1.3.3 Facilities and Rolling Stock

(1) Track, structure and station

1) Standards for the existing permanent way

Standards for the existing permanent way are as follows.

Gauge	: 1,000mm
Minimum curve radius	: 400m
Maximum gradient	: 10 ‰
Distance between track centers	: 4m outside of station yard
	: 5m between main lines and between main line and side track inside station yard
Rail	: 70-80 lbs/yd
Sleeper spacing	: 60cm for PC sleeper
	: 65cm for timber sleeper
Ballast depth	: 25cm for PC sleeper
	: 20cm for timber sleeper
Turnout	: 1:12
Overhead clearance	: 5.1m above rail level
Construction gauge	: Fig. 1.3.4

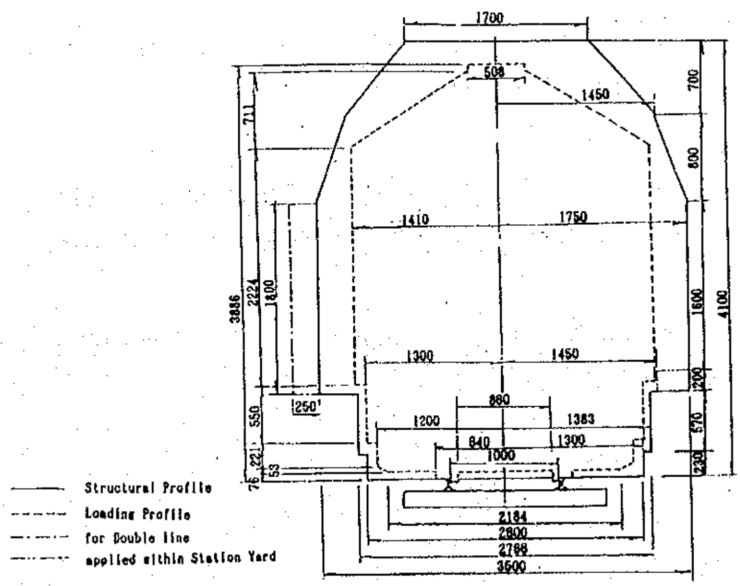


Fig. 1.3.4 Construction Gauge and Loading Profile

2) Track

At present the SRT possesses the total route length of 3,956 km. Ninety-eight percent (98%) of the route (3,866 km) is single track and 2% (90 km), from Hua Lamphong to Ban Phachi Junction in the Northern Line, is double track.

Most of the rails are either 70 lbs/yd or 80 lbs/yd rails. Wooden sleepers are used for approx. 80% of the main line, and PC sleepers are used for the sections recently constructed including the section between Chachoengsao and Sattahip. The rails covering 80% of the main line, including those in the section with wooden sleepers, are welded into longer rails. In the sections where standard length rails are used, unevenness at rail joints is noticed. Large sleepers for a rail joint, which are used in Japan, are not found. In some places layout improvement of sleepers should be contrived.

The ballast thickness is specified as 25 cm for the sections with PC sleepers, and 20 cm for the sections with wooden sleepers. Mud-pumping spots caused by a high ground water level are often found. In general, ballast is sufficiently supplied. A lot of wheel burns are found on rails within station yards, therefore, adequate measures including the improvement of train driving technique should be taken.

3) Stations

(a) Classification of stations by their locations

Few stations are located in the center of cities and most stations are located on the outskirts of cities or several km away from the center.

There are 322 stations (including 134 stopping places) in the 200km radius area and the average distance between stations (including stopping places) is 4.7km.

There are also 86 stations (including 44 stopping places) in the 50km radius area and the average distance between stations is 2.3km.

(b) Number of passengers getting on

There are 23 stations with more than 1,000 passengers getting on a day, and most of them, 19 stations, are located in the 50km radius area.

Table 1.3.8 Classification of Stations by Number of Passenger Getting on

Number of passengers a day / Area	Above 10,000	5,000 to 10,000	3,000 to 5,000	1,000 to 3,000	500 to 1,000	100 to 500	Under 100	Total
In 200km radius	1	2	5	15	20	56	81	180
In 50km radius	1	2	5	9	8	12	6	43
Remarks	Bangkok	Don Muang Wong Wien Yai	Samsen Bang Khen Lak Si Ayutthaya Maha Chai					

Notice: Except beyond Lam Na Rai Stn.

(c) Facilities and equipment

(Refuge tracks) Most stations are equipped with refuge tracks (at an installation rate of 95%). Simple turnouts are installed on main lines by regarding the main lines as the straight side. Standard effective length of refuge tracks is 500m and the length differs slightly at each station.

(Station buildings) Station buildings have the function of selling tickets and no function of collecting tickets since there are no wickets. People are free to enter and leave stations. Waiting spaces are also provided in front of their railway information windows.

(Platforms) Low platforms (requiring 2-step stairs of coaches) of a height of 20cm from the rail level are used and their standard length is 200m (but it differs at each station).

(Passenger passages) Passages for passengers crossing tracks at most stations to platforms from station buildings are installed at-grade directly on the tracks

4) Station plazas and feeders

In general, station plazas of the SRT do not carry out their proper function as places for transference to/from buses and cars. Many of them do not have sufficient space. Even where enough space is provided, connection to buses on regular routes is hardly ensured. At present, no feeders of mass rapid transit systems such as subways and new transit systems are prepared. Therefore, in order to use the SRT, it is necessary to rely on feeders of automobiles such as private cars, taxis and busses or to go on foot. However, the buses of the existing regular routes and stops seem to be arranged without any specific consideration to SRT stations, so it is not convenient for railway passengers to use them.

5) Major projects of the SRT

Ongoing major development projects of the SRT are as follows.

(a) Track adding project

A track adding project is being carried out during the fiscal year 1994 through 1999.

Khlong Rangsit - Lop Buri	104km
Hua Mak - Chachoengsao	45km
Bang sue - Nakhon Pathom	41km
Ban Phachi - Map Kabao	44km

(b) Track rehabilitation

The first phase track rehabilitation, 141km on the Northern Line from Lop Buri to Chumsaeng and 148km on the Southern Line from Hua Hin to Ban Krut, started in 1992 and is expected to be completed in 1998. A total of 791km of track on the Northern Line and Southern Line will be renewed by the year 2000.

Replacement of the existing 70 lbs/yd, rails with 100 lbs/yd rails
Replacement of the existing sleepers with monoblock PC sleepers
Cleaning/replacement of the existing ballast and increase of ballast depth to 25 cm
Necessary improvement of roadbed

(c) New lines

Construction of new railway lines under the Eastern Seaboard development program started with land acquisition in 1978.

The Chachoengsao - Sattahip line (134km) was opened to traffic in 1985. The Si Racha - Laem Chabang line (9.3km) completed construction on civil works and 80% of the installation of signalling and telecommunications in 1992. The line opened to traffic in October, 1992 and completed in 1993. The Sattahip - Map Ta Phut line (24.1km) started construction on civil works in 1992. It was completed in mid 1995.

The Khlong Sip Kao - Kaeng Khoi line (82.6km) started construction on civil works in April, 1993 and was completed in mid 1995. Improvement of the railway of Chachoengsao - Khlong Sip Kao (24km) started in 1993 and will be completed by 1996. Earthwork at the Inland Container Depot at Lat Krabang (640 rai) started in June, 1993, and all works are expected to be completed in 1995.

(d) Hopewell Project

Hopewell project is planned as follows;

Route section	Distance (km)	Tentative completion time
Yommarat - Don Muang	18.8	1996
Yommarat - Hua Mak	13	1996
Don Muang - Khlong Rangsit	7	1997
Hua Lamphong - Yommarat	2.2	1997
Makkasan - Maenam	3.3	1997
Hua Lamphong - Wong Wien Yai	3.2	1999 (New line)
Yommarat - Thon Buri	3.5	1999 (New line)
Wong Wien Yai - Ponimit	3	2000
Thon Buri - Taling Chan	6.1	2000

The location of the Track adding project and the new line projects are shown in Fig. 1.3.5.

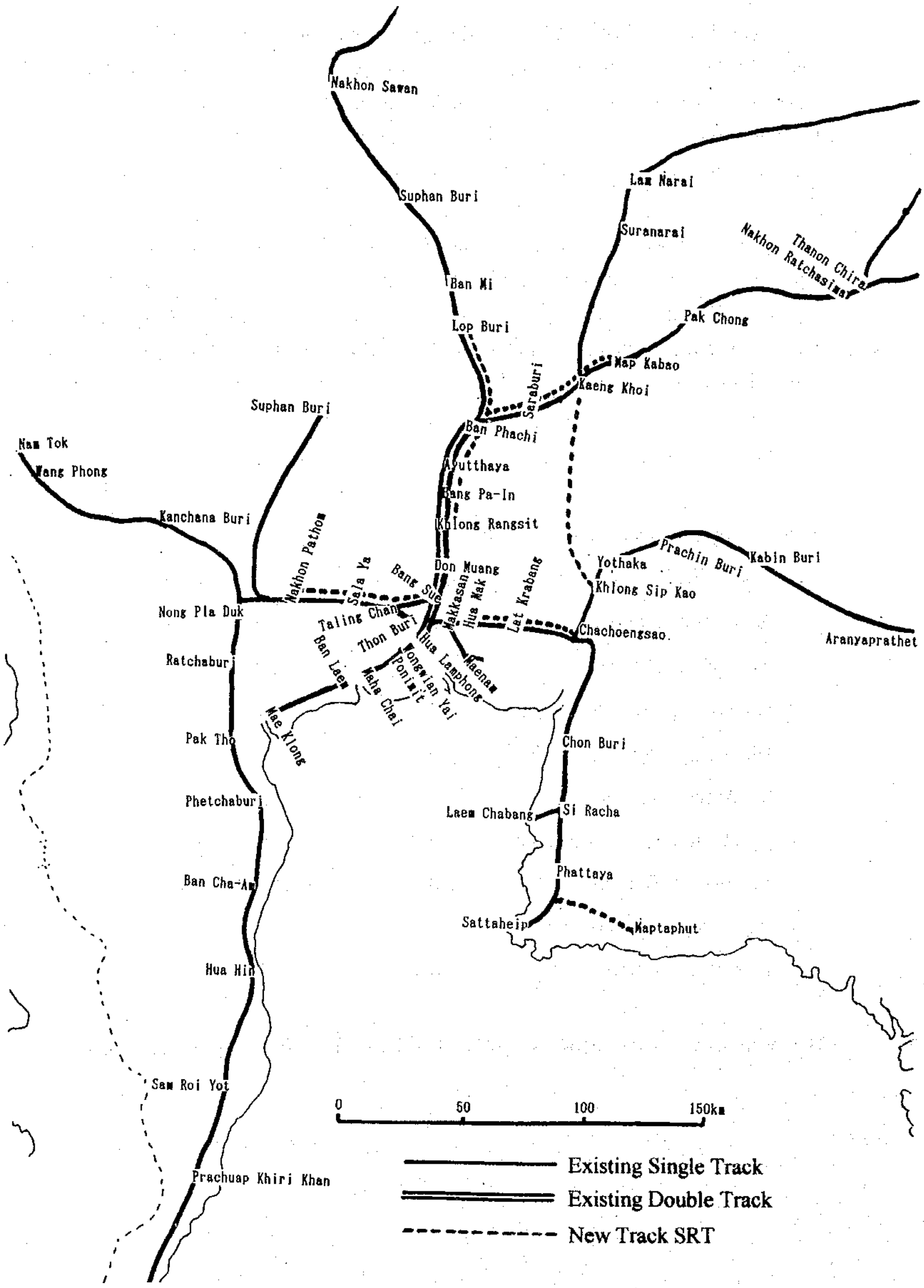


Fig. 1.3.5 Track Adding and New Line Projects of SRT

(2) Signalling and telecommunications

1) Present situation of signalling and telecommunication equipment

The present situation of the equipment within the 200km radius area is as follows.

(a) Despatching system and blocking system

All the railway lines of the SRT are divided into 14 regions and the operation of SRT trains is controlled according to the corresponding despatcher. A despatcher collects information from each station by despatcher telephone and gives a command to each station, preparing an actual train schedule. Fig. 1.3.6 shows location of the despatcher centers and jurisdictions.

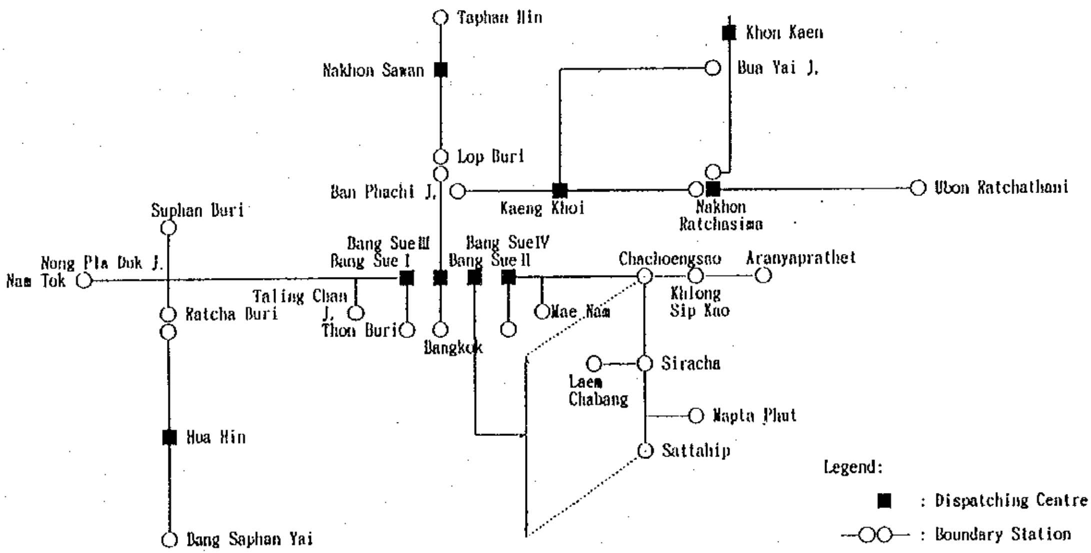


Fig. 1.3.6 Train Despatching System

There are various types of blocking systems in the SRT; an automatic block in a part of the Northern Line where the CTC construction work is under way, an electric or mechanical type tokenless, tablet blocking and telephone blocking. Fig. 1.3.7 shows a blocking system of each section.

(b) Signalling facilities

The signalling facilities of the SRT have been modernized in the trunk lines and new and old facilities are mixed. The outline is as follows.

a) Block device

The block device is composed of an automatic block device which is just introduced, an electric type tokenless which is developed along with a color light signal and a relay system, a mechanical type tokenless, a tablet block device, etc. The old ones have become considerably decrepit.

b) Interlocking device

A mechanical interlocking device is mainly used. However, with the construction work for automatic block signals and color light signals, it is being replaced with an electric type relay interlocking device in the trunk line. There are still stations with a non-interlocking device in sections with little traffic.

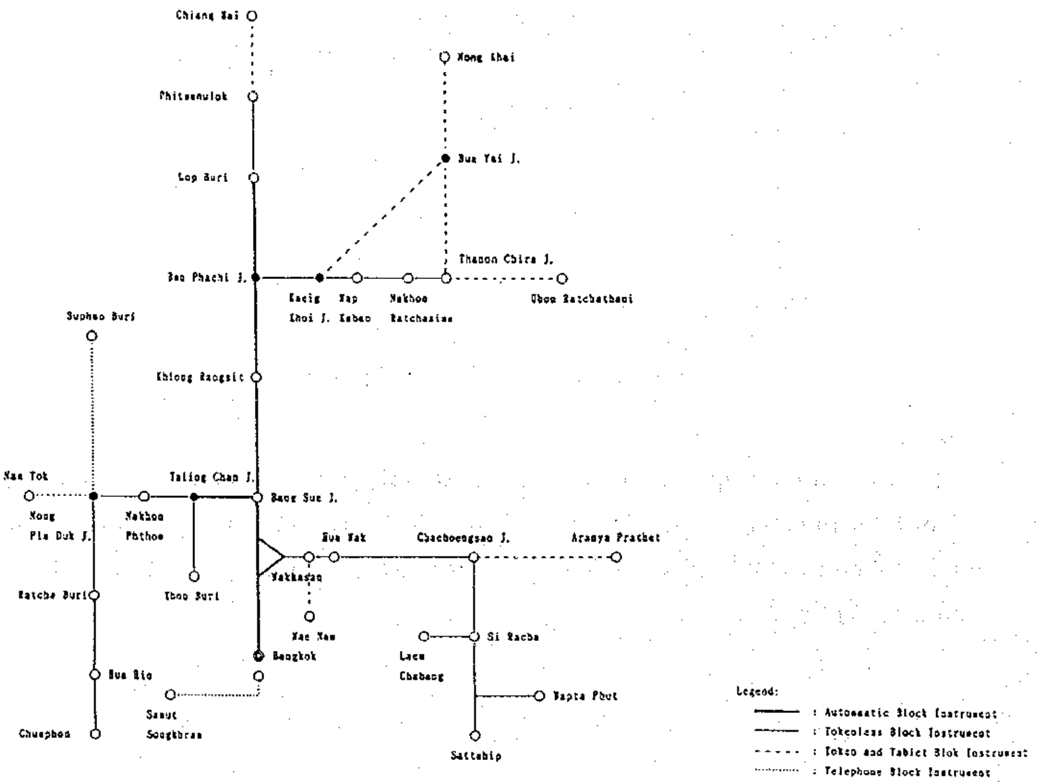


Fig. 1.3.7 Blocking System of Each Section

In the relay interlocking devices with a high reliability, among others, multi-color light signals, trailable electric switch machines and DC track circuits are used. The mechanical type interlocking devices are divided into two types; signal levers are concentrated but the electric switch machines are operated locally, and both signal levers and switch machines are concentrated and interlocking between signals and switch machines is carried out mechanically by using a lock device with "dog".

c) Signal

Many semaphore signals used to be used, but, with the promotion of construction work of automatic block signals, tokenless and color light signals, they have been replaced with electric signals. Fig. 1.3.8 shows the present situation of the signals. There are some cases where electric multi-color light signals are adopted while mechanical type interlocking devices are used.

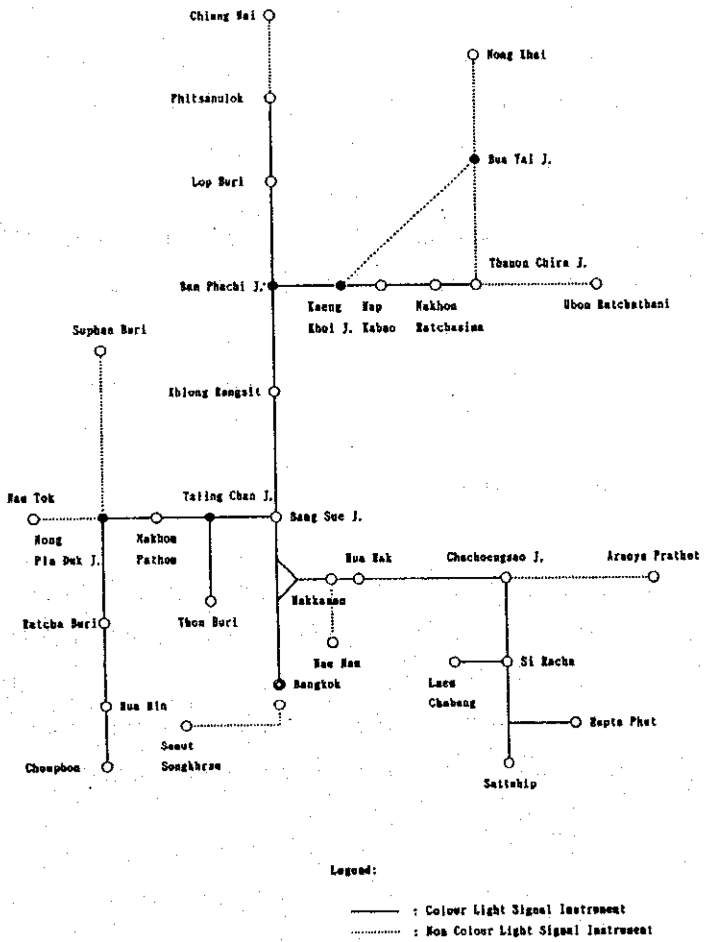


Fig. 1.3.8 The Present Situation of Signals

d) Turnout switch device

With the modernization of signalling apparatuses, mechanical switch machines have been replaced with electric switch machines. The mechanical switch machines are divided into two types; one that is operated exclusively on the site and another that is operated in the center interlocked with the mechanical interlocking machine. The latter is composed of two types; one that is controlled with a pipe and another that is controlled with a steel wire.

e) At-grade crossing protection

At present, in many cases at-grade crossing operators open and close a barrier for level crossing protection, and there are not so many at-grade crossing protections which automatically detect the approach of a train and give an alarm. Usually, after being informed of the departure of a train by the stationmaster by phone, an crossing-keeper closes the crossing at the right timing so that the road traffic interruption time varies. Since train speed is different depending on types of trains and braking distance also differs greatly depending on types of trains, mechanization is not easy. A signal for trains is provided before the level crossing and go sign is not given to a train until the level crossing barrier is closed. Therefore, high-speed trains and trains requiring a long braking distance must reduce their speed in advance, which is a major obstruction to train service. The number of accidents at at-grade crossings is far greater than that of other train accidents.

A large number of at-grade crossings without protection can be found in the whole country.

(a) Telecommunication equipment

In the SRT, modernization of telecommunication equipment has been delayed compared with signalling facilities. Only in a part of the Northern Line where CTC is planned, replacement with optical fiber has been performed. A project in which telecommunication posts along the railway lines are put out to lease to an outside telecommunication company for optical cable laying and in return the SRT uses a part of the telecommunication channels free of charge is being promoted (Comlink project).

a) Telecommunication line network

As for the present situation of the telecommunication line network of the SRT, a open wire carrier system is used for a long distance circuit. When the Comlink project is completed, the SRT plans to use optical circuits of Comlink.

On the other hand, an aerial steel and copper bare wire system is adopted for a short distance and branch line system, which makes it very difficult to constitute a network of good quality.

b) Despatcher telephone

As for the operation despatcher telephone line, in the Chachoengsao - Sattahip Line a radio communication system is applied, but in all other sections bare wires are used. Advanced electronic equipment of a frequency selective method is installed so that speech quality is good with little noise and the communication is clear. The equipment is designed so that it works even if cabling is executed. A command message is transmitted from the Bang Sue despatcher center to some relay stations by radio on the Chachoengsao - Sattahip Line, which broadcasts to each station.

c) Radio equipment

In addition to the despatching facilities described in "b)" above, despatcher centers are connected with each other by radiotelephone, 6 channels from 3 MHz to 8 MHz are used. In addition, the portable transceiver is used locally but its communication distance is short.

d) Exchange facilities

NEC crossbar type automatic telephone exchanges are installed at base stations. As for automatic telegraphy, NEC telex exchanges are also installed at base stations and, like the telephone exchanges, those are connected through a bare wire carrier system.

e) Telephone facilities

Automatic telephones are installed near the automatic exchanges as mentioned in "d)" above and can call any subscribers through toll dial where trunk circuits are composed.

In local stations where automatic telephones are not installed, a despatcher telephone shared by several stations, or a public telephone is only available for a long distance call. A direct block telephone to adjacent stations, a railway crossing direct telephone, a direct telephone in a station yard, etc. are available as a local telephone.

2) Signalling and telecommunication system improvement projects of the SRT

At present, the signalling and telecommunication system has been modernized mainly in the metropolitan area. A part of the projects are completed but many projects are under construction and are still in the planning stage. The following are the projects (including those partly completed).

a) The Installation of color light signal project

- Southern line from Ratcha Buri to Chum Phon
  Northern line from Lop Buri to Phitsanulok
  North-eastern line from Ban Phachi Junct. to Thanon Jira Junct.
- 109 stations to be installed with color light signals and 116 stations to be installed with tokenless block systems
- Commencing date 1 April, 1989
- Expected completion date July, 1994

b) The central main line project (CTC Project)

- Centralized traffic control (CTC) with color light signals and automatic block systems from Bang Sue Junct. to Lop Buri on the Northern Line and from Bang Sue Junct. to Taling Chan Junct. on the Southern Line, total of 23 stations
- Remote indicator from Hua Lamphong to Bang Sue Junct.
- Commencing date 20 October, 1989
- Expected completion date April, 1994

c) The construction of Si Racha - Laem Chabang railway Project

- Installation of color light signals at Si Racha and Laem Chabang stations
- Commencing date 16 June, 1991
- Expected completion date October, 1993

d) The construction of Kao Chi Chan - Map Ta Phut railway project

- Installation of color light signals for 3 stations
- Commencing date 16 May, 1992
- Expected completion date April, 1994

e) Installation of signalling and telecommunications for the Khlong Sip Kao to Kaeng Khoi railway project

- Installation of the signalling and telecommunication facilities between Khlong Sip Kao and Kaeng Khoi station (4 stations)
- Expected commencing date August, 1994
- Expected completion date August, 1996

f) The upgrading of the signalling system for Makkasan - Chachoengasao railway project

- Installation of colour light signals from Makkasan station to Chachoengsao station.
- Expected commencing date August, 1994
- Expected completion date April, 1996

g) Upgrading of level crossing protection on the Eastern Line

- Upgrading 94 level crossings and installation of all relay interlocking at 2 stations
- Expected commencing date June, 1995
- Expected completion date June, 1997

h) Track rehabilitation project

- Replacement of the existing 70 lb/yd rails with 100 lb/yd rails, Northern Line from Lop Buri to Chumsaeng (141 km) and on the Southern Line from Hua Hin to Ban Krut (148 km)
- Expected commencing date January, 1995
- Expected completion date December, 1997

i) Track duplication project

- Installation of signalling equipment on new double-tracked sections:
  Northern Line from Ban Pachi Junct. to Lop Buri, Northeastern Line from Ban Phachi Junct. to Map Kabao, Eastern Line from Hua Mak to Chachoengsao, Southern Line from Bang Sue Junct. to Nakhon Pathom and Northern Line from Khlong Rangsit to Ban Pachi Junct (triple track).

j) The Installation of optical fibre systems along railway lines (Comlink project)

- Installation of optical fibre cables on SRT's pole routes in total length of approx. 3,000 km
- Total telephone circuit 40,840 circuits
- SRT will be provided with the following:

  Circuits for train dispatcher system
  Circuits for seat and ticketing reservation system
  Circuits for SRT telephone network
  Equipment

Signalling facilities at the time when the above-mentioned improvement projects as well as Hopewell Project are completed will be as shown in Fig. 1.3.9.

When the improvement projects the SRT are completed, a part of the Comlink's optical telecommunication lines which are under way will be used as a long distance circuit . In the CTC section and a newly constructed railway, the optical telecommunication system will be established for the medium distance circuit connecting stations , and a copper cable will be used for a local circuit in station yards. Fig. 1.3.10(1) shows the Comlink fiber optical network architecture and Fig.1.3.10(2) shows a conceptual diagram of transmission line between stations.

