(5) Characteristics of yard handling and relay time

The number of cars handled at yards and relay time are assumed to have the characteristics shown in Figure 5.2.2.

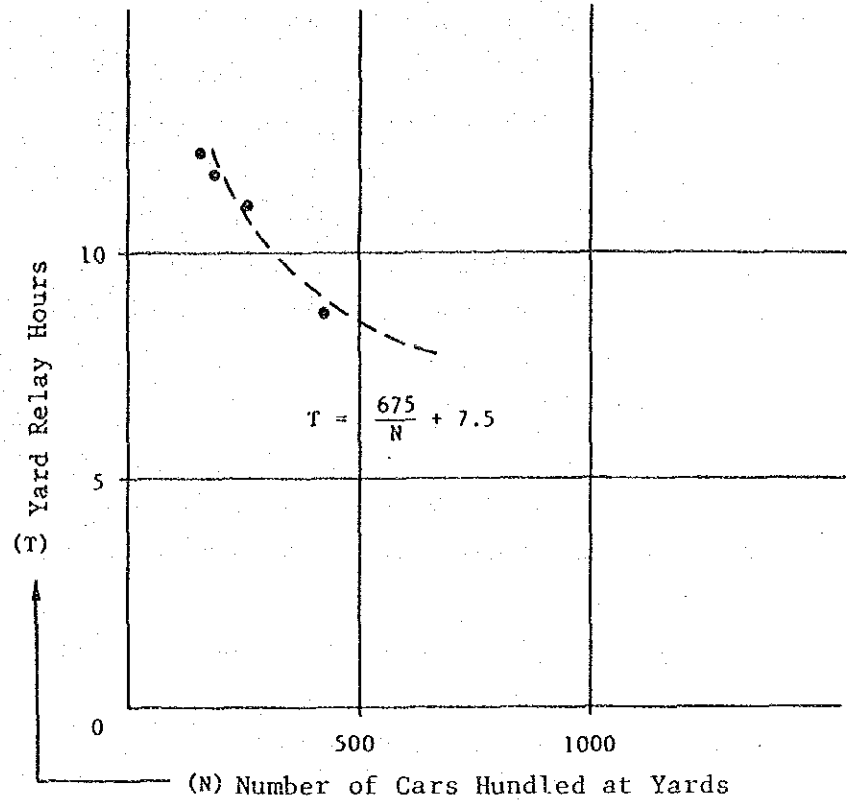


Fig. 5.2.2 Number of Cars Handled at Yards and Relay Time

5-3 Optimization of Freight Car Flow between Yards

For "minimization of empty-freight-car kilometers by empty car control", and "minimization of the total yard relay time through a choice of relay yards," optimum ones were chosen from among those that were deemed feasible by linear programming.

5-3-1 Minimization of Empty-Freight-Car Kilometers

The loaded cars arriving at, and the cars forwarded from, the respective stations or blocks may be taken as the generation of empty cars and demand for empty cars. Then, it will be possible to prepare a table of demand and supply of empty cars between the blocks (25 x 25) in the national network in the form of a control total.

In the following, the type of linear programming used will be described.

(1) Restrictive conditions: Empty car supply and demand volumes by block.

(2) Evaluation index: Distances between blocks.

(3) Non-negative condition: Number of cars to be forwarded.

(4) Objective function: Empty-car-travel distance.

(5) Simplex criterion: Code representing the effect of improvement with the increase of the assignment by one unit at the point at which the initial assignment was made.

(6) Initial setting: Feasible initial settings (assigned in order of blocks of greater number of empty cars generated).

These values are as shown in Appendices 5.2.2-(4) and 5.2.3-(4).

5-3-2 Minimization of Total Freight Car Relay Time

To obtain the optimum forward OD of empty cars in the preceding paragraph 5-3-1, the loaded car OD, except for the unit transportation, is added to the loaded/empty OD.
Examining the elements of this loaded/empty OD against the relay yard, they are as follows:

(1) OD element of departure and arrival in the same block: Non-relay car

(2) OD element between adjacent blocks: 1-yard relay car

(3) OD element between three successive blocks: 2-yard relay car
The foregoing three are fixed yard relays (no alternative yards can be chosen).

(4) OD elements other than (1), (2) and (3): 3-yard or more relay car (Selection is made from among the yards, and becomes the object of calculation.)

With respect to (4), linear programming is carried out with the total yard relay time as an objective function, in order to minimize the total yard relay time.

1)	Restrictive condition:	Handling capacity according to the track layout of the respective yards.
2)	Evaluation index:	Mean one-car relay time of the respective yards.
3)	Non-negative condition:	Selective relay freight car number of the respective yards.
4)	Objective function:	Value reducing the sum of the relay time of all the yards to a minimum.
5)	Simplex criterion:	Code of the coefficient showing the improvement of the time hours by increasing by one unit at the point of the new assignment against the initial assignment.
6)	Initial settings:	Choosing the yard with the least relay time.

The results obtained according to the foregoing are shown in Appendices 5.2.2-(5) and 5.2.3-(5).

5-4 Positioning of the 10 Yards and Principles for Yard Improvement

Based on the result of calculation, positioning of the yards is made as follows:

(1) As the yards play an important role in forming direct trains, Bang Sue, Mae Nam, Phitsanulok block, and New Port are cited.

(2) In SRT, there are four principal collective transportation yards: Bang Sue, which is most important, Phitsanulok along the Northern Line, Nakhon Ratchasima along the Northeastern Line, and Hat Yai along the Southern Line.

(3) Generation of empty cars occurs in the metropolitan area and southern part of Thailand, with demand for empty cars concentrated in the northern, northeastern, and southern parts of the country. The controlling yards are Bang Sue, Mae Nam, Hat Yai, and New Port.

(4) The local yards are the 4 yards of Ban Phachi and Chumphon, and Surat Thani and Thung Song in the south.
The collective volume shares of these yards are as follows: For Mae Nam and New Port, freight handled at Mae Nam is held at about 4 million tons/year, with the excess transferred to New Port. The decrease in Bang Sue is due to the reinforcement of direct transportation.

Figure 5.4.1 shows that yard transportation is concentrated at two stations. Table 5.4.1 shows the values of direct transportation in cars/day, station departure and arrival, yard relay, yard handling (station arrival and departure + yard relay) and shares by yard for 1996 and 2006.

Table 5.4.2 shows the conditions of yard relay. It indicates that the increase in OD traffic will be the result of the cultivation of direct transportation. The direct transportation trains require yards at the starting and terminating ends, but in between, they pass the yards. Thus, the transportation has not only the relay cost reduced but the efficiency as a whole improved.

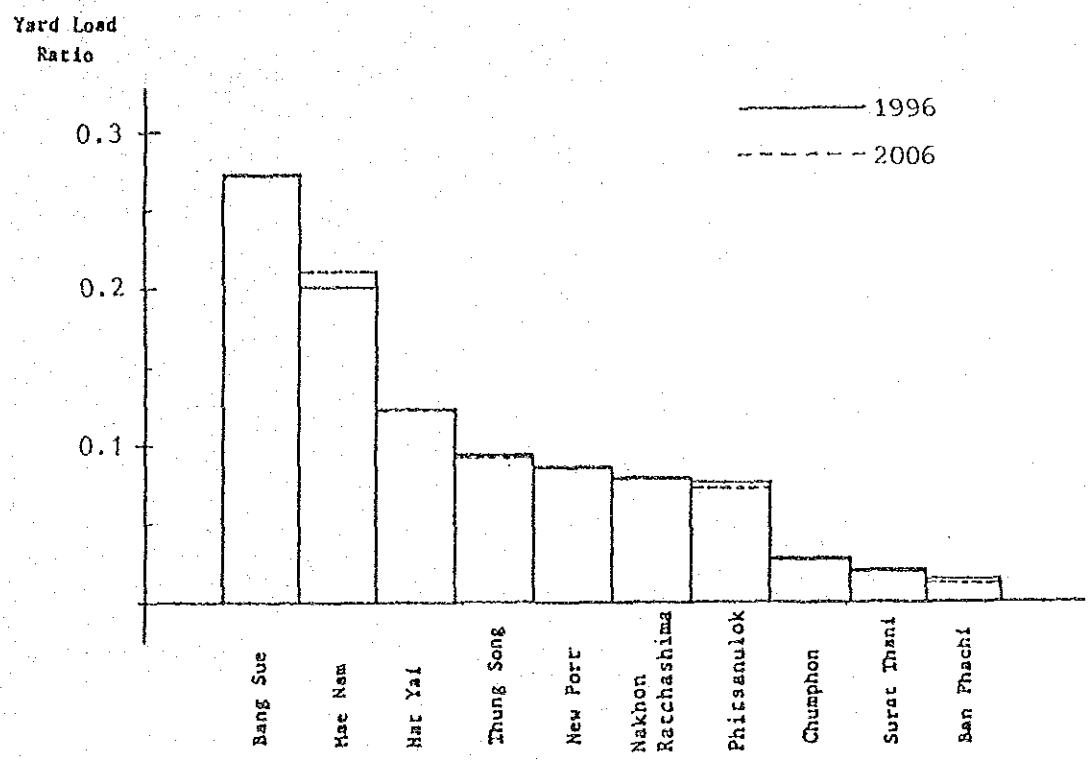


Fig. 5.4.1 Yard Load Ratio

Table 5.4.1 Optimum Shares of Transportation for Yards

Unit: Cars/day (average)

District	Yard Name	Capacity	1984 1 Through	1984 2 Terminus	1984 3 Yard Relay	1984 4 = 2 + 3 No. of Yard Cars	1996 1 Through	1996 2 Terminus	1996 3 Yard Relay	1996 4 = 2 + 3 No. of Yard Cars	1996 Yard Load Ratio	2006 1 Through	2006 2 Terminus	2006 3 Yard Relay	2006 4 = 2 + 3 No. of Yard Cars	2006 Yard Load Ratio
N	Phitsanulok	472		90	105	195		105	100	205	0.077		110	105	215	0.072
	Ban Phachi	186			40	40			40	40	0.015			40	40	0.013
NE	Nakhon Ratchashima	286		80	110	190		80	130	210	0.079		90	150	240	0.081
C	Bang Sue	2,680	290	145	435	580	430	160	565	725	0.273	485	170	640	810	0.273
	Mae Nam	450	350	600		600	440	540		540	0.203	440	630		630	0.212
E	New Port*						110	230		230	0.086	180	260		260	0.087
S	Chumphon	156		30	30	60		40	35	75	0.028		45	35	80	0.027
	Surat Thani	118		30	20	50		35	20	55	0.021		40	20	60	0.020
	Thung Song	310		50	180	230		60	190	250	0.094		70	200	270	0.091
	Hat Yai	314		130	180	310		140	190	330	0.124		160	210	370	0.124
	Total		640	1,155	1,100	2,255	980	1,390	1,270	2,660	1.000	1,105	1,575	1,400	2,975	1.000

Note: New Port Yard is treated as an "external factor."

Table 5.4.2 Yard Relay Indices of Total Freight Transportation System

Item \ Fiscal year				1984	1996	2006	Remarks
1	Number of cars generated	Direct		537	686	787	
		Cars requiring coupling/ uncoupling	(Loaded)	477	661	739	
			(Empty)	185	234	257	
2	Total relay car time (hours)	WITHOUT		13,574	17,103	21,175	
		WITH		13,574	15,240	14,350	
		DIFFERENTIAL		0	1,863	6,825	
3	Total number of cars relayed			1,100	1,270	1,400	
4	Average relay time (hours)			12.34	12.00	10.25	
5	Average frequency of relays per car			1.66	1.42	1.41	

CHAPTER 6 YARD WORK PLAN

CHAPTER 6 Yard Work Plan

6-1 Present Conditions and Themes of Improvement

6-1-1 General

The work of each yard is considered in respect to its handling facilities, disposition of shunting locomotives, assignment of personnel, and work schedule, and is set forth in the following.

(1) Handling facilities

In all of the yards, the facilities are generally deteriorated and obsolete and are unable to cope with the changing passenger and freight flows. Many of them are not appropriate to the present traffic system.

Particularly, in Bangkok, Mae Nam, and Hat Yai, where traffic volume has been increasing over the past few years, arrival and departure tracks, passenger car storage tracks, and sorting tracks are unable to meet handling requirements; thus, there are bottlenecks in traffic.

In Bang Sue, Nakhon Ratchasima and Thung Song, where handling is stagnant, unused and obsolete facilities are also noticeable.

(2) Assignment of shunting locomotives

In all stations, except Bangkok (a passenger station), Bang Sue (a freight station), and Ban Phachi (no shunting locomotives assigned), shunting work is usually done for both passenger and freight cars by the same shunting locomotives. Except for Bangkok, each yard has a greater number of shunting locomotives than the workload requires. But this may be unavoidable since train delays occur often and work for the inbound and outbound trains must be conducted concurrently.

Among such yards, the Bang Sue has as many as four shunting locomotives for the relatively small number of cars it handles. It will be necessary to curtail the number of shunting locomotives by reducing the area used in the compound.

Nakhon Ratchasima and Thung Song also seem to have too many shunting

locomotives allocated to them, and it is considered necessary to reduce the hours of allocation through a review of work.

(3) Personnel assignment

The yard work is carried out by a relatively small number of personnel, a party of three workers for each of the three or four shifts during a 24-hour period; and due to such factors as the type of car brakes, push-off shunting is done as a rule, not high-speed kick-off shunting. Thus, the work time seems to be rather long, but is done efficiently.

(4) Work schedule of yard handling

During the site survey of the experts group, as a key to understanding yard handling performance, a "yard work diagram" was requested, but there were none available for any yard.

In general, the preparation of a yard work diagram may be difficult or not necessary if there are daily changes in work or only a small amount of work. However, in the case of routine work such as that performed in these yards, schedules should standardize the work process, and improve the efficiency and utilization of crews and workers.

In the present situation, yard handling is normally by field work experts. If a yard work diagram is prepared well, the work can be done by other less trained persons and efficiency enhanced, resulting in fewer train delays.

According to train delay data, freight train delays are the most serious and may be caused by a number of factors. In the transportation business, the "punctuality" of transport is as important as its "price" and "speed". To achieve punctuality, as a first step, a yard handling schedule should be made.

6-1-2 Outline of Each Yard (See Appendix 6.1.1 - 6.1.6)

(1) Bangkok

Bangkok is the most important station for originating and terminating passenger trains. It is a comprehensive passenger terminal and also

has a depot for DRCs and passenger cars, as well as having a passenger car yard.

1) Number of inbound and outbound trains

The number of inbound trains is 59 per day (34 are DRCs); the number of outbound trains is the same.

2) The average number of passengers per day was 42,499 in 1984.

3) Yard work

a) Work outline

a. Handling of outbound and inbound passenger trains

b. Handling of passenger car storage, arrangement, and repair

b) Handling of passenger trains

The turnaround operation of inbound trains, inducing trains to the storage track, shunting of trains, and inducing outbound trains to the departure track

a. Storage, cleaning, shunting of 50 passenger trains

b. Turnaround operation of 68 DRC trains and inducing them to and from the DRC depot

c. Total number of passenger cars that can be stored in peak time is 270 (190 for operation and 80 for reserve).

c) Yard handling system

The shunting of trains is done by 2 locomotives (24-hour operation) with 2 groups of 3 shunters in 4 shifts (2:00-8:00, 8:00-14:00, 14:00-20:00, 20:00-2:00).

The number of personnel at this station is 434.

4) Themes of improvement

One of the themes in this yard is the insufficient capacity of the storage tracks. The other theme is the improper track layout. The present track layout requires inbound trains to go to the storage tracks and then turn back to the outbound track. This makes arrival and departure tracks inflexible for meeting traffic demand, and yard handling seems busy all the time.

(2) Mae Nam

The Mae Nam station, which is located near the Bangkok sea coast, handles the importing and exporting of goods such as oil, rice, and rubber, with freight volume being 3 million tons per year. This makes Mae Nam SRT's biggest freight handling station, and accounts for about 15% of the total freight volume handled by Bangkok Port (20 million tons per year).

1) Number of inbound and outbound trains

The number of inbound and outbound trains is 36 per day (including temporarily operated trains), with 24 of these trains (including the return trip with empty tanks) used for oil transportation. The other trains are for general goods for Bang Sue.

2) Freight volume

This station's major cargo is oil. Its freight volume has increased rapidly in recent years and reached 3.03 million tons in 1985.

The Mae Nam station has been handling cargo at three places, the main station, the wharf line, and the refinery. The ratio of cargo handled at the main yard of Mae Nam compared to that of the wharf and refinery line is estimated to be 50:50.

3) Yard work

a) Work outline

a. Handling of originating and terminating cars
b. Uncoupling and making up of originating and terminating trains

b) Work details and number of cars handled

a. Uncoupling and making up of 24 special trains per day
b. Uncoupling and making up of 12 other trains for Bang Sue
c. Inducing inbound and outbound cars from and to loading and unloading tracks

The number of cars handled per day is about 1,000.

c) Yard handling system

Freight train handling in Mae Nam is done at 3 locations: Mae Nam station, Bangkok port (both the old and new ports) and Bang Chak oil refinery. Inbound and outbound trains are handled in the station yard, except for the oil trains that are directly induced to Bang Chak oil refinery (7 km east of Mae Nam).

The shunting work in this yard is done by 3 locomotives (24-hour operation) with 3 groups of 3 shunters in 3 shifts (0:00-8:00, 8:00-16:00, 16:00-24:00).

The number of personnel at this station is 98.

4) Themes of improvement

The freight train handling system corresponds to the needs of the direct freight transportation service, such as in oil transportation where trains for crude oil directly enter or leave the loading/unloading tracks. However, in the main yard of Mae Nam, the imbalance between the short sorting tracks and long and dispersed loading/unloading tracks is remarkably large, and has resulted in low train-handling efficiency. The capacity of facilities should be larger to assure the performance of SRT's biggest freight handling yard.

(3) Bang Sue

The Bang Sue yard is located near the central part of Bangkok and is a junction point for major lines. Therefore, Bang Sue is the most appropriate yard for freight handling.

However, in recent years, Bang Sue has reduced its freight handling role due to the increase in the direct transportation of goods such as oil, cement, and gypsum. The numbers of trains and cars handled at present are much lower than the actual capacity.

1) Number of inbound and outbound trains

The number of inbound and outbound trains (including temporarily operated trains) is 39 per day. However, at present, 16 trains are not in operation and many others are only operated when the need arises. Thus, the actual number of inbound trains is around 20-25 per day.

2) Freight volume

The volume of outgoing and incoming freight handled in this yard is 123,000 and 868,000 ton/year respectively, totalling 992,000 ton/year. Major incoming and outgoing commodities are cement and alcoholic products respectively.

3) Yard work

a) Work outline

a. Relay of cars between the Northern, Northeastern, Southern, Eastern and Mae Nam Lines
b. Freight car control for surrounding areas
c. Handling of originating and terminating cars (freight handling, freight car depot)
d. Storage of empty cars

b) Freight car handling

This yard is supposed to handle 39 inbound and 39 outbound trains per day; however, this includes a certain number of temporary trains. The actual number of inbound trains is usually around 20-25 per day to meet traffic fluctuations, and the number of cars handled about 900. The number of trains that need handling in the hump yard is only 12 per day (general trains). Cement trains generally enter or leave loading/unloading tracks and the 7 trains from Mae Nam are uncoupled on the coupling side.

c) Freight car relay time

From the results of the sample investigation at the end of January 1986, the average relay time is about 9 hours.

d) Yard handling system

Shunting work is done by 4 locomotives (hump uncoupling, train making up, shunting in the freight station, and others) on a 24-hour operation basis. The 4 parties, 3 persons in each, are assigned to shunting work in 4 shifts (0:00-6:00, 6:00-12:00,

12:00-18:00, 18:00-24:00). For hump decomposition, 7 brakemen in 3 shifts do car braking.

There are 242 personnel in the yard and 41 in the freight station, totalling 283 persons. In addition to this, there are 240 conductors; total personnel is 523.

4) Themes of improvement

It is said that the number of cars handled at Bang Sue yard is 2,500 per day. But increases in direct transport service has reduced the actual number of cars being handled to 900 per day (calculation based on a 2-bogie car), and only 600 cars (12 trains) out of this total need hump decomposition. This trend will probably continue in the future.

The efficiency of the Bang Sue Yard and freight station is relatively low due to the large number of personnel (283 persons) and to shunting work being carried out in the whole yard. Consequently, the reconsideration of yard layout and work processes should be done based on future transportation demand and the transportation system.

