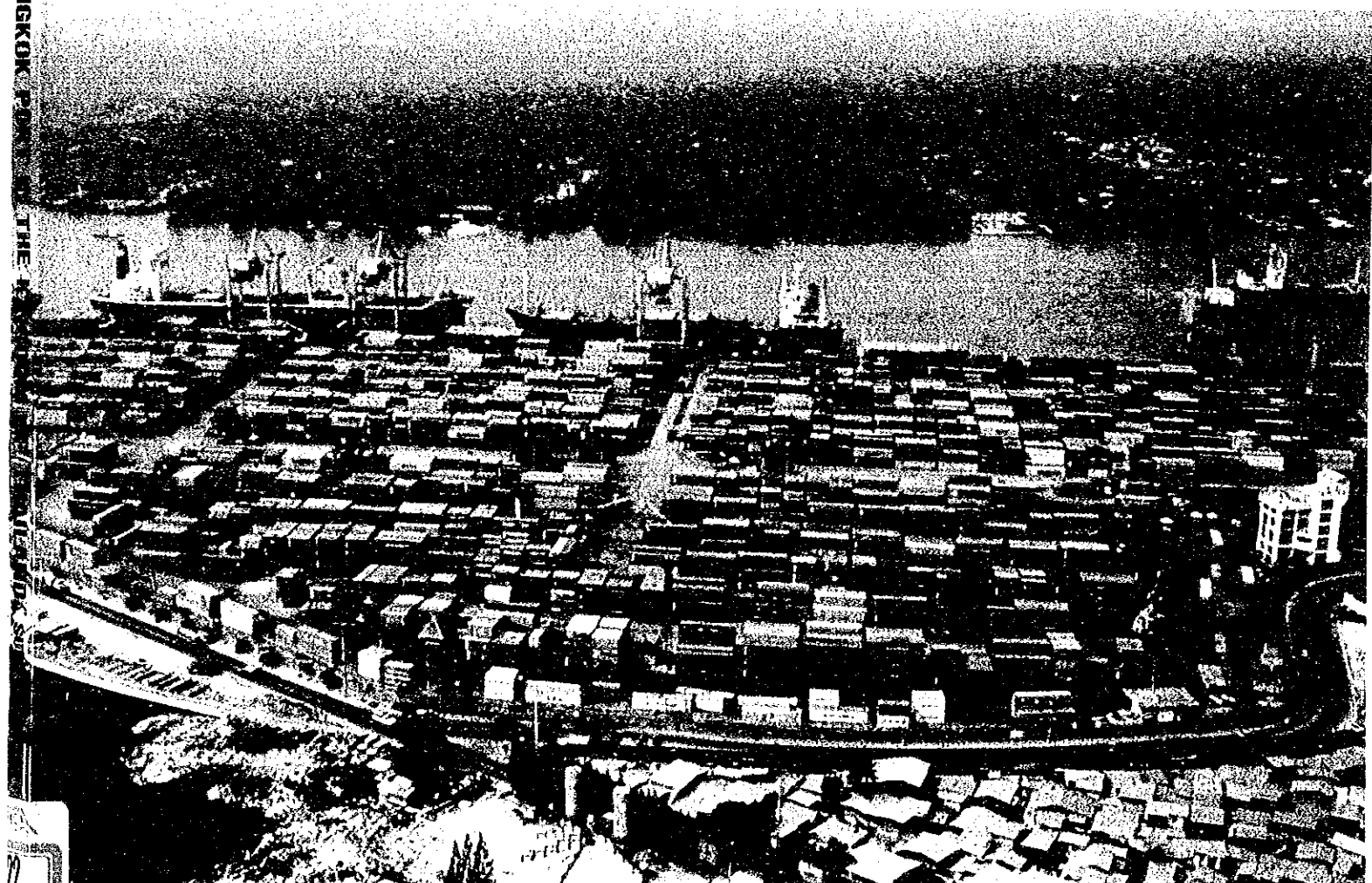


FINAL REPORT

THE STUDY ON MODERNIZATION OF BANGKOK PORT IN THE KINGDOM OF THAILAND

SUMMARY



JULY 1994

THE OVERSEAS COASTAL AREA DEVELOPMENT INSTITUTE OF JAPAN (OCDI)
PACIFIC CONSULTANTS INTERNATIONAL (PCI)

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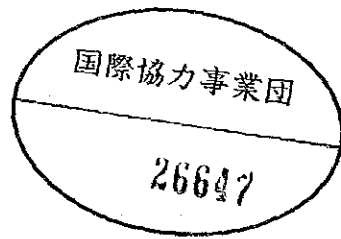
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PORT AUTHORITY OF THAILAND
THE KINGDOM OF THAILAND

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SUMMARY

JULY 1994

Exchange Rate

US\$ 1.00 = Baht 25.18 = ¥ 107.50

(As of June 18th, 1993)

PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a study on modernization of Bangkok Port and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team four times between March 1993 and July 1994, which was headed by Mr. Yugo Otsuki and was composed of members from the Overseas Coastal Area Development Institute of Japan (OCDI) and Pacific Consultants International (PCI).

The team held discussions with the officials concerned of the Government of Thailand and conducted field surveys at the port. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Thailand for their close cooperation they extended of the team.

July, 1994



Kensuke Yanagiya

President

Japan International Cooperation Agency

LETTER OF TRANSMITTAL

July, 1994

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency

Dear Mr. Yanagiya:

It is my great pleasure to submit herewith the Report for the Study on Modernization of Bangkok Port in the Kingdom of Thailand.

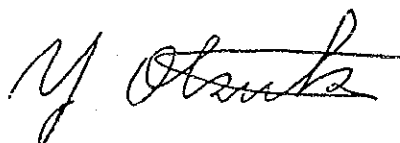
The study team which consists of the Overseas Coastal Area Development Institute of Japan (OCDI) and Pacific Consultants International (PCI), headed by myself, conducted a survey in Thailand from March 1993 to March 1994 as per the contract with the Japan International Cooperation Agency.

The findings of this survey were fully discussed with the officials of the Port Authority of Thailand and other authorities concerned to formulate the Master Plan for the period up to the year 2005 and to formulate and examine the feasibility of the Short-Term Plan for the period up to the year 1997, and were then compiled into this report.

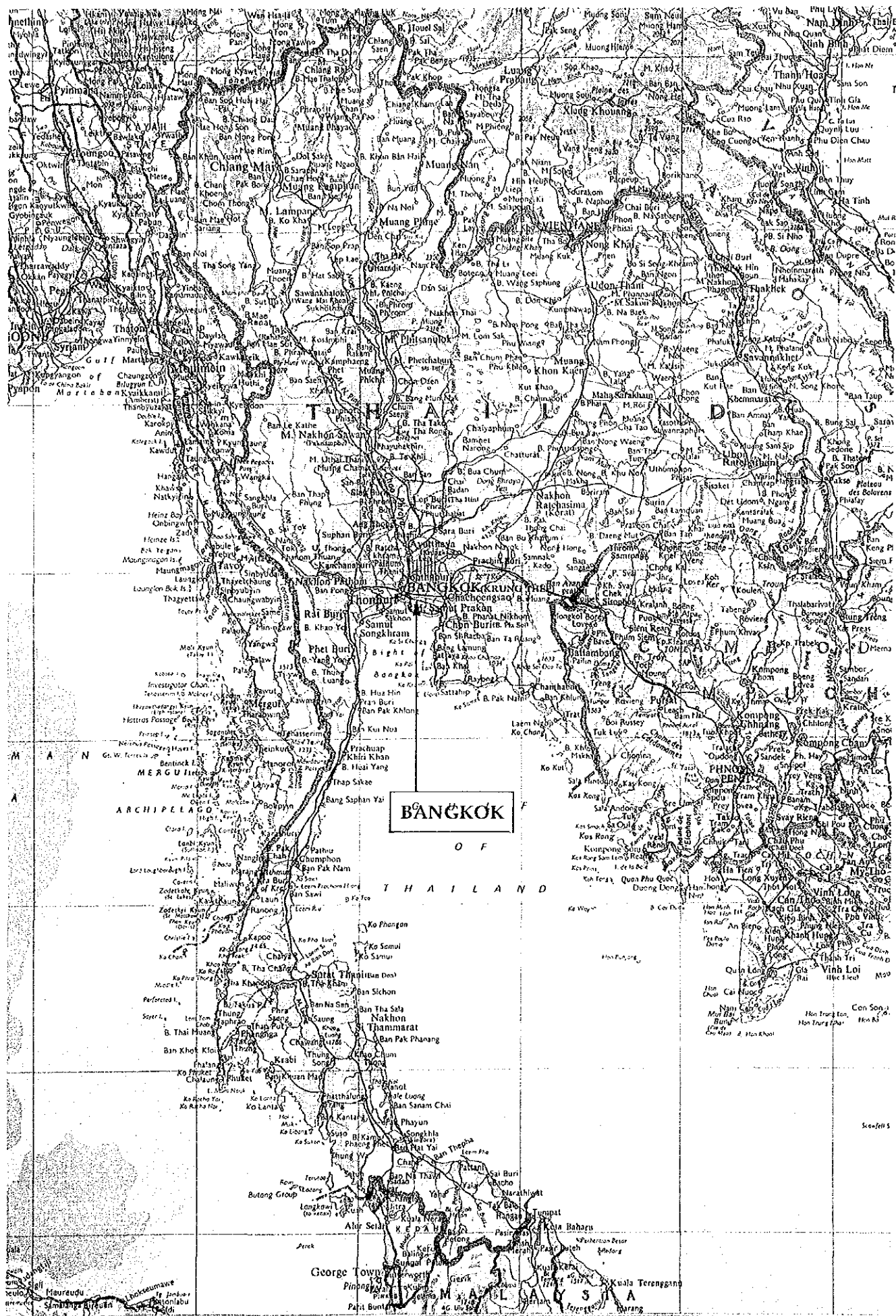
On behalf of the study team, I would like to express my deepest appreciation to the Government of Thailand, the Port Authority of Thailand and other authorities concerned for their brilliant cooperation and assistance and for the heartfelt hospitality which they extended to the study team during our stay in Thailand.

I am also greatly indebted to the Japan International Cooperation Agency, the Ministry of Foreign Affairs, the Ministry of Transport and the Embassy of Japan in Thailand for giving us valuable suggestions and assistance during the preparation of this report.

