and addition of new DELs (D12E); addition of new wagons (roller bearing)	Rehabilitation of present DELs and addition of new DELs (D12E); addition of new wagons (roller bearing)	Rehabilitation of present DELs and addition of new DELs (D12E); addition of new wagons (roller bearing)
	Rolling Stock Maintenance	• Improvement of Gia Lam Workshop - Maintenance facilities for DELs and PCs for high speed trains - Maintenance facilities for DELs - Spare parts for repair of DELs • Improvement of DEL maintenance depots • Improvement of PC and wagon maintenance workshops and depots	• Improvement of Gia Lam Workshop - Maintenance facilities for DELs • Improvement of DEL maintenance depots • Improvement of PC and wagon maintenance workshops and depots	Same as Alternative I

Item		Alternative I		Alternative II		Alternative III	
Safety; Reliability; Speed-Up	Disaster Prevention						
	Slope Improvement	Slopes posing a safety hazard for train operation		Half the number of slopes to be improved under Alternative I		Same as Alternative I	
	Prevention of Falling Stones	Sites posing a safety hazard for train operation (guardfences; warning signals)		Same as Alternative I		Same as Alternative I	
	Drainage Facilities	Sites posing problems in terms of train operation, safety and the environment		Half the number of sites to be improved under Alternative I		Same as Alternative I	
	Banking to Avoid Flooding	Total length of sections vulnerable to flooding: 57 km (new high banked track)		Same as Alternative I		Same as Alternative I	
Service Standards	Maximum Speed/ Travelling Time	Vmax	Travelling Time	Vmax	Travelling Time	Vmax	Travelling Time
	Limited Express Passenger Service	110 km/hr (new trains)	24 hours	80 km/hr (existing rolling stock)	30 hours	110 km/hr (new trains)	25 hours
	Inter-Regional Express Passenger Service	110 km/hr (new trains)		80 km/hr (existing rolling stock)		80 km/hr (existing rolling stock)	
	Local Passenger Service	75 km/hr (existing rolling stock)		75 km/hr (existing rolling stock)		75 km/hr (existing rolling stock)	
	Through-Stop Cargo Service	80 km/hr	40 hours	80 km/hr	43 hours	80 km/hr	41 hours
	Inter-Regional Cargo Service	80 km/hr		80 km/hr		80 km/hr	
	Local Cargo Service	70 km/hr		70 km/hr		70 km/hr	
Environmental Measures		Waste water from workshops and depots to be treated Mitigating measures on train noise in large cities		Waste water from workshops and depots to be treated Mitigating measures on train noise in large cities		Waste water from workshops and depots to be treated Mitigating measures on train noise in large cities	
Training Facilities		Reinforcement of existing practical training facilities of railway colleges in Hanoi and Ho Chi Minh City		Same as Alternative I		Same as Alternative I	
Investment Amount (million US$)		1630.5		1227.0		1419.3	

APPENDIX 6.4-2.1 OUTLINE OF EACH MASTER PLAN ALTERNATIVE

1 Components and Investment Size of Alternative I

1.1 Marketing and Transportation Control

With regard to the railway transportation service and its marketing, it is crucial to establish communication network and consolidation of a central organization to create a national marketing network and to provide upgraded services for passengers and consignors.

In order to achieve upgraded services, Alternative I envisages the introduction of such hardware measures as an advance reservation counter for express passenger trains at main stations and a freight information system for the modernization of freight service marketing and the efficient operation of freight cars.

In terms of the organizational structure, the current limited manpower level of the VNR Headquarters is the cause of the difficulty of comprehensively and efficiently controlling both passenger and freight transportation and train operation. Consequently, increase of staff will be required to strengthen the transportation service in addition to the general improvement and modernization of the Hanoi - Ho Chi Minh Railway.

By adopting the above-mentioned measures, efficient management and operation will become feasible in terms of general marketing, ticket sales and control, transportation control, quick acquisition of operational accident information and accident analysis, instruction and training and employment of emergency measures, etc. All these improvements will lead to a further increase of the passenger and freight volumes.

1.2 Transportation Plan

The following transportation plan has been prepared based on the basic policies for the preparation of the Master Plan.

(1) Basic Conditions for Train Operation (Common to All Alternatives)

1) Operation System

It is essential for a railway service to have an integrated operation system set in place to ensure safe, reliable, high speed and mass transportation through the efficient integration of such infrastructure as the track, rolling stock and stations, etc.

The following operational safety system is adopted as the basis for such an integrated operation system.

a. Block System : Token-less block system

b. Signal System : 3 colour indicate system using a multiple colourlight signal

c. Interlocking System : Class 1 electrical relay interlocking at main stations (10 stations under Alternative I and 3 stations under the other Alternatives) and Class 2 relay interlocking at other stations

d. Train Safety System : Provision of ATS (Automatic Train Stop)

2) Types of Trains and Their Formation

Table 1.2-1 shows the types of train services and their formation planned for the railway service between Hanoi and Ho Chi Minh City, taking the current conditions of the infrastructure, the infrastructure improvement plan, demand forecast and prospective passenger convenience, etc. into consideration. Table 1.2-2 and Table 1.2-3 give similar information for Alternative II and Alternative III respectively.

Table 1.2-1 Types of Trains, etc. Under Alternative I in 2010

Category	Type of Service	Max. Speed (km/hr)	Train Formation	Traction Load (tons)	Approx. Transportation Capacity/Train
Passenger Trains	Limited Express	110	DEL+10PC+DEL	350	450 persons
	Inter-Regional Express	110	DEL+10PC+DEL	350	520 persons
	Local	75	D12E+5PC+1BC(*)	260	400 persons
Freight Trains	Through	80	Pulled by D18E	600	350 tons
	Inter-regional	80	Pulled by D18E	upto 800	upto 410 tons
	Local	70	Pulled by 2 D12Es	upto 750	upto 410 tons

Note: 110 km/hr express trains will be served by new push-pull type diesel locomotives.

(*) BC = baggage car

Table 1.2-2 Types of Trains, etc. Under Alternative II in 2010

Category	Type of Service	Max. Speed (km/hr)	Train Formation	Traction Load (tons)	Approx. Transportation Capacity/Train
Passenger Trains	Limited Express	80	D18E+10PC	400	480 persons
	Inter-Regional Express	80	D18E+10PC	400	550 persons
	Local	75	D12E+5PC+1BC	260	400 persons
Freight Trains	Through	80	Pulled by D18E	600	350 tons
	Inter-regional	80	Pulled by D18E	upto 800	upto 410 tons
	Local	70	Pulled by 2 D12Es	upto 750	upto 410 tons

Table 1.2-3 Types of Trains, etc. Under Alternatives III in 2010

Category	Type of Service	Max. Speed (km/hr)	Train Formation	Traction Load (tons)	Approx. Transportation Capacity/Train
Passenger Trains	Limited Express	110	DEL+10PC+DEL	350	450 persons
	Inter-Regional Express		D18E+10PC	400	550 persons
	Local	75	D12E+5PC+1BC	260	400 persons
Freight Trains	Through	80	Pulled by D18E	600	350 tons
	Inter-regional	80	Pulled by D18E	upto 800	upto 410 tons
	Local	70	Pulled by 2 D12Es		upto 410 tons

Note: 110 km/hr express trains will be served by new push-pull type diesel locomotive.

(2) Calculation of Travelling Time

Calculation of the travelling time is based on the operation diagramme. The running resistance and other calculation factors are those currently used in Japan. Table 1.2-4, Table 1.2-5 and Table 1.2-6 give the calculation results.

Table 1.2-4 Travelling Time Under Alternative I in 2010

Train Type	Section	Distance (km)	Travelling Time	Remarks
Limited Express Passenger Trains	Hanoi - Ho Chi Minh	1,726.2	24 hours	Inclusive of some 70 minutes for stoppages and spare time
Through Freight Trains	G. Bat - S. Than	1,705.4	40 hours	Inclusive of 13 hours for stoppages and spare time

Table 1.2-5 Travelling Time Under Alternative II in 2010

Train Type	Section	Distance (km)	Travelling Time	Remarks
Limited Express Passenger Trains	Hanoi - Ho Chi Minh	1,726.2	30 hours	Inclusive of some 80 minutes for stoppages and spare time
Through Freight Trains	G. Bat - S. Than	1,705.4	43 hours	Inclusive of 13 hours for stoppages and spare time

Table 1.2-6 Travelling Time Under Alternatives III in 2010

Train Type	Section	Distance (km)	Travelling Time	Remarks
Limited Express Passenger Trains	Hanoi - Ho Chi Minh	1,726.2	25 hours	Inclusive of some 80 minutes for stoppages and spare time
Through Freight Trains	G. Bat - S. Than	1,705.4	41 hours	Inclusive of 13 hours for stoppages and spare time

(3) Transportation Plan

The transportation plan has been prepared based on the conditions described above and the demand forecast results.

1) Planning Conditions

- Seat-Load Factor of Passenger Trains

  All seats on the limited express and inter-regional express trains are reserved seats and a seat-load factor of 80 - 85% is used for the transportation plan.

- Load Efficiency of Freight Cars

  Based on past performance records, a freight load efficiency of 85% is used.

- Freight Car Return Period

  Based on past performance records and the prospective introduction of a freight information system, the return period for freight cars is set at 9 days.

- Empty Car Rate of Freight Trains

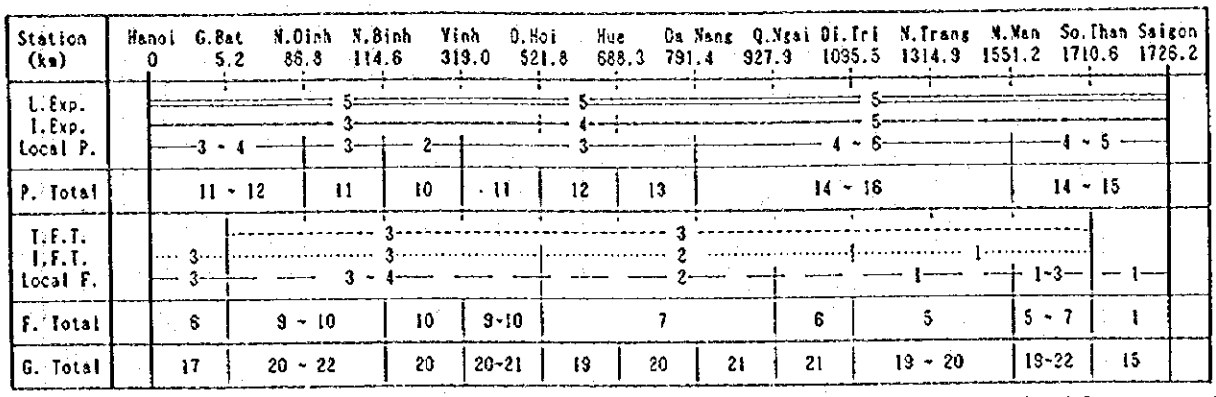
  The empty car rate of freight trains is set at 30%.

2) Resulting Transportation Plan

The following transportation plans for the different Alternatives have been prepared with concrete figures for the number of trains for different sections, train-kilometers, car-kilometers and required number of rolling stocks.

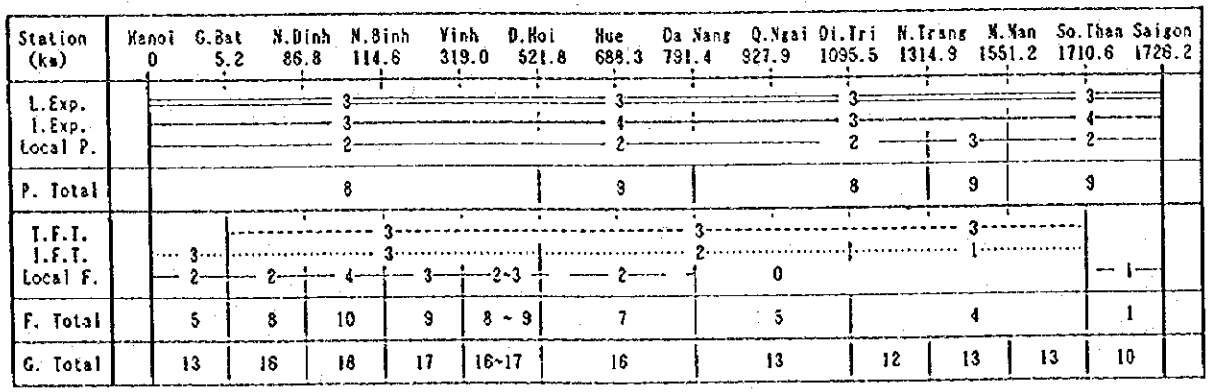
a) Number of Trains

Table 1.2-7 Number of Trains for Different Sections (one way/day) under Alternative I in 2010



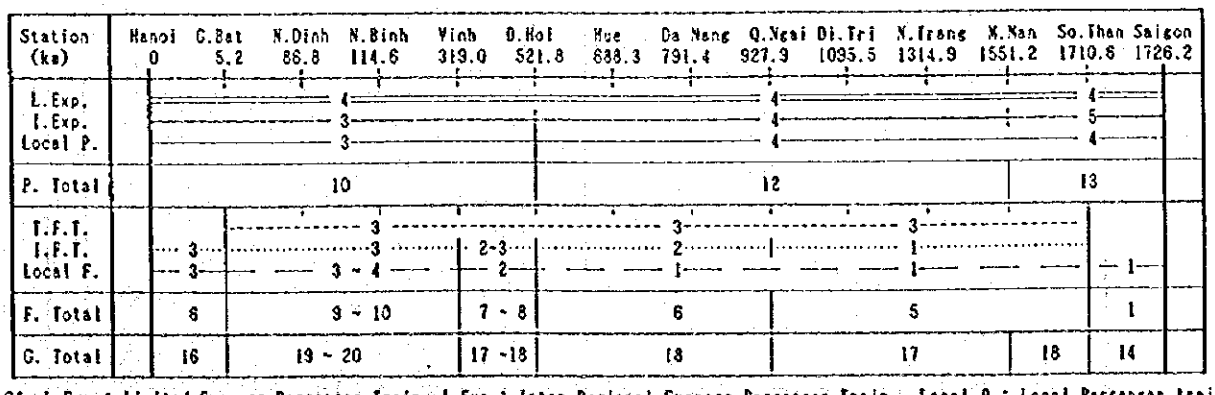
Cf. L.Exp.: Limited Express Passenger Train. I.Exp.: Inter Regional Express Passenger Train. Local P.: Local Passenger train.
T.F.T.: Through Freight train. I.F.T.: Inter Regional Freight train. Local F.: Local Freight train.

Table 1.2-8 Number of Trains for Different Sections (one way/day) under Alternative II in 2010



Cf. L.Exp.: Limited Express Passenger Train. I.Exp.: Inter Regional Express Passenger Train. Local P.: Local Passenger train.
T.F.T.: Through Freight train. I.F.T.: Inter Regional Freight train. Local F.: Local Freight train.

Table 1.2-9 Number of Trains for Different Sections (one way/day) under Alternative III in 2010



Cf. L.Exp.: Limited Express Passenger Train. I.Exp.: Inter Regional Express Passenger Train. Local P.: Local Passenger train.
T.F.T.: Through Freight train. I.F.T.: Inter Regional Freight train. Local F.: Local Freight train.

b) Train-Kilometers and Car-Kilometers

Table 1.2-10 Train-Kilometers and Car-Kilometers (km/day) Under Alternative I in 2010

Train Type		Train-Kilometers	Car-Kilometers		
			PC	FC	DL
Passenger	Limited Express	17,260	172,600	–	34,520
	Inter-regional Express	15,160	151,600	–	30,320
	Local	13,300	79,800	–	13,300
	Sub-Total	45,720	404,000	–	78,140
Freight	Through	10,360	–	396,100	10,360
	Inter-regional	6,710	–		6,710
	Local	7,360	–		14,720
	Sub-Total	24,430	–	396,100	31,790
Total		70,150	404,000	396,100	109,930

Note: Figures do not include the travelling kilometers of forwarding trains and locomotives travelling alone, etc.

Table 1.2-11 Train-Kilometers and Car-Kilometers (km/day) Under Alternative II in 2010

Train Type		Train-Kilometers	Car-Kilometers		
			PC	FC	DL
Passenger	Limited Express	10,360	103,600	–	10,360
	Inter-regional Express	11,270	112,700	–	11,270
	Local	7,400	44,400	–	7,400
	Sub-Total	29,030	260,700	–	29,030
Freight	Through	10,360	–	312,100	10,360
	Inter-regional	6,710	–		6,710
	Local	3,390	–		6,780
	Sub-Total	20,460	–	312,100	23,850
Total		49,490	260,700	312,100	52,880

Note: Figures do not include the travelling kilometers of forwarding trains and locomotives travelling alone, etc.

Table 1.2-12 Train-Kilometers and Car-Kilometers (km/day) Under Alternatives III in 2010

Train Type		Train-Kilometers	Car-Kilometers		
			PC	FC	DL
Passenger	Limited Express	13,700	137,000	–	13,700
	Inter-regional Express	12,700	127,000	–	12,700
	Local	12,700	127,000	–	12,700
	Sub-Total	39,100	391,000	–	39,100
Freight	Through	10,300	–		10,300
	Inter-regional	6,300	–	343,300	6,300
	Local	5,800	–		11,500
	Sub-Total	22,400	–	343,300	28,100
Total		61,500	391,000	343,300	67,200

Note: Figures do not include the travelling kilometers of forwarding trains and locomotives travelling alone, etc.

c) Required Number of Rolling Stocks

Table 1.2-13 Required Number of Rolling Stocks Under Alternative I in 2010

(Unit: cars)

Train Type		Required Number of Rolling Stocks				
		New Train	D18B	D12E	PC	FC
Passenger	Limited Express; Inter-regional Express	40 trains	–	–	–	–
	Local	–	–	50	282	–
	Sub-Total	40 trains	–	50	282	–
Freight	Through; Inter-regional	–	38	–	–	–
	Local	–	–	64	–	–
	Sub-Total	–	38	64	–	6,300
Total		40 trains	38	114	282	6,300

Note: Limited express and express trains: 800 km/day, local passenger trains: 270 km/day, through and inter-regional freight trains: 450 km/day, local freight trains: 230 km/day.

Table 1.2-14 Required Number of Rolling Stocks Under Alternative II in 2010

(Unit: cars)

Train Type		Required Number of Rolling Stocks				
		New Train	D18E	D12E	PC	FC
Passenger	Limited Express; Inter-regional Express	–	42	–	420	–
	Local	–	–	30	168	–
	Sub-Total	–	42	30	588	–
Freight	Through; Inter-regional	–	38	–	–	–
	Local	–	–	42	–	–
	Sub-Total	–	38	42	–	5,300
Total		–	80	72	588	5,300

Note: Limited express and express trains: 520 km/day, local passenger trains: 250 km/day, through and inter-regional freight trains: 450 km/day, local freight trains: 160 km/day.

Table 1.2-15 Required Number of Rolling Stocks Under Alternatives III in 2010

(Unit: cars)

Train Type		Required Number of Rolling Stocks				
		New Train	D18E	D12E	PC	FC
Passenger	Limited Express; Inter-regional Express	13 trains	21	–	210	–
	Local	–	–	40	222	–
	Sub-Total	13 trains	21	40	432	–
Freight	Through; Inter-regional	–	38		–	5,700
	Local	–	–	50	–	
	Sub-Total	–	38	50	–	5,700
Total		13 trains	59	90	432	5,700

Note: Limited express and express trains: 780 km/day, local passenger trains: 340 km/day, through and inter-regional freight trains: 440 km/day, local freight trains: 120 km/day.

1.3 Civil Engineering Facilities

(1) Bridge and Tunnel Improvement

Under Alternative I, bridges and tunnels will be improved in the following manner.

1) In Connection with Train Operation

- Those bridges and tunnels posing a safety hazard will be improved.
- Those bridges and tunnels currently restricting train speed will be improved.

2) Bridges Submerged at Time of Flooding

- The elevation of those bridges of not less than 20m in length will be raised as part of the improvement work.
- The elevation of those bridges of less than 20 m in length will not be raised this time but will be raised when the adjacent subgrade is raised in the future.
- With respect to the bridges located in the section between Vinh and Thuan Ly, all the bridges in the selected sections which are highly vulnerable to flooding will be raised.

Table 1.3-1 Bridge Improvement

Number of Bridges	Aggregate Length	Cost
628	19.7 km	430.4 million US$

(9 bridges already appraised by the OECF are not included.)

Table 1.3-2 Tunnel Improvement

Number of Tunnels	Aggregate Length	Cost
27	7.8 km	55.4 million US$

(2) Track and Stations

The common components of all the Alternatives are as follows.

- All necessary improvements will be conducted to allow a travelling speed of 80 - 110 km/hr between stations.
- Improvement Priority

① 27 kg rail and 30 kg rail sections and those sections posing a serious safety hazard.

② Sections subject to a travelling speed of 80 - 110 km/hr where improvement will significantly reduce the travelling time.

1) Track Reinforcement

a. Rails

- 27 kg rails and 30 kg rails will be replaced by 43 kg rails (25m in length).
- The present length of 12.5m of the 43 kg rails will be doubled through on-site welding work.
- Long welded rails will be used at those sections where ever feasible (R > 600m)

b. Turnouts

All turnouts on the main track will be renewed by ordinary turnouts (V ≤ 70 km/hr), improved type turnouts (V ≤ 80 km/hr) or high speed turnouts (V ≥ 80 km/hr) depending on the train passing speed.

c. Sleepers

- All wooden and steel sleepers at those sections where radius (R) is more than 600m will be replaced by improved type concrete block sleepers. The fastening system will also be improved. The laying density will be 1,660 sleepers/km.
- The number of wooden sleepers will be increased from 1,600 sleepers/km to 1,720 sleepers/km at those sections where R is 600m or less.
- The existing concrete block sleepers will be replaced by improved type concrete block sleepers and the fastening system will also be improved.

d. Ballast

The minimum ballast thickness will be 25 cm.

2) Roadbed Improvement

The roadbed at those sections posing problems in terms of train operation and its maintenance will be improved. Depending on the roadbed situation, the improvement work will involve auger agitation type grouting or the complete replacement of the existing roadbed.

3) Cant and Transition Curve Improvement

In response to the introduction of a maximum speed of 110 km/hr, the cant and transition curve will be revised where necessary.

4) Curvature Improvement

The radius of the curvature at one particular curved section which greatly hinders the speeding up of operation and the improvement work of which poses little difficulty will be improved to 600m (207.884 km site).

5) Level Crossing Improvement

All level crossing sites will be paved with asphalt and safety fencing will be erected along the track near level crossings to prevent any unnecessary invasion of pedestrians on the track.

6) Maintenance Equipment

New maintenance equipment will be procured, consisting of one high speed track inspection car, 6 MTTs, 3 sets of crusher and quality control apparatus to produce suitable ballast and miscellaneous track maintenance tools and equipment (tie tamper, crane type rail traverser, rail transporter and rail cutter, etc.)

7) Stations

Four new signal stations will be constructed to secure sufficient track capacity. In addition, new storage siding will be introduced at stations where necessary.

8) Disaster Prevention Facilities

Slope improvement work, falling rock preventive constructions and protective fencing and the installation of falling rock warning devices will be conducted at those sections posing a safety hazard in terms of train operation. In addition, drainage facilities will be introduced at those sections which pose a safety hazard in terms of train operation, a maintenance hazard and/or environmental hazard. Furthermore, new high banked track will be constructed for a total length of 57 km due to the high vulnerability to flooding.

9) Station Square Improvement

The station square will be improved at 6 major stations together with the installation of a car park and bicycle park for better feeder services. (The subject stations are Hanoi, Vinh, Hue, Da Nang, Nha Trang and Ho Chi Minh City.)

Table 1.3-3 Track and Station Improvements

	Cost (million US$)
Track Improvement (Rails; Sleepers; Turnouts; Ballast; Fastenings)	
Roadbed Improvement (50 km)	
Cant and Transition Curve Improvement	
Curvature Improvement (at one site)	
Level crossing improvement (860 sites)	
Maintenance Equipment	
Sub-Total	275
Station Improvement (4 New Signal Stations; 6 Station Squares; Storage Siding)	31
Disaster Prevention Facilities (Slope Improvement: 160 km; Falling Rock Preventive Constructions: 2 km; Falling Rock Warning System: 20 km; Drainage Improvement: 130 km)	45
Banking to Prevent Flood Damage (57 km)	59
Total	410

1.4 Electrical Facilities

(1) Signalling Facilities

In preparing the Master Plan, it is assumed that those sections using the tablet block system will be completely replaced by the token-less block system by the end of 1995, such replacement being undergoing currently.

1) Introduction of Colourlight Signals

All existing semaphore signals will be replaced by electric, multiple colourlight signals for easy recognition at night. The new electric signals will be the same as the existing electric signals (3 colourlight type).

2) Improvement of Interlocking Devices

- Class 1 relay interlocking devices will be introduced at 10 key stations.
- Class 2 relay interlocking devices will be introduced at all other stations.

3) Power Units

A power unit will be newly installed or improved at all stations with the construction of a new power distribution cable to secure the essential power source for the introduction of colourlight signals and the improvement of interlocking devices.

4) Installation of ATS System

An ATS system will be installed at all stations as a back-up safety measure in the case of a train driver not properly reacting to signal signs. This system will improve the degree of train safety in and out of stations.

5) Safety Facilities for Level Crossings

A train approach warning system will be newly installed at the main level crossings near urban areas and at national roads to improve level crossing safety and to make the duration of closure in response to an approaching train appropriate.

Table 1.4-1 Improvements of Signalling Facilities

Item	Unit	Quantity	Cost (million US$)
Introduction of Colourlight Signals	Station	143	
Improvement of Interlocking Devices	Station	153	
Installation or Improvement of Power Units	Station	166	
Installation of ATS System	Station	166	
Installation of Level Crossing Safety Facilities	Site	200	
Total			61.9

(2) Communication Facilities

As the existing communication network and communication equipment are out of date and aged, fundamental modernization of the communication system will be conducted.

1) Communication Line

The existing open-wire communication line has such problems as qualitative deterioration and channel shortage. These will be solved by the underground laying of composite communication cable (8C + 30P with optical fibre and metal) along the entire track. In addition, a distribution box and MDF will be installed at each station. TBs will be installed at 1 km intervals between stations.

2) Transmission Facilities

By today's technical standards, the existing carrier facilities and radio facilities are antiquated and lack sufficient quality and capacity to meet the future communication demand. Optical transmission facilities capable of sending data at a rate of 34 Mb/sec will be introduced taking the required investment size and future maintenance work requirements into consideration.

3) Switchboards

The present manual switchboards will be automated (14 will be replaced and 16 new sub-switchboards will be installed) to improve the telephone exchange network which will become the core for future information conveyance in view of the establishment of an instant access telephone network between Hanoi and Ho Chi Minh City. The terminal facilities at each station will consist of at least 2 telephone sets and one facsimile machine.

4) Data Transmission Facilities

In order to improve the passenger service, a terminal for the reservation system for limited express and inter-regional express trains will be introduced at major stations. In addition, a freight information system will also be introduced and terminals will be installed at those stations with a large freight handling volume, in order to modernise freight operation and to achieve the efficient use of freight cars.

5) Terminal Facilities

a. The existing centralised telephone system at each station and yard telephones will be renewed.

b. A local radio communication system to improve communication within stations and with manned level crossings and bridges will be introduced.

c. A talk back system will be introduced at large stations where shunting frequently takes place for better communication purposes.

Table 1.4-2 Improvements of Communication Facilities

Item	Unit	Quantity	Cost (million US$)
Construction of New Communication Line	km	1,726	
Installation of New Transmission Facilities	set	1	
Renewal of Switchboards	set	14	
Installation of New Data Transmission Facilities	system	2	
Improvement of Terminal Facilities	set	1	
Total			109.2

1.5 Rolling Stock and Its Maintenance

(1) Rolling Stock

1) Pre-Conditions for Rolling Stock Plan (Common to All Alternatives)

a. Rolling stock plan is made only for Hanoi - Ho Chi Minh Railway.

b. Locomotives

① The existing SLs, D4Hs, D9Es and standard gauge locomotives are condemned before 2010 or reserved as spare locomotives in and after 2010. These locomotives are excluded from the rolling stock plan upto 2010.

② The new locomotives will be D12Es and D18Es in view of locomotive standardisation.

③ The existing D11H (10 locomotives), D12E (40 locomotives), D13E (14 locomotives) and D18E (16 locomotives) will be rehabilitated after the age of rolling stock will reach 15 -20 years old.

④ D11H and D13E will be utilised as equivalent to D12E. Namely, existing number of D12E is 64.

c. Passenger Coachs and Wagons

The existing passenger coaches and wagons equipped with plain bearing are condemned before 2010 or reserved as spare cars in and after 2010. These cars are excluded from the rolling stock plan upto 2010.

d. Existing Number of PC and FC for Hanoi-Ho Chi Minh Railway

Existing number of PC and FC for Hanoi-Ho Chi Minh Railway is calculated based on the following ratio of passenger-km and ton-km in 1993 between all Viet Nam Lines and Hanoi-Ho Chi Minh Railway.

Passenger-kilometers	1,720,984: 1,400,530 = 100: 81.4
Ton-kilometers	978,132: 601,797 = 100: 61.5

e. Other

Dining cars, baggage cars and mail cars will be connected to trains appropriately, but are not included in the rolling stock plan, because their operation plan is not clear.

2) Rolling Stock Plan

a. Introduction of New High Speed Trains

40 new high speed trains will be introduced to serve as limited express passenger trains connecting Hanoi and Ho Chi Minh City in 24 hours and as inter-regional express passenger trains.

b. 50 D12Es and 22 D18Es will be newly procured to serve as local passenger trains and freight trains.

c. 4,800 wagons equipped with roller bearing will be newly introduced.

d. No new passenger coaches will be introduced as the existing fleet equipped with roller bearing is sufficient to meet the demand.

e. The improvement plan and investment cost of rolling stock are shown in Table 1.5-1.

Table 1.5-1 Improvements of Rolling Stock

Item	Unit	Quantity	Cost (million US$)
New High Speed Trains	Train	40	
New D18Es	Car	22	
New D12Es	Car	50	
New Wagons	Car	4,800	
Rehabilitation of D11Hs	Car	10	
Rehabilitation of D13Es and D18Es	Car	30	
Rehabilitation of D12Es	Car	40	
Total			498.6

(2) Rolling Stock Maintenance

The following reinforcement of the maintenance facilities, improvement of the work method and consolidation of the spare parts inventory, etc. will be conducted to ensure the reliable maintenance of the rolling stock.

1) Maintenance Facilities for New High Speed Trains (DEL and PC)

- DEL maintenance facilities will be introduced at the Gia Lam Workshop for the DEL of high speed train.

- New facility will be introduced at the Gia Lam Workshop for the maintenance of the air-conditioning system of PC of high speed train.
- Sewerage disposal facility will be introduced at the Gia Lam Workshop, Hanoi, Vinh, Da Nang, Nha Trang, and Saigon Station Yards to treat sewage from the toilets and wash basins in high speed trains.

2) DEL Maintenance Facilities

In view of the general inadequacy of the current DEL maintenance facilities, the relevant facilities at the Gia Lam Workshop and various depots will be improved.

3) Preparation of DEL Spare Parts

Spare equipments or parts used for DELs will be stocked at the Gia Lam Workshop to shorten the DEL maintenance cycle time with a view to reduce the DEL staying days for maintenance at the Workshop and to improve DEL operation efficiency.