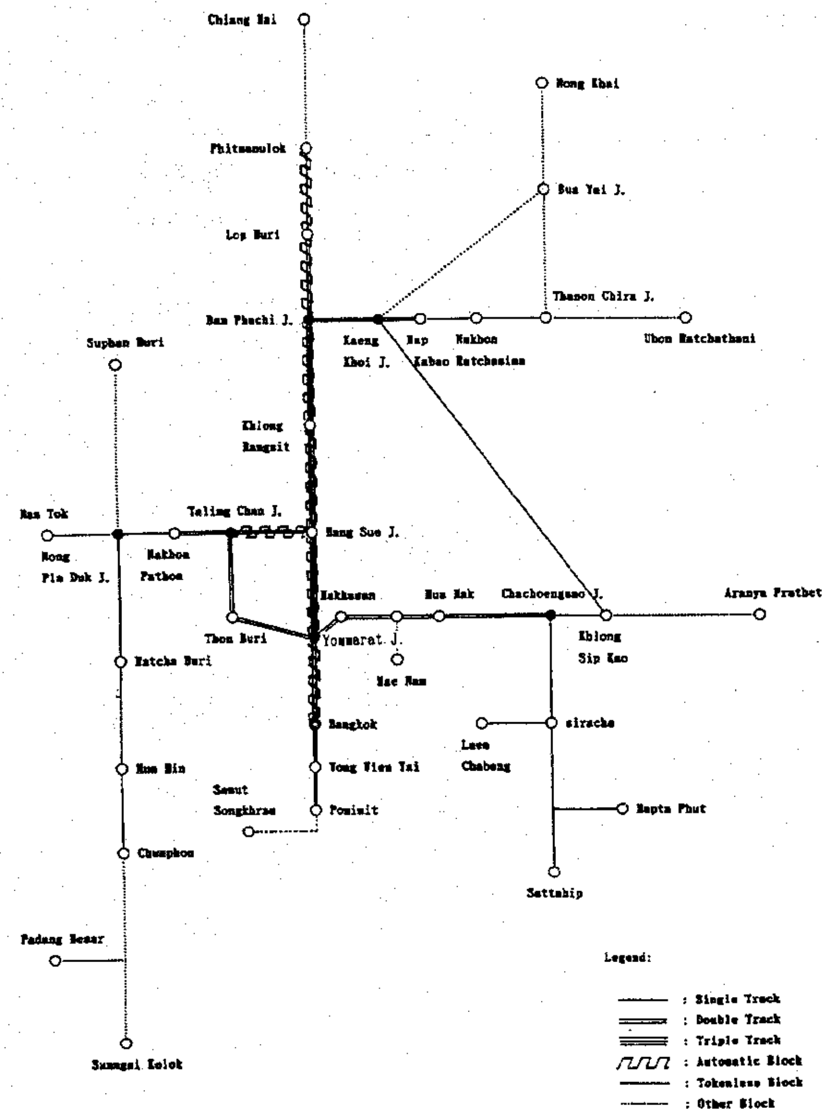


Fig. 1.3.9 Signalling Facilities in the Future

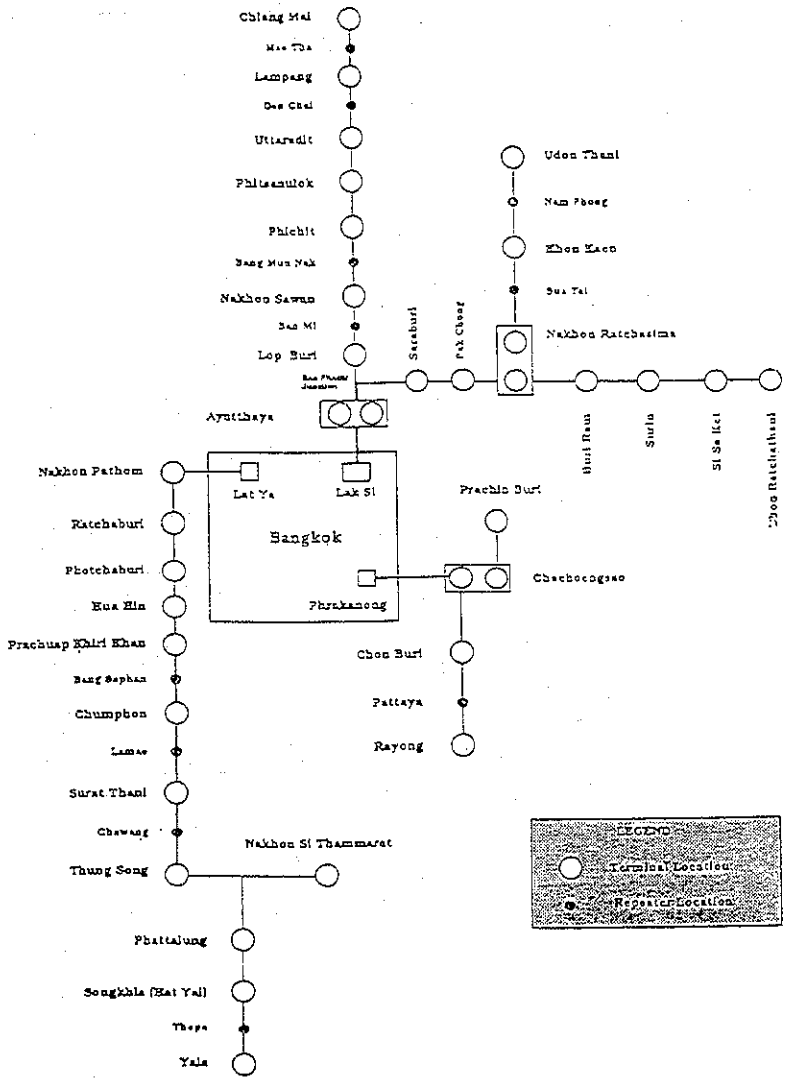


Fig. 1.3.10(1) 565Mb/s Fibre Optic Network Architecture

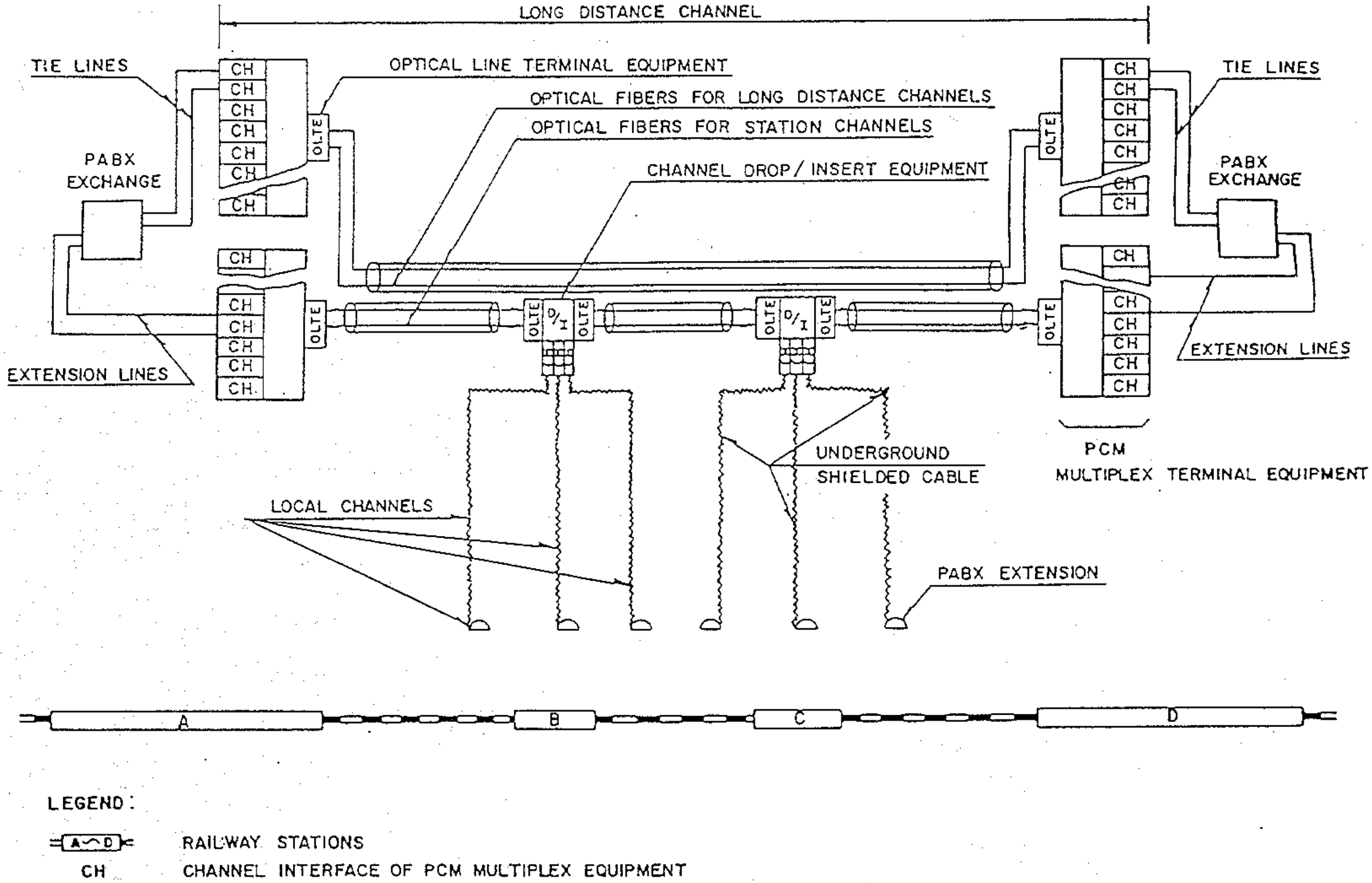


Fig. 1.3.10(2) Conceptual Diagram of Transmission Line

(3) Rolling stock

1) Number of rolling stock

The number of the existing rolling stock of the SRT in May, 1993 is as follows.

a) Number of diesel locomotives

Table 1.3.9 (1) Number of Diesel Locomotives

Electric	Hydraulic	Total number	
		On book	In service
206	73	279	191

b) Number of diesel railcars

Table 1.3.9 (2) Number of Diesel Railcars

Total number	
On book	In service
200	158

(Except the 23 diesel railcars of Maeklong Line)

c) Number of passenger coaches

Table 1.3.9 (3) Number of Passenger Coaches

Ordinary passenge coaches	Other coaches	Total number	
		On book	In service
730	439	1,169	1,073

(Other passenger coaches: including luggage, restaurant and sleeping coaches)

d) Number of freight cars

Table 1.3.9 (4) Number of Freight Cars

Covered goods cars	Other cars	Total number	
		On book	In service
4,286	4,624	8,910	7,839

e) Number of steam locomotives (Reference)

Table 1.3.9 (5) Number of Steam Locomotives

Wood burning	Oil burning	Total number	
		On book	In service
2	5	7	7

(Steam locomotives are operated only on the three memorial days in the year.)

2) Number of rolling stock by age (As of May, 1993)

The number of rolling stock classified by age in May, 1993 is as follows:

a) Diesel locomotives

Table 1.3.10 (1) Age of Diesel Locomotives

Age group	Number	Percent
Under 5 years	0	0
6 - 10 years	39	14
11 - 15 years	30	11
16 - 20 years	52	19
21 - 25 years	29	10
Over 26 years	129	46
Total	279	100

b) Diesel railcars

Table 1.3.10 (2) Age of Diesel Railcars

Age group	Number	Percent
Under 5 years	20	10
6 - 10 years	115	58
11 - 15 years	0	0
16 - 20 years	0	0
Over 21 years	65	33
Total	200	100

(Except the 23 railcars of Maeklong Line, which is grouped over 21 years)

c) Passenger coaches

Table 1.3.10 (3) Age of Passenger Coaches

Age group	Number	Percent
Under 10 years	181	15
11 - 20 years	354	30
21 - 30 years	277	24
31 - 40 years	272	23
Over 41 years	85	7
Total	1,169	100

d) Freight cars

Table 1.3.10 (4) Age of Freight Cars

Age group	Number	Percent
Under 10 years	1,078	12
11 - 20 years	1,262	14
21 - 30 years	2,486	28
31 - 40 years	1,596	18
Over 41 years	2,488	28
Total	8,910	100

3) Rolling stock inspection

a) Cycle of inspection

The cycle of rolling stock inspection of each type is shown in Table 1.3.11.

Table 1.3.11 Cycle of Rolling Stock Inspection

Type of inspection	Diesel locomotives	Diesel railcars	Passenger coaches	Freight cars
Daily or trip inspection	Every trip	Daily or trip	Daily or trip	Daily or trip
Regular inspection	500 operating hours 1,500 " 3,000 " 6,000 "	1 month 3 months 6 " 18 "	4 months 8 " 12 " 20 "	8 months 16 " 32 " 40 "
Partial heavy inspection	12,000 operating hours			2 years
Heavy repair or general overhaul	24,000 operating hours	400,000 km (For engine) 1,000,000 km (For torque converter and body)	2 years or 40 months	4-6 years

b) Outline of workshops and depots

Outline of the existing workshops and depots of the SRT are shown in Table 1.3.12 and their location is shown in Fig. 1.3.11.

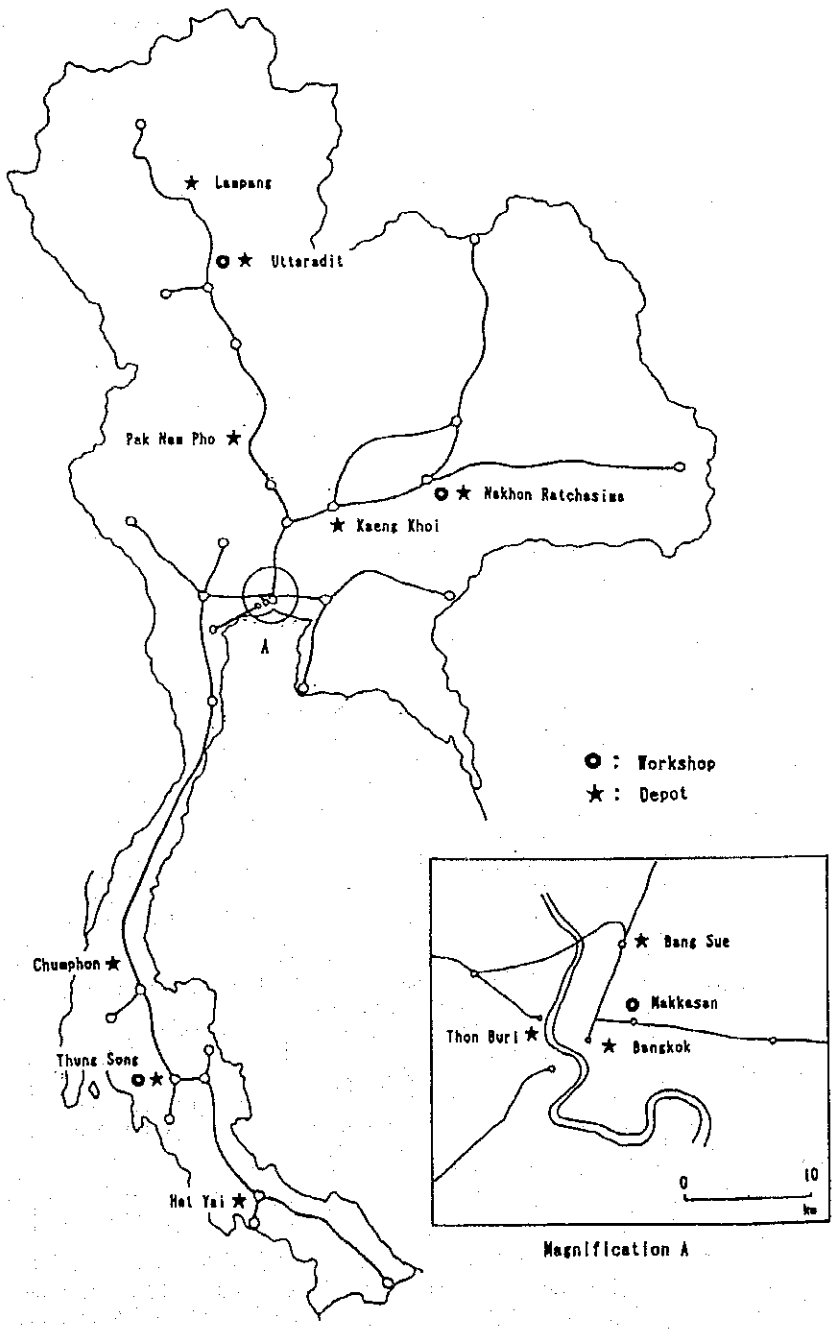


Fig. 1.3.11 Location of Workshop and Depots

4) Summary of workshop and depot (As of End 1993)

a) Workshop

Table 1.3.12 Summary of Workshop

Workshop	Makkasan	Nakhon Ratchasima	Uttaradit	Thung Song
Major work	Heavy repair & general overhaul (except freight cars)	Partial heavy repair (Freight cars) Regular inspection (Diesel locomotive · 6,000-operating hour)		
Number of employees	2,464	89	90	69
Work time per day (Rest time)	7:30 ~ 16:30 (11:30 ~ 12:30)	7:00 ~ 16:00 (11:00 ~ 12:00)		
※ Work days per year (Holidays)	248 (117)			
Average of vacation per person (Per year)	10			

※ : Include average of vacation per person

b) Depot

Table 1.3.12 Summary of Depot (1)

Depot	Bang Sue	Thon Buri	Nakhon Ratchasima	Kaeng Khoi
Major work	Daily or trip inspection Regular inspection Partial heavy repair		Daily or trip inspection Regular inspection	
Assigned section	Northern Line Ban Phachi ~ Bangkok Eastern Line Bangkok ~ Aranyaprathet Chachoengsao ~ Ban Plutaluang	Southern Line Prachuap Khiri Khan ~ Bangkok Nam Tok ~ Nong Pladuk Suphan Buri ~ Nong Pladuk Thon Buri ~ Taling Chan	Northeastern Line Nakhon Ratchasima ~ Nong Khai Ubon Ratchathani ~ Pak Chong	Northern Line Ban Phachi ~ Bua Yai Kaeng Khoi ~ Pak Chong
Number of employees	305	85	100	42
Work time per day (Rest time)	Day time 7:00 ~ 16:00 (12:00 ~ 13:00) Night time 16:00 ~ 7:00 circulation (Examiner at station) 0:00 ~ 8:00, 8:00 ~ 16:00, 16:00 ~ 24:00			
※ Work days per year (Holidays)	248 (117)			
Average of vacation per person (Per year)	10			

Table 1.3.12 Summary of Depot (2)

Depot	Lampang	Uttaradi	Pak Nam Pho	Chunphon
Major work	Daily or trip inspection Regular inspection			
Assigned section	Northern Line Chiang Mai ~ Denchai	Northern Line Denchai ~ Tapan Hin Sawankhalok ~ Ban Dara	Northern Line Taphan Hin ~ Ban Phachi	Southern Line Prachuap Khiri Khan ~ Ban Thung Pho
Number of employees	59	77	42	53
Work time per day (Rest time)	Day time 7:00 ~ 16:00 (12:00 ~ 13:00) Night time 16:00 ~ 7:00 circulation (Examiner at station) 0:00 ~ 8:00, 8:00 ~ 16:00, 16:00 ~ 24:00			
※ Work days per year (Holidays)	248 (117)			
Average of Vacation per person (Per year)	10			

Table 1.3.12 Summary of Depot (3)

Depot	Thung Soong	Hatyai	Bangkok (D.R.C. & Passenger)	Bang Sue (Freight)
Major work	Daily or trip inspection Regular inspection		Daily or trip inspection Regular inspection Partial heavy inspection	Daily or trip inspection Regular inspection Partial heavy/ Heavy inspection
Assigned Section	Southern Line Ban Thung Pho ~ Phatthalung Ban Thung Pho ~ Rattangchom Thung Song ~ Kantang Khao Chum Thong ~ Nakhon Si Thammarat	Southern Line Phatthalung ~ Sungai Kolok Hatyai ~ Padang Besar Hatyai ~ Somkhla		
Number of employees	123	97	367	177
Work time per day (Rest time)	Day time 7:00 ~ 16:00 (12:00 ~ 13:00) Night time 16:00 ~ 7:00 circulation (Examiner at station) 0:00 ~ 8:00, 8:00 ~ 16:00, 16:00 ~ 24:00			
※ Work days per year (Holidays)	248 (117)			
Average of vacation per person (Per year)	10			

5) Existing problems for rolling stock and their inspection/repairing

(a) Rolling stock

Many of the passenger coaches are commonplace and uncomfortable, most of which are very old cars used more than 30 years. Generally, passenger coaches and diesel railcars are dirty. It is essential that they are clean and comfortable to win the competition with automobiles.

Promotion of acquisition of new cars and renovating the existing old cars is desirable. The SRT should grapple positively with providing clean and comfortable rolling stock. It is preferable to install automatic body cleaners at depots and to clean up cars systematically at depots as well as to carry out technical inspection.

High quality diesel railcars such as "Sprinter" are necessary for intercity express service because the existing diesel locomotives' acceleration/deceleration and speed are not very high.

Safety systems by ATS and train-radio etc., which are closely related to operation are necessary.

Improvement of the brake system of vacuum brakes is necessary for speed up and countermeasures at at-grade crossing.

(b) Inspection/repair

In order to keep safety and good repairs, preparation of sufficient spare parts is essential. Intentional purchase of spare parts and making an effort to get enough budget are necessary. To seek a possibility of producing spare parts in Thailand is preferable.

Modernization and improvement of old facilities for inspection and repair as well as mechanization and computerization of the work are desirable.

It is desirable to examine improvement of the working conditions in order to prevent a shortage of employees.

1.3.4 Management and Financial Affairs

(1) Management

The entire railway network of 3,900 km belongs to the State Railway of Thailand (SRT). The State Railway of Thailand is a government owned enterprise. It came into being as a department of the government in 1890. It was made an autonomous organization on July 1, 1951 by the State Railway of Thailand Act B.E. 2494 (1951).

The organization of the SRT is shown in Fig. 1.3.12. The formulation of policies and the supervision of the general affairs of the SRT are entrusted to the Board of Commissioners consisting of a chairman and other four to six members appointed by the Cabinet. The General Manager, chief executive of the SRT, is an ex-officio member of the Board. The Minister of Transport and Communications has general supervisory power and may call upon the SRT to give statement or opinion or to submit report or suspend SRT's actions.

The number of SRT's permanent employees is 22,619 as of the end of fiscal 1990 (Sept. 30) and that of temporary employees is 3,880, for a total of 26,499. The number of permanent employees is decreasing little by little. The ratio (including permanent and temporary employees) classified by organization is shown in Fig. 1.3.13. The majority of the temporary employees belong to the Civil Engineering Department.

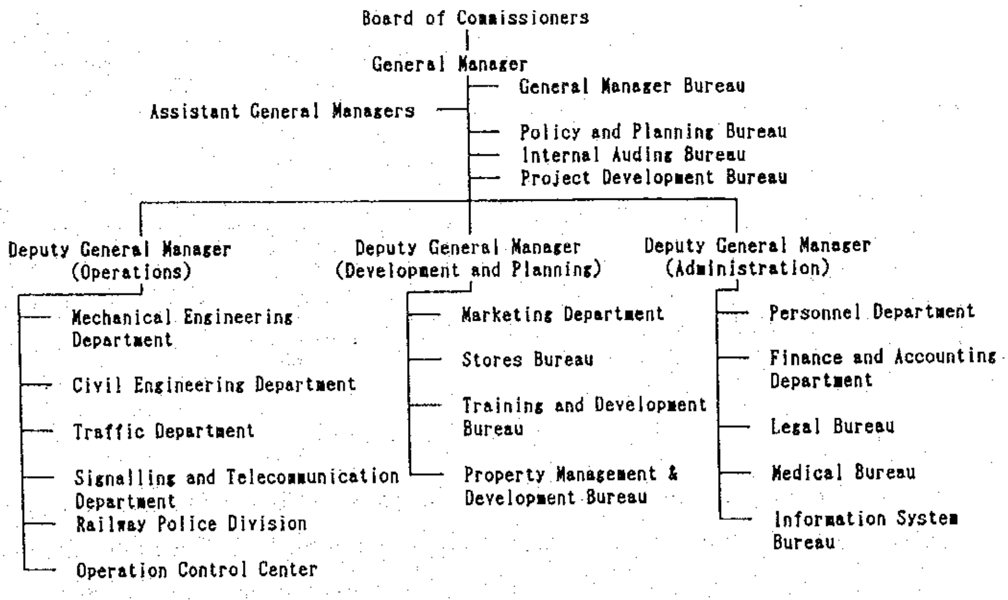


Fig. 1.3.12 Organization Chart of the SRT

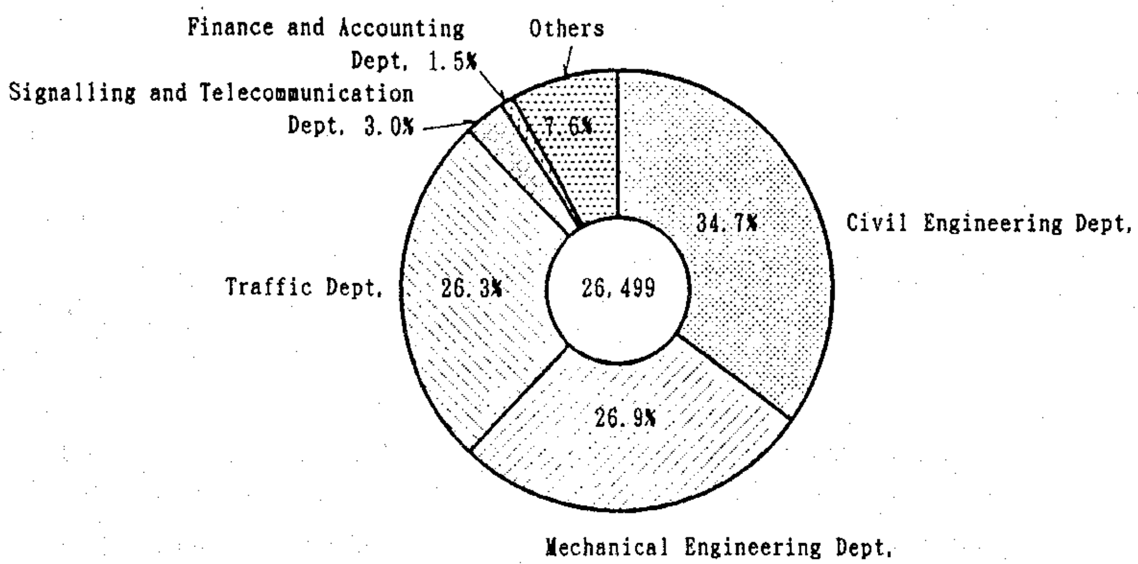


Fig. 1.3.13 Employees Classified by Organization (As of Sept. 30, 1990)

(2) Financial affairs and investment

SRT's revenues and expenditures, the rates of their increase and the change of operating coefficient figure for the recent period of 4 years from 1989 to 1993 are shown in Table 1.3.13.

Table 1.3.13 Revenues and Expenditures of the SRT

Unit: Million bahts

Fiscal year	1989	1990	1991	1992	Rate of increase	
					1992/1989	Average (Com.)
Passenger revenue	2,452	2,707	3,095	3,484	42 %	12.4 %/year
Freight revenue	1,107	1,230	1,325	1,312	18.5 %	5.8 %/year
Other revenue	393	450	912	948	141.2 %	34.1 %/year
Total revenue (A)	3,952	4,387	5,332	5,744	45.3 %	13.3 %/year
Total expenditure (B)	4,186	4,826	5,744	6,337	51.4 %	14.8 %/year
Operating deficit (A-B)	-234	-439	-412	-593	--	--
Operating coefficient (B/A x 100)	105.9	110.0	107.7	110.3	--	--

The Thai Government aims to keep the public welfare stable by means of the policy of cheap railway tariffs, both for passengers and freight, which has remained unchanged since 1985. The annual operating deficits caused by this policy have been all replenished by the government in the next year or later, and the SRT has not been in the difficult position of a big accumulating deficit.

However, as a result of this government policy, the facilities of the SRT have been deteriorating without appropriate renewal, even though they are well maintained by the efforts of the railwaymen, while the SRT has hardly saved autonomous funds for new investments and must have depended upon borrowing or the government subscription of capital for necessary investments. Accordingly, most of the necessary investments, which were required to meet with the augmented transport volumes of passengers and freight in the recent period (1989-1993), were financed by borrowing (long-term 4.7 billion baht and short-term 2.2 billion baht totaling to 6.9 billion baht) and government subscription of capital (2.2 billion baht). As a result, the properties of the SRT have increased by 8.7 billion baht or 62% for the same period.