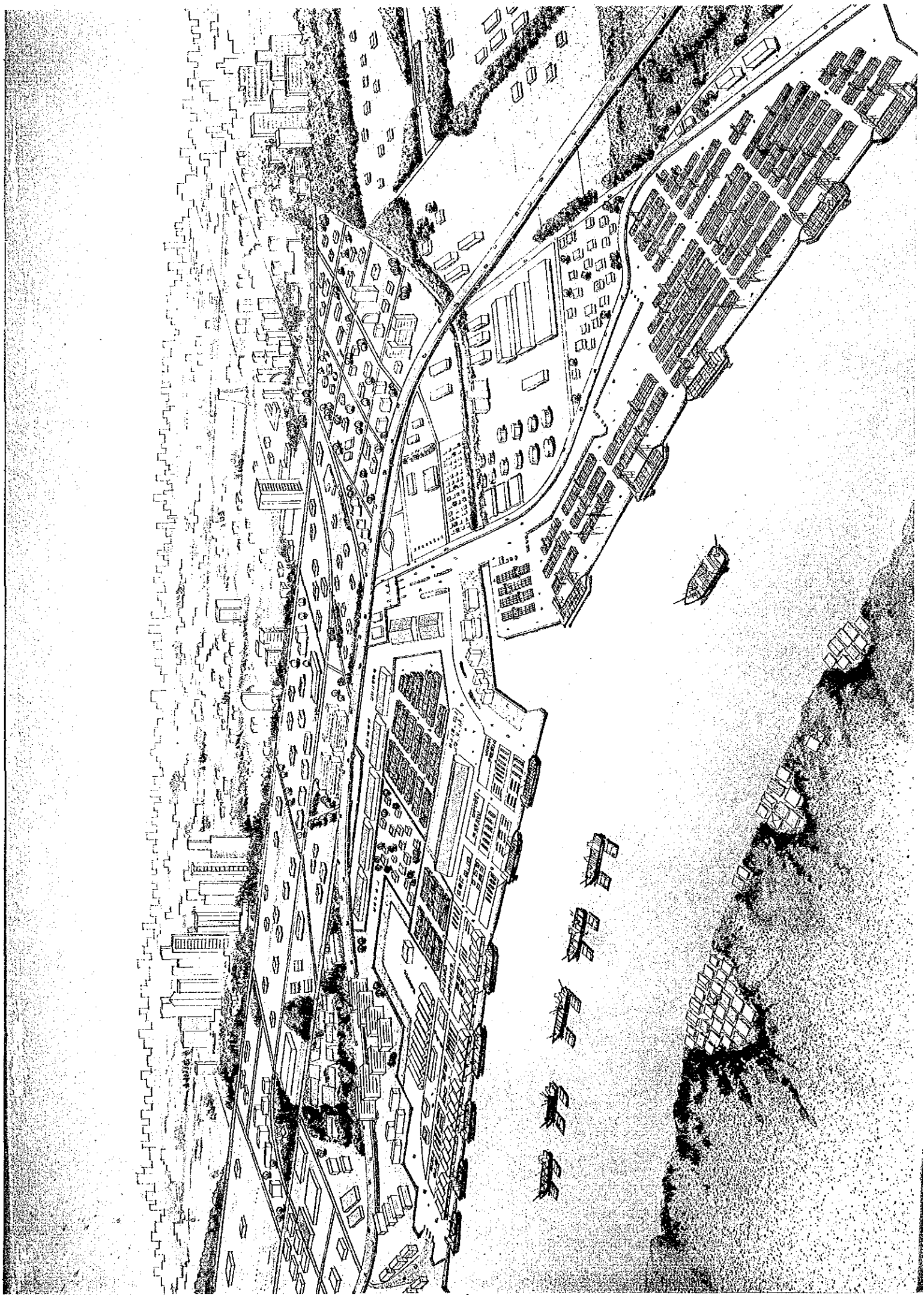
Respectfully,



Yugo Otsuki
Leader of the Study Team for
the Study on Modernization of
Bangkok Port



LOCATION MAP (1)





Klong Toei Wharf

ABBREVIATIONS

A

A/N	Arrival Notice
AASHTO	American Association of State Highway and Transportation Office
AC	Alternate Current
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
APL	American President Line
ASTM	American Society for Testing Materials

B

B/N	Boat Note
B/L	Bill of Lading
BHP	Brake Horse Power
BKK	Bangkok
BKP	Bangkok Port
BMA	Bangkok Municipal Administration
BMT	Bangkok Modern Terminal

C

CAT	Communication Authority of Thailand
CFC	Conversion Factor for Consumption
CFS	Container Freight Station
CIF	Cost Insurance Freight
CLP	Container Load Plan
CY	Container Yard

D

D/O	Delivery Order
D/R	Dock Receipt
DBT	Declaration of Bonded Transportation
DC	Direct Current
DOH	Department of Highway
DTS	Data Transmission System
DWT	Dead Weight Tonnage

E

E/D	Export Declaration
-----	--------------------

E

EDI	Electronic Data Interchange
EDO	Equipment Dispatch Order
EIA	Environmental Impact Assessment
EIR	Equipment Interchange Receipt
EIRR	Economic Internal Rate of Return
EIT	Engineering Institute of Thailand
ESCAP	Economic Social Conference Asia and Pacific
ETA	Estimated Time of Arrival
ETA	Expressways and Rapid Transit Authority of Thailand
ETO	Express Transportation Organization of Thailand

F

FCL	Full Container Load
FEU	Forty-foot Equivalent Unit
FIRR	Financial Internal Rate of Return
ft.	foot/feet

G

GDP	Gross Domestic Products
GRT	Gross Registered Tonnage

H

HWL	High Water Level
-----	------------------

I

IALA	International Association of Lighthouse Authorities
IBRD	International Bank for Reconstruction and Development
IC	Integrated Circuit
ICD	Inland Container Depot
IEAT	Industrial Estate Authority of Thailand
IEE	Initial Environmental Examination
IES	Illumination Engineering Society
IMO	International Maritime Organization

J

JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standard

L

LOA	Length Over All
LBP	Length between Perpendiculars
LCL	Less than Container Load
LCP	Laem Chabang Port
LLW	Lowest Low Water
LSI	Large-scale Integration
LT	Long Ton

M

M/F	Manifest
MARPOL	The International Convention of the Prevention of Pollution from Ships of 1973 with Protocol of 1978
MEA	Metropolitan Electricity Authority
MOTC	Ministry of Transport and Communications
MSL	Mean Sea Level
MT	Metric Ton
MWWA	Metropolitan Water Works Authority

N

NEC	National Electric Code
NESDB	National Economic and Social Development Board
NFPA	National Fire Protection Associates
NIDA	National Institute of Development Administration
NPKC	National Peace-keeping Council
NRT	Net Registered Tonnage

O

O/D	Origin and Destination
ODA	Official Development Assistance
OEP	Office of Environmental Policy and Planning

P

PAT	Port Authority of Thailand
PDC	Personnel Development Center
PDS	Position Detection System
PR	Ply Rating
PTT	Petroleum Authority of Thailand

R	
RC	Reinforced Concrete
RPM	Revolution Per Minutes
RTG	Rubber-tired Gantry Crane
S	
S/A	Shipping Application
SCF	Standard Conversion Factor
SHIPNETS	Shipping Cargo Information Network System
SRT	State Railway of Thailand
SSP	Ship Stowage Planning
T	
TEU	Twenty-foot Equivalent Unit
TIS	Thailand Industrial Standard
TMN	Thai Maritime Navigation
TORC	Thai Oil Refinery Company
TOS	Transtainer Operation Supervising System
TOT	Telephone Authority of Thailand
TPT	Thai Prosperity Terminal
U	
Unithai	United Thai Shipping Co.
V	
VAT	Value Added Tax
VVVF	Variable Voltage and Variable Frequency
W	
WCTS	Worldwide Cargo Trace System
Y	
YOCS	Yard Operation Computer System
YPCS	Yard Plan Computer System
YSP	Yard Stowage Planning

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ABBREVIATIONS

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EXECUTIVE SUMMARY

Executive Summary

1. Background of the Study

Bangkok Port is the most important port for international trade in Thailand through which a great portion of cargo destined for or originating from the country passes. Recently, along with the growth of the Thai economy, the volume of cargo handled through the port has shown a sharp increase especially in container cargo, amounting to around 1.3 million TEUs in 1992.

At present, however, the port has many problems; the port area is very narrow and some of the facilities are old and arranged improperly, creating inefficient operations and congestion in the port area. To resolve those problems and support further growth of the trade-oriented industries in Thailand, it is necessary to modernize Bangkok Port by introducing an efficient cargo-handling system and management/operations systems, relocating port facilities and rearranging the land use in the limited port area.

In the meantime, the Port Authority of Thailand constructed Laem Chabang Port and opened it in January 1991. Proper functional allotment of the ports of Bangkok and Laem Chabang should be accomplished through the promotion of the both ports.

Under the above situation, the Government of Thailand requested the Government of Japan to conduct a study on modernization of Bangkok Port. In response to the request, the Government of Japan conducted the preliminary study in October, 1992 which was entrusted to Japan International Cooperation Agency (JICA). The Government of Japan decided to conduct the study and entrusted it to JICA. The study was conducted from March 1993 to July 1994 and the results of the study are incorporated in this report.

2. Objectives of the Study

The objectives of the study are as follows:

- 1) To formulate the Master Plan for modernization of Bangkok Port for the period up to the year 2005,
- 2) To conduct a feasibility study for the Short-Term Plan for modernization of Bangkok Port for the period up to the year 1997.

3. Outline of the Master Plan and the Short-Term Plan

3.1 Port Facilities

The plans of volumes of cargo port facilities and construction costs proposed in this study are outlined as shown in the table below.

Item	Master Plan	Short-Term Plan
1. Target Year	2005	1997
2. Volume of Cargo		
2.1 Containers (TEUs)	1,000,000	1,000,000
2.2 Conventional Cargo(MT)	3,910,000	3,810,000
3. Facility Plan		
3.1 Facilities for Containers		
1) Expansion of the marshaling yard of the east quay	*	*
2) Introduction of 9 large RTGs	*	*
3) Construction of a concentrated reefer yard	*	*
4) Addition of one lane to the bridge connecting the east and west quays	*	*
5) Construction of 2 Import CFSs at Area II	*	*
6) Construction of 3 Export CFSs at Zone 1	*	*
7) Improvement of sheds Nos.13 and 14 as Import CFSs	*	*
8) Preparation of a yard specialized for stuffing export container cargo	*	*
9) Preparation of empty container yards west and behind sheds Nos.15-17	*	*
10) Introduction of modernized information system using computers	*	*
3.2 Facilities for Conventional Cargo		
1) Demolition of sheds Nos.7-9 to provide open storage yards	*	*
2) Relocation of the yard for import steel to inside the port from outside	*	*
3) Relocation of the existing bonded warehouse to inside the port from outside	*	*
4) Demolition of the existing supplementary sheds Nos.1,4-7,9, the bonded warehouse	*	*
5) Realignment and expansion of the existing port roads	*	*
6) Modification of sheds Nos.1-9 to create additional port roads	*	*
7) Dismantlement of the existing dockside cranes at the west quay	*	*
8) Relocation of the existing warehouses and yards for dangerous cargoes	*	*
9) Relocation of railway operations to the west quay from the east quay	*	*
10) Relocation of parking lots for port-related vehicles	*	*
11) Relocation of some of the existing offices from inside the port to outside	*	*
12) Relocation of the Vehicle Section to near Parking Lot No.3	*	*
4. Construction Cost (Billion Bhat)	3.5	1.2

3.2 Management/Operations and Institutional Matters

- 1) Introduction of the Closed Terminal System
- 2) In the stage of the Master Plan, it is proposed to create a new organization established and funded by PAT responsible for cargo-handling operations both for containers and conventional cargo at the port in order to conduct cargo handling operations in a commercial manner and simultaneously avoid the possible social problems of relocation of workers. Prior to the establishment of the above organization, in the Short-Term Plan, it is proposed that PAT take full responsibility of container-handling at a part of the marshaling yard of the east quay as a terminal operator in cooperation with shipping lines/agents under the closed terminal system so as to get operational knowhow which is expected to be transferred to the new organization proposed in the Master Plan.
- 3) In order to achieve quick decision-making and efficient management, it is proposed that PAT rearrange its organization including the Headquarters and Bangkok Port Office.
- 4) Improvement of the statistical system etc.