4) Modernization of PC and FC Maintenance Work

The machinery and equipment at the workshops and various depots responsible for PC and FC maintenance will be introduced and upgraded.

5) Effluent Treatment Plant

An oil separator and pH treatment unit, etc. will be installed at the depots to treat effluent from maintenance work.

Table 1.5-2 Improvements at Gia Lam Workshop and Depots

Item		Cost (million US$)
Gia Lam Workshop	Buildings and Structures, etc.	
	Machinery, Equipment and Tools, etc.	
	Spare Parts	
Sub-Total		45
Dian Workshops/ Depots	Buildings and Structures, etc.	
	Machinery, Equipment and Tools, etc.	
Sub-Total		20
Total		65

1.6 Total Investment Cost

The total investment cost under Alternative I is given in Table 1.6-1.

Table 1.6-1 Total Investment Cost Under Alternative I

Item	Cost (million US$)
Track	275.0
Stations	31.0
Disaster Prevention	104.0
Bridges	430.4
Tunnels	55.4
Signalling	61.9
Communication	109.2
Rolling Stock	498.6
Workshop and Depots	65.0
Total	1630.5

2 Components and Investment Size of Alternative II

2.1 Marketing and Transportation Control

All aspects of the marketing and transportation control under Alternative II are the same as those under Alternative I.

2.2 Transportation Plan

The transportation plan under Alternative II is basically the same as that under Alternative I. However, the over-riding necessity to minimise investment in railway infrastructure necessitates the adoption of a maximum operation speed of 80 km/hr and some slow speed sections of 40 km/hr - 60 km/hr will remain at bridges, etc. No new rolling stock will be procured and limited express trains will be pulled by D18Es and comprised of existing passenger cars. The main differences between Alternative II and Alternative I are explained below.

① The Class 1 electrical relay interlocking devices referred to in 1.2 will be introduced at 3 stations instead of the 10 stations under Alternative I.

② The limited express trains and express trains will comprise the existing rolling stock (D18Es and others capable of running at 80 km/hr).

③ The travelling time of a limited express train between Hanoi and Ho Chi Minh City will be 30 hours and the train - kilometer figures are the smallest of all the Alternatives (see 1.2).

2.3 Civil Engineering Facilities

(1) Bridge and Tunnel Improvement

Under Alternative II, bridges and tunnels will be improved in the following manner.

1) In Connection with Train Operation

- Those bridges and tunnels posing a safety hazard will be improved.
- Those bridges and tunnels currently restricting train speed to under 40 km/hr will be improved.

2) Bridges Submerged at Time of Flooding

- The elevation of those bridges of not less than 20m in length will be raised as part of the improvement work.
- The elevation of those bridges of less than 20m in length will not be raised this time but will be raised when the adjacent roadbed is raised in the future.
- With respect to the bridges located in the section between Vinh and Thuan Ly, all the bridges in the selected sections which are highly vulnerable to flooding will be raised.

Table 2.3-1 Bridge Improvement

Number of Bridges	Aggregate Length	Cost
437	12.6 km	306.8 million US$

(9 bridges already appraised by the OECF are not included.)

Table 2.3-2 Tunnel Improvement

Number of Tunnels	Aggregate Length	Cost
27	7.8 km	50.3 million US$

(2) Track and Stations

The basic concept of improvement is the same as that under Alternative I. The main components of the improvement work under Alternative II are outlined below, focusing on the differences between Alternative II and Alternative I.

1) Track Reinforcement

a. Rails

- 27 kg rails and 30 kg rails will be replaced by 43 kg rails (25m in length).
- The present length of 12.5m of the 43 kg rails will be doubled through on-site welding work.
- Long welded rails will be used at those sections where ever feasible (R > 600m) and effective.

b. Turnouts

All turnouts on the main track will be renewed by ordinary turnouts (V ≤ 70 km/hr).

c. Sleepers

- All wooden and steel sleepers at those sections where radius (R) is more than 600m will be replaced by improved type concrete block sleepers. The fastening system will also be improved. The laying density will be 1,660 sleepers/km.
- The number of wooden sleepers will be increased from 1,600 sleepers/km to 1,720 sleepers/km at those sections where R is 600m or less.
- The density of the existing concrete block sleepers will be increased from 1,440 sleepers/km to 1,660 sleepers/km, accompanied by improvement of the fastening system.

d. Ballast

- The minimum ballast thickness will be 25 cm for those sections where a train speed of 80 km/hr is feasible.
- The minimum ballast thickness for other sections will be 20 cm.

2) Roadbed Improvement

The roadbed at those sections posing problems in terms of high speed train operation and its maintenance will be improved. Depending on the roadbed situation, the improvement work will involve auger agitation type grouting or complete replacement of the existing roadbed.

3) Cant and Transition Curve Improvement

In response to the maximum speed of 80 km/hr, the cant and transition curve will be revised where necessary.

4) Curvature Improvement

See Alternative I.

5) Level Crossing Improvement

Those level crossings where track improvement work will be conducted will be paved with asphalt and safety fencing will be erected along the track near these level crossings to prevent any unnecessary invasion of pedestrians on the track.

6) Maintenance Equipment

See Alternative I.

7) Stations

One signal station will be constructed to secure a sufficient track capacity. In addition, new storage siding will be introduced at stations where necessary.

8) Disaster Prevention Facilities

Slope improvement work, fall rock preventive constructions, protective fencing and the installation of falling rock warning devices will be conducted at those sections posing a safety hazard in terms of high speed train operation. In addition, drainage facilities will be introduced at those sections which pose a serious hazard in terms of train operation safety, a maintenance hazard and/or environmental hazard. Other improvement features will be the same as those under Alternative I.

9) Station Square Improvement

See Alternative I.

Table 2.3-3 Track and Station Improvements

	Cost (million US$)
Track Improvement (Rails; Sleepers; Turnouts; Ballast; Fastenings)	
Roadbed Improvement (25 km)	
Cant and Transition Curve Improvement	
Curvature Improvement (at one site)	
Level Crossing Improvement (420 sites)	
Maintenance Equipment	
Sub-Total	212
Station Improvement (1 New Signal Station; 6 Station Squares; Storage Siding)	29
Disaster Prevention Facilities (Slope Improvement: 80 km; Prevention of Falling Rocks: 1 km: Falling Rock Warning System: 20 km; Drainage Improvement: 70 km)	26
Banking to Prevent Flood Damage (57 km)	59
Total	326

2.4 Electrical Facilities

(1) Signalling Facilities

Some changes have been made to Alternative I as described below where safety of the electrical facilities is not compromised. All other components are the same as those of Alternative I.

- Safety Facilities for Level Crossings

  A train approach warning system will be newly installed at 57 level crossings, mainly located in urban areas.

- Installation of Class 1 Relay Interlocking Devices

  Instead of at 10 stations under Alternative I, Class 1 relay interlocking devices will be installed at 3 stations.

Table 2.4-1 Improvement of Signalling Facilities

Item	Unit	Quantity	Cost (million US$)
Introduction of Colourlight Signals	Station	140	
Improvement of Interlocking Devices	Station	143	
Renewal of Power Units	Station	23	
Installation of ATS System	Station	163	
Introduction of Level Crossing Safety Facilities	Site	57	
Total			45.4

(2) Communication Facilities

The basic concept of improvement is the same as that under Alternative I except for the following differences.

- The capacity of the composite communication cable conductor is reduced to 4C + 20P.
- TBs will be installed at 2 km intervals instead of at 1 km intervals.
- 8 key switchboards will be automated because of their crucial importance vis-a-vis the creation of a telephone exchange network.
- The existing terminal facilities will be replaced without any new additions.

Table 2.4-2 Improvement of Communication Facilities

Item	Unit	Quantity	Cost (million US$)
Construction of New Communication Line	km	1,726	
Installation of New Transmission Facilities	set	1	
Renewal of Switchboards	set	8	
Installation of New Data Transmission Facilities	system	2	
Improvement of Terminal Facilities	set	1	
Total			87.2

2.5 Rolling Stock and Its Maintenance

(1) Rolling Stock

1) Pre-Conditions for Rolling Stock Plan

See Alternative I.

2) Rolling Stock Plan

a. No new high speed trains will be introduced as the target travelling time between Hanoi and Ho Chi Minh City is 30 hours.

b. 8 D12Es and 64 D18Es will be newly procured to serve as both passenger and freight trains.

c. Passenger cars for limited express and inter-regional express services will be air-conditioned for increased passenger comfort.

- The air-conditioning system will be installed for the existing 47 first class sleeping cars, 87 first class coaches and 73 second class sleeping cars along with their rehabilitation.
- In view of the shortage of passenger cars, 16 first class sleeping cars, 18 first class coaches, 32 second class sleeping cars and 91 second class coaches, totalling 157 cars, all of which will be air-conditioned, will be newly manufactured.
- 14 new second class coaches will also be manufactured for the local passenger service.
- 3,800 new wagons equipped with roller bearing will be manufactured.
- The investment plan of rolling stock are shown in Table 2.5-1.

Table 2.5-1 Investment Plan of Rolling Stock

Item		Unit	Quantity	Cost (million US$)
New D18Es		Car	64	
New D12Es		Car	8	
New Passenger Cars		Car	157	
New Wagons		Car	3,800	
Rehabilitation of D11Hs		Car	10	
Rehabilitation of D13Es and D18Es		Car	30	
Rehabilitation of D12Es		Car	40	
Rehabilitation and Air-Conditioning of Passenger Cars	First Class Sleeping Cars	Car	47	
	First Class Coaches	Car	87	
	Second Class Sleeping Cars	Car	73	
	Second Class Coaches	Car	14	
Total				358.3

(2) Rolling Stock Maintenance

The basic concept of improvement and the planned new facilities are the same as those under Alternative I except that the maintenance facilities for high speed DELs and PCs and the provision of DEL spare parts have been withdrawn.

Table 2.5-2 Improvements at Workshops and Depots

Item		Cost (million US$)
Gia Lam Workshop	Buildings and Structures, etc.	
	Machinery, Equipment and Tools, etc.	
Sub-Total		34
Dian Workshop/ Depots	Buildings and Structures, etc.	
	Machinery, Equipment and Tools, etc.	
Sub-Total		19
Total		53

2.6 Total Investment Cost

The total investment cost under Alternative II is given in Table 2.6-1.

Table 2.6-1 Total Investment Cost Under Alternative II

Item	Cost (million US$)
Track	212.0
Stations	29.0
Disaster Prevention	85.0
Bridges	306.8
Tunnels	50.3
Signalling	45.4
Communication	87.2
Rolling Stock	358.3
Workshops and Depots	53.0
Total	1227.0

3 Components and Investment Size of Alternative III

3.1 Marketing and Transportation Control

All aspects of the marketing and transportation control under Alternative III are the same as those under Alternative I.

3.2 Transportation Plan

The transportation plan under Alternative III is basically the same as that under Alternatives I and II. However, a maximum train speed of 110 km/hr is adopted with a slower 80 km/hr being adopted for those sections where 110 km/hr is impractical because of the limitations imposed by the curvature, etc., making use of the relatively smaller investment size. Consequently, new rolling stock will be procured to provide a limited express service to shorten the travelling time between Hanoi and Ho Chi Minh City to approximately 25 hours which is one hour longer than that envisaged by Alternative I (see 1.2). The main differences between Alternative III and Alternative I are described below.

① The operational safety system in the form of relay interlocking devices will be the same as that under Alternative II.

② New rolling stock will only be procured for the limited express service.

③ The 110 km/hr sections are shown in Table 3.2-1.

Table 3.2-1 List of 110 km/hr Sections (all bridges, etc. will be improved)

Maximum Speed of 110 km/hr Sections	Length (km)	Remarks
Thuong Tin (17.4) - Cho Tia (25.5)	8.1	
Don Van (44.7) - Cau Yen (120.4)	75.7	
Nghia Trang (161.0) - Khoa Truong (229.0)	68.0	
Cau Giat (261.0) - Yen Due (351.5)	90.5	
Huong Pho (386.8) - Tan Ap (408.7)	21.9	
Ngan Son (488.8) - Thua Luu (741.6)	252.8	
Le Trach (804.1) - Hoa Vinh Tay (940.4)	136.3	
Tam Quan (1,004.3) - Phu Cat (1,070.9)	66.6	
Dai Lanh (1,232.2) - Ca Na (1,436.3)	204.1	
S. Long Song (1,465.5) - Muong Man (1,551.2)	85.7	
Total Length	1,009.7	

Notes: 1) All slow speed sections, excepting 18 sections where the required slow speed is not less than 40 km/hr, in the above 110 km/hr sections will be improved.
2) In the case of 80 km/hr sections, those slow speed sections of less than 40 km/hr will be improved.
3) The total length of 80 km/hr sections is 716.5 km.

3.3 Civil Engineering Facilities

(1) Bridge and Tunnel Improvement

Under Alternative III, bridges and tunnels will be improved in the following manner.

1) In Connection with Train Operation

- Those bridges and tunnels posing a safety hazard will be improved.
- Those bridges currently restricting train speed to under 40 km/hr will be improved.
- All but 18 slow speed bridges in the 110 km/hr sections will be improved.
- Those tunnels currently restricting train speed will be improved.

2) Bridges Submerged at Time of Flooding

- The elevation of those bridges of not less than 20m in length will be raised as part of the improvement work.
- The elevation of those bridges of less than 20m in length will not be raised this time but will be raised when the adjacent roadbed is raised in the future.
- With respect to the bridges located in the section between Vinh and Thuan Ly, all the bridges in the selected sections which are highly vulnerable to flooding will be raised.

Table 3.3-1 Bridge Improvement

Number of Bridges	Aggregate Length	Cost
555	16.4 km	374.0 million US$

(9 bridges already appraised by the OECF are not included.)

Table 3.3-2 Tunnel Improvement

Number of Tunnels	Aggregate Length	Cost
27	7.8 km	55.4 million US$

(2) Track and Stations

The basic concept of improvement is the same as that under Alternative I. The main components of the improvement work under Alternative III are outlined below, focusing on the differences between Alternative III and Alternative I.

1) Track Reinforcement

a. Rails

- 27 kg rails and 30 kg rails will be replaced by 43 kg rails (25m in length).
- The present length of 12.5m of the 43 kg rails will be doubled through on-site welding work.
- Long welded rails will be used at those sections where ever feasible (R > 600m) and the train speed is 80 - 110 km/hr.

b. Turnouts

See Alternative I.

c. Sleepers

See Alternative I.

d. Ballast

- The minimum ballast thickness will be 25 cm for those sections where a train speed of 80 - 110 km/hr is feasible.
- The minimum ballast thickness for other sections will be 20 cm.

2) Roadbed Improvement

See Alternative I.

3) Cant and Transition Curve Improvement

In response to the maximum speed of 80 km/hr or 110 km/hr, the cant and transition curve will be revised where necessary.

4) Curvature Improvement

See Alternative I.

5) Level Crossing Improvement

See Alternative I.

6) Maintenance Equipment

See Alternative I.

7) Stations

Two signal stations will be constructed to secure a sufficient track capacity. In addition, new storage siding will be introduced at stations where necessary.

8) Disaster Prevention Facilities

See Alternative I.

9) Station Square Improvement

See Alternative I.

Table 3.3-3 Track and Station Improvements

	Cost (million US$)
Track Improvement (Rails; Sleepers; Turnouts; Ballast; Fastenings)	
Roadbed Improvement (50 km)	
Cant and Transition Curve Improvement	
Curvature Improvement (1 site)	
Level Crossing Improvement (860 sites)	
Maintenance Equipment	
Sub-Total	272
Station Improvement (2 New Signal Stations; 6 Station Squares; Storage Track)	29
Disaster Prevention Facilities (Slope Improvement: 160 km; Prevention of Falling Rocks: 2 km: Falling Rock Warning System: 20 km; Drainage Improvement: 130 km)	45
Banking to Prevent Flood Damage (57 km)	59
Total	405

3.4 Electrical Facilities

(1) Signalling Facilities

See Alternative II.

(2) Communication Facilities

See Alternative II.

3.5 Rolling Stock and Its Maintenance

(1) Rolling Stock

1) Pre-Conditions for Rolling Stock Plan

See Alternative I.

2) Rolling Stock Plan

a. 13 new high speed trains will be introduced between Hanoi and Ho Chi Minh City to achieve a travelling time of 25 hours.

b. 26 D12Es and 43 D18Es will be newly procured to serve as express and local passenger trains and freight trains.

c. Passenger cars for limited express and inter-regional express services will be air-conditioned for increased passenger comfort.

- The air-conditioning system will be installed for the existing 47 first class sleeping cars, 87 first class cars and 55 second class sleeping cars along with their rehabilitation.

d. 13 new second class cars will also be manufactured for the local passenger service.

e. 4,200 new wagons equipped with roller bearing will be manufactured.

f. The investment plan of rolling stock are shown in Table 3.5-1.

Table 3.5-1 Investment Plan of Rolling Stock

Item		Unit	Quantity	Cost (million US$)
New High Speed Passenger Trains		Train	13	
New D18Es		Car	43	
New D12Es		Car	26	
New Passenger Cars		Car	13	
New Freight Cars		Car	4,200	
Rehabilitation of D11Hs		Car	10	
Rehabilitation of D13Es and D18Es		Car	30	
Rehabilitation of D12Es		Car	40	
Rehabilitation and	First Class Sleeping Cars	Car	47	
Air-Conditioning	First Class Cars	Car	87	
of Passenger Cars	Second Class Sleeping Cars	Car	55	
Total				387.3

(2) Rolling Stock Maintenance

See Alternative I.

3.6 Total Investment Cost

The total investment cost under Alternative III is given in Table 3.6-1.

Table 3.6-1 Total Investment Cost Under Alternative III

Item	Cost (million US$)
Track	272.0
Stations	29.0
Disaster Prevention	104.0
Bridges	374.0
Tunnels	55.4
Signalling	45.4
Communication	87.2
Rolling Stock	387.3
Workshops and Depots	65.0
Total	1,419.3

4. Planned Investment Size of Each Alternative

The Planned investment size of each Alternative is given in Table 4-1.

Table 4-1 Planned Investment Size of Each Alternative

(Unit: million US$)

Item	Alternative I	Alternative Ii	Alternative III	Remarks
Track Stations Disaster Prevention	410.00	326.00	405.00	
Bridges	430.40	306.80	374.00	
Tunnels	55.40	50.30	55.40	
Signalling	61.90	45.40	45.40	
Communication	109.20	87.	87.20	
Rolling Stock	498.60	357.30	387.30	
Workshops and Deports		53.00	65.00	
Total	1,630.50	1,227.00	1,419.30	

APPENDIX 6.4-2.2 TRAFFIC SURVEY

1. Traffic Count Survey on the Hanoi Cordon Line

In order to confirm the volume and distribution pattern of dominant traffic generation zones, traffic count and roadside interview survey was conducted in the end of June, 1995 on the Hanoi cordon line. The survey locations are presented in Figure 1.1.

Total volume of traffic generation and attraction of Hanoi account for 74,000 in non-motorized-vehicle (NMV), 90,000 in motor cycle (MC), and 24,000 in motorized vehicles of more than four wheels (MV). More than 80% of traffic is made by NMV and MC, while only 13% of traffic is made by MV.

Table 1.1 Traffic Volume on the Hanoi Cordon Line

(1) 16 Hours Ttraffic Volume (Vehicles)

Location	From Hanoi			To Hanoi			Both direction			Both direction share		
	NMV	MC	MV	NMV	MC	MV	NMV	MC	MV	NMV	MC	MV
(1)	2,046	2,138	793	2,100	2,305	737	4,146	4,443	1,530	5.6	5.0	6.4
(2)	972	637	335	896	589	71	1,868	1,226	406	2.5	1.4	1.7
(3)	3,476	6,566	1,544	3,159	5,885	1,447	6,635	12,451	2,991	8.9	13.9	12.5
(4)	2,326	4,982	2,249	2,138	4,433	2,365	4,464	9,415	4,614	6.0	10.5	19.4
(5)	2,373	3,645	2,660	2,547	4,903	2,699	4,920	8,548	5,359	6.6	9.5	22.5
(6)	17,916	17,819	2,097	18,717	20,864	2,533	36,633	38,683	4,630	49.3	43.2	19.4
(7)	7,049	5,142	961	4,753	4,567	995	11,802	9,709	1,956	15.9	10.8	8.2
(8)	177	80	16	169	127	20	346	207	36	0.5	0.2	0.2
(9)	1,833	2,607	1,139	1,619	2,335	1,174	3,452	4,942	2,313	4.6	5.5	9.7
Total	38,168	43,616	11,794	36,098	46,008	12,041	74,266	89,624	23,835	100.0	100.0	100.0

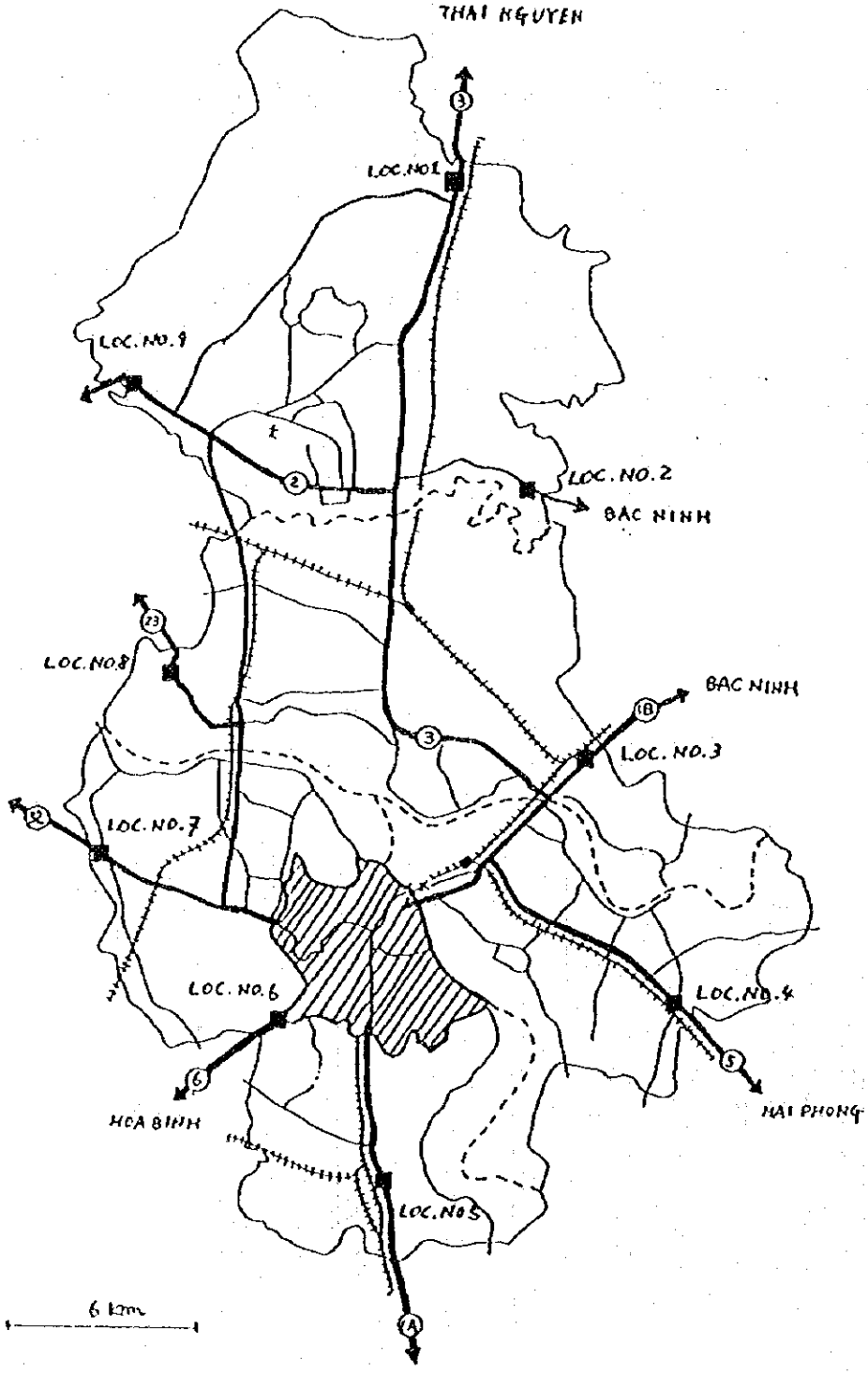


Figure 1.1 Survey Locations

(2) Share by Vehicle Type

Location	From Hanoi			To Hanoi			Both direction		
	NMV	MC	MV	NMV	MC	MV	NMV	MC	MV
(1)	41.1	43.0	15.9	40.8	44.8	14.3	41.0	43.9	15.1
(2)	50.0	32.8	17.2	57.6	37.9	4.6	53.4	35.0	11.6
(3)	30.0	56.7	13.3	30.1	56.1	13.8	30.1	56.4	13.5
(4)	24.3	52.1	23.5	23.9	49.6	26.5	24.1	50.9	24.9
(5)	27.3	42.0	30.7	25.1	48.3	26.6	26.1	45.4	28.5
(6)	47.4	47.1	5.5	44.4	49.5	6.0	45.8	48.4	5.8
(7)	53.6	39.1	7.3	46.1	44.3	9.6	50.3	41.4	8.3
(8)	64.8	29.3	5.9	53.5	40.2	6.3	58.7	35.1	6.1
(9)	32.9	46.7	20.4	31.6	45.5	22.9	32.2	46.2	21.6
Total	40.8	46.6	12.6	38.3	48.9	12.8	39.6	47.7	12.7

(3) 24 Hours Traffic Volume

Location	From Hanoi			To Hanoi			Both direction		
	NMV	MC	MV	NMV	MC	MV	NMV	MC	MV
(3)	3,591	6,857	1,701	3,297	6,062	1,678	6,888	12,919	3,379
(4)	2,359	5,177	2,526	2,294	4,559	2,672	4,653	9,736	5,198
(5)	2,431	3,830	2,918	3,033	5,072	3,144	5,464	8,902	6,062
(9)	1,908	2,676	1,255	1,824	2,404	1,275	3,732	5,080	2,530

(4) 42/16 Ratio

Location	From Hanoi			To Hanoi			Both direction		
	NMV	MC	MV	NMV	MC	MV	NMV	MC	MV
(3)	1.033	1.044	1.102	1.044	1.030	1.160	1.038	1.038	1.130
(4)	1.014	1.039	1.123	1.073	1.028	1.130	1.042	1.034	1.127
(5)	1.024	1.051	1.097	1.191	1.034	1.165	1.111	1.041	1.131
(9)	1.041	1.026	1.102	1.127	1.030	1.086	1.081	1.028	1.094
Average	1.028	1.042	1.106	1.104	1.031	1.141	1.065	1.036	1.124

2 Traffic Characteristics of Passengers of Long-Distance Trip

Three transport modes are available for a long-distance person trip in Viet Nam, those are railways, buses, and air. Motor vehicles are scarcely used for long-distance trips of Vietnamese people since private vehicle ownership is very limited at present.

Questionnaire surveys were conducted in order to find the traffic characteristics of long-distance passengers in Viet Nam. The survey forms presented in the appendix are translated into Vietnamese and the trained survey staffs from TEDI and VRDI asked domestic passengers (Vietnamese) to answer the questions at the Noi Bai airport, the three bus terminals in Hanoi, the three railway sections of the Hanoi - Ho Chi Minh line, the Hanoi-Lao Cai line and the Hanoi-Ha Long line.

Table 2.1 Survey Performance

Survey Location	No. of Samples	
Noi Bai Airport	Hanoi - Ho Chi Minh	404
	Hanoi - Da Nang	122
	Hanoi - Hue	15
	Hanoi - Vinh	34
Railways	Hanoi - Vinh	243
	Da Nang - Hue	204
	Ho Chi Minh - Muong Man	273
	Hanoi - Lao Cai Line	177
	Hanoi - Ha Long Line	219
Bus Terminals	Giap Bat	280
	Gia Lam	171
	Kim Ma	170

In the questionnaire survey, nationality, age, sex, type of job, personal income, household income and permanent address were inquired as a personal profile. Since there have been no such the survey in Viet Nam, it provide very valuable information to understand the characteristics of travelers by each mode.

As a traffic characteristics, trip origin and destination places, available stations or terminals for the trip, trip purpose, travel cost, travel time, departure frequency, access mode and its cost and time. Besides the above mentioned questions which are described in a numeric variables, each passenger's evaluation on the cost, time, frequency, comfortableness and safety is inquired in a form of ordering of five steps. Since, this information directly indicates people's awareness to the transport systems, it must be useful to developing a principle of improvement of LOS (level of service).

(1) Age

Age is widely distributed from one to eighty years old. The average ages by the type of transport mode are slightly different. The average age of air transport user is 42 years old. The average age of the others are middle of thirty's.

Survey Location	Average Age
Noi Bai Airport	42.0
HN-HCM Line	38.0
HN-Lao Cai Line	34.6
HN-Ha Long Line	36.8
Giap Bat Bus Terminal	34.0
Gia Lam Bus Terminal	35.0
Kim Ma Bus Terminal	29.0

(2) Sex

More than half of the passengers of every transport mode are male. Rather good occupation by female (40% of total passenger) was observed on the Hanoi - Ho Chi Minh line and Hanoi - Ha Long line. On the contrary, about 70% of passenger are male in the other modes.

(3) Job

There are significant difference in type of job between the modes. About 30% of air passenger and 20% of Hanoi-Ho Chi Minh line are government officials, which are the most dominant passenger for the two transport modes. On the Hanoi - Lao Cai line, about 20% of passenger belong to tertiary industry, which is followed by peddler (16.6%) and farmer / fishermen

(12.9%). On the Hanoi - Ha Long line, about half of the passengers are the employee of secondary and tertiary industry, which is followed by peddler. It is generally observed that employee and peddler have rather high proportion in the East - West lines in Northern part of Viet Nam, which indicates that the lines have an important role for the regional economy. In the bus passenger, it is noted that rather good proportion was occupied by students.

Major Users by Type of Job

	Ranking		
Survey Location	1	2	3
Noi Bai Airport	Government(27.9)	Employee II(22.5)	Employee III(15.6)
HN-HCM Line	Government(18.2)	Self-business(18.2)	Employee II(12.9)
HN-Lao Cai Line	Employee III(22.9)	Self-business(16.6)	Farmer(13.7)
HN-Ha Long Line	Employee II(29.2)	Employee III(21.5)	Self-business(16.4)
Giap Bat Bus Terminal	Student(21.1)	Self-business(20.4)	Employee(16.1)
Gia Lam Bus Terminal	Farmer(27.3)	Employee II(13.3)	Student(12.7)
Kim Ma Bus Terminal	Employee II(13.9)	Self-business(12.7)	Student(10.3)

(4) Personal and Household Income

There is a significant difference among the modes in level of passenger's income. It is generally observed that income level of passenger in the North - South direction is higher than that of the East - West direction.

Survey Location	Private Income	Household Income
Noi Bai Airport	981,939 Dong	1,918,489 Dong
HN-HCM Line	489,781 Dong	898,299 Dong
HN-Lao Cai Line	447,725 Dong	845,417 Dong
HN-Ha Long Line	268,673 Dong	479,904 Dong
Giap Bat Bus Terminal	373,939 Dong	1,210,435 Dong
Gia Lam Bus Terminal	394,429 Dong	501,434 Dong
Kim Ma Bus Terminal	306,893 Dong	476,364 Dong

(5) Trip Purpose

About half of the air passengers and 13.9 % of the Hanoi - Ho Chi Minh railway passengers have "official" purpose for their trips. On the contrary, "official" purpose passengers are scarcely observed in the other transport modes. It is safely stated that there is almost no possibility that half of the air passenger who have the "official" purpose use other modes for their trip. The other transport mode except the air are mainly used by the passenger whose trip purpose is "self-business", which account about 30 to 40 % of total.