In recognition of the fact that the living standard of customers of the SRT has remarkably advanced in recent years, the SRT is now desired to transform itself to a new railway of "more suitable fares and more comfortable service" from the old one of "low fares and low quality of service".

Simultaneously "more suitable fares" will expectedly alleviate the dependence on outside money and enhance soundness and efficiency of the management of the SRT.

1.3.5 Right-of-way (SRT's Land)

Land with a width of 40m on both the sides of the center (80m in total) of each line has been and should be held in principle. In some sections, especially in recently constructed sections, the width is 40m in total. Such broad right-of-way brings large potential/possibility of improvement, reinforcement and development to the railway.

Only on the Maeklong line, the width is 14 to 20m in total, which is, however, useful enough for future improvement and reinforcement.

The extent of land differs at each station, but at main stations it is extensive enough to prepare necessary facilities, generally.

Table 1.3.14 shows the existing state of right-of-way of the SRT.

Table 1.3.14 Right-of-Way of SRT

Position / Line	Section between stations	Area of right of way in main stations (Approx. measurements from plan 1/1,000)
Northeastern Line	40m of right and left each from railway center (Total width 80m) Except Bangkok - Lak Rok	Ayutthaya 50rai, Ban Phachi 200rai, Lop Buri 90 rai, Nakhon Sawan 300rai
Northeastern Line	40m of right and left each from railway center (Total width 80m)	Sara Buri 60rai, Kaeng Khoi 350rai, Nakhon Ratchasima 260rai
Kaeng Khoi - Lam Na Rai	40m of right and left each from railway center (Total width 80m)	Lam Na Rai 250rai.
Eastern Line	Makkasan - Chachoengsao 20 - 40m of right and left each from railway center (Total width 40 - 80m) Others 40m of right and left each from railway center (Total width 80m)	Chachoengsao 70rai, Aranyaprathet 450rai
Chachoengsao - Ban Pluta Luang	20m of right and left each from railway center (Total width 40m)	Chon Buri 70rai, Si Racha 130rai, Patthaya 70rai, Ban Pluta Luang 130rai
Southern Line	Thon Buri - Phetcha Buri 30m of right and left each from railway center (Total width 60m) Others 40m of right and left each from railway center (Total width 80m)	Taling chan 40rai, Nakon Pathom 40 rai, Nong Pladuk 140rai, Phetcha Buri 75rai, Prachuap Khiri Kan 55rai
Nong Pladok - Nam Tok	40m of right and left each from railway center (Total width 80m)	Nam Tok 100rai
Nong Pladok - Suphan Buri	40m of right and left each from railway center (Total width 80m)	Suphan Buri 110rai
Maeklong Line	7-10m of right and left each from railway center (Total width 14 - 20m)	Wong Wien Yai 10rai, Maha Chai 10rai

1.3.6 Master Plan of the SRT and Relevant Big Projects

(1) Master Plan of the SRT issued in 1993

The State Railway of Thailand (SRT) commissioned the "SRT Master Development Plan Study" to the Thailand Development Research Institute (TDRI), and it was issued in May, 1993.

This study states mainly the following:

- SRT's future role corresponding to energetic economic growth in Thailand and investment plan
- Proposal of Public Service Obligation (PSO) to cope with the growing debt of the SRT (As for the PSO, it is mentioned in 1.7.6.)

It suggests that the SRT should make efforts to deal with increasing transport demands which will be brought by economic growth in Thailand, making the most of its advantages especially of fuel efficiency, of environmental conditions and of safety. It recognizes commuter service as an important role of the SRT.

In this study, future transport demand is forecasted and an investment plan is shown targetting the year of 2011. The plan includes urgent matters such as replacement of track structures, rolling stock, etc. which are aged and in poor condition caused by the low level of investment in the financial turmoil since the year of the oil crisis, and programmes which will deal with the increasing demand actively such as double (triple) tracking projects, reinforcement of rolling stock. Double (triple) tracking projects occupies more than half of the requirement.

In order to realize such a huge investment, the understanding and intention of the government are essential. Financial conditions corresponding to these are necessary to be included in the "PSO", which is explored in the study.

For actual execution of investment, further careful and profound demand forecast and financial analysis reflecting the government's policy on transport concerning allotment in transport mode and will of bearing burden is essential.

It should be taken into account that elimination of external diseconomies cannot produce any cash even if it is valued, and that an easy debt without serious financial analysis is a way to ruin. A debt will grow by producing its own interest.

(2) Relevant big projects

Besides the mass rapid transit systems in the study area, there are several big projects which are closely related to this study. The contents of the projects and their related matters are mentioned below.

(a) Second Bangkok International Airport (SBIA)

The Second Bangkok International Airport (SBIA) has been planned on land with an area of 3,100 ha, which was previously procured from 1963 to 1973 at Nong Ngu Hao located about 25km east of the center of Bangkok and on the southern side of the section from Lat Krabang Station (26.8km from Hua Lamphong) to Hua Takhe Station (30.9km from Hua Lamphong) on the Eastern Line. Master plan study has been completed and detailed investigation is now being carried out. The airport has been planned to be put into operation in 2000 when the capacity of the present Bangkok International Airport (BIA) is expected to become insufficient for passenger traffic.

As for the volume of passenger traffic, the new airport (SBIA) has been planned to handle 25/38 million passengers per year (2000/2010) out of the 35/56 million passengers (2000/2010) expected to be annually handled by both the airports.

If the airport is constructed, the airport is required to provide not only these passengers but also airport operators, airline staff members and cargo operators with ground access. In this regard, it is necessary to introduce a railway line.

Access to the airport is now under consideration in the study of the airport. The SRT should actively try to enable SRT's Eastern Line, located 2.5km north of the airport site, to be used as access to the airport. Since SRT's lines are connected with the center of Bangkok as well as Don Muang where the BIA is located, this line can be used to get access to the center of the city and connect both the airports. The Hopewell commuter train line can be imagined to be extended to the airport, but, in this case, it is necessary to construct a railway line with a length of 11.4km between Hua Mak and Lat Krabang in addition to SRT's existing railway line in this section and it is also difficult to operate rapid trains owing to structural conditions. It is, therefore, desirable for the SRT to provide access to the new airport. If the capacity of SRT's commuter service between Hua Mak and Lat Krabang becomes insufficient for future passenger traffic, it is possible to cope with this matter by four-tracking. Only at that time only it will become necessary to invest in the construction of new track. If SRT's railway line is used as access to the new airport, its investment efficiency is, therefore, expected to be high.

(b) Lat Krabang Inland Container Depot

The Lat Krabang Inland Container Depot (ICD) is under construction on land with an area of 91 ha (excluding land for an access road), which was procured in Lat Krabang district on the northern side of the Eastern Line just opposite to the SBIA about 25km east of the center of Bangkok.

This ICD is regarded as a part of the development of Laem Chabang Port. The shuttle operation of freight trains will be conducted between the container depot and the port to transport marine containers without opening them for customs examinations at the port and to load/unload cargos at the depot in order to handle effectively freight transport between the Bangkok Metropolis and overseas areas.

Up to this time Bangkok's Khlongtoey Port located up the Chao Phraya River has been the gateway for distribution between Thailand and overseas areas. It is difficult for ships with a capacity of 12,000 deadweight tons or above to enter this port owing to the small depth of water. Since large-sized container ships, which often have been used for recent marine freight transport, can not enter this port, it is necessary to transship freight into small-sized ships in Singapore or Hong Kong. The capacity of the port itself has also become insufficient for the present freight traffic. Laem Chabang Port constraction works started in 1989 and was completed in October, 1991 to cope with these matters. Large-sized container ships with a capacity of 50,000 deadweight tons can enter this new port. The new railway line between Laem Chabang Port's container depot and Si Racha has already been completed. Freight transport between the port and the existing depots such as Bang Sue Depot has already started. The Lat Krabang ICD was planned to be completed in February, 1995. The volume of freight handled by this depot is expected to be 370 thousand TEUs (TEU: Twenty-foot Equivalent Unit)/year in 1997 when the depot will be put into full operation and to reach 400 thousand TEUs/year in 2000. And among them, the volume of freight transported by train is estimated at 40%. This volume of freight is equivalent to 42%/34% (1997/2000) of the total volume of freight handled by Laem Chabang Port.

Since container transport is expected to be conducted in the section between the ICD and Laem Chabang Port, a railway spur will be constructed as access to the ICD from Hua Takhe Station located on the east side. The operation of trains will be conducted to provide 4 to 5 shuttle freight transport services a day in 1997 when container transport will be put into full operation.

(c) High Speed Train

The NESDB is carrying on the study of "High Speed Train (HST)". This study is to research application of high-speed trains which run at a speed of 160km/h with an improved meter gauge or at a speed of 300km/h with a standard gauge. And to carry on the feasibility study of a new railway line (whose high-speed train operation will be conducted at a certain speed level) required for connecting Bangkok with the Eastern Seaboard (ESB), which is under development as a national project and expected to grow into an urban area with a population of 2 to 3 million second to the Bangkok Metropolis.

The study is being carried out in parallel with this Study. Transport between Bangkok and ESB is included in the scope of this Study. A new line between these urban areas of respectable size is supposed to be feasible. However, the development of the railway line between Chachoengsao and ESB has just been completed to handle both passenger and freight traffic between both the areas. It is, therefore, necessary to synthetically study the project by giving consideration to the functions and return of the investment of the line just completed. Since the Chaochengsao-ESB line, equipped with a meter gauge, goes a roundabout way 25km longer than the shortest distance between Bangkok and ESB, this line can not avoid being placed at a disadvantage in competition with the new HST line expected to directly connect both the areas.

The proposed study of HST aims at the further development and growth of transport in the ESB beyond 2010, which is the target year of this Study. It is consistent with and an outgrowth of this Study.

Future passenger transport connecting the Bangkok Metropolis and the SBIA with the ESB will be the improved Eastern Line and the Chachoengsao-Rayong Line through Chachoengsao as a first step, and after the remarkable increase in demand as the next step, it will be an additional line going straight in the section between the SBIA and Chon Buri, which will have alternatives of a meter gauge and a standard gauge. A meter gauge will have a limited speed of 160km/h, but it can use the same track within the center of Bangkok where land acquisition will be difficult and costly and large construction costs will be required, and also in the section near the end where a sharp increase in demand of both passengers and freight can not be expected. A standard gauge will have a possibile speed of 300 km/h, but it needs an entirely exclusive track which will require huge investment costs as well as a great amount of demand to support the investment. The time to choose will be far off and what is necessary at present is to take into consideration the future possibility of selecting either in the plan.

1.3.7 Countermeasures for At-grade Crossings

(1) Regulations for passing over at-grade crossings

It is unbelievable that there are a considerable number of trunk roads crossing at the same level with railways in one of the largest metropolises in the world. Surprisingly, in preparation for stopping, SRT trains reduce their speed greatly at major at-grade crossings in the city area of Bangkok. This makes the speed of trains passing through such crossings extremely low and at the same time the time needed for closing crossing gates longer. If, like other countries, priority is established for the railways, crossing gates can be closed exactly when the train is passing. Consequently, trains do not have to lower their speed at at-grade crossings and, therefore, the time of closing crossing gates becomes relatively short.

Trains can not stop suddenly. Therefore, from the viewpoint of smooth traffic flow, the condition that trains need not stop or reduce speed at at-grade crossings should be established. In other words, trains can quickly pass through railway and road intersections, and then cars are not hindered from passing through at-grade crossings so much. For this purpose, cars should be prohibited from stopping within at-grade crossings, and it should be clarified that car drivers are regarded as responsible for any hindrance to trains passing through at-grade crossings.

For example, in Japan, since it is commonly recognized that trains cannot stop suddenly, when a warning signal of a train approaching is raised, a car must stop before the at-grade crossing and wait until the train passes through it. With the exception of special cases such as an at-grade crossing situated within a station yard, the time necessary for closing a crossing gate is about one to two minutes and, therefore, it has little influence on the total time for cars to reach their destinations.

Table 1.3.15 shows conditions of at-grade crossings in some countries.

Japan's Road Traffic Law specifies the responsibility of car drivers as follows:

Article 33. A vehicle must, if they intend to pass a railway crossing, come to a halt just before the railway crossing, and shall not proceed unless after they confirmed safety. (Except the crossing indicated by signal machine.)

2. A vehicle must not enter railway crossing, while the crossing gate is about to close or is closed or while warning is being given by the warning device of the crossing.

3. A driver of a vehicle must, if he became unable to drive his vehicle in a railway crossing due to a reason such as engine trouble, take necessary measures for removing the vehicle to place other than the crossing, together with taking measures, such as immediate emergency signal, etc., for notifying a person in charge of the railway officer of the fact that there is a stopping vehicle at the crossing.

Article 44. A vehicle must neither stop nor park on a portion of a road being prohibited stopping and parking by means of road signs and on other portions of a road mentioned in the followings.

(6) A portion within 10 meters respectively before and behind from the side edge of a railway crossing.

Article 50.

2. A vehicle must not if, in the case of entering a railway crossing, etc., there is a fear of proving to stop in that portion, due to circumstances of vehicles in front of the course intended to proceed, enter those portions.

(Reference; Road Traffic Law, Fukio Nakane, EIBUN-HOREISHA)

(2) Source of revenue to improve at-grade crossings

In Japan, according to the Level (At-grade) Crossing Improvement Promotion Act, a national subsidy is granted within the limit of half of the cost required for building a grade separation for a at-grade crossing where "(the number of vehicles passing through the crossing) × (the total time required for the crossing gate to be closed)" is more than 10,000 vehicle hours per day.

As to cost allotment for a grade separation to be shared by the relevant railway company and road administrator, an agreement concluded between the Ministry of Transport and the Ministry of Construction specifies that the amount which may otherwise be required for maintenance of the level crossing is to be borne by the railway company and that the rest is to be borne by the relevant road administrator. As to the cost involved in the introduction of a continuous grade separation, in principle, the railway company is to bear only the amount equivalent to the benefit brought to the company by the grade separation, and the relevant local public organization, which enforces the city/town planning, is to bear the rest being subsidized by the national treasury. The amounts to be borne by the railway company are estimated to be 5%, 7%, 10% and 14% of the total construction cost in local cities, cities of more than 300,000 population, large cities and ultra large cities respectively.

Table 1.3.16 shows cost sharing for grade separation in some countries.

(3) Plan for at-grade crossing improvement

Considering the fact that the at-grade crossings are the worst bottleneck of railway commuter service, an improvement plan should be implemented step-by-step.

(a) Primary step

As an immediate countermeasure, a regulation on road traffic on passing over at-grade crossings should be established. Trains may pass over at-grade crossings quickly without slowing down, and by holding down the influence on road traffic, frequency and speed of trains can be improved.

(b) Secondary step

Hopewell Project will clear the at-grade crossings in the center of Bangkok. However, other at-grade crossings will still remain . A policy should be established for management of the grade separation.

(c) Third step

The priority of grade separation must be decided according to the total product of vehicles and time [(The number of vehicles passing) × (The total closing time of the level crossing)]. It must also be judged whether it is better to elevate the railway or construct a fly over (under pass) of the road, considering the circumstances and the intervals of at-grade crossings.

Table 1.3.15 Circumstances of At-grade Crossings (Level Crossings) in Some Countries

Item \ Country		British National Railway	German Federal Railway	French National Railway	American Railway (First class)	Japanese Railway
Installation of at-grade crossing security equipment and cost sharing	Applicable law etc.	January 1980 Security Standard of Level Clossings	Railway Crossing Act, Ordinance for Railway Construction and Operation, Railway Level Crossing Regulations	Article 19-2, New Agreement	Federal Auxiliary Road Act	November, 1961 Level Crossing Remodeling Promotion Act
	Cost sharing	In principle, causer bears. In case the railway bears, it shall be covered by compensation system.	The railway bears 50 %. Road administrators (federal, state, local public organization) bears other 50%.	The railway bears entirely. (However 50% to be covered by a national subsidy.)	The nation bears 90% of expenses. State/local self-governing body bears the remaining 10%. (In some cases, partially the railway bears.)	The railway bears. (However, subsidy may be paid the ratios: 50% by the government, 33% by the relevant self - governing body.)
	Builder	The railway	The railway	The railway	The railway	The railway
Responsibility for maintenance/administration of at-grade crossing and cost sharing		The railway is responsible. Under EC Regulation No. 1192, 50% of the expenses is to be compensated.	The railway is responsible. Under EC Regulation No. 1192 / 69, 50% of the expenses is to be compensated.	The railway is responsible. (50% of the expenses is to be subsidized by the government.)	The railway is responsible. In some states, the expenses is to be partially borne by the state.	The railway is responsible.
Passage rules		Priority to be given to the railway. In principle, cars are under no obligation to stop at crossing.	Priority to be given to the railway. Cars are under no obligation to stop at crossing.	Priority to be given to the railway. Cars are under no obligation to stop at crossing.	Priority to be given to the railway. Cars are under no obligation to stop at crossing.	Priority to be given to the railway. Cars are under an obligation to stop in front of crossing.

Table 1.3.16 Cost Sharing for Grade Separations in Some Countries

Item	Country	British National Railway	German Federal Railway	French National Railway	American Railway (First Class)	Japanese Railway
Cost sharing	Applicable law etc.	No legal standards	Railway Crossing Act	Article 30, French National Railway Licence Conditions	Federal Auxiliary Road Act, 1973 (Vol. 23, Federal Code)	Level Crossing Remodeling Promotion Act November, 1961
	Installation of grade separation with abolition of at-grade crossings	The causer bears. In case the railway bears, to be covered by a compensation system.	One third of the expenses are equally borne by the road administrator, federation and the state government; Article 13, Railway Crossing Act	Decided through discussion between the concerned bodies (The railway shall bear the amount equivalent to the advantage caused by the abolition of at-grade crossings); Article 30-III	The federal bears 90 % of the expenses; The state/local self government bears 10%. (In some cases, the railway bears partially.)	The railway bears amount equivalent to the advantage caused by the abolition of at-grade crossings. The road administrator shall bear the remaining cost but subsidized by the nation.
	Grade separation accompanying new establishment of road	The causer bears. However, in case borne by the railway compensation system shall cover it.	The causer bears; Article 11, Railway Crossing Act	The causer bears; Article 30 - I, Licence Conditions	The same as above	The causer bears.
	Remodeling / alteration of the existing grade separation	The same as above	The causer bears; Article 12. But if the profit acquired by other concerned, it shall be adjusted.	The causer bears; Article 30-II. But if the profit acquired by other concerned, it shall be adjusted.	The same as above	The same as above
	Cost sharing concept and the base for cost sharing calculation	"To be borne by causer" is considered as fair. Compensation is based on "justification of cost shared by the railway and road administrator".	Based on the concept of "cost to be borne by causer" and "profit adjustment"; Compensation to be based on Article 17, Railway Crossing Act and EC Regulation	Based on the concept of "cost to be borne by causer" and "profit adjustment"; Article 19-2, New Agreement; Article 30, Licence Conditions	Traffic safety such as prevention of at-grade crossing accidents is the most important policy of the transport administration. Based on the concept of aid to road work	Based on the concept of "cost to be borne by causer"; According to the agreement between Ministry of Transport and Ministry of Construction

1.3.8 Problems of the SRT Railways within the Hopewell Project Area

The Hopewell Project was started based on the Concessional Agreement concluded by the Ministry of Transport and Communications and the SRT with Hopewell (Thailand) Co., Ltd., which came into effect on December 6, 1991. A concrete track layout plan of SRT railway lines in the first phase construction area was already proposed. It will determine and restrict future functions of SRT railways. Although the Hopewell Project area is not included in the scope of this Study, SRT railway lines in the area need to be given attention, because they are closely related to this Study. There are some serious problems, which are mentioned below.

(a) Station at Yommarat

Under the Hopewell Project a cross-shaped main line system penetrating the city center of Bangkok will be built up as the Red Line (north-south alignment) and the Green Line (east-west alignment), and Yommarat is the important spot where both the lines cross and are connected with each other. Although Yommarat Station should play a great role in connecting both the lines, it is not planned for in the service of the SRT. It is essential to provide the station. If it is not provided, the following problems will arise.

- Passengers between the Northern/Maeklong Line and the Eastern/Southern Line will be forced to transfer two or three times (SRT → HWCT ((→ HWCT)) → SRT). Operating through trains using connecting tracks at Yommrat instead of providing the station is difficult, rather impossible, because of level crossings among tracks especially during rush hours, the high density train operation period, which is not preferable. (The connecting tracks between the Northern Line and Eastern Line ((eastward only)) are provided for special purposes such as long distance passenger service, shuttle service between both the airports and freight service in off-peak periods, having insufficient capacity for commuter service in rush hours.)

- As for the Eastern/Southern Line it will have no station between Makkasan and Thon Buri. This means the line will have no station in the city center which is the most important origin/destination area of passengers, besides having no station at an important spot which should be a junction. Thus the trains will only pass through with few passengers in this section of 7 km. (It is preferable to provide one more station between Yommarat and Thon Buri in the Para Nakhon Area.)

- Until the completion of Yommarat to Thon Buri, the section in later stages, during rush hours most or all of the trains on the Eastern Line will be forced to stop and turn back at the next Makkasan Station because of level crossings at Yommarat and insufficient tracks for the confluence of trains on both the lines. Yommarat Station will be necessary from the commencement of operation of the Hopewell Project first phase, which is the start of full-scale commuter service proposed and planned in this Study, as the terminal of the Eastern Line and the junction to transfer to the Northern Line of commuter service.

(b) Proposed track layout

The track layout plan proposed by Hopewell side also has some problems, and they will restrict SRT railway services in the future. Therefore, it should be examined carefully taking into consideration future possibilities. The track layout is drawn up without sufficient consideration to the importance of stations consisting of tracks which have various functions. Since only the number of main tracks is prescribed in the Concessional Agreement, necessary passing tracks and refuge tracks are not prepared for other than at Bang Sue Yard.

- Long sections without side tracks make the line lose flexibility for operation of various types of trains and reduce the efficiency and capacity of the line.

- Between Hua Lamphong and Yommarat Junction, the existing third track is lost. The track is an important element of the Hua Lamphong passenger car yard as a leading track. It is also functioning as a supplementary track for confluence of the Northern Line and the Eastern Line and a refuge track for the level crossings at the junction. It is much related to the future plan of both the Hua Lamphong and Bang Sue yards and Yommarat Station of both the Northern Line and Eastern Line. At the least, it can not be disused before removal of the Hua Lamphong yard.

- The transport system in the Hopewell Project area can be considered to function as a corridor having four (or five) tracks including the two tracks of the Hopewell Community Train. In the future, when the function is required to extend to suburban areas by four-tracking SRT lines for the increasing demand brought by urban development, it will be impossible to connect smoothly the additional tracks with Hopewell CT, because the number of SRT tracks is to be limited to two or three at Hua Mak Station and Khlong Rangsit Station respectively and the station areas are to be surrounded by structures making it impossible to expand any more. It is essential to consider future possibilities in the plan.

(c) Ensuring the east-west connection

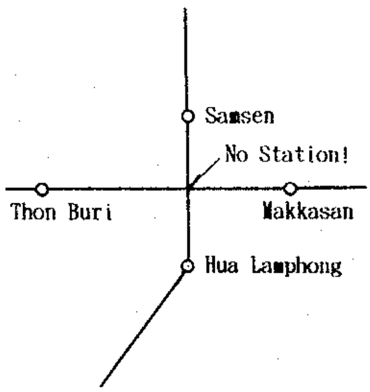
Connecting the Eastern Line with the Southern Line and the Northern Line with the Maeklong Line forming a cross-shaped main line system penetrating the city center of Bangkok is the essential element of the Hopewell Project, which makes the role of SRT lines more important, more useful and more efficient. (Railway systems with deadends in the sections of heavy demand are inefficient and not preferable. Therefore, for railways in large cities it is desirable to go through the center without deadends.) The construction of SRT line between Yommarat and Thon Buri seems to have been deserted in the proposal. Only the tracks of Hopewell CT cross over the Northern Line and reach to the west side of the Northern Line. No concrete plan for the SRT's Eastern Line crossing the Northern Line is shown and it is difficult on the proposed plan. Building up the east-west main line connected with the Northern Line at Yommarat forming a cross-shaped main line system is very important. Therefore, it is essential to keep the possibility of an underground line between Makkasan and Thon Buri in the design of the structure and track layout of Makkasan station area, if any concrete plan to connect the Eastern Line to Thon Buri Station is not prepared until then.

(d) Possibility of future improvement

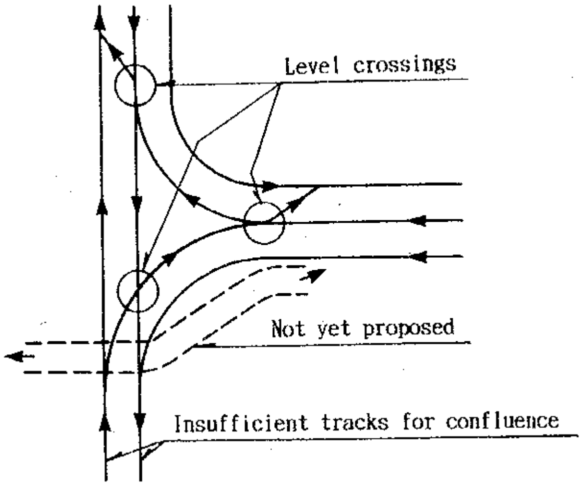
The anticipated functions of railway lines will change as time goes by. Therefore, it is necessary to make improvement in railway facilities continuously and the design of structures and track layout should be prepared taking into consideration flexibility for future improvement and change. It is preferable that the structure will allow crossover tracks to be set at any place.

(e) Explanation of problems and examples of countermeasures

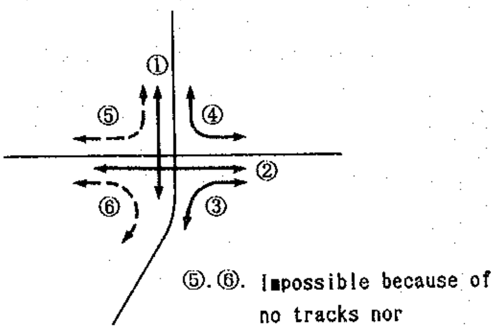
Explanation of problems and examples of countermeasures in figures are shown in Fig. 1.3.14.



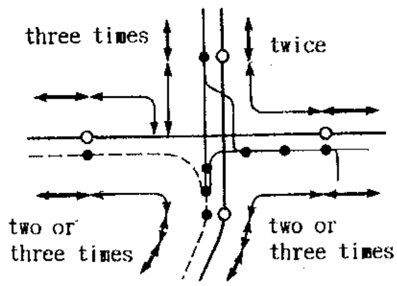
(i) How to connect both the lines?



(ii) Is it possibile to operate trains of high density during rush hours?

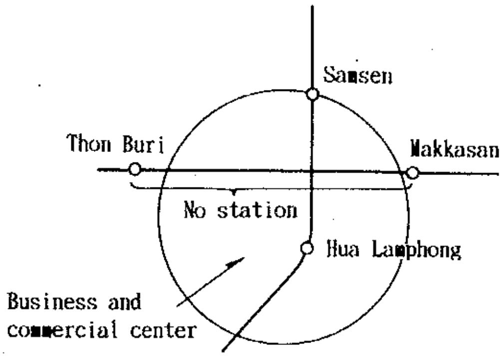


(iii) Is it efficient/convenient?