(4) Ban Phachi

Ban Phachi is the junction point for the Northern and Northeastern Lines, and plays an important role in both passenger and freight transportation.

1) Number of inbound and outbound trains

The number of inbound and outbound passenger and freight trains is 70 and 66 per day respectively.

2) Passenger and freight volumes

a) Passengers: 2,308 persons per day (average for 1984)

b) Freight: The volume of cargo loaded and unloaded at this station is 156 and 182 tons respectively, totalling 338 tons.

3) Yard work

a) Work outline

a. Relay of freight cars between the Northern and Northeastern Lines
b. Relay of freight cars between trains of the Northern and Northeastern Lines
c. Storage of empty cars
d. Handling originating and terminating passenger trains
e. Adjusting the waiting time of the Northern and Northeastern Lines

b) Work details and number of cars handled

a. Passenger car
Turnaround operation of trains numbers 221 and 222 (8 cars per train), one round trip

b. Freight car
Turnaround operation of one round-trip of gypsum and uni-product trains between the Northern and Northeastern Lines.
Freight car relay between the Northern and Northeastern Lines.
Relay of freight cars between trains on the Northern and Northeastern Lines.
The number of cars handled in the 2 latter items are 40 per day.

c. Freight car relay time
From the results of the sample investigation for September-November 1985, the average relay time is 12 hours.

d. Yard handling system
The shunting work is done by a traction engine and 1 group of 3 shunters in 3 shifts (0:00-8:00, 8:00-16:00, 16:00-24:00). The manpower of the station as a whole is 36 persons.

4) Themes of improvement

There are no significant problems in this yard. However, some measures should be taken concerning train conflicts on the down-direction side, after some checks on the problems of train operation (such as the condition of delays) and changes in traffic.

(5) Phitsanulok

Phitsanulok is one of the most important stations on the Northern Line, and is becoming even more important with the development of the Sirikit oil field nearby. The number of inbound and outbound trains is large.

1) Number of trains handled

The number of trains for passengers and freight are 34 and 20 per day respectively.

2) Passenger and freight volumes

a) Passengers: 3,868 persons per day (average for 1984)

b) Freight:

The outgoing and incoming freight volumes are 10,000 and 140,000 ton/year respectively. The major cargos are rice for outgoing freight and oil for incoming freight.

3) Yard work

a) Work outline

a. Handling of originating and terminating cars
b. Control of freight cars for nearby stations
c. Arrangement of cars released at intermediate stations
d. Handling of originating and terminating passenger trains

b) Work details and number of cars handled

a. Passenger car

Handling the turnaround operation for 7 round trips, the 14 trains are 93, 94; 97, 98; 95, 96; 91, 92; 319, 320; 901, 902; 905, 906.

b. Freight car

Uncoupling and coupling of 1 outbound and inbound train each
Rearrangement of cars released at intermediate stations, 5 up and down trains each
Inducing originating and terminating cars to and from the loading/unloading tracks
Storage of empty cars
The number of cars handled is 200 per day.

c) Freight car relay time

According to the results of the sample investigation for the middle of January 1986, the average relay time is 6 hours.

d) Yard handling system

The shunting work is done by 1 locomotive and 1 group of 3 shunters in 3 shifts (0:00-8:00, 8:00-16:00, 16:00-24:00). The total personnel in this station is 58.

4) Themes of improvement

The yard handling of both passenger and freight trains is effectively done in a relatively small yard.
The freight handling volume, especially the 9,000 tons of rice, is very small although the yard is located in a rice distributing center.

To enhance the direct transportation of rice now envisaged, some measures such as the construction of a circulating warehouse should be considered.

(Reference)

Transportation of Crude Oil from Phitsanulok

The inbound trains 632, 634, 636, and 638, arriving at and departing from Phitsanulok, are crude oil transport trains going from Bung Phra station (loading station for the crude oil of the Sirikit oil field) to Mae Nam. The outbound trains 631, 633, 635, and 637 transport the returning empty tank cars.

These trains transport 1.2 million tons of crude oil a year, using 4 trains every day, with each train consisting of 22-32 tank cars or an average of 26 cars.

These trains actually start from and terminate at the Bung Phra station. They have entry to and exit from the loading line made possible by the tractive locomotives; the locomotives are forwarded independently to Phitsanulok. Shunting in the Bung Phra station yard is done efficiently by using two shifts of 6:00-18:00 and 18:00-6:00 with two workers for each party.

(6) Nakhon Ratchasima

Nakhon Ratchasima is one of the most important cities in the northeastern area, and it also plays a vital role as a central station of the railway.

1) Number of trains handled

The number of trains handled per day are: 44 passenger, 20 freight, and 2 mixed.

2) Passenger and freight volumes

a) Passengers: 1,562 persons per day (average for 1984)

b) Freight:

The outgoing and incoming freight volumes are 19,000 and 105,000 ton/year respectively. The major cargos are rice for outgoing freight and oil for incoming freight.

3) Yard work

a) Work outline

a. Handling of originating and terminating cars (freight handling, passenger car checking and repair)
b. Regional control of freight cars
c. Rearrangement of cars released at intermediate stations
d. Handling of originating and terminating passenger trains

b) Work details and number of cars handled

a. Passenger car
Handling the turnaround operation for 10 round trips, the 20 trains are 73, 74; 81, 82; 205, 206; 77, 78; 115, 116; 85, 86; 111, 112; 79, 80; 63, 64; 39, 40.

b. Freight car
Uncoupling and coupling of 8 up and down trains each
Rearrangement of cars released at intermediate stations, 3 up and down trains each
Inducing originating and terminating cars to and from the loading/unloading tracks
Storage of empty cars
The number of cars handled is 190 per day.

c) Freight car relay time
From the results of the sample investigation for the end of January 1986, the relay time for up trains is 8 hours, and for down trains 13 hours and 22 minutes, an average of 11 hours.

d) Yard handling system
The shunting work is done by 2 locomotives and 2 groups of 3 shunters in 3 shifts (0:00-8:00, 8:00-16:00, 16:00-24:00). The total personnel in this yard is 86.

4) Themes of improvement

Direct transportation service for such products as oil is increasing, while that for general freight is decreasing. Although the upward sorting tracks are almost not used, the handling of both passenger and freight trains at the eastern station is effectively done.

Rice for southern Thailand is only 15,000 ton/year, too small for establishing a direct transportation service. Some measures such as construction of circulating warehouses by joint-ventures from the private agricultural sector can be considered for utilizing unused land in the yard.

(7) Chumphon

Chumphon station is the most important passenger station in Chumphon Province.

1) Number of trains handled

The number of trains handled per day are: 18 passenger, 14 freight, and 2 mixed.

2) Passenger and freight volumes

a) Passengers: 923 persons per day (average for 1984)

b) Freight:

The outgoing and incoming freight volumes are 6,000 and 82,000 ton/year respectively. The commodities are general goods for outgoing freight and mainly cement for incoming freight.

At present, there is a project under implementation to enhance the direct cement transportation service. In accordance with this project, SRT is making improvements in the loading/unloading tracks, while a customer is constructing a stock house on a yard site leased from SRT. Therefore, increases in freight handling volume are expected.

3) Yard work

a) Work outline

a. Handling of originating and terminating freight cars
b. Regional control of freight cars
c. Rearrangement of cars released at intermediate stations
d. Adjustment of tractive capacity
e. Handling of originating and terminating passenger trains

b) Work details and number of trains handled

a. Passenger car
Handling the turnaround operation for 4 round trips, the 8 trains are 363, 364; 169, 170; 149, 150; 119, 120.

b. Freight car
Uncoupling and coupling of cars released at intermediate stations, 5 up and down trains each
Uncouping and making up of a mixed train, 1 up and down train each
Inducing of originating and terminating freight cars to and from the loading/unloading tracks
Storage of empty cars
The number of cars handled is 60 per day.
In addition to the above, the storage of 50 empty cars waiting for inspection is also performed.

c) Freight car relay time
From the results of the sample investigation for the middle of January 1986, the relay time for down trains is 5 hours and for up trains 20 hours, an average of 12 hours.

d) Yard handling system
The shunting work is done by 1 locomotive and 1 group of 3 shunters in 3 shifts (0:00-8:00, 8:00-16:00, 16:00-24:00).
The total personnel of this yard is 68.

4) Themes of improvement

No significant themes of improvement

(8) Surat Thani

This yard is the most important passenger and freight station in Surat Thani Province.

1) Number of trains handled

The number of trains handled per day are: 20 passenger, 14 freight, and 2 mixed.

2) Passenger and freight volumes

a) Passengers: 1,930 persons per day (average for 1984)

b) Freight:

The outgoing and incoming freight volumes are 42,000 and 66,000 ton/year respectively.

3) Yard work

a) Work outline

a. Handling of originating and terminating cars
b. Regional control of freight cars
c. Rearrangement of cars released at intermediate stations
d. Handling of originating and terminating passenger trains

b) Work details and number of trains handled

a. Passenger car

Handling the turnaround operation for 4 round trips, the 8 trains are 123, 124; 149, 150; 147, 148; 395, 396. Handling the transit of 2 round trips, the 4 trains are 47, 48; 41, 42.

b. Freight car

Uncoupling and making up of freight trains, 1 up and down train each

Uncoupling and rearrangement of cars released at intermediate stations, 6 up and down trains each

Inducing of originating and terminating freight cars to and from the loading/unloading tracks

The number of cars handled is 50 per day.

c) Freight car relay time

According to the results of the sample investigation for the middle of January 1986, the relay time is about 7 hours.

d) Yard handling system

The shunting work is done by 2 locomotives in the daytime, and 1 locomotive in the nighttime. The operating times of the locomotives are as follows:

A Locomotive 9:00 - 7:40 of the following day

B Locomotive 7:15 - 15:30

There is 1 group of 3 shunters in 2 shifts (6:00-18:00, 18:00-6:00) that take care of the shunting work.

The total personnel in this yard is 45.

4) Themes of improvement

No significant themes of improvement

(9) Thung Song

Thung Song is one of the most important stations on the Southern Line, having both a locomotive depot and passenger and freight car depot.

1) Number of trains handled

The number of trains handled per day are: 18 passenger, 16 freight, and 4 mixed.

2) Passenger and freight volumes

a) Passengers: 1,328 persons per day (average for 1984)

b) Freight:

The outgoing and incoming freight volumes are 29,000 and 11,000 ton/year respectively. The major good for outgoing freight is rubber.

3) Yard work

a) Work outline

a. Regional control of freight cars
b. Rearrangement of cars released at intermediate stations
c. Handling of originating and terminating freight cars (freight handling, car checking)
d. Handling of originating and terminating passenger trains

b) Work details and number of trains handled

a. Passenger car

Handling the turnaround operation for 3 round trips, the 6 trains are 417, 418; 415, 416; 147, 148.

b. Freight car

Uncoupling and coupling of freight trains, 5 up and down trains each

Uncoupling and coupling rearrangement of cars released at intermediate stations, 5 up and down trains each

Uncoupling and coupling of 2 mixed trains

Induce originating and terminating cars to and from the loading/unloading tracks

The total number of cars handled is 230 per day.

c) Freight car relay time

According to the results of the sample investigation for the end of January 1986, the average relay time is about 10 hours.

d) Yard handling system

The shunting work is done by 2 locomotives (A Locomotive 0:00-24:00, B Locomotive 0:00-16:00) with 2 groups of 3 shunters in 3 shifts (0:00-8:00, 8:00-16:00, 16:00-24:00).

The total personnel in this yard is 84.

4) Themes of improvement

Since Thung Song is provided with both a locomotive depot and passenger and freight car depot, the maintenance of passenger and freight cars from Chumphon and Hat Yai are done together here. A large number of PCs and FCs waiting for maintenance have interfered with yard handling; some preventive measures should be considered. The number of cars stored and waiting for maintenance on January 29, 1986 were 14 PCs and 228 FCs.

(10) Hat Yai

Hat Yai city is in the southern part of Thailand. With its large population and location, Hat Yai station plays an important role in railway transportation in southern Thailand and also in trade with Malaysia.

1) Number of trains handled

The number of trains handled per day are: 24 passenger and 22 freight.

2) Passenger and freight volumes

a) Passengers: 3,649 persons per day (average for 1984)

b) Freight:

The outgoing and incoming freight volumes are 34,000 and 243,000 ton/year respectively. The major cargo for outgoing freight is rubber, and for incoming freight they are cement and rice.

3) Yard work

a) Work outline

a. Handling of originating and terminating cars
b. Regional control of freight cars
c. Rearrangement of cars released at intermediate stations
d. Base station for freight transport to Malaysia
e. Handling of originating and terminating trains

b) Work details and number of trains handled

a. Passenger car

Handling the turnaround operation for 6 round trips, the 12 trains are 129, 130; 43, 44; 123, 124; 125, 126; 119, 120; 127, 128.

b. Freight car

Uncoupling and coupling of freight trains, 8 up and down trains each

Coupling, uncoupling, and rearrangement of cars released at the intermediate stations, 2 up and down trains each

Inducing originating and terminating cars to and from the loading/unloading tracks

Storage of empty cars

The number of cars handled is about 310 per day.

c) Freight car relay time

According to the results of the sample investigation for the middle of January 1986, the relay time is about 30 hours. The result of the field survey on August 12 to 14, 1986 was about 15 hours.

d) Yard handling system

The shunting work is done by 2 locomotives (A Locomotive 0:00-24:00, B Locomotive 8:00-16:00) with 2 groups of 3 shunters

in the daytime and 1 group in the nighttime. The A group operates in 3 shifts (0:00-8:00, 8:00-16:00, 16:00-24:00), while the B group works only in the daytime (8:00-16:00).
The total personnel in this yard is 104.

4) Themes of improvement

As the base station for freight transport to Malaysia, there are about 70-100 freight cars that have to be transported to Padang Besar. However, due to the small transport capacity of the Malaysian side, a large number of freight cars have to wait at Hat Yai. Besides this, a large number of empty cars are also generated in this yard. So it is always full of freight cars and empty cars, which interferes with yard handling.

6-2 Improvement of Yard Work

6-2-1 Master Plan

(1) General

The future traffic volume of passengers is estimated to be 134% in 1996 and 150% in 2006 as against the 100% for the base year of 1984. Particularly in the vicinity of Bangkok where increases in commuter transportation are expected, the estimates for 1996 and 2006 are 161% and 189% respectively. For freight transportation, the respective estimates are 131% and 148%.

As a result, train frequency and the number of cars handled in the respective yards are also expected to increase during this time (Table 6.2.1).

However, each of the yards, except for Bangkok, seems to have an excess of shunting locomotives and personnel allocated for the working time assigned; thus, they will be able to cope with the expected increase in handling volume.

Accordingly, the following improvements for yard work are proposed for the Bang Sue yard, which has a handling volume that falls greatly below the initial plan; for Mae Nam, which is the largest key station in SRT but with a inefficient layout; for Hat Yai, the center of

Table 6.2.1 Number of Trains Terminating at Each Yard and Total Number of Cars Handled

	Train Frequency												Numbers of Cars Handled					
	1984				1996				2006				1984		1996		2006	
	P	M	F	T	P	M	F	T	P	M	F	T	P	F	P	F	P	F
Bangkok	118			118	150			150	176			176	500		686		815	
Mae Nam			32	32			32	32			32	32		1000		1000		1070
Bang Sue			62	62			66	66			70	70		870		1155		1295
Ban Phachi	70		56	126	106		56	166	128		62	190	8	40	68	40	80	40
Phitsanulok	34		12	46	40		18	58	46		20	66	52	200	112	210	120	220
Nakhon Ratchasima	44	2	18	64	48		24	72	54		26	80	73	190	72	210	80	240
Chumphon	18	2	10	30	26		12	38	34		14	48	25	60	40	75	48	80
Surat Thani	20	2	10	32	26		12	38	30		14	44	30	50	36	55	44	60
Thung Song	18	4	12	34	28		12	40	34		14	48	9	230	38	250	46	270
Hat Yai	22		16	38	28		16	44	32		20	52	59	310	80	330	88	370

Note: 1 Future train frequencies are estimated from the flows between the block and sectional traffic volumes.

2 The number of freight cars in the respective yards is assumed from the freight car flows between the blocks.

3 P: Passenger, M: Mixed, F: Freight, T: Total

railway transportation in southern Thailand and a transportation base for trade with Malaysia having heavy traffic congestion; and for Bangkok, whose handling volume is likely to increase greatly.
At the same time, the introduction of a "yard work diagram" is recommended for improving work efficiency and assigning appropriate personnel and shunting locomotives.

(2) Bangkok

A considerable increase in inbound and outbound trains, mainly due to an increase in commuter transportation, is expected. However, most of those trains will use diesel railcars. Therefore, it is desirable to convert departure tracks 7 and 8 to arrival/departure tracks, in addition to the present arrival/departure tracks of 5 and 6, so that the arrival trains can be turned back in a smooth manner.
If this is done, part of the passenger car storage tracks may be obstructed, and PC storing capacity will decrease. To avoid this, it is desired to introduce diesel railcars for short- and medium-distance transport in place of the present passenger cars.
In the present schedule, long-distance trains mainly arrive in the morning and leave in the evening, resulting in a very small number of passenger cars being stored during the night. On the other hand, future diesel railcars will be mainly used for short-distance transport and will increase the number of cars stored at night in and around Bangkok. It is desired, therefore, to store diesel railcars at night on vacant storage tracks for passenger cars.

(3) Mae Nam

As for the freight handling of the Mae Nam station, the present level is expected to be maintained, although there may be some shift to marine containers due to the development of the Laem Chabang Port.
On the other hand, the yard has an inefficient track layout, with the site being divided into a main station and a wharf and oil refinery plant at the entrance; yard work is done by operating three shunting locomotives. Thus, it is proposed to provide a shortcut track for smooth handling of the freight cars in both compounds for the improvement of uni-product freight transportation, and to review the present work system using three shunting locomotives.

(4) Bang Sue

1) Basic principles

a) Roles in transportation

It is estimated that freight traffic will increase to some degree due to construction of transportation facilities such as the Laem Chabang New Port and improvements in service. Regarding the kind of transportation for realizing this, it is expected that the direct transportation system for key stations will play a leading role. It is also thought that yards will have to bear a larger burden than before. In Bang Sue, especially, there will be a need to make up for the functions that the other key stations lack and to develop a direct transportation system. In addition, it will have to have functions that smoothly conduct relays between lines and make transportation adjustments for traffic fluctuations.

b) Present yard functions

Presently, the Bang Sue yard cannot cope with the recent demands of consignors and the recent form of transportation because of the emphasis put on the efficiency of transportation based on the scattered station system. In other words, this yard is inappropriate for the following reasons.

- o It is not suited for direct transportation between key stations because the yard is now a full decomposition and composition type.
- o Due to the hump yard, work is not effective when they handle approximately 1,000 freight cars.
- o Many facilities are left idle in comparison with the scale of the sorting tracks and loading facilities, causing low work efficiency.

c) Improvements in yard functions and scale

For these reasons, there is a need to improve functional arrangements and to modify the scale as follows:

- o As a transportation base, it will have to function so as to compile a unit made up from several to more than ten cars into a direct train, and it will have to increase efficiency in the transportation of general freight cars.
- o Make adjustments to meet traffic fluctuations that will help improve transportation in sections and the yard work of surrounding stations (storage of trains and freight cars, etc.).
- o Have unit cement trains enter the cargo-handling tracks smoothly.
- o Draw up a compact and highly efficient layout for future handling and work: abolition of the hump, integration of arrival and departure tracks, adjustment of the scale of the sorting tracks and integration of loading/unloading places.
- o Improve distribution warehouses for agricultural and miscellaneous goods.

In improving the layouts, there should be reasonable amendments in view of future prospects, and savings on investment by making full use of present equipment.

2) Improvements

The Bang Sue yard is a hump yard for total decomposition and composition and is designed to handle 2,500 cars. It is intended to handle a flow system in order to efficiently sort out freight cars in various directions. It thus exhibits its capacity best when it handles a great number of freight cars (usually 2,000 cars or more). However, the number of freight cars going to the hump for decomposition at the Bang Sue yard has decreased greatly because of little growth in transportation and increases in direct transportation in recent years. In addition, the uncoupling work of the arrival trains from Mae Nam is done on the composition side, with the number of freight cars remaining at 600. Thus, the efficiency of the yard has greatly decreased.