Major Trip Purpose

	Ranking		
Survey Location	1	2	3
Noi Bai Airport	Official(52.4)	Self-business(22.5)	Recreational(14.6)
HN-HCM Line	Self-business(25.8)	Recreational(17.7)	Official(13.9)
HN-Lao Cai Line	Self-business(41.8)	Employer's-business(12.4)	Others(11.3)
HN-Ha Long Line	Self-business(35.2)	Recreational(20.1)	Other to home(14.6)
Giap Bat Bus Terminal	Self-business(25.7)	School to home(13.9)	Recreational(12.9)
Gia Lam Bus Terminal	Self-business(34.3)	Other to home(21.5)	Home to work(10.5)
Kim Ma Bus Terminal	Self-business(58.2)	Others(12.1)	Shopping(9.7)

(6) Decision Making Factors for Selection of Transport Mode

Five items; cost, time, frequency, comfortableness and safety are presented in the questionnaire as factors which make effect on decision making for selection of transport mode. Each interviewee was asked to select one factors which have the most dominant effect in selection of transport mode.

There observed significant difference between the modes. Almost all the air passenger selected "time" for their dominant decision making factor. The railway passenger of significant proportion selected the "Safety" and "Comfortableness" and the major bus passenger selected the "Frequency" and "Time". It may say that since there is not significant difference in travel cost between the railway and the buses, these two transport modes are substitution for each

other in terms of the other four factors.

Major Decision Making Factors for Selection of Transport Mode

Survey Location	Ranking (%)		
	1	2	3
Noi Bai Airport	Time(82.3)	Comfortableness(6.7)	Cost(6.3)
HN-HCM Line	Safety(49.2)	Comfortableness(31.5)	Cost(9.8)
HN-Lao Cai Line	Comfortableness(74.0)	Safety(16.9)	Others(4.0)
HN-Ha Long Line	Safty(64.8)	Comfortableness(30.1)	Cost/Time(1.8)
Giap Bat Bus Terminal	Frequency(49.4)	Time(29.6)	Cost(16.6)
Gia Lam Bus Terminal	Time(36.1)	Frequency(34.9)	Cost(19.9)
Kim Ma Bus Terminal	Frequency(48.2)	Time(31.0)	Cost/Comfort(8.9)

(7-1) Evaluation on Travel Cost

The most frequent answer for the cost evaluation is "Reasonable" , which well exceed 50 % of total passengers by each mode except the Hanoi - Ho Chi Minh line passenger. More than half of the passengers on the Hanoi - Ho Chi Minh line answered "Rather expensive", which indicates that there exist other important factors to select the railway such as "Safety" and "Comfortableness".

Survey Location	Mode (%)
Noi Bai Airport	Reasonable (64.4)
HN-HCM Line	Rather expensive (54.3)
HN-Lao Cai Line	Reasonable (65.3)
HN-Ha Long Line	Reasonable (70.3)
Giap Bat Bus Terminal	Reasonable (57.3)
Gia Lam Bus Terminal	Reasonable (69.4)
Kim Ma Bus Terminal	Reasonable (67.3)

(7-2) Evaluation on Travel Time

The most frequent answer for the cost evaluation in the air passengers is "Rather short" , which coincides with the fact that the dominant decision making factor for the air passengers is "Time". There are variations in the railway passengers' responses. Major part of the railway passengers on the Hanoi - Ho Chi Minh line and the Hanoi - Ha Long line responded "Rather long", on the contrary the passengers on the Lao Cai line responded "Rather short". The bus passengers at the Giap Bat bus terminal which is used for the south direction bus services responded "Reasonable", that seems to be a contrast with the responses of the Hanoi - Ho Chi Minh railway passengers.

Survey Location	Mode (%)
Noi Bai Airport	Rather short (51.7)
HN-HCM Line	Rather long (54.3)
HN-Lao Cai Line	Rather short (47.5)
HN-Ha Long Line	Rather long (53.0)
Giap Bat Bus Terminal	Reasonable (40.6)
Gia Lam Bus Terminal	Reasonable (53.2)
Kim Ma Bus Terminal	Rather short (46.4)

(7-3) Evaluation on Departure Frequency

The most frequent answer for the frequency evaluation common to all the passenger except at the Kim Ma bus terminal is "About Average" or "Convenient". The average occupancy ratio against the maximum available seats are 27.0% at the Giap Bat terminal, 68.3% at the Gia Lam terminal and 90.9% at the Kim Ma terminal. This fact indicates that supply of bus services at the Kim Ma is very close to its maximum capacity, which may lead to the major responses of "Inconvenient" at the Kim Ma bus terminal.

Survey Location	Mode (%)
Noi Bai Airport	Convenient (46.2)
HN-HCM Line	About average (78.6)
HN-Lao Cai Line	Convenient (48.6)
HN-Ha Long Line	About Average (42.9)
Giap Bat Bus Terminal	Convenient (57.7)
Gia Lam Bus Terminal	About Average (62.0)
Kim Ma Bus Terminal	Inconvenient (52.4)

(7-4) Evaluation on Comfort of Travel

The most frequent answer for the comfortableness evaluation common to all the passenger except at the Giap Bat bus terminal is "About Average" or "Satisfied". Even the passengers at the Giap Bat bus terminal responded "Dissatisfied", they used the buses, that indicates that they valued other factors such as "Frequency" and "Time" in comparison with the Hanoi - Ho Chi Minh railway..

Survey Location	Mode (%)
Noi Bai Airport	Satisfied (66.7)
HN-HCM Line	About average (55.2)
HN-Lao Cai Line	Satisfied (79.1)
HN-Ha Long Line	Satisfied (47.5)
Giap Bat Bus Terminal	Dissatisfied (43.8)
Gia Lam Bus Terminal	About average (43.6)
Kim Ma Bus Terminal	Satisfied (49.4)

(7-5) Evaluation on Comfortableness of Travel

The most frequent answer for the safety evaluation common to all the passenger is "Rather safe" or "About average". However, it should be noted that about 20 % of the Giap Bat bus terminal passengers and about 10 % of the Gia Lam bus terminal passengers responded "Rather dangerous".

Survey Location	Mode (%)
Noi Bai Airport	Rather safe (85.3)
HN-HCM Line	Rather safe (73.3)
HN-Lao Cai Line	Rather safe (80.7)
HN-Ha Long Line	Rather safe (47.3)
Giap Bat Bus Terminal	Rather safe (48.1)
Gia Lam Bus Terminal	Rather safe (58.1)
Kim Ma Bus Terminal	Very safe (39.9)

Appendix Table 6.4.3-1 Project Cost of Alternative I ; Grand Total (at Market Price)

(unit: million US$)

Items	Grand Total						
	Materials		Working Compensation		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Total
1 Bridges	35.8	242.2	39.6	112.7	75.4	354.9	430.35
2 Tunnel	7.5	28.4	4.1	15.4	11.6	43.8	55.41
3 Track Improvement	3.6	89.9	8.5	0.0	12.1	89.9	102.02
4 Roadbed Improvement	117.7	76.5	41.5	4.5	159.2	81.1	240.24
5 Equip. for Track & Roadbed Impro.	0.2	21.2	0.1	2.2	0.3	23.4	23.71
6 Natural Disaster Protection	25.5	0.1	18.5	0.0	44.0	0.1	44.03
7 Signal	0.0	54.9	0.9	6.1	0.9	61.0	61.90
8 Communication	0.5	101.3	4.7	2.8	5.2	104.1	109.25
9 Rolling Stocks (New)	195.2	210.1	0.0	0.0	195.2	210.1	405.25
10 Rolling Stocks (Rehabilitation)	0.0	0.0	0.0	0.0	0.0	0.0	0.00
11 Workshop & Depots	0.5	12.0	-0.5	0.0	0.0	12.0	12.00
Total	386.7	836.5	117.3	143.7	503.9	980.3	1,484.16

Appendix Table 6.4.3-2 Project Cost of Alternative I ; Grand Total (at Economic Price)

(unit: million US$)

Items	Grand Total						
	Materials		Working Compensation		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Total
1 Bridges	34.7	242.2	31.7	112.7	66.4	354.9	421.35
2 Tunnel	7.3	28.4	3.3	15.4	10.6	43.8	54.37
3 Track Improvement	3.5	89.9	6.8	0.0	10.3	89.9	100.21
4 Roadbed Improvement	114.2	76.5	33.2	4.5	147.4	81.1	228.42
5 Equip. for Track & Roadbed Impro.	0.2	21.2	0.0	2.2	0.3	23.4	23.69
6 Natural Disaster Protection	24.8	0.1	14.8	0.0	39.5	0.1	39.57
7 Signal	0.0	54.9	0.7	6.1	0.7	61.0	61.72
8 Communication	0.5	101.3	3.7	2.8	4.2	104.1	108.30
9 Rolling Stocks (New)	189.3	210.1	0.0	0.0	189.3	210.1	399.39
10 Rolling Stocks (Rehabilitation)	0.0	0.0	0.0	0.0	0.0	0.0	0.00
11 Workshop & Depots	0.5	12.0	-0.4	0.0	0.1	12.0	12.09
Total	375.1	836.5	93.8	143.7	468.9	980.3	1,449.11

Appendix Table 6.4.3-3 Project Cost of Alternative I ; up to 2000 (at Market Price)

(unit: million US$)

Items	up to Year 2000						
	Materials		Working Compensation		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Total
1 Bridges	11.9	80.8	13.2	37.6	25.2	118.4	143.51
2 Tunnel	3.1	11.5	1.7	6.3	4.7	17.8	22.50
3 Track Improvement	0.3	55.2	3.1	0.0	3.4	55.2	58.56
4 Roadbed Improvement	12.8	20.7	9.4	1.4	22.1	22.1	44.23
5 Equip. for Track & Roadbed Impro.	0.0	7.1	0.0	0.7	0.0	7.8	7.82
6 Natural Disaster Protection	5.5	0.0	3.9	0.0	9.4	0.0	9.39
7 Signal	0.0	31.7	0.8	0.0	0.8	31.7	32.50
8 Communication	0.2	38.3	1.8	0.9	2.1	39.2	41.21
9 Rolling Stocks (New)	64.9	69.3	0.0	0.0	64.9	69.3	134.13
10 Rolling Stocks (Rehabilitation)	0.0	0.0	0.0	0.0	0.0	0.0	0.00
11 Workshop & Depots	0.5	2.0	-0.5	0.0	0.0	2.0	2.00
Total	99.2	316.5	33.3	46.8	132.5	363.3	495.85

Appendix Table 6.4.3-4 Project Cost of Alternative I ; up to 2000 (at Economic Price)

(unit: million US$)

Items	up to Year 2000						
	Materials		Working Compensation		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Total
1 Bridges	11.6	80.8	10.6	37.6	22.2	118.4	140.51
2 Tunnel	3.0	11.5	1.3	6.3	4.3	17.8	22.08
3 Track Improvement	0.3	55.2	2.5	0.0	2.7	55.2	57.94
4 Roadbed Improvement	12.4	20.7	7.5	1.4	19.9	22.1	41.97
5 Equip. for Track & Roadbed Impro.	0.0	7.1	0.0	0.7	0.0	7.8	7.82
6 Natural Disaster Protection	5.4	0.0	3.1	0.0	8.4	0.0	8.45
7 Signal	0.0	31.7	0.6	0.0	0.6	31.7	32.34
8 Communication	0.2	38.3	1.5	0.9	1.7	39.2	40.84
9 Rolling Stocks (New)	62.9	69.3	0.0	0.0	62.9	69.3	132.18
10 Rolling Stocks (Rehabilitation)	0.0	0.0	0.0	0.0	0.0	0.0	0.00
11 Workshop & Depots	0.5	2.0	-0.4	0.0	0.1	2.0	2.09
Total	96.2	316.5	26.7	46.8	122.9	363.3	485.21

Appendix Table 6.4.3-5 Project Cost of Alternative I ; 2000-2005 (at Market Price)

(unit: million US$)

Items	Years 2001 - 2005						
	Materials		Working Compensation		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Total
1 Bridges	11.9	80.8	13.2	37.6	25.2	118.4	143.51
2 Tunnel	3.4	12.8	1.8	6.9	5.2	19.7	24.90
3 Track Improvement	1.5	23.6	3.2	0.0	4.7	23.6	28.24
4 Roadbed Improvement	40.8	20.8	15.4	1.5	56.2	22.3	78.52
5 Equip. for Track & Roadbed Impro.	0.2	9.5	0.0	1.0	0.3	10.5	10.73
6 Natural Disaster Protection	13.1	0.0	9.4	0.0	22.5	0.0	22.51
7 Signal	0.0	14.1	0.1	0.0	0.1	14.1	14.22
8 Communication	0.3	53.0	2.1	1.5	2.4	54.5	56.88
9 Rolling Stocks (New)	64.6	67.8	0.0	0.0	64.6	67.8	132.31
10 Rolling Stocks (Rehabilitation)	0.0	0.0	0.0	0.0	0.0	0.0	0.00
11 Workshop & Depots	0.0	5.0	0.0	0.0	0.0	5.0	5.00
Total	135.8	287.3	45.3	48.5	181.1	335.8	516.82

Appendix Table 6.4.3-6 Project Cost of Alternative I ; 2000-2005 (at Economic Price)

(unit: million US$)

Items	Years 2001 - 2005						
	Materials		Working Compensation		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Total
1 Bridges	11.6	80.8	10.6	37.6	22.2	118.4	140.51
2 Tunnel	3.3	12.8	1.5	6.9	4.8	19.7	24.43
3 Track Improvement	1.4	23.6	2.5	0.0	4.0	23.6	27.56
4 Roadbed Improvement	39.6	20.8	12.3	1.5	51.9	22.3	74.21
5 Equip. for Track & Roadbed Impro.	0.2	9.5	0.0	1.0	0.2	10.5	10.72
6 Natural Disaster Protection	12.7	0.0	7.5	0.0	20.2	0.0	20.24
7 Signal	0.0	14.1	0.1	0.0	0.1	14.1	14.20
8 Communication	0.3	53.0	1.7	1.5	2.0	54.5	56.44
9 Rolling Stocks (New)	62.6	67.8	0.0	0.0	62.6	67.8	130.37
10 Rolling Stocks (Rehabilitation)	0.0	0.0	0.0	0.0	0.0	0.0	0.00
11 Workshop & Depots	0.0	5.0	0.0	0.0	0.0	5.0	5.00
Total	131.7	287.3	36.2	48.5	167.9	335.8	503.69

Appendix Table 6.4.3-7 Project Cost of Alternative I ; 2006-2010 (at Market Price)

(unit: million US$)

Items	Years 2006 - 2010						
	Materials		Working Compensation		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Total
1 Bridges	11.9	80.7	13.2	37.6	25.1	118.2	143.36
2 Tunnel	1.1	4.1	0.6	2.2	1.7	6.3	8.02
3 Track Improvement	1.8	11.1	2.3	0.0	4.1	11.1	15.22
4 Roadbed Improvement	64.2	35.0	16.7	1.7	80.9	36.6	117.49
5 Equip. for Track & Roadbed Impro.	0.0	4.7	0.0	0.4	0.0	5.1	5.16
6 Natural Disaster Protection	6.9	0.0	5.2	0.0	12.1	0.0	12.13
7 Signal	0.0	9.1	0.0	6.1	0.0	15.2	15.18
8 Communication	0.0	10.1	0.7	0.4	0.7	10.5	11.16
9 Rolling Stocks (New)	65.8	73.1	0.0	0.0	65.8	73.1	138.81
10 Rolling Stocks (Rehabilitation)	0.0	0.0	0.0	0.0	0.0	0.0	0.00
11 Workshop & Depots	0.0	5.0	0.0	0.0	0.0	5.0	5.00
Total	151.7	232.8	38.7	48.4	190.4	281.2	471.53

Appendix Table 6.4.3-8 Project Cost of Alternative I ; 2006-2010 (at Economic Price)

(unit: million US$)

Items	Years 2006 - 2010						
	Materials		Working Compensation		Total		
	Local	Foreign	Local	Foreign	Local	Foreign	Total
1 Bridges	11.6	80.7	10.6	37.6	22.1	118.2	140.36
2 Tunnel	1.1	4.1	0.5	2.2	1.5	6.3	7.87
3 Track Improvement	1.8	11.1	1.8	0.0	3.6	11.1	14.71
4 Roadbed Improvement	62.2	35.0	13.3	1.7	75.6	36.6	112.23
5 Equip. for Track & Roadbed Impro.	0.0	4.7	0.0	0.4	0.0	5.1	5.16
6 Natural Disaster Protection	6.7	0.0	4.2	0.0	10.9	0.0	10.88
7 Signal	0.0	9.1	0.0	6.1	0.0	15.2	15.18
8 Communication	0.0	10.1	0.5	0.4	0.5	10.5	11.02
9 Rolling Stocks (New)	63.8	73.1	0.0	0.0	63.8	73.1	136.84
10 Rolling Stocks (Rehabilitation)	0.0	0.0	0.0	0.0	0.0	0.0	0.00
11 Workshop & Depots	0.0	5.0	0.0	0.0	0.0	5.0	5.00
Total	147.1	232.8	30.9	48.4	178.1	281.2	459.24

Appendix Table 6.4.3-9 Net Cost of New Car and Rehabilitation Cost (at Market Price)

(unit: million US$)

		Unit Price		1995-2000				2001-2005				2006-2010				Total			
		Fore.	Loc.	No.	Fore.	Loc.	Total	No.	Fore.	Loc.	Total	No.	Fore.	Loc.	Total	No.	Fore.	Loc.	Total
Cost Summary																			
Alt. I	New				74.86	66.80	141.66		75.80	66.80	142.60		81.10	68.00	149.10		231.75	201.60	433.35
	Rehabili.				4.40	3.10	7.50		19.80	11.70	31.50		16.40	9.80	26.20		40.60	24.60	65.20
	Total				79.26	69.90	149.16		95.60	78.50	174.10		97.49	77.80	175.30		272.35	226.20	498.55
Alt. II	New				38.17	45.60	83.77		39.11	48.80	87.91		41.01	49.40	90.41		118.28	143.80	262.08
	Rehabili.				8.16	6.39	14.55		26.76	17.79	44.55		22.24	14.91	37.15		57.16	39.09	96.25
	Total				46.33	51.99	98.32		65.87	66.59	132.46		63.25	64.31	127.56		175.44	182.89	358.33
Alt. III & IV	New				43.68	51.25	94.93		44.62	51.25	95.87		49.92	53.00	102.92		138.21	155.50	293.71
	Rehabili.				8.16	6.39	14.55		26.76	17.79	44.55		20.80	13.65	34.45		55.72	37.83	93.55
	Total				51.84	57.64	109.48		71.38	69.04	140.42		70.72	66.65	137.37		193.93	193.33	387.26
W/O	New				5.61	1.92	7.53		8.05	2.24	10.29		8.05	2.24	10.29		21.70	6.40	28.10
	Rehabili.				4.40	3.10	7.50		19.80	11.70	31.50		16.40	9.80	26.20		40.60	24.60	65.20
	Total				10.01	5.02	15.03		27.85	13.94	41.79		24.45	12.04	36.49		62.30	31.00	93.30
Net Cost (= Alter.- W/O)																			
Alt. I	New				69.25	64.88	134.13		67.75	64.56	132.31		73.05	65.76	138.81		210.05	195.20	405.25
	Rehabili.				0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
	Total				69.25	64.88	134.13		67.75	64.56	132.31		73.05	65.76	138.81		210.05	195.20	405.25
Alt. II	New				32.56	43.68	76.24		31.06	46.56	77.62		32.96	47.16	80.12		96.58	137.40	233.98
	Rehabili.				3.76	3.29	7.05		6.96	6.09	13.05		5.84	5.11	10.95		16.56	14.49	31.05
	Total				36.32	46.97	83.29		38.02	52.65	90.67		38.80	52.27	91.07		113.14	151.89	265.03
Alt. III & IV	New				38.07	49.33	87.40		36.57	49.01	85.58		41.87	50.76	92.63		116.51	149.10	265.61
	Rehabili.				3.76	3.29	7.05		6.96	6.09	13.05		4.40	3.85	8.25		15.12	13.23	28.35
	Total				41.83	52.62	94.45		43.53	55.10	98.63		46.27	54.61	100.88		131.63	162.33	293.96

Appendix Table 6.4.3-10 Net Cost of New Car and Rehabilitation Cost (at Economic Price)

(unit: million US$)

		Unit Price		1995-2000				2001-2005				2006-2010				Total			
		Fore.	Loc.	No.	Fore.	Loc.	Total	No.	Fore.	Loc.	Total	No.	Fore.	Loc.	Total	No.	Fore.	Loc.	Total
Cost Summary																			
Alt. I	New				74.86	64.80	139.66		75.80	64.80	140.59		81.10	65.96	147.06		231.75	195.55	427.30
	Rehabili.				4.40	3.01	7.41		19.80	11.35	31.15		16.40	9.51	25.91		40.60	23.86	64.46
	Total				79.26	67.80	147.06		95.60	76.15	171.74		97.49	75.47	172.96		272.35	219.41	491.76
Alt. II	New				38.17	44.23	82.40		39.11	47.34	86.44		41.01	47.92	88.92		118.28	139.49	257.77
	Rehabili.				8.16	6.20	14.36		26.76	17.26	44.02		22.24	14.46	36.70		57.16	37.92	95.08
	Total				46.33	50.43	96.76		65.87	64.59	130.46		63.25	62.38	125.63		175.44	177.40	352.84
Alt. III & IV	New				43.68	49.71	93.39		44.62	49.71	94.33		49.92	51.41	101.33		138.21	150.84	289.05
	Rehabili.				8.16	6.20	14.36		26.76	17.26	44.02		20.80	13.24	34.04		55.72	36.70	92.42
	Total				51.84	55.91	107.75		71.38	66.97	138.34		70.72	64.65	135.37		193.93	187.53	381.46
W/O	New				5.61	1.86	7.47		8.05	2.17	10.22		8.05	2.17	10.22		21.70	6.21	27.91
	Rehabili.				4.40	3.01	7.41		19.80	11.35	31.15		16.40	9.51	25.91		40.60	23.86	64.46
	Total				10.01	4.87	14.88		27.85	13.52	41.37		24.45	11.68	36.12		62.30	30.07	92.37
Net Cost (= Alter.- W/O)																			
Alt. I	New				69.25	62.93	132.18		67.75	62.62	130.37		73.05	63.79	136.84		210.05	189.34	399.39
	Rehabili.				0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00
	Total				69.25	62.93	132.18		67.75	62.62	130.37		73.05	63.79	136.84		210.05	189.34	399.39
Alt. II	New				32.56	42.37	74.93		31.06	45.16	76.22		32.96	45.75	78.71		96.58	133.28	229.86
	Rehabili.				3.76	3.19	6.95		6.96	5.91	12.87		5.84	4.96	10.80		16.56	14.06	30.62
	Total				36.32	45.56	81.88		38.02	51.07	89.09		38.80	50.70	89.50		113.14	147.33	260.47
Alt. III & IV	New				38.07	47.85	85.92		36.57	47.54	84.11		41.87	49.24	91.11		116.51	144.63	261.14
	Rehabili.				3.76	3.19	6.95		6.96	5.91	12.87		4.40	3.73	8.13		15.12	12.83	27.95
	Total				41.83	51.04	92.87		43.53	53.45	96.98		46.27	52.97	99.24		131.63	157.46	289.09

Appendix Table 6.4.3-11 Replacement Cost Flow and Residual Value; Alternative I

(unit: million US$)

		Year	Bridges	Tunnel	Track Improvement		Roadbed Improve-ment	Equip. for Track & Roadbed Improv.	Natural Disaster Protection	Signal	Communi-cation	Rolling Stocks (New)	Rolling Stocks (Rehabi)	Workshop & Depots
					Rail	Others								
Life of Property			>50	>50	35	35	>50	25	50	20	20	25	25	20
1		1994												
2		1995												
3		1996												
4		1997												
5		1998	140.51	22.08	38.80	19.14	41.97	7.82	8.45	32.34	40.84		0.00	2.09
6		1999												
7		2000										132.18		
8	1	2001												
9	2	2002												
10	3	2003	140.51	24.43	3.11	24.45	74.21	10.72	20.24	14.18	56.44		0.00	5.00
11	4	2004												
12	5	2005										130.37		
13	6	2006												
14	7	2007												
15	8	2008	140.36	7.87	3.22	11.49	112.23	5.16	10.88	15.18	11.02		0.00	5.00
16	9	2009												
17	10	2010										136.84		
18	11	2011												
19	12	2012												
20	13	2013												
21	14	2014												
22	15	2015												
23	16	2016												
24	17	2017												
25	18	2018								32.34	40.84			2.09
26	19	2019												
27	20	2020												
28	21	2021												
29	22	2022												
30	23	2023						7.82		14.18	56.44		0.00	5.00
31	24	2024												
32	25	2025										132.18		
33	26	2026												
34	27	2027												
35	28	2028						10.72		15.18	11.02		0.00	5.00
36	29	2029												
37	30	2030										130.37		
Total			421.38	54.38	45.13	55.08	228.41	42.24	39.57	123.40	216.60	661.94	0.00	24.18
Residual Value					4.12			15.16		32.73	57.53	247.51	0.00	7.98

=Replacement Cost

Appendix Table 6.4.3-12 Summary of Traffic Demand by Mode ; 2010

Items	Alternative	Railway Volume		Road Transport Volume	
			with-w/o		with-w/o
		(unit; mil. person-km/year)		(unit; mil. veh*-km/year)	
Passenger	Alternative I	6,299	4,120	7,955	-979
	Alternative II	3,945	1,766	8,523	-411
	Alternative III	5,119	2,940	8,240	-694
	Without	2,179	0	8,934	0
		(unit; mil. ton-km/year)		(unit; mil. ton-km/year)	
Cargo	Alternative I	2,800	2,179	24,502	-2,063
	Alternative II	2,244	1,623	25,040	-1,525
	Alternative III	2,449	1,828	24,841	-1,724
	Without	621	0	26,565	0

Note; * vehicle in PCU

Appendix Table 6.4.3-13 Time Value

Year	GDP per capita (US$)	Working Hours (hrs/year)	Working Force Ratio (%)	Time Value (US$/hr)
1994	242	2,439	0.5353	0.1853
2010	769	2,439	0.5353	0.5890

Appendix Table 6.4.3-14 Annual Working Hours

Year (days/year)	Work Days (days/week)	National Holiday	Working Hours (hr/day)	Working Hours (hr/year)
365	6	8	8	2,439

Note: formula = ROUND((365*(6/7)-8)*8,0) = 2,439

Appendix Table 6.4.3-15 Benefit and Cost Flow ; Alternative I

(unit: million US$)

		Year	Project Cost													O & M Cost	Economic Benefit					
			Construction Cost												Total		Time Saving		Saving in Pass. Vehicle Capital	Saving in Cargo Vehicle Capital	Saving in O/M	Net Flow
			Bridges	Tunnel	Track Improvement		Roadbed Improvement	Eqip. for Track & Roadbed	Natural Disaster Protection	Signal	Communication	Rolling Stocks (New)	Rolling Stocks (Rehabil)	Workshop & Depots			Passenger	Cargo				
					Rail	Others																
1		1994																				0.00
2		1995																				0.00
3		1996	28.10	4.42	7.76	3.83	8.39	1.56	1.69	6.47	8.17	26.44	0.00	0.42	97.24	0.00						-97.24
4		1997	28.10	4.42	7.76	3.83	8.39	1.56	1.69	6.47	8.17	26.44	0.00	0.42	97.24	0.00						-97.24
5		1998	28.10	4.42	7.76	3.83	8.39	1.56	1.69	6.47	8.17	26.44	0.00	0.42	97.24	0.00						-97.24
6		1999	28.10	4.42	7.76	3.83	8.39	1.56	1.69	6.47	8.17	26.44	0.00	0.42	97.24	0.00						-97.24
7		2000	28.10	4.42	7.76	3.83	8.39	1.56	1.69	6.47	8.17	26.44	0.00	0.42	97.24	0.00						-97.24
8	1	2001	28.10	4.89	0.62	4.89	14.84	2.14	4.05	2.84	11.29	26.07	0.00	1.00	100.73	46.60	5.90	2.40	6.50	7.30	1.00	-124.23
9	2	2002	28.10	4.89	0.62	4.89	14.84	2.14	4.05	2.84	11.29	26.07	0.00	1.00	100.73	48.90	8.54	3.78	8.98	10.06	1.38	-116.89
10	3	2003	28.10	4.89	0.62	4.89	14.84	2.14	4.05	2.84	11.29	26.07	0.00	1.00	100.73	51.40	11.18	5.16	11.46	12.82	1.76	-109.75
11	4	2004	28.10	4.89	0.62	4.89	14.84	2.14	4.05	2.84	11.29	26.07	0.00	1.00	100.73	53.90	13.82	6.54	13.94	15.58	2.14	-102.61
12	5	2005	28.10	4.89	0.62	4.89	14.84	2.14	4.05	2.84	11.29	26.07	0.00	1.00	100.73	56.60	16.46	7.92	16.42	18.34	2.52	-95.67
13	6	2006	28.07	1.57	0.64	2.30	22.45	1.03	2.18	3.04	2.20	27.37	0.00	1.00	91.85	59.40	19.10	9.30	18.90	21.10	2.90	-79.95
14	7	2007	28.07	1.57	0.64	2.30	22.45	1.03	2.18	3.04	2.20	27.37	0.00	1.00	91.85	62.30	23.93	11.95	23.18	25.88	4.28	-64.95
15	8	2008	28.07	1.57	0.64	2.30	22.45	1.03	2.18	3.04	2.20	27.37	0.00	1.00	91.85	65.40	28.75	14.60	27.45	30.65	5.65	-50.15
16	9	2009	28.07	1.57	0.64	2.30	22.45	1.03	2.18	3.04	2.20	27.37	0.00	1.00	91.85	68.60	33.58	17.25	31.73	35.43	7.03	-35.45
17	10	2010	28.07	1.57	0.64	2.30	22.45	1.03	2.18	3.04	2.20	27.37	0.00	1.00	91.85	72.00	38.40	19.90	36.00	40.20	8.40	-20.95
18	11	2011													0.00	72.00	41.09	21.29	38.52	43.01	8.99	80.90
19	12	2012													0.00	72.00	43.96	22.78	41.22	46.02	9.62	91.61
20	13	2013													0.00	72.00	47.04	24.38	44.10	49.25	10.29	103.06
21	14	2014													0.00	72.00	50.33	26.08	47.19	52.69	11.01	115.31
22	15	2015													0.00	72.00	53.86	27.91	50.49	56.38	11.78	128.42
23	16	2016													0.00	72.00	57.63	29.86	54.03	60.33	12.61	142.45
24	17	2017													0.00	72.00	61.66	31.96	57.81	64.55	13.49	157.47
25	18	2018								32.3	40.8			2.1	75.20	72.00	65.98	34.19	61.85	69.07	14.43	98.33
26	19	2019													0.00	72.00	70.60	36.59	66.18	73.91	15.44	190.72
27	20	2020													0.00	72.00	75.54	39.15	70.82	79.08	16.52	209.11
28	21	2021													0.00	72.00	80.83	41.89	75.77	84.62	17.68	228.78
29	22	2022													0.00	72.00	86.48	44.82	81.08	90.54	18.92	249.84
30	23	2023							8.5	14.1	56.4		0.0	5.0	84.00	72.00	92.54	47.96	86.75	96.88	20.24	188.37
31	24	2024													0.00	72.00	99.02	51.31	92.83	103.66	21.66	296.47
32	25	2025										145.3			145.30	72.00	105.95	54.90	99.33	110.91	23.18	176.97
33	26	2026													0.00	72.00	113.36	58.75	106.28	118.68	24.80	349.86
34	27	2027													0.00	72.00	121.30	62.86	113.72	126.98	26.53	379.39
35	28	2028							21.3	15.2	11.1		0.0	5.0	52.60	72.00	129.79	67.26	121.68	135.87	28.39	356.39
36	29	2029													0.00	72.00	138.87	71.97	130.19	145.38	30.38	444.80
37	30	2030			-4.12			-15.16		-32.73	-57.53	-117.14	0.00	-7.98	-234.66	72.00	148.60	77.01	139.31	155.56	32.51	715.64
Total			421.4	54.4	41.0	55.1	228.4	8.5	69.4	90.6	159.1	427.6	0.0	16.2	1,571.6	2,025.1	1,884.1	971.7	1,773.7	1,980.7	405.5	3,419.1