4. Evaluation of Feasibility of the Short-Term Plan

4.1 Economic Feasibility

Two kinds of economic benefits shown below are evaluated as benefits from the *Short-Term Plan for modernization of Bangkok Port*.

- 1) Savings in ships staying costs
- 2) Savings in administration and operation costs

The economic internal rate of return (EIRR) of the project is calculated as 12.4%. It exceeds the criterion of 10% which is generally adopted to assess the economic justifiability of a project. Accordingly, the Short-Term Plan is considered economically feasible.

4.2 Financial Viability

Four kinds of revenues shown below are evaluated as revenues that PAT receives from the Short-Term Plan.

- 1) Reduction of revenues of berth hire through less berthing time of container vessels
- 2) Increase of revenues from the land rent
- 3) Increase of revenues from container repair and cleaning
- 4) Increase of revenues by increase of the port tariff related to containers

Costs of investment, reinvestment, management and operation are taken into account. The personnel cost is calculated based on the assumption that PAT would recruit a smaller number of personnel than that of retirees by 50 persons per year as an effect of the Short-Term Plan.

The financial internal rate of return (FIRR) of the project is calculated as 9.3%. This figure keeps a favorable level judging from the range of the interest rates of the bank deposits. Accordingly, the Short-Term Plan is considered financially viable.

5. Outline of Recommendations

It is recommended that the project proposed in the above modernization plan of Bangkok Port be implemented to achieve economical, efficient, safe and reliable operations for port users. When implementing the project, it is proposed to take the following measures:

- 1) Both restructuring of management and operations systems and investment in necessary physical facilities in Bangkok Port shall be given emphasis and be implemented simultaneously.
- 2) The purpose of modernization of Bangkok Port is not to increase cargo throughput but to upgrade service levels of port services for its port users. The required amount of the investment is moderate judging from an average income level of PAT. Those points shall be made clear to the authorities concerned.
- 3) The port tariff is proposed to be raised slightly to cover some portion of the capital investment. In other words, the proposed increase rate is considered to be conservative compared with the benefits for the port users generated from the project. That point shall be understood by the port users.
- 4) Knowhow to control the container terminal under the closed terminal system shall be obtained by PAT through employment of competent yard planners along with cooperation with private companies as port users. Even in the transitional period when PAT will operate a part of the marshaling yard, it is essential that PAT take full responsibility of container-handling at that terminal.

SUMMARY

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. Necessity of Modernization of Bangkok Port

(1) Container-Handling

The number of containers through Bangkok Port has sharply increased recently.

1. Since the start of containerization in Thailand in 1977, along with the development of the Thai economy, especially in the export-oriented industries, the number of containers through Bangkok Port has continuously increased. In the last five years, from 1988 to 1992, the number shows a sharp increase, indicating an average growth rate of 14% per annum. In 1992, the number of containers handled at Klong Toei Wharf of Bangkok Port reached around 1.3 million TEUs. In 1991/1992, the average berth occupancy rate of seven berths of the east quay where over 90% of containers are handled reached a high value of 75%.

Present system of terminal operations at Bangkok Port remains as an open type.

2. Although machines specialized for container-handling were introduced and containers of more than one million TEUs per annum are already passing through the port, the container terminal at Klong Toei Wharf of Bangkok Port remains as an open type terminal as of old where operations are performed by an individual shipping line/agent independently with the permission of PAT by each operation. The modernized system is not yet adopted in which container-handling operations are wholly controlled by a terminal operator that takes full responsibility for handling and storing containers after receipt or before delivery at its terminal gates by conducting yard planning and inventory control of containers based on data/information interchanged with customers or the authorities concerned (hereinafter referred to as "the closed terminal system").

Shortage of the marshaling yard space and incomplete yard planning cause long berthing hours of container vessels at Bangkok Port.

3. In addition to the above fact, the marshaling yard in the east quay can only rarely afford to prepare necessary stacking space for outbound containers before ship arrivals

due to shortage of yard area. Consequently, the marshaling yard in the east quay is left in a chaotic condition, and the shipping lines/agents are often forced to do costly direct loading of containers onto ships from the open yard at the west quay or off-dock CYs outside the port. When conducting the direct loading, traffic jams in and around the port cause unpredictability of boxes' arrivals to ships, and even in the port, it sometimes takes a long time to get from the west quay to the east quay.

4. In addition to the direct loading, long hauls of outbound boxes once stacked within the marshaling yard from stacking places to dockside are often found due to lack of proper yard planning. Thus, the actual gross container-handling productivity per dockside gantry crane is small, with the result that costly container ships are forced to berth for a long period, 33 hours per vessel on average.

Chaotic conditions are found in handling LCL and empty containers at Bangkok Port.

5. As to handling export LCL cargoes, stuffing operations of export cargoes and stacking operations of empty containers are conducted in mixture at the open yards of the west quay without Export CFSs, creating a dangerous situation for the people working on ground, cargoes and cargo-handling equipment within the yards. On the other hand, import LCL cargoes are stored in Import CFSs scattered within the port area, forcing tractor-chassis units and ordinary trucks to engage in intricate movements, which has led to serious traffic congestion in the port.

It is necessary to modernize container-handling at Bangkok Port through the introduction of the closed terminal system together with increase in container storage capacity at the marshaling yard.

6. Thus, to resolve the present problems mentioned above and achieve economical, efficient, safe and reliable operations for the port users, it is necessary to modernize container-handling at Klong Toei Wharf of Bangkok Port through the introduction of the closed terminal system and the preparation of the required infrastructures, upper-structures and container-handling machines including an increase of container storage capacity at the marshaling yard. By realizing the modernization of the marshaling yard, berthing times of container vessels are expected to be reduced remarkably; that results in economical container transportation and consequently generates benefits for the Thai economy.

After introducing the closed terminal system, container-handling capacity at Bangkok Port is estimated as one million TEUs per annum, reduced from the present level despite the increase in the container storage capacity, and the figure matches the ceiling number of containers decided by the government.

7. To ensure the above mentioned modernized services for the port users, by adopting the closed terminal system, a terminal with the system needs a more spacious marshaling yard than the present open type terminal to handle the same number of containers, in other words, the terminal with the closed system can handle less containers than the present open type terminal given the same storage capacity of marshaling yard. This is because it is necessary for the terminal with the closed system to receive export containers and stack them within its marshaling yard before an arrival of a container vessel without allowing the direct loading from outside and also to stack import containers once after discharging within the yard.

8. After introducing the closed terminal system at Bangkok Port, the container-handling capacity of the container terminal is estimated to be reduced to approximately one million TEUs per annum from the present level despite the increase in the container storage capacity, though it may sound paradoxical.

9. The estimated figure of approximately one million TEUs per annum in container-handling capacity almost matches the figure of one million TEUs which was determined by the Government of Thailand to restrict the total number of containers through Bangkok Port and thereby reduce the road traffic burden generated by port cargoes in Bangkok Metropolis.

Owing to the modernization of Bangkok Port, traffic volume generated from port activities at Bangkok Port is expected to be remarkably reduced.

10. The total traffic volume from/to Bangkok Port in the stage of the Master Plan is forecast to decrease about 50% from the present traffic volume due to the reduction in the number of containers through the port mentioned above, the percentage of 20ft. containers and LCL containers, though the traffic volume of the conventional cargo is forecast to increase slightly at that stage.

Proper functional allotment between the ports of Bangkok and Laem Chabang is expected to be accomplished through the market mechanism.

11. In the meantime, since a great portion of containers originate from or are destined for in and around Bangkok Metropolis, and the container-handling capacity of Bangkok Port is restricted due to the limitation of available space and necessity of reducing road traffic generated from its port activities, a considerable portion of containers must be diverted to Laem Chabang Port, a deep sea port that has recently opened.

12. Although presently most containers are transported through Bangkok Port and the portion through Laem Chabang Port is still small, the number of containers through Laem Chabang Port is expected to steadily increase in the future on routes where the cost of land transport from Bangkok area to Laem Chabang Port can be compensated or covered by the savings on maritime transport costs derived through the introduction of bigger container vessels. Some eastbound routes including routes for East Asia are considered to be such routes where Laem Chabang Port has an advantage or potential advantage over Bangkok Port.

13. Consequently, proper functional allotment between the ports of Bangkok and Laem Chabang is expected to be achieved. That will be beneficial to both ports and also for port users; the moderate amount of containers that will be handled at Bangkok Port will enable services for port users to be upgraded, and Laem Chabang Port will be promoted at the same time.

(2) Handling Conventional Cargo

All ten berths of the west quay at Bangkok Port will be exclusively used to receive the forecast volume of conventional cargo in the stage of the Master Plan.

14. In 1991/1992, the berth occupancy rate of ten berths at the west quay of Klong Toei Wharf of Bangkok Port which received mainly conventional vessels (87% of the total number at the west quay) reached a high value of 78%. In recent years the volume of conventional cargoes handled at the west quay has shown a downward trend, and the volume of conventional cargo handled in the stage of the Master Plan is projected to remain almost at the same level as at present. On the other hand, container vessels, some of which are presently received at the west quay, are planned to be received only

at the east quay in the stage of the Master Plan as a result of the modernization of container-handling at Klong Toei Wharf of Bangkok Port and the subsequent reduction in the total container number from the present level. This means all ten berths will be exclusively used for conventional vessels. Thus, the usage conditions of the west quay are expected to remain almost the same as at present and the preparation of additional berths for conventional cargo in the Master Plan is not required.

Mixing use of the sheds and open storage yards behind the conventional berths for both conventional and container cargoes induces the shortage of space for storing conventional cargo and serious traffic congestion in the port.