Regarding the volume of future handling, the number of freight cars sent to the hump for uncoupling is estimated at about 730 for 1996 and about 850 for 2006. This volume can easily be dealt with by the plan when its layout is improved. In such a case, economizing on hump shunting locomotives, hump shunting personnel, personnel waiting below the hump, and some of the control tower personnel will be possible.

Note: Estimated savings on shunting locomotives and personnel if the hump is not used.

Shunting locomotive	1	
Personnel	55	
Crew	2 persons	x 4 = 8 persons
Hump shunting	3	x 5 = 15 persons
Servicing below hump	7	x 4 = 28
Control tower	1	x 4 = 4

(5) Hat Yai

Hat Yai is an important station in the southern part of Thailand and has a number of originating and terminating passenger trains. It also conducts total decomposition and composition of freight trains and has many freight cars waiting for preparation to Malaysia.
On the other hand, the yard is limited in space and performs a large amount of complicated work. To meet the increase in traffic volume in the future, it is proposed to improve the passenger car storage tracks and freight car sorting tracks to alleviate yard work.

(6) Employment of a yard work diagram

The respective yards under study in the present master plan have a great number of inbound and outbound trains and cars to be handled. Thus, except for Ban Phachi, they all have 1 to 4 shunting locomotives and the necessary working personnel assigned.
However, these shunting locomotives and work personnel seem to have some margin of freedom in view of the present workload or number of cars handled. This may be unavoidable due to the daily delay of freight trains. But as "quick delivery" and "punctuality of arrival"

are the main sales points together with "fares," it will be important to determine the work procedures for the yard according to a "yard work diagram," along with implementation of other measures for securing the punctuality of train operation and assigning of shunting locomotives and personnel adequately. By this, it will be possible to secure the punctuality of train operations and decrease the allocation time of the shunting locomotives and the number of personnel assigned.

Preparation of a yard work diagram is intended to accomplish the following.

1) Systematic planning of yard work.
2) More efficient yard work.
3) Adequate arrangement of personnel and shunting locomotives.
4) Proper arrangement of yard work so personnel concerned can easily understand it.

A yard work diagram is prepared prior to a detailed investigation of the yard work: standard time required for each job, composition of freight trains and movement of freight cars. If there is any work that is not included in the diagram, it will be necessary to change the time zones for composing trains, the arrangement of personnel, and the shunting of locomotives, so that the work is incorporated in the diagram and a practicable plan provided.

Where trains are delayed every day, it may be useless to prepare a work diagram. In such case, a manual showing the work procedures for each work unit (handling trains, etc.) is often provided, but it helps little in the adequate arrangement of shunting locomotives and personnel.

It is, therefore, important to secure the punctuality of train operation.

Hereafter, freight transportation will have to compete with trucks, so it is necessary to reduce the cost of transportation and to also ensure quick delivery and definite arrival times, and for this, the securing of punctuality is a precondition.

Bulky materials (cement, oil, etc.)	Fixed-pattern transportation + Punctuality
General goods	Quick delivery + Definite arrival time + Punctuality

To realize the foregoing, it will be important to improve the yard work in the station so that it is carried out systematically, thus making the railway an attractive means of transportation. This will lead to a recovery in the volume of railway freight traffic.

6-2-2 Short-term Plan for the Feasibility Study

(1) Bangkok

1) Outline of handling

a. Handling of passengers

In 1984, the average number of passengers using this station amounted to approx. 42,000 people on a daily basis. As far as the future is concerned, it is estimated that passengers will steadily increase due to improvements in transportation service from the addition of arrival/departure tracks and the use of DRCs.

b. Yard work

a) Yard's roles

This station is regarded as SRT's central passenger station, and it contains a sorting yard for passenger trains and a DRC depot. The station plays the following roles:

- o It is the originating and terminating station for passenger trains coming from and going out to each line throughout the country.

- o It stores, replaces, inspects and repairs passenger cars.

b) Number of departure and arrival trains

The total number of arrival and departure trains at this station is 118, consisting of 59 arrival and 59 departure trains at the present time. It is estimated that arrival and departure trains will total 150 in 1996. Therefore, the promotion of DRC's is expected to occur in the areas of car operation efficiency, speeding up of trains, and the increase in arrival and departure line capacity.

Table 6.2.2 Number of Arrival and Departure Trains

Railway Line		1985			1996 (Planned)		
		PC Train	DRC Train	Total	PC Train	DRC Train	Total
Down train	EL	2	9	11		16	16
	NL	9	12	21	5	22	27
	NEL	8	10	18	6	15	21
	SL	6	3	9	6	5	11
Total		25	34	59	17	58	75
Up train	EL	2	9	11		16	16
	NL	9	12	21	5	22	27
	NEL	8	10	18	6	15	21
	SL	6	3	9	6	5	11
Total		25	34	59	17	58	75
Grand Total		50	68	118	34	116	150

c) Handling of passenger cars

The work done at this station yard consists of washing, inspecting, and shunting cars. Usually, washing is conducted on arrival and departure tracks. However, large-scale washing, which is done once every two months, is conducted on the washing track in the passenger car sorting yard. Inspection is usually conducted on arrival and departure tracks also, while regular inspections are done on the DRC depot.

Shunting consists of such kinds of work as the following: (1) transfer of arrival trains on the arrival track to the storage track, and placing of trains on the departure track in time for the departure time; (2) removal of cars requiring periodic inspection from trains on the storage track, and replacing them,

as well as malfunctioning cars, with reserve cars, and exchanging the positions of cabooses; (3) formation of a train to replace a delayed train, and modification of a train formation to meet demands in times of heavy traffic. Presently, the number of cars handled is as follows:

PC: Storage and replacement of 50 trains
(Approx. 350 cars handled per day, Max. storage 226 cars)

DRC: Turnaround, entry, and departure of 68 trains
(Approx. 150 cars handled per day)

It is thought that handling will be conducted mainly by turn-around DRC trains, in spite of the number of trains increasing due to improvements in transportation service. However, some increases in the number of passenger cars that can be handled are anticipated.

d) Work system

Shunting work is conducted by three locomotives: two for the station yard and one for the DRC depot. The work content is as follows:

Table 6.2.3 Shunting Work Party

Party	Work Allotment	Shunting Locomotive	Work System
A	Shunting in station yard	1	Shift 2:00 - 8:00 8:00 - 14:00 14:00 - 20:00 20:00 - 2:00 A party consists of three persons. 24-hour schedule
B	Shunting in station yard (Assisting parties C and A, irregular special work)	1	Shift 4:00 - 10:00 10:00 - 16:00 A party consists of three persons. 12-hour schedule
C	DRC depot shunting	1	Shift 11:00 - 16:00 17:00 - 23:00 A party consists of three persons. 11-hour schedule

2) Improvements in yard work

There are eleven platforms at Bangkok station, the center of SRT's passenger transportation, with four used only for arrivals, two for arrivals and departures, and five for departures only. In addition, the yard is not flexible because the capacity of the passenger car storage track is limited. This poses a bottleneck for improvements in SRT passenger transportation.

Arrival and departure tracks are separated at this station. There is little flexibility among these tracks, since arrival trains are stored on the passenger car storage track and then moved to the departure track for starting.

This shunting conflicts with the many arrival trains of the morning rush hour and restricts the scheduling of trains. As the storage track's capacity is very small, the yard is easily filled with the cars of these arrival trains from morning till afternoon. This is a barrier to the betterment of transportation service.

On the other hand, passenger transportation will be effectively improved by DRCs, as viewed from the standpoints of speeding up trains and the flexibility of car operation in connection with short and medium distances. Therefore, if we set up new departure and arrival tracks, which will make arrival trains depart without shunting via the storage track, the confusion of the yard work will be lessened considerably and more trains can be set up in the effective time zones.

Upon such improvements, the train handling capacity of Bangkok station will improve greatly. It is thought that the storage track for passenger cars will be used for the storage of superior PC trains, mainly long-distance trains. At night, when the number of stored passenger cars is small, DRCs will also be kept there.

As a result of the survey of the yard work plan in Bangkok station the number of trains handled in the future will be increased greatly.

It is necessary to estimate the number of shunting locomotives and yard works after the planning of the actual train diagram and train operation schedule.

(See Appendix 6.2.2.)

(2) Mae Nam

1) Outline of handling

a. Freight handling

In 1985, this station handled 3.03 million tons of freight and is classified as follows.

Table 6.2.4 Freight Volume Handled in 1985

(Unit: Million tons)

Classification	Freight Handled	Breakdown	
Departure	1.47	Oil products 1.34	Rice, miscellaneous goods in containers 0.14
Arrival	1.56	Crude oil 1.21	Rice, rubber 0.34
Total	3.03	Petroleum 2.55	Others 0.48

Petroleum occupied approx. 84 percent of all the goods dealt with while others made up for approx. 16 percent. The volume of freight will remain at the same level, because Bangkok Port has reached its limitations, and a new port on the Eastern Seaboard is being planned.

b. Yard work

The number of trains amounts to 32 a day, including arrival and departure trains. Twenty-four trains use the arrival and departure tracks, excluding the eight trains for crude oil.

Table 6.2.5 Number of Arrival and Departure Trains (Planned)

	1985				1996 (Planned)
		Breakdown			
		Arrival and Departure at the Port (Crude Oil Transportation)	Arrival and Departure at Mae Nam		
			Transportation of Oil Products	(Others)	
Arrival	16	4	6	6	16
Departure	16	4	6	6	16
Total	32	8	12	12	32

The number of freight cars handled amounts to approx. 1,000 a day. Approx. 600 cars arrive and depart at the yard of this station, excluding the 440 crude oil cars that are directly moved as train units to the loading/unloading track.

Arrival freight cars are sorted at this station into those for the port line and those for the main station, and further divided at the cargo-handling tracks. As for departing cars, most of the oil tank cars are coupled by direction as special trains, and ordinary cars are coupled as trains for Bang Sue. However, the yard work gets confusing because the capacity of the sorting tracks is small.

It is estimated that the number of trains and freight cars to be handled in the future will remain at the present level.

At Mae Nam station, shunting work is conducted by three parties using three locomotives. A 24-hour work schedule is enforce for the station's two locomotives and for the Port Line's one.

Table 6.2.6 Shunting Work Party

Party	Work Allotment	Shunting Locomotives	Work System
A	Shunting at main station (Mainly general cargo)	1	"Three shifts "A party consists of three persons "24-hour schedule
B	Shunting at main station (Mainly oil cargo)	1	"Three shifts "A party consists of three persons "24-hour schedule
Port line	Shunting at Port Line Handling freight cars of main station and Port Line	1	"Three shifts "A party consists of three persons "24-hour schedule

Arriving and departing cars on the Port Line (excluding oil tank cars directly moved to and from the Port Line) are transferred by the Port Line shunting party on the section between the main station and the Port Line.

It takes seven times to transfer the cars with approx. 25 transferred each time. It is about 7 kilometers from this station to the PTT (Petroleum Authority of Thailand) Line, which is located at the tip of the Port Line. Therefore, it will take approx. 30 minutes to get there, in operation time only, due to a turnaround by crossing the Rama IV street and slow operation in a densely built-up area.

2) Improvements in yard work

This is SRT's most strategic station, handling 27 percent of all its freight, and it is considered that the smooth handling of cargo and establishment of shippers at this station will have a big impact on the trend of freight transportation in the future.

At this station, decomposition and composition is conducted in a narrow area, excluding crude oil cars moved directly to and from loading/unloading tracks, with little room for expanding the sorting tracks. Therefore, the following should be promoted for improving the transportation services and the yard work.

- o The returning empty oil cars that depart from this station arrive from 2:00 pm to 9:00 pm and compete with the filled oil cars departing during that time zone. It seems that such competition confuses yard work further, and it will have to be studied about how to lessen the confusion during that time by deferring the arrival train time zone of the returning cars to after the departing time zones for oil trains.

- o As for general cars, a lot of empty ones are stored in the yard, and measures have to be taken to make them depart for Bang Sue as early as possible.

- o A new shortcut line should be set up to make the transfer work between the main station and the Port Line smoother.

The present yard work system consists of 3 shunting locomotives and 3 work parties assigned for 24 hours.

The possibility of changing the allocation time for one shunting party will be studied.

Judging from the yard work study, covering the above-mentioned contents for improvement, it is estimated that the time for a party can be reduced from between 0:00 and 8:00.

3) Personnel reduction

2 crews x 1 party + Free crew = 3 persons
3 shunting staff members x 1 party + Free crew = 4 persons
Total 7 persons

(See Appendix 6.2.3.)

(3) Bang Sue

1) Outline of handling

a. Freight handling

This freight terminal handled cargo weight 0.99 mil. tons in 1985. The breakdown is as follows.

Table 6.2.7 Freight Volume Handled in 1985

(Unit: Million tons)

Classification	Tonnage	Breakdown	
Departure	0.12	Cement -	Others 0.12
Arrival	0.87	Cement 0.79	Others 0.08
Total	0.99	Cement 0.79	Others 0.20

Cement, accounting for 80 percent of the freight volume handled, is made by three manufacturers. Cement is transported from Map Kabao, Ban Mo, Phon Thong, and Ban Cha-am in unit trains (tank cars). Some cement is transported by packages in general cars.

Table 6.2.8 Cement Transportation to Bang Sue

(Unit: Million tons)

Place of Departure	Tonnage Received	Breakdown	
		Bulk	Package
Ban Mo	0.31	0.26	0.05
Map Kabao	0.37	0.35	0.02
Phon Thong	0.09	0.05	0.04
Ban Cha-am	0.02	0.02	-
Total	0.79	0.68	0.11

Other general cargo, excluding outgoing alcoholic drinks, has decreased considerably, with most freight terminal facilities idle these days.

As this station is located in the most advantageous place in Bangkok, its biggest consumer, the freight to be handled will gradually increase due to improvements in transportation.

b. Yard work

a) Yard's roles

This yard as the center of SRT freight transportation, plays the following roles.

- o Relaying of general freight cars departing and arriving from the Northern, Northeastern, Southern, Eastern and Mae Nam Lines
- o Operation of freight cars for surrounding stations
- o Operation of empty cars
- o Handling originating and terminating cars (freight terminal, freight car section)

b) Number of arrival and departure trains

Regarding the number of trains scheduled for this yard, there are 31 up and down trains respectively, totalling 62 in all. Out of these, the number of respective up and down trains for unit freight (cement) is 9 for a total of 18.

The trains are actually operated depending on the current trend of freight transportation flexibility. According to recent records, the number of trains arriving at Bang Sue is from 20 to 30, which is equal to 50 percent of all scheduled trains.

Table 6.2.9 Number of Arrival and Departure Trains

	1985									1996 (Planned)		
	Down Train			Up Train			Total			Up	Down	Total
	General	Unit	Total	General	Unit	Total	General	Unit	Total			
Northern Line	4	(2) 4	(2) 8	4	(2) 4	(2) 8	8	(4) 8	(4) 16	7	7	14
North-eastern Line	4	(2) 4	(2) 8	4	(2) 4	(2) 8	8	(4) 8	(4) 16	6	6	12
Southern Line	(4) 7	1	(4) 8	(4) 7	1	(4) 8	(8) 14	2	(8) 16	9	9	18
Eastern Line	7		7	7		7	14		14	11	11	22
Total	(4) 22	(4) 9	(8) 31	(4) 22	(4) 9	(8) 31	(8) 44	(8) 18	(16) 62	33	33	66

Note: Figures in ( ) indicate the number of temporarily operated trains.

It seems that freight arising from the construction of the Laem Chabang New Port will show steady growth while transportation of cement from Ban Chongtai will decline. Overall, there will be some growth in the near future.

c) Freight car handling

This station is well located as a freight transportation base because it it near the sea and the junction point of the Northern, Northeastern, Southern and Eastern Lines. However, the role of this station is lessening relatively due to an increase in direct and unit trains that carry oil and cement. Under such conditions, the number of freight cars handled at present amounts to approx. 900. It is estimated that this number will increase to approx. 1,150 in 1996 due to improvements in transportation service and construction of a new port.

Table 6.2.10 Estimate of Freight Cars Handled

(Unit: Car/day)

Existing			1996		
Direct	Yard Work	Total	Direct	Yard Work	Total
290	580	870	430	725	1,155

(See Appendix 6.2.4.)

d) Work system

This yard has a hump where trains are totally decomposed and composed. In this yard, four working parties carry out work 24 hours a day by using four shunting locomotives.

Table 6.2.11 Shunting Work Party

Party	Work Allotment	Shunting Locomotive	Work System
Hump	* Decomposition work at hump	1	•Four shifts •A party consists of three persons •24-hour schedule (Allocating seven breakmen under hump for three shifts)
Composition A	* Northern, Northeastern Southern Line train composition	1	•Four shifts •A party consists of three persons •24-hour schedule
Composition B	* Decomposition and composition of Eastern and Mae Nam Line trains * Decomposition of cement unit trains * Shunting on freight track	1	•Four shifts •A party consists of three persons •24-hour schedule
Freight line	* Shunting on freight track * Shunting on freight car section	1	•Four shifts •A party consists of three persons •24-hour schedule

In response to the increase in cement unit trains, 12 trains are decomposed and the other arrival trains (excluding some cement trains) made to arrive on the arrival/departure track of the Mae Nam Line, and sorted mainly from the composing side.

2) Improvements in yard work

Up to 1996, it is recommended that the following improvements be promoted.

a. Improvement of cement transportation

The volume of cement transported annually to Bang Sue is equivalent to approx. 0.91 mil. tons (0.68 mil. tons in bulk by tank car and 0.23 mil. tons in package by general freight car) in terms of cement received and transferred. Out of this, 0.79 mil. tons (87%) was received and the rest shipped to Thon Buri, Khlong Tan and Hua Mak.

Furthermore, 13 special trains, at a maximum, come in with cement. Of these, trains totally composed of cars terminating at Bang Sue are small in number, and uncoupling work is conducted at Bang Sue for the cars of other stations. It is recommended to increase direct shuttle trains between originating and terminating stations, so as to promote fixed-pattern unit transportation and improve yard work.

b. Reduction of workers needed for shunting locomotives due to the centralization of decomposition work (concentration on hump)

Regarding yard work, the hump and composition sides both have a small volume of work with a lot of waiting time. As their work is not so efficient, the following recommendations are suggested.

- o Presently, the number of trains decomposed at the hump is confined to 12. Hump efficiency will have to be raised by including trains arriving from Mae Nam in the decomposition work at the hump.

- o In connection with the above, work time will be reduced concerning the shunting locomotives and working parties in charge of coupling and uncoupling of trains coming from or going to Mae Nam.

As a result of considering the above recommendations, it is possible to reduce the number of personnel in the working party scheduled from 0:00 to 12:00.

3) Personnel reduction

2 crews × 2 parties + 1 reserve = 5 persons

3 ground shunting members × 2 parties + 1 reserve

= 7 persons

Total 12 persons

(See Appendix 6.2.5.)

(4) Hat Yai

1) Outline of handling

a. Handling of passengers and freight

The number of passengers using this station has steadily increased and reached approx. 3,700 in 1984.

Regarding freight, general goods have played the most important role. The total amount of freight for 1985 was 277,000 tons, consisting of 34,000 tons for departure and 243,000 tons for arrival. The breakdown is as follows:

Table 6.2.12 Freight Volume Handled in 1985

Classification	Weight Handled	Breakdown	
Departure	34,000 tons	Rubber Cement	20,000 tons 5,000 tons
Arrival	243,000 tons	Cement Liquor Rice Petroleum Miscellaneous	63,000 tons 10,000 tons 55,000 tons 13,000 tons 42,000 tons
Total	277,000 tons		

It is estimated that in the future the number of passengers and amount of freight transported will show a steady growth due to improvements in transportation service.

b. Yard work

a) Yard's roles

This station is located at a key point in terms of transportation for passengers and freight in South Thailand. This station plays the following roles:

- o Relaying of freight cars between the up trains of the Southern Line and down trains for Padang Besar and Sungai Kolok
- o Freight transportation base to Malaysia
- o Operation of freight cars to surrounding stations
- o Handling originating and terminating cars
- o Origin and terminal station of passenger trains

b) Number of arrival and departure trains

At this station, the number of arrival and departure trains totals 38, consisting of 22 for passengers and 16 for freight. The breakdown is as follows:

Table 6.2.13 Number of Arrival and Departure Trains

		1985				1996 (Planned)			
		Passing	Originating	Terminating	Total	Passing	Originating	Terminating	Total
	Down train	5	3	3	11	6	4	4	14
	Up train	5	3	3	11	6	4	4	14
	Total	10	6	6	22	12	8	8	28
	Down train	(1)	(2) 3	5	(3) 8		4	4	8
	Up train	(1)	5	(2) 3	(3) 8		4	4	8
	Total	(2)	(2) 8	(2) 8	(6) 16		8	8	16

Note: Figures in ( ) indicate the number of temporarily operated trains and are separate from other calculations.