EIRR= 7.6%

Appendix Table 6.4.3-16 Benefit and Cost Flow ; Alternative II

(unit: million US$)

		Year	Project Cost													O & M Cost	Economic Benefit					Net Flow
			Construction Cost												Total		Time Saving		Saving in Pass. Vehicle Capital	Saving in Cargo Vehicle Capital	Saving in O/M	
			Bridges	Tunnel	Track Improvement		Roadbed Improvement	Eqip. for Track & Roadbed	Natural Disaster Protection	Signal	Communication	Rolling Stocks (New)	Rolling Stocks (Rehabil)	Workshop & Depots			Passenger	Cargo				
					Rail	Others																
1		1994																				0.00
2		1995																				0.00
3		1996	20.05	3.27	7.76	1.62	7.91	1.26	0.90	6.47	6.81	14.99	1.39	0.00	72.44	0.00						-72.44
4		1997	20.05	3.27	7.76	1.62	7.91	1.26	0.90	6.47	6.81	14.99	1.39	0.00	72.44	0.00						-72.44
5		1998	20.05	3.27	7.76	1.62	7.91	1.26	0.90	6.47	6.81	14.99	1.39	0.00	72.44	0.00						-72.44
6		1999	20.05	3.27	7.76	1.62	7.91	1.26	0.90	6.47	6.81	14.99	1.39	0.00	72.44	0.00						-72.44
7		2000	20.05	3.27	7.76	1.62	7.91	1.26	0.90	6.47	6.81	14.99	1.39	0.00	72.44	0.00						-72.44
8	1	2001	20.05	3.29	0.61	2.48	13.12	1.94	2.81	1.44	9.77	15.24	2.57	0.00	73.34	39.39	2.30	1.10	2.80	4.90	3.10	-98.53
9	2	2002	20.05	3.29	0.61	2.48	13.12	1.94	2.81	1.44	9.77	15.24	2.57	0.00	73.34	40.47	3.26	1.68	3.88	6.76	4.90	-93.33
10	3	2003	20.05	3.29	0.61	2.48	13.12	1.94	2.81	1.44	9.77	15.24	2.57	0.00	73.34	41.59	4.22	2.26	4.96	8.62	6.70	-88.17
11	4	2004	20.05	3.29	0.61	2.48	13.12	1.94	2.81	1.44	9.77	15.24	2.57	0.00	73.34	42.73	5.18	2.84	6.04	10.48	8.50	-83.03
12	5	2005	20.05	3.29	0.61	2.48	13.12	1.94	2.81	1.44	9.77	15.24	2.57	0.00	73.34	43.91	6.14	3.42	7.12	12.34	10.30	-77.93
13	6	2006	20.04	3.28	0.64	6.14	13.35	1.14	0.83	1.14	0.72	15.74	2.16	0.00	65.18	45.11	7.10	4.00	8.20	14.20	12.10	-64.69
14	7	2007	20.04	3.28	0.64	6.14	13.35	1.14	0.83	1.14	0.72	15.74	2.16	0.00	65.18	46.36	8.70	5.03	9.93	17.20	16.60	-54.09
15	8	2008	20.04	3.28	0.64	6.14	13.35	1.14	0.83	1.14	0.72	15.74	2.16	0.00	65.18	47.63	10.30	6.05	11.65	20.20	21.10	-43.51
16	9	2009	20.04	3.28	0.64	6.14	13.35	1.14	0.83	1.14	0.72	15.74	2.16	0.00	65.18	48.94	11.90	7.08	13.38	23.20	25.60	-32.97
17	10	2010	20.04	3.28	0.64	6.14	13.35	1.14	0.83	1.14	0.72	15.74	2.16	0.00	65.18	50.29	13.50	8.10	15.10	26.20	30.10	-22.47
18	11	2011													0.00	50.29	14.45	8.67	16.16	28.03	32.21	49.22
19	12	2012													0.00	50.29	15.46	9.27	17.29	30.00	34.46	56.19
20	13	2013													0.00	50.29	16.54	9.92	18.50	32.10	36.87	63.64
21	14	2014													0.00	50.29	17.70	10.62	19.79	34.34	39.45	71.61
22	15	2015													0.00	50.29	18.93	11.36	21.18	36.75	42.22	80.15
23	16	2016													0.00	50.29	20.26	12.16	22.66	39.32	45.17	89.28
24	17	2017													0.00	50.29	21.68	13.01	24.25	42.07	48.33	99.05
25	18	2018								32.37	34.05			33.60	100.02	50.29	23.20	13.92	25.94	45.02	51.72	9.48
26	19	2019													0.00	50.29	24.82	14.89	27.76	48.17	55.34	120.69
27	20	2020													0.00	50.29	26.56	15.93	29.70	51.54	59.21	132.66
28	21	2021													0.00	50.29	28.42	17.05	31.78	55.15	63.36	145.46
29	22	2022													0.00	50.29	30.40	18.24	34.01	59.01	67.79	159.16
30	23	2023								7.20	48.86		8.32	0.00	64.38	50.29	32.53	19.52	36.39	63.14	72.54	109.45
31	24	2024													0.00	50.29	34.81	20.89	38.94	67.56	77.61	189.51
32	25	2025										93.24			93.24	50.29	37.25	22.35	41.66	72.29	83.05	113.06
33	26	2026													0.00	50.29	39.85	23.91	44.58	77.35	88.86	224.26
34	27	2027													0.00	50.29	42.64	25.59	47.70	82.76	95.08	243.48
35	28	2028								5.70	3.61		15.40	0.00	24.71	50.29	45.63	27.38	51.04	88.55	101.74	239.33
36	29	2029													0.00	50.29	48.82	29.29	54.61	94.75	108.86	286.05
37	30	2030			-4.11			-13.29		-20.48	-44.30	-66.49	-16.92		-165.59	50.29	52.24	31.34	58.43	101.39	116.48	475.18
Total			300.7	49.2	40.9	51.2	171.9	8.4	22.7	70.0	128.7	256.6	37.4	33.6	1,171.5	1,452.2	664.8	396.9			1,459.3	1,936.0

EIRR= 5.4%

Appendix Table 6.4.3-17 Benefit and Cost Flow ; Alternative III

(unit: million US$)

		Year	Project Cost												Total	O & M Cost	Economic Benefit					
			Construction Cost														Time Saving		Saving in Pass. Vehicle Capital	Saving in Cargo Vehicle Capital	Saving in O/M	Net Flow
			Bridges	Tunnel	Track Improvement		Roadbed improvement	Eqip. for Track & Roadbed	Natural Disaster Protection	Signal	Communication	Rolling Stocks (New)	Rolling Stocks (Rehabil)	Workshop & Depots			Passenger	Cargo				
					Rail	Others																
1		1994																				0.00
2		1995																				0.00
3		1996	24.41	3.63	7.76	3.71	8.45	1.58	1.73	6.47	6.81	17.18	1.39	0.42	83.55	0.00						-83.55
4		1997	24.41	3.63	7.76	3.71	8.45	1.58	1.73	6.47	6.81	17.18	1.39	0.42	83.55	0.00						-83.55
5		1998	24.41	3.63	7.76	3.71	8.45	1.58	1.73	6.47	6.81	17.18	1.39	0.42	83.55	0.00						-83.55
6		1999	24.41	3.63	7.76	3.71	8.45	1.58	1.73	6.47	6.81	17.18	1.39	0.42	83.55	0.00						-83.55
7		2000	24.41	3.63	7.76	3.71	8.45	1.58	1.73	6.47	6.81	17.18	1.39	0.42	83.55	0.00						-83.55
8	1	2001	24.41	3.63	0.80	4.53	14.84	2.14	4.22	1.44	9.77	16.82	2.57	1.00	86.18	39.39	3.60	1.40	4.30	5.30	2.40	-108.57
9	2	2002	24.41	3.63	0.80	4.53	14.84	2.14	4.22	1.44	9.77	16.82	2.57	1.00	86.18	40.47	5.32	2.28	6.08	7.50	3.56	-101.91
10	3	2003	24.41	3.63	0.80	4.53	14.84	2.14	4.22	1.44	9.77	16.82	2.57	1.00	86.18	41.59	7.04	3.16	7.86	9.70	4.72	-95.29
11	4	2004	24.41	3.63	0.80	4.53	14.84	2.14	4.22	1.44	9.77	16.82	2.57	1.00	86.18	42.73	8.76	4.04	9.64	11.90	5.88	-88.69
12	5	2005	24.41	3.63	0.80	4.53	14.84	2.14	4.22	1.44	9.77	16.82	2.57	1.00	86.18	43.91	10.48	4.92	11.42	14.10	7.04	-82.13
13	6	2006	73.22	10.88	0.76	1.99	21.94	1.02	1.94	1.14	0.72	18.22	1.63	1.00	134.45	45.11	12.20	5.80	13.20	16.30	8.20	-123.86
14	7	2007	73.22	10.88	0.76	1.99	21.94	1.02	1.94	1.14	0.72	18.22	1.63	1.00	134.45	46.36	15.33	7.50	16.28	20.08	11.18	-110.46
15	8	2008	73.22	10.88	0.76	1.99	21.94	1.02	1.94	1.14	0.72	18.22	1.63	1.00	134.45	47.63	18.45	9.20	19.35	23.85	14.15	-97.08
16	9	2009	73.22	10.88	0.76	1.99	21.94	1.02	1.94	1.14	0.72	18.22	1.63	1.00	134.45	48.94	21.58	10.90	22.43	27.63	17.13	-83.74
17	10	2010	73.22	10.88	0.76	1.99	21.94	1.02	1.94	1.14	0.72	18.22	1.63	1.00	134.45	50.29	24.70	12.60	25.50	31.40	20.10	-70.44
18	11	2011													0.00	50.29	26.43	13.48	27.29	33.60	21.51	72.01
19	12	2012													0.00	50.29	28.28	14.43	29.19	35.95	23.01	80.57
20	13	2013													0.00	50.29	30.26	15.44	31.24	38.47	24.62	89.73
21	14	2014													0.00	50.29	32.38	16.52	33.43	41.16	26.35	99.53
22	15	2015													0.00	50.29	34.64	17.67	35.77	44.04	28.19	110.02
23	16	2016													0.00	50.29	37.07	18.91	38.27	47.12	30.16	121.24
24	17	2017													0.00	50.29	39.66	20.23	40.95	50.42	32.28	133.25
25	18	2018								32.37	34.05			33.60	100.02	50.29	42.44	21.65	43.81	53.95	34.54	46.06
26	19	2019													0.00	50.29	45.41	23.16	46.88	57.73	36.95	159.85
27	20	2020													0.00	50.29	48.59	24.79	50.16	61.77	39.54	174.56
28	21	2021													0.00	50.29	51.99	26.52	53.67	66.09	42.31	190.29
29	22	2022													0.00	50.29	55.63	28.38	57.43	70.72	45.27	207.14
30	23	2023								7.20	48.66		8.32	0.00	64.38	50.29	59.52	30.36	61.45	75.67	48.44	160.78
31	24	2024													0.00	50.29	63.69	32.49	65.75	80.97	51.83	244.44
32	25	2025										93.24			93.24	50.29	68.15	34.76	70.36	86.63	55.46	171.83
33	26	2026													0.00	50.29	72.92	37.20	75.28	92.70	59.34	287.14
34	27	2027													0.00	50.29	78.02	39.80	80.55	99.19	63.49	310.76
35	28	2028								5.70	3.61		15.40	0.00	24.71	50.29	83.48	42.59	86.19	106.13	67.94	311.33
36	29	2029													0.00	50.29	89.33	45.57	92.22	113.56	72.69	363.08
37	30	2030			-4.54			-15.21		-20.48	-44.30	-76.51	-16.70	-7.98	-185.72	50.29	95.58	48.76	98.68	121.51	77.78	577.73
Total			610.3	90.7	42.0	51.1	226.1	8.5	39.5	70.0	128.7	277.9	35.0	37.7	1,617.6	1,459.2	1,210.9	614.5			976.0	2,531.4

EIRR= 6.5%

Appendix Table 6.4.3-18 Benefit and Cost Flow; Alternative I (Implementation Program, Revised)

(unit: million US$)

		Year	Project Cost													O & M Cost	Economic Benefit					Net Flow
			Construction Cost												Total		Time Saving		Saving in Pass. Vehicle Capital	Saving in Cargo Vehicle Capital	Saving in O/M	
			Bridges	Tunnel	Track Improvement		Roadbed Improvement	Eqip. for Track & Roadbed	Natural Disaster Protection	Signal	Communication	Rolling Stocks (New)	Rolling Stocks (Rehabi)	Workshop & Depots			Passenger	Cargo				
					Rail	Others																
1		1994																				0.00
2		1995																				0.00
3		1996	27.90	4.42	7.76	7.65	8.39	1.56	1.69	6.47	7.98	24.34	0.00	0.42	98.58	0.00						-98.58
4		1997	27.90	4.42	7.76	7.65	8.39	1.56	1.69	6.47	7.98	24.34	0.00	0.42	98.58	0.00						-98.58
5		1998	27.90	4.42	7.76	7.65	8.39	1.56	1.69	6.47	7.98	24.34	0.00	0.42	98.58	0.00						-98.58
6		1999	27.90	4.42	7.76	7.65	8.39	1.56	1.69	6.47	7.98	24.34	0.00	0.42	98.58	0.00						-98.58
7		2000	27.90	4.42	7.76	7.65	8.39	1.56	1.69	6.47	7.98	24.34	0.00	0.42	98.58	0.00						-98.58
8	1	2001	27.90	4.89	0.62	3.57	14.84	2.14	4.05	2.84	11.28	44.72	0.91	1.00	118.76	46.60	3.29	1.59	21.16	21.82	15.06	-102.44
9	2	2002	27.90	4.89	0.62	3.57	14.84	2.14	4.05	2.84	11.28	44.72	0.91	1.00	118.76	48.90	5.09	3.91	19.27	24.47	14.74	-100.19
10	3	2003	27.90	4.89	0.62	3.57	14.84	2.14	4.05	2.84	11.28	44.72	0.91	1.00	118.76	51.40	6.89	6.22	17.37	27.12	14.42	-98.15
11	4	2004	27.90	4.89	0.62	3.57	14.84	2.14	4.05	2.84	11.28	44.72	0.91	1.00	118.76	53.90	8.68	8.54	15.48	29.76	14.10	-96.10
12	5	2005	27.90	4.89	0.62	3.57	14.84	2.14	4.05	2.84	11.28	44.72	0.91	1.00	118.76	56.60	10.48	10.85	13.58	32.41	13.78	-94.25
13	6	2006	27.90	1.74	0.64	0.46	22.45	1.03	2.18	3.04	2.21	42.28	1.00	1.00	104.93	59.40	12.28	13.17	11.69	35.06	13.46	-78.67
14	7	2007	27.90	1.74	0.64	0.46	22.45	1.03	2.18	3.04	2.21	42.28	0.00	1.00	104.93	62.30	18.01	27.75	10.59	39.10	13.17	-58.62
15	8	2008	27.90	1.74	0.64	0.46	22.45	1.03	2.18	3.04	2.21	42.28	0.00	1.00	104.93	65.40	23.73	42.34	9.50	43.13	12.88	-38.76
16	9	2009	27.90	1.74	0.64	0.46	22.45	1.03	2.18	3.04	2.21	42.28	0.00	1.00	104.93	68.60	29.46	56.92	8.40	47.17	12.59	-19.01
17	10	2010	27.90	1.74	0.64	0.46	22.45	1.03	2.18	3.04	2.21	42.28	0.00	1.00	104.93	72.00	35.18	71.50	7.30	51.20	12.30	0.55
18	11	2011													0.00	72.00	37.64	76.51	7.81	54.78	13.16	117.90
19	12	2012													0.00	72.00	40.28	81.86	8.36	58.62	14.08	131.20
20	13	2013													0.00	72.00	43.10	87.59	8.94	62.72	15.07	145.42
21	14	2014													0.00	72.00	46.11	93.72	9.57	67.11	16.12	160.64
22	15	2015													0.00	72.00	49.34	100.28	10.24	71.81	17.25	176.92
23	16	2016													0.00	72.00	52.80	107.30	10.96	76.84	18.46	194.35
24	17	2017													0.00	72.00	56.49	114.81	11.72	82.22	19.75	212.99
25	18	2018								32.3	39.1			2.1	73.55	72.00	60.45	122.85	12.54	87.97	21.13	159.39
26	19	2019													0.00	72.00	64.68	131.45	13.42	94.13	22.61	254.29
27	20	2020													0.00	72.00	69.20	140.65	14.36	100.72	24.20	277.13
28	21	2021													0.00	72.00	74.05	150.50	15.37	107.77	25.89	301.57
29	22	2022													0.00	72.00	79.23	161.03	16.44	115.31	27.70	327.72
30	23	2023						7.82		14.2	56.4		0.0	5.0	83.42	72.00	84.78	172.30	17.59	123.38	29.64	272.28
31	24	2024													0.00	72.00	90.71	184.37	18.82	132.02	31.72	385.64
32	25	2025										172.8			172.78	72.00	97.06	197.27	20.14	141.26	33.94	244.89
33	26	2026													0.00	72.00	103.86	211.08	21.55	151.15	36.31	451.95
34	27	2027													0.00	72.00	111.13	225.86	23.06	161.73	38.85	488.63
35	28	2028						10.72		15.2	11.1		4.5	5.0	46.50	72.00	118.91	241.67	24.67	173.05	41.57	481.37
36	29	2029													0.00	72.00	127.23	258.58	26.40	185.17	44.48	569.86
37	30	2030			-4.12			-15.16		-32.73	-57.22	-228.10	-4.00	-7.98	-349.31	72.00	136.14	276.68	28.25	198.13	47.60	964.10
Total			418.5	55.2	41.0	58.4	228.4	27.1	39.6	90.7	156.8	501.4	5.1	16.2	1,638.3	2,025.1	1,696.3	3,379.1	454.6	2,597.1	676.0	5,139.7
																	7.0%				EIRR=	8.25%

Appendix Table 6.4.3-19 Replacement Cost and Residual Value; Alternative I (Implementation Program, Revised)

(unit; million US$)

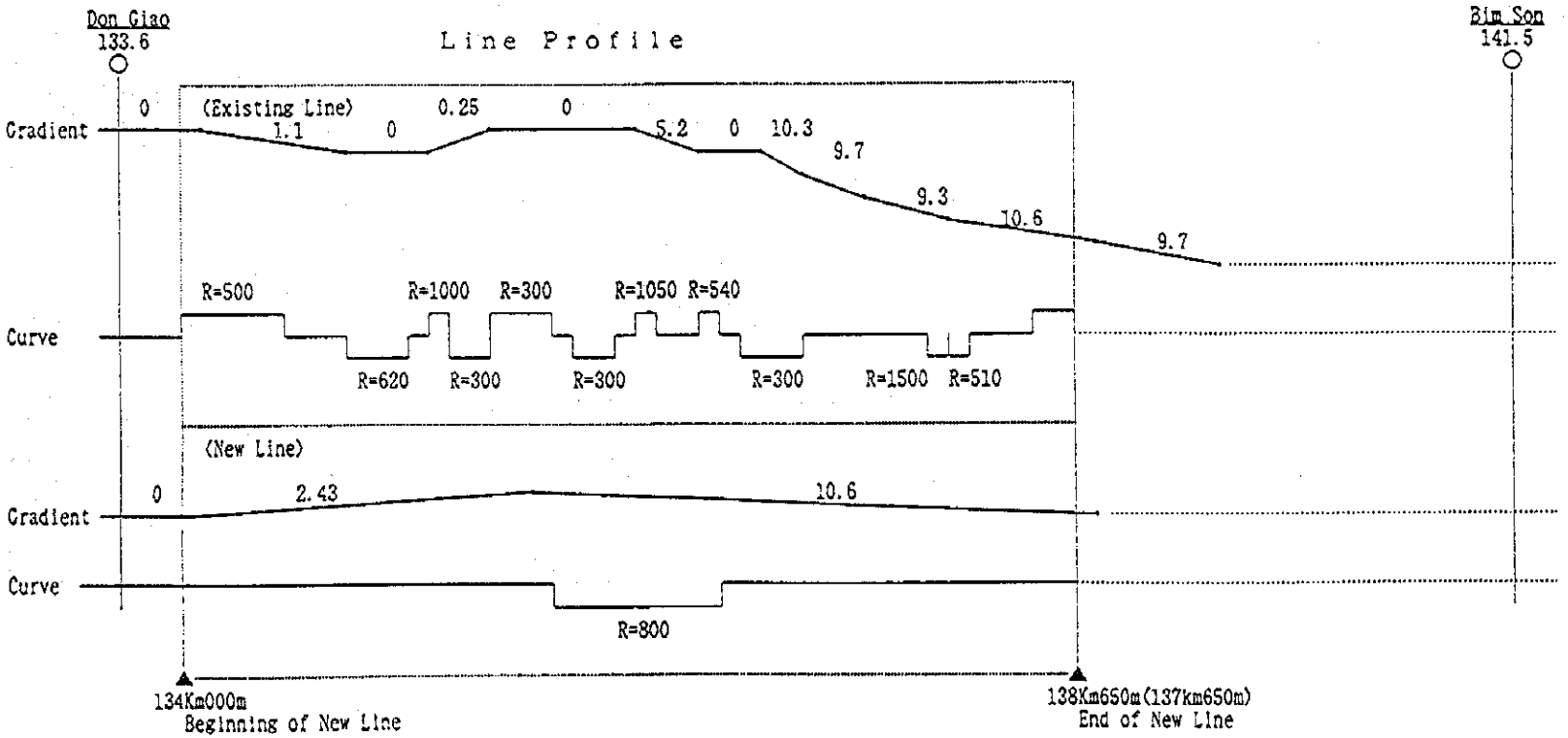
		Year	Bridges	Tunnel	Track Improvement		Roadbed improve-ment	Equip. for Track & Roadbed Improv.	Natural Disaster Protection	Signal	Communi-cation	Rolling Stocks (New)	Rolling Stocks (Rehabi)	Workshop & Depots
					Rail	Others								
Life of Property			>50	>50	35	35	>50	25	50	20	20	25	25	20
1		1994												
2		1995												
3		1996												
4		1997												
5		1998	139.51	22.08	38.80	38.23	41.97	7.82	8.45	32.34	59.62		0.00	2.09
6		1999												
7		2000										121.70		
8	1	2001												
9	2	2002												
10	3	2003	139.51	24.43	3.11	17.85	74.21	10.72	20.24	14.18	57.25		4.54	5.00
11	4	2004												
12	5	2005										223.00		
13	6	2006												
14	7	2007												
15	8	2008	139.51	8.72	3.22	2.30	112.23	5.16	10.88	15.18	10.85		0.00	5.00
16	9	2009												
17	10	2010										211.40		
18	11	2011												
19	12	2012												
20	13	2013												
21	14	2014												
22	15	2015												
23	16	2016												
24	17	2017												
25	18	2018								32.34	59.62			2.09
26	19	2019												
27	20	2020												
28	21	2021												
29	22	2022												
30	23	2023						7.82		14.18	57.25		0.00	5.00
31	24	2024												
32	25	2025										121.70		
33	26	2026												
34	27	2027												
35	28	2028						10.72		15.18	10.85		4.54	5.00
36	29	2029												
37	30	2030										223.00		
Total			418.53	55.23	45.13	58.38	228.41	42.24	39.57	123.40	255.44	900.80	9.08	24.18
Residual Value					4.12			15.16		32.73	64.44	340.40	4.00	7.98

Appendix 6.4.6-1

Travelling Time Reductions and Countermeasure and Improvement Works Costs for Major Areas of Poor ALignment (Under Optimum Alternative in 2010)

1. Section (Don Giao~Bim Son)
133.6 141.5

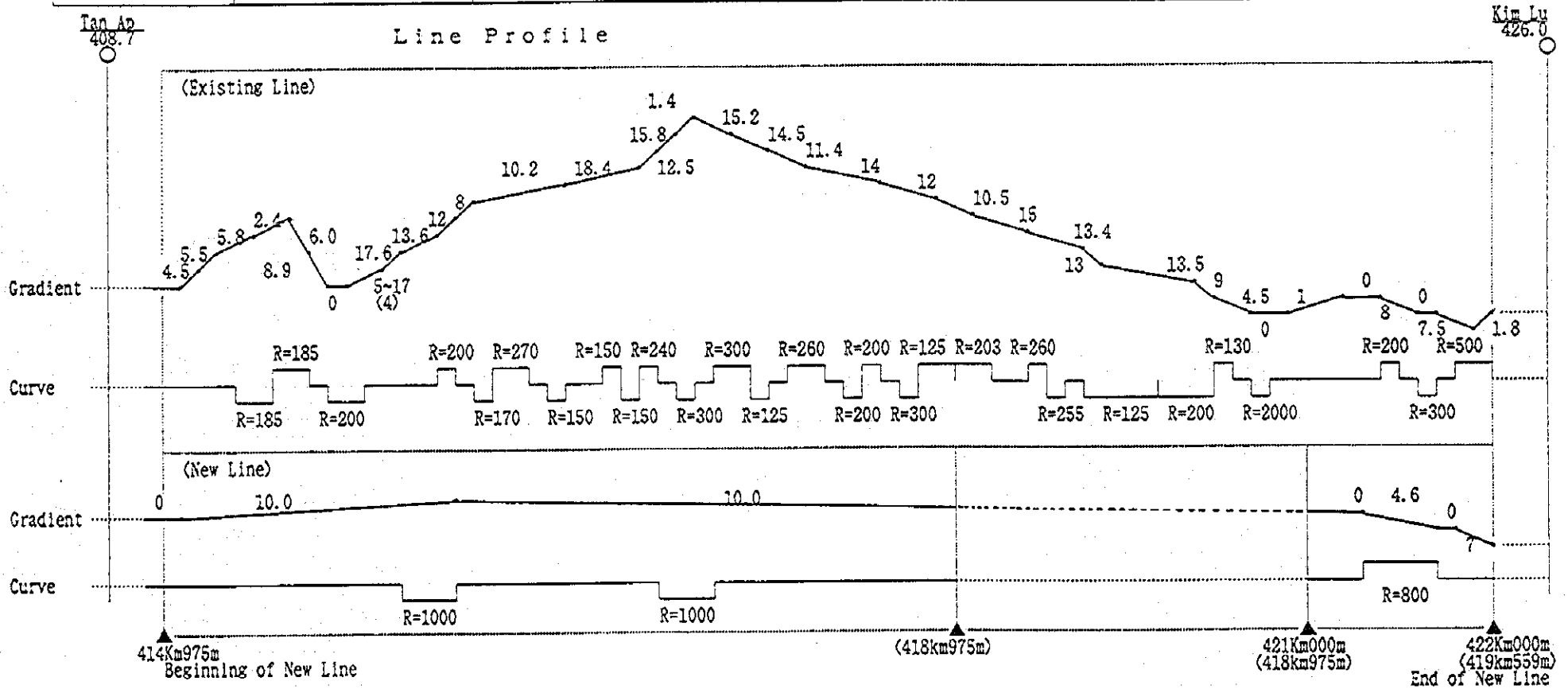
Item			(A) Existing Line	(B) Result of Study New Line	(B)-(A)	Remarks
Section of New Line	Kilo Meter	From	134.000	134.000		
		To	138.300	137.650		
	Extension(Km)		4.300	3.650	Δ 0.650	
Travelling Time	Express(110Km/H)		6'30"	5'30"	Δ 1'00"	Don Giao ~Bim Son (7.9Km)
	Freight Trains(80Km/H)		7'00"	6'00"	Δ 1'00"	
Cost	(Million US$)		0.24	25.37	25.13	



2. Section (Tan Ap 408.7 ~Kim Lu 426.0)

Item			(A) Existing Line	(B) Result of Study New Line	(B)-(A)	Remarks
Section of New Line	Kilo Meter	From	414.975	414.975		
		To	421.584	419.559		
	Extension(Km)		6.609	4.584	Δ 2.025	
Travelling Time	Express(110Km/H)		20'00"	12'30"	Δ 7'30"	Tan Ap ~Kim Lu (17.3Km)
	Freight Trains(80Km/H)		20'30"	14'00"	Δ 6'30"	
Cost	(Million US$)		4.71	46.21	41.50	