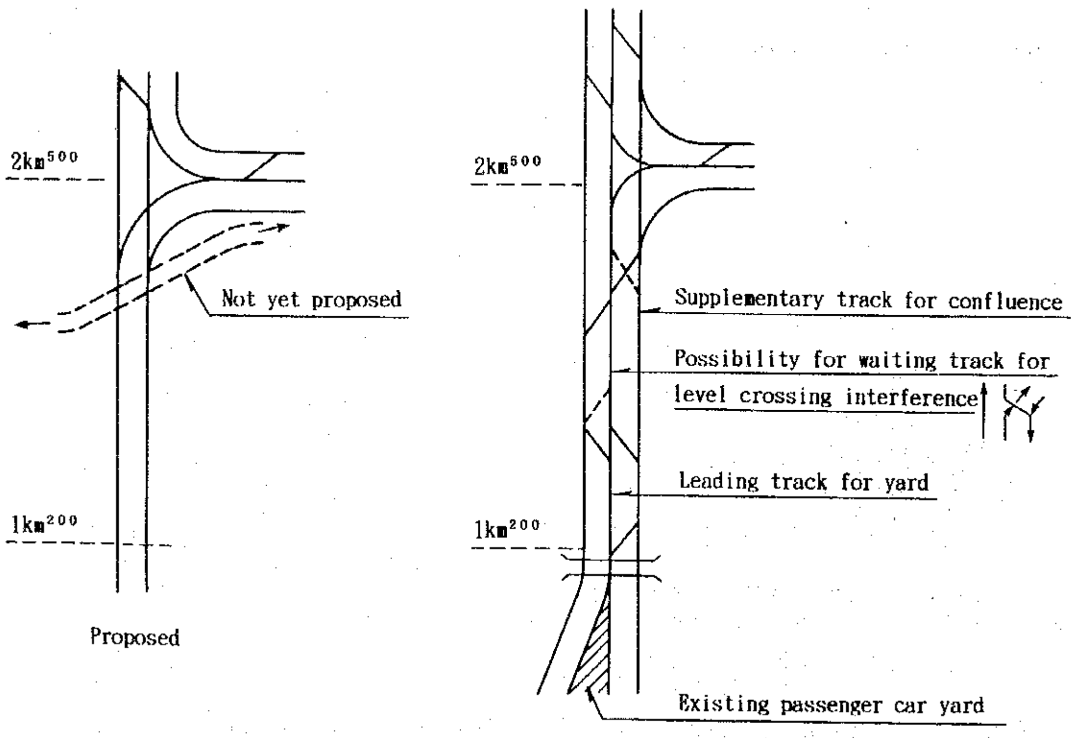


(iv) Transferring two or three times through the HWCT, is it convenient ?

Fig. 1.3.14 Explanation of Problems on SRT Railway within the Hopewell Project Area and Examples of Countermeasures (1)

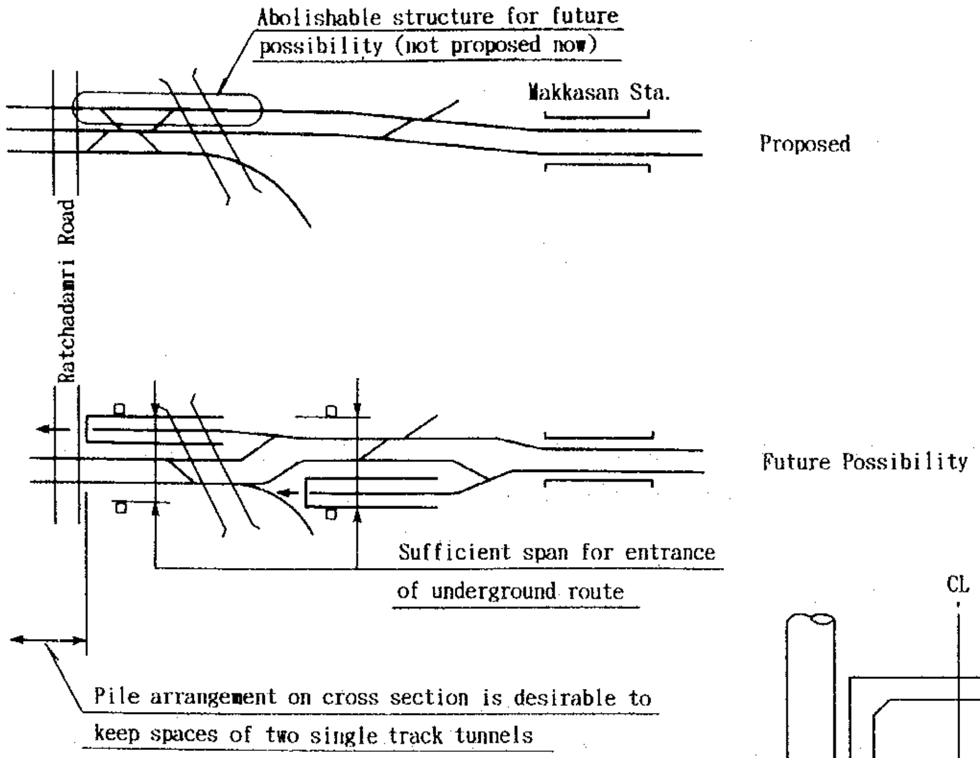


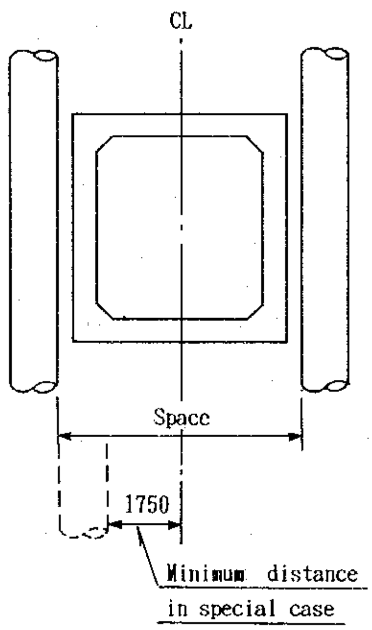
(v) Who use trains between Makkasan and Thon Buri?



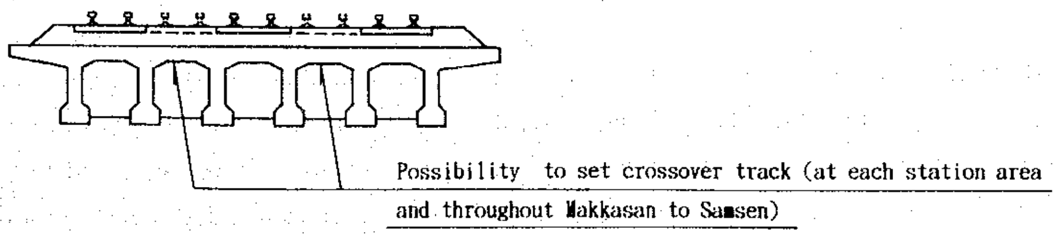
(vi) How to operate the Eastern Line?
How to operate passenger car yard?

Fig.1.3.14 Explanation of Problems on SRT Railway within the Hopewell Project Area and Examples of Countermeasures (2)





(vii) Possibility for underground line between
Makkasan and Thon Buri



(viii) Possibility of future improvment/change on detailed design of structure

Fig. 1.3.14 Explanation of Problems on SRT Railway within the Hopewell Project Area and Examples of Countermeasures (3)

1.4. Concept of Railway Improvement Master Plan

1.4.1 General Aspect of Railway Improvement

(1) Aims and effects of railway improvement

1) Premise

The object of this Study is railway improvement integrated with urban development in and around the Bangkok Metropolis (within a radius of 200 km).

Based on this, the Study is to target

- Commuter service in the urban and suburban area of the Bangkok Metropolis and
- Intercity express service in the area within a 200 km radius

among the roles to be fulfilled by the railways. (Roles of railways are described previously in paragraph 1.2.3.)

2) Commuter service

(a) Importance of railway transport

The characteristics of railway transport are "fast, reliable, safe, comfortable, suitable for large volume, inexpensive, environment-friendly, natural-resource-saving and space-saving". This is suitable and preferable for urban transport.

At present thanks to the remarkable development of the automobile industry, people can own cars easily. On the other hand, it has brought violent traffic congestion to great city areas such as the Bangkok Metropolis because it occupies enormous space compared with its transport capacity. It has reached the extent that it paralyzes economic and social activities.

In such a situation, railways as well as other mass rapid transit systems, are desirable and especially the merits of "reliability" and "large capacity" contribute greatly.

(b) Aim of commuter service

Railways and other mass rapid transit systems work both for radial transport connecting the downtown with suburban areas and for various movements within the downtown. The former is required to be fast (of scheduled speed) to extend commutable areas, and the latter is expected to be rather convenient than fast. The railway improvement project in this study is for commuter service for radial directions. The proposed network for the service is shown in Fig. 1.4.10, which is planned to be integrated with the urban development plan examined in Part II.

Aims of the service are as follows:

- To provide reliable, fast, comfortable commuting measures of a large capacity instead of the existing measures on congested roads which are unreliable and require the wasting of vast amounts of time
- To create areas which are suitable for developing favorable housing sites, education and research situations, commercial complexes and light industry sites
- To promote a modal shift from road transport to railway transport in order to save natural resources, to reduce environmental disruption and to decrease traffic accidents
- To utilize space effectively in the crowded city center
- To ease traffic congestion for those who need to use automobiles

(c) Basic service

Services required for the commuter service are basically as follows:

- Scheduled speed of trains is to be at least 70km/h by rapid trains in order to provide commuting measures of less than one hour for the area within a radius of 50km.
- High level reliability, which is an important characteristic of a railway, is to be ensured.
- A headway of less than 10 min. in rush hours or 20 min. off peak, which is a necessary condition to be chosen as a convenient transport means, is to be ensured.
- Attractive and comfortable rolling stock are to be prepared to make people want to shift their transport mode.
- Convenient access/egress means are to be provided inevitably.

On the suburban side: Bus, minibus, taxi, etc. and parking lot for park and ride
On the urban side: Mass rapid transit system and bus network

Bus service of radial directions between the city center and suburban areas is necessary to be reorganized and diverted to adapt to the above.

(d) Effects of improvement

Expected effects of railway improvement for commuter service are as follows:

- People can more easily obtain favorable houses in a suburban area of good environment with reliable commuting transport.
- They can use their time effectively for their own lives because of reliable and fast commuting transport.
- The force of urban sprawl in the Bangkok Metropolis can be reduced.
- The traffic congestion in the Bangkok Metropolis is getting serious rapidly. The project will reduce this.
- The environmental disruption from automobile exhaust gas especially in the Bangkok Metropolis will be eased by a modal shift.

An outline of aims and effects of railway improvement for commuter service is shown in Fig. 1.4.1, 1.4.2.

3) Intercity express service

(a) Situation of intercity express in railway services

Fast, reliable, safe and comfortable intercity express service by trains stopping at a few limited stations of major population centers and by high performance rolling stock is an important service of railways in the world even if it is not executed by special facilities such as "Shinkansen". If it is provided with sufficient convenience (reliability, speed, frequency, etc.) and comfort, it can compete against bus service and automobiles and obtain a certain share. One hour headway is enough in view of travelling time.

The maximum operation speed desirable is 120km/h in the first stage, which is possible in the SRT. Schedule speed of 100km/h on SRT's existing good alignment is to be aimed for except in mountainous areas such as Kaen Khoi to Pak Chon. However, within a stage of single track operation, it is to be reduced because of waiting loss.

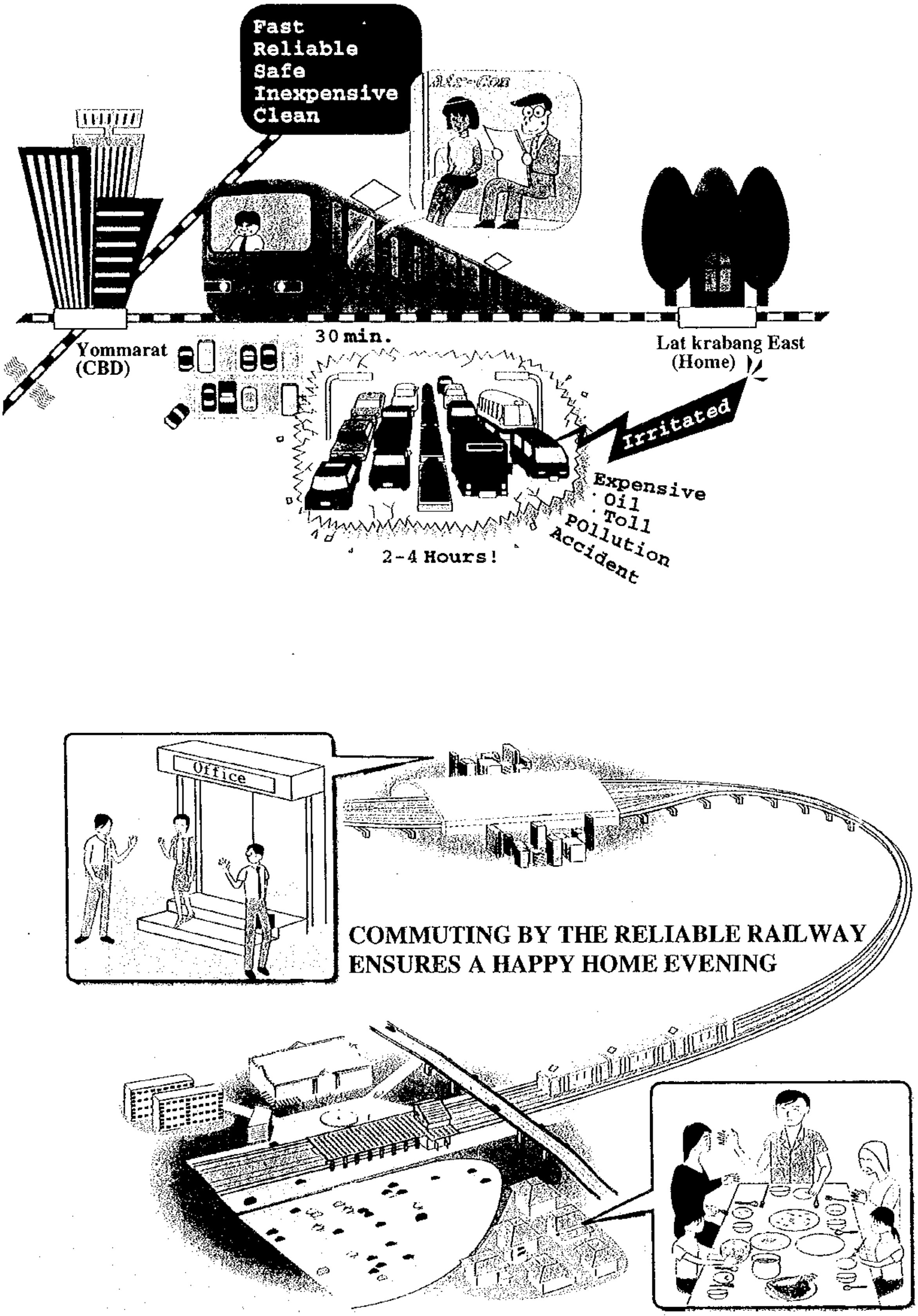


Fig.1.4.1 Outline of Aims and Effects of Railway Improvement for Commuter Service

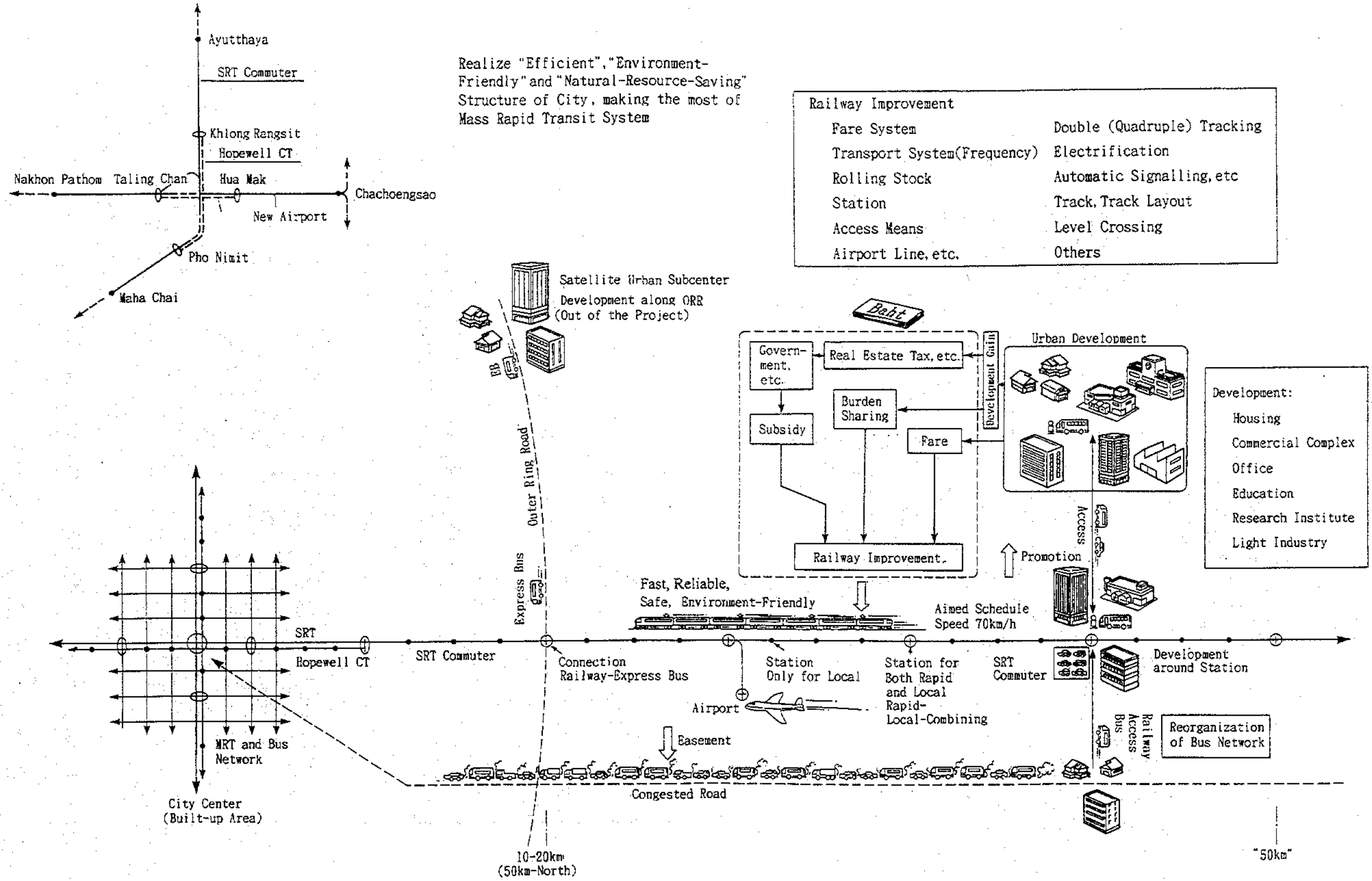


Fig.1.4.2 Outline of Aims and Effects of Railway Improvement for Commuter Service

In the later stage, the maximum speed of 160km/h will come to be possible requiring suitable rolling stock, improvement of facilities, strengthening the maintenance force and especially getting rid of at-grade crossings.

(b) Aims of intercity express service

Aims of intercity express service are as follows. It is forward-looking, therefore, the service should be attractive enough.

- To provide fast, reliable and comfortable intercity express service in order to raise economic activity with better communications and to promote the enjoyment of leisure time
- To prepare safe travel compared with buses and automobiles

(c) Effects of service

Expected effects of carrying out intercity express service are as follows:

- People can travel in shorter time and without loss time of margins for delays caused by traffic congestion especially on travel to/from the Bangkok Metropolis for both business and leisure.
- People can travel without anxiety about traffic accidents.

An outline of aims and effects of carrying out intercity express service is shown in Fig. 1.4.3.

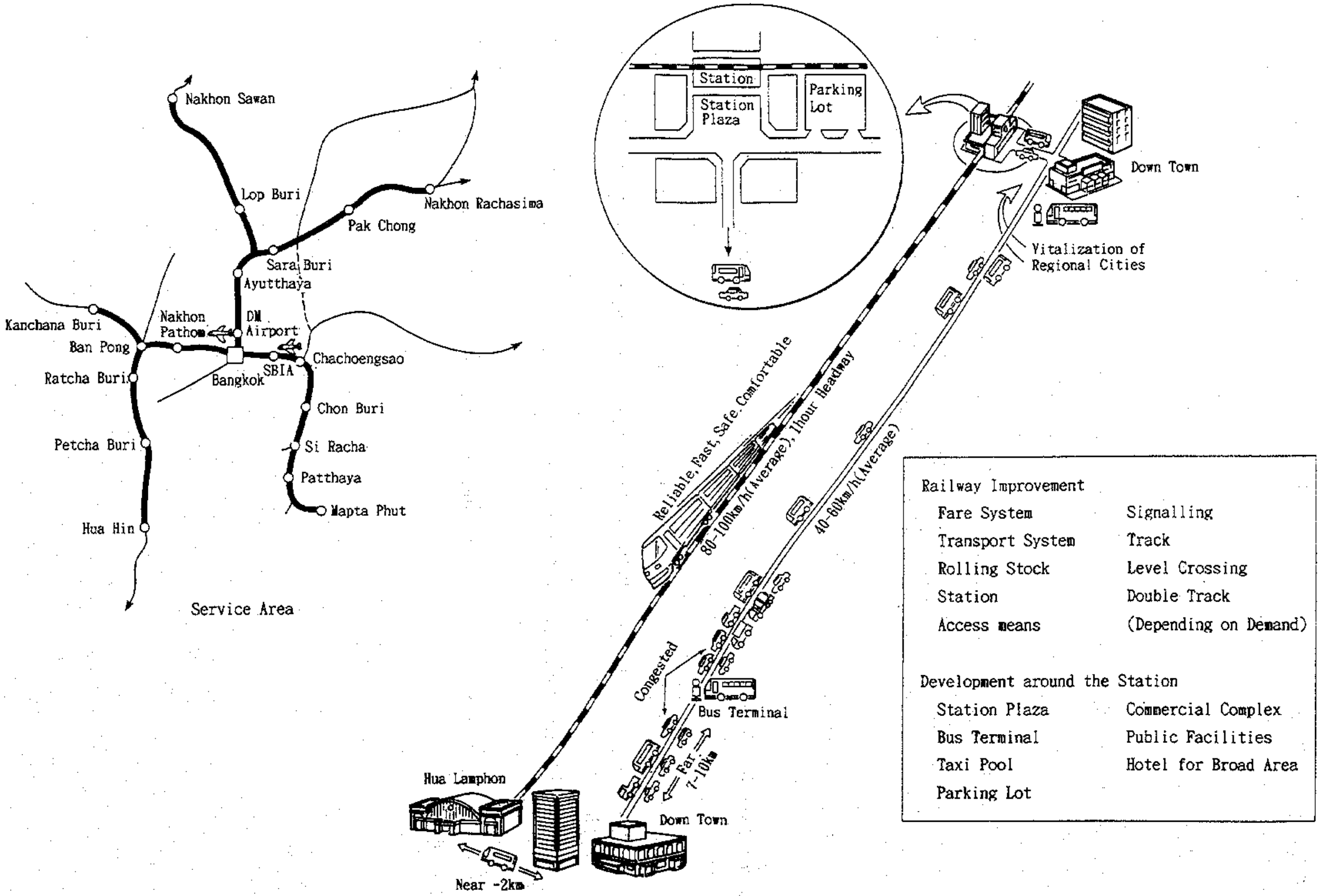


Fig.1.4.3 Outline of Aims and Effects of Railway Improvement for Intercity Express Service

(2) Factors of railway improvement

1) Factors of railway improvement

A role of a railway is essentially to offer transport service. Railway improvement is, therefore, in principle improvement of transport service. Improvement of transport service is classified as follows:

- Improvement of quality of transport itself, to make it faster, more reliable, more convenient, more comfortable, etc.
- Improvement of software such as fare systems, ticketing systems, etc.
- Improvement of access means and related measures of railways

From another view point:

- Improvement of those matters which relate directly to transport service such as rolling stock and facilities (These are further classified to those which serve customers directly, such as rolling stock and station facilities, and other facilities.)
- Improvement of those matters which relate indirectly such as management and maintenance

Matrices of factors and items of railway improvement concerning commuter service and intercity express service are shown in Table 1.4.1 and Table 1.4.2.

2) Steps for railway improvement

From the existing state, which requires urgent countermeasures, to a possible future stage, steps for railway improvement of the SRT are as follows.

(a) The existing state requiring urgent countermeasures

- At-grade crossing problem
- Aged rolling stock (especially cars with vacuum brakes)
- Aged facilities

These matters cause reduced speed and unreliable service at present.

Table 1.4.1 Factors of Railway Improvement (Commuter Service)

Factor / Item	Fare and Ticketing	Service	Speed-up
Fare	Fare Level Season Ticket Coupon Ticket Discount Fare Through Fare with Access Sure Collection		
Transport		Frequent Service Rush Hours: 10 min Off Peak: 20 min	Rapid-Local-Combining Operation
Rolling Stock		Comfortable Coaches Accommodation, Cleanness, Air Condition	High Performance Multiple Wide Door High Level Platform
Station Around the Station	Barrier and Fence	Comfortable Station High Level Platform Elevator, Escalator Information	
Track Station Function		Track Strengthening (Comfortability to ride)	Increase of Crossing Loops and Refuge Tracks Single Track → Double Track Double Track → Quadruple Track Track Strengthening (Maintenance labor supply)
Signalling Telecommunications		Information	Automatic Block Signalling
Electrification			
At-grade Crossing		At-grade Crossing Improvement (Law/Regulation, Manners, Equipment) Grade Separation	At-grade Crossing Improvement (Law/Regulation, Manners, Equipment) Grade Separation
Connection with MRT in the City Center	Through Fare Through Ticket	Easy Transfer at Junction	
Feeder Transport in Suburban Area	Through Fare Through Ticket	Bus Station Near Railway Station	
Others	New Line (SBIA and Others) Others around the Station		

Increased Capacity	Reliability/Safety	Cost Reduction	Access
		Automatic Ticketing and Examining (Corresponding conditions of labour cost and supply)	
Electrification Long Train Making-up (Approx. up to 15 cars)		Electrification (Economical in case of large volume transport)	
Expansion	High Level Platform Over Bridge	Automatic Ticketing and Examining (Corresponding conditions of labour cost and supply)	Station Plaza Bus Station/Bus Network Taxi Pool Parking Lot
Increase of Closing Loops and Refuge Tracks Single Track → Double Track Double Track → Quadruple Track (Exceeding 50,000 passengers/hour x direction) Track Strengthening (Maintenance labour supply and train interval)	Single Track → Double Track	Track Strengthening (Maintenance expenses)	
Automatic Block Signalling Shortening Block Section	ATS (Automatic Trains Stop) Train Radio	CTC (Centralized Traffic Control)	
Electrification (Economical matter)		Electrification (Economical in case of large volume transport)	
At-grade Crossing Improvement (Law/Regulation, Manners, Equipment) Grade Separation			
			Easy Transfer at Junction
			Establish Bus Feeder System Reorganization of Bus Network

Table 1.4.2 Factors of Railway Improvement (Intercity Express Service)

Factor / Item	Fare and Ticketing	Service	Speed-up
Fare	Fare Level Special Rate in Specific Conditions		
Transport		1 - 2 Hours Headway	Super Express
Rolling stock		Comfortable Coaches Accommodation, Clean-ness, Air Condition	High Performance (Diesel Car)
Station Around the Station		Comfortable Station Information	
Track Station Function		Track Strengthening (Comfortability to ride)	Increase of Crossing Loops and Refuge Tracks Single Track → Double Track Double Track → Quadruple Track Track Strengthening (Maintenance Labour Supply)
Signalling Telecommunications		Information	Automatic Block Signalling Tokenless Signalling
At-grade Crossing		At-grade Crossing Improvement (Law/Regulation, Manners, Equipment) Grade Separation	At-grade Crossing Improvement (Law/Regulation, Manners, Equipment) Grade Separation

(b) Normal state

- Reliable service
- No speed reduction
- Maximum services by the rolling stock and Facilities on hand

(c) First stage improvement

- Speed-up
- Increased capacity
- Comfortable and attractive services

Increased Capacity	Reliability/Safety	Cost Reduction	Access
			Station Plaza Bus Station Taxi Pool Parking Lot
Increase of Crossing Loops and Refuge Tracks Single Track → Double Track Double Track → Quadruple Track Track Strengthening (Maintenance labour supply and train interval)	Single Track → Double Track	Track Strengthening (Maintenance expenses)	
Automatic Block Signalling	ATS (Automatic Train Stop) Train Radio	CTC (Centralized Traffic Control)	
At-grade Crossing Improvement (Law/Regulation, Manners, Equipment) Grade Separation			

(d) Second stage improvement

- Grade-up
- Expansion/extension

(e) Future possibility

- High level standard

150 ~ 160 km/h by meter gauge

200 ~ 300 km/h by standard gauge

This depends on demand and ability to invest.