It is estimated that in 1996 the total number of passenger and freight trains will be 28 and 16 respectively.

c) Number of cars handled

Presently, 60 passenger cars (six round-trips) stay a day on the average. It is estimated that 80 cars (seven round-trips) will stay a day on the average in 1996.

Regarding the handling of freight cars, it is a principle to engage in the total decomposition and composition of each train. Now, 310 cars a day are handled for departure, arrival and relay. It is estimated that this will increase to 330 cars a day in 1996.

On the other hand, sorting work at this station is conducted on both the arrival/departure tracks of freight (six tracks), because there are not any exclusive sorting tracks. That is to say, work is conducted using empty tracks or space at the end of arrival/departure tracks. When these tracks are being used for arrival and departure trains, the cars already sorted and stored have to be transferred elsewhere. For this reason, there are apt to be duplications of work with a very low efficiency rate at the busiest times, resulting in relay time taking longer.

d) Work system

Table 6.2.14 Shunting Work Party

Party	Work Allotment	Shunting Locomotive	Work System
Shunting A	Shunting of freight cars mainly	1	•Three shifts •A party consists of three persons •24-hour schedule
Shunting B	Shunting of passenger cars mainly	1	•Daytime shift •A party consists of three persons •8-hour schedule

In this yard, shunting work is conducted by two shunting locomotives and two working parties. The party in charge of shunting passenger cars works only in the daytime (8:00 - 16:00).

2) Improvement of yard work

Recently, a new marine container base has been built in Padang Besar (transporting approx. 30 containers a day). However, the transportation of limestone from Ban Song to Malaysia has stagnated (from 0.12 mil. tons to approx. 40,000 tons). For this reason, the congestion in yard work has lessened as compared with that of last year at this station. However, large-unit transportation by railway

is now very effective as compared with other modes of transportation in terms of distance and geography. It is expected that the railway traffic volume will steadily increase due to improvements in transportation service, including fast delivery and clarification of arrival date/time.

Under such circumstances, it is recommendable that the sorting tracks be rearranged and strengthened, the problems of duplicating and complicating work resolved, the relay time shortened, and the degree of accuracy in relaying freight cars improved.

The existing number of yard workers at Hat Yai station should be kept the same since the number of passenger trains handled will also increase.

(See Appendix 6.2.6)

CHAPTER 7 YARD FACILITY PLAN

CHAPTER 7 Yard Facility Plan

7-1 Introduction

7-1-1 Working Procedure

Based on the results of the first field survey from December 1985 to February 1986, a master plan was formulated, then four yards (Bangkok, Mae Nam, Bang Sue and Hat Yai) were selected for the from F/S among the plan's ten yards.

In the second field survey from July to September 1986, consultations were held with the SRT personnel concerned, and as a result, the Master Plan was corrected with respect to the four F/S yards and Thung Song yard. Then, F/S Plan was prepared, which showed the procedures for improvement work to be tentatively done for the four F/S yards and Ban Phachi and Thung Song yards with respect to tracks and signals.

In this Report, the requests presented by SRT personnel during the third field survey in December 1986, concerning the alternative plan for the shortcut line of Mae Nam and elaboration on the future plan of the Bang Sue yard, are taken into consideration.

7-1-2 Preconditions for Calculation of Investment Amount

(1) The amount of investment is calculated using the prices of May 1986, with price rises not taking into account.

(2) In calculating the investment amount, parts pertaining to the "Track Elevation Project of Existing Railway Lines in the Bangkok Metropolitan Area" are not counted.

(3) The exchange rate is US$1 = 26.44฿ = ¥174.83 (¥6.61/฿) (average rate from March to May 1986).

7-2 Bangkok (Passenger Terminal)

7-2-1 Present Condition of Yard Facilities

(1) General

This station is a passenger terminal having a passenger car yard and a DRC depot. As this is a dead-end station, arrival trains have to be turned back; however, there are no particular facilities for replacing tractive locomotives.

The passenger car yard is located between arrival and departure tracks to permit shunting work, which poses few inconveniences to the operation of the main track. However, as a rule, passenger trains arriving at the arrival tracks have to be led to the car yard then set up as departing trains to the departure tracks.

The main work of the car yard is to remove the passenger cars composing the arrival trains and keep them until they are used for the departure trains. During storing the cars, rearrangement of composition and car washing are sometimes done, and for such purposes, reserve cars are kept in the yard.

The DRC depot is located on the left and outside of the main line and affects shunting to the main line little. In this depot, daily inspection, 1-month inspection, and 4-month inspection of DRCs and PCs are carried out in addition to storing, washing, and oil supply of DRCs.

The track layout is as shown in Figure 7.2.1.

(2) Condition of the compound, land, and buildings

The yard is limited in space, and there is little room for enlargement but SRT has a plan to increase the number of arrival and departure tracks and extend the DRC storage track.

The buildings in the compound are steel-framed or of reinforced concrete structure and are usable if maintained properly.

The surrounding area of the station is the most built-up in Bangkok, but there is space for extension on each side of the railway from the Mahanak river bridge to about 1 km 640 m away and to the Petchburi Rd crossing 2 km 170 m away.

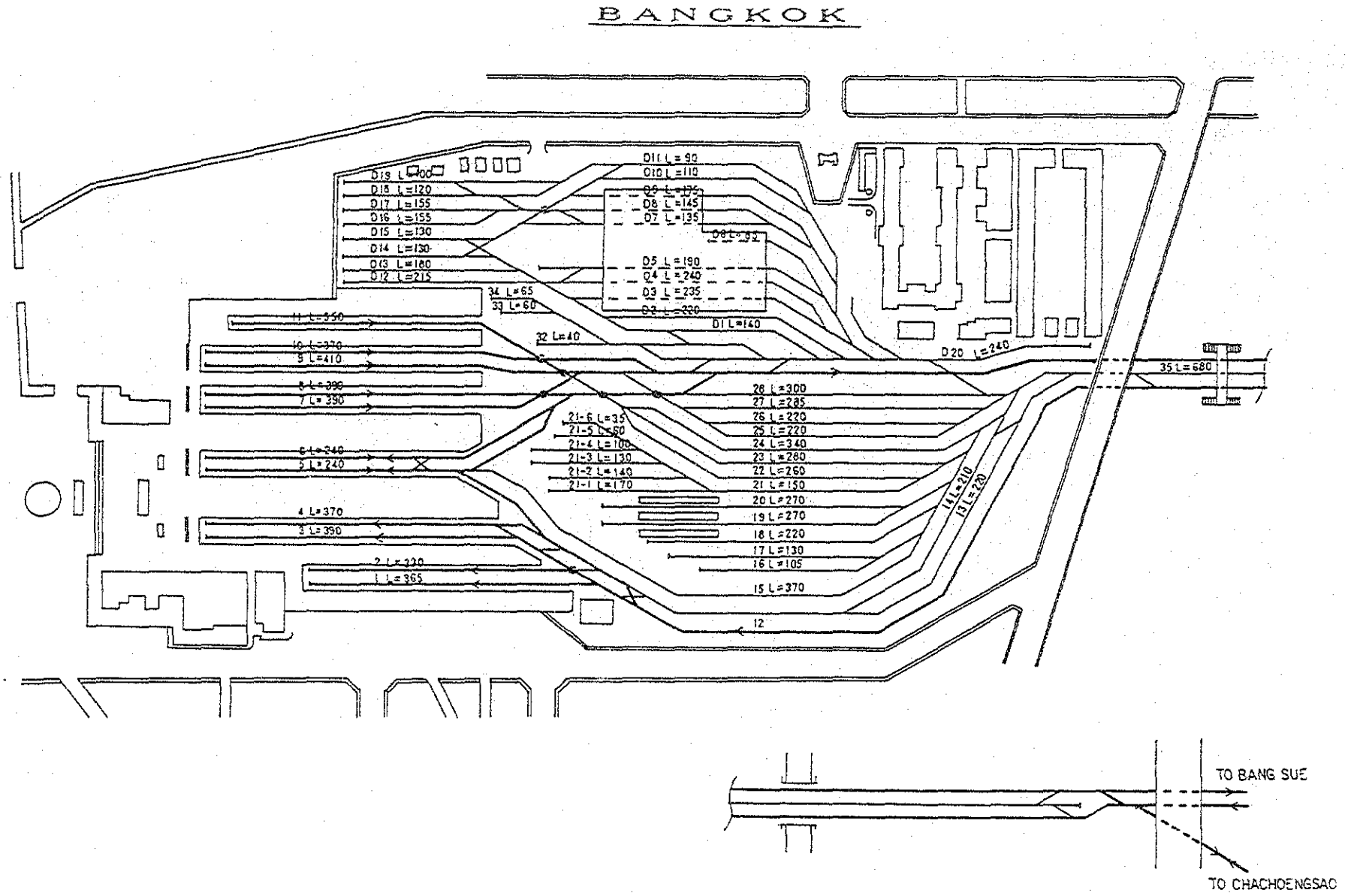


Fig. 7.2.1 Present Track Layout at Bangkok Station

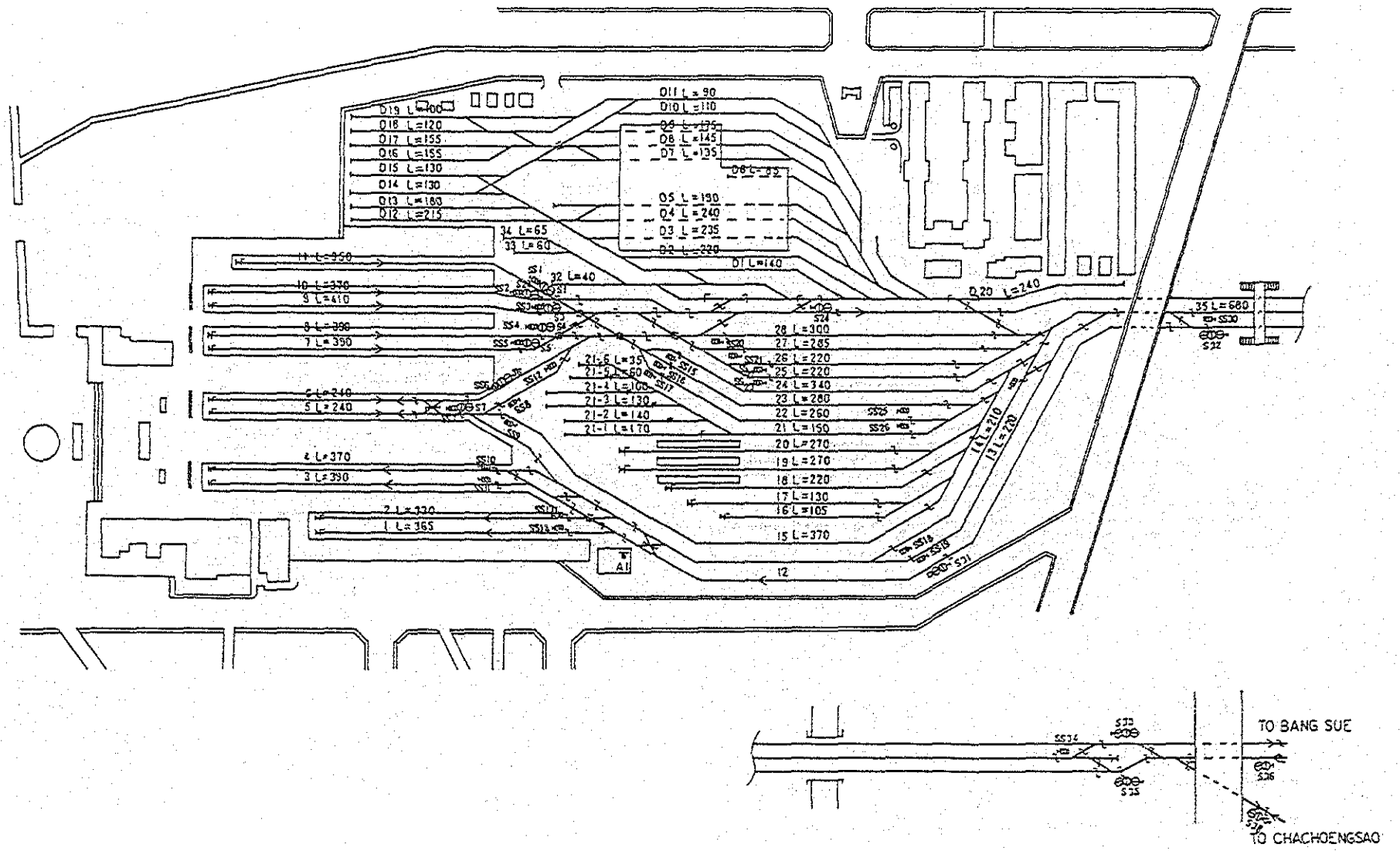


Fig. 7.2.2 Present Signalling Facilities at Bangkok Station

(3) Yard facilities

The yard facilities are as shown in Appendix 7.2.1.

(4) Signalling and telecommunication facilities

1) Interlocking devices are of the electrical type (relay interlocking, route lever).
2) Signals are of the electrical type, and there are starter signals and home signals.
3) Turnouts are of the electrical type.
4) Train detection is performed by track circuits.
5) There are dispatching telephones, block telephones and exchangers. A radio is used for shunting work.

The signalling facilities are shown in Figure 7.2.2.

(5) Summary of themes of improvement

1) The capacity of the arrival track has reached its limit and there is little room for an increase in trains.
2) The capacity of the departure track has reached its limit and the setting work of departure trains from the DRC depot has to be done via the main departure track.
3) Effective length of tracks is short, and the storing capacity limited.
4) Trains on the Eastern and Northern Lines concentrate at the point near the outlet of the station due to the joint use of the tracks.
5) Presence of many multiple branch routes.
6) Many trains are forced to arrive or depart outside the departure signal, and the interlocking device has been used often and deteriorated greatly.

7-2-2 Master Plan

(1) Plan for improving existing facilities

1) Additional installation of arrival tracks and changing departure tracks into arrival/departure tracks.

Since the Bangkok station is a dead-end station, its arrival and departure tracks are nearly at their limits. The capacity of the arrival or departure tracks is generally determined by the maximum frequency of arrival or departure trains per unit time. The

frequencies of the arrival and departure tracks are 8 and 6 trains per hour respectively, with number of the arrival trains being greater. Moreover, the trains arriving at this time are all PCs requiring longer shunting time. Therefore, Bangkok station urgently requires an increase in the capacity of its arrival tracks (Appendix 7.2.1).

As elements for increasing the capacity of arrival tracks, the following may be cited.

(1) Increase the number of arrival tracks

(2) Reduce shunting and passenger handling time

(3) Reduce arrival train headway

As a result of these elements being examined, it was found that increasing the number of arrival tracks and reducing shunting times would be effective measures. Further more, should the frequency of arrival trains increase greatly, there is a possibility that the minimum headway would have to be reduced from 5 minutes to 3 minutes (Appendix 7.2.3).

Although the foregoing examination found that an increase in tracks allowing arrival and a reduction in shunting time would be effective for increasing arrival track capacity, it became necessary to show that Bangkok station would be compatible for such improvement at the present site. Thus, by assuming a yard improvement plan and doing a simulation, the number of trains that could be handled at a certain time under the plan was calculated and the result tested (Appendix 7.2.4).

As a result of the simulation, it was found that increases in train frequency until 2006 could be coped with by increasing the tracks available for arrival. To do this, arrival trains will be handled by providing 2 additional arrival tracks and changing departure tracks 7 and 8 into arrival/departure tracks. The arrival/departure tracks 7 and 8 will be very advantageous for DRCs, which will increase greatly hereafter.

2) Additional installation of departure tracks

Arrival trains often come up to platforms other than those specified, but departure trains are generally handled at the specified platforms (Table 7.2.1). This is because at the starting station there is little disorder in the diagram so that the work is carried out as scheduled. Departure trains have both PCs and DRCs and the

tracks are laid out so as to permit train setting work from either the passenger car yard or the DRC depot, resulting in little competition between the two.

However, the track layout is such that the moving of departure trains from the passenger car yard does not greatly obstruct the main arrival track; however, the moving of departure trains from the DRC depot has to be done via the main departure track. To make a track layout that does not have the shunting work of the passenger car yard and DRC depot concurring together, it is necessary to change the tracks so as to directly connect the DRC depot and departure tracks.

Also, since there is a possibility of the departure tracks becoming congested in the event of increases in train frequency or diagram disturbances, it is desirable to install as many additional departure tracks as practicable.

Table 7.2.1 Differences between Actual Trains and the Train Diagram

(As of 1986)

	Inbound Trains			Outbound Trains		
	Proper	Different	Total	Proper	Different	Total
PC	20	5	25	25	0	25
DRC	28	6	34	32	2	34
Total	48	11	59	57	2	59

3) Extension of the effective track length and increase in the storage capacity

The effective track length of SRT includes turnouts that have a relatively high frequency of use, which is fine so long as they do not obstruct work; but trains are often set over the turnouts (Appendix 7.2.5). This may cause few problems in a siding such as in a passenger car storage track, but on the main track, it may be a hazard to safety and speedy route formation. On the departure track side, trains of a long composition ride over the turnouts, resulting in the locomotives of these trains being situated beyond the signal

with train drivers being unable to see the signal display. Thus, these trains have to be started by a tablet.

These disorders should be eliminated as much as possible by extending effective track length.

Particularly, tracks 5 and 6 are designated as arrival/departure tracks and are advantageous for drawing out arrival trains on the departure track side. Therefore, it is desirable to extend their effective length to allow them to be used by PC trains.

The number of formed trains staying in the yard for more than 1 hour is 13 at the maximum, while available tracks number 18, thus, there is room for 5 more trains (Appendix 7.2.6 (1)).

However, when shunting work for the drawing out of locomotives after their arrival or departure and after passenger handling of PC trains is taken into consideration, the arrival/departure tracks should not be used. Other tracks have reached their storage limit for formed train.

Also, the passenger car yard has a short effective track length (Appendix 7.2.6 (2)) and formed train divided for storage there, resulting in congestion of the yard work.

The maximum number of cars that can now stay at the yard use 93% of the total effective length, meaning the storage capacity of the passenger car yard is now at its limit.

Corrective measures will reduce PC trains by promoting the use of DRCs, installing additional arrival and departure tracks, and increasing storage capacity.

Also, the DRC depot has a short effective track length and is at its storage capacity limit, so DRC storage tracks are being constructed at Bang Sue station. However, as the depot is situated in the yard at the most convenient location for shunting work, inspection and repair work will be done at this depot in the future. Furthermore, as many DRC storage tracks as space allows should be built.

4) Concurrence of trains between the Eastern and Northern Lines

The Eastern Line branches off from the Northern Line at a point approximately 2.1 km from the Bangkok.

At this point, an outbound train of the Eastern Line crosses the inbound track of the Northern Line. Also, trains of the Eastern

Line are forced to run partly on the inbound tracks of the Northern Line.

Due to these reasons, the train diagrams of both lines are very crowded and have little headway. (Appendix 7.2.7)

Also, as it is rather difficult to completely shut off the Petchburi Rd. crossing, due to its being only 2.17 km away from Bangkok, trains of the Eastern Line are frequently forced to temporarily stop before the crossing, which is the cause of the train diagram disorder of the Northern Line.

To increase the number of trains handled at Bangkok station, it is necessary to operate all trains punctually. For this purpose, it is desirable to increase the number of tracks in this area to four. All trains will be stopped for time adjustment, then an outbound train of the Eastern Line will be allowed to cross the inbound tracks of the Northern Line and an inbound train of the Eastern Line to run into the inbound tracks of the Northern Line.

As to this area, a plan for elevating the existing tracks is underway in accordance with "The Kingdom of Thailand Track Elevation Project of Existing Railway Line in the Bangkok Metropolitan Area (JICA 1984)"; therefore, it is desirable to elevate the four tracks by taking advantage of this opportunity.

5) Elimination of multiple branch routes

The multiple branch routes are provided for train operation or shunting work to avoid busy routes or for trains riding on turnouts because of shortages in effective track length.

In the case of multiple branch routes, securing train safety with signals is important; and for higher efficiency and safety, multiple routes are not desirable. Particularly, three or more branch routes per track should be abolished.