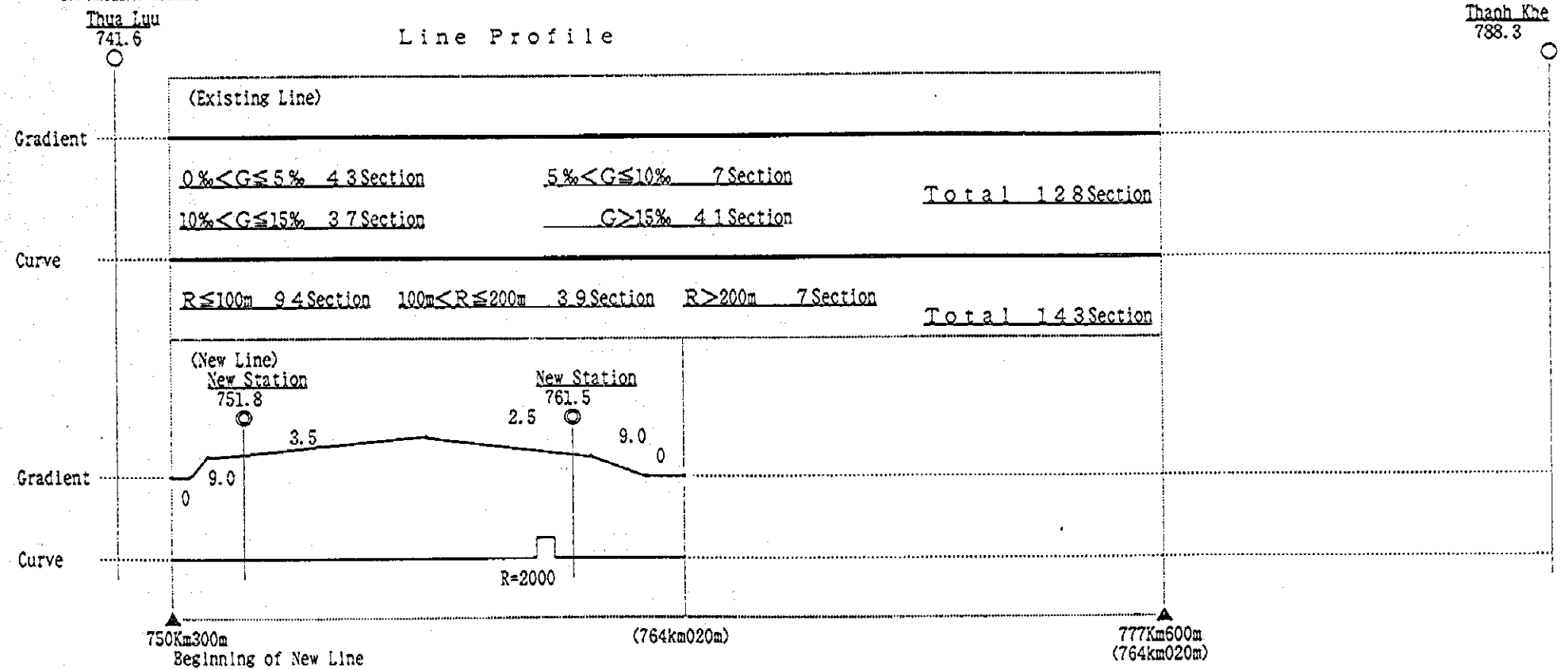
Line Profile



3. Section (Thua Luu~Thanh Khe)
741.6 788.3

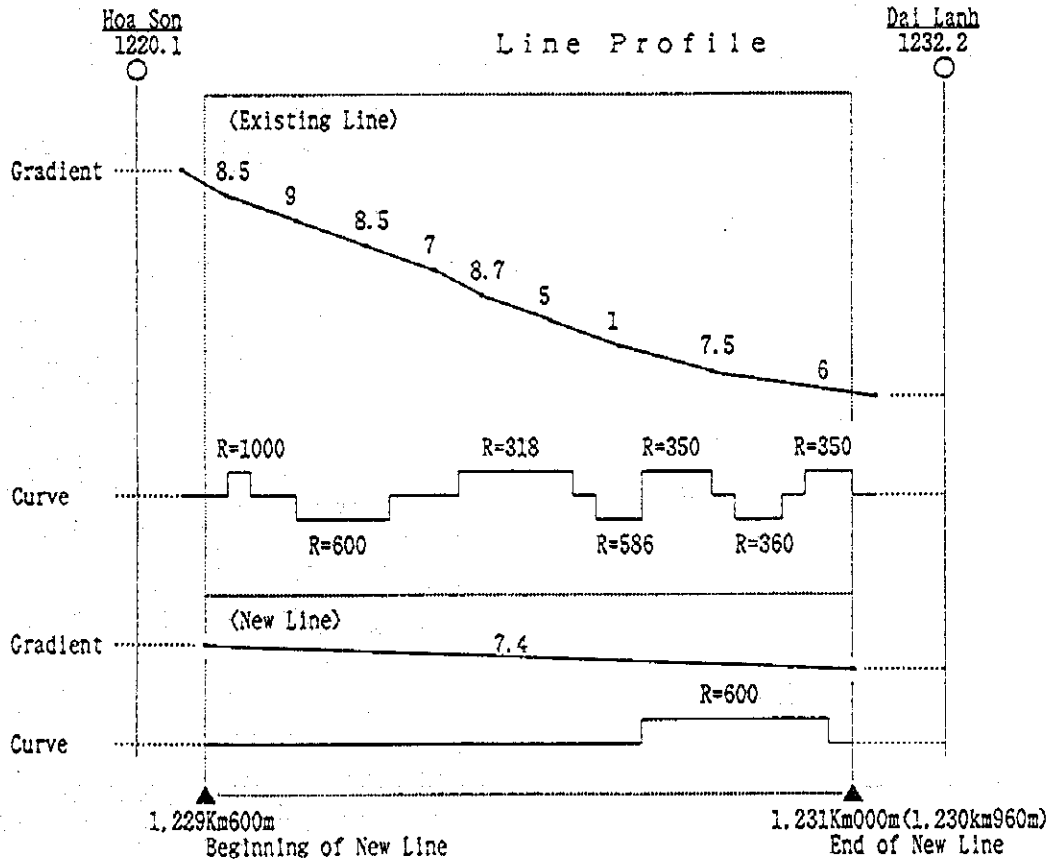
Item			(A) Existing Line	(B) Result of Study New Line	(B)-(A)	Remarks
Section of New Line	Kilo Meter	From	750.300	750.300		
		To	777.600	764.020		
	Extension(Km)		27.300	13.720	Δ 13.580	
Travelling Time	Express(110Km/H)		67'40"	27'10"	Δ 40'30"	Thua Luu ~Thanh Khe (46.7Km)
	Freight Trains(80Km/H)		79'00"	31'30"	Δ 47'30"	
Cost	(Million US$)		52.79	125.73	72.94	

Line Profile



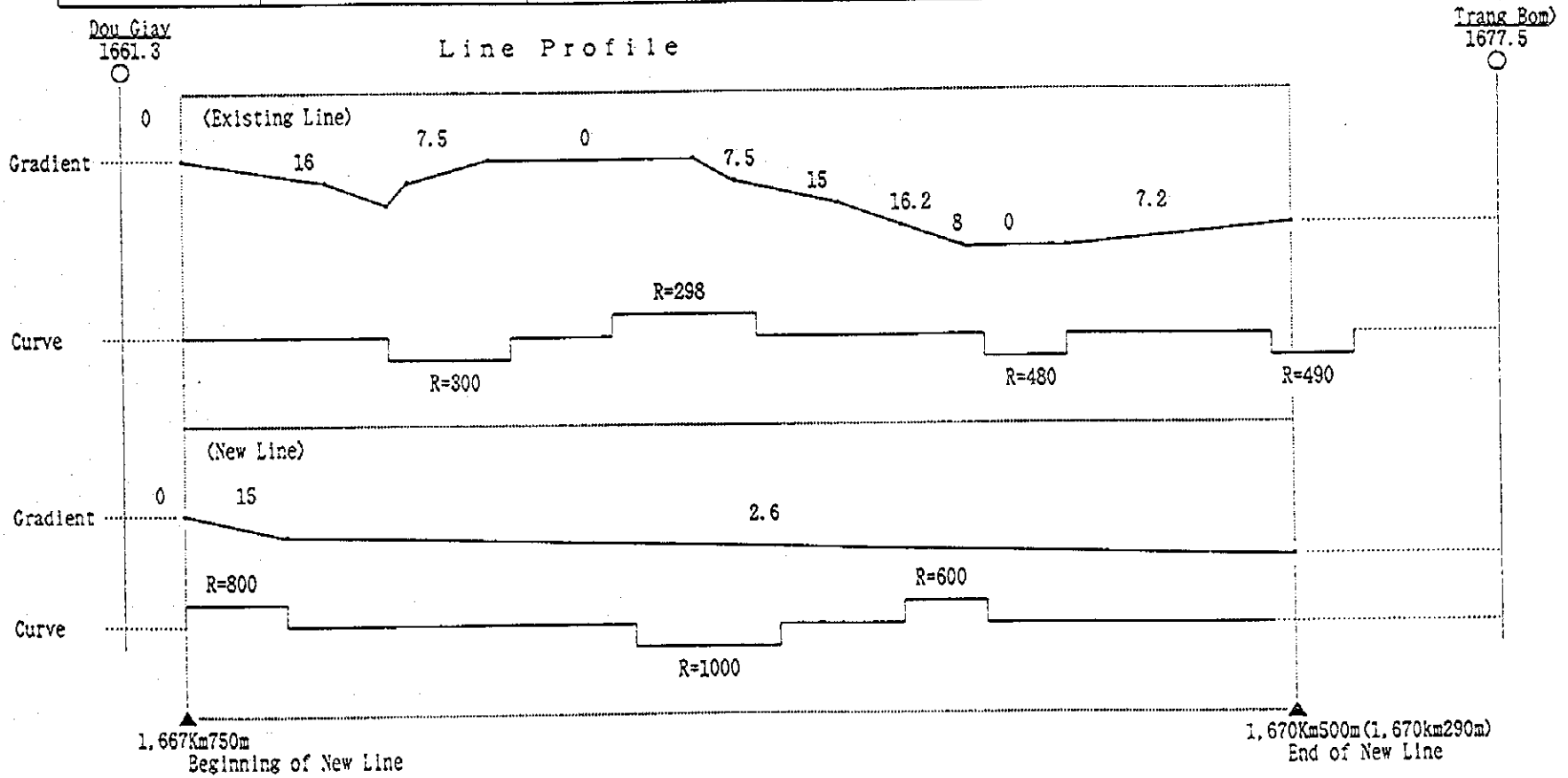
4. Section (Hoa Son ~Dai Lanh)
1220.1 1232.2

Item			(A) Existing Line	(B) Result of Study New Line	(B)-(A)	Remarks
Section of New Line	Kilo Meter	From	1,229.600	1,229.600		
		To	1,231.000	1,230.960		
	Extension (Km)		1.400	1.360	Δ 0.040	
Travelling Time	Express (110Km/H)		10'30"	10'00"	Δ 0'30"	Hoa Son ~Dai Lanh (12.1Km)
	Freight Trains (80Km/H)		11'00"	11'00"	Δ 0'00"	
Cost	(Million US$)		0.09	13.74	13.65	



5. Section (Dou Giay~Trang Bom)
1661.3 1677.5

Item			(A) Existing Line	(B) Result of Study New Line	(B)-(A)	Remarks
Section of New Line	Kilo Meter	From	1,667.750	1,667.750		
		To	1,670.500	1,670.290		
	Extension(Km)		2.750	2.540	Δ 0.210	
Travelling Time	Express(110Km/H)		11'20"	10'30"	Δ 0'50"	Dau Giay ~Trang Bom (6.2Km)
	Freight Trains(80Km/H)		14'00"	13'30"	Δ 0'30"	
Cost	(Million US$)		0.33	6.51	6.18	



Appendix 7.1-1

Outline of Passenger Information System
(Ticket Advance Reservation System)

The passenger information system (ticket advance reservation system) is to be introduced with the aims of improving information-linked facilities and raising the level of passenger services.

The introduction of this system shall entice more passengers and so raise income by transforming the VNR into a transport body that is in step with railway passenger transportation needs and is convenient for users.

For this purpose, together with the introduction of the system, it is necessary to carry out a fundamental rethink of the fare system and further strengthen the business and sales setup in order to make the system an efficient one.

As can be seen in the System Outline Drawing, a central unit will be installed at VNR Headquarters, supplementary units at each Union and terminals at each main station. Concentrated control of the sales situation of each type of ticket will be performed at Headquarters and at each Union. Passengers will become able to quickly purchase normal and sleeper advance reservation tickets at each station etc. (by telephone at intermediate stations), enabling the VNR to become a convenient transport body and allow its passengers to utilize it with peace of mind.

At each station, the system will strengthen the sales setup and also allow business affairs to be carried out in a swift, precise and efficient manner.

In the case of Headquarters and the Unions, the system will enable the automatic totalling of daily passenger transportation, sales and passenger revenue figures and moreover, make forecasting of passenger trends and sales possible. Such data can be reflected in the formulation of timetables and thus enable detailed aspects of service to be improved.

Appendix 7.1-2

Outline of Freight Information System

The freight information system will store data on the state of freight transportation and present at all times that data, which is required for freight business (sales management), operation of services and service control, to freight stations, yards, freight dispatchers and top management. That is to say that it is a comprehensive information system for freight transportation centered around freight information and a freight information data base.

Furthermore, in the case where yard systems such as freight car management are introduced, these will be incorporated into the freight information system as sub-systems.

The central unit of this system (see System Outline Drawing) will carry out the concentrated management of such information as the locations, situations, loads, departing stations and arriving stations of all freight cars in the country (initially between Hanoi and Ho Chi Minh).

Such information will be renewed every time the freight car situation changes such as at times of applications for transportation, decision on use of freight cars, train departure and arrival and completion of loading and unloading. In particular, composition communications at train departure times are vital for showing actual freight car movement. These communications can be relayed from departure stations to arriving stations via the central unit and so enable the data base to be renewed.

The main functions of the system can be summarized as follows.

(1) Sales management

1) Transportation applications, commitments and loading work can be performed smoothly and in a planned fashion a number of days in advance)
Moreover, fares and arrival schedules can be output at the same time as applications.

2) For regular customers, transportation capacity can be secured in advance and handling can be given priority treatment.

3) Sales management information such as the reservations situation for each train and transportation spare room inquiries are output.

4) At the same time as transportation applications, revenue statistics such as fares are output.

(2) Transportation management

1) The state of rolling stock is output based upon the input of daily inventory reports from each yard.

2) Transportation planning, such as freight car assignment and empty car return commands, is rapidly output based upon transportation applications, and data necessary for work is presented to departing, arriving and intermediate stations.

3) In the event of transportation abnormalities arising, train stoppage and arrangement can be performed via train dispatchers, enabling confusion to be held to a minimum.

4) Transportation results are output as daily and monthly reports.

(3) External functions

The system enables the following kind of external functions to be performed.

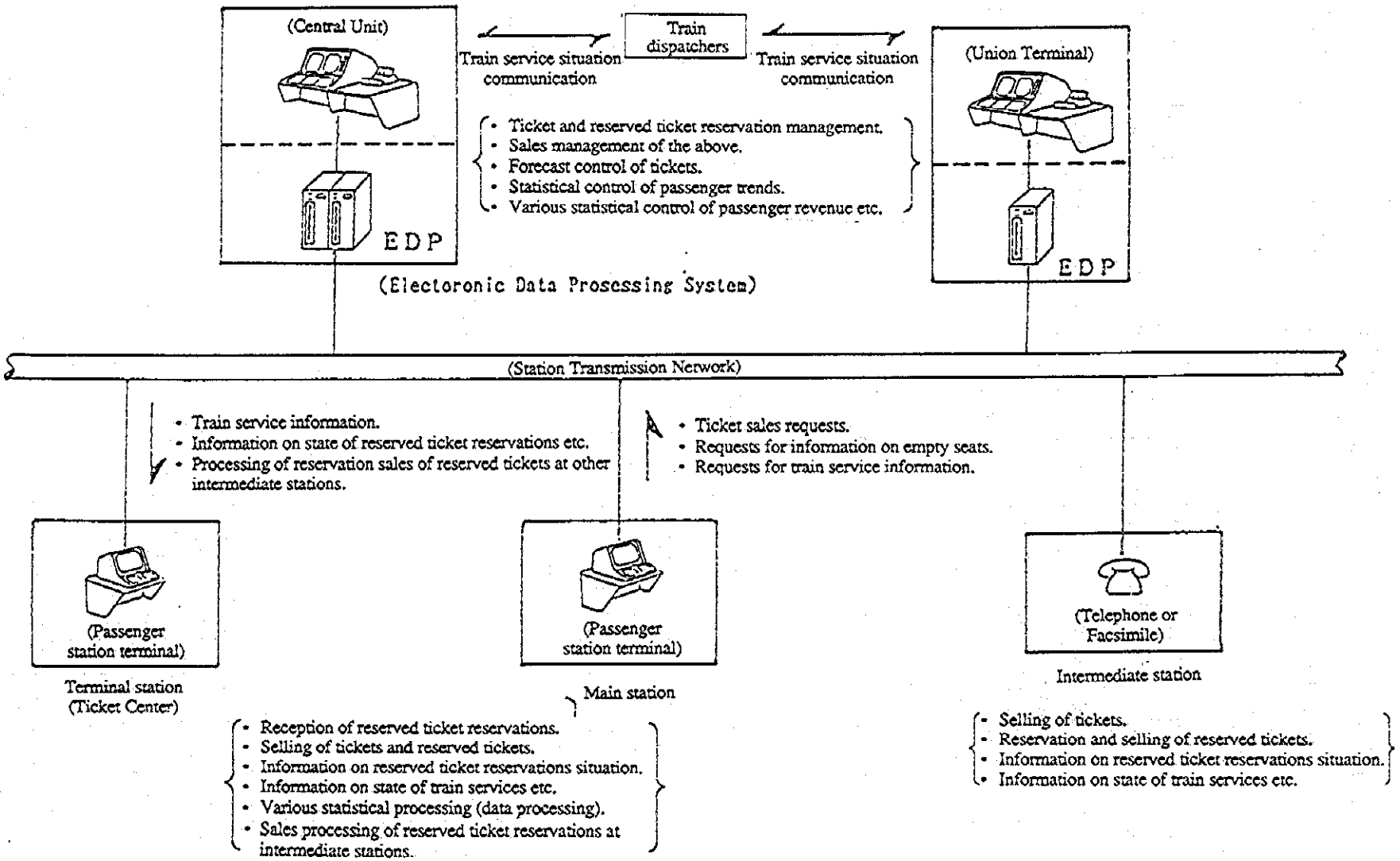
1) The issue of Freight Notifications.

2) Retrieval of freight car locations (stations).

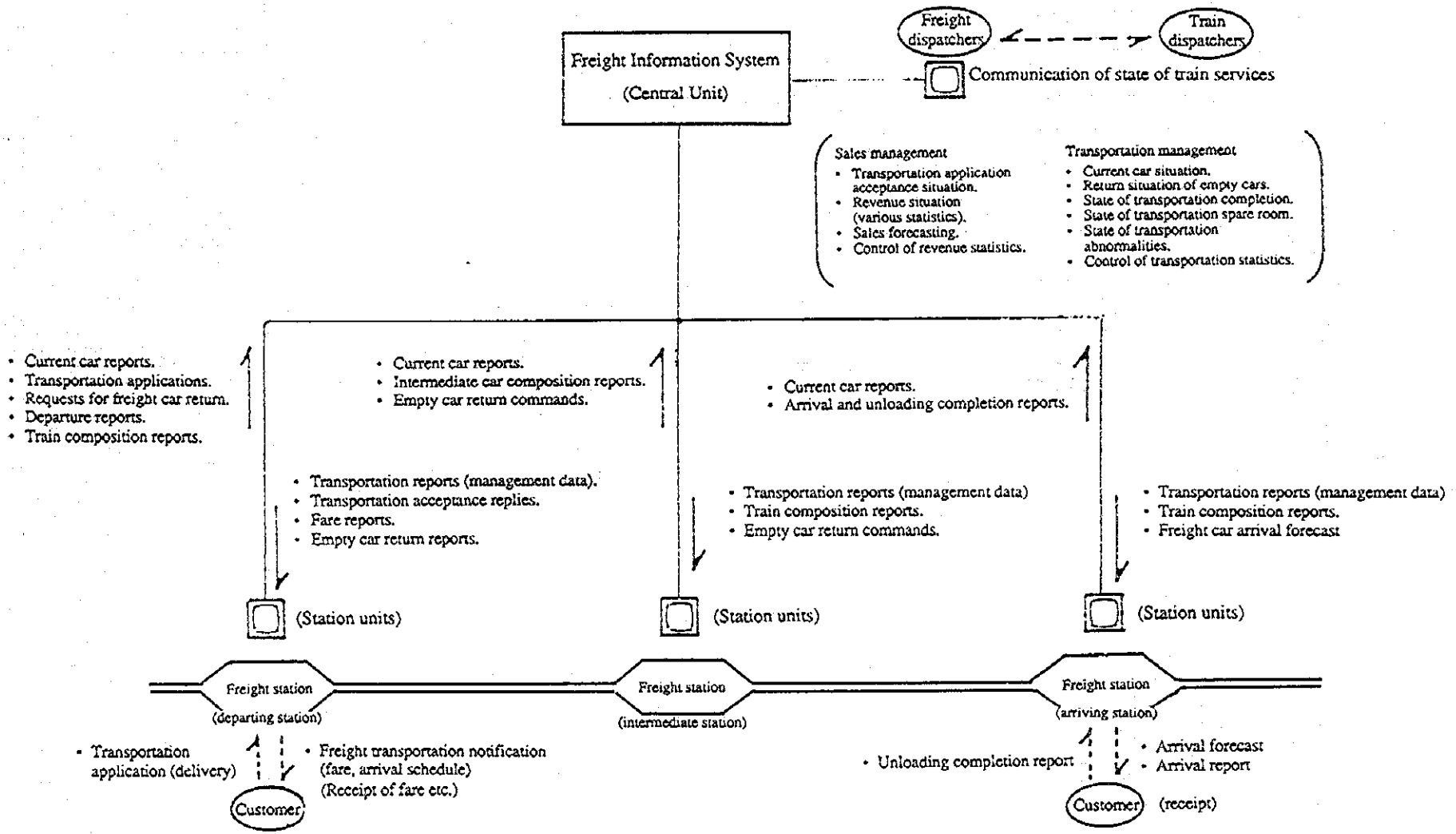
3) The transmission of Composition Reports.

4) The presentation of management data to freight stations.

5) Management of data on inspected and repaired cars.

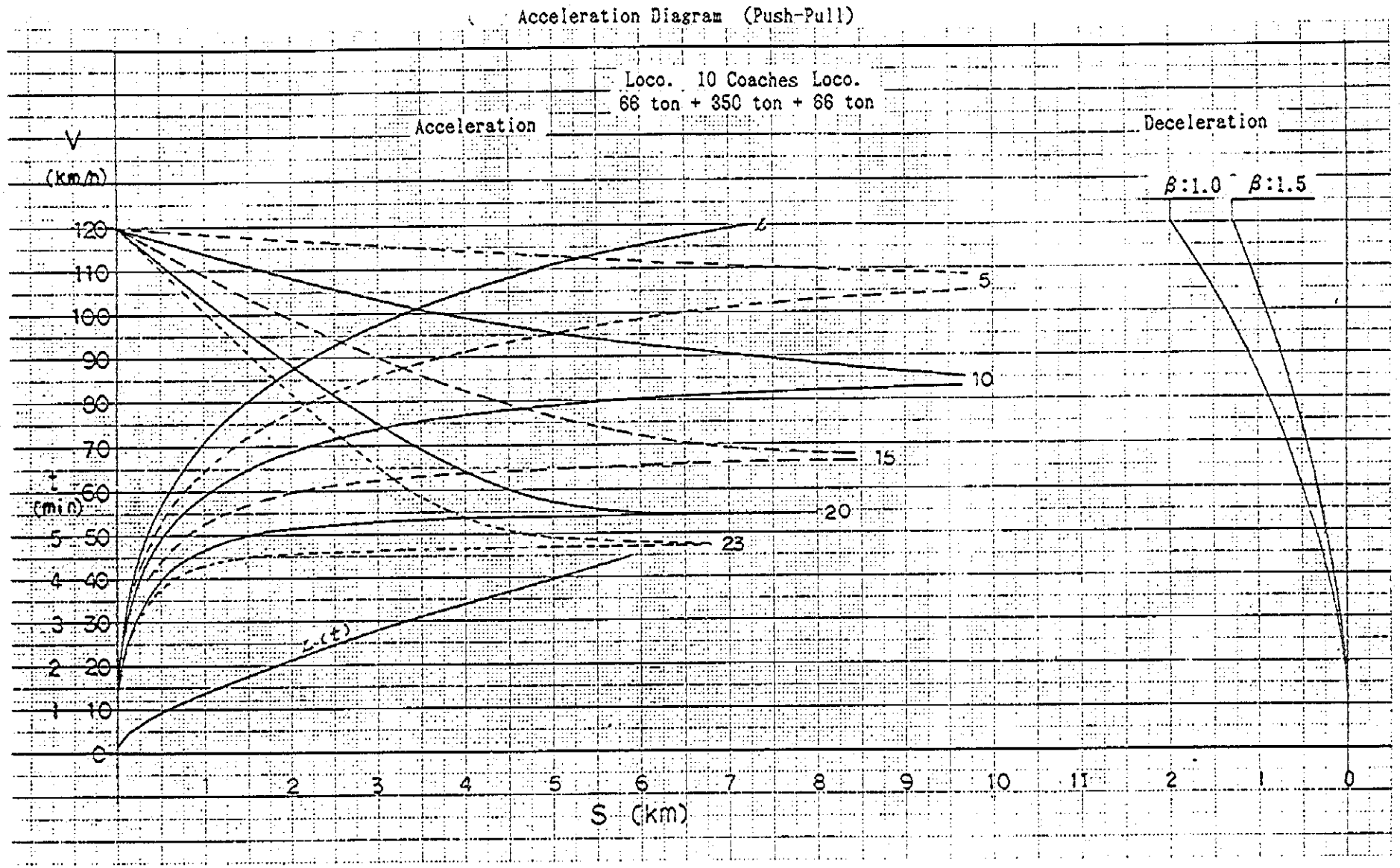


Outline of Passenger Information System (Ticket Advance Reservation System)



Outline of Freight Information System

Appendix 7.2-1



Appendix 7.2-2

Phased Plan of Transportation Capacity

(1) Passenger (2000 year)

			- 6	6 -12	12-15	15-22	22-35	35-44	44-56	56-66	66-73	73-84	84-96	96-110	-117	-128	-134	-142	-P	142-154	-163	
No.-sec.		Down		3005	2685	2954	2859	2449	2547	2530	2676	2768	3449	2635	2814	2478	2510	2685	2611	480	3047	3055	
(A)		Up		2929	2876	2884	2773	2377	2416	2383	2750	2842	3581	2567	2511	2353	2386	2556	2488	484	2527	2916	
Get on		Down	3005	9	553	42	470	838	211	1083	92	1166	740	143	205	65	464	89	207	-	8	-	
		Up	-	69	485	148	853	684	223	681	186	466	1545	146	344	40	273	159	80	484	1	2910	
Get off		Down	-	125	485	137	880	740	228	737	200	485	1553	164	340	33	269	163	88	480	1	3055	
		Up	2929	16	493	38	456	718	205	1019	101	1204	672	150	186	53	463	91	217	-	4	-	

P 方 17

No.-sec.	L.Ex.→		898	898	917	919	1055	1287	1330	1484	1507	1786	1766	1739	1832	1615	1482	138	-	1370	1370	
	Ex.		1425	1427	1566	1581	1182	1259	1086	1222	1246	1803	756	802	842	950	1173	1135	-	1285	1282	
	Total		2323	2324	2484	2500	2237	2547	2396	2706	2755	3449	2522	2541	2674	2465	2655	2522	0	2655	2652	
	others←		682	561	470	359	212	0	133	170	13	0	113	72	4	25	30	89	480	384	403	
No.-sec.	L.Ex.→		889	889	905	907	1063	1250	1289	1428	1451	1703	1703	1677	1582	1543	1424	1315	-	1297	1297	
	Ex.		1408	1410	1525	1538	1118	1160	970	1144	1170	1678	703	756	786	786	1105	1167	-	1229	1229	
	Total		2298	2298	2430	2444	2181	2410	2259	2572	2620	3381	2406	2434	2368	2330	2530	2482	0	2527	2526	
	others←		632	577	453	329	196	0	133	158	22	0	101	77	5	36	27	6	484	0	391	

Passenger Train Operation Plan

No. of Train	S.Exp.		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	
	S.Exp.		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0	4	4	
	L.Exp.		1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	0	1	1	
	L.Exp.		3	3	3	3	2	1	1	2	2	3	2	2	2	2	2	2	0	3	3	
	Local		5	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	5	
	Total		14	11	11	11	9	9	9	10	10	11	9	9	9	9	9	9	2	11	14	
Transp. Capa.	S.Exp.	440	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	0	352	352	
	S.Exp.	430	1376	1376	1376	1376	1376	1376	1376	1376	1376	1376	1376	1376	1376	1376	1376	1376	0	1376	1376	
	Total		1728	1728	1728	1728	1728	1728	1728	1728	1728	1728	1728	1728	1728	1728	1728	1728	0	1728	1728	
	L.Exp.	460	368	368	368	368	368	736	736	736	736	736	368	368	368	368	368	368	0	368	368	
	L.Exp.	360	864	864	864	864	576	288	288	576	576	864	576	576	576	576	576	576	0	864	864	
	Total		1232	1232	1232	1232	944	1024	1024	1312	1312	1600	944	944	944	944	944	944	0	1232	1232	
Exp.C.	Total		2960	2960	2960	2960	2672	2752	2752	3040	3040	3328	2672	2672	2672	2672	2672	2672	0	2960	2960	
	Local	320	1088	512	512	512	256	256	256	256	256	256	256	256	256	256	256	256	512	512	1088	
(B)	G.Total	240	4048	3472	3472	3472	2928	3008	3008	3296	3296	3584	2928	2928	2928	2928	2928	2928	512	3472	4048	
(B)/(A)×			1.35	1.20	1.18	1.21	1.20	1.18	1.19	1.15	1.19	1.04	1.11	1.12	1.16	1.17	1.09	1.12	1.07	1.14	1.33	
			1.38	1.21	1.20	1.25	1.23	1.25	1.26	1.21	1.25	1.06	1.17	1.17	1.24	1.24	1.15	1.18	1.06	1.27	1.39	
Train km	S.Exp.	10	67	107	56	121	288	154	251	201	132	206	273	335	204	235	185	287	0	293	57	3452
	S.Exp.	9	266	428	222	485	1150	616	1005	805	529	825	1092	1341	816	939	742	1149	0	1170	230	13810
	L.Exp.	9	67	107	56	121	288	309	502	402	264	412	273	335	204	235	185	287	0	293	57	4397
	L.Exp.	6	200	321	167	364	575	154	251	402	264	619	546	670	408	470	371	574	0	878	172	7406
	Local	5	333	214	111	242	288	154	251	201	132	206	273	335	204	235	185	287	47	585	287	4572
	Total		932	1177	612	1333	2588	1390	2261	2008	1322	2268	2457	3017	1836	2113	1669	2585	47	3219	804	33637
Loco. km	S.Exp.	8	67	107	56	121	288	154	251	201	132	206	273	335	204	235	185	287	0	293	57	3452
	S.Exp.	DEL1 2	266	428	222	485	1150	616	1005	805	529	825	2184	2682	1632	1878	1483	2298	0	2341	459	21286
	L.Exp.	DEL1 2	67	107	56	121	288	309	502	402	264	412	546	670	408	470	371	574	0	585	115	6267
	L.Exp.	DEL1	200	321	167	364	575	154	251	402	264	619	546	670	408	470	371	574	0	878	172	7406
	Local	DEL1	333	214	111	242	288	154	251	201	132	206	273	335	204	235	185	287	47	585	287	4572
	Total		932	1177	612	1333	2588	1390	2261	2008	1322	2268	3022	4693	2856	3287	2596	4021	47	4682	1091	42985
Car km	S.Exp.	10	666	1070	556	1212	2876	1544	2512	2008	1322	2062	2730	3352	2040	2348	1854	2872	0	2928	574	34524
	S.Exp.	9	2398	3852	2002	4363	10354	5558	9043	7229	4759	7423	9828	12067	7344	8453	6674	10339	0	10534	2066	124286
	L.Exp.	9	599	963	500	1091	2588	2779	4522	3614	2380	3712	2457	3017	1836	2113	1669	2585	0	2633	517	38575
	L.Exp.	6	1199	1926	1001	2182	3451	926	1507	2410	1586	3712	3276	4022	2448	2818	2225	3446	0	5267	1033	44435
	Local	5	1665	1070	556	1212	1438	772	1256	1004	661	1031	1365	1676	1020	1174	927	1436	235	2926	1263	22480
	Total		6327	8881	4615	10060	20707	11580	18040	16265	10700	17939	19656	24113	14688	16906	13349	20678	235	24286	5453	265308