The SRT has broad rights-of-way of good alignment. Therefore, it is easy to construct a railway of a high level standard when demand comes to require it.

A railway of 150 to 160 km/h by meter gauge can be obtained step by step by investments to improve the existing railway.

A railway of 200 to 300 km/h by standard gauge requires a huge investment in an exclusive new line. Therefore, it will not pay its way, unless it is located along a corridor where large or medium cities of 100 thousand to a million or more population live creating demand of more than 50 thousand averaged traffic volume in profile in both directions. At present there is no such corridor in Thailand.

3) Steps and measures for increased capacity

In order to increase traffic capcity of a railway line, many steps and various measures can be adopted in accordance with growing demand step by step in consideration of an investment scale and funds.

Steps and measures started from the minimum level of single track with tablet block system are shown in Fig 1.4.4. These figures do not include direct measures such as increasing rolling stock, operators, etc.

4) Measures of speed-up

Speed-up (including reduction of traveling time) is an important factor for improving railway service. It is also an important factor for increasing transport capacity.

Measures for speed-up are listed as follows.

(a) Operation speed

- High performance electric railcars and diesel railcars
- High performance locomotives, passenger coaches and freight cars
- Weeding out low performance cars especially vacuum brake cars
- High grade track
  Alignment

Equipment (Turnout, etc)

Strengthened track

- Reliable at-grade crossing treatment

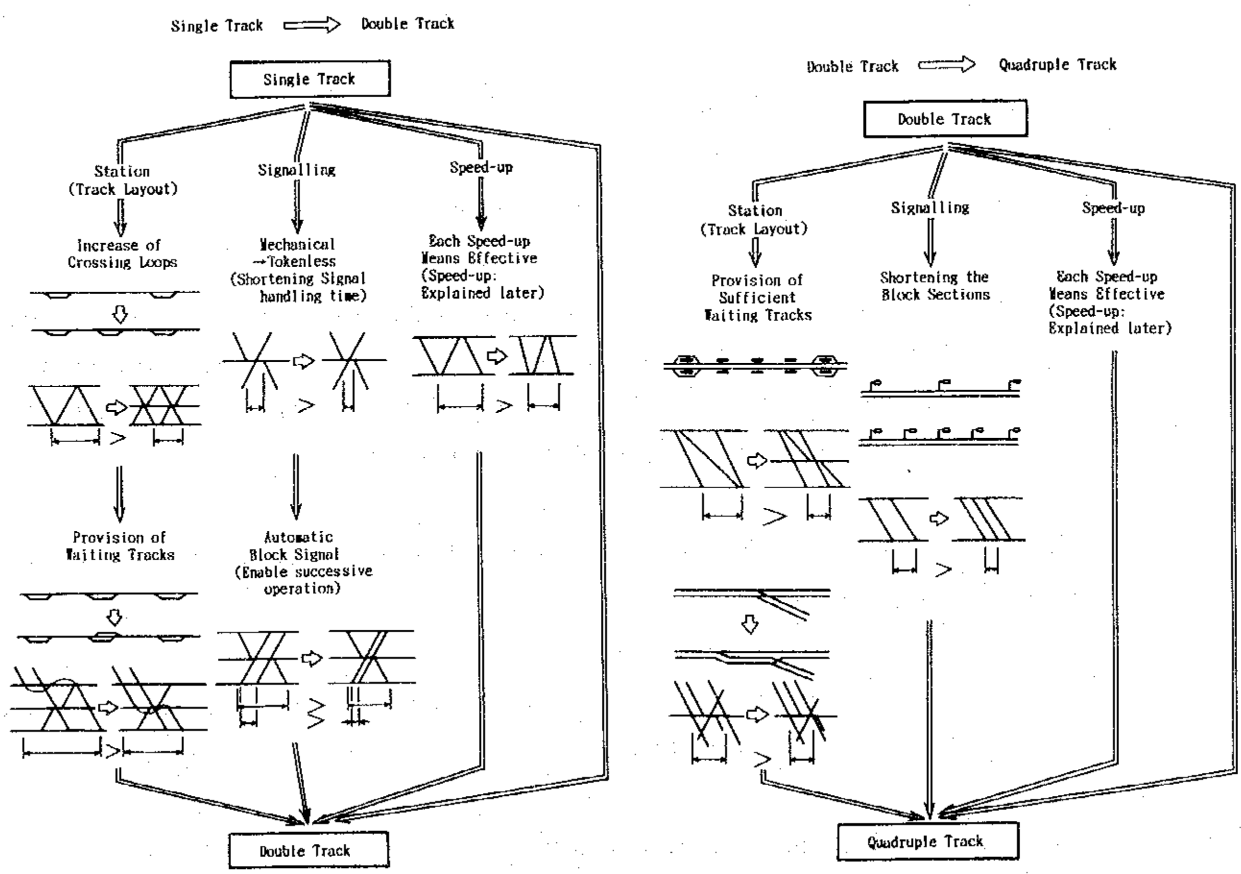


Fig 1.4.4 Steps and Measures for Increased Capacity

(b) Reduction of loss time (waiting time)

- Track layout
  - Crossing loops
  - Refuge tracks
- High grade signalling

5) Back-up measures for increased capacity and speed-up

Increased capacity and speed-up can be carried out by the measures mentioned above. However, increase of train operation volume and speed requires increase of maintenance works and fuel consumption and makes the possibility of accidents greater. In view of economy, it is preferable that back-up measures are executed together. They are in some cases required by limited maintenance forces and limited train intervals for mainteinance work. In view of reinforcement of safety and reliability, they are also necessary. Back-up measures are as follows.

(a) In view of economy and maintenance

a) Electrification and CTC (Centralized traffic control)

Electrification can reduce operation and maintenance expenses and rolling stock procurement costs and requires large initial construction costs. Therefore, deciding whether to electrify or not mainly depends on transport volume. (Electrified railways are clean and environment-friendly but this is not significant for small traffic volume.)

Generally speaking, for a commuter railway electrification is economical and can ease the difficulty of ensuring maintenance forces.

Utilizing CTC, a small staff can control traffic. It can reduce personnel expenditures and make traffic control smooth and quick.

b) Track and other equipment strengthening

Track maintenance requirements are proportional to passing tonnage and train speed. Therefore, traffic volume increase, which is a purpose of increased capacity, and speed-up enlarge track maintenance requirements. In some cases, it becomes too much and exceeds the possible scale of maintenance forces and possible volume of train intervals for maintenance work. On the other hand, increased demand can produce funds to invest in track strengthening.

As for other equipments, conditions are similar.

(b) In view of reinforcement of safety and reliability

- ATS (Automatic train stop devices)
- Dead man devices
- Train radio
- CTC (Centralized traffic control)

It is impossible to eliminate human mistakes. Increased traffic and speed create more and larger accidents. Therefore, such back-up systems to reinforce safety and reliability are essential.

(6) Importance of management and maintenance

As mentioned above, for a railway it is necessary to make much more of "management" and "maintenance". It should be recognized that unlimited extension of forces for management and maintenance is difficult even if economic conditions allow it.

1.4.2 Railway Improvement Integrated with Urban Development

(1) Purport

Smooth movement of the many people gathering in a city for commutting, business, school attendance, shopping and other activities is indispensable for the prosperity of the city. Cities should naturally be provided with mass rapid transit systems as part of their infrastructure.

The Bangkok Metropolis has been developed with no mass rapid transit systems so far, and now suffers from traffic congestion. Its remarkable traffic congestion has become bad enough to prevent the city from developing and growing anymore while its environment is rapidly deteriorating.

At long last, serious attention has started to be paid to the introduction of mass rapid transit systems after such problems reached an unbearable level. However, citizens have lived without these systems so far and have no habit of using them either. Especially, car users, who are a main factor in causing traffic congestion, are not aware of the importance of mass rapid transit systems. Commuter transport by this mode which connects the center of the city with the outskirts, which is the main theme of this study, has the advantages of getting to a destination reliably and quickly but requires secondary access. Therefore, it is not easy to realize a modal shift smoothly.

Urban development has been made based on roads and automobiles so far. Although railway lines are improved and their transport capacity is reinforced, it is unlikely that citizens will increasingly use railway transport right away, because the development lacks organic connections with the railway lines. As large investment should be made to improve railway lines and reinforce their transport capacity, ensuring smooth returns on such large investment by creating sure demand is indispensable. To secure financial resources and to recycle development profits are important factors as well.

Taking the above into consideration, it is desirable to organize railway improvement and reinforcement by integrating it with urban development which creates the demand of the railway transport and ensures the effect of the project.

Urban development, which has been made along main roads in the form of a ribbon, has started to reach the limit of its capacity since it is impossible to get useful means of transport while the center of the city and the entrances to the center of the city are remarkably crowded with cars. Urban development integrated with railway improvement projects is really required since developers also want to get development targets supported by means of transport.

As mentioned above, railway improvement integrated with urban development can provide measures to meet the needs of both the urban side and the railway side as follows:

- (Need of the urban side) Development with transport only by road has reached the limit and come to require development integrated with a mass rapid transit system.

- (Need of the railway side) Railways want to play their role on urban transport making the most of their characteristics to transport a large number of passengers reliably and fast, but on the other hand, hope to avoid such large scale investment as railway improvement whose prompt and secure return might be uncertain if it is carried out alone.

Urban development is classified based on its size and contents as shown below:

- Many development projects in a wide area have to do with improvement and reinforcement of a main railway line.

- Each development project has to do with improvement or construction of each station or branch line.

(2) Urban development plan related to railway improvement

With the remarkable economic development in recent years, population and wealth have converged on the Bangkok Metropolis which has been the center of politics and economy and of industrialization, which is a driving force of growth. Together with the development of the worldwide automobile industry as well as economic growth, the number of cars in the Bangkok Metropolis increased rapidly, which has resulted in constant traffic congestion in the city. During this development, since mass rapid transit systems were not well arranged, traffic congestion became a serious problem which might hinder future prosperity. Simultaneously, the environment has seriously deteriorated.

In the 7th Plan from 1993 to 1997, these problems also have been ranked as the most important issues and their directions have been shown. However, solution of these issues can not be cleared only during these five years of the 7th Plan but they should be continued in the 8th Plan and further on.

- The position of the Bangkok Metropolis as the center of politics and economy will not be changed.

- In order to relieve excessive centralization in the Bangkok Metropolis, decentralization should be scheduled to distribute into peripheral and regional areas.

- Development which is sprawling out around Bangkok should be stopped, especially the ribbon-like development along principal roads should be controlled so as not to spread further.

- The stress of development should be shifted to the southeast and the north of the Bangkok Metropolis such as the Eastern Seaboard (ESB) which has been developed as a national project and the Upper Central Region (UCR) centering on Sara Buri which will be the center of industrial activities.

- In order to relieve traffic congestion, fulfillment of mass public transport, particularly railways and mass rapid transit systems, should be seriously considered.

Taking these points into consideration, the situation of the Study Area in a 200km radius is as follows.

- Bangkok Metropolitan Region (BMR including BMA), a region which includes Bangkok and its peripheral areas, which have already grown up as the center of politics and economy and is extremely congested with people:

  within a 50km area

- Expanded BMR including ESB and UCR to which future development will be led in order to relieve the extreme congestion in Bangkok as well as the West District centering on Racha Buri and Pecha Buri (an important developing area after ESB and UCR):

  50 to 150km area

- Nakhon Sawan in the Northern Region and Nakhon Rachasima in the Northeastern Region which are considered to be regional core cities situated at the pivot of the region near Bangkok, which has been the center of politics and economy:

  150 - 200km area

(3) Commuter service and integrated urban development

Commuter service in great city areas is the role which should be played by railways as well as mass rapid transit systems which most effectively can carry a large number of passengers reliably, fast, safely and comfortably at low cost while consuming less resources. At the same time, it discharges no fumes which might deteriorate the environment (even in a dieselized case it discharges very little fumes) with less noise (unlike automobiles which always make noise).

It can be classified into two major roles. One is to serve as transport for business and commuting in the center of Bangkok which has been extremely centralized as mentioned previously. The other is to serve as transport for commuting in a radial direction for the residential developments in suburbs.

The target of the project of commuter service dealt with in this Study is radial lines which connect the suburbs and the city center, which covers the areas up to approximately 50km from the city center. Hopewell Project sections (up to 10 to 30 km from the city center, depending on lines) will be improved by the Hopewell Project.

The commuter service is provided within the 50km radius area because a little over one hour (including the second access/egress at both ends) will be a maximum time for ordinary commuting. For this, the time on a train in a radial direction will be less than one hour. If a rapid-local-combining operation pattern is applied and passengers use mostly rapid trains (70 km/h), the areas within 50km fall under this category.

Since it is an inevitable fact that railways cannot provide door-to-door service, the combination of convenient access/egress is essential, and so a service area of a station becomes a circle centering the station. Walkable areas will be limited to very close places. (Since it is very hot in Thailand throughout the year, walking a long distance will not be accepted.) If the intervals between stations are made shorter in order to increase walkable areas, the average speed of trains will become slower due to increased stops and the areas for commuter service will decrease. As the influence of these demerits is larger, the interval between stations should be about 2.5km at the shortest.

In this section, stations including new ones will be established at appropriate intervals, and integrated urban development will be carried out as follows:

- In an area very near a station, urban development will proceed with a commercial complex connected with the station and multistoried condominiums the main feature of which will be their nearness to the station.

- In an area near a station, schools and factories will be established so that demand in the opposite direction of commuters in rush hours will be created. As a result, transport means will be used more effectively.

- In areas within several kilometers from a station, a set of access roads and traffic facilities will be established. Development for residences, local commercial centers, schools, and factories will be implemented also. A station plaza and a parking area also will be provided being adjusted with the development very near to the station.

- For areas which have been already developed ribbon-like along principal roads, a road access to the nearest station will be made in order to commute by train instead of by automobile using congested roads.

- By connecting a station with an existing road which crosses or passes near by a railway, a transport route to the city center by the railway can be provided for already developed areas along the road widely and effectively.

- Since the existing railways in Thailand have not been utilized as an urban transport means, there remain many open places within the 50km radius area so that stations and their surrounding areas can be easily developed.

In addition to a combination of rapid and local trains for commuter service, these lines are used for both regional and trunk line services. It is necessary for the lines to be used for various needs such as express, rapid, and local trains for passengers as well as for freight. Therefore, it is important to establish comprehensive arrangements of refuge tracks for smooth operation of various trains at different speed.

Reorganization of the bus network based on organic combination with the railways will be necessary together with improvement of the railways. To go to a bus terminal provided near a station and go by train to the center of the city will be better than to go on a congested road in a radial direction after improvement of the railways.

(4) Intercity express service and integrated urban development

To relieve the extreme congestion in the Bangkok Metropolis and to solve various problems which have derived from it, regional developments from the nationwide point of view as well as the introduction of ESB (Eastern Seaboard) and UCR (Upper Central Region) projects have taken place. In the study area of this Study of a 200 km radius ESB and UCR, which are important in the area, and regional core cities are situated. These strategically developing cities and regional core cities have large populations which will increase further in the future. The traffic of people among these cities and Bangkok, which is the center of politics and economy, as well as the interrelated businesses among these cities will become brisker. Therefore, the intercity express service which provides fast, reliable, safe, and comfortable features of railways should be realized because railways can operate economically obtaining a large number of passengers, realizing a modal shift. These trains can be run at 120 km/h at maximum by diesel railcars of high performance. If a train stops only at stations with many passengers getting on and off, it will be able to target an average speed of 100 km/h within straight and flat sections (the Study Area is mostly flat).

The integrated urban development in this area will be based on conditions not utilizing a railway daily, different from commuting because a completed city has its own core. Few, if any, will be commuting by railway.

An important function related both to a railway and a city is access means between both. In Thailand, most railway stations are situated apart from the center of the cities. Providing a station plaza and an access road and inducing access transport are important. In addition, development should create a subcenter consisting of facilities of use for wide area, a hotel for visitors on business, etc.

Since the Bangkok Metropolis, ESB and USR are centers of industrial development, a heavy traffic of goods are conducted there. ESB is becoming the main port for import and export taking the place of the shallow and small Bangkok Khlong Toey Port. Considerable parts of these goods are treated in bulk and in large volume and they are just suitable for railway transport, though they are transported only a short distance. To transport them is also a very important role of a railway system like intercity express service. This system can realize a modal shift from transport by large trucks to railways to decrease danger on the roads. Establishing the Lat Krabang Inland Container Depot at 25km east of Bangkok and transporting marine containers between the Laem Chabang Port and the depot will be a typical example.

(5) National/international trunk line service to be taken into consideration

One of important roles of the railway is the trunk line service. This is the main role which the SRT is playing at present. So it has established a nationwide network covering many places in the north, northeast, south and east of the Bangkok Metropolis which is a pivotal point. Main service for passengers are long distance night trains, long distance daytime trains which leave early in the morning and middle distance daytime trains. Very long trains, mainly consisting of third class cars, are operated to carry a large number of passengers at a time to maintain low cost and cheap fares. That is, it has been characterized by a role of national social welfare. It is considered that this policy will be continued for a while in the future, however, as people's income standards are raised in accordance with economic development, there is a fear that the railways will lose their competitiveness unless stress is put on conveniente and comfortable trains. At present convenience and comfort are provided only in first and second class air conditioned sleeping coaches of night trains and a few daytime intercity express trains (Sprinter).

The size of the country and distribution of cities are suitable for night trains service, but in future as standards of travels will be raised, the competition with airplanes will become severer for upper class service. It is necessary to forecast carefully both increasing trips and the decreasing share of railways.

Since Thailand is continental, there is suitable field of railway transport such as long distance freight, and it will be continued as a basic major role of the railways. Furthermore, due to changes in international affairs, it is considered that transport over boundaries will become necessary (and extension of new lines may be required).

Most present freight trains are using vacuum breaks and slow. It takes too long a time to reach a destination, which lowers transport capacity of the railways not only on freight transport but also on passenger transport. There is also the problem of at-grade crossings and it is not at a level to be able to fulfill its roles. What will be created with economic development in future are only new and high level service such as container transport including marine containers and bulk transport of oil products, cement, etc.

As mentioned above, national/international trunk line services will be an important role of the SRT from now on as well. Although they are out of the scope of this Study for the 200 km radius area, it is necessary to treat them as a base and inevitable to take them into consideration.

(6) Some examples in Japan

In Japan, there are a lot of examples of integrated railway improvement and urban development such as Tama New Town, Tama Den'entoshi, Kohoku New Town, Chiba New Town, Chiba-Ichihara New Town, Senri New Town, Senboku New Town, Izumi New Town, Seishin New Town, Hokusetsu New Town and others. All of them are large-sized new towns which were planned by regarding their respective new railway lines as the most important infrastructure and the main means of transport required to commute to the center of their respective main cities. There is also another project named New Joban Line Project which is under consideration.

Among them, three examples are mentioned below. (As for examples of integrated development further explanation is compiled in the previous chapter "Overview".)

(a) Tama Den'entoshi ("Den'entoshi" means "pastoral town".)

This new town is a project with a development area of 3200 ha, which is 18 to 36 km away from the center of Tokyo. Tokyu Corporation (a railway company) is the developer of the new town who had previously-procured land and the company to construct and operate the new railway line. The company is in charge of land readjustment on previously-procured land as well as others' land as a blanket agent and has systematically conducted all the work required for the entire development of the new town and has carried out the construction and operation of the railway line. (Fig. 1.4.5)

(b) Seishin New Town, etc. ("Seishin" means "West Kobe".)

Seishin New Town and three other new towns with a total area of 1500ha, which were developed in stretching hilly areas, are located 6 to 18km west of the center of Kobe City. The railway line was extended from the subway system operated by Kobe City. The relevant developers consisting of the City's Development Bureau, the Public Housing Development Public Corporation and private developers. Since the City took the initiative in carrying out the project, heavier than usual burdens on the developers based on the city's development policy could be realized.

In order to create the demand for railway transport in the opposite direction and to bring people's residences and places of work closer together, not only houses but also an industrial and research core, a research and educational core, a sports complex and commercial complexes were constructed. (Fig. 1.4.6)

(c) New Joban Line

Since the Tokyo Metropolitan area has continuously been developed, there are few places suitable for urban development remaining. However, the area in the north of the Joban Line (already four-tracked) toward the northeast direction remains undeveloped because there have been no radial railways from the center of Tokyo.

This project is to make urban development together with the construction of a new railway line of 60km length connecting with Tsukuba Science City (whose urban development was previously carried out, but it is 5 to 10km away from the nearest station on the Joban Line). The section of 15 km located in the built up area of Tokyo will be constructed as an underground line.

Since this project requires a huge investment of nearly ¥1 trillion, it is now carried out by the united efforts of the government and private enterprises.

In order to carry out this project, the "Special Treatment Act Relating to the Promotion of Integrated Land and Development in Large Cities....Integrated Development Act" (1989) was enacted, while the implementing body in the form of a third sector company was established by the prefectual governments concerned (1991) and others. The study of the project is now being made aimed at the execution of the project. In this project, efforts to realize recycling of value capture and internalization of the developer's profits in some form are being made.

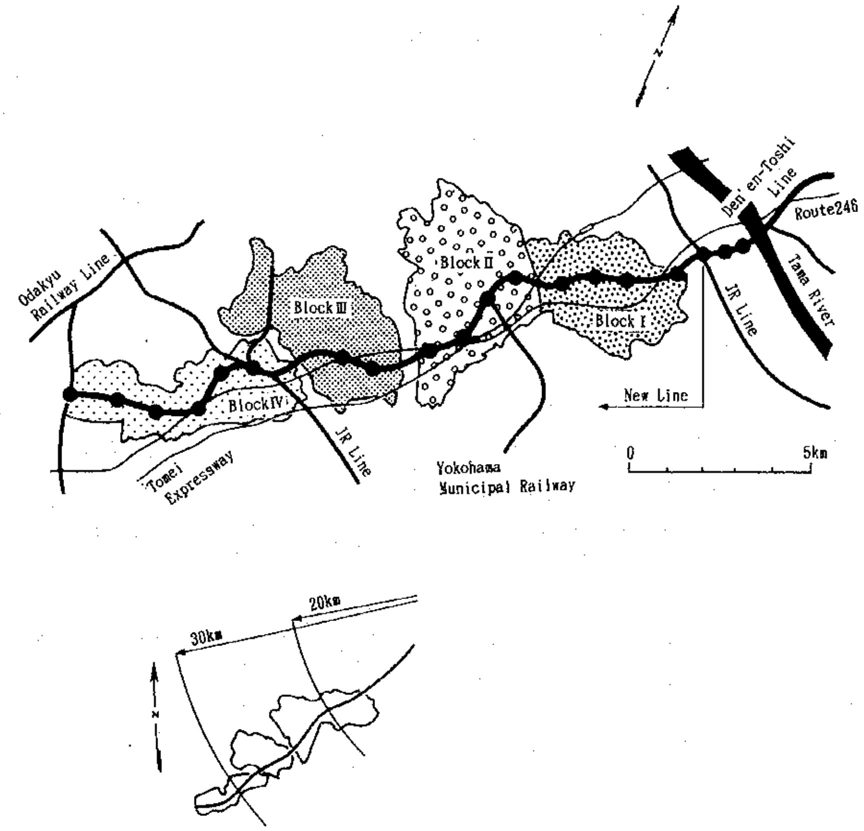


Fig. 1.4.5 Tama Den'en Toshi

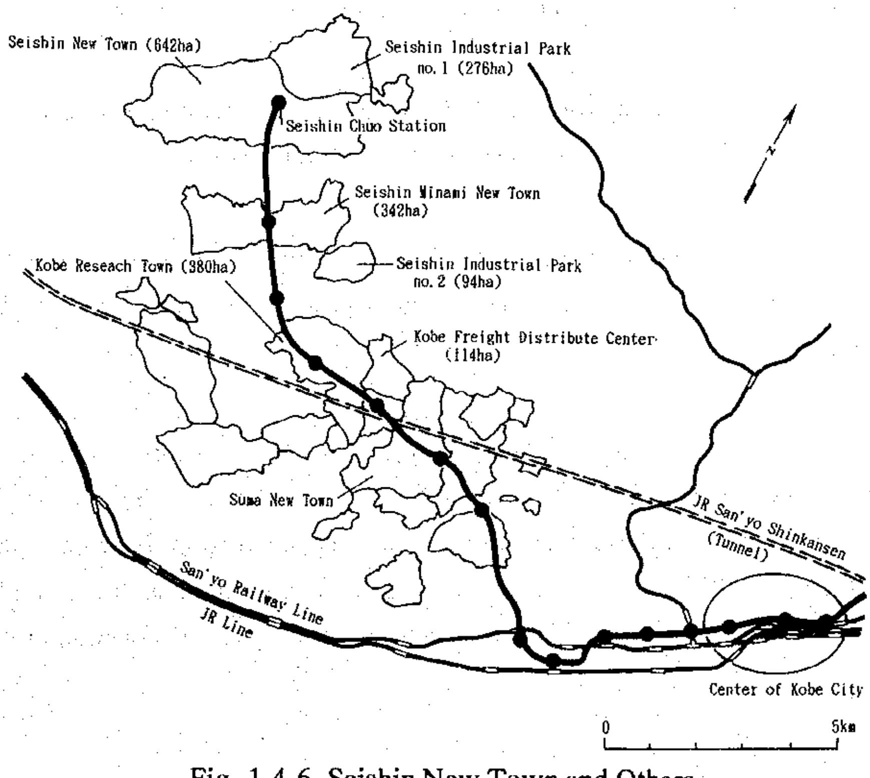


Fig. 1.4.6 Seishin New Town and Others

1.4.3 Proposed Railway Network in the Study Area

(1) Conceivable future railway network in the study area

1) Role of railways

Roles of a railway are as follows, as mentioned in "1.2".

- Commuter service in great city areas
- Regional service (for passengers and freight)
- National/international trunk line service (for passengers and freight)

The railway network in the study area (within a radius of 200 km from the center of Bangkok) should be made to fulfill these roles.

2) Present railway network

The existing railway network in the study area is shown in Fig. 1.4.7.

The lines extend from Bangkok, which is the political and economical center of Thailand, to all the country to carry out trunk line service and regional service.

Within the urban and suburban area of the Bangkok Metropolis, the lines lie radially northward, eastward, westward and southwestward from the center, which can offer commuter service.

At present commuter service only with the rolling stock and facilities on hand is enforced by the SRT. Full-scale service is expected to be provided which is the most important element of this study. Two of these lines at present are separated from the core of the city and the other lines by the Chao Phraya River, and are to be connected in the second phase of the Hopewell Project completing a cross-shaped main line system penetrating the core of the city.

3) Conceivable railway network

The existing railway network in the area has been prepared at a certain level for trunk line service and regional service and can work for commuter service. Improvement and reinforcement are expected in the future.

A conceivable railway network in the future is shown in Fig. 1.4.8. Its expected future roles on each section are as follows.