Further, when multiple branch routes are eliminated, turnouts will decrease and the effective length of track will increase. Thus, along with extension of the effective track length, multiple branch routes are reduced as much as practicable.

6) Improvement of signals and interlocking device

Departure signals are erected so that trains do not run over the turnout nearest to the platform, except for tracks 5 and 6. (A shunting signal is erected for each of the track to indicate the starting point for shunting.)

However, trains are often set beyond the location of such signals. In such cases, the track circuit controlling the signal is short-circuited and the proceed signal not displayed. Then, manual operation using blocking ticket is conducted. It is necessary to use it carefully. In order to secure train safety, which is the purpose of signalling facilities, signals should have their locations changed along with improvement of the yard; also, the interlocking device should be improved so that trains do not start before they receive confirmation from the proceed signal. Accordingly, departure tracks for long trains are limited. Particularly, turnouts in the effective lengths of tracks 8, 9, 5, and 6 should have electrical connections to their signals done, with the handling of long as well as short trains fully taken into consideration.

Shunting signals should be done away with entirely and changed to ones using the route signal system which indicates departure and arrival points with alphabetic characters and numerals. Installation should be done in consideration of the track circuit sections, locations of erection, etc. so that safety is secured for the shunting work.

(2) Master plan

1) Ground Plan

The Master Plan was designed to implement, as much as practicable, measures for improvement pointed out in Section (1). The proposed improvement plan is shown in Figures 7.2.3 and 7.2.4. In the drawings, the index numbers show the following.

1)-a Installation of 2 additional arrival tracks.

1)-b Improvement of Departure Tracks 7 and 8 to departure/arrival tracks.

2)-a Installation of 1 additional departure track.

2)-b Connecting the DRC depot and the departure tracks directly.

3)-a Extension of the effective length and increase of the storage capacity of the passenger car yard.

3)-b Same as above for the DRC depot.

4) Resolution of train concurrence between the East and North Lines.

5) Resolution of multiple branch routes.

6) Changing the locations of erection for signals.

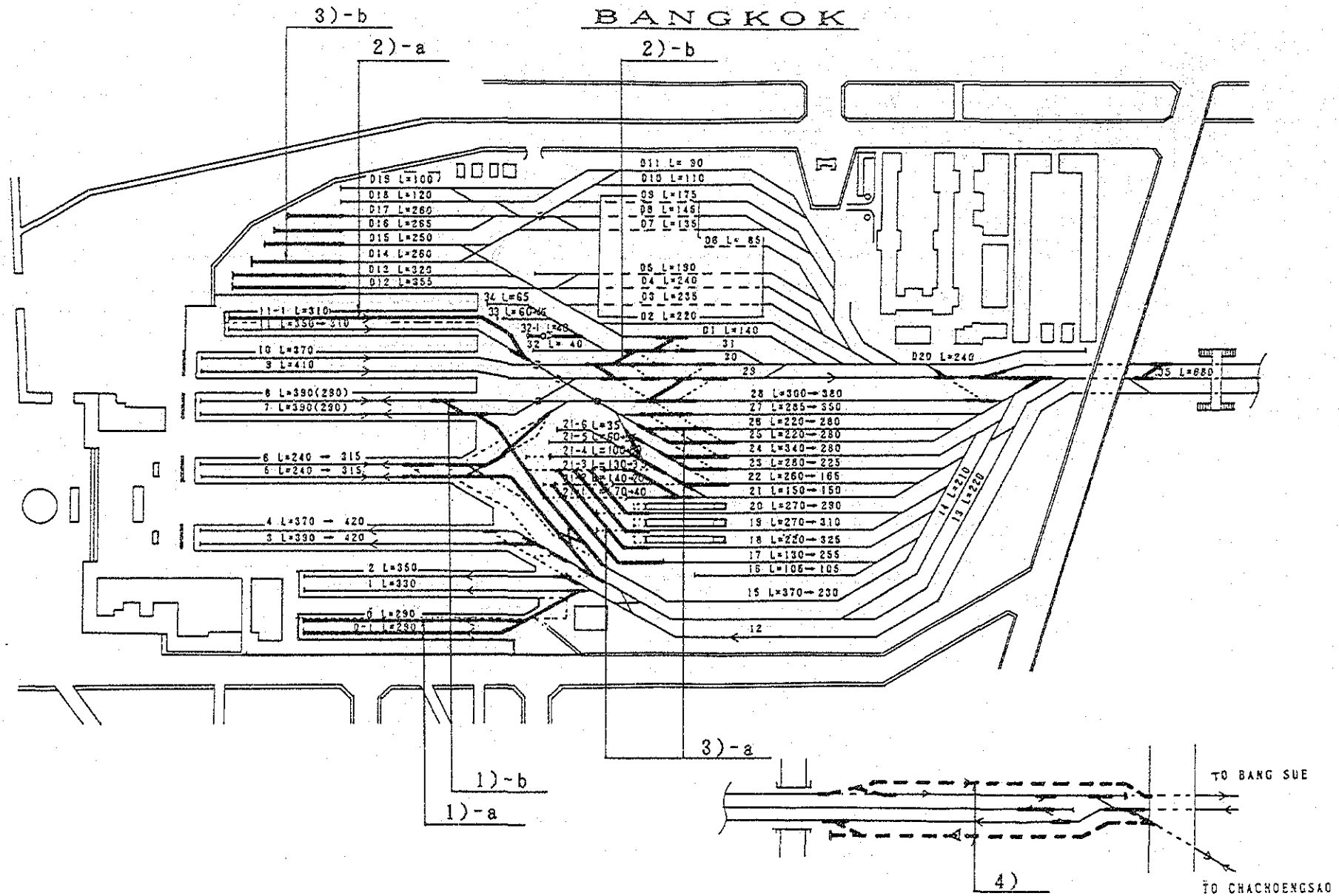


Fig. 7.2.3 Future Track Layout at Bangkok Station (Master Plan)

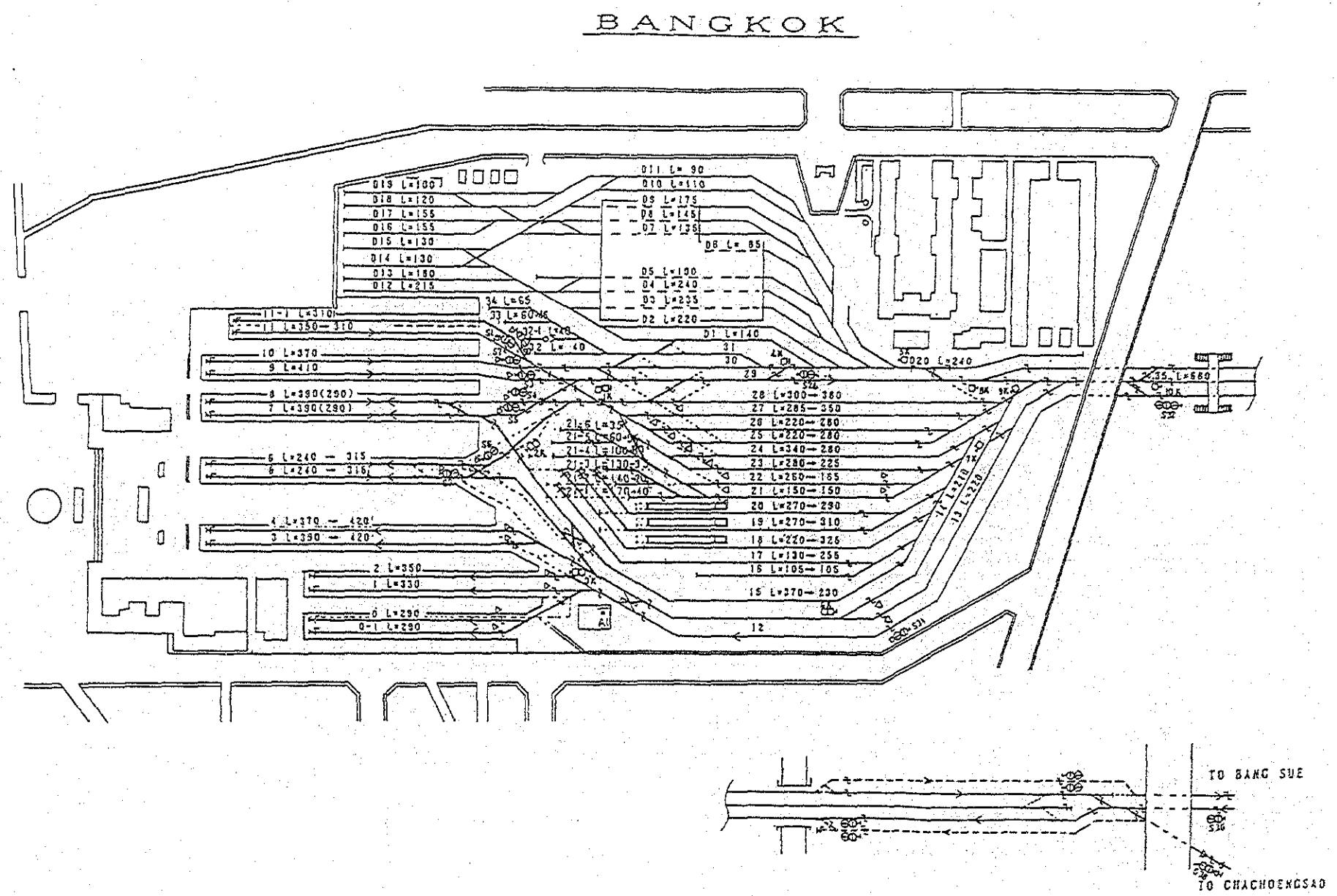


Fig. 7.2.4 Future Signalling Facilities at Bangkok Station (Master Plan)

2) Outline of the facilities to be improved

Facilities to be improved according to the improvement plan are outlined below. (See Appendix 7.2.9.)

Table 7.2.2 Passenger Facilities

Tracks	Present facilities		Improved facilities		Increase/decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
Passenger arrival	4	300 - 390	6	290 - 420	2 Tracks Effective length increased by 645 m
Passenger arrival and departure	2	240	4	315 - 390	2 Tracks Effective length increased by 930 m
Passenger departure	5	350 - 410	4	310 - 410	1 Track Effective length decreased by 510 m

Table 7.2.3 Passenger Car Yard

Tracks	Present facilities		Improved facilities		Increase/decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
Spare car storage	9	30 - 220	9	20 - 325	Effective length decreased by 140 m
Formed storage for trains	10	150 - 370	10	150 - 380	Effective length decreased by 85 m
Washing	2	270	2	290 - 310	Effective length increased by 60 m
Other storage	3	40 - 65	3	40 - 65	Effective length decreased by 15 m
Engine waiting track			1	40	1 Track Effective length increased by 40 m

Table 7.2.4 DRC Base Station Facilities

Tracks	Present facilities		Improved facilities		Increase/decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
DRC storage	5	130 - 220	5	110 - 265	Effective length increased by 305 m
Daily inspection and lubrication	3	130 - 220	3	260 - 355	Effective length increased by 410 m

3) Investment: 162.0 million bahts

7-2-3 F/S Plan

(1) Items of improvement in F/S plan

Of the problems of the existing facilities stated in "7-2-2(1)," the resolution of train competition of the East and North Lines" is related to the "Track Elevation Project" and may require some remodification, so it is removed from the F/S plan. The other problems are included in the F/S plan as they are port of the work sequentially carried out when the tracks in the yard are changed.

A plane figure of the F/S plan is shown in Figure 7.2.5. and 7.2.6.

(2) Work execution plan and investment

1) Work period: 10 months (after acquisition of materials)

2) Track changeover

(a) Tracks are changeovered during train intervals, and the work is carried out so that at the time when it is completed trains can be handled properly. For details of the sequence of changeover, see Appendix 7.2.10.

(b) Signalling and telecommunication systems work will be done as track changeover progresses.

3) Investment: 162.0 million bahts

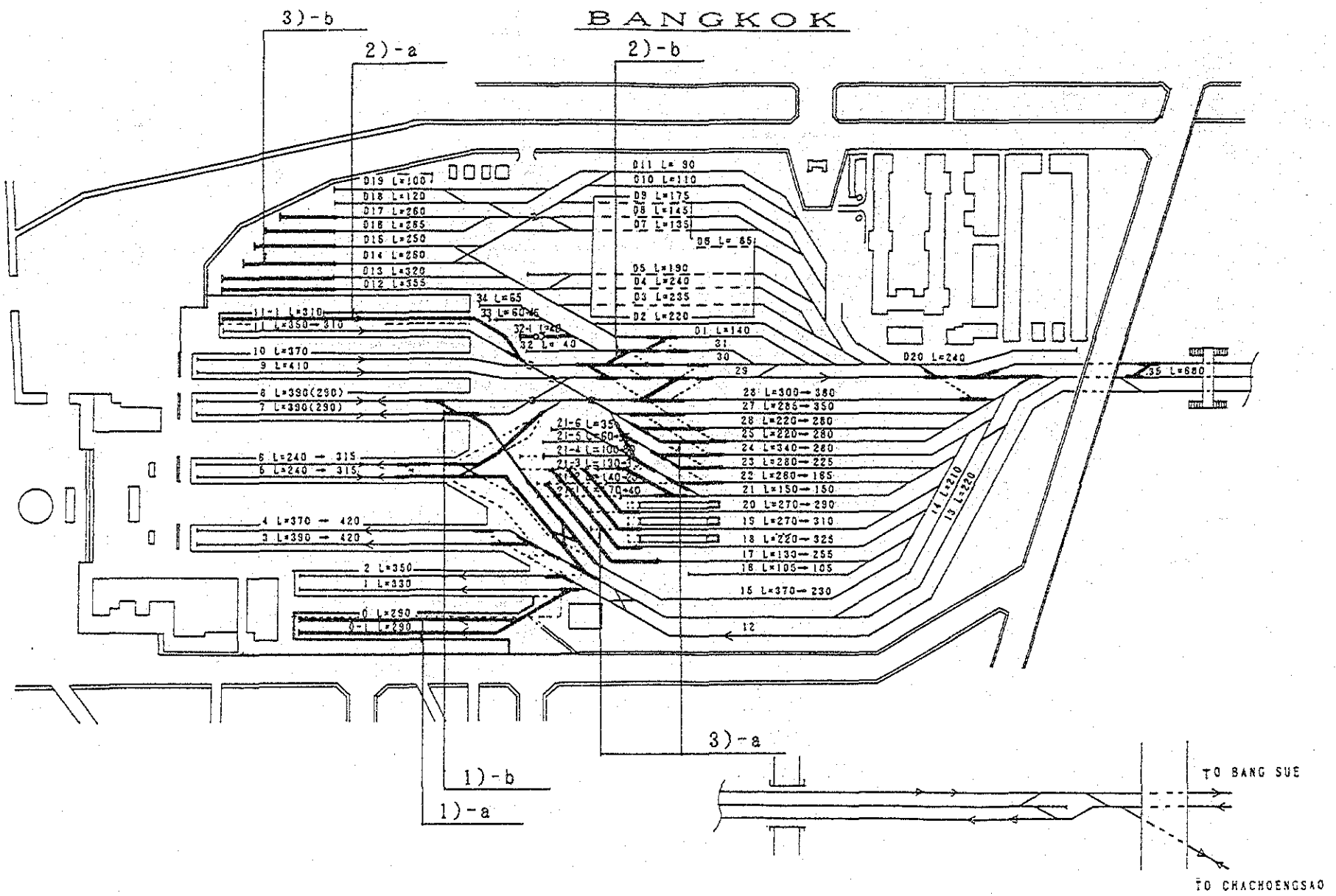


Fig.7.2.5 Future Track Layout at Bangkok Station (F/S Plan)

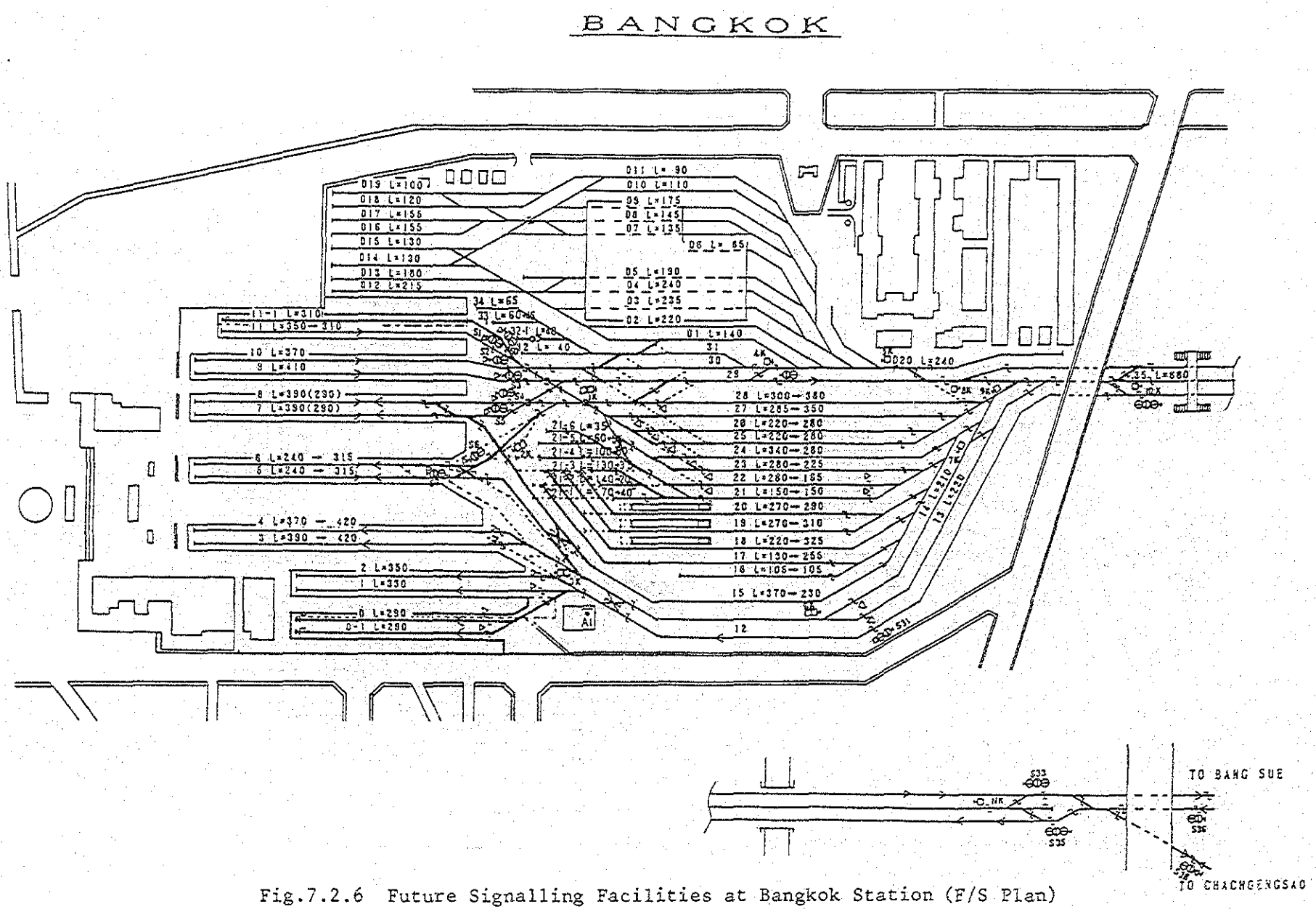


Fig.7.2.6 Future Signalling Facilities at Bangkok Station (F/S Plan)

7-3 Mae Nam (Freight Terminal)

7-3-1 Present Condition of Yard Facilities

(1) General

Mae Nam station is a waterfront freight station adjacent to Bangkok Port in a center of commodity distribution, with the volume of cargo handled being the largest in SRT.

The compound of the station is divided into two, a main station and port station. General cargo arrives at and departs from the main station by freight train, with the Port station having freight cars shunted to it. However, freight trains containing such products as PTT petroleum directly arrive at and depart from the Port station.

As for the petroleum and the like, crude oil is brought into this station, and the refined products are sent inland. These are directly delivered between the arrival and departure stations by unit trains by commodity.

Also, for grains and raw rubber, it serves as a central station of gathering and distribution, and these materials are forwarded via the Bang Sue yard to various stations in the country as general cargos.

The track layout is as shown in Figure 7.3.1.

(2) Condition of the compound, land, and buildings

The compound is located in the port and is therefore confined. Also, at about the branch to the Port station, the track crosses the Rama IV Road, which has the largest volume of road traffic in Bangkok.