Note : No.-sec.: Number of persons passing through the section

(2) Passenger (2005 year)

O - D Chart Passenger (2005)

Station			1 - 6	6 -12	12-15	15-22	22-35	35-44	44-56	56-66	66-73	73-84	84-96	96-110	-117	-128	-134	-144	-P	144-157	-163	
No.-sec.	Down		3638	3484	3571	3464	3317	3382	3324	3450	3384	4611	3562	3529	3355	3428	3520	3438	634	3932	3947	
(A)	Up		3543	3471	3491	3365	3222	3230	3178	3307	3272	4577	3445	3458	3265	3306	3418	3347	638	3566	3835	
Get on	Down	3638	6	691	81	892	1209	274	1102	159	1753	1314	271	378	123	532	131	271	-	16	-	
	Up	-	87	601	182	1007	1065	320	908	210	513	2369	272	549	60	413	205	108	638	3	3833	
Get off	Down	-	183	804	188	1039	1144	332	976	225	526	2363	304	550	50	440	213	107	634	2	3947	
	Up	3543	15	620	54	867	1073	287	1038	175	1818	1237	286	354	101	526	133	294	-	8	-	
																	P 5	30				
No.-sec.	L.Ex. —		942	942	971	974	1233	1558	1824	1778	1807	2070	2070	2028	1876	1851	1888	1593	-	1587	1587	
	Ex.		1639	1841	2038	2067	1682	1824	1557	1502	1553	2541	1276	1364	1471	1490	1775	1714	-	1893	1892	
	Total		2781	2783	3009	3041	2915	3382	3181	3280	3360	4611	3346	3391	3347	3342	3463	3307	0	3480	3479	
	Others —		857	701	561	423	403	0	144	170	25	0	216	137	8	88	58	131	634	472	483	
No.-sec.	L.Ex. —		932	852	957	959	1256	1542	1803	1742	1771	2029	2029	1988	1831	1805	1860	1551	-	1523	1522	
	Ex.		1819	1822	1981	2015	1594	1668	1431	1406	1459	2548	1224	1325	1424	1431	1707	1785	-	1843	1842	
	Total		2751	2754	2946	2974	2850	3230	3034	3149	3231	4577	3254	3313	3255	3236	3367	3336	0	3366	3364	
	others —		792	717	543	589	573	0	143	158	42	0	192	146	10	69	51	11	638	0	489	

Train Operation Plan

No.of	S.Exp.			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	
train	S.Exp.			4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0	4	4	
	L.Exp.			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	
	L.Exp.			2	2	2	2	2	2	2	2	5	2	2	2	2	2	2	0	3	3	
	Local			5	3	2	2	2	1	1	1	1	2	2	2	1	1	2	2	3	2	5
	Total			14	12	11	11	11	10	10	10	10	14	11	11	10	10	11	11	3	12	15
Transp.	S.Exp.	440	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	352	0	352	352	
Capa.	S.Exp.	440	1408	1408	1408	1408	1408	1408	1408	1408	1408	1408	1408	1408	1408	1408	1408	1408	0	1408	1408	
	Total		1760	1760	1760	1760	1760	1760	1760	1760	1760	1760	1760	1760	1760	1760	1760	1760	0	1760	1760	
	L.Exp.	480	738	738	738	738	738	736	736	736	736	736	736	736	736	736	736	736	0	736	736	
	L.Exp.	450	720	720	720	720	720	720	720	720	720	1800	720	720	720	720	720	720	0	1080	1080	
	Total		1456	1456	1456	1456	1456	1456	1456	1456	1456	2536	1456	1456	1456	1456	1456	1456	0	1816	1816	
Exp.G.	Total		3216	3216	3216	3216	3216	3216	3216	3216	3216	4296	3216	3216	3216	3216	3216	3216	0	3576	3576	
	Local	320	512	768	512	512	512	256	256	256	256	512	512	512	256	256	512	512	768	512	512	
(B)	G.Total		3728	3984	3728	3728	3728	3472	3472	3472	3472	4808	3728	3728	3472	3472	3728	3728	768	4088	4088	
(B)/(A)%			1.02	1.14	1.04	1.08	1.12	1.03	1.04	1.01	1.03	1.04	1.05	1.08	1.03	1.01	1.06	1.08	1.21	1.04	1.04	
			1.05	1.15	1.07	1.11	1.16	1.07	1.09	1.05	1.06	1.05	1.08	1.08	1.06	1.05	1.09	1.11	1.20	1.21	1.07	
Train	S.Exp.	10	87	107	56	121	288	164	251	201	132	206	273	335	204	235	185	287	0	293	57	3452
	S.Exp.	10	266	428	222	485	1150	618	1005	803	529	825	1092	1341	816	939	742	1149	0	1170	230	13810
km	L.Exp.	10	133	214	111	242	575	309	502	402	264	412	546	670	408	470	371	574	0	585	115	6905
	L.Exp.	9	133	214	111	242	575	309	502	402	264	1031	546	670	408	470	371	574	0	878	172	7873
	Local	6	333	321	111	242	575	154	251	201	132	412	546	670	204	235	371	574	71	585	287	6277
	Total		932	1284	612	1333	3164	1544	2512	2008	1322	2887	3003	3687	2040	2348	2039	3159	71	3511	861	38317
Loco.	S.Exp.	P-P	133	214	111	242	575	309	502	402	264	412	546	670	408	470	371	574	0	585	115	6905
	S.Exp.	P-P	533	856	445	970	2301	1235	2010	1606	1058	1650	2184	2682	1632	1878	1483	2298	0	2341	459	27619
km	L.Exp.	P-P	266	428	222	485	1150	618	1005	803	529	825	1092	1341	816	939	742	1149	0	1170	230	13810
	L.Exp.	DEL	133	214	111	242	575	309	502	402	264	1031	1092	1341	816	939	742	1149	0	1756	344	11963
	Local	DEL1	333	321	111	242	575	154	251	201	132	412	546	670	204	235	371	574	71	585	287	6277
	Total		1399	2033	1001	2182	5177	2625	4270	3414	2247	4330	5460	6704	3876	4461	3708	5744	71	6437	1435	66573
Car	S.Exp.	10	866	1070	556	1212	2876	1544	2512	2008	1322	2062	2730	3352	2040	2346	1854	2872	0	2928	574	34524
	S.Exp.	10	2664	4280	2224	4848	11504	6176	10048	8032	5286	8248	10920	13408	8160	9392	7416	11488	0	11704	2296	138098
km	L.Exp.	10	1332	2140	1112	2424	5752	3088	5024	4016	2644	4124	5460	6704	4080	4696	3708	5744	0	5852	1148	69048
	L.Exp.	9	1199	1926	1001	2182	5177	2779	4522	3614	2380	9279	4914	6034	3672	4226	3337	5170	0	7900	1550	70661
	Local	6	1465	1926	667	1454	3451	926	1507	1205	793	2474	3276	4022	1224	1409	2225	3446	425	3511	1263	36671
	Total		7326	11342	5560	12120	28760	14514	23613	18875	12427	26187	27300	33520	19176	22071	18540	28720	425	31893	6831	349200

(3) Passenger (2010 year)

1 O-D Chart (2010)

Station		1 - 6	6 -12	12-15	15-22	22-35	35-43	43-56	56-66	66-73	73-84	84-96	96-110	-117	-128	-134	-144	-P	144-157	-163
No.-sec.	Douwn	5130	4884	4876	4699	4545	4425	4287	4367	4321	5612	4881	4763	4581	4724	4754	4880	751	5135	5164
(A)	Up	4916	4764	4669	4473	4434	4270	4149	4225	4225	5580	4775	4734	4551	4648	4702	4640	752	4812	5085
Get on	Douwn	5130	13	1033	107	1658	1430	388	1110	208	1011	2008	458	806	225	722	221	345	-	31	-	
	Up	-	153	1018	294	1882	1444	477	966	239	616	2714	512	777	87	850	283	126	752	5	5085	
Get off	Douwn	-	287	1041	284	1812	1550	507	1030	254	620	2739	573	788	82	893	284	124	751	5	5164	
	Up	4916	21	903	99	1643	1280	357	1043	230	1970	1909	471	694	192	706	222	377	-	16	-	
																P 75		41				

Passenger Train Operation Plan

																					C.Total
No.of	S.Exp.		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	0	6	6	
train	L.Exp.		5	5	5	4	4	4	4	4	6	5	5	4	4	4	4	0	5	5	
	Local		4	4	3	3	3	3	2	2	4	3	2	3	3	3	3	3	3	4	
	Total	(p/tr.)	15	15	14	13	13	13	12	12	16	14	13	13	13	13	13	3	14	15	
Transp.	S.Exp.	440	2112	2112	2112	2112	2112	2112	2112	2112	2112	2112	2112	2112	2112	2112	2112	0	2112	2112	
Capa.	L.Exp.	510	2040	2040	2040	1632	1632	1632	1632	1632	2448	2040	2040	1632	1632	1632	1632	0	2040	2040	
	Local	400	1280	1280	960	960	960	960	640	640	1280	960	640	960	960	960	960	960	960	1280	
(B)	Total		5432	5432	5112	4704	4704	4704	4384	4384	5840	5112	4792	4704	4704	4704	4704	960	5112	5432	
(B)/(A)%			1.05	1.11	1.05	1.00	1.04	1.08	1.02	1.00	1.01	1.04	1.05	1.01	1.03	1.00	0.99	1.00	1.28	1.00	1.05	
			1.11	1.14	1.09	1.05	1.08	1.10	1.06	1.04	1.04	1.05	1.07	1.01	1.03	1.01	1.00	1.01	1.28	1.11	1.07	
Train	S.Exp.		400	842	334	727	1726	926	1507	1205	703	1237	1638	2011	1224	1409	1112	1723	0	1758	344	20714
	L.Exp.		333	535	278	485	1150	618	1005	803	529	1237	1365	1876	816	939	742	1149	0	1463	287	15409
km	Local		266	428	167	364	863	463	502	402	264	825	819	670	612	704	556	862	71	878	230	9946
	Total		999	1805	778	1576	3739	2007	3014	2410	1586	3299	3822	4558	2652	3052	2410	3734	71	4096	861	46070
Loco	S.Exp.		400	842	334	727	1726	926	1507	1205	703	1237	1638	2011	1224	1409	1112	1723	0	1758	344	20714
	L.Exp.		333	535	278	485	1150	618	1005	803	529	1237	1365	1876	816	939	742	1149	0	1463	287	15409
km	Local		266	428	167	364	863	463	502	402	264	825	819	670	612	704	556	862	71	878	230	9946
	Total		999	1805	778	1576	3739	2007	3014	2410	1586	3299	3822	4558	2652	3052	2410	3734	71	4096	861	46070
Car	S.Exp.	10	3888	8420	3338	7272	17256	9264	15072	12048	7032	12372	16380	20112	12240	14088	11124	17232	0	17556	3444	207.44
	L.Exp.	10	3330	5350	2780	4848	11504	6176	10048	8032	5288	12372	13650	16760	8160	9392	7416	11488	0	14830	2870	154094
km	Local	6	1598	2568	1001	2182	5177	2779	3014	2410	1586	4949	4914	4022	3672	4226	3337	5170	425	5267	1378	59675
	Total		8824	14338	7117	14302	33937	18219	28134	22490	14906	29693	34944	40894	24072	27706	21877	33890	425	37453	7692	420913

(4) Cargo (2000 year)

O - D Chart Cargo F/S (2000) Includ Cal Len

Station		1 6	8 12	12 15	15 22	22 35	35 43	43 58	58 66	66 73	73 84	84 96	96 110	110 117	117 128	128 134	134 144	144 P	144 157	157 163	
Grade		8%	8%	13%	13%	8%	17%	17%	7%	7%	23%	8%	8%	10%	10%	13%	13%		16%	8%	
No.-sec. Down		1572	1570	1570	1558	2164	2048	1989	1040	1844	1536	795	709	476	491	448	473	0	467	432	
(A) Up		3728	3775	3904	3202	2265	2087	2070	2052	1840	1800	1814	1700	1799	1800	1780	1750	0	1738	1738	
Send out Down	1572	0	21	96	1278	122	45	96	226	6	80	60	3	42	41	42	40	-	2	-	3779
Up		0	5	645	1457	265	18	84	250	86	84	37	15	14	45	11	14	0	1	1738	4756
Arrive Down	-	1	21	108	672	258	104	245	222	315	830	146	224	20	84	18	46	0	37	432	2776
Up	3728	47	134	33	430	87	7	38	38	55	100	13	24	16	4	8	2	-	0	-	4756
D.F.T.-ton	DFT	350	350	350	350	350	350	350	350	330	330	350	350	350	350	350	350	-	350	350	
F.T.-ton	DFT	540	540	450	400	410	380	380	540	510	330	410	410	410	410	410	410	-	410	410	
Exclu.F.-ton	Coal	390	390	390																	
Exclu.F.-ton	Cement	420	420	420	420																
Total(ton)		1700	1700	1590	1260	760	730	730	890	840	660	760	760	760	760	760	760	0	760	760	
No.of D.F.T.		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-	3	3	
No.of F.T.		2	2	2	2	3	3	3	2	2	3	2	2	2	2	2	2	-	2	2	
No.of Exclu.F.T Coal		2	2	2																	
No.of Exclu.F.T Cement		3	3	3	3																
Total		10	10	10	8	8	8	8	5	5	6	5	5	5	5	5	5	0	5	5	
Transp.Capa.-D.F.T.		1050	1050	1050	1050	1050	1050	1050	990	990	990	1050	1050	1050	1050	1050	1050	0	1050	1050	
Transp.Cap.-F.T.		1080	1080	860	980	1230	1140	1140	1080	1020	990	820	820	820	820	820	820	0	820	820	
Transp.Cap.-Exc.Coal		780	780	780	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Transp.Cap.-Exc.Cement		1260	1260	1260	1200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Tr.Cap.-Total	(B)	4170	4170	3950	3290	2280	2190	2190	2070	2010	1980	1870	1870	1870	1870	1870	1870	0	1870	1870	
No.-sec-T.C.	Down	-2598	-2600	-2380	-1732	-116	-142	-201	-230	-166	-444	-1075	-1161	-1302	-1370	-1422	-1397	0	-1403	-1438	
No.-sec-T.C.	Up	-442	-395	-446	-2	-15	-165	-112	-18	-170	-171	-56	-80	-71	-70	-110	-120	0	-132	-132	
(B)/(A)	X	2.7	2.7	2.5	2.1	1.1	1.1	1.1	1.1	1.1	1.1	2.4	2.6	3.0	3.8	4.2	4.0		4.0	4.3	
		1.1	1.1	1.0	1.0	1.0	1.0	1.1	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.1	1.1		1.1	1.1	
Train-km		666	1070	556	970	1726	814	1620	1004	681	1237	1365	1676	1020	1174	927	1436	0	1463	287	14671
D.F.T.		200	321	167	364	863	407	810	602	387	618	819	1006	612	704	556	862	0	878	172	10357
F.T.		133	214	111	242	863	407	810	402	264	618	546	670	408	470	371	574	0	585	115	7804
Exc.T. Coal		133	214	111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	458
Exc.T. Cement		200	321	167	364	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1051
Loco.-km Total		666	1070	556	970	1726	814	1620	1004	681	1237	2730	3352	2040	2348	1854	2872	0	2926	574	29010
D.F.T.		200	321	167	364	863	407	810	602	387	618	1638	2011	1224	1409	1112	1723	0	1756	344	15966
F.T.		133	214	111	242	863	407	810	402	264	618	1092	1341	816	939	742	1148	0	1170	230	11543
Exc.T. Coal		133	214	111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	458
Exc.T. Cement		200	321	167	364	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1051
Car-km F.T.		7526	11770	6005	12605	545.2	15052	29070	21486	13881	21032	25754	32850	19992	23010	18190	28146	0	28675	5625	356859
Ex.T.		4529	7276	3781	5000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20676
D.F.T.-No.of Cars		18	18	18	18	18	18	18	17	17	17	18	18	18	18	18	18	-	18	18	
F.T. - No.of Cars		26	26	27	25	22	19	19	26	27	17	22	22	22	22	22	22	-	22	22	
Ex.T. -No of Cars		15	15	15																	
Ex.T. -No of Cars		14	14	14	14																
Revision car-km		-1090	-1585	-94	11	-159	-518	-1122	-135	-831	-1308	-584	-892	-537	-605	-754	-1275	0	-1431	-282	-13248

Train.km	Loco.km D18E	Loco.km D12E	Car-km
19671	10323	18696	364287
D.F.T. 10357	D.F.T. 4748	D.F.T. 11218	
F.T. 7804	F.T. 4065	F.T. 7478	
Exc.T. 1510	Exc.T. 1510	Exc.T. 0	

D18E	10323
D12E-W	18696
Loc.km	29019

Total 8535 No.of Cars 2529 (8535/27-8)

8535

(5) Cargo (2005 year)

O - D Chart Cargo (2005)

Station			1 5	6 12	12 15	15 22	22 35	35 43	43 58	58 68	68 73	73 84	84 98	98 110	110 117	117 128	128 134	134 144	144 P	144 157	157 185	
Grade			8%	8%	13%	13%	8%	17%	17%	7%	7%	23%	8%	8%	10%	10%	13%	13%		18%	8%	
No.-sec (A)	Down		1800	1722	1704	1755	2670	2440	2288	2180	2186	1782	1225	1148	840	724	729	885	0	881	1070	
	Up		4598	4664	5235	4731	3660	3200	3007	2932	2620	2428	2382	2404	2280	2332	2269	2243	0	2230	2671	
Get on	Down	1800	0	78	137	1580	305	86	263	317	7	392	197	5	191	119	161	63	-	319	-	6081
	Up	-	0	18	735	2156	840	206	268	377	267	262	83	142	79	106	136	15	0	2	2671	8378
Get off	Down	-	77	96	87	656	595	247	371	310	431	930	274	512	108	115	25	47	0	131	1070	6081
	Up	4598	66	590	231	1085	380	15	193	64	66	215	125	27	122	43	112	2	-	443	-	8378

Train Operation Plan

No.of train	D.F.T.		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0	4	4	
	O.F.T.		2	2	5	3	6	5	4	4	3	2	3	3	3	3	3	3	0	3	3	
	S.F.T.		5	5	5	5																
	Total		11	11	14	12	9	9	8	8	7	6	7	7	7	7	7	7	0	7	7	
Net ton	D.F.T.		410	410	350	350	410	350	350	410	410	410	330	410	380	380	380	380		350	410	
	O.F.T.		490	490	410	410	540	490	490	490	410	490	410	410	410	410	410	410		410	490	
	S.F.T.		480	480	480	480																
Cars/tr	D.F.T.		22	22	18	18	22	18	18	22	22	22	17	22	19	19	19	19		18	22	
	O.F.T.		25	25	22	22	28	25	25	23	22	25	22	22	22	22	22	22		22	25	
	S.F.T.		16	16	16	16																
Tranep. Cape.	D.F.T.		1640	1640	1400	1400	1640	1400	1400	1640	1640	1640	1320	1640	1520	1520	1520	1520	0	1400	1640	
	O.F.T.		980	980	2050	1230	2700	2450	1960	1800	1230	980	1230	1230	1230	1230	1230	1230	0	1230	1470	
	S.F.T.		2400	2400	2400	2400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
(B)	Total		5020	5020	5850	5030	4340	3850	3360	3440	2870	2620	2550	2870	2750	2750	2750	2750	0	2630	3110	
(B)/(A)%			2.79	2.91	3.43	2.87	1.62	1.57	1.47	1.58	1.31	1.49	2.08	2.50	4.20	5.80	5.77	5.18		2.98	2.91	
			1.09	1.08	1.12	1.06	1.10	1.20	1.12	1.17	1.10	1.08	1.08	1.16	1.20	1.18	1.21	1.23		1.18	1.16	
Train (km)	D.F.T.		266	428	222	485	1150	542	1080	803	529	825	1082	1341	816	930	742	1149	0	1170	230	13810
	O.F.T.		133	214	278	384	1438	678	1080	803	397	412	819	1006	612	704	556	862	0	878	172	11406
	S.F.T.		333	535	278	806	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1752
	Total		733	1177	778	1454	2588	1220	2160	1606	925	1237	1911	2346	1428	1644	1298	2010	0	2048	402	26967
Loco. (km)	D.F.T.	D18E	266	428	222	485	1150	542	1080	803	529	825	1082	1341	816	930	742	1149	0	1170	230	13810
	O.F.T.	D18E	133	214	278	384	1438	678	1080	803	397	412	819	1006	612	704	556	862	0	878	172	11406
	S.F.T.	D18E	333	535	278	806	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1752
	Total		733	1177	778	1454	2588	1220	2160	1606	925	1237	1911	2346	1428	1644	1298	2010	0	2048	402	26967
Car (km)	D.F.T.	D18E	5861	9418	4883	8726	25309	9783	19440	17670	11634	18148	18584	20486	15504	17845	14080	21827	0	21067	5051	273414
	O.F.T.	D18E	3330	5350	6116	7999	40264	16950	27000	18474	8725	10310	18018	22125	13464	15497	12236	18955	0	19312	4305	268426
	S.F.T.	D18E	5328	8560	4446	9696	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28032
	Total		14519	23328	14567	26422	65573	26713	46440	36144	20359	28458	36582	51621	28968	33342	26327	40782	0	40379	9356	569875
			D12E	D12E	D12E	D12E	D12E	D12E	D12E			D12E D12E								D12E		4525 3690
No.-sec.-Tran.C	Down		-3220	-3298	-4146	-3275	-1661	-1401	-1072	-1280	-884	-858	-1325	-1722	-2110	-2026	-2021	-1885	0	-1749	-2040	
	Up		-422	-356	-815	-299	-680	-650	-353	-508	-250	-192	-188	-466	-461	-418	-481	-507	0	-400	-439	
Car km			-1040	-1409	-1266	-1340	-7241	-3264	-3528	-3775	-1225	-1464	-1902	-5762	-3483	-3637	-3305	-5398	0	-4340	-934	-54333

(6) Cargo (2010 year)

O-D Chart Cargo (2010)

Station		1 8	6 12	12 15	15 22	22 35	35 43	43 56	56 68	68 73	73 84	84 98	98 110	110 117	117 128	128 132	134 142	144 F	142 157	157 163	
Grade		6‰	6‰	15‰	15‰	6‰	17‰	17‰	7‰	7‰	23‰	8‰	8‰	10‰	10‰	15‰	15‰		16‰	6‰	
No.-sec. (A) Down		1927	1814	1383	1435	2559	2041	2108	2020	2107	1720	1416	1288	986	1221	1585	1816	0	2239	2427	
Up		5009	5085	5438	5125	4210	3341	3241	3158	3064	2874	2611	2790	2720	2734	2866	2992	0	3298	4249	
Get on Down	1927	0	52	144	1714	452	300	436	430	107	875	320	280	384	482	279	468	-	75	-	9187
Up	-	0	505	747	2493	1422	319	491	380	420	544	144	308	122	201	185	10	0	185	4249	12706
Get off Down	-	313	304	72	590	921	283	524	343	493	981	447	601	114	138	29	44	0	563	2427	9187
Up	5009	76	858	436	1577	554	220	407	277	239	282	325	235	136	434	190	517	-	1136	-	12706

Train Operation Plan

G.Total

No. of train	D.F.T.		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4		4	4	
	O.F.T.		2	2	4	4	5	4	4	4	3	4	3	3	3	3	4	4		5	6	
	S.F.T.		6	6	6	6																
	Total		12	12	14	14	9	8	8	8	7	8	7	7	7	7	8	8	0	9	10	
Net ton	D.F.T.		410	410	350	350	410	350	350	410	410	330	410	410	380	380	380	380		350	410	
	O.F.T.		490	490	410	410	540	490	490	410	490	410	410	410	410	410	410	410		410	490	
	S.F.T.		480	480	480	480																
Transp. Capa. (B)	D.F.T.		1640	1640	1400	1400	1640	1400	1400	1640	1640	1320	1640	1640	1520	1520	1520	1520	0	1400	1640	
	O.F.T.		980	980	1640	1640	2700	1960	1960	1640	1470	1640	1230	1230	1230	1230	1640	1640	0	2050	2940	
	S.F.T.		2880	2880	2880	2880	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Total		5500	5500	5920	5920	4340	3360	3360	3280	3110	2960	2870	2870	2750	2750	3160	3160	0	3450	4580	
(B)/(A)%			2.85	3.41	4.34	4.12	1.70	1.81	1.59	1.62	1.48	1.72	2.03	2.23	2.85	2.25	2.02	1.74		1.54	1.89	
			1.10	1.08	1.09	1.16	1.03	1.01	1.04	1.04	1.02	1.03	1.10	1.03	1.01	1.01	1.07	1.06		1.05	1.08	
Train km	D.F.T.		266	428	222	485	1150	542	1080	803	529	625	1092	1341	816	930	742	1149	0	1170	230	13610
	O.F.T.		133	214	222	485	1438	542	1080	803	397	625	819	1006	612	704	742	1149	0	1463	344	12678
	S.F.T.		400	642	334	727	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2102
	Total		799	1284	778	1697	2588	1085	2160	1606	925	1250	1911	2346	1428	1644	1483	2298	0	2633	574	28390
Loco. km	D.F.T.		266	428	222	485	1150	542	1080	803	529	625	1092	1341	816	930	742	1149	0	1170	230	13610
	O.F.T.		133	214	222	485	1438	542	1080	803	397	625	819	1006	612	704	742	1149	0	1463	344	12678
	S.F.T.		400	642	334	727	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2102
	Total		799	1284	778	1697	2588	1085	2160	1606	925	1250	1911	2346	1428	1644	1483	2298	0	2633	574	28390
Car km	D.F.T.		5881	8416	4005	8726	25300	9763	19440	17670	11634	14022	24024	29498	15504	17845	14080	21827	0	21087	5051	274750
	O.F.T.		3330	5350	4893	10866	40264	13560	27000	17670	9915	16146	18018	22123	13464	15497	16315	25274	0	32186	8610	302280
	S.F.T.		6394	10272	5338	11635	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33638
	Total		15584	25038	14234	31027	65573	23323	46440	35341	21549	32167	42042	51621	28968	33342	30406	47101	0	53253	13661	610669
No.of cars/Tr.	D.F.T.		22	22	18	18	22	18	18	22	22	17	22	22	19	19	19	19		18	22	
	O.F.T.		25	25	22	22	28	25	25	22	25	22	22	22	22	22	22	22		22	25	
	S.F.T.		16	16	16	16																

			•D12E	•D12E	•D12E	•D12E	•D12E	•D12E	•D12E			•D12E								•D12E		
ton	Down		-3573	-3666	-4557	-4485	-1781	-1269	-1252	-1260	-1003	-1240	-1455	-1582	-1784	-1529	-1595	-1345	0	-1211	-2153	
	Up		-491	-415	-484	-795	-130	-19	-119	-122	-56	-88	-258	-80	-30	-16	-194	-166	0	-152	-331	
km			-1212	-1046	-907	-3569	-1390	-96	-1185	-908	-274	-680	-2815	-983	-228	-141	-1331	-1789	0	-1642	-704	-21379

Appendix 7.3-1

Breakdown of Bridge Improvement Costs

Unit: million US$

Bridge by type of improvement	Span length	Quantity	Unit	Domestic currency		Foreign currency		Total costs	Summary
				Materials costs	Labor costs	Materials costs	Labor costs		
① Superstructure frame replacement									
a. Steel bridges	Span length 40 m or more	1,451	m	2.2	2.5	22.1	8.0	34.8	
b. Steel bridges	Span length 40-20 m	1,055	m	1.2	1.3	11.3	3.0	16.8	
c. Steel bridges	Span length 20 m or less	2,059	m	1.0	1.2	9.9	2.7	14.8	
d. RC bridges	Span length 20-10 m	1,364	m	0.8	0.7	4.8	1.3	7.6	
e. RC bridges	Span length less than 10 m	1,505	m	0.7	0.6	4.3	1.2	6.8	
② Superstructure frame replacement and substructure reinforcement									
a. Steel bridges	Span length 40 m or more	3,150	m	6.2	6.7	59.9	21.7	94.5	
b. Steel bridges	Span length 40-20 m	1,230	m	2.0	2.1	18.1	4.9	27.1	
c. Steel bridges	Span length 20 m or less	381	m	0.3	0.3	2.5	0.7	3.8	
d. RC bridges	Span length 20-10 m	1,161	m	0.9	0.8	5.5	1.6	8.8	
e. RC bridges	Span length less than 10 m	161	m	0.1	0.1	0.6	0.2	1.0	
③ New construction on separate lines									
a. Steel bridges	Span length 40 m or more	3,777	m	7.1	7.7	69.5	25.2	109.5	
b. Steel bridges	Span length 40-20 m	1,241	m	2.3	2.4	20.8	5.5	31.0	
c. Steel bridges	Span length 20 m or less	100	m	0.1	0.1	0.8	0.2	1.2	
d. RC bridges	Span length 20-10 m	251	m	0.3	0.2	1.4	0.4	2.3	
e. RC bridges	Span length less than 10 m	24	m	0.1	0.0	0.1	0.0	0.2	
④ Installation approach		41	Site	8.8	8.8	3.3	1.1	22.0	
⑤ Stone bridge repair		607	m	1.8	4.2	4.9	1.2	12.1	
⑥ Inspection and repair and measurement instruments		1	Set	0.0	0.1	0.5	1.0	1.6	
⑦ Investigation design		1	Set	0.0	3.2	0.0	28.5	31.7	
Total				35.9	43.0	240.3	108.4	427.6	

Breakdown of Tunnel Improvement Costs

Unit: million US$

Improvement type	Quantity	Unit	Domestic currency		Foreign currency		Total costs	Summary
			Materials costs	Labor costs	Materials costs	Labor costs		
Type 1	4,293	m	4.6	2.0	21.2	7.3	35.1	
Type 2	1,664	m	1.4	0.7	4.1	2.1	8.4	
Type 3	1,944		0.7	0.5	1.9	1.3	4.4	
Tunnel mouth protection	10	Site	0.1	0.3	0.4	0.2	1.0	
Work relief track	27	Site	0.3	0.8	1.1	0.5	2.7	
Sectional measurement device	1	Set	0.0	0.1	0.2	0.1	0.4	
Investigation design cost	1	Set	0.0	0.4	0.0	3.8	4.2	
Total			7.1	4.9	28.9	15.4	56.3	

Appendix 7.3-2

Investment Cost of Track and Stations and Other Civil Engineering Structures (1)

(Unit:Million US$)

Item		Domestic Currency		Foreign Currency		Total Cost	Remarks
		Personnel Expenses	Cost of Material	Personnel Expenses	Cost of Material		
Track	Rails	4.36		0.40	57.13	61.89	
	Turnouts	0.51	0.78		26.46	27.75	
	Sleepers	15.86	53.03		53.95	122.84	
	Ballast	3.84	0.13			3.97	
	Roadbed Improvement etc.	6.08	1.41	4.00	2.89	14.38	
	Maintenance Facilities	0.05	0.22	1.63	17.40	19.30	
Station	New Interchange Station etc.	10.58	15.65		4.92	31.15	
Disaster Pervention Measures	Banking to Prevent Flood	4.40	41.40		8.20	54.00	
	Slope Improvement etc.	16.78	23.20		0.04	40.02	
Sub Total Cost		62.46	135.82	6.03	170.99	375.30	
Managerial Cost		6.28	13.68	0.67	17.37	38.00	
Total Cost		68.74	149.50	6.70	188.36	413.30	

Investment Cost of Track and Station and Other Civil Engineering Structures (2)

(Unit:Million US$)

Item		Total Cost	First Phase	Second Phase	Third Phase	Remarks
Track	Rails	61.89	42.29	12.57	7.03	
	Turnouts	27.75	8.07	11.38	8.30	
	Sleepers	122.84	39.63	39.87	43.34	
	Ballast	3.97	1.35	1.15	1.47	
	Roadbed Improvement etc.	14.38	1.60	3.99	8.79	
	Maintenance Facilities	19.30	5.55	8.45	5.30	
Station	New Interchange ----Station etc.	31.15	19.09	6.40	5.66	
Disaster Pervention Measures	Banking to Prevent Flood	54.00	0.00	16.20	37.80	
	Slope Improvement etc.	40.02	10.51	20.39	9.12	
Sub Total Cost		375.30	128.09	120.40	126.81	
Managerial Cost		38.00	11.00	13.00	14.00	
Total Cost		413.30	139.09	133.40	140.81	

Investment Cost of Track and Stations and Other Civil Engineering Structures (3)

Item	Details	Personnel Expenses	Material	Remarks
Track	Rails	Welding technical guidance	Rails, welding tools and materials, expansion joints	
	Turnouts		Turnouts	
	Sleepers		Fasteners	
	Track bed			
	Roadbed improvement etc.	Injection roadbed improvement technical guidance	Earth auger, injection materials, rails	Road bed improvement, curve improvement
	Maintenance facilities	Measurement device attachment and technical guidance Technical guidance Technical guidance Technical guidance	Measuring device and incidental materials MMT and incidental materials Manufacturing and quality control machinery Maintenance and inspection and repair tools	High speed track inspection car MMT Ballast making device
Station	New Station etc.		Rails, turnouts, fasteners	New station
Disaster prevention measures	Banking to prevent flood		Rails, turnouts, fasteners, welding materials	
	Slope improvement etc.		Cable (only for protection purposes, not for communication)	Falling rock protection system

Appendix 7.3-3

Allowable Velocity on Curves

1. Balanced Cant

$$Cm + Cd = \frac{GV^2}{0.127R}$$

G = 1000 mm, so:

$$Cm + Cd = 7.87\frac{V^2}{R}$$

Cm : real cant (mm)
Cd : cant deficiency (mm)
V : train velocity (km/h)
R : curve radius (m)

2. Cant maximum limit

(1) For safety

The safety ratio for overturning inward when stopped is 3.

$$\frac{X}{h} \fallingdotseq \frac{C}{G}$$

$$X = \frac{G}{6},\ G = 1{,}000\text{mm},\ h = 1{,}700\text{mm}$$

$$C = \frac{G}{h} \cdot \frac{G}{6} \cdot = \frac{G^2}{6h} = 98\text{mm}$$

$$Cmax = 95\text{mm}$$

(2) For ride comfort

$$\frac{m\alpha}{mg} = \frac{C}{G} \qquad \alpha = \frac{C}{G}\,g$$

C = 95mm, G = 1,000mm
$\alpha = 0.095g$

This is the allowable range.