15. The sheds and open storage yards behind the conventional berths of the west quay are presently used for not only conventional cargo but container cargo, resulting in shortage of space for storing conventional cargo, especially in open storage yards for steel products. Consequently, import steel products are forced to be stored at the yard outside the custom fences, resulting in inefficient discharging of the cargo from conventional vessels.

16. Moreover, mixing use of the sheds and open storage yards behind the conventional berths for both conventional and container cargoes induces serious traffic congestion on the roads behind the berths due to intricate movements of various kinds of vehicles such as ordinary trucks and tractor-chassis units. Also, passenger cars and trucks/tractor-chassis units parking along the existing roads narrow the effective widths of the roads and exacerbate the traffic congestion.

The modernization of the container-handling at Bangkok Port makes it possible to withdraw container storage from the area behind the conventional berths, and consequently storage for steel products can be transferred to yards inside the port from outside.

17. Such congestion in cargo storage or traffic behind the conventional berths of the west quay can be resolved by the withdrawal of container storage at the area behind the conventional berths of the west quay and subsequent rearrangement of usage of the existing sheds, warehouses, open storage yards and offices, and realignment of the existing port roads. The above withdrawal of container storage is linked to the proposed modernization of the container-handling at Bangkok Port. In such rearrangement of the

existing storages, storage for steel products can be transferred to yards inside the port from outside.

18. It is also effective for the reduction of traffic congestion to prepare new parking lots for passenger cars and trucks/tractor-chassis units near the port gates and transfer the existing various offices inside the port having no direct linkage with cargo-handling operations to outside the customs fences.

2. Master Plan (Target Year: 2005)

The Master Plan includes both modernization of management, operations and institutional matters, and that of physical facilities in Bangkok Port. Both of these are indispensable for the modernization of the port and should be realized simultaneously.

(1) Container-Handling

Containers of one million TEUs per annum are planned to be handled.

19. The Master Plan is formulated with a target year of 2005. In that year, the number of containers to be handled at Bangkok Port (Klong Toei Wharf and private terminals) and Laem Chabang Port is estimated as 3.47 million TEUs as a total. Out of the total, one million TEUs and 2.19 million TEUs are allocated to Klong Toei Wharf of Bangkok Port and Laem Chabang Port, respectively. The remaining 280,000 TEUs are allocated to the private terminals within the limits of Bangkok Port.

It is proposed to introduce the closed terminal system along with an increase in container storage capacity at the marshaling yard.

20. To accommodate the above containers of one million TEUs at Klong Toei Wharf of Bangkok Port with economical, efficient, safe and reliable terminal operations for the port users, it is proposed to introduce the closed terminal system. To enable the introduction of the closed terminal system, it is essential to increase the storage capacity of the marshaling yard at the east quay by converting the site of the two existing sheds into the container-stacking yard. At the newly expanded stacking yard, RTGs which are larger than those presently used are proposed to be procured so as to increase the

container storage capacity as much as possible (which would result in a total capacity of approximately 10,000 TEUs).

21. In addition, it is proposed to introduce information systems using computers which is prerequisite to handle containers of one million TEUs per annum in the closed terminal system.

It is proposed to rationalize LCL-handling operations at the west quay by installing new Export CFSs in Zone 1 and Import CFSs in Area II.

22. To back up container-handling operations at the marshaling yard of the east quay which will be modernized as mentioned above, it is proposed to rationalize LCL-handling operations at the west quay and thereby LCL containers can be delivered to the marshaling yard of the east quay swiftly before a closing time from the west quay or be delivered to the west quay from the marshaling yard just after the completion of the necessary procedure at the marshaling yard. For that purpose, it is proposed to install new Export CFSs in Zone 1 and Import CFSs in Area II facing Ajnarong Road running along the port area.

23. Thus, areas for stuffing operations for exported container cargoes will be separated from the empty container stacking yards. Furthermore, the movements of ordinary trucks from outside to CFSs will be separated from the movements of tractor-chassis units. The yards for storing empty containers with a total storage capacity of around 12,000 TEUs are allocated behind and west of the sheds Nos.15-17.

(2) Handling Conventional Cargo

The existing ten berths at the west quay are allocated exclusively for conventional vessels.

24. In the target year of the Master Plan, the volume of conventional cargo to be discharged at Klong Toei Wharf of Bangkok Port is estimated as 3.91 million tons. To accommodate the above amount of conventional cargo, the existing ten berths at the west quay are allocated exclusively for conventional vessels.

It is proposed to rearrange the usage of the existing sheds, warehouses, open storage

yards and offices, and realign the existing port roads.

25. The sheds and open storage yards behind the conventional berths will be used exclusively for storing the cargo discharged from conventional vessels. Some of the existing sheds will be converted into open storage yards, and thereby import steel products which are presently stored outside the port will be stored at the yards just behind the berths. The usage of the existing warehouses will be rearranged, and thereby bonded cargoes for Laos which are presently stored outside the customs fences will also be stored inside the port.

26. Corresponding to the above rearrangement, it is proposed to realign and expand the existing port roads, and prepare parking lots near the port gates.

27. In addition, it is also proposed to relocate the existing warehouses for dangerous cargo to a place with a sufficient buffer zone by expanding the present area for the storage.

(3) Necessity of Land for New Port Facilities

The areas containing Area II, Zone 1, the area facing the Phra Kanong Canal and the area behind the planned storage area for dangerous cargo are considered to be indispensable for port activities in the stage of the Master Plan.

28. It is difficult to prepare lands for installing new Export CFSs, Import CFSs and parking lots for port-related vehicles within the present customs fences because of the limitation of space. Therefore, they should be located outside of existing customs fences. The areas containing Area II, Zone 1, the area facing the Phra Kanong Canal and the area behind the planned storage area for dangerous cargo are considered to be the most suitable places for the above new port facilities judging from their location and are indispensable in the stage of the Master Plan.

(4) Navigational Safety

It is proposed to widen the breadth of the stretches of the Bar Channel and institute special new rules to improve navigational safety.

29. It is proposed to widen the breadth of the stretches of the Bar Channel to 150 meters to improve navigational safety from the present level especially for large vessels whose lengths and breadths are close to the maximum permissible ones. In addition, it is also proposed to institute special new rules for the port including certain restrictions/controls on overtaking, anchoring, maximum speed and reciprocal meeting of large vessels within the fairway to prevent accidents.

(5) Construction Costs

30. The total construction cost of the Master Plan is roughly estimated as 3.5 billion Baht.

(6) Management, Operations and Institutional Matters

It is proposed to create a new organization established by PAT responsible for cargo-handling operations and rearrange the remaining PAT organization including the Headquarters and Bangkok Port Office.

31. It is advisable that the cargo-handling operations at Bangkok Port be carried out in a commercial manner where business is run efficiently with a flexible management system especially in container-handling operations where the closed terminal system will be newly introduced and the existing facilities will be redeveloped to back up the new system. As to container-handling operations, all-out operations by private companies are not realistic taking account of the situation of Bangkok Port: more than fifteen shipping lines/agents are using the terminal with limited space and social problems of relocation of workers would arise if cargo-handling operations were privatized.

32. To conduct cargo-handling operations in a commercial manner and simultaneously avoid the possible social problems, it is proposed to create a new organization established and funded by PAT responsible for cargo-handling operations both for containers and conventional cargo at the port.

33. Prior to the establishment of a new organization for cargo-handling operations, it is proposed to rearrange the remaining PAT organization including the Headquarters and Bangkok Port Office to achieve quick decision-making and efficient management.

(7) Environmental Consideration

Estimated annual throughput at the port and the total traffic volume to be generated from the port activities in the stage of the Master Plan are less than the present level and the project has positive environmental effects.

34. Bangkok Port is already an operating port with an annual throughput of 16 million tons. Estimated annual throughput in 2005, when the modernization project is completed, is less than the present levels, and therefore the total traffic volume to be generated from the port activities will decrease from the present level. Moreover, the maximum size of calling vessels will not be changed. Consequently, the project has positive environmental effects reducing number of calling ships and induced road traffic.

35. A comprehensive system to satisfy requirements of MARPOL 73/78 convention should be studied by the Government of Thailand.

3. Short-Term Plan (Target Year: 1997)

The Short-Term Plan includes both modernization of management, operations and institutional matters, and that of physical facilities in Bangkok Port. Both of these are indispensable for the modernization of the port and should be realized simultaneously.

(1) Container-Handling

Containers of one million TEUs per annum are planned to be handled.

36. The Short-Term Plan is prepared as a first-stage plan for the modernization of Bangkok Port with a target year of 1997. In that year, the number of containers to be handled at Bangkok Port (Klong Toei Wharf and private terminals) and Laem Chabang Port is estimated as 2.12 million TEUs as a total. Out of the total, one million TEUs and 840,000 TEUs are allocated to Klong Toei Wharf of Bangkok Port and Laem Chabang Port, respectively. The remaining 280,000 TEUs are allocated to the private terminals within the limits of Bangkok Port.

It is proposed to introduce the closed terminal system along with an increase in

container storage capacity at the marshaling yard.

37. To accommodate the above containers of one million TEUs at Klong Toei Wharf of Bangkok Port, it is proposed to introduce the closed terminal system in the stage of the Short-Term Plan with an increase in storage capacity of the marshaling yard at the east quay by the same way proposed in the Master Plan.

It is proposed to rationalize LCL-handling operations at the west quay by installing new Import CFSs in Area II and separating stuffing yard for exported container cargoes from the stacking yards for empty containers.

38. To back up container-handling operations at the marshaling yard of the east quay which will be modernized as mentioned above, it is proposed to rationalize LCL-handling operations at the west quay by installing new Import CFSs in Area II and separating stuffing yard for exported container cargoes from the stacking yards for empty containers. The yards for stuffing export container cargoes or storing empty containers neighboring with each other are allocated behind or west of the sheds Nos.15-17.

(2) Handling Conventional Cargo

The existing ten berths at the west quay are allocated exclusively for conventional vessels.

39. In the target year of the Short-Term Plan, the volume of conventional cargo to be discharged at Klong Toei Wharf of Bangkok Port is estimated as 3.81 million tons. To accommodate the above amount of conventional cargo, the existing ten berths at the west quay are allocated exclusively for conventional vessels.

It is proposed to rearrange the usage of the existing sheds, warehouses, open storage yards and offices, and realign the existing port roads.

40. The sheds and open storage yards behind the conventional berths will be used exclusively for storing the cargo discharged from conventional vessels. Some of the existing supplementary sheds and Bonded Warehouse will be converted into open storage yards, and thereby import steel products which are presently stored outside the port will be stored at the yards just behind the berths.

41. Corresponding to the above rearrangement, it is proposed to realign and expand the existing port roads, and prepare parking lots near the port gates.