The buildings are not worth mentioning except for the grain warehouses along the loading and unloading tracks. The land extends along the expressway and is located in the port facilities. Therefore, extension of the yard is very difficult, and the improvement of the facilities is not practicable, except at about the container loading and unloading yard area as planned by SRT.

(3) Yard facilities

The yard facilities are as shown in Appendix 7.3.1.

(4) Signalling and telecommunication systems

1) Interlocking devices are of the mechanical type.
2) Signals are of the electrical type, and there are approaching, starter, and home signals.
3) Turnouts are of the mechanical type.
4) Train detection is performed by track circuits.
5) The token system is used for blocking with the adjacent station applies.
6) There are dispatching telephones and teleprinters.
7) There are no problems worth mentioning.

The signalling facilities are shown in Figure 7.3.2.

(5) Summary of themes of improvement

1) There is no sorting track for shunting freight cars going to and coming out of the loading and unloading tracks of Bangkok Port.
2) Simplification of shunting work in the compound, and elimination of the level crossing at the Rama IV Road required.
3) Since the capacity of the arrival/departure tracks are at their limit, changing the weighing track in to an arrival/departure track was proposed. (The improvement was made.)
4) Additional empty car storage tracks are required at the main station.
5) Track capacity between Mae Nam and Chitralada is in adequate.
6) General cargo handling tracks are long, and the loading and unloading tracks are dispersed.

7-3-2 Master Plan

(1) Plan for improving existing facilities

1) Improvement of sorting facilities at Bangkok Port station

Bangkok Port has loading and unloading facilities at both its new and old ports. However, only those at the new port are presently used.

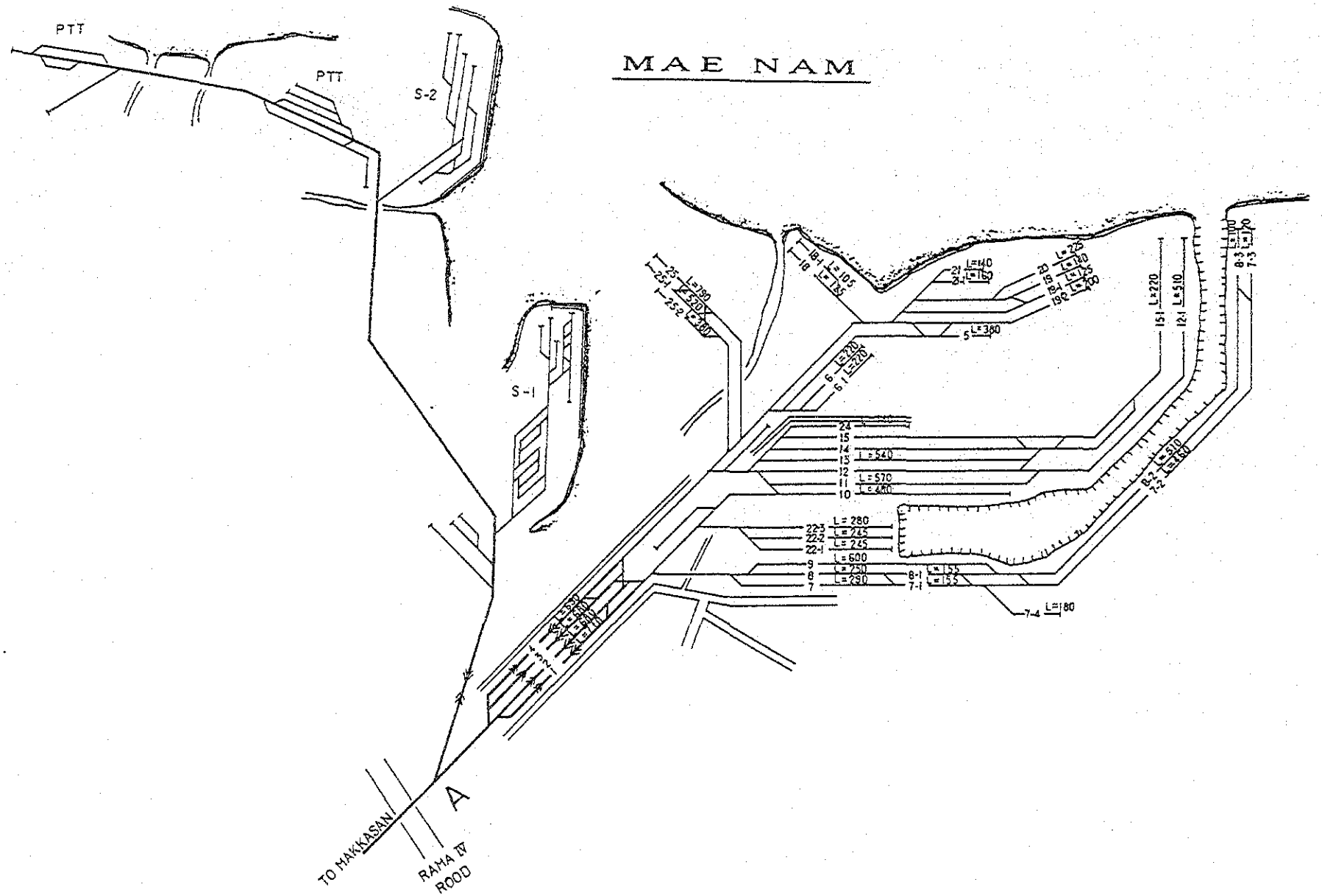


Fig. 7.3.1 Present Track Layout at Mae Nam Station

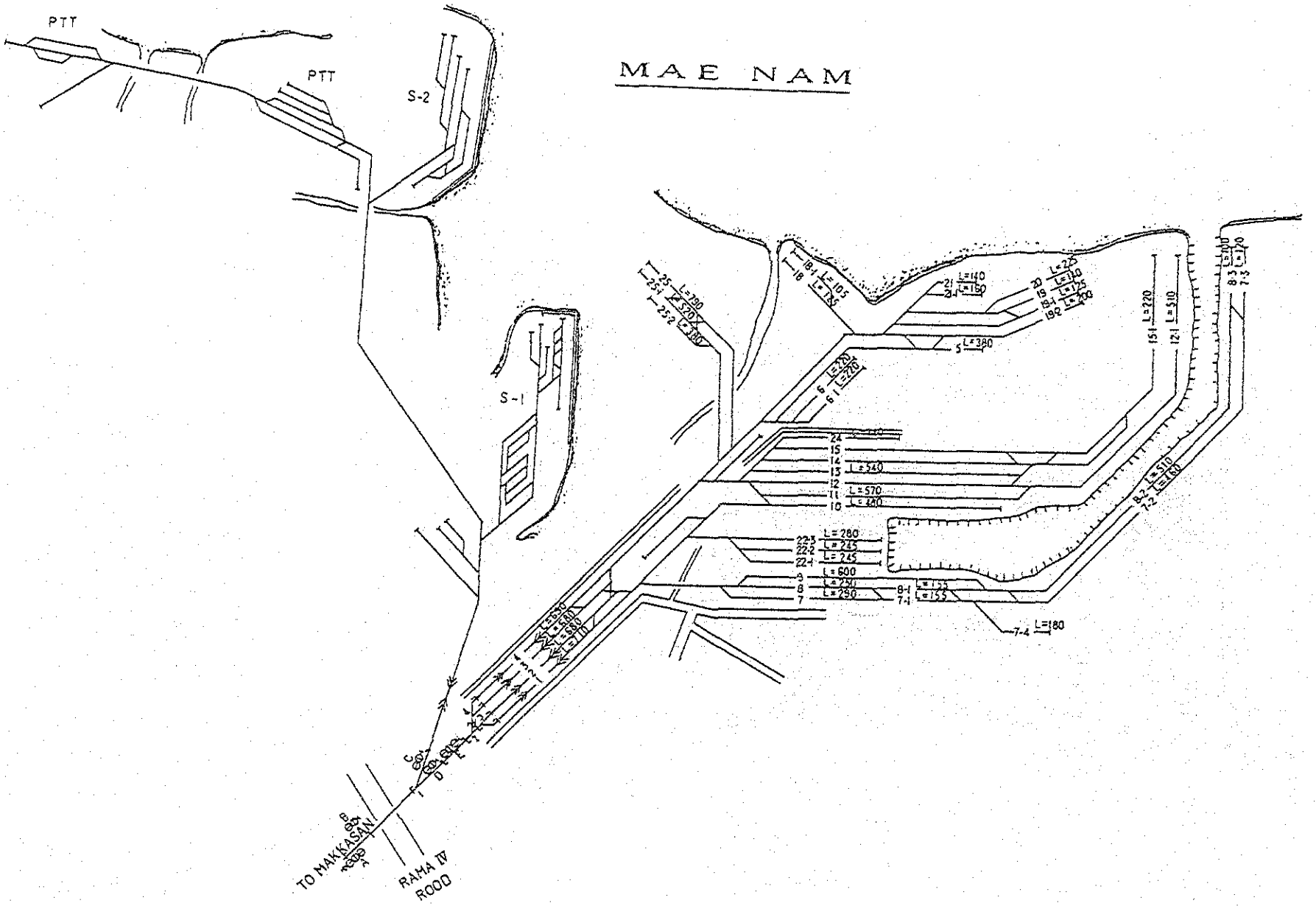


Fig. 7.3.2 Present Signalling Facilities at Mae Nam Station

The shunting of cars between Mae Nam's main station and new port station is done by a tractive locomotive, as a rule, and the placement of locomotives in the front or back of the freight cars, as well as the sorting work of freight cars going to and coming out of the port's unloading and loading tracks, is done using the sorting tracks on the PTT refinery product dispatch side outside of the stockade of the port. As this work is carried out during PTT work intervals and apart from the freight loading and unloading facilities, it is very inefficient.

In order for the delivery of freight cars between the main station and the freight loading and unloading tracks to be done smoothly, it is desirable to install 2 freight car sorting tracks at the head of the loading/unloading tracks of the new port, about 4 km from Mae Nam station, on the Bangkok Port Line.

2) Simplification of shunting work in the compound and elimination of the level crossing at the Rama IV Road.

Freight cars arriving at and departing from Mae Nam's main station, which load and unload at the loading and unloading tracks of the port station, are placed temporarily on its arrival and departure tracks before being shunted to and from the port station.

This shunting is done using turnout A (Figure 7.3.1), which is located at about 400 m in the direction of the port station at the neck of the arrival and departure tracks, and trains are taken back and forth to the Bangkok side of the main track. One way to turn trains back to the Bangkok side is to use a pusher operation. As the port track uses a hauling operation, a pusher operation is applied when departing from and arriving at the arrival and departure tracks.

This turning trains back, because it passes through the Rama IV Road level crossing, is very dangerous. Also, it interrupts the flow of traffic at the crossing for long periods of time.

The Rama IV Road also has the largest volume of traffic in Bangkok. Thus, elimination of this crossing with the Mae Nam Line is urgently required.

However, as Mae Nam's branch line to the Bangkok Port Line is located at about 150 m from the crossing, and an express way runs along the railway, grade separation is nearly impossible except by raising the railway track.

Main line trains passing the crossing (both ways) total 36, including 8 direct trains arriving at and departing from PTT. Shunting operations (both ways) pass it 14 times.

To resolve such difficulties due to shunting, a shortcut line should be provided between the main station and Bangkok Port to eliminate the turning back of trains towards the Rama IV Road crossing. If a shortcut line is provided as planned, working time will be reduced by about 5 minutes, or a saving of about 70 minutes a day.

If this shortcut line is constructed, only those trains running along the main line will pass through the Rama IV Road crossing. Moreover, when the branch line has no more turn back work being done in the vicinity, it may be included in the work for grade separation from the Rama IV Road.

However, it is reportedly very difficult to purchase the necessary land for the shortcut line. So, relocation of the branch towards the main station was comparatively examined with respect to operation, handling and construction costs. However, such a branch may pose a hazard in the near future when the grade separation of the Rama IV Road is done. Thus, such a plan should be avoided (Appendix 7.3.2).

3) Shortage of arrival and departure tracks

At the time of the survey in January 1986, there were 3 arrival and departure tracks, but one of them was used as an engine/removal track, leaving only 2 tracks for arrival and departure; thus, the capacity of the arrival and departure tracks was at its limit. So, a proposal was made to change the weighing track to an arrival/departure track. In August 1986, the track had its weighing table removed and was modified into an arrival/departure track.

4) Additional installation of empty car storage tracks at the main station

In seasons when the demand for oil is small, there is an excess of empty tank cars that causes a shortage in storage facilities. Thus, they are stored on an arrival/departure track (track 4), provided as stated in preceding subparagraph 3, which results in difficulties in the draw-out work of shunting.

To store freight cars in accordance with such seasonal fluctuations, it is necessary to install additional sorting tracks and extend their effective length.

Also, it is necessary to examine the relationship between Bang Sue yard and Mae Nam station, for example, to relieve Mae Nam station by having its empty cars handled by Bang Sue yard.

5) Shortage in line capacity between Mae Nam and Chitralada

Since there is a shortage of line capacity between Mae Nam and Chitralada, the arrival and departure trains are restricted at Mae Nam station (Appendix 7.3.3). In this section, the East Line and unit freight train line run in parallel to a 2-km subsection between Makkasan and Chitralada. With the track layout changed, part of this subsection will be used as a double-track (Appendix 7.3.3), resulting in line capacity being improved.

By this, the diagram of trains arriving at and departing from Mae Nam station will be greatly improved. At the same time, delays of freight trains due to shortages in line capacity will also be alleviated.

6) Separated places of loading and unloading cargo

There is no land available for integration on the one hand, and not much is expected of the integration as compared to its expensive construction costs on the other. Thus, the existing facilities will be utilized to the maximum, and no equipment investment will be made for integration.

(2) Master plan

1) Ground plan

The improvement plan is shown in Figure 7.3.3, and the locking diagram in Figure 7.3.4. The numbers in the drawings show the following improvement plans.

1)-a Improvement of the sorting facilities, Bangkok Port station

For engine operation and sorting facilities, 2 additional sorting tracks with an effective length of 580 m are installed.

2)-a Installation of shortcut line

For the case where it is difficult to install the shortcut line because of difficulties in acquiring the required land, an alternative plan is shown as dotted (Figure 7.3.3).

3)-a Changing the weighing track to an arrival/departure track (already executed).

4)-a Additional installation of empty car storage tracks

Installation of an additional sorting track with an effective length of 270 m, and extension of the effective length of 2 tracks to 330 m.

The grade separation from the Rama IV Road and the doubling track between Mae Nam and Chitralada, referred to in preceding paragraph (1)-5), are planned in the "Track Elevation Project of Existing Railway Lines in the Bangkok Metropolitan Area" and are excluded in the present plan. However, implementation of the Elevation Project is urgently desired.

2) Facilities to be improved in accordance with the improvement plan are outlined below.

Table 7.3.1 Main Station

Tracks	Present facilities		Facilities to be improved		Increase/decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
Freight arrival and departure	3	680 - 710	4	680 - 710	1 Track Effective length increased by 690 m
Sorting	7	140 - 640	8	140 - 800	1 Track Effective length increased by 600 m
Weighing	1	690	0		Decrease of 1 track
Shortcut	0		1		Increase of 1 track

Table 7.3.2 Port Station

Tracks	Present facilities		Facilities to be improved		Increase/decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
Sorting	0		2	290	2 Tracks Effective length increased by 580 m

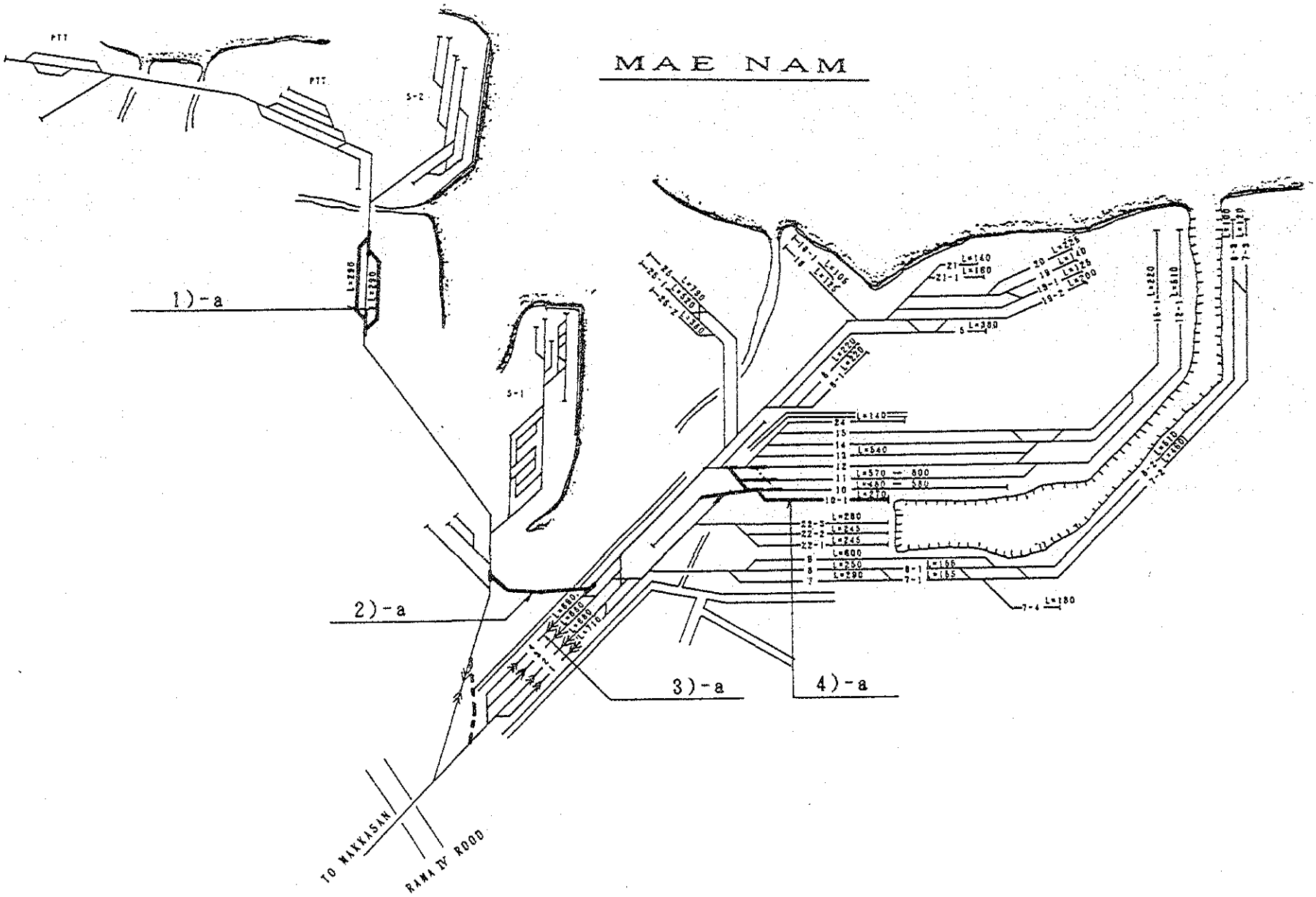


Fig. 7.3.3 Future Track Layout at Mae Nam Station

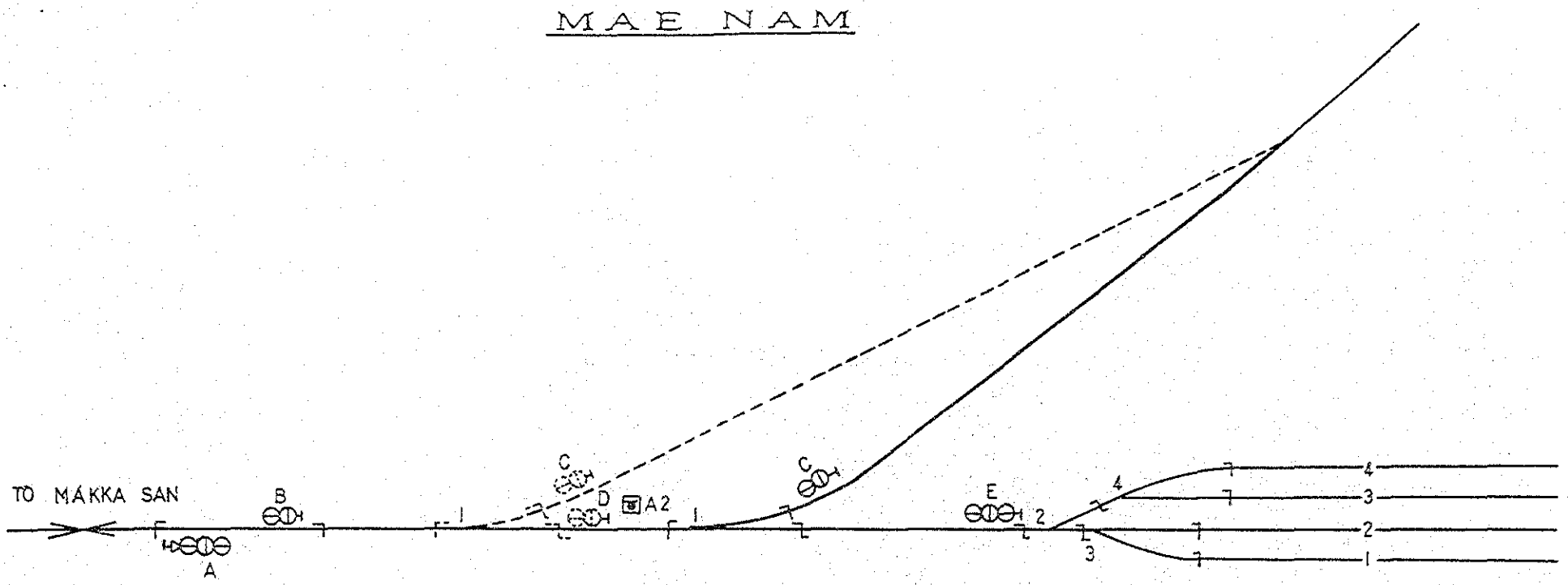


Fig. 7.3.4 Future Facilities at Mae Nam Station

7-3-3 F/S Plan

(1) Items of improvement in F/S Plan

Work to improve Mae Nam station should be started as soon as practicable. The track elevation of the crossing with the Rama IV Road and doubling of track between Makkasan and Chitralada are greatly related to the track elevation project in the metropolitan area; therefore, they are to be solved under the project with the track layout of the station. Then, the F/S Plan is the same as the Master Plan.