(3) Based upon these calculations, the VNR regulation (C max = 95 mm) is appropriate.

3. Allowable maximum cant deficiency

(1) For safety

The safety ratio for overturning outward while running is 4.

$$\frac{X}{h} = \frac{\Delta C}{G}$$

if: $X = \frac{G}{8}$

$$\Delta C = \frac{G^2}{8h}$$

G = 1,000mm, h = 1,700mm

ΔC = 73.5mm

Assuming an allowance of 20% (The measured left-right movement acceleration of a running car is 20% more than in the case where the effects of spring etc. are not considered):

$$\Delta C = 73.5 \times 0.8 \fallingdotseq 60\text{mm}$$

(2) For ride comfort

$$\frac{\Delta\alpha}{g} = \frac{\Delta C}{G} \qquad \Delta C = \frac{G}{g}\Delta\alpha$$

$\Delta\alpha \leqq 0.08g$

$\Delta C = 0.08G = 80$mm

Assuming an allowance of 20%:

$80 \times 0.8 = 64$mm

$Cd \leqq 60$mm

4. Allowable velocity judging from cant and cant deficiency

$$Cm + Cd = 7.87\frac{V^2}{R}$$

$$\therefore \quad V = \sqrt{\frac{Cm+Cd}{7.87}}\sqrt{R}$$

Cm = 95mm, Cd = 60mm

$$V = \sqrt{\frac{155}{7.87}}\sqrt{R} = 4.43\sqrt{R}$$

Conventional curve allowable velocity was determined with cant as zero and overturn safety ratio as 3, which gives the following.

$$\frac{m\frac{V^2}{R}}{mg} = \frac{X}{h} \quad X = \frac{1}{6} G$$

$$\therefore \quad \frac{V^2}{Rg} = \frac{G}{6h}$$

$$\therefore \quad V^2 = \frac{G}{6h} Rg$$

$g = 9.8 m/sec^2$, G = 1,000m, h = 1,650mm

$$V = 3.64\sqrt{R}$$

5. Wind overturn threshold

Danger ratio D is expressed by the following.

$$\left(D = \frac{1}{a}\right)$$

$$a = \frac{G}{2}, \quad D = 1$$

$$a = \frac{G}{4}, \quad D = 0.5$$

$$D = \pm 2hG^*/G \times \{V^2/(Rg) - C/G\}$$
$$+ 2hG^*/G \times (1-\mu/(1+\mu) \times h_{GT}/hG^*) \alpha\gamma$$
$$+ hBC^* \cdot \rho \cdot U^2 \cdot S \cdot C\gamma/(W \cdot G)$$

$$\begin{pmatrix} + \text{ outward overturn} \\ - \text{ inward overturn} \end{pmatrix}$$

Looking at the above equation, the curve radius is included in the $\left(\frac{V^2}{RG} - C/G\right)$ item, however this is equal to $\frac{\Delta C}{G}$. Thus, if ΔC is made constant, the above D can be estimated regardless of R.

Moreover, it can be tied up with $\frac{1}{G}$ and so in the case where G=1,067 mm and 1,000 mm, if the D calculated with G=1,067 mm is multiplied, the result is D in the case of G=1,000 mm.

(1) Inward overturn

Overturn threshold wind velocity V ≧ 30 m/sec (D = 0.5) from Figure 1 (Speedup of Railway*, p. 106)

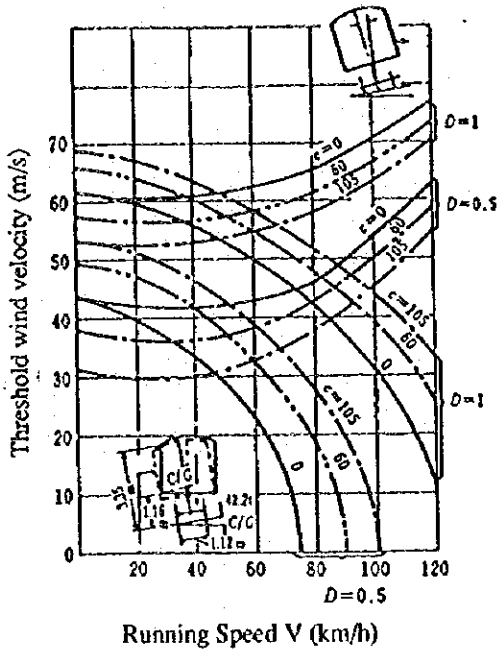


Figure 1 Relationship between running speed and car overturn threshold wind velocity on a curve (Shinkansen)

D ≒ 0.6 when Cmax = 95 mm from Figure 2 (Speedup of Railway, p107)

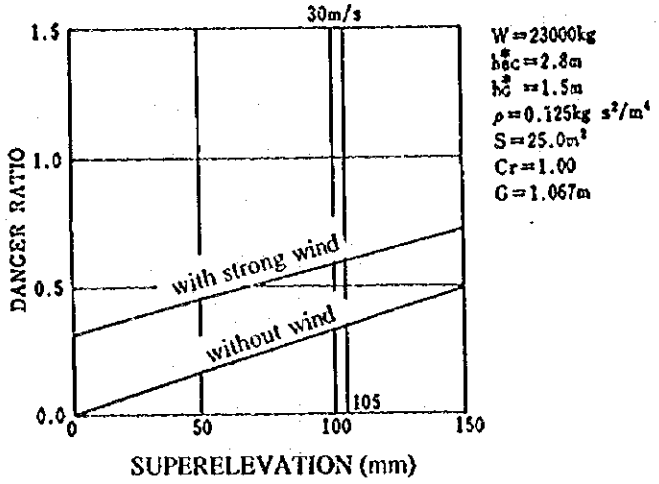


Figure 2 Relationship between superelevation and danger ratio

* "Speed up of Railway" by Mr. Ono.

(2) Outward overturn

In the same way from Figure 1:

$R = 400m$, $Cm = 95mm$, $Cd = 60mm$

$V = 4.43, \sqrt{R} = 88.6km/h$

Threshold wind velocity is:

$D = 1$, $V \geqq 40m/sec$

$D = 0.8$, $V \geqq 29.2m/sec$

Based upon the above, for wind velocity V = 25 m/sec, stop the train where necessary and for wind velocity V 30 m/sec, always stop the train. Thus, Cm = 95 mm, Cd = 60 mm is safe.

6. Regarding Curve Speed Limits in Japan

(1) According to Train Service Handling Standard Regulations, $V=3.7\sqrt{R}$ and $V=3.5\sqrt{R}$ are basically set for high performance trains and ordinary trains respectively.

(2) Regardless of the above, line sections are designated and $V=3.7\sqrt{R}$ is set for all trains.

(3) Regardless of the above, it is prescribed that high performance trains in designated line sections and designated freight trains can travel at speeds 5 km/h, 10 km/h, 15 km/h and 20 km/h faster.

That is to say that for electric and rail-car high performance trains, the speeds by curve radius in most of the line sections will be as shown in the following table.

Speed Limits by Curve Radius

R (m)	In case of curves not connected to line forks	
	High performance trains	Ordinary trains
	+5km/h	
1400	120	115
1200	115	110
1000	110	105
800	105	100
700	100	95
600	95	90
500	90	85
400	80	75
300	70	65
200	55	50

7. Train Service Regulations Regarding Wind

The service rules prescribed in Articles 489, 490 and 491 of the JR Service Handling Standard Regulations are to be applied in Vietnam.

(Disposition when wind velocity is 20 m or more)

Article 489

The station masters of stations equipped with wind speedometers must report to the Railway Control Board Manager etc. when the wind velocity reaches 20 m/sec or more.

2. The station masters of stations without wind speedometers must report to the Railway Control Board Manager etc. when they consider the wind velocity to have reached 20 m/sec or more by rough judgement.

(Disposition when wind velocity is 25 m or more)

Article 490

Station masters must carry out the following when they consider the wind velocity to have reached 25 m/sec or more.

(1) Temporarily suspend the departure or passing of trains according to the conditions when they consider running to be dangerous due to wind gusts etc.

(2) Make an effort not to connect empty cars or freight cars loaded with light and large cargo to trains.

(3) Take strict measures to prevent the overturn of detained rolling stock.

(Disposition when wind velocity is 30 m or more)

Article 491

The Railway Control Board Manager etc. shall issue orders to temporarily suspend train services when he considers wind velocity to have reached 30 m/sec or more based upon weather reports and reports from station masters.

2. In cases where station masters consider wind velocity to have reached 30 m/sec or more, and they do not, or cannot, receive orders from the Railway Control Board Manager etc., they must temporarily suspend train services and quickly report that situation to the Railway Control Board Manager etc.

8. Track Structure by Speed Limit

The Track Structure by Speed Limit Standard Regulations prescribe the track structures for lines where specific speed limits are applied.

9. Conclusion

(1) It may not be possible to apply a maximum cant of 95 mm to curves on some existing lines (due to it being impossible to obtain sufficient TCL length etc.). This means that if allowable speed is set st $V = 4.43\sqrt{R}$, allowable speed will vary over the same curve radii, which is not a desirable situation. Therefore, the conventional allowable speed formula $V = 3.64\sqrt{R}$ is to be used (there is to be no distinction between high performance trains and ordinary trains. High performance trains refer to electric and rail-car trains with an axial weight of 13 tons or less and unsprung mass of 2 tons or less).

This means that speed limits by curve will be as shown in Table 7.3.6-3 in the main text. Furthermore, if transition curves are sufficient, higher speeds of $V = 4.43\sqrt{R}$ are to be considered in future depending on the curve and according to necessity.

(2) As we described in section 7, specific speed limits regarding wind have to be applied.

Appendix 7.3-4

Station Plaza

(1) Function and Its Design Principle

Station plaza plays a role of transport node, connecting railway with other railways or land transport modes (pedestrian, bicycle, motorbike, private car, bus and so on), and requires a well organized connecting roads. This is a gateway of the town, and it can also be a symbolic scenery especially for the major towns that play pivots of inter-regional transport network.

Station plaza should be designed in coordination with a location and layout of railway station itself, and with surrounding streets. Especially these days, as a land transport is well developed, it is getting significance as a space for the public transport such as bus terminal and parking space for taxi and private vehicles.

(2) Required Size

Area required for station plaza can be calculated by the functions. Those for Japan's railway station plaza are regulated by the Station Plaza Sub-Committee, Town Planning Association of Japan. This is shown in Appendix Figure 7.3-4 - 1. In case season ticket passengers share a large portion, this factor is taken into consideration in calculating a necessary area. This calculation function targets an expected volume 20 years later. In case that plazas will be facilitated at both sides of the station, each area of plaza is set according to the proportion of passengers.

(3) Design of Station Plaza

Plaza's shape is quite similar to a rectangle (proportion in length and breadth: 1/1 ~ 1/3, standard is 1/2.), and a minimum size both in length and breadth is preferred to be over 40 meters. Layout itself should be simple enough for any new users to use without troubles. Major facilities in the plaza are passenger concourses and walkways, and parking spaces for bus, taxi and private cars. Design principles of these facilities are as follows;

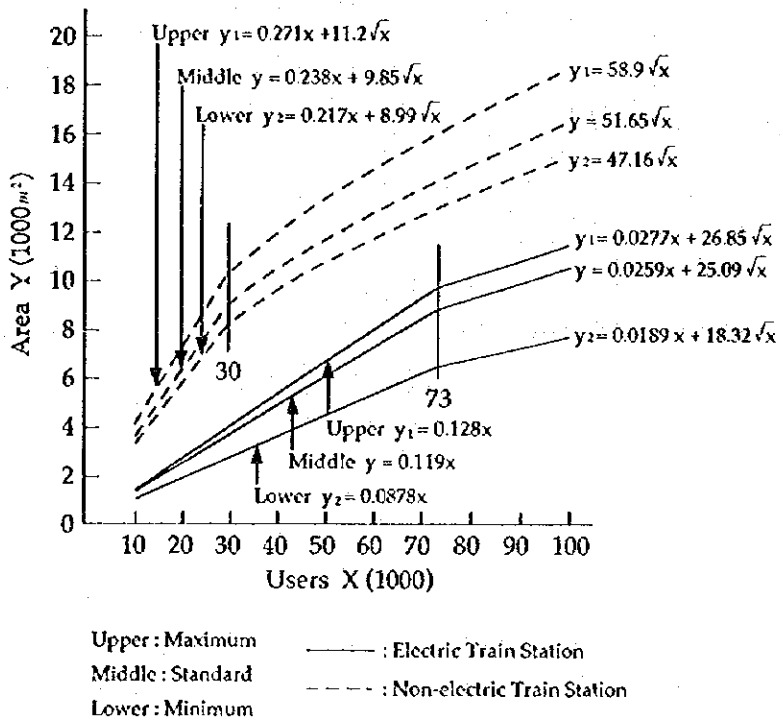


Figure 7.3-4-1 Function of Estimating Station Plaza's Area

a. Highest priority is to assure a safety of users and a convenience for everyone. It is important to take a device for the pedestrian to go on a visible shortest path, and a device to avoid a level crossing with vehicles as much as possible.

b. Priority is given to assure the most convenient and efficient connection between major facilities in the plaza and connecting roads.

c. Coverage of facilities in the plaza should be limited to the minimum indispensable ones to keep the traffic flow smooth, and exclude others such as working space of cargo vehicles, garage of buses, waiting rooms and so on.

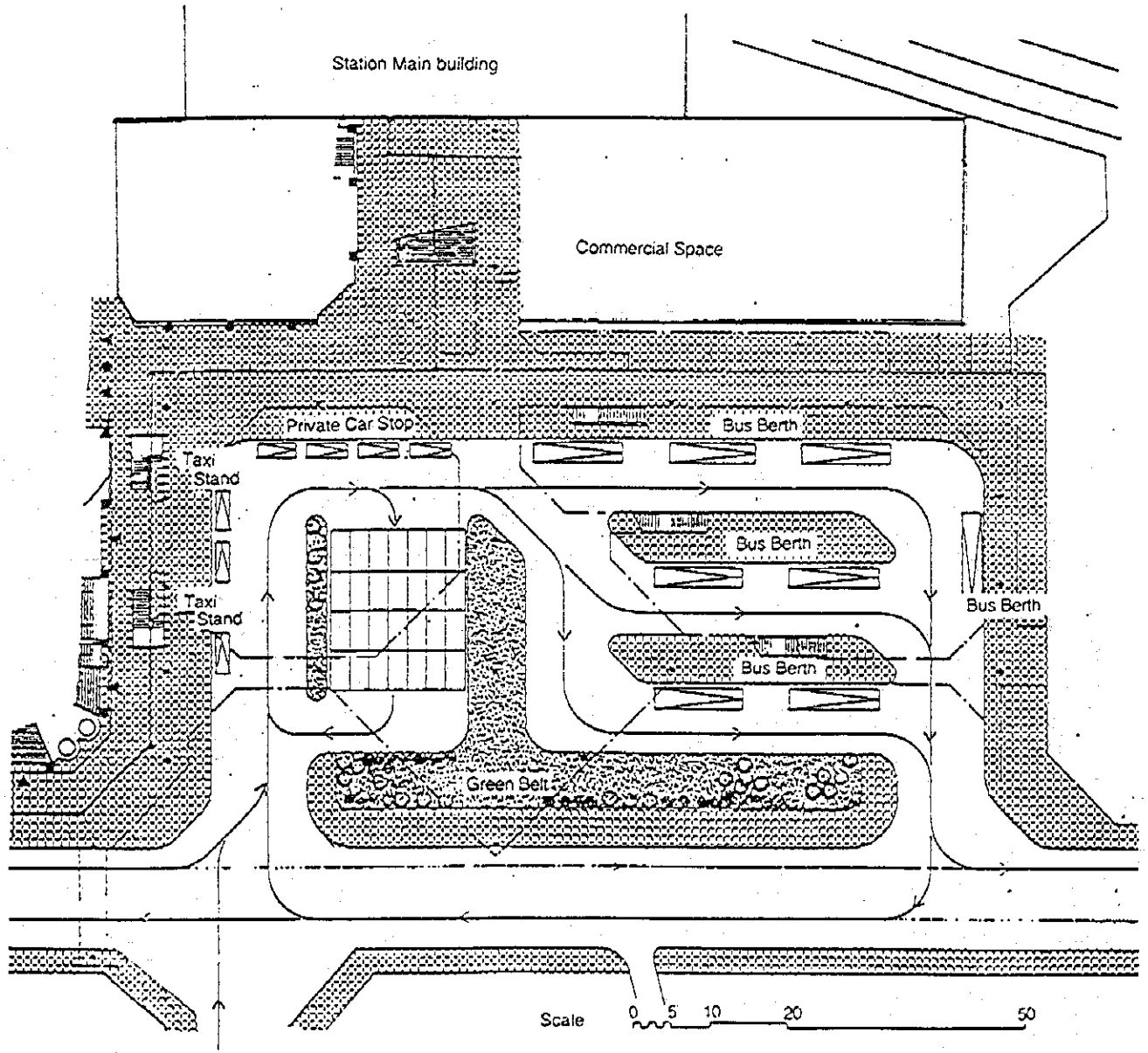
d. It should be well coordinated with the future plan of railway facilities and urban planning.

e. Necessary facilities in the station plaza are as follows:

- Pedestrian path	Its width of 5 meter at least are necessary since cars usually park in front of the station.
- Vehicle path	Two (2) lanes and one way flow are recommended. Layout of lanes should be designed not to cross each other and make the traffic flow smooth.
- Car parking	Parking space are necessary for both private cars and taxis. This space should be located at a place convenient to connect with the vehicle path and ticketing gates, apart from the vehicle roads. Since many station plazas are used as a parking space these days and are occupied, there is a need to construct a parking space near the station, and parking regulation that restricts the parking time should be formulated.
- Bus stop	This should be located close to the station building for users' convenience. Width of bus stop requires 1 meter at least.
- Traffic management facilities	Rotary, fences etc. are necessary.
- others	Green space, station of street cars, space for group tour passengers (=0.5 sq. meter for one person) are necessary.
- Parking space for bicycles	In Japan, there are few space for bicycle in front of station. However, since there is tendency that the local governments are apt to formulate "Bicycle Law" and railway operation authority show positive attitudes to follow this law by providing own pace for the parking space of bicycles.

Figure 7.3-4-2

HACHIOHJI Station Plaza



Appendix 7.4-1

Signals Related Work Costs Estimate Table

(Unit: million US$)

Work type	Unit	Quantity	Domestic currency		Foreign currency		Item-separate total
			Equipment etc.	Labor costs	Equipment etc.	Labor costs	
Change to colorlight signals	Station	143		1.27	10.68	1.48	12.93
Power facilities renewal	Station	166		0.45	5.84		6.29
ATS system installation	Station	166		1.04	14.61	0.66	16.31
Installation of level crossing approach warning systems	Site	200		1.09	13.49	0.16	14.04
Type-1 electrical relaying	Station	10		0.70	9.11	1.48	11.49
Total				3.55	53.73	3.78	61.06
			3.55		57.51		

[Phase 1] Up to 2000

Work type	Unit	Quantity	Domestic currency		Foreign currency		Item-separate total
			Equipment etc.	Labor costs	Equipment etc.	Labor costs	
Change to colorlight signals	Station	139		1.25	10.36	1.48	13.09
Power facilities renewal	Station	162		0.44	5.71		6.15
ATS system installation	Station	62		0.40	5.46	0.24	6.10
Installation of level crossing approach warning systems	Site	57		0.18	2.62	0.05	2.85
Sub-Total				2.27	24.15	1.77	28.19
			2.27		25.92		

[Phase 2] Up to 2005

ATS system installation	Site	100		0.62	8.80	0.40	9.82
Installation of level crossing approach warning systems	Site	143		0.91	10.87	0.11	11.89
Sub-Total				1.53	19.67	0.51	21.71
			1.53		20.18		

[Phase 3] Up to 2010

Change to colorlight signals (Signal sites)	Station	4		0.02	0.32		0.34
Renewal of power facilities (Signal sites)	Station	4		0.01	0.13		0.14
ATS system installation (Signal sites)	Station	4		0.02	0.35	0.02	0.39
Type-1 electrical relaying	Station	10		0.70	9.11	1.48	11.29
Sub-Total				0.75	9.91	1.50	12.16
			0.75		11.41		

Appendix 7.4-2

List of Communication Related Investment Costs

(Unit: million US$)

Item	Type	Unit	Quantity	Materials cost domestic currency	Labor cost domestic currency	Materials cost foreign currency	Labor cost foreign currency	Total
Communication line	New	km	1730		3.36	64.02	0.58	67.96
Transmission equipment	New	Set	1	0.50	0.58	15.78	1.13	17.99
Switchboards	Replace-ment	Site	14		0.32	2.08	0.43	2.83
Data transmission equipment	New	Set	1		0.01	10.56	0.61	11.18
Telephone terminals	ment	Set	1		0.36	7.97	0.04	8.37
Total				0.50	4.63	100.41	2.79	108.33
				5.13		103.20		

Phase 1

Item	Type	Unit	Quantity	Materials cost domestic currency	Labor cost domestic currency	Materials cost foreign currency	Labor cost foreign currency	Total
Communication line	New	km	735		1.55	29.65	0.28	31.48
Transmission equipment	New	Set	1	0.22	0.27	7.76	0.55	8.80
Total				0.22	1.82	37.41	0.83	40.28
				2.04		38.24		

Phase 2

Item		Unit	Quantity	Materials cost domestic currency	Labor cost domestic currency	Materials cost foreign currency	Labor cost foreign currency	Total
Communication cable	New	km	995		1.81	34.37	0.3	36.48
Transmission equipment	New	Set	1	0.28	0.31	8.02	0.58	9.19
Data transmission equipment	Replace-ment	set	1		0.01	10.56	0.61	11.18
Total				0.28	2.13	52.95	1.49	56.85
				2.41		54.44		

Phase 3

Item	Type	Unit	Quantity	Materials cost domestic currency	Labor cost domestic currency	Materials cost foreign currency	Labor cost foreign currency	Total
Switchboards	Replace-ment	Site	14		0.32	2.08	0.43	2.83
Telephone terminals	Replace-ment	Set	1		0.36	7.97	0.04	8.37
Total					0.68	10.05	0.47	11.20
				0.68		10.52		

Appendix 7.5-1

Phased Rolling Stock Plan upto 2010 for Hanoi - Ho Chi Minh Line

(Million US$)

	Unit Price		1996 - 2000				2001 - 2005				2006 - 2010				Total			
	F	D	Number	F	D	Total	Number	F	D	Total	Number	F	D	Total	Number	F	D	Total
New high speed train	3.8	1.2	5	19.0	6.0	25.0	22	83.6	26.4	110.0	17	64.6	20.4	85.0	44	167.2	52.8	220.0
D18E (New)	1.5		33	49.5		49.5	12	18.0		18.0	0			0	45	67.5		67.5
D12E (New)	0.98		16	15.7		15.7	0			0	0			0	16	15.7		15.7
PC (New)		0.11	21		2.3	2.3	56		6.2	6.2	68		7.5	7.5	145		16.0	16.0
FC (New)		0.032	661		21.2	21.2	1791		57.3	57.3	2860		91.5	91.5	5312		170.0	170.0
D11H (RHB)	0.44	0.24	10	4.4	2.4	6.8	0			0	0			0	10	4.4	2.4	6.8
D13E, D18E (RHB)	0.66	0.39	0			0	30	19.8	11.7	31.5	0			0	30	19.8	11.7	31.5
D12E (RHB)	0.44	0.246	0			0	0			0	40	17.6	9.8	27.4	40	17.6	9.8	27.4
PC (Remodelling)		0.06	20		1.2	1.2	0			0	0			0	20		1.2	1.2
Total				88.6	33.1	121.7		121.4	101.6	223.0		82.2	129.2	211.4		292.2	263.9	556.1

Appendix 7.5-2

Investments at Gia Lam Workshop and Depots

Costs Estimate Table

Unit: million US$

Item	D/C		F/C		Total
	Material	Labor	Material	Labor	
1. Gia Lam Workshop					
(1) Building remodeling and new buildings, work pieces, civil engineering structures etc.	1.3	2.6	0.3	0.2	4.4
(2) Machinery, equipment, tools, instruments etc.	0.5	2.2	24.0	1.3	28.0
(3) DEL circulatory spare parts	–	–	10.0	–	10.0
(4) Sewage disposal and effluent treatment	0.2	0.5	1.6	0.3	2.6
Sub total	2.0	5.3	35.9	1.8	45.0
2. Dian Workshop and Hai Phong Workshop					
(1) Building remodelling, etc.	0.2	1.0	0.5	0.3	2.0
(2) Machinery, equipment, tools, instruments etc.	0.4	1.0	4.0	0.6	6.0
(3) Effluent treatment	0.1	0.2	0.6	0.1	1.0
Sub total	0.7	2.2	5.1	1.0	9.0
3. DL Maintenance Depots					
(1) Building remodeling etc.	0.1	0.2	0.1	0.1	0.5
(2) Machinery, equipment, tools, instruments etc.	0.2	1.0	8.5	0.8	10.5
(3) Effluent treatment	0.3	0.5	1.0	0.2	2.0
Sub total	0.6	1.7	9.6	1.1	13.0
4. PC/FC Maintenance Depots etc.					
(1) Building remodeling etc.	1.6	2.0	1.0	0.2	4.8
(2) Machinery, equipment, tools, instruments etc	0.1	0.6	5.0	0.5	6.2
(3) Sewage disposal and effluent treatment	0.5	0.9	3.0	0.6	5.0
Sub total	2.2	3.5	9.0	1.3	16.0
Total	5.5	12.7	59.6	5.2	83.0

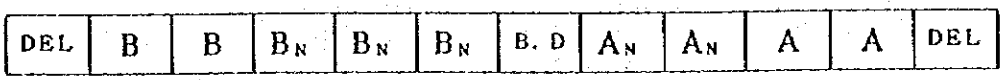
Appendix 7.5-3

NEW HIGH SPEED TRAIN

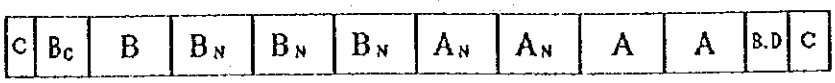
(Comparison between push-pull train and autorail train)

1. Train configuration

(1) Push-pull train (PP)



(2) Autorail (DC)



DEL : Diesel Electric Locomotive

B : Hard Seating

B_N : Hard Sleeper

B. D : Baggage and Dining (In case of autorail, trailer car with generator for cooking)

A_N : Soft Sleeper

A : Soft Seating

C : Driver's Cab

2. Particulars

	PP	DC	REMARKS
Seating Capacity	446	434	A(64), A_N(24), B(72), B_N(42), B_c(60)
Weight (t)	482	450	DEL(66), PPPC(35), DC(45)
Max axle weight (t)	11	11.25	Axle arrangement of DEL of PP: B-2-B
Driving System	Electric	Hydraulic	
Out put power (HP)	1450X2	330X9	
Train length (m)	228	200	DEL (14mX2) PC, DC (20m)
Max speed (km/h)	120	120	
Air conditioning	Electri-cal	Mechanical	PP: Power source installed on DEL DC: Mechanical power source directly connected with engine

3. Comparison on both systems

	PP	DC	REMARKS
1. Manufacturing cost	◎	×	(1)
2. Maintenability	◎	×	(2)
3. Flexibility of train configulation	×	○	
4. Acceleration performance	×	○	
5. Room noise and vibration	◎	×	(3)

(1) Train cost

PP : 2 X 150 X 10^6(¥1) + 10 X 20 X 10^6(¥2) = ¥500 X 10^6

DC : 10 X 105 X 10^6(¥1) = ¥ 1050× 10^6

¥1 : Import

¥2 : Domestic Production

(2) Maintainability

DC : • Maintenance for engine and torque converter is complicated and number of them is very large in case of autorail.

• Equipment installed under floor are covered by dust and it may cause overheat of engine.

(3) Room noise and vibration

These are fatal defect for sleeping car.

4. Recommendation

24-hours high speed train between Hanoi and Ho Chi Minh City is to be push-pull train from view points of manufacturing cost, maintenability, and pasenger room's noise and vibration.

Appendix 7.5-4

Phased Development Plan (Rolling Stock Maintenance)

First Stage (1996-2000)

1. Gia Lam Workshop

The Installation of maintenance facilities for DL and PC of high speed train.

(1) Workshop improvement for DEL maintenance

1) Remodeling and new construction of maintenance shops.

* Remodeling of existing buildings involving partitioning, floor covering and painting.
* Construction of engine performance testing room, new shops and boiler room.

2) Improvement of maintenance facilities.