42. In addition, it is also proposed to relocate the existing warehouses for dangerous cargo to a place with a sufficient buffer zone by expanding the present area for the storage.

(3) Necessity of Land for New Port Facilities

The areas containing Area II, the area facing the Phra Kanong Canal and the area behind the planned storage area for dangerous cargo are considered to be indispensable for port activities in the stage of the Short-Term Plan.

43. The areas containing Area II, the area facing the Phra Kanong Canal and the area behind the planned storage area for dangerous cargo are considered to be the most suitable places for installing new Import CFSs and the parking lots for port-related vehicles and are indispensable in the stage of the Short-Term Plan.

(4) Construction Costs

44. The total construction cost of the Short-Term Plan is estimated as 1.2 billion Baht.

(5) Management, Operations and Institutional Matters

It is proposed that PAT take full responsibility of container-handling operations at a part of the marshaling yard cooperating with shipping lines/agents, and rearrange PAT's organization including the Headquarter and Bangkok Port Office.

45. It is proposed that PAT take full responsibility of container-handling at a part of the marshaling yard of the east quay in cooperation with shipping lines/agents under the closed terminal system to be newly introduced so as to get operational know-how which is expected to be transferred to the new organization proposed in the Master Plan.

46. Prior to the establishment of the new organization mentioned above, it is advisable to rearrange PAT organization including the Headquarters and Bangkok Port Office so as to achieve quick decision-making and efficient management in the stage of

Short-Term Plan.

(6) Economic Analysis

The proposed modernization project with the EIRR of 12.4% is considered to be economically justifiable.

47. A comparison between the "Without Modernization" case and the "With Modernization" case was carried out to evaluate the feasibility of the project for modernization of Bangkok Port proposed in the Short-Term Plan from the viewpoint of the national economy of Thailand. In the comparison, the economic rate of return (EIRR) is used to evaluate the measurable economic benefits compared with the economic costs. The main economic benefits of the project are the savings on staying costs of container vessels at the port and the costs of port administration and operations generated from the modernization project. The resulting EIRR is estimated as 12.4% exceeding the general criterion to assess the economic justifiability.

(7) Financial Analysis

The proposed modernization project with the FIRR of 9.3% is considered to be financially feasible.

48. The main financial benefits of the project are increases of revenues from the new business of container repair/cleaning, tariff raised slightly to cover some portion of the capital investment and reduction of administration and operation costs generated from the project. The resulting financial rate of return (FIRR) is estimated as 9.3% keeping a favorable level judging from the range of the interest rates of bank deposit.

(8) Environmental Consideration

The modernization project proposed in the Short-Term Plan has positive environmental effects and EIA as an administration procedure will not be needed.

49. The Short-Term Plan has positive environmental effects, reducing number of calling ships and induced road traffic. Consequently, EIA as an administration procedure will not be needed.

50. In the stage of the construction works, contractors of the works should take heed of regulations in Thailand regarding environmental consideration such as disposition of waste materials from demolition sites.

RECOMMENDATIONS

In accordance with the results of the study, it is recommended that the Government of Thailand implement the modernization project of Bangkok Port to achieve economical, efficient, safe and reliable operations for port users. The project is divided into two phases: the first phase project is that proposed in the Short-Term Plan with the target year 1997 and the second phase project is that to be completed by the target year 2005 of the Master Plan.

1. The First Phase Project

The main components of the first phase project are summarized as follows:

1.1 Container-Handling

- (1) Introduction of a closed container terminal system
- (2) Expansion of the marshaling yard of the east quay:
 - Total storage capacity: 9,942 TEUs (4,128 ground slots)
 - Demolition of sheds Nos.11 and 12 to provide an open yard
- (3) Introduction of 9 large RTGs (6 rows + 1 lane) to be used partly at the marshaling yard
- (4) Construction of a concentrated reefer yard at the west end of the marshaling yard:
 - Number of plugs: 352 units
 - Reefer-handling equipment: RTGs of small size
- (5) Adding one traffic lane to the bridge connecting the east and west quays
- (6) Construction of 2 Import CFSs with the total floor space of 15,000 sq.m at Area II
- (7) Improvement of sheds Nos.13 and 14 as Import CFSs
- (8) Preparation of a yard specialized for stuffing export container cargo:
 - Ground slots of 912 TEUs
 - Container-handling equipment: toplifters
- (9) Preparation of yards for storing empty containers west and behind sheds Nos.15-17:
 - Total storage capacity: 7,272 TEUs (2,424 ground slots)
 - Container-handling equipment: toplifters

(10) Preparation of other main facilities:

- Marshaling yard:
 - Terminal office near gate No.3
 - Repair yards for RTGs (No.1 ~ No.3)
 - 3 terminal gates
- West quay:
 - Maintenance shop for container boxes
 - Cleaning area for container boxes
 - Parking lot for tractors/chassis
 - Area for container-handling equipment

(11) Introduction of Modernized Information System Using Computer:

- Review and modification of the current documentation forms to meet the requirements of the new terminal operation system
- Development of required software through purchase of package software and improvement of it by trained PAT staffs to minimize a lead time

1.2 Handling Conventional Cargo

(1) Transference of the storage yard for import steel products to inside the port from outside:

- Preparation of storage yards behind the conventional berths
- Conversion of the site of existing Import Steel Open Yard located outside the port into commercial use

(2) Demolition of the existing supplementary sheds Nos.1,4-7,9 and the Bonded Warehouse to provide open yards

(3) Realignment and expansion of the existing port roads

(4) Modification of sheds Nos.1-9 to create additional port roads

(5) Dismantlement of the existing dockside cranes at the west quay

(6) Relocation of the existing warehouses and yards for dangerous cargoes including cotton to an area with a sufficient buffer zone

(7) Transference of railway operations to the yard west of the west quay from the east quay

(8) Preparation of parking lots for passenger cars and trucks/tractor-chassis units:

- Parking Lot No.1 near Checking Post 1 for passenger cars
- Parking Lot No.3 behind the planned dangerous cargo area for trucks
- Parking Lot No.2 near Checking Post 2 for trucks/tractor-chassis units

- (9) Transference of offices having no direct linkage with cargo-handling operations from inside the port to outside

1.3 Navigational Safety

To improve safety in the navigational waterways of Bangkok Port, special new rules including certain restrictions/controls on overtaking, anchoring, maximum speed and reciprocal meeting of large vessels within the fairway should be instituted.

1.4 Management, Operations and Institutional Matters

PAT should start container-handling operations at a part of the marshaling yard and take full responsibility for the container-handling there to get operational know-how which could be transferred to the new organization controlling the entire terminal proposed to be established in the next phase. In the early stage, it is advisable to employ competent yard planners who are indispensable in controlling the terminal under the closed terminal system.

Moreover, PAT should rearrange its organization including the Headquarters and Bangkok Port Office to achieve quick decision-making and efficient management. PAT should also improve the statistical system.

1.5 Environmental Consideration

A study on which sector should be responsible for receiving and treating oily wastes and a study on the location of treatment plant should be made by the government in preparing to ratify MARPOL 73/78 convention. PAT will not be primarily responsible for the system, but it will have to share responsibility for backing up the system to some extent.

2. The Second Phase Project

The main components of the second phase project are summarized as follows:

2.1 Container-Handling

- (1) Construction of 3 Export CFSs with the total floor space of 27,000 sq.m at Zone 1
- (2) Expansion of yards for storing empty containers west and behind sheds Nos.15-17:
 - Total storage capacity: 11,832 TEUs (3,944 ground slots)
 - Container-handling equipment: toplifters
- (3) Upgrading Information System Using Electronic Computer:
 - Participation to computer network system connecting port users and authorities concerned internationally

2.2 Handling Conventional Cargo

- (1) Demolition of sheds Nos.7-9 to provide open storage yards
- (2) Transferring the warehouse for bonded cargo for Laos to inside the port from outside:
 - Preparation of sheds Nos.15-17 to store the bonded cargo
 - Conversion of the site of existing In-Transit Warehouse located outside the port into commercial use
- (3) Expansion of parking lots
 - Parking Lot No.1 for passenger cars
 - Parking Lot No.2 for passenger cars and trucks
- (4) Transference of the Vehicle Section to the area adjacent to Parking Lot No.4

2.3 Navigational Safety

It is advisable to widen the breadth of the stretches of the Bar Channel to 150 m.

2.4 Management, Operations and Institutional Matters

To conduct cargo-handling in a commercial manner and simultaneously avoid the possible social problems arising from the relocation of workers, it is advisable to create a new organization established and funded by PAT responsible for cargo-handling operations at the port.