(2) Work execution plan and investment

1) Work period: 7 Months (after acquisition of materials).

2) Execution plan

Immediate improvement measures are desired for the freight sorting tracks in the main station and port station. But, installation of a new shortcut line between the main station and the Port will take time, and so it should be carried out along with the first stage of the Track Elevation Project.

Changeover of the freight car sorting tracks in the main station is to be done during train intervals, with the sequence as shown in Appendix 7.3.4.

Improvement of the signalling and telecommunication systems are carried out along with the progress of the track changeover.

3) Investment: 91.8 million bahts.

7-4 Bang Sue (Key Yard)

7-4-1 Present Condition of Yard Facilities

(1) General

As a general station, Bang Sue station has a passenger station, engine depot, DRC storage tracks, freight car yard and freight station arranged as shown in Figure 7.4.1.

1) Passenger station

The passenger station is a separate organization from the freight car yard and cargo loading and unloading yard. The station is located along 7.5 km of the Northern Line and is a junction point for the Southern Line. The station also has the largest engine depot in SRT, and changes part of the tractive locomotives of the passenger trains and locomotives of direct freight trains starting from and terminating at Mae Nam station.

2) Engine depot

The engine depot is assigned almost all the locomotives arriving at and departing from the metropolitan area and carries out the inspection and maintenance.

Overhauling is done at the Makkasan workshop.

3) DRC storage track

To cope with the increase in passenger cars due to the increase in transportation capacity, a car shed carrying out the daily inspection for DRCs is mainly to be constructed, (the work has already been completed).

To relieve the burden of Bangkok station, which only has limited space, it is desirable to transfer DRCs to this station that can do turnback operations with ease so far as is practicable.

4) Freight car yard

Bang Sue yard is the only hump yard located along the Northern Line in SRT and is connected with the Eastern Line and Mae Nam freight station by a freight track from the adjacent station, Chitralada, via Makkasan, an with the Southern Line by the Southern Line's freight track crossing the Northern Line at ground level.

The inbound and outbound trains of the metropolitan area from and to the Northern, Northeastern, Eastern, and Southern Lines start from and terminate at this yard, except for the direct trains starting from or terminating at Mae Nam. The yard also relays freight trains between the respective lines.

However, the yard is not a completely enclosed type, and it is difficult to handle passing trains. Thus, the oil and other direct trains starting from or terminating at Mae Nam have their locomotives changed at the passenger station without entering the yard.

5) Freight station

The freight station is located adjacent to and outside of the freight car yard. It handles about 1,000,000 tons of cargo a year, including 800,000 tons of cement. The number of freight cars introduced and discharged is about 450.

6) Track layout

The track layout is as show in Fig. 7.4.2.

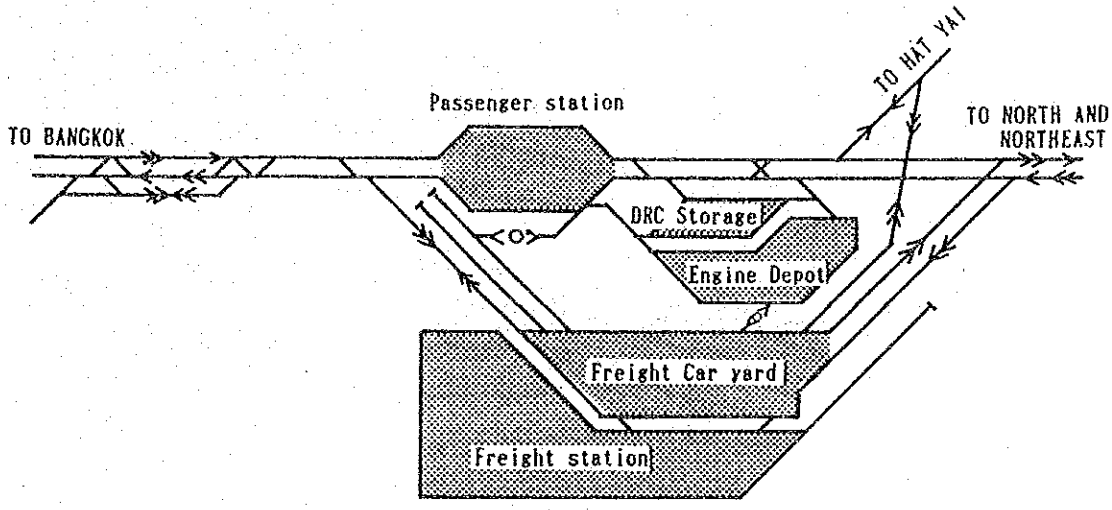


Fig. 7.4.1 Bang Sue Track Layout Diagram

(2) Condition of the compound, land, and buildings

The compound is vast, and a considerable amount of vacant space is available between the passenger station and freight car yard. The buildings in the freight car yard are relatively new, but others are generally old.

In the vicinity of the station, there are many houses on the right hand side of the main line from the station building toward Bangkok, and at about the entrance of the cargo loading and unloading yard.

(3) Yard facilities

The yard facilities are as shown in Appendix 7.4.1.

(4) Signalling and telecommunication systems

1) There are two sets of interlocking devices of the electrical type (relay interlocking type, route lever type).

2) Signals are of the electrical type and there are starters and home signals.
3) Turnouts are of the electrical type.
4) Train detection is performed by track circuit.
5) There are dispatching telephones, block telephones, exchangers, carrier terminal equipment, teleprinters and radios.
6) Tokenless system is used in blocking with the adjacent station.
7) There are not any problems with the signalling system. One set of telecommunication exchangers of the step-by-step type is old. A talk-back is used for shunting work.

The signalling facilities are shown in Fig. 7.4.3.

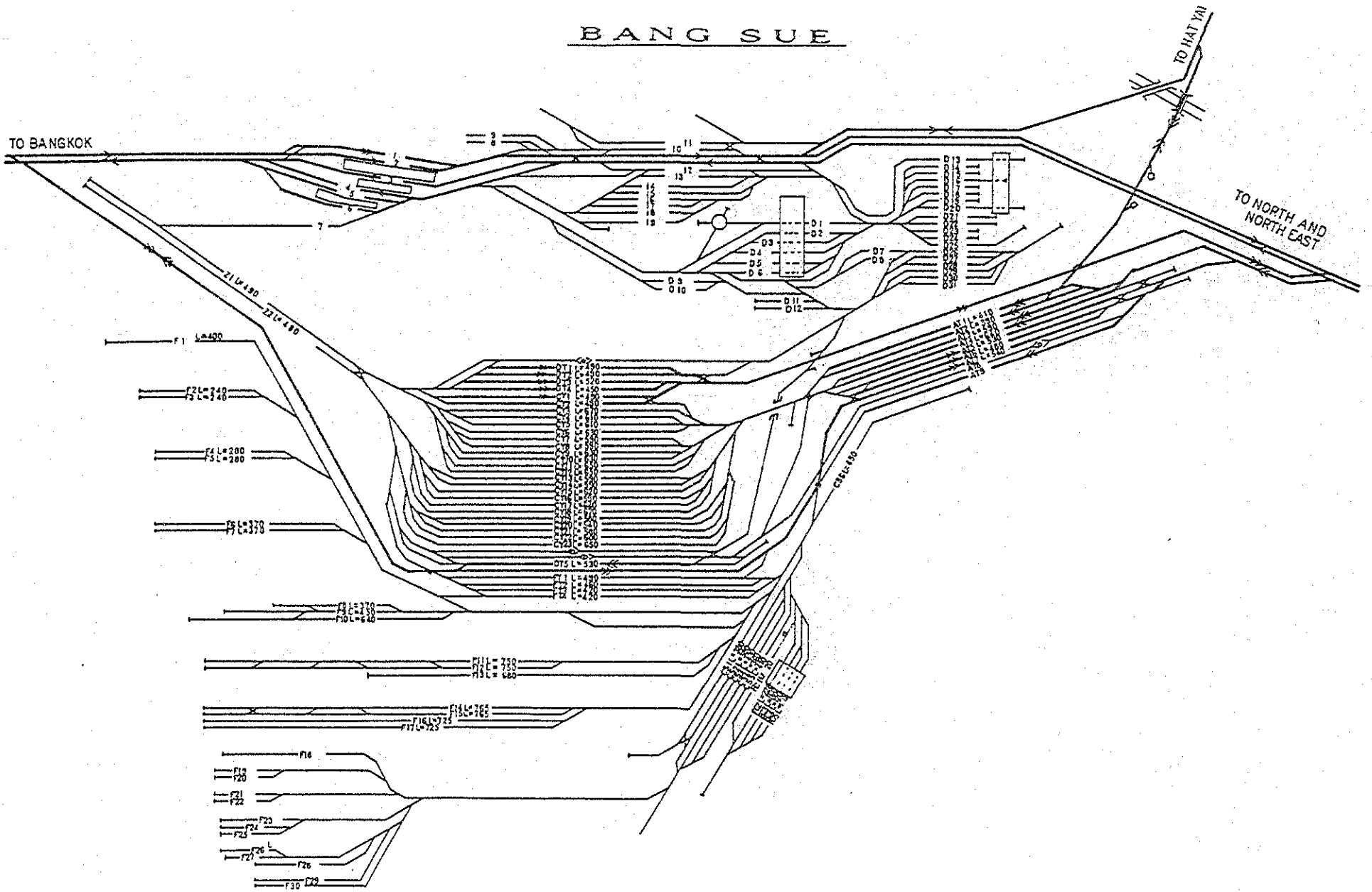


Fig. 7.4.2 Present Track Layout at Bang Sue Station

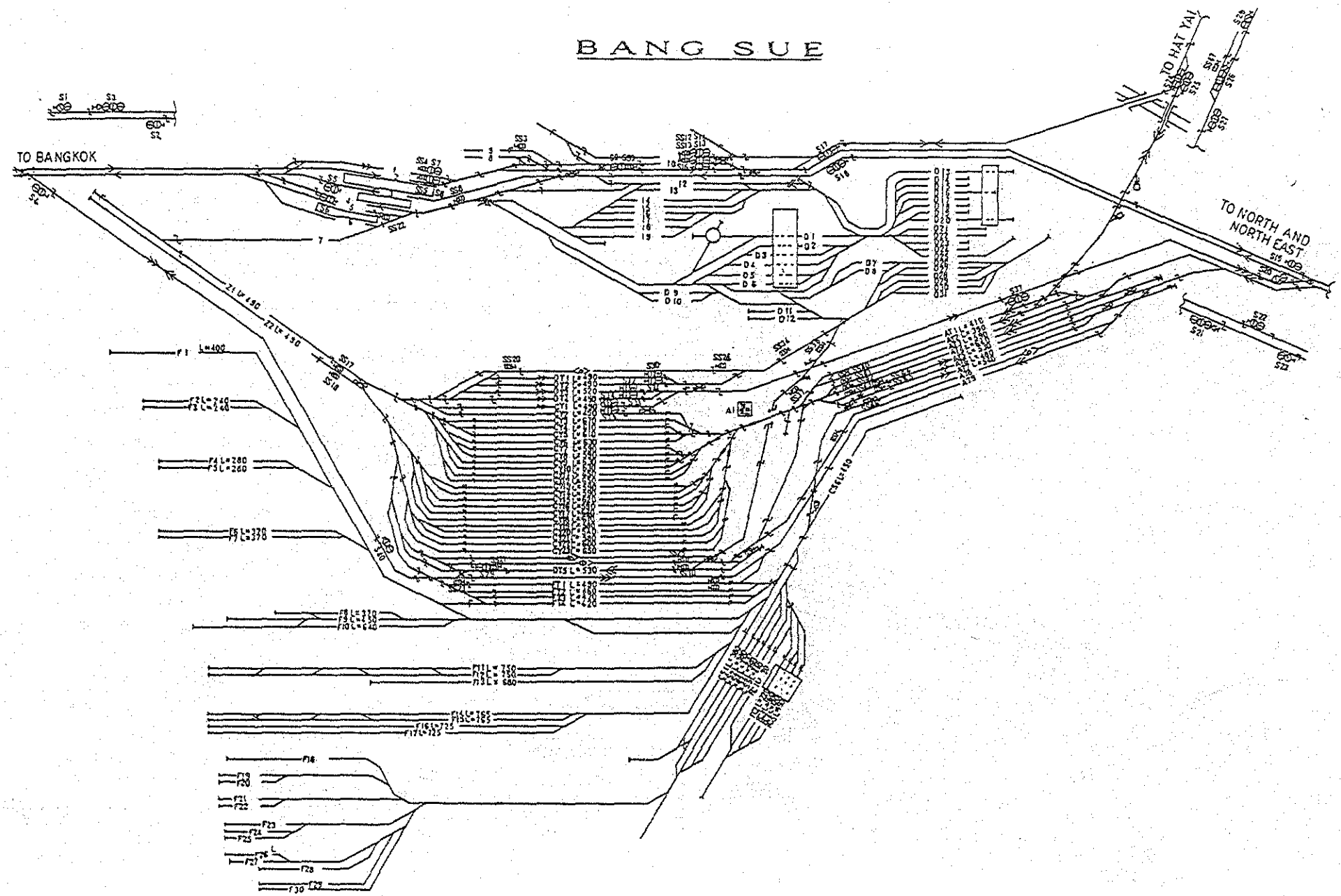


Fig. 7.4.3 Present Signalling Facilities at Bang Sue Station

(5) Summary of themes of improvement

1) The Bang Sue yard is a hump yard for total composition and decomposition and so is not in its present form adaptable to the modernization of freight traffic, including direct transportation between freight stations, reduction of yard handling cars and special relay transportation.
2) Freight trains coming in and going out of the freight yard in the direction of Bangkok concur with passenger trains along the North Line.
3) The freight track capacity of the Southern Line is nearly at its limit, and the level crossing with the Northern Line is curved so that trains on both the Southern and Northern Lines are subject to a speed limit of 30 km/h.
4) Crossing the main track to change locomotives at the passenger station, as well as entry and exit of DRCs, is coming up to its limit.
5) The passenger track of the Southern Line runs directly into the inbound track of the Northern Line, resulting in the interference of trains with each other and delays.

7-4-2 Master Plan

(1) Plan for improving existing facilities

1) Modification of the structure of the freight car yard

The freight car yard is a hump yard designed for total composition and decomposition with a handling scale of 2500 cars/day. In general, a hump yard system is used when sorting large numbers of freight cars (normally 2000 cars or more) for many destinations, with work carried out according to a flow system.

However, SRT freight traffic volume has been sluggish recently, furthermore, yard relay cars are decreasing with the expansion of direct transportation. For example, petroleum is generally transported by unit trains that pass the yard; for cement, about 800,000 tons a year arrive at Bang Sue, but this is in unit trains that are not subjected to humping, but are introduced to the loading tracks.

Thus, freight cars subjected to hump decomposition work have decreased greatly. Moreover, trains coming from Mae Nam are

decomposed at the composition side. Thus, although the yard handles about 900 cars a day, only 600 are actually dealt with by the hump (result for 1986), meaning the efficiency of the hump is very low.

To cope with such structural changes in transportation, the following measures are required.

(1) Increase of direct transportation between freight stations
(2) Measures to counter the decrease in the yard's handling of freight cars
(3) Measures for special relay transportation

In the case of the foregoing changes in the track layout of Bang Sue yard, the following must be taken into consideration (Appendix 7.4.2).

(1) Handling of marine container trains
(2) Handling of cement trains
(3) Relationship with the improvement of the Mae Nam arrival and departure tracks

The problems of Bang Sue yard under the present conditions and measures for solving the problems are as follows.

a) Meeting the increase in direct traffic volume between freight stations Freight cars arriving at the freight handling yard of the station enter the sorting tracks through the hump generally, and at the receiving tracks, they are received to shunting locomotives belonging to the freight station. The freight cars sent out of the freight station are decomposed at the hump into the sorting tracks where they are composed into trains. However, for quick delivery of freight cars and direct trains, it is desirable to receive them directly from the arrival/departure tracks and freight handling yard without composition or decomposition at the hump yard. That is, with the increase in cement trains arriving at and departing from Bang Sue, 2 arrival/ departure tracks should be provided at the side of the draw-out track of the freight station, so that the cement freight cars carried by these trains are entirely separated from the yard work and allowed to go to or come out of the loading and unloading tracks directly (Appendix 7.4.2 (2)). Upon completion of the Eastern Seaboard Program, direct container trains will start from or arrive at the station, and here the facilities for marine container trains are to be newly

installed in the vacant lot on the outside of the freight station's sorting tracks (Appendix 7.4.2 (1)).

b) Measures to counter the decrease in the yard's handling of freight cars

Freight cars handled at Bang Sue yard will increase to 900 cars/day in the future. However, this number of freight cars can be handled well by a flat yard having draw-out tracks on both sides of the sorting tracks, but the work to remove the hump is very costly. Therefore, the hump will be left for use when composition and decomposition on both sides of the sorting tracks becomes possible in the future (Appendix 7.4.3).

When the number of freight cars handled in the yard is 600, as it is presently, composition and decomposition work is possible by using only the decoupling/draw-out tracks Z1 and Z2 (Figure 7.4.2). Thus, SRT is examining a plan to temporarily stop using the hump (Appendix 7.4.4).

c) Measures for special relay transportation

Improvements should be made so that trains passing Bang Sue yard are introduced to the arrival or departure tracks for arrival to or departure from this yard to permit uncoupling and coupling of freight cars. Then, the marginal traffic capacity of trains will be fully utilized. Further, special relays of groups of freight cars from one train to another train will be possible and ensure quick delivery of freight car transportation. For this purpose, it is desirable to connect the departure tracks to the Bangkok side for use as arrival/departure tracks (Appendix 7.4.2 (3)).

2) Concurrence of Eastern Line freight trains and Northern Line passenger trains

Of Eastern Line's freight trains departing from Mae Nam, 20 trains cross the Northern Line's inbound track and enter its outbound track. Of these 20, 9 trains cross the Northern Line's inbound track at ground level at the entrance of Bang Sue into the arrival track.