(a) Commuter service

Commuter service is to be provided for the area within a radius of "50 km" from the center of the city. The lines extend radially from the center in the northern, eastern, western and southwestern directions at present. These lines are located in good positions for urban development without contradiction on development regulations. The missing links at the Chao Phraya River are to be connected in the second phase of the Hopewell Project, forming cross-shaped alignment of main lines.

(New lines for commuter service)
An important step to be taken from now on may be to promote the development of ESB, UCR and regional cities as well as to contrive recentralization. The position of the Bangkok Metropolis as the center of politics and economy will remain unchanged; even if the extent of such centralization may be decreased more or less, centralization in Bangkok will continue to exist.

In the Bangkok Metropolis, it is important to promote residential development so that a good living environment may be ensured without leaving any environment and resource problems. For this purpose, the existing lines extending radially in four directions from the urban district to the suburbs should be improved and reinforced for commuter service. For further development of the area, additional preparation and intensification of radial lines may be contrived subsequent to or in parallel with the improvement of the existing lines.

Although many routes may be planned to extend radially unless they contradict with regulation on land use, in consideration of the total amount of investment two routes in the north-eastern and north-western directions would be listed as a first step. In the future beyond the target year of this study, more radial commuter railway lines would be provided. For example, commuter service for a population of about 30 million in the Tokyo Metropolis are provided by 30 double track lines of radial direction.

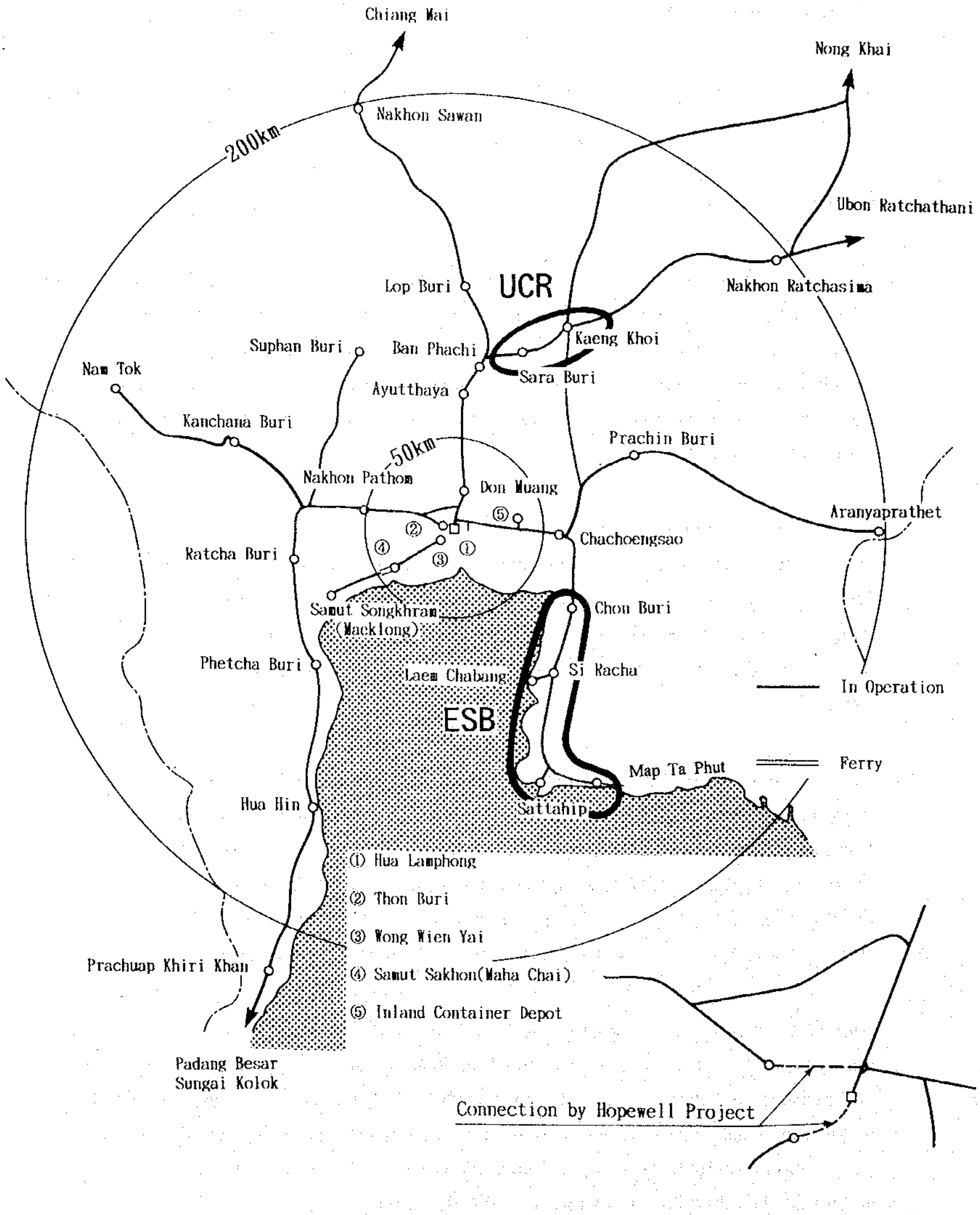


Fig. 1.4.7 The Existing Railway Network

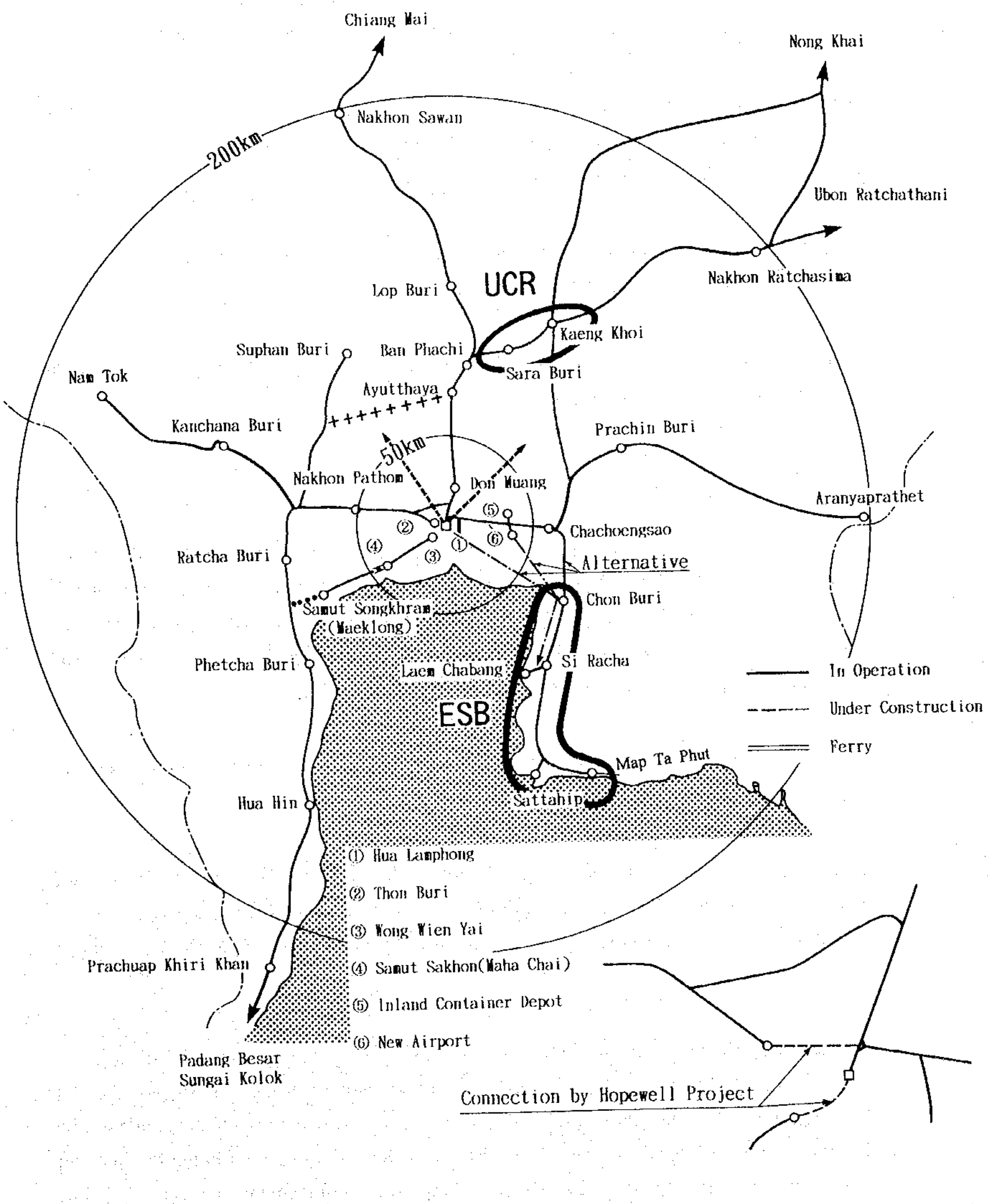


Fig. 1.4.8 Conceivable Railway Network

Such new lines in a radial direction have no other role as trunk lines, so they need not be prepared as new lines of the SRT. For these lines, underground routes in the center of the city will be necessary or they can be extensions of subway or other mass rapid transit lines.

As to the Maeklong Line, it has a missing link at Tha Chin River connected by the ferry at present. In order to extend full-scale commuter service toward Maeklong (Samut Songkhram), it is necessary to be connected by a bridge.

In addition to the new lines above, branch lines such as the ones to the New Airport and to a planned new town are to be planned.

The commuter service network at present and a conceivable network in the future are shown in Fig. 1.4.9 (i), Fig. 1.4.9 (ii) and Fig. 1.4.9 (ix).

(b) Regional service

Regional service is focused on organical connection in the area within a radius of 200 km from the center of Bangkok. The area covers Bangkok which is the political and economic center of the country, pivotal cities of the national development such as the Eastern Seaboard (ESB) and Upper Center Region (UCR) and regional core cities such as Nakhon Sawan and Nakhon Rachasima which are foothold cities of the Region.

Expected service is intercity expresses by fast, reliable and comfortable trains between Bangkok and other cities and among the cities.

Another service is middle distance large volume shuttle freight transport, which is expected to be provided between ESB and UCR through the Kaen Khoi – Khlong Sip Kao line by-passing Bangkok, between the Laem Chabang Port and the Lat Krabang Inland Container Depot, etc.

Concerning the Eastern Line toward the Eastern Seaboard, many large national projects such as the Eastern Seaboard Development, the Second Bangkok International Airport, the Rat Krabang Inland Container Depot and various related projects are being executed, and the line is expected to be improved and reinforced. This has alternatives of reinforcing the line and constructing a short-cut line to Chon Buri. About the reinforcement of the railway line connecting Bangkok and ESB, another study was also carried out on the "High Speed Train

Study" which was completed in March, 1994. In this Study, it is examined as reinforcement of the Eastern Line and selection of the alternatives will be carried out coordinating with that study.

(New lines for regional service)
The Maeklong Line is divided and separated from the rest of the railway network by three large rivers (the Chao Phraya River, the Tha Chin River and the Maeklong River) and only a few sections of 17 km between Samut Songkhram and Pak Tho on the Southern Line. At the Chao Phraya River, it is to be connected with the Northern Line in the second phase of the Hopewell Project. At the Tha Chin River it is also expected to connect for commuter service. When all the missing links are connected, the Maeklong Line can be a trunk line connecting Bangkok with the southern area 40 km shorter than the existing detouring Southern Line and intercity expresses between Bangkok and Phetcha Buri/Hua Hin will be made advantageous in the competition with road transport.

A conceivable regional service network in the future is shown in Fig. 1.4.9 (iii), Fig. 1.4.9 (iv) and Fig. 1.4.9 (x).

(c) Trunk line service

The railway network which connects Bangkok, the center of politics and economy having a port as a gateway for imported and exported goods, with other nationwide regions in the northern, northeastern, eastern, western and southern directions was completed long ago and has served as arteries of Thailand.

Although the share of the railways has decreased owing to the preparation of a road network and development of automobiles, the railways will continue to play an important role of trunk line service. The trunk line service network at present with the study area is shown in Fig. 1.4.9 (v) and Fig. 1.4.9 (vii).

(New lines and routes for trunk-line service)
The railway network for trunk line service which is to cover the whole country and neighboring countries may be regarded as having been completed.

At present the emphasis on nationwide development is on the Eastern Seaboard (ESB) and Upper Central Region. Transport from/to these area as well as Bangkok will become prominent. Especially the position of ESB as a gateway to Thailand and neighboring countries as well will rise. The new line connecting ESB with UCR and the northeastern and northern regions directly has just been completed.

Subsequently, emphasis will also be put on promoting development of the Southern Seaboard and establishing an additional gateway facing the Andaman Sea which will link Thailand and other neighboring inland countries with western countries without passing through the Strait of Malacca which is narrow and crowded with ships. In line with these requirements, a new line connecting the southern region with the northern and northeastern regions is expected.

The future railway network will be required that freight (except that arriving in/departing from Bangkok) does not pass through Bangkok where traffic is very congested. The Kaeng Khoi J. – Khlong Sip Kao new line just completed and the expected Ayutthaya – Nong Pla Duk J. new line mentioned above will meet this requirement.

The short-cut line through the Maeklong Line mentioned above will work for trunk line service as well as regional service.

A conceivable trunk line service network in the future is shown in Fig. 1.4.9 (v) – Fig. 1.4.9 (viii b).

4) Future possibilities

In the above network, the major portion will provide all of the commuter, regional and trunk line services. The question is how to correspond with the increase in demand accompanied by the economic growth and development of the Bangkok Metropolis (within a radius of 200 km from the center).

In the existing network (including the lines just completed), land with a width of 40 m and over (14 to 20 m in the Maeklong Line) has already been secured and a line of three double-track or four-track with roads on both sides may be built whenever required. A four-track line has a capacity more than twice as large as that of a double-track line because it can handle separately different kinds of trains with different speeds. In addition, by providing by-pass lines, competition between commuter service and transport of a considerable amount of freight may be avoidable. Consequently, considerable commuter service for the future may be fully available.

Although the number of tracks for SRT railways is restricted to double or triple in the Hopewell Project area, the commuter trains in the sections operated by the Hopewell Project may serve as local trains, so that, the capacity corresponding to four-track lines in total may be expected. In case three double-track lines are introduced in the future, a direct underground route to the center of the city will be required. However, the development achieved to such extent may acquire sufficient economic capacity to cope with such a ituation.

(2) Proposed railway network

A conceivable future railway network in the study area is shown in the previous paragraph. In the long view, it will be necessary to provide all of this. Taking into consideration the National Economic and Social Development Plan and the national projects as well as the related studies such as the "Metropolitan Regional Structure Planning Study" and the "Strategic Planning for Metropolitan Bangkok", a proposed future railway network in the study area with the target year of 2010 is to be examined.

A proposed railway network in 2010 in the study area is shown in Fig. 1.4.10 and the bases of the selection are as follows.

(a) Commuter service

Until the target year of 2010, emphasis on urban development is put on the corridors toward the two big development projects of the Eastern Seaboard (ESB) and Upper Central Region (UCR), the two projects of decentralizing government agencies adjacent to Chachoengsao and Nakhon Pathom, another big project of the Second Bangkok International Airport (SBIA) and related developments, and the evolving satellite urban sub-centers along the Outer Ring Road. The railway network required by the above will consist of the Eastern Line (Bangkok – Chachoengsao) the Northern Line (Bangkok – Ayutthaya), the Southern Line (Bangkok – Nakhon Pathom) and the Maeklong Line (Bangkok – Maha Chai). A branch line for the SBIA Project and well-planned connections between the Outer Ring Road and each line are necessary. On the Outer Ring Road an express bus system or a mass rapid transit system (in future stage) will be provided.

In other radial directions, no development project is planned until the target year of 2010. Therefore, commuter service lines in the northeastern and north western directions will be expected to be provided beyond the year 2010, and in the area along the Maeklong Line beyond the Tha Chin River as well.

(b) Regional Service and trunk line service

At present, the nationwide large development projects are in the ESB and UCR which are distributed in he easterly area. Projects in the westerly and southerly areas such as the Southern Seaboard development project are allocated in later turns. New lines connecting the Southern Line with Ayutthaya and extending the Maeklong Line to the Southern Line will be required after the year 2010.

Completion of the Maeklong Line through Hua Lamphong to Pak Tho (on the Southern Line) needs to be supported by development projects promoting both commuter transport and trunk line transport. While it is allocated beyond the year 2010, it is a preferable project for the SRT network. Therefore, it should be taken into consideration in planning improvement of the Maeklong Line.

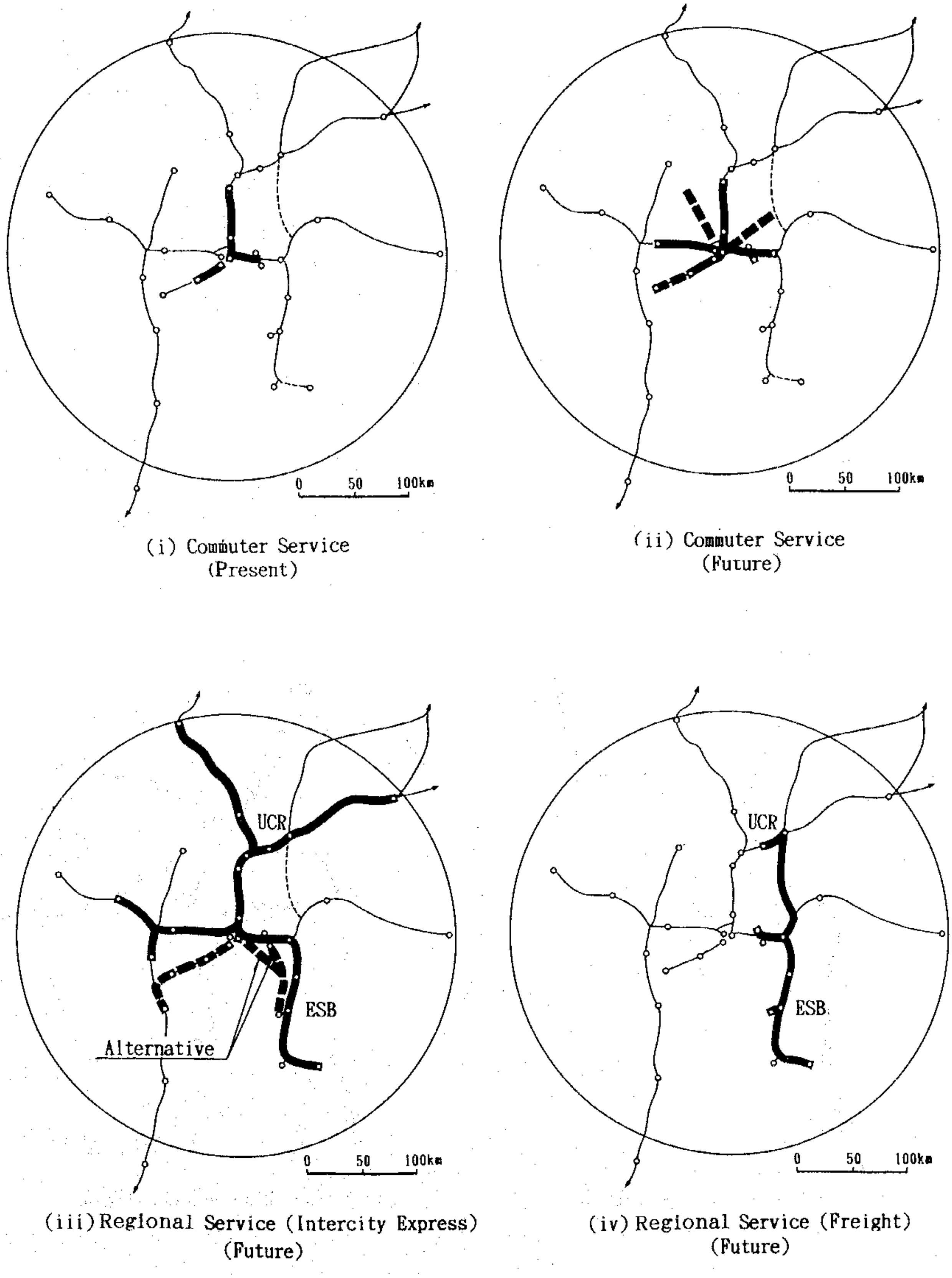
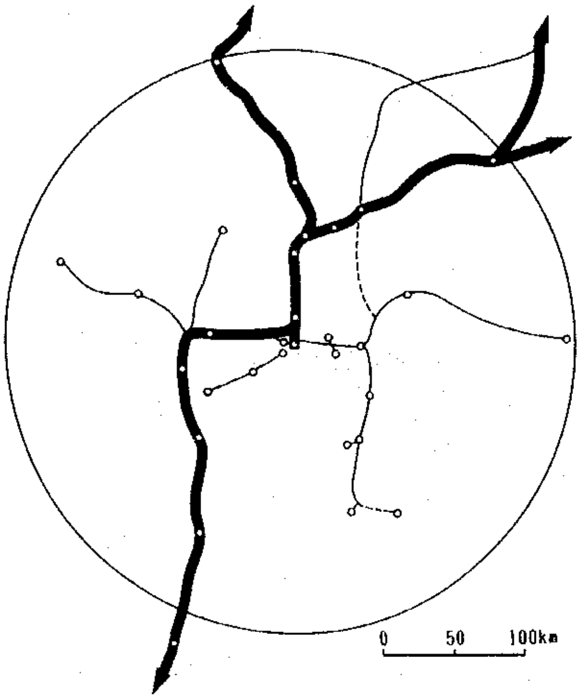
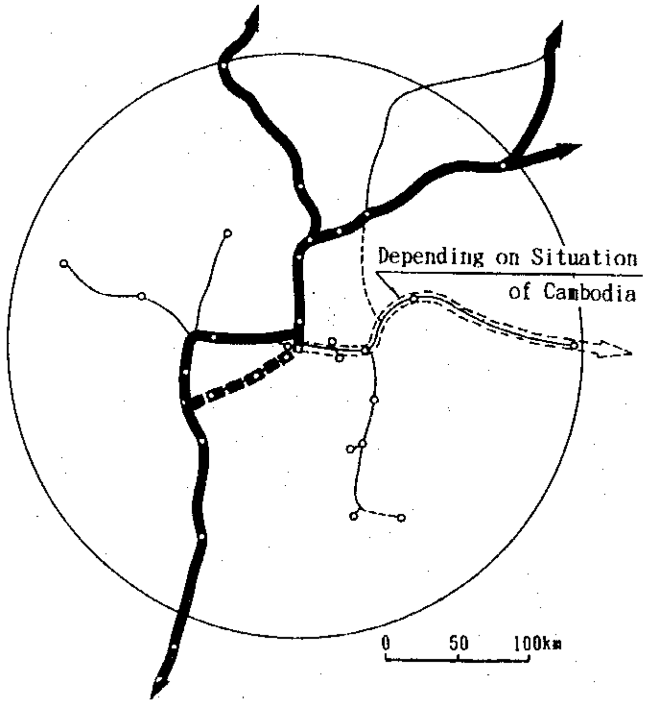


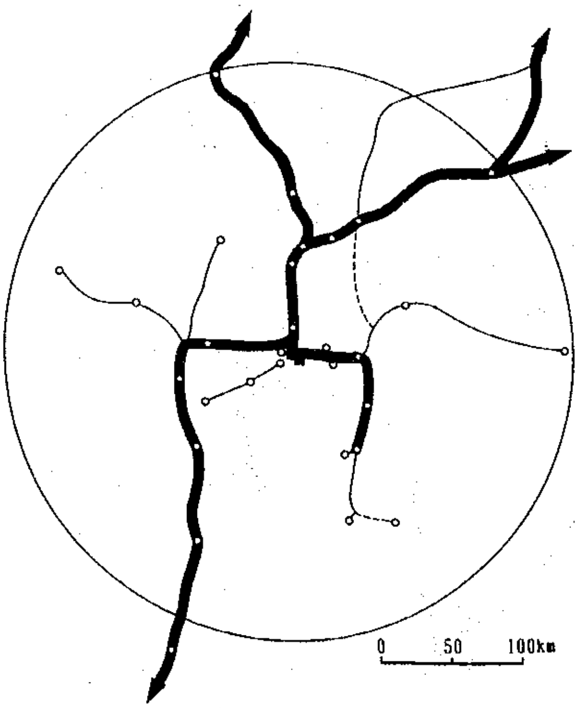
Fig. 1.4.9 Routes of Each Role in Network (Present and Future) (1)



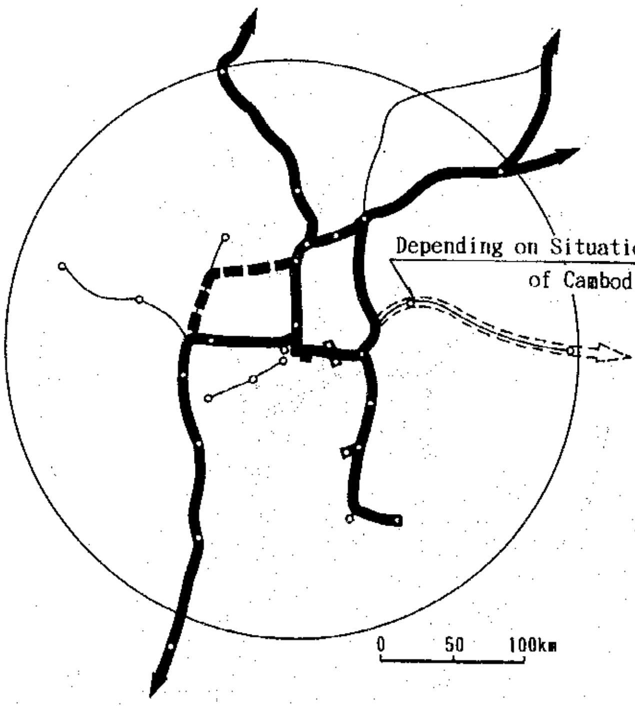
(v) Trunk Line Service (Passenger)
(Present)



(vi) Trunk Line Service (Passenger)
(Future)

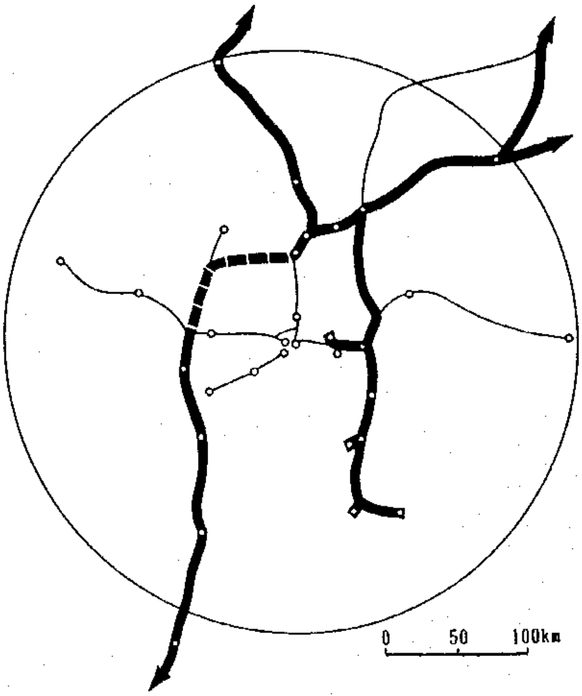


(vii) Trunk Line Service (Freight)
(Present)