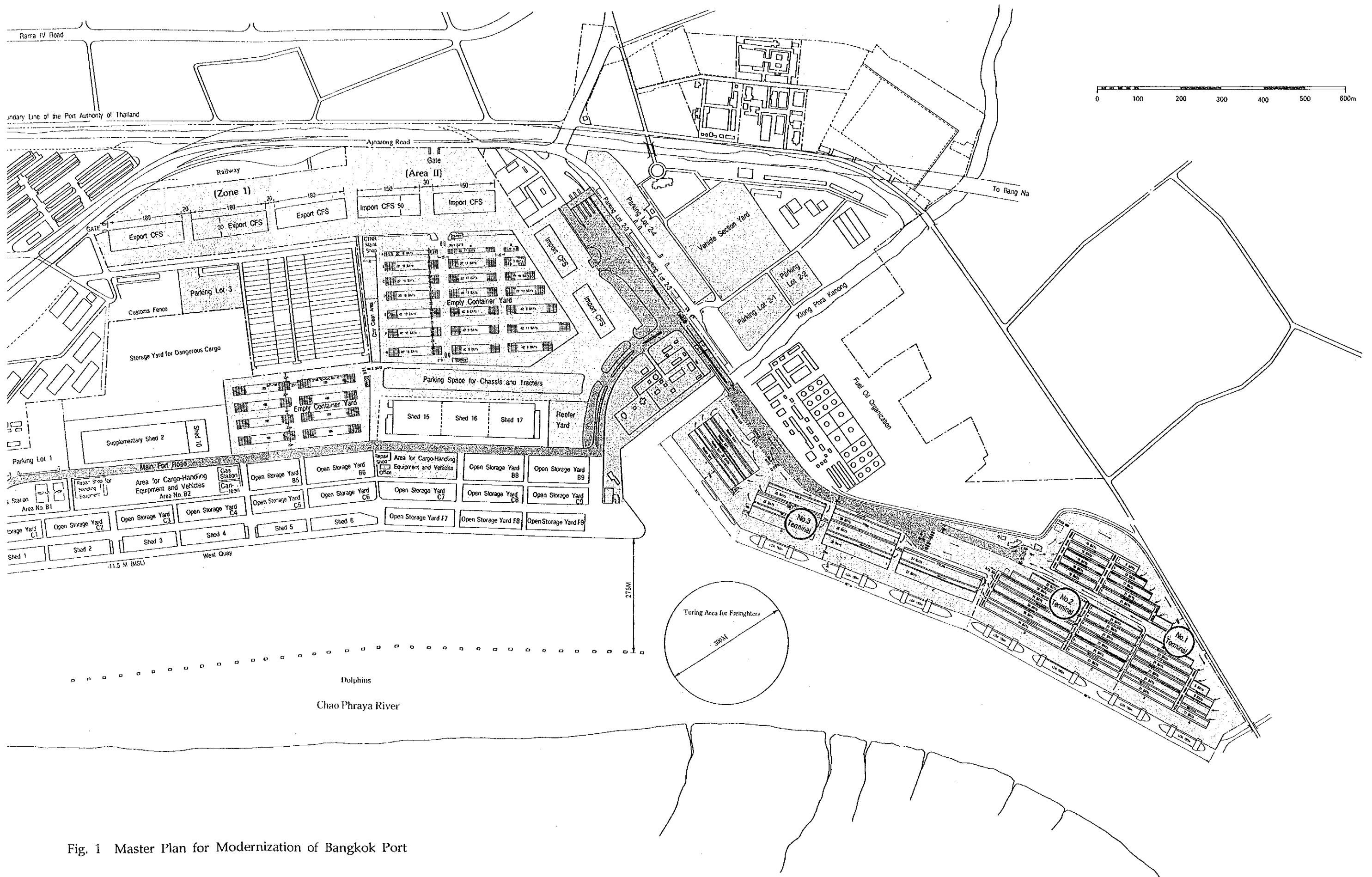


Fig. 1 Master Plan for Modernization of Bangkok Port

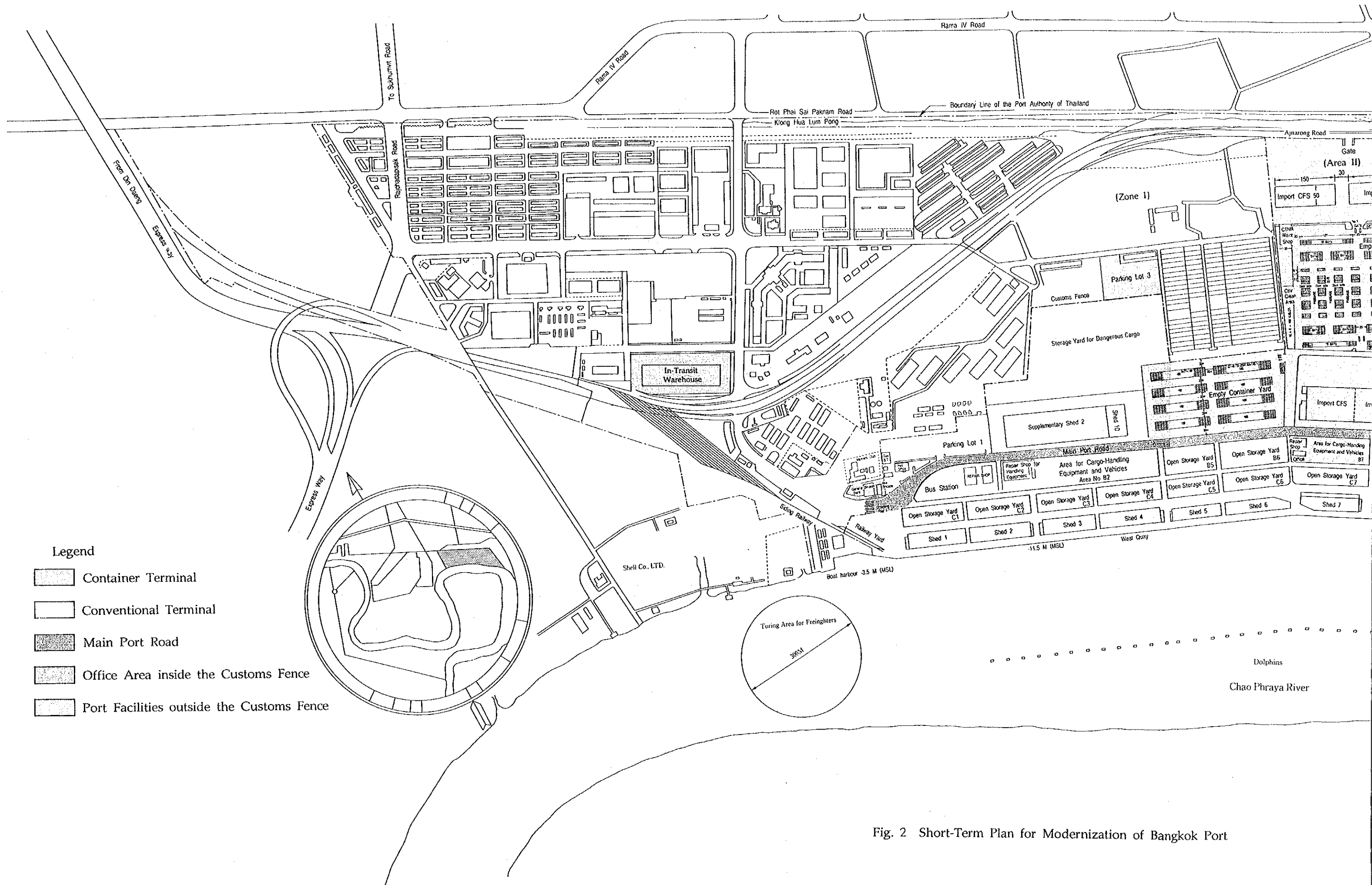
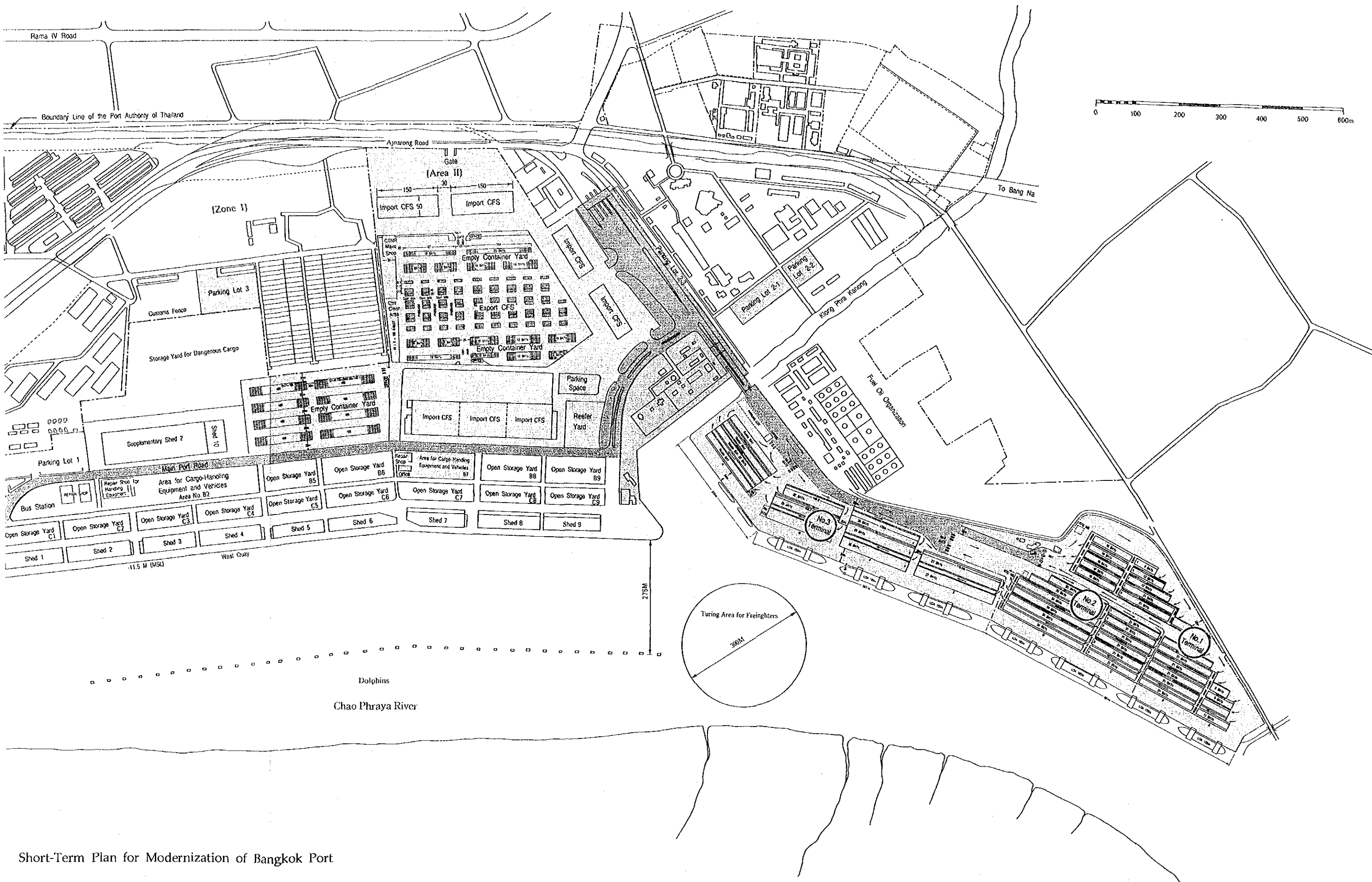


Fig. 2 Short-Term Plan for Modernization of Bangkok Port



Short-Term Plan for Modernization of Bangkok Port

ORGANIZATION OF THE STUDY TEAM

ORGANIZATION OF THE STUDY TEAM

The study team is comprised of 13 specialists. Their names and responsibilities are listed below.

Name	Responsibility
Yugo Otsuki	Team Leader, Overall Management, Port Planning(I) (OCDI)
Yoshiaki Higuchi	Port Planning(II), Environmental Consideration (OCDI)
Shigeki Tsushima	Demand Forecast, Economic analysis (OCDI)
Shingo Shiratori	Port Traffic Demand Forecast, Facility Planning (OCDI)
Nobuaki Kojima	Navigation Aids Planning (OCDI)
Takahiro Yamada	Management and Operations, Financial Analysis (OCDI)
Heiroke Hanada	Cargo-Handling System (OCDI)
Nobuaki Nagao	Port Facility Planning (PCI)
Ryuji Kaneda	Information System (PCI)
Mitsuhiko Hasegawa	Natural Conditions, Environmental Investigation (PCI)
Moriyoshi Sakurada	Redevelopment Construction Planning (PCI)
Hiroshi Namiki	Port Facility Cost Estimate (PCI)
Toshikazu Ono	Cargo-Handling Machine Planning, Cost Estimate (PCI)
Atsuki Shibata	Coordinator (OCDI)

PART I MASTER PLAN

1.1 Outline of the Kingdom of Thailand

1.1.1 General Condition

The population of Thailand increased to 59.933 million in 1991 from 48.709 million in 1982 with an average annual growth rate of 1.7%. Presently, population density is 111 persons/km².