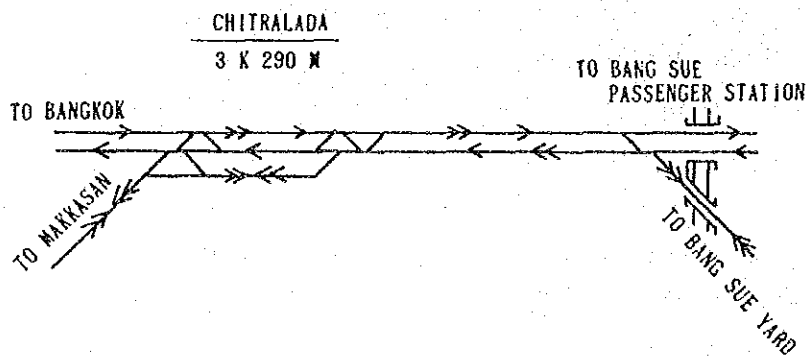
When crossing the Northern Line's inbound track and a riding on its outbound track are done consecutively, train operation is restricted greatly with respect to time, and the diagram hardly arranged (Appendix 7.4.4). Also, when the diagram is disrupted, trains have

to stop on the Northern Line's outbound track for crossing, and disturb the diagram of subsequent passenger trains.

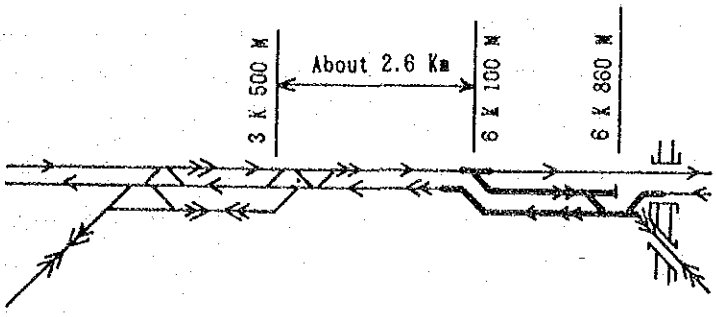
Furthermore, when container trains are allowed to run directly into the station upon completion of the Eastern Seaboard Program, this section will become even more of a bottleneck.

As a corrective measure, the Northern Line's inbound track should cross through a railway siding on an intermediate track (Fig. 7.4.4b)). But, the distance to Chitralada is only about 2.4 km. Thus, when marine containers are forwarded directly from Sriracha to Bang Sue, the introduction at Chitralada is likely to become a bottleneck, and work will have to be corrected again at the time of improvement. Therefore, for the 3.2 km section between Chitralada and Bang Sue, a freight track will be laid (Figure 7.4.4.c)). However, for this section, track elevation and increases are planned in the "Track Elevation Project of Existing Railway Lines in the Bangkok Metropolitan Area," meaning the foregoing difficulty will be resolved by this project. Thus, implementation of the elevation project is highly desired.

a) Present condition



b) Intermediate railway siding



c) Track increase

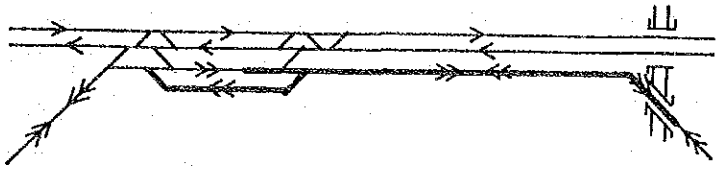


Fig. 7.4.4 Increase of Transportation Capacity between Chitralada and Bang Sue

3) Level crossing of the Southern Line freight track and Northern Line track

The Bang Sue-Ban Bamru section on the Southern Line has a frequency of 42 trains and has reached its track capacity of 44 trains (Appendix 7.4.5).

Moreover, the Southern Line's inbound passenger trains cross the Northern Line's outbound track at ground level, and the Southern Line's freight trains have their time adjusted on the Bang Sue departure track and at Bang Bamru about 10 km from Bang Sue before they cross the Northern Line at ground level.

At the level crossing of the Southern Line freight track and the Northern Line, the Southern Line freight track curves in a radius of 180 m, and the diamond crossing is of manganese, but because of the curved crossing, it is an assembly of small parts and is therefore subject to cracking. Thus, both lines have a speed limit of 30 km/h.

Particularly, for Northern Line passenger trains, the crossing is located at 1 k 900 m from Bang Sue station, and so trains with a maximum speed of 80 km/h have their speed limited to 30 km/h, resulting in a loss of about 1 minute per train or about 80 minutes per day. (Appendix 7.4.6)

To resolve the problem of the level crossing, grade separation is ideal, but as no considerable increase in freight transportation is seen, the following plan will be set up.

a) In order for the time adjustment of the Southern Line freight track to be done at a point as close as practicable to the station, interchange facilities are provided at about the merging point of passenger and freight trains.

b) The level crossing should be changed to a modern diamond crossing as soon as possible. Also, improvement in the structure of tracks should be examined so as to permit crossing in straight lines.

4) Crossing the main track for locomotives, and DRSs moving in or out of the passenger station

As shown in Figure 7.4.1, when locomotives and DRCs move in or out of the car depot from or to the passenger station, they have to cross the main track, but presently there are no problems with this. However, if a large number of DRCs use the station as a storage shed and originate from or terminate at Bangkok in the future, the crossing at the main track may become a bottleneck. Therefore, it is considered that the changing of locomotives of freight trains should not be allowed forever at the passenger station. Also, it is desirable to provide, along with the special relay facilities, locomotive removal facilities in the freight yard.

For the passenger station, it is considered that it will be necessary to improve the station into an enclosed type. To avoid unnecessary work, it is desirable to utilize the existing facilities until the future plan of Bang Sue station is determined.

5) Concurrence of passenger trains on the Southern and Northern Lines

At the exit of the passenger station, the Southern Line's inbound trains cross the Northern Line's outbound track at ground level before they enter the Northern Line's inbound track. However, when the diagram is disrupted, there is much trouble for time adjustments.

Accordingly, it is desirable to separate both lines for about 1.3 km from the Bang Sue station to the turnout on the Southern Line. But, in order to prevent unnecessary work, it is desirable to take adequate measures using the existing facilities until the future plan of Bang Sue station is determined.

(2) Master plan

1) Ground plan

The track layout, installation of signals and improvement of interlocking in the future plan are shown in Figures 7.4.5 and 7.4.6.

The numbers shown in the track layout diagram represent the following.

1)-a Installation of 2 arrival/departure tracks for direct transportation between freight stations.

1)-b Improvement of departure tracks to arrival/departure tracks for special relay and locomotive changes.

2)-a Signal station provided at the Southern Line outlet of Bang Sue station and the junction of the passenger and freight tracks.

2)-b Diamond crossing at ground level of the Southern Line's freight track and the Northern Line straightened.

2) Outline of facilities to be improved

Facilities to be improved according to the improvement plan are outlined below.

Table 7.4.1 Freight Car Yard Facilities

Tracks	Present facilities		Facilities to be improved		Increase/decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
Arrival (up)	4	410 - 640	3	410 - 640	
Arrival (down)	3	480 - 540	2	530 and 540	
Departure (down)	5	490 - 550	0		
Arrival and departure			5	520 - 630	Effective length increased by 450 m

Table 7.4.2 Freight Station Facilities

Tracks	Present facilities		Facilities to be improved		Increase decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
Arrival and departure			2	580 and 620	2 Tracks Effective length increased by 1,200 m
Engine run - round	1		1		
Handling Station	1	450	1	780	Effective length increased by 330 m

Table 7.4.3 Signal Station

Tracks	Present facilities		Improved facilities		Increase/decrease
	Number of tracks	Effective length(m)	Number of tracks	Effective length(m)	
Siding track	0		1	600	1 Track Effective length increase by 600 m

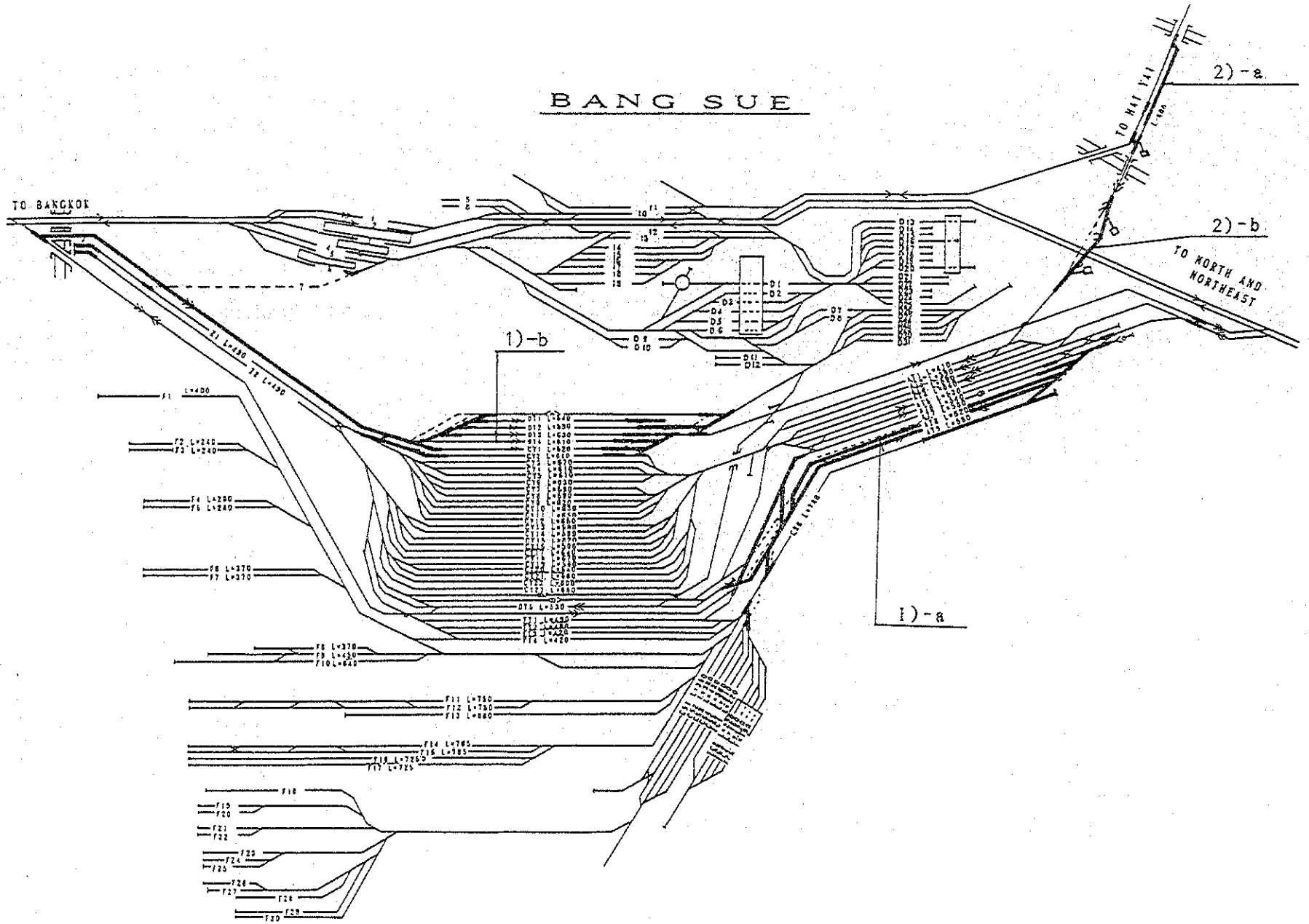


Fig. 7.4.5 Future Track Layout at Bang Sue Station (Master Plan)

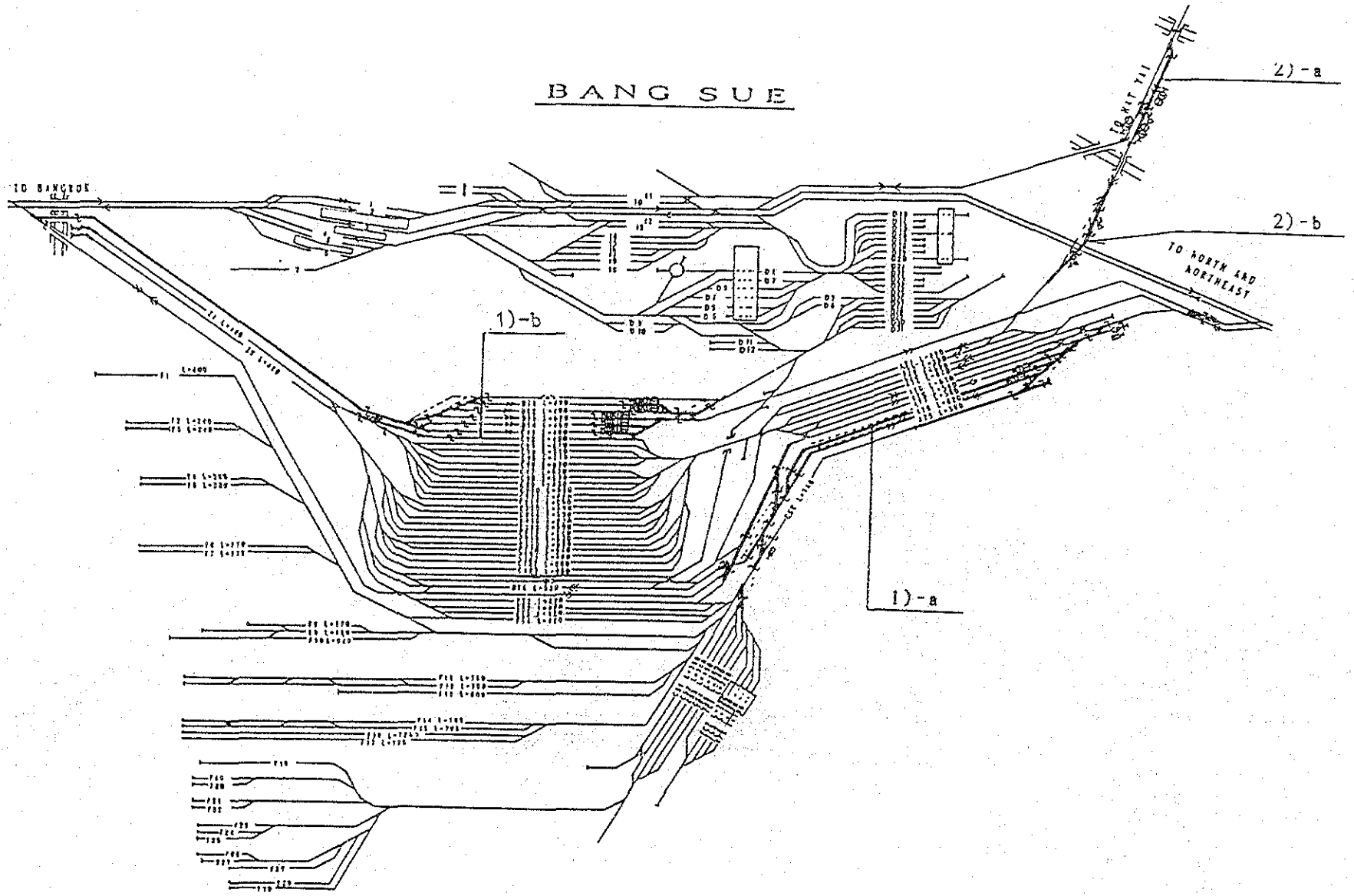


Fig. 7.4.6 Future Signalling Facilities at Bang Sue Station (Master Plan)

3) Work period: 3 months.

4) Investment: 9 million bahts.

7-4-3 F/S Plan

(1) Items of improvement in F/S Plan

Direct transportation between freight stations is the most important measure for SRT, and improvement work for direct transportation must be carried out immediately in order to reduce the sorting load of Bang Sue yard.

The work to increase the number of freight tracks between Chitralada and Bang Sue should be carried out along with the Bangkok Metropolitan Track Elevation Project.

If improvement of the level crossing at the Southern Line's freight track and Northern Line, and entry into the Southern Line's passenger track, is done, there is a possibility of unnecessary work being done, so this improvement should not be carried out before it is entirely determined.

Improvement of the departure track to an arrival/departure track is an important matter for future freight transportation in that such work as special relaying and coupling and uncoupling of direct trains passing the yard is possible.

However, SRT is urgently examining suspension of the use of the hump and using the sorting tracks on the Bangkok side only as a flat yard for sorting. When it is decided to take this measure, it will be advantageous to send freight cars to be relayed at Bang Sue yard to surrounding yards, and thus decrease the number of freight cars handled at Bang Sue yard and delay the resumption of hump sorting as long as practicable. When freight cars handled at Bang Sue yard are reduced to minimum, the arrival/departure track will not be required so much and therefore, is excluded from the present F/S Plan.

(2) Work execution plan and investment

1) Work period: 7 months (after acquisition of materials)

2) Track changeover will be done during train; intervals the work sequence is as shown in Appendix 7.4.8. Improvement of the signalling and telecommunication systems will be done as track changeover progresses.

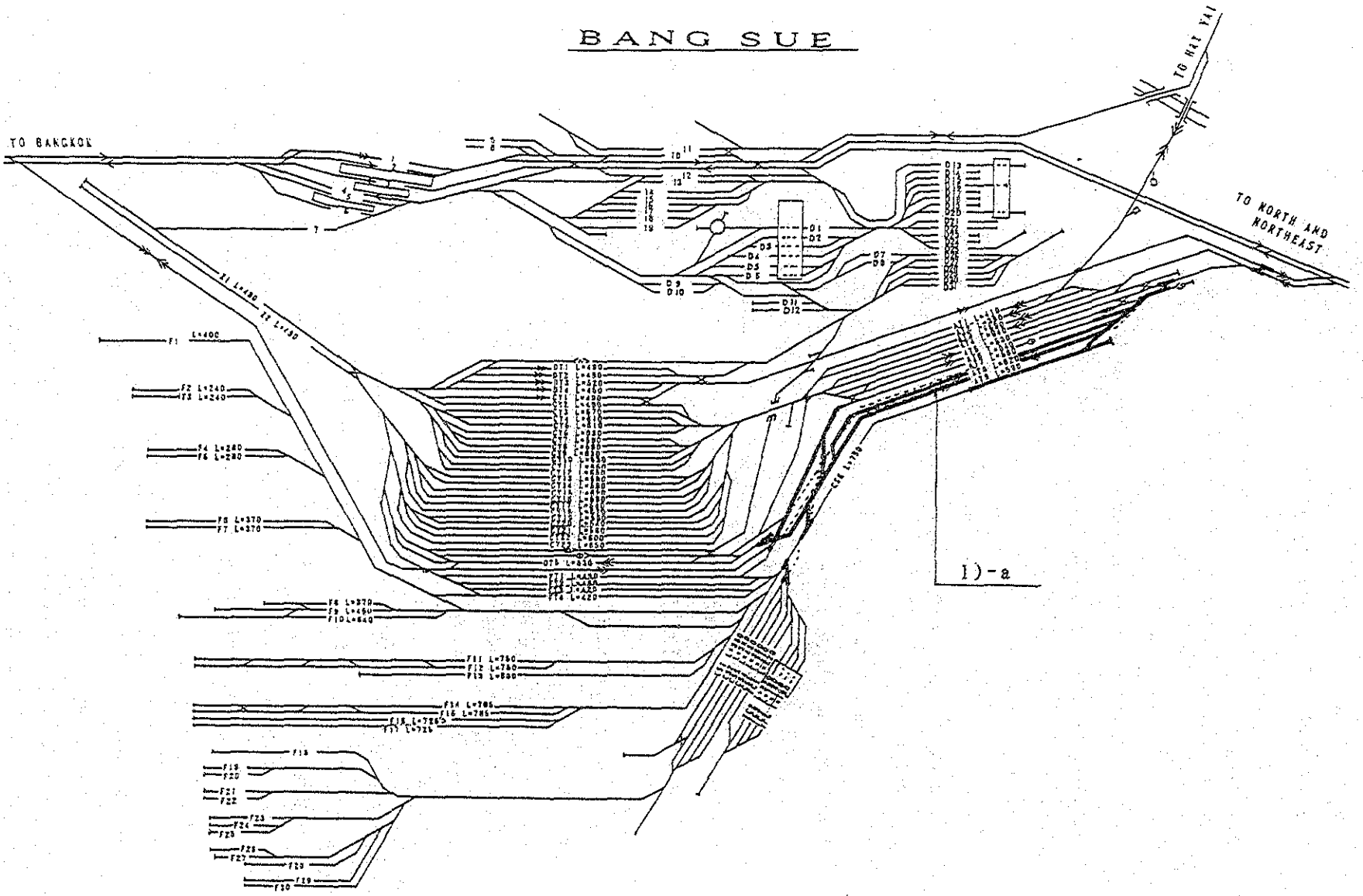


Fig. 7.4.7 Future Track Layout at Bang Sue Station (F/S Plan)