* Pit, work scaffolding, rails, roads, drainage gutters etc.

3) New installation of maintenance facilities.

* Facilities for cleaning, inspection, repair, painting and testing of engines, electric rotating machines, wheel sets and bogies.

4) Preparation of maintenance equipment, tools and instruments.

(2) Workshop improvement for PC maintenance

1) Partial remodelling of PC maintenance shop.

* Remodelling of existing building involving partitioning, floor covering and painting.

2) New installation of maintenance equipment for rolling stock air conditioning equipment.

3) Improvement of maintenance equipment for carbody and bogie.

* Facilities for cleaning, inspection, repair, painting and testing etc.

4) Improvement of maintenance equipment, tools and instruments.

5) New installation of a disposal facility for sewage from high speed cars (PC).

(3) Preparation of reserved equipment and spare parts for DEL maintenance (1)

Preparation of engines, main generators, traction, motors and other major equipment and their spare parts in order to reduce DEL maintenance cycle time. (To be completed by 2009 over three stages).

2. Hanoi, Vinh, Da Nang, Nha Trang and Saigon (5 sites)

(1) New installation of a disposal facility for sewage from high speed cars (PC).

Second Stage (2001-2005)

1. Gia Lam Workshop

(1) Preparation of reserved equipment and spare parts for DEL maintenance (2).

2. Dian Workshop and Hai Phong Workshop

(1) Installation of a clean room for maintenance of bearings.

(2) Improvement of PC and FC maintenance facilities.

Facilities for cleaning, inspection, repair and painting of carbody, bogie, etc.

(3) Improvement of maintenance equipment, tools and instruments.

3. DL Maintenance Depots (Hanoi, Vinh, Da Nang, Saigon, Yen Bai, Yen Vien)

(1) Improvement of engine maintenance shop and bearing maintenance shop (clean room).

(2) Improvement of DEL maintenance facilities.

* Facilities of cleaning, inspection, repair, painting and comprehensive testing of engine and bogie.

(3) Improvement of maintenance equipment, tools and instruments.

Third Stage (2006-2010)

1. Gia Lam Workshop

   (1) Preparation of reserved equipment and spare parts for DEL maintenance (3).

   (2) New installation of an effluent treatment plant.

2. Dian Workshop and Hai Phong Workshop

   (1) New installation of an effluent treatment plant.

3. DL Maintenance Depots (Hanoi, Vinh, Da Nang, Saigon, Yen Bai, Yen Vien)

   (1) New installation of an effluent treatment plant.

4. PC and FC Maintenance Depots (Hanoi, Vinh, Da Nang, Saigon, Thuan Hai, Song Than, Yen Vien)

   (1) Rebuilding of maintenance shops (Hanoi, Da Nang).

      * Rebuilding will raise roofs so that EOTC (Electric Overhead Travelling Cranes) can be installed.

   (2) New installation of EOTC (Hanoi, Da Nang).

   (3) Improvement of rolling stock maintenance facilities (Hanoi, Vinh, Da Nang, Saigon, Thuan Hai, Song Than, Yen Vien).

      * Cleaning, inspection, repair, painting and testing equipment for bogies etc.

   (4) Improvement of maintenance equipment, tools and instruments (Hanoi, Vinh, Da Nang, Saigon, Thuan Hai, Song Than, Yen Vien).

   (5) New installation of effluent treatment plants (Hanoi, Vinh, Da Nang, Saigon, Thuan Hai, Song Than, Yen Vien).

Appendix 7.9-2

Financial Analysis for the Hanoi-Ho Chi Minh Railway Improvement Project
(Master Plan up to 2010 Modified)

Estimate of Accounts	1,994	0 1,995	1 1,996	2 1,997	3 1,998	4 1,999	5 2,000	6 2,001	7 2,002	8 2,003	9 2,004	10 2,005	11 2,006	12 2,007	13 2,008	14 2,009	15 2,010
Revenue	518,794	572,157	631,076	696,071	767,786	846,973	934,365	1,004,034	1,079,245	1,160,469	1,248,197	1,342,999	1,429,834	1,523,614	1,624,942	1,734,494	1,853,026
Passenger	259,219	283,766	310,644	340,054	372,249	407,503	446,090	488,338	534,573	585,197	640,610	701,267	767,679	840,373	919,951	1,007,068	1,102,433
Freight	259,575	288,391	320,432	356,017	395,537	439,470	488,275	515,696	544,672	575,272	607,587	641,732	662,155	683,241	704,991	727,426	750,593
Expense	352,042	417,087	458,165	502,143	549,359	600,089	654,749	705,672	759,631	816,779	877,453	941,846	1,001,366	1,064,806	1,132,453	1,204,639	1,281,760
Working Cost																	
Personnel	142,253	140,140	138,243	136,352	134,495	132,595	130,720	125,941	121,401	117,010	112,854	108,834	104,037	99,539	95,305	91,313	87,560
Non-Personnel	209,789	231,174	254,765	280,766	309,432	341,058	375,932	404,786	435,994	469,761	506,299	545,854	583,081	623,374	667,005	714,276	765,524
Sub Total	352,042	371,314	393,009	417,118	443,927	473,653	506,652	530,727	557,395	586,771	619,153	654,688	687,118	722,913	762,310	805,589	853,084
Depreciation																	
Carriage	0	0	10,710	21,419	32,129	42,838	53,548	73,172	92,796	112,420	132,044	151,668	170,271	188,874	207,478	226,081	244,684
Workshop	0	0	3,960	7,920	11,880	15,840	19,800	21,450	23,100	24,750	26,400	28,050	29,590	31,130	32,670	34,210	35,750
Sub Total	0	0	14,670	29,339	44,009	58,678	73,348	94,622	115,896	137,170	158,444	179,718	199,861	220,004	240,148	260,291	280,434
Contribution (Tax)	0	45,773	50,486	55,686	61,423	67,758	74,749	80,323	86,240	92,838	99,856	107,440	114,387	121,889	129,995	138,760	148,242
Profit	166,752	155,070	172,911	193,928	218,427	246,884	279,616	298,362	319,614	343,690	370,744	401,153	428,468	458,808	492,489	525,855	571,266

(Unit : Million Dong)

Cash Flow Projection

	1,994	1,995	1,996	1,997	1,998	1,999	2,000	2,001	2,002	2,003	2,004	2,005	2,006	2,007	2,008	2,009	2,010
Cash In																	
Profit		-11,682	6,159	27,176	51,675	80,132	112,864	131,610	152,862	176,938	203,992	234,401	261,716	292,056	325,737	363,103	404,514
Depreciation	0	0	14,670	29,339	44,009	58,678	73,348	94,622	115,896	137,170	158,444	179,718	199,861	220,004	240,148	260,291	280,434
Total	0	-11,682	20,829	56,515	95,684	138,810	186,212	226,232	268,758	314,108	362,436	414,119	461,577	512,060	565,885	623,393	684,948
Cash Out (Investment)																	
Carriage	0	0	267,740	267,740	267,740	267,740	267,740	490,600	490,600	490,600	490,600	490,600	465,080	465,080	465,080	465,080	465,080
Workshop			79,200	79,200	79,200	79,200	79,200	33,000	33,000	33,000	33,000	33,000	30,800	30,800	30,800	30,800	30,800
Total	0	0	346,940	346,940	346,940	346,940	346,940	523,600	523,600	523,600	523,600	523,600	495,880	495,880	495,880	495,880	495,880
Surplus or Deficit	0	-11,682	-326,111	-290,425	-251,256	-208,130	-160,728	-297,368	-254,842	-209,492	-161,164	-109,481	-34,303	16,180	70,005	127,513	189,068
Cumulative Cash Flow	0	-11,682	-337,793	-628,217	-879,473	-1,087,603	-1,248,331	-1,545,699	-1,800,541	-2,010,032	-2,171,196	-2,280,677	-2,314,979	-2,298,799	-2,228,794	-2,101,281	-1,912,213

(Unit : Million Dong)

	FIRR	Residual Value (Carriage)	Residual Value (Workshop)
15 years later	8.03%	-4,356,968	-368,500
25 years later	8.92%	-1,910,128	-407,000
35 years later	9.43%	-3,254,988	-368,500

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
2,011	2,012	2,013	2,014	2,015	2,016	2,017	2,018	2,019	2,020	2,021	2,022	2,023	2,024	2,025	2,026	2,027	2,028	2,029	2,030
1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026	1,853,026
1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433	1,102,433
750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593	750,593
1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760	1,281,760
87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560	87,560
765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524	765,524
853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084	853,084
244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684	244,684
35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750	35,750
280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434
148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242	148,242
571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266	571,266

2,011	2,012	2,013	2,014	2,015	2,016	2,017	2,018	2,019	2,020	2,021	2,022	2,023	2,024	2,025	2,026	2,027	2,028	2,029	2,030
404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514	404,514
280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434	280,434
684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948	684,948
0	0	0	0	0	0	0	0	0	0	267,740	267,740	267,740	267,740	267,740	490,600	490,600	490,600	490,600	490,600
0	0	0	0	0	79,200	79,200	79,200	79,200	79,200	33,000	33,000	33,000	33,000	33,000	30,800	30,800	30,800	30,800	30,800
0	0	0	0	0	79,200	79,200	79,200	79,200	79,200	300,740	300,740	300,740	300,740	300,740	521,400	521,400	521,400	521,400	521,400
684,948	684,948	684,948	684,948	684,948	605,748	605,748	605,748	605,748	605,748	384,208	384,208	384,208	384,208	384,208	163,548	163,548	163,548	163,548	163,548
-1,227,265	-542,317	142,631	827,579	1,512,527	2,118,274	2,724,022	3,329,770	3,935,518	4,541,266	4,925,474	5,309,682	5,693,890	6,078,098	6,462,306	6,625,854	6,789,402	6,952,950	7,116,497	7,280,045

A - 7 - 39

Appendix Table 8.3-1

Passenger OD in 2000 ; Selected Master Plan (Alternative I)

(UNIT:Persons/day)
(ref) Traffics through Ha Noi from Northern Parts

		14 (ref)	17	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	37	41	38	Generated Total
14	Ha Noi /Giap Bat (ref)	0	194 (82)	474 (129)	103 (48)	224 (56)	337 (29)	92 (11)	34 (13)	13 (2)	76 (3)	208 (12)	18 (1)	63 (1)	16 (1)	89 (1)	16 (1)	16 (1)	17 (1)	27 (8)	613 (5)	2,631
17	Phu Xuyen	164 (65)	0	137	12	11	9	6	11	2	8	5	2	3	5	2	5	2	2	34	6	425
19	Nam Dinh	476 (130)	140	0	81	201	86	28	9	1	2	29	1	4	1	6	3	1	3	7	39	1,116
20	Ninh Binh	100 (46)	10	80	0	24	10	5	3	0	2	8	0	1	1	2	1	1	1	7	11	268
21	Thanh Hoa	209 (53)	11	183	23	0	206	64	32	1	4	11	1	8	2	14	3	3	2	7	107	891
22	Vinh	317 (26)	8	71	9	191	0	6	493	17	16	57	2	26	3	20	2	2	1	10	132	1,384
23	Huong Pho	85 (9)	5	25	5	55	6	0	143	5	6	25	1	11	1	11	3	2	1	7	59	456
24	Dong Hoi	35 (11)	9	8	3	27	436	139	0	196	355	231	4	32	13	10	3	2	1	20	136	1,658
25	Dong Ha	15 (1)	1	1	0	1	15	5	180	0	15	67	1	5	1	1	1	1	1	4	32	347
26	Hue	77 (3)	6	2	2	4	13	6	330	23	0	505	13	24	6	19	3	1	11	17	167	1,229
27	Da Nang	201 (9)	4	31	8	11	55	25	223	67	527	0	124	102	8	64	11	9	81	175	561	2,287
28	Quang Ngai	16 (1)	2	1	1	1	1	1	3	1	14	117	0	90	6	10	1	1	22	8	53	349
29	Dieu Tri	64 (1)	2	4	1	7	23	11	30	3	24	99	94	0	14	48	9	9	16	13	83	554
30	Tuy Hoa	18 (1)	4	1	1	2	3	1	13	1	11	8	6	15	0	129	6	3	2	24	33	280
31	Nha Trang	84 (1)	1	6	2	13	19	11	9	1	23	64	10	48	124	0	57	105	40	11	244	873
32	Thap Cham	17 (2)	4	3	1	3	2	3	3	1	3	11	1	9	6	56	0	4	28	41	151	349
33	Muong Man	17 (1)	2	2	1	3	2	2	2	1	2	9	1	9	3	104	4	0	40	27	167	397
37	Da Lat (Branch)	17 (1)	2	3	1	2	1	1	1	1	11	80	22	16	2	40	28	40	0	20	384	673
41	Bien Hoa	28 (9)	28	8	7	7	10	7	20	3	18	175	7	12	26	11	39	27	20	0	223	679
38	Sai Gon /Song Than	588 (5)	5	42	11	131	106	58	119	32	161	545	54	82	31	250	152	164	376	221	0	3,130
	Attracted Total	2,528	439	1,082	273	919	1,342	470	1,658	368	1,278	2,252	362	560	271	884	349	393	666	679	3,201	19,976

Appendix 10.2-1

Advancement of the Electrification Plan

1. Regarding Electrification

The effect of railway transportation can be greatly increased by changing over from SL (steam locomotive) and DEL (diesel electric locomotive) services to electric services using EL (electric car), following an increase in transportation volume. The effects of electrification can be roughly divided into the following.

(1) Improvement of railway business.

An increase in transportation capacity through savings on power and personnel costs, higher speeds and better traction coefficient.

(2) The efficient utilization of energy and prevention of exhaust gas pollution.

(3) The development of industries and local communities.

The improvement of passenger services through higher speeds and more frequent services.

Such railway electrification is not necessarily however, to be carried out on all line sections. The failure or success of electrification depends on the state of transportation and the line conditions in each section.

In order to carry out electrification, a massive amount of investment is required to reinforce tracks, provide rolling stock and install power generation and transmission facilities, substations and overhead contact system.

Generally speaking, electrification is planned and carried out on line sections, which either provide around 80 or more train services (up and down) a day, or are subject to special conditions (sections with steep gradients requiring a stronger traction coefficient or sections with many tunnels). Judging from future transportation demand, those sections which can only expect to provide from 10 to 30 services a day (up and down) require preparation of the transportation infrastructure more than anything else, and transit by DEL and DC (diesel car) is considered to be the most sensible method. Electrification should be carried out at that point in the future, when DEL and DC have become superannuated and when demand for transportation has increased sufficiently. It is, however, important to start making research into the feasibility, planning and advancement of electrification for future purposes.

2. Comparison of Electric and Diesel Services

(1) Rolling stock performance

It is said that EL have greater output, or tractive force in low speed sections, and are also cheaper compared to DEL. Compared to DC, EC are generally better in terms of acceleration and deceleration performance.

(2) Rolling stock maintenance

Except for a few expendable items such as pantograph, almost all of the EC power unit requires little maintenance, which means that in terms of maintenance costs, it is cheaper than both DL and DC.

(3) Power costs

The cost of power required for a set transportation volume (ton/km) varies depending on the conditions of each country, however in Japan electric services work out cheaper.

(4) Electric service above ground facilities

Electrification requires investment into substation and overhead contact facilities, the various improvement works entailed in the construction of these facilities, and the prevention of inductive interference to signals and communication facilities. Such investment costs and maintenance costs rise in proportion with the transportation volume, however most are fixed costs irrespective of the transportation volume. Consequently, it is necessary to assess the economic divergence point for electric and diesel services, and examine whether or not the transportation volume is in excess of this point.

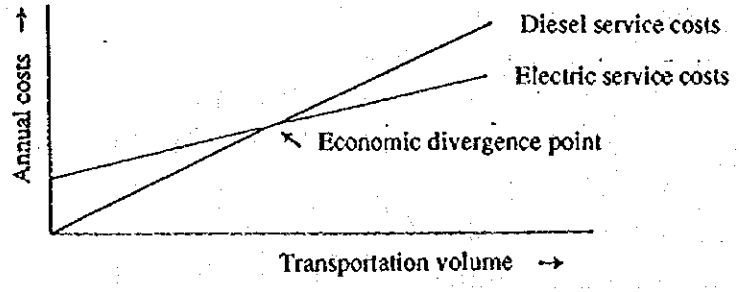


Figure 1 Electric Service and Diesel Service Economic Divergence Point

The additional investment profit ratio is calculated as a simple way to make this judgement.

$$\text{Additional investment profit ratio} = \frac{\text{Cost reduction + increased revenue from electric services}}{\text{Electric system investment cost - diesel system investment cost}}$$

Note: cost reduction = diesel service annual costs - electric service annual costs.

If the additional investment profit ratio is greater than profit ratio thought of as necessary in terms of the investment funds, then electrification is advantageous. Incidentally,the electric and diesel service plans are made as similar as possible, and if the inducement effect of electrification cannot be grasped, the revenue increase item is not considered.

3. Advancement of the Electrification Plan

As can be seen from the above, ample examination of the following factors needs to be made when determining the feasibility of the electrification overall plan and implementation plans by section, and also when implementing the plans.

(1) Transportation forms and volumes in the section and future transportation demand.

(2) Power mode and form of services on line sections directly linked to electrified sections.

(3) Energy resources and power supply and demand.

(4) Industrial capacity and future development plans.

(5) The state of the transportation infrastructure and various modernization plans.

Regarding these points, based upon social trends, consideration should be given to plans which result from changes in the roles of sections due to business policies and the construction of new lines, the operation of rolling stock and supply and demand of personnel on surrounding lines, and at the same time specific plans for modernization policies. Electrification should be used as a chance to further promote modernization.

The specific procedure for electrification is as follows.

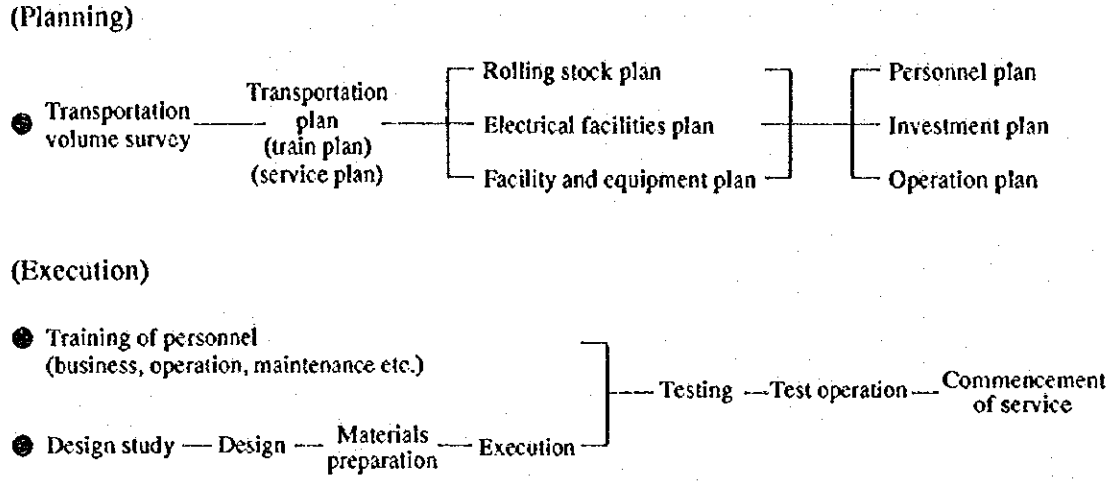


Figure 2 Electrification plan procedure

The fundamental items which require particular examination are summarized below.

4. Electrification Mode

(1) Mode

Selection of the electrification mode is the most important matter in planning railway electrification. The modes currently adopted throughout the world are DC (600-3000 V) and AC (6000 V-25 kv) and these can be further divided into single phase and triple phase. Each mode has its merits and demerits and each country has its own electricity development background, which means that there is thus no single absolutely best mode.

However, 1500 V and 3000 V have become the mainstream for DC electrification, and as for AC, a commercial frequency of 25 kv has become the international standard as with the UIC etc.

(2) Consideration Points in Mode Selection

The following lists the main points which should be given consideration when selecting mode.

1) Transportation conditions (types of passenger and freight trains, those transportation volumes and ratios).

2) Standard voltage and power source.

3) Application of rolling stock and relationship with other electrified sections.

4) Insulation intervals and repair of obstacles.

5) Communication networks and the level of and countermeasures against inductive interference.

6) Accident currents and protection.

7) Line section special conditions.

8) Future plans (power development, urbanization, building of industrial estates and the possibility of highly frequent services).

(3) Comparison Between AC and DC Electrification Modes

In the case of Japan, it is generally thought that AC electrification possesses the following advantages and drawbacks compared to DC electrification.

a. Advantages

1) Above ground facilities such as substations are simple.

2) Transmission loss is small.

3) AC cars perform better than DC cars in terms of tractive force and speed control etc.

b. Drawbacks

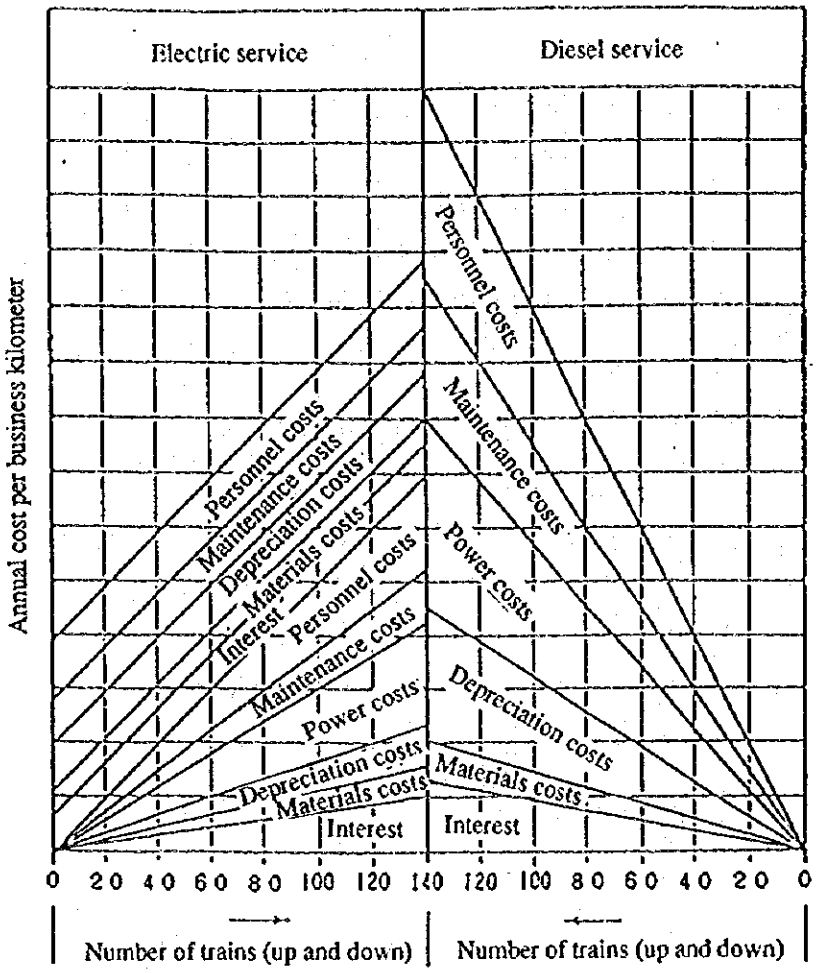
1) Work costs are high due to communication line inductive interference countermeasures and repair work on obstacles etc.

2) AC cars are complex in construction and expensive.

3) High voltage means that maintenance work is restricted.

Reference 1: Electric and diesel service annual cost comparison.
Reference 2: Outline of railway electrification throughout the world.

Reference 1: Electric and diesel service annual cost comparison.



Reference 2: Outline of railway electrification throughout the world

Country	Non-electrified km	Electrified km	Total km	Electrification ratio %	Direct Current (DC)			Alternative Current (AC)				Driving direction etc.
					km	v	Electrification mode	km	kv	Hz	Electrification mode	
Japan	12,479	8,840	21,319	41	5,284	1,500	Overhead line	2,174 1,371 1,177 808	20 20 25 25	50 60 60 50	Overhead line " " "	Left side
U.K.	13,214	3,750	16,964	21	27 1,787	1,500 750	Overhead line 3rd track	1,936	25	50	Overhead line	Left side
W. Germany	16,841	11,204	28,045	40	7 20 102	3,000 1,500 1,200	Overhead line " 3rd track	1 11,074	25 15	50 16 2/3	Overhead line "	Right side
E. Germany	12,131	2,096	14,227	15	5 3 327	700 500 800	Overhead line " 3rd track	27 1,734	25 1.5	50 16 2/3	Overhead line "	Right side
France	23,622	11,088	34,710	32	5,658 63 34 18	1,500 850 800 650	Overhead line " " 3rd track	5,314 1	25 15	50 16 2/3	Overhead line "	Left side
Italy	7,664	8,811	16,475	53	8,811	1,500	Overhead line					Left side
Poland	16,501	7,828	24,329	32	7,793 35	3,000 650	Overhead line "					Right side
Sweden	4,619	7,088	11,707	61				7,088	15	16 2/3	Overhead line	Left side
Spain	7,302	6,162	13,464	46	7,793 35	3,000 650	Overhead line "					Left & Right side
China	49,270	2,334	51,604	5				2,334	25	50	Overhead line	Right side
S. Korea	2,693	428	3,121	14				428	25	60	Overhead line	Left side

Note 1: from 1983 Railways of the World (JNR, 1985.8).
Note 2: Shinkansen (25 kv, 50, 60 Hz) is not included in Japan figures.

Appendix 10.2-2

Calculation of Line Capacity

In the event where the transportation volume increases and judgement is made on whether or not it is necessary to increase tracks, the following calculation method will be used as the initial standard.

Double tracks allow line capacity to increase by two to three times, however first of all, it is necessary to decide whether to change all lines or just some lines to double track, based upon careful consideration of future transportation demand levels. In either case, commencement of work on the busy and smaller capacity lines takes priority.

In the case of adopting double tracks on all line sections, it is best to link all double track sections because this produces immediate beneficial results in that it enables easier driving for drivers and prevents stoppages due to minor timetable confusion. In the case of adopting double tracks on only parts of sections, it is better to double track three or four consecutive sections in the area where up-bound and down- bound trains intersect, upon giving ample consideration to the introduction of high speed trains and the form that future timetables will take.

By using the following line capacity simple equation, it is possible to calculate the degree of line capacity blockage.

(1) Single-track sections

$$N = \frac{1,440}{t + c} \times f \quad \text{..... (2.8)}$$

N : line capacity (trains)
t : mean service time of one train between stations (minutes/trains)
c : block handling time (minutes)
Automatic, interlocked, tokenless block sections 1.5 mins
Other sections 2.5 mins
f : Line utilization ratio
0.6 as a rule

(2) Double track sections

$$N = \frac{1{,}440}{hv'+(r+u+1)v} \times f \quad \text{..... (2.9)}$$

N : single-way line capacity. Needs to be calculated separately for up-bound and down-bound.

h : time interval between consecutive high speed trains. 4-6 minutes is standard.

r : minimum time interval required between slow train arriving at station first and fast train arriving after it. 3-4 minutes is standard.

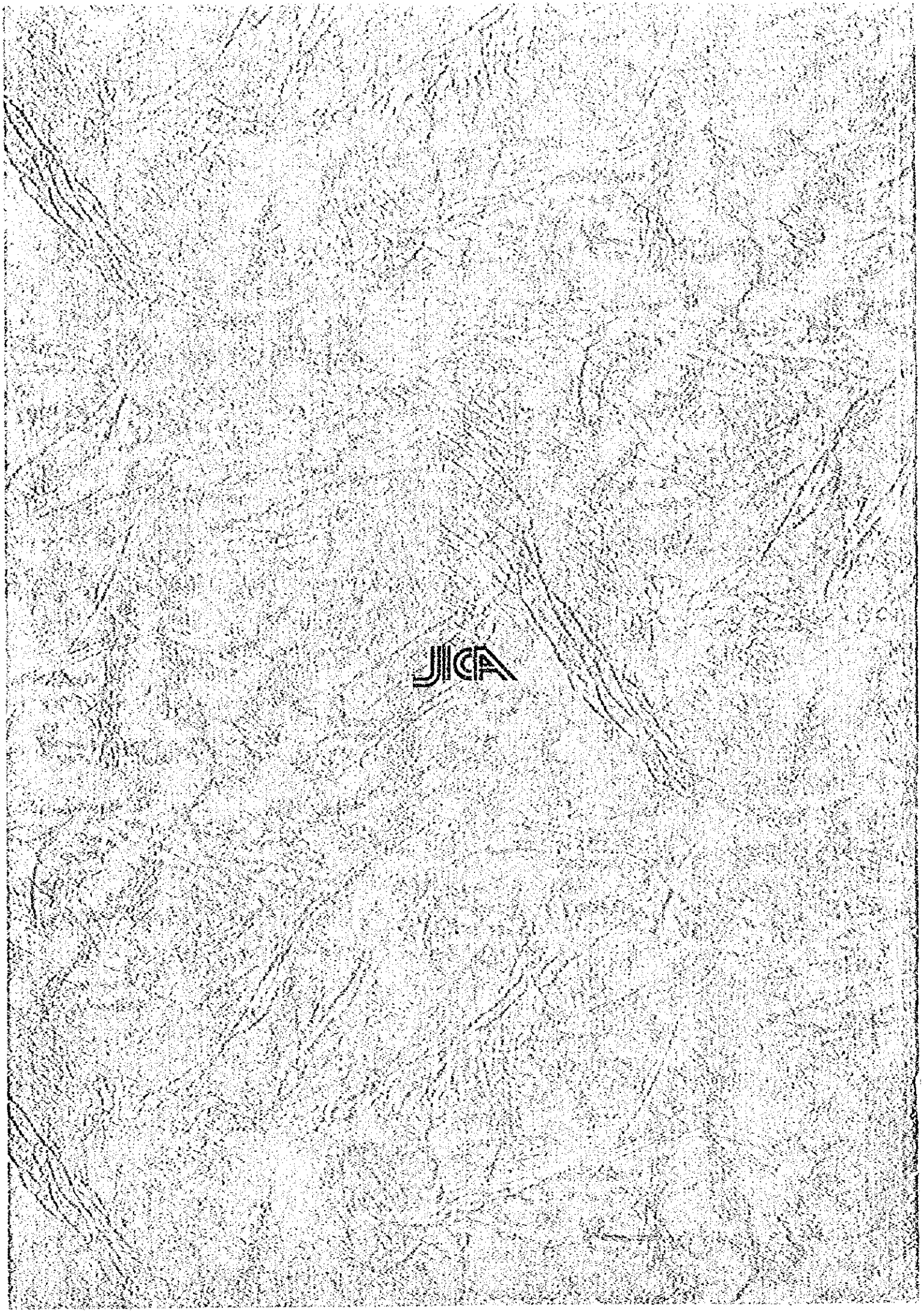
u : minimum time interval required between fast train arriving at station first and slow train arriving after it. 2.5 minutes is usual.

v : fast train ratio = $\frac{\text{Number of fast trains (set)}}{\text{Number of single-way trains (set)}}$

v' : slow train ratio = $\frac{\text{Number of slow trains (set)}}{\text{Number of single-way trains (set)}}$

Slow trains here refers to the number of trains in front of still freight trains. Fast trains here refers to all trains other slow and still freight trains.

f : Line utilization ratio is determined according to character of section, however 0.6-0.75 is usual.


JICA