Urbanization has proceeded along with the progress of the industrialization of the Thai economy. However, only 17 cities have a population of more than 50,000, all of which are connected by the major transport network. Cities having more than 100 thousand inhabitants are Chiang Mai and Nakhon Sawan in the north region, Khon Kaen, Nakhon Ratchasima in the northeastern region, Hat Yai in the southern region and Bangkok.

The structure of the Thai economy remained virtually unchanged up to the late 1950s. Since the early 1960s, the industrial and service sectors have been increasing their shares of the total GDP and the total employment, respectively. Agricultural sector, however, is still the major sector in generating income and employment in the Thai economy; about two thirds of the working population are engaged in agriculture and 13.2% of the national income is derived from agriculture.

Significant structural changes in the Thai economy have taken place since the early 1960s. The agricultural sector's share of the national income declined steadily from about 40% in 1960 to 13.2% in 1991. At the same time, the manufacturing sector expanded very rapidly, increasing its share of the national income from 13% in 1960 to 28.8% in 1991. Such a structural change does not, however, imply that agricultural output failed to rise during the period. On the contrary it increased by about 5% per year.

The industrialization process initiated during the 1960s was geared toward import substitution. It was succeeded in the 1970s by a drive to produce export-oriented items. By the mid 1970s, Thailand was exporting manufactured goods ranging from cement to watch parts, and including canned fruits, garments, chemical products, transport equipment and television sets. In 1991, manufactured exports accounted for about 76% of total export earnings.

International trade is vital to the Thai economy. Thailand's entry into foreign markets has enabled its economy to expand rapidly. Today the economic structure has become more outward-oriented and internationalized, as indicated by the increase in the proportion of international trade to GDP from 60% in 1986 to 80% by 1991. Although there were annual deficits, the balance of payments recorded a continuous surplus

throughout the 1960s and the early 1970s. A sharp increase in oil prices since 1973, though, has affected the balance of payment position severely.

In short, the performance of the Thai economy over the 25 years ranks high among developing countries. Some basic economic problems such as income disparity, the need to conserve natural resources, the high dependence on energy consumption and the need for improving administrative efficiency remain to be solved, but judging from the past performance as well as from the present economic outlook, it is clear that Thailand has the potential to greatly expand its economy.

1.1.2 Industrialization

Industrialization in Thailand began in the early 1960s. Although the Industrial Promotion Act was enacted in 1954, it was actually implemented in 1960 through the establishment of the Board of Investment. The Act was revised in 1962 to include the promotion of investment through such incentives as exemption from customs duties and other taxes on imported materials, equipment and machinery, and was revised again in 1972 together with the change in policy emphasis from import substitution toward export promotion.

Since the formation of IEAT in 1972 the establishment of industrial estate has branched out from the Bangkok Metropolitan area to other provinces of the country. The total area of the industrial estate now covers 35,000 rai and is prepared to meet the increasing demand. To cope with the rapidly growing number of industries resulting from the implementation of the National Economic and Social Development Plan, more industrial estates are planned for in three regions, North, Northeast and South, in conjunction with the strong support provided by the government and private sector.

Major industries in Thailand are cement, textiles, electric appliances, sugar, paper and iron and steel. Light industries producing consumer goods are dominant. Almost all the major industries are concentrated in the Bangkok Metropolitan Area except for sugar mills and gunny bag producers which are located in the northeastern region, and tin smelting in the southern region.

Major mining products in Thailand are tin, fluorite, manganese, antimony, lead, lignite, gypsum and rock salt. Almost all of these mining products are exported to neighboring countries in South Asia, Japan, England, Germany and the Netherlands as raw materials. Among these, smelted tin is exported through Phuket port.

1.1.3 Foreign Trade

The amount of foreign trade cargo increased from 36,846 thousand tons in 1982 to 76,051 thousand tons in 1991, at an average annual rate of 8.6%. Total imports fluctuated between 15 million tons and 20 million tons during the period from 1982 through 1986, but after 1987 rapidly increased and reached 45 million tons in 1991. Total exports fluctuated between 17 million tons and 23 million tons during the period from 1982 to 1987, but after 1988 rapidly increased and reached 31 million tons in 1991.

1.1.4 The Seventh National Economic and Social Development Plan (1992-1996)

Evaluation of past development efforts suggests that the development objectives of the Seventh Plan will have to be carefully balanced in terms of quantitative and qualitative development dimensions, as well as social equity aspect in order to bring about more sustainable development for the country. Therefore, the three main development objectives of the Seventh Plan have been set out as follows.

- i) Maintain economic growth rates at appropriate levels to ensure sustainability and stability.
- ii) Redistribute income and decentralize development to the regions and rural areas more widely.
- iii) Accelerate the development of human resources, and upgrade quality of life, the environment and natural resource management.

In order to bring about the pattern of more sustainable development mentioned earlier, it is essential to accord equal priority to the three main development objectives.

The overall economic targets in the Seventh Plan are shown as follows.

Overall Economic Targets in the Seventh Plan

Category	Sixth Plan Actual trends (1987-1991)	Seventh Plan Targets (1992-1996)
1. Economic growth (% per year at constant prices)	10.5	8.2
1.1 Agriculture sector	3.4	3.4
1.2 Non-agriculture sector	12.1	8.6
- Industry	13.7	9.5
- Construction	18.7	8.9
- Services and others	11.0	8.1
2. Per capita income (baht/year)*1	41,000	71,000
3. Export of goods		
3.1 Average value (billion bath)	496	1,063
3.2 Average growth rate per year (%)	24.5	14.7
4. Import of goods		
4.1 Average value (billion bath)	664.3	1358.0
4.2 Average growth rate per year (%)	32.6	11.4
5. Inflation (%)	4.7	5.6
6. Number of population (million)	56.9	61.0
Population growth rate (%)	1.4	1.2

*1 Figures of the last year (1991 and 1996) of the Sixth and Seventh Plans respectively

Source: The Seventh National Economic and Social Development Plan
(NESDB)

1.2 Natural and Environmental Conditions

1.2.1 Natural Conditions

(1) Geography

The country's total area is 513,115 square kilometers and its longest north to south distance is approximately 1,650 kilometers from 5°37' to 20°27' north latitude.

(2) Climate

The year can be divided into three seasons, i.e., rainy season, cold season and hot season. The rainy season is from late May to mid October and the average annual rainfall of the country is about 1800 mm. The cold season is from mid October to February, the mildest season of the year. The hot season begins from late February and lasts to mid May, and the average temperature is above 30°C.

(3) Tide in Bangkok Port

Highest High Water (H.H.W.)	: + 2.11 m
Mean Sea Level (M.S.L.)	: 0.00 m
Lowest Low Water (L.L.W.)	: - 1.72 m

(4) Subsoil in Bangkok Port

The subsoil up to -35 m in Bangkok Port consists of three different layers as follow;

- 1st layer : Ground level to around -12 m, soft clay, N = 0.
- 2nd layer : Around -12 m to - 20 m, stiff silty clay, N = 10 to 20.
- 3rd layer : Below around - 20 m, very stiff silty clay, N = 20 to 30.

(5) Water Discharge of Chao Phraya River

The average flow of flood water is approximately 1,700 m³/sec. and the average flow of low water is 90 m³/sec.

1.2.2 Environmental Conditions

(1) Natural Environment in Thailand

In Thailand there are some 15,000 vascular plants native to the country, but the number could be 30 to 40% higher than known presently. 918 birds of 282 species were found up to the end of 1989. Thailand's coast line fronts the Gulf of Thailand in the east

coast and the Andaman Sea on the west. Consequently, the marine life includes flora and fauna which have the characteristics of both the Indian Ocean and the Indo-Pacific regions.

(2) Environmental Conditions in Bangkok

Bangkok had favorable water conditions which are bases for society and the economy. However, environmental pollution problems have occurred with industrial urbanization in Bangkok. The most significant pollutions are air pollution and water pollution. The water pollution is caused by drainage discharges. The Chao Phraya River is the most important river which is taking the drainage discharges for houses and factories in Bangkok. The water pollution increases in the dry season (January - May). Oxygen content of the river (D.O) decreases to its lowest value during this season.

The lowest value of oxygen content of the river occurs 30 km - 40 km from the river mouth. Bangkok Port is located on the left bank of the Chao Phraya River about 30 km from the river mouth. This means that Bangkok Port (center of city) is in the zone of the excessive water pollution.

Port Authority of Thailand has been monitoring water quality, air quality, noise and so on from July, 1993.

1.2.3 Government's Policy on Environmental Consideration

(1) Environmental Impact Assessment (EIA)

Issues regarding development and environment conservation have been a common concern of the international community.

In Thailand also, the importance of environmental consideration had come to be acknowledged widely. The Office of Environmental Policy and Planning is set in the Ministry of Science, Technology and Environment as the examining body of environmental impact assessment (EIA).

Commercial port and harbor projects in which vessels capacity is of greater than 500 GRT require EIA reports and measures for the prevention of and remedy for the adverse effects on the environmental quality.

(2) MARPOL 73/78 in Thailand

The International Maritime Organization (IMO) is a body of the United Nations and drew up the International Convention for Prevention of Pollution from Ships of 1973 with Protocol of 1978 (MARPOL 73/78).

The MARPOL 73/78 convention is the principal convention on the prevention of pollution of seas from ships and a majority of the maritime nations of the world have already signed the convention. The Kingdom of Thailand is studying the convention and plans to sign it in the near future.

1.3 Transport

1.3.1 Outline of Transport in Thailand

Since the formulation of the first five-year plan, infrastructures for transport have been developed according to the subsequent five-year plans. According to the current five-year plan, namely the 7th National Economic and Social Development Plan (1992-1996), high economic growth is projected onward to the year 1996. The plan also identifies present problems of infrastructures, and indicates following major development plan guidelines in the field of transport.

- 1) Ensure higher efficiency of urban land use, assignment of each modal infrastructure services and solve traffic problems in order to meet the strong demand resulting from the rapid economic growth around Bangkok Metropolis.
- 2) Promote development of Bangkok Metropolises to integrate with development of the new economic zone of the Eastern Seaboard and industrial zone of the upper central region.
- 3) Develop regional centers in order to redistribute income and decentralize development of the regions and rural areas.
- 4) Set main development guidelines and promote development of regional urban centers in the north area, the northeast, the south, the west of Thailand and also target areas of Southern Seaboard Development Plan.

Roads, railways, inland waterway, coastal shipping and aviation comprise the transport modes in Thailand. Modal shares of freight transport in 1991 was dominated by road(89.3%), followed by railway(5.2%), coastal shipping(2.9%) and inland waterway(2.6%).