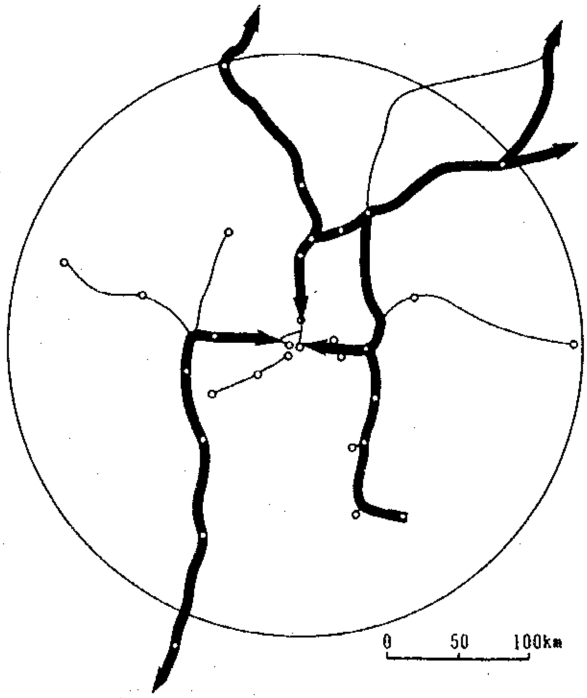


(viii) Trunk Line Service (Freight)
(Future)

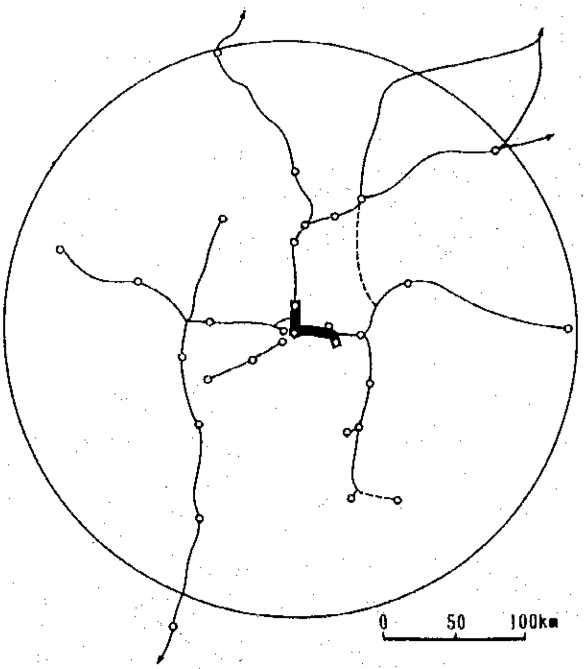
Fig. 1.4.9 Routes of Each Role in Network (Present and Future) (2)



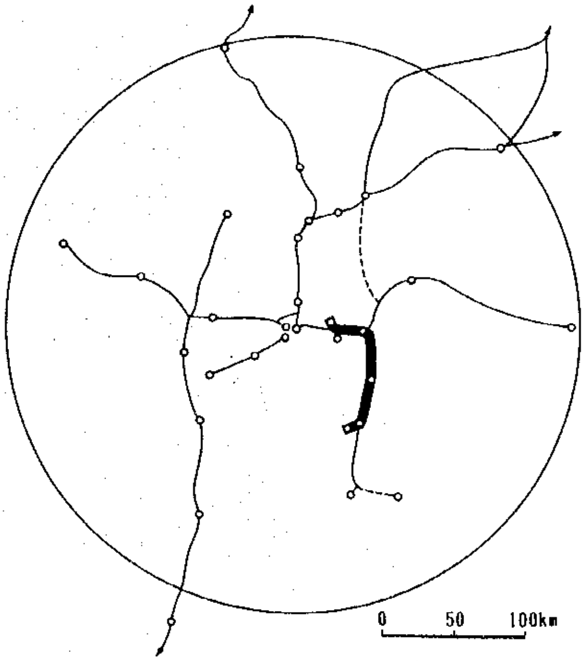
(viii.a) Trunk Line Service(Freight)
(Routes of freight which by-passes Bangkok)
(Future)



(viii.b) Trunk Line Service (Freight)
(Routes of freight which arrives at / departs from Bangkok) (Future)



(ix) Service Related to New Airport
(Passenger)
(Future)



(x) Service between ICD and Port (Freight)
(Future)

Fig. 1.4.9 Routes of Each Role in Network (Present and Future) (3)

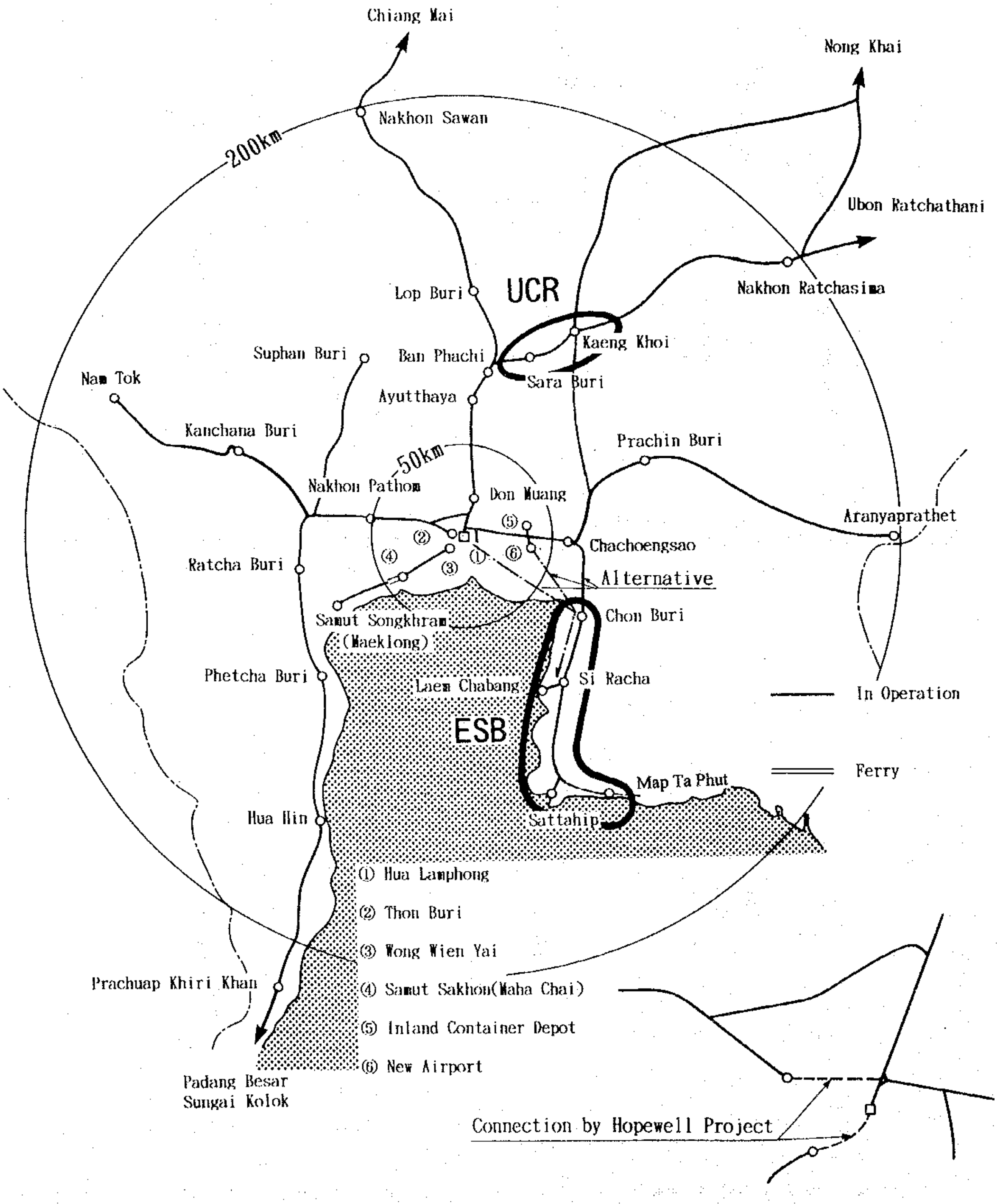


Fig. 1.4.10 Proposed Railway Network

1.5 Demand Forecast

1.5.1 Railway Network

The railway transport system proposed in the preceding chapter is translated into the 200 km area Railway Traffic assignment network shown in the Fig. 1.5.1.

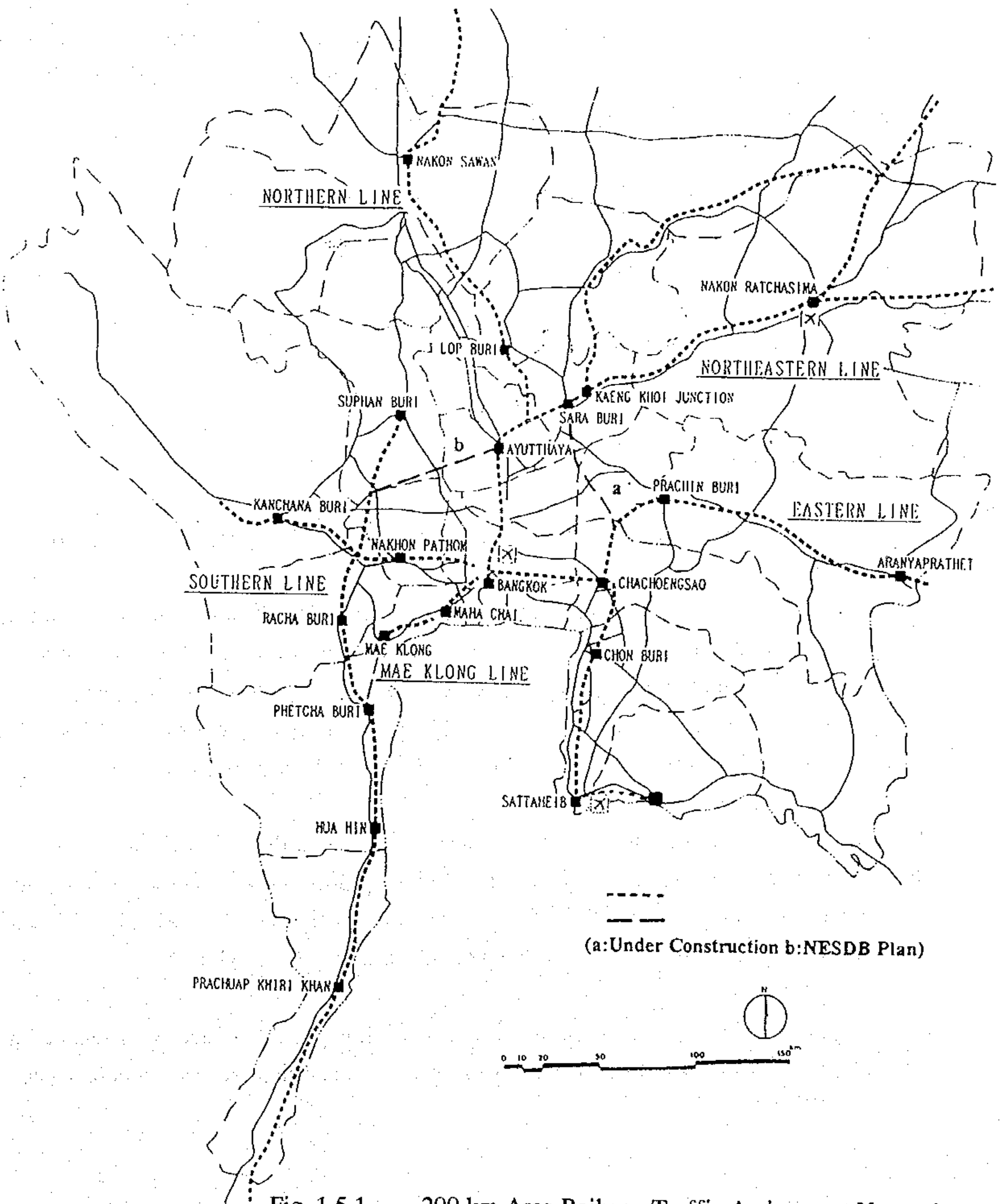


Fig. 1.5.1 200 km Area Railway Traffic Assignment Network

1.5.2 Demand Forecasting

(1) Introduction

The purpose of demand forecasting procedure is to examine the railway traffic volume of SRT for 200 km which is mainly consist of medium distance trips (regional train) and Bangkok commuter trips (commuter train). Emphatize should be put on getting general information to enable to examine the development directions and available transport policies for SRT improvement but detail examination of each alternatives. The examined items in the traffic simulation section are as follows;

1) Person trip pattern around 200 km area around Bangkok in year 1990 and 2010

2) Potential railway catchment area

3) Railway traffic demand volume

(2) Traffic simulation

1) Person trip pattern in and around 200 km area around bangkok in year 1990 and 2010

Person trip pattern around Bangkok had examined to evaluate planning direction of railway network for 200 km area. Present (1990) trip pattern is shown in Fig. 1.5.2 and future trip pattern is shown in Fig. 1.5.3. Both figures show that O-D trip distribution pattern will not change much in the planning period. Linkages between Bangkok area and Maha Chai, Chachoengsao, Supan Buri will continue to be conspicuously also strong in future.

The structure of O-D trip distribution becomes clearer when the O-D trips are assigned to the spider network which is a hypothetical network connecting zone centroids adjacent to each other with straight lines. When comparing the two figures for 1990 (Fig. 1.5.4) and 2010 (Fig. 1.5.5) concentrate trend to Bangkok area are very impressive.

As a development strategy of future railway network, it is possible to accomodate spital trip by strengthening present railway network pattern without addition to circumstantial route.

Table 1.5.1 ALL - OD Matrix by Aggregated Zone Level (Year 2010)

PUBLIC TRAFFIC FLOW BY REGION (AGGREGATED ZONE LEVEL)

	1	2	3	4	5	6	7	8	9	10	11	TOTAL
1	10608	641	335	36	146	123	60	147	139	6	141	12383
2	658	242	34	6	17	31	9	22	29	1	23	1072
3	302	32	95	17	27	13	7	19	16	0	31	563
4	32	5	14	17	8	3	1	5	4	0	48	137
5	122	14	28	7	34	8	11	37	13	0	23	298
6	94	26	13	2	8	74	10	16	49	13	16	321
7	50	7	10	1	11	11	7	15	5	0	8	125
8	129	28	23	5	40	20	17	0	7	0	0	261
9	138	30	21	5	15	62	7	9	0	0	0	287
10	4	0	0	0	0	14	0	0	0	0	1	20
11	127	21	28	47	26	19	9	0	0	0	0	277
TOTAL	12269	1038	601	143	332	380	138	270	262	20	291	15744

NOTE : LESS THAN 1000 TRIP IS OMITTED (YEAR 2010 : 1,000 TRIP)
: INTRA TRIP IN SMALL ZONE LEVEL IS OMITTED

Table 1.5.2 Potential Railway OD Matrix (Year 2010)

PUBLIC TRAFFIC FLOW IN RAILWAY USER POTENTIAL AREA BY REGION

	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
1	1434	548	485	163	26	16	17	11	5	47	39	1	37	2828
2	752	940	231	120	12	6	13	10	3	29	31	1	27	2175
3	721	227	437	154	9	8	10	6	3	28	24	1	42	1670
4	336	156	186	335	7	6	9	5	2	22	21	1	62	1157
5	29	9	8	4	7	2	2	1	0	13	6	0	6	87
6	17	6	7	3	2	8	1	0	0	9	2	0	3	59
7	17	10	7	5	2	0	36	6	2	9	20	2	9	125
8	12	9	4	3	1	0	6	2	2	4	18	5	4	69
9	6	3	2	1	0	0	3	2	0	3	0	0	3	23
10	56	24	25	14	15	9	11	5	4	0	7	0	0	170
11	53	29	23	15	8	8	27	22	0	9	0	0	0	189
12	1	0	0	0	0	0	2	8	0	0	0	0	1	12
13	45	23	38	51	7	8	10	5	3	0	0	0	0	185
TOTAL	3479	1993	1453	868	96	60	147	83	24	173	168	11	194	8749

NOTE : LESS THAN 1000 TRIP IS OMITTED (YEAR 2010 : 1,000 TRIP)
: INTRA TRIP IN SMALL ZONE LEVEL IS OMITTED

Table 1.5.3 Railway Available user OD Matrix (Year 2010)

PUBLIC TRAFFIC FLOW IN RAILWAY USE AVAILABLE AREA BY REGION

	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
1	219	193	74	38	9	2	4	3	3	15	27	0	11	598
2	257	189	83	69	7	1	7	5	2	16	16	0	27	679
3	77	93	21	4	4	0	6	4	3	3	24	0	0	239
4	62	105	10	0	3	0	5	3	2	1	18	0	1	210
5	11	5	3	2	0	0	0	0	0	0	5	0	5	31
6	2	1	0	0	0	0	0	0	0	0	2	0	1	6
7	5	4	4	3	0	0	0	0	0	0	0	0	9	25
8	4	3	3	2	0	0	0	0	0	1	0	0	4	17
9	3	1	2	1	0	0	0	0	0	3	0	0	3	13
10	19	11	4	1	0	0	0	2	4	0	7	0	0	46
11	34	14	23	1	0	3	0	0	0	9	0	0	0	90
12	0	0	0	0	0	0	0	0	0	0	0	0	1	1
13	18	23	0	1	6	1	10	5	3	0	0	0	0	67
TOTAL	711	642	227	122	35	7	32	22	17	48	99	0	62	2024

NOTE : LESS THAN 1000 TRIP IS OMITTED (YEAR 2010 : 1,000 TRIP)
: INTRA TRIP IN SMALL ZONE LEVEL IS OMITTED

2) Potential railway catchment area

From initial demand forecasting results, rail user demand will be 483 thousand passengers per day in 2010 even after improvement of railway system, if mode choice characteristics validated by present traveling pattern. This values only 3% of total public trip. This is mainly because potential railway users generally distributed quite limited area around station. To examine this trend, finer zones aggregated to 11 zones and made three aggregated O-D matrixes. Table 1.5.1 shows public O-D matrix in year 2010, table 1.5.2 shows potential railway user O-D matrix made by aggregated zones in which SRT station located. Table 1.5.3 shows railway available user O-D matrix made by finer zones in which SRT station located. Future railway demand volume 483 thousand values 23.8% for railway available public transport users.

These results shows that railway catchment areas are limited to rather small area. In other words, there are possibilities to increase railway users if railway catchment area can be expand to bigger area. Introduction of new railway line required quite big investment. Therefore it is recommendable to introduce access transport improvement rather than new line.

(3) Railway traffic demand volume

Considering above mentioned two analysis, feeder service improvement, and comprehensive transport fare system and finally urban development area examined.

Table 1.5.4 Railway Traffic Demand in Year 2010

	Do Minimum		Railway Improvement		Railway Improvement Feeder Service*		Railway Improvement Feeder Service * Fare System**	
Total		360		483		825		1056
	Commuter	Medium Dis.	Commuter	Medium Dis.	Commuter	Medium Dis.	Commuter	Medium Dis.
Sub-total	313	47	419	64	714	111	914	142
Northern	186	18	249	18	425	31	544	40
Eastern	54	18	72	25	123	43	157	55
Southern	17	16	23	21	38	37	49	47
Mae Klong	56		75		128		164	
Total		411		670		1194		1533
	Commuter	Medium Dis.	Commuter	Medium Dis.	Commuter	Medium Dis.	Commuter	Medium Dis.
Sub-total	338	73	582	88	1059	135	1366	167
Northern	201	18	327	22	600	36	744	45
Eastern	58	24	101	30	138	48	263	68
Southern	20	31	71	36	115	54	164	62
Mae Klong	59		83		146		198	

* Average Access + Egress time decrease 30%

** Average Access + Egress cost decrease 30%

(Unit : 000 Trip/Day)

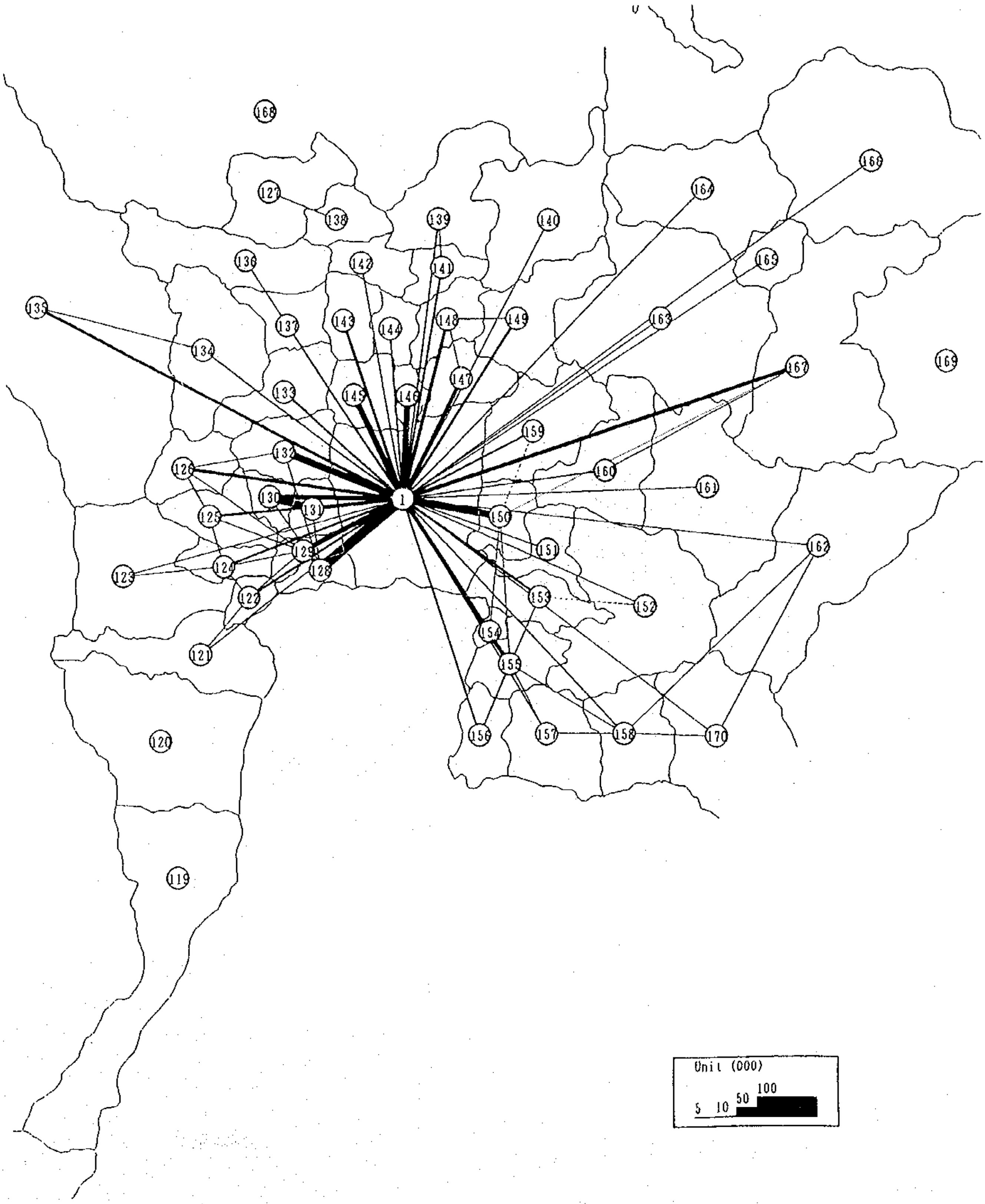


Fig. 1.5.2 OD Person Trip from, in and around Bangkok 1990

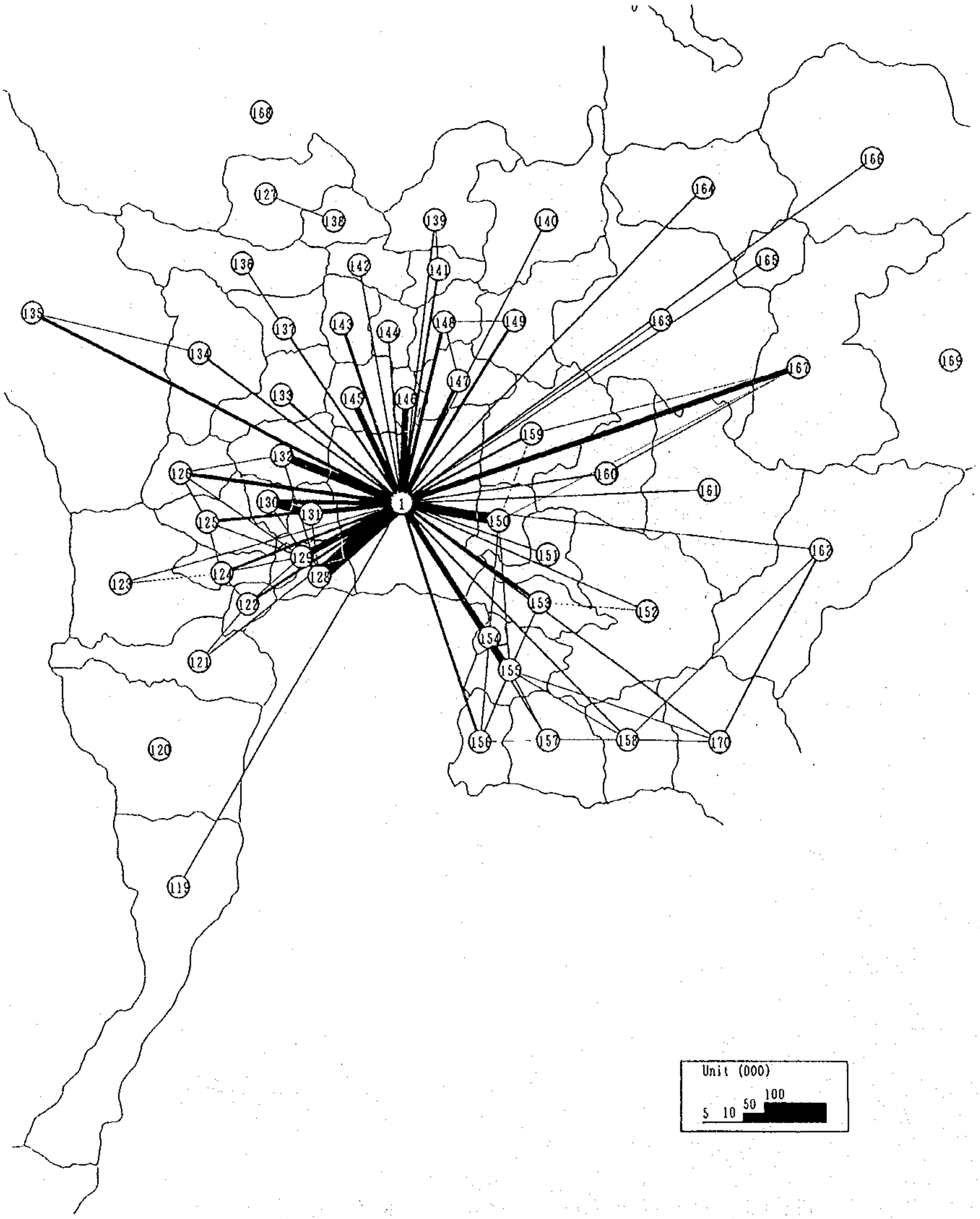


Fig. 1.5.3 OD Person Trip from, in and around Bangkok 2010

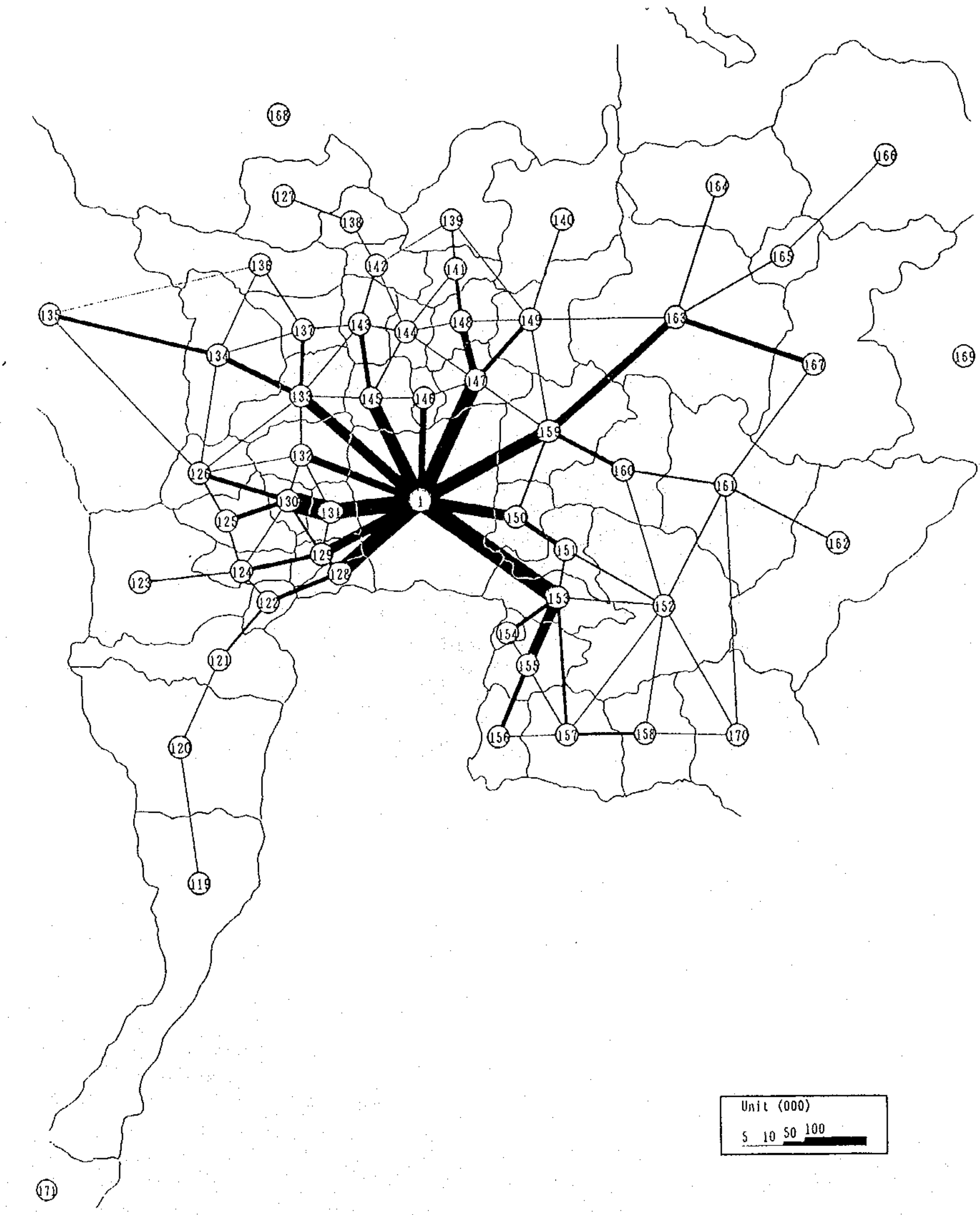


Fig. 1.5.4 Spider Trip Bangkok 1990 (Person)

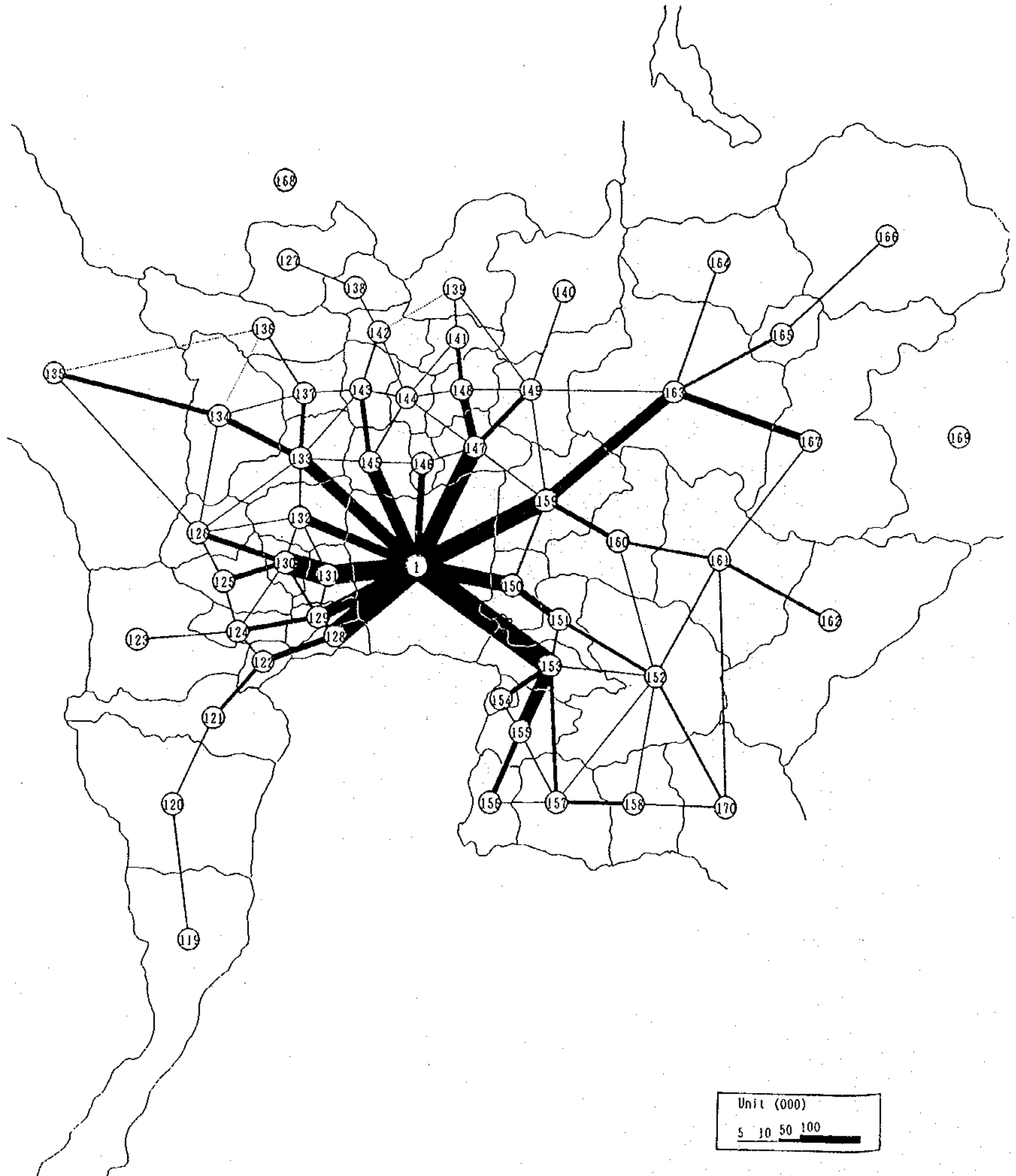


Fig. 1.5.5 Spider Trip Bangkok 2010 (Person)

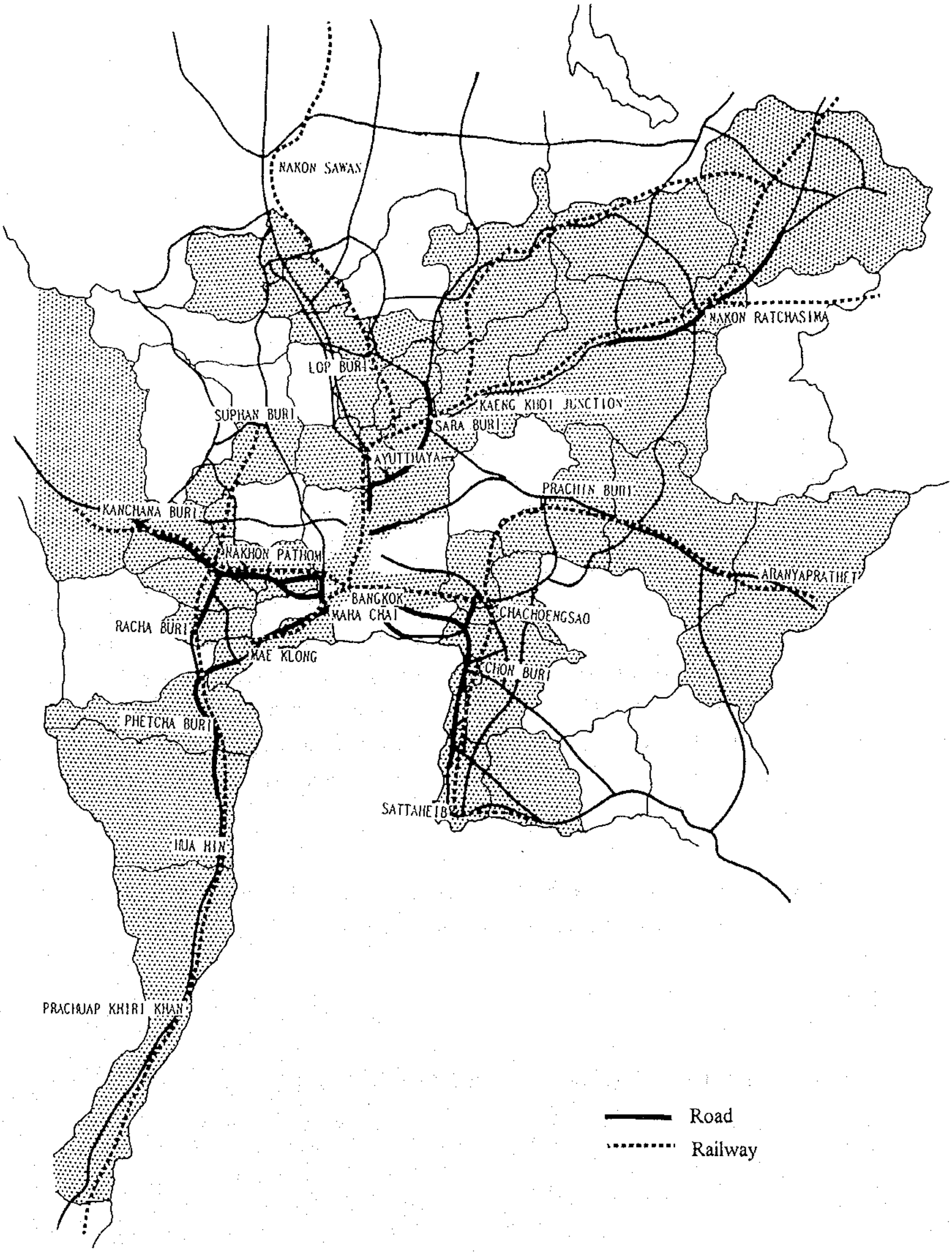


Fig. 1.5.6 Potential Railway Area

1.6 Railway Improvement Plan

1.6.1 Application of Demand Forecast

(1) General

The demand forecast is carried out for railway improvement planning. Its details are described in the previous paragraph (1.5).

The railways in the Study area of a 200 km radius should play the roles of

- Commuter service,
- Regional service (Intercity express service) and
- National/international trunk line service.

National/international trunk line service is out of the scope of this Study. However, the service is provided utilizing the same railway facilities. Therefore, it should be taken into consideration to a certain level. There is no useful data to make a plan for the trunk line service. Information that demand will grow to 2 to 4 times or more of the current demand is shown in some materials, but it is not clear enough. Accordingly, for planning improvement for regional intercity express service, additional crossing loops and refuge tracks are assessed as requirement for establishment of the service whether the lines be double-tracked or not.

As for commuter service, its traffic volume is much larger than trunk line service and improvement should be planned mainly for commuter service.

(2) Basic service plan

Basic service plan to be preconditions of demand forecast are as follows.

(a) Commuter service

a) Section

Eastern Line	Yommarat - Chachoengsao
Northern Line	Hua Lamphong - Ayutthaya
Southern Line	Yommarat - Thon Buri - Nakhon Pathom
Maeklong Line	Hua Lamphong - Won Wien Yai - Maha Chai

b) Headway

Rush hours	10 minutes (Rapid-local-combining operation)
Off peak	20 minutes (Rapid-local-combining operation)

c) Average schedule speed

65 km/h (Simplified by averaging among stations at which rapid trains stop and do not stop on rapid-local-combining operation)

d) Fare

0.215 baht/km (Current third class)
0.44 baht/km (Current second class fare)
1.0 baht/km (Upper limit, equivalent to the proposal of the Hopewell Project)

(b) Intercity express service

a) Section

Eastern Line	Hua Lamphong - Chon Buri - Map Ta Phut (- Rayong)
Northern Line	Hua Lamphong - Nakhon Sawan
Northeastern Line	(Hua Lamphong -) Ban Phachi Junction - Nakhon Rachasima
Southern Line	Hua Lamphong - Hua Hin
	- Kanchana Buri

b) Headway

1 hour

c) Schedule speed

100 km/h (70 km/h: Kaen Khoi J. - Pak Chong, mountainous area)

d) Fare and Charge

0.6 B/km (Averaged, including charge and seat-reservation, about 2nd-class fare x 1.5)

(3) Application of estimated demand

The results of the forecast of commuter service is shown in Fig. 1.6.1 and that concerning the intercity express service is shown in Table 1.6.1. They are applied in making the improvement plan.

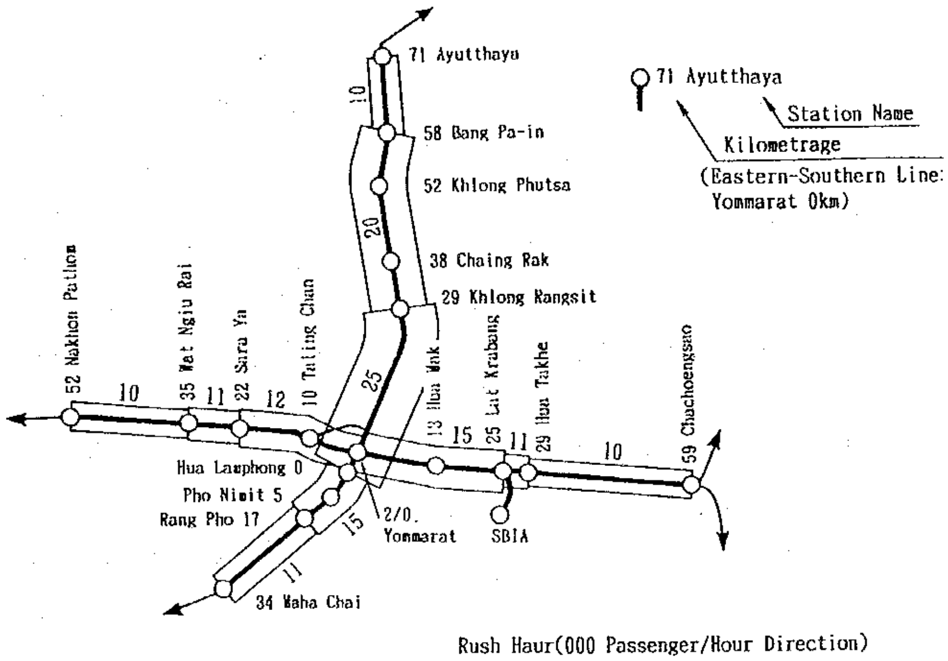
Table 1.6.1 Estimated Traffic Volume of Intercity Express Service

Passengers/Day-Direction

Section \ Year	1997	2000	2010
Hua Lamphong - ESB	1,700	2,400	5,300
Hua Lamphong - Nakhon Sawan	1,350	1,600	3,000
Hua Lamphong - Nalchon Ratchasima	1,400	1,100	3,200
Hua Lamphong - Hua Hin	1,550	1,900	3,600
Hua Lamphong - Kanchana Buri	1,350	1,600	3,000

Remarks:

- Estimation is based on the demand of air-conditioned bus service in 1993.
- Growth rate is according to the GDP.
- In 1997 service will be started of 2 hours headway as trial.
- In 2000 service will be reinforced to 1 hour headway as ful-scale service.



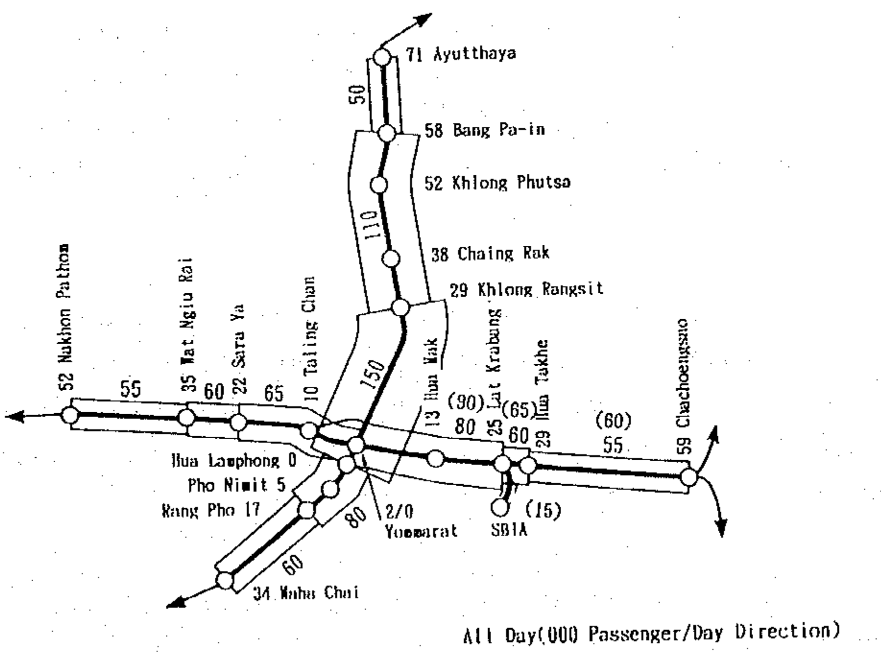


Fig. 1.6.1 Estimated Traffic Volume of Commuter Service

1.6.2 Service and Transport

Based on the estimated demand described in preceding paragraph, the railway improvement plan is to be made.

As for the service plan for making up facilities and the rolling stock plan, the basic service plan described in the preceding paragraph is applicable, because the results of demand forecast have not required its re-examination. The transport plan is basically as follows.

(a) Commuter service

The commuter service in this project is connecting urban and suburban Bangkok Metropolis radially within the area of a "50 km" radius.

Therefore, trip length for commuters is rather long and requires rapid transport.

In Thailand, people do not wish to walk long distances because of the climate. Accordingly, the areas people can reach on foot from a station are very small. Therefore, a railway system needs an access means to cope with such a situation. In such conditions, to provide many stations at short distances is not effective and besides makes the schedule speed low being contrary to the rapid transport required.

From such a view point, station arrangement at not so short distances is proposed based on rapid-local-combining operations (about 2.5 km respectively). Generally, stations at which rapid trains stop are allocated to every fourth station, taking into consideration operation of 2 rapids and 1 local every 10 minutes in the final stage of double-track operation in the future. This concept is shown in Fig. 1.6.2.

In order to utilize the facilities effectively, in rush hours commuter transport will be of high priority in the same way as it is at present.

An outline of the proposed commuter service routes and stations is shown in Fig. 1.6.3.

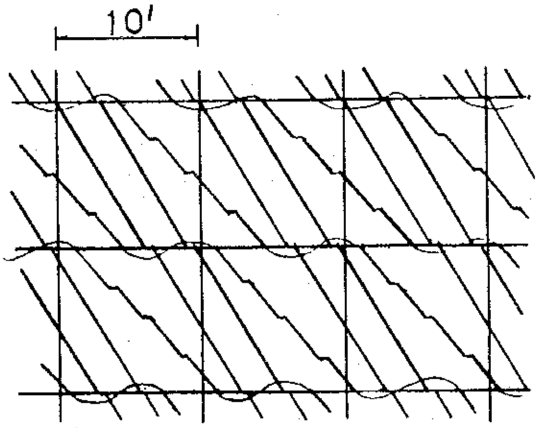


Fig 1.6.2 Proposed Operation Pattern

(b) Regional service (Intercity express)

Intercity express service raises the level of railway service with fast, reliable and comfortable trains.

In the first step, the service will commence utilizing new high quality and high performance diesel railcars at available speed on the existing facilities at two hours headway, anticipating people will recognize the usefulness of railway service.

In the second step, the service will be improved and reinforced. Speed-up and headway of one hour will be carried out. One hour headway is convenient enough if train operation is reliable. Therefore, after this step, the number of cars of which a train is made up will be increased corresponding to traffic demand.

As improvement work of this project, additional crossing loops and refuge tracks including signalling systems and other related equipment are applied for in the Master Plan, because traffic demand for trunk line service is not clear enough to calculate the necessary facilities exactly. They are estimated to be one for every 20 km (in the sections having no concrete track-doubling plan) or 40 km (in the other sections).

An outline of the proposed intercity express service routes and stations including new stations is shown in Fig. 1.6.4.

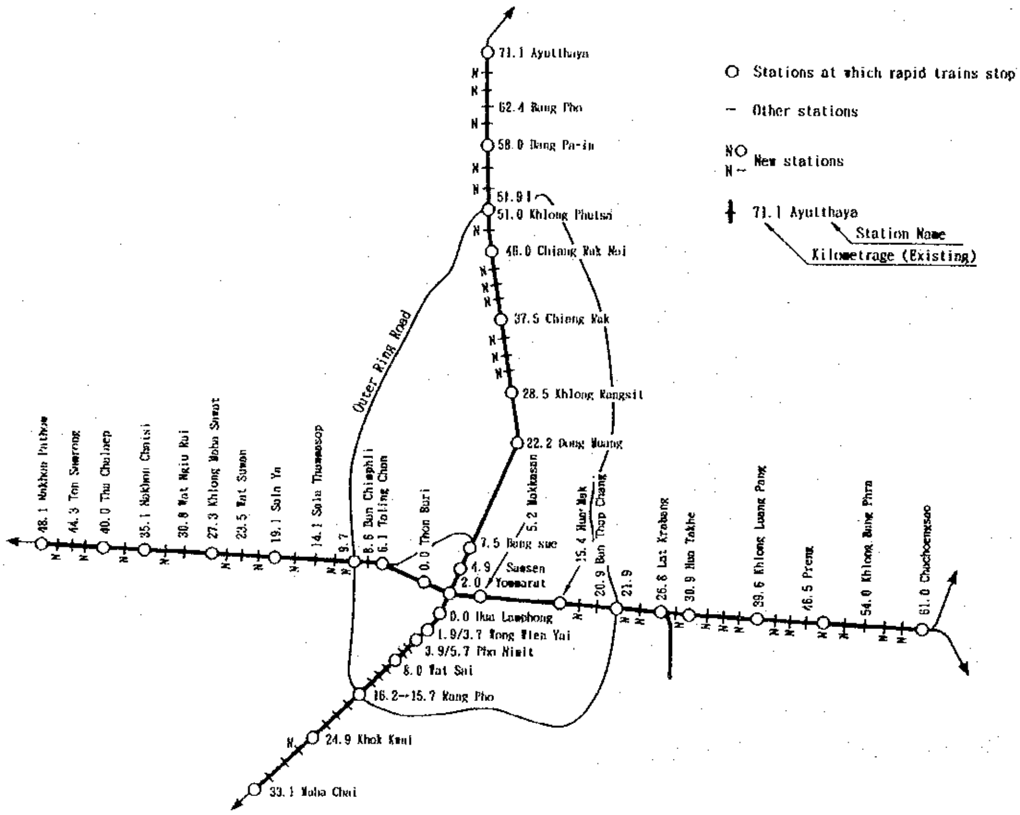


Fig. 1.6.3 Proposed Commuter Service Routes/Stations

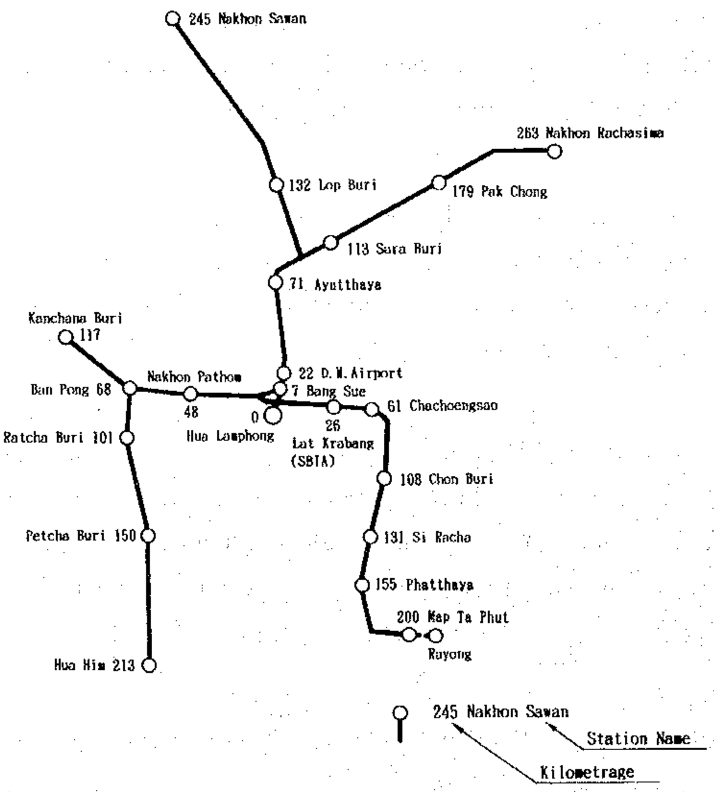


Fig. 1.6.4 Proposed Intercity Express Service Routes/Stations

(c) Choice of electric railcars for commuter service

This Study proposes electrification to provide service by electric railcars for commuter service in urban areas within the "50km" radius area.

The basis for the choice of electric railcars is as follows:

Table 1.6.2 shows a omparison between electric railcars and diesel railcars.

As shown in the table, electric railcar trains are superior to diesel trains in car repair costs, operating performance, energy supply conditions and pollution prevention, especially in car repair costs.

Operation of electric railcar trains is superior in the above-mentioned matters to that of diesel railcar trains, but facilities and equipment for electrification is necessary, which requires large initial investment costs. The operation of electric railcar trains is, therefore, more advantageous in cases where the density of train operation is high, generally more than 80 trains on a double track or 50 trains on a single track.

(Advantages of railcar trains)
Besides, a electric (/diesel) railcar train has the following outstanding merits compared with a locomotive hauled passenger train.

- A electric (/diesel) railcar train has larger traction force, larger acceleration and higher deceleration in general.
- A locomotive hauled train should change the locomotive position when the train turns back, but a railcar train can turn back without such work. Shunting work at the turn-back station is not necessary for a railcar train.
- A railcar train can change the number of railcars of which the train is made up flexibly without spoiling efficiency, and moreover be devided easily.

Table 1.6.2 Comparison between Electric Railcar and Diesel Railcar

Item	Electric railcar	Diesel Railcar
Operating performance	Power supplied externally: Output is not restricted High tractive force per unit of car weight: High acceleration, and high schedule speed	Power supplied on board: Output is restricted Low tractive force per unit of car weight: Low acceleration and for schedule speed (In case of commuter transport which requires rather low cost)
Operable line	Limited to electrified one	No limitation
Energy efficiency	High (difference not so large)	Low
Energy source	Various sources such as water, oil, coal, nuclear and others	Liquid fuel only
Energy supply	Supplied through trolley	Oil carrying by itself
Pollution	Negligible	Air pollution (not so much)
Ground installation	Heavy initial investment for electrification	
Car repair cost	Low cost on account of simple and rugged traction motor	High cost on account of diesel engine repair for worn cylinder and deterioration due to high temperature and oil
Power cost	Depending on the condition of energy source of the country	

- Axle load of a railcar is light compared with a locomotive. Therefore, restricted speed in a curve, by a track condition, etc. of a railcar train is higher than a locomotive hauled train.

- A railcar train has multiple motor cars in a train set. Even if a motor car in the train set fails, the train can operate with other motor cars.