1.3.2 Road

(1) General

According to the road regulation in Thailand, highways are classified into seven categories. The authorities that administrate the above highways and the total length by each category are listed in Table 1-3-1.

Table 1-3-1 Total Length by Each Category

Administered by	Road Type	1991 Route kms
Department of Highways	National Highways	18,437
Department of Highways	Provincial Highways	27,163
Department of Highways	Construction/Minimum Maintenance	6,801
The Office of Accelerated Rural Development	Rural Roads	26,661
Public Works Department	Rural Roads	12,827
The Royal Irrigation Department	Rural Roads	11,178
Bangkok Metropolitan Administration	Municipal & Sanitary Highways	2,800
Local Authorities	Municipal & Sanitary Highways	N. A. 1
Department of Local Administration	Rural Roads	N. A. 2
Expressway and Rapid Transit Authority of Thailand	Special Highways	27

Remarks : 1 Latest available data : 11,900 in 1985

Source : MOTC, Department Land Transport

2 Latest available data : 82,400 in 1987

(2) Traffic Congestion in Bangkok Metropolis and Bangkok Port

The Klong Toei Wharf of Bangkok Port is located in Bangkok Metropolis where traffic congestion is a serious problem and the transport generated by this wharf is limited by traffic regulations which prohibit trailers and trucks during rush hour. Inside the port, traffic accidents often occur and the number of accidents shows an upward trend year by year along with the increase of the volume of cargoes through the port.

ETO (state enterprise) and trucking companies conduct forwarding business for cargoes from/to Bangkok Port. Most of the hauls by ETO's trucks are transported from/to origins/destinations in Bangkok Metropolis.

(3) Highway Projects Supporting the Eastern Seaboard Development

Newly developed Laem Chabang Port is expected to receive not only cargoes from/to the areas around Laem Chabang Port but also cargoes overflowing from Bangkok Port which seems to be already saturated. To promote such cargo flow from the areas in and around Bangkok Metropolis and Laem Chabang Port, it is essential to develop infrastructures of roads and railways connecting them. For that purpose, the following highway projects are proposed in the Eastern Seaboard Development Plan:

- 1) Eastern Bangkok Outer Ring Road(New highway)
- 2) New Bangkok-Chonburi Highway Project(New highway)

- 3) Chonburi-Pattaya Highway(New Highway)
- 4) Highway Route 34,Bang Na-Bang Pakong(Widening Project)
- 5) Minburi-Chachoengsao-Phanom Sarakham(Widening and Rehabilitation project)
- 6) Bang Pakong-Chachoengsao(Widening and Rehabilitation Project)

(4) Expressway Development Plan

Bangkok Port has access to 3 directions(Bang Na, Din Daeng and Dao Kanong) of the expressway(namely 1st stage expressway). Furthermore, Expressway Development Plan is set up, namely 2nd-4th stage expressway and Atnarong-Ram Inthra expressway which are expansions of the 1st stage expressway.

(5) Road Traffic Investigation

On May 12th, 1993, road traffic investigation was conducted to grasp the data of present traffic condition in and around Bangkok Port. From results of investigation, total traffic volume in and out of Bangkok Port was 51,129 vehicles including 38,035 passenger cars and motorcycles.

1.3.3 Railway Network

The railway system is managed and operated by the State Railway of Thailand (SRT) and at the end of the fiscal year 1990, the length of the railway lines totaled 4,609 kilometers. Railway construction between Si Racha and Laem Chabang began in the middle of 1991. SRT and American President Line (APL) reached an agreement in May 1992 for container management and operation at Bang Sue Terminal, and for general container transportation by railway. The volume has increased accordingly, reaching 5,553 TEUs/month in March 1993. Bang Sue terminal has been developed to support a transportation volume of up to 120,000 TEUs/year(stack area: 1,626TEUs). Main future Railway-Container Project are Lard Krabang ICD project and Klong Sip Kao to Kaeng Koi Railway Construction Project(railway distance:85 km). Double track railway project around Bangkok Metropolis area is 234 km in total distance. The elevated way project (combined expressway) is under construction to reduce traffic congestion in Bangkok Metropolis. The concession routes consist of 60.1 km of railway and are split into two distinct lines in Bangkok. The whole project is scheduled for completion in December 1999.

1.3.4 Marine Transport

In recent years, marine transport activities involving Thailand have been developing remarkable in line with the great strides being taken to improve the socioeconomic situation of the country. International shipping, in particular, accounted for 76% of the value and 95% of the quantity of the total foreign trade in 1991, highlighting the important role of marine transport.

Keeping in step with the global practice of container shipment, most of the general cargoes have been containerized; as for the other major commodities such as mineral oils, raw materials, steel products, cereals, vehicles etc, conventional ships, tankers and/or bulk carriers are employed. The distribution ratio of total shipping cargoes(1992) is estimated at about 20(container):80(others) in terms of quantity.

Those cargoes are being handled at five major ports, among which Bangkok port complex shares in almost all types, i.e. containers are handled mostly at the east quay while other commodities are handled at several public berths and 72 private berths scattered along both banks of the Chao Phraya river.

The number of seagoing vessels calling at major Thai ports has been increasing for years; the rate of increase in Bangkok complex(1987-1992) was 52%, among which the rate of the private wharves (82%) was particularly remarkable.

In addition to the above, the size of calling vessel has shown a tendency to become larger. In 1982, the majority of vessels fell in the 1,000-3,000 NRT(42%) followed by the 5,000-9,999 NRT(20%) and the 3,000-4,999 NRT(%); but in 1991, these shares had changed to 30%, 23% and 22% respectively.

The Thai merchant marine fleet with vessels larger than 500 GRT has a capacity of 800,000 GRT(1,230,000 DWT). Although the fleet is gradually growing, the transport capacity still leaves something to be desired.

1.4 Principal Ports

Ports in Thailand are divided into sea ports which face the Gulf of Thailand or Andaman Sea and river ports which were developed along rivers. Principal ports for international trade are Bangkok Port, which is the only river port used for international trade, Laem Chabang Port, Map Ta Phut Port, Songkla Port and Phuket Port.

Among these ports, only Bangkok Port has long been in operation as a gateway to Thailand. Klong Toei Port which is managed by PAT is situated about 28 km from the mouth of the river on the left bank. There are many terminals other than Klong Toei and among them there are three private terminals which handle container cargoes.

The other ports for international trade have opened just recently. Songkla Port and Phuket Port were opened in 1988. Laem Chabang Port and Map Ta Phut Port were opened in 1991 and 1992 respectively as key projects of the Eastern Seaboard Development Plan.

River ports are distributed along the Chao Phraya River and are mainly used to shuttle goods to and from the Bangkok area. There are about thirty coastal ports and most of them are located along the Gulf of Thailand Coast and Andaman Sea Coast in South Thailand.

Besides these ports, there is a berthing area of Si Racha just north of Laem Chabang Port and is used by big vessels for importing oil or exporting tapioca.

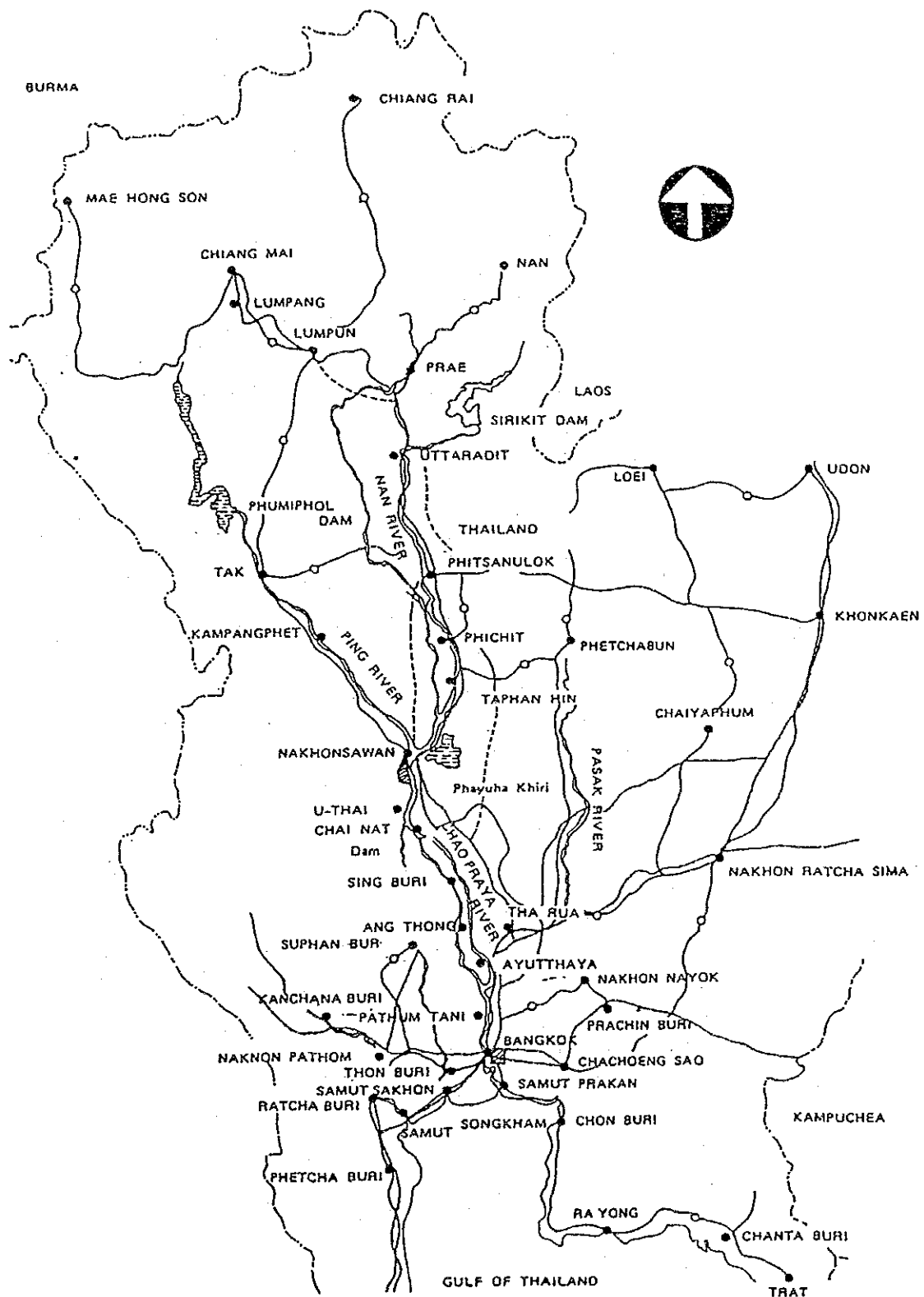


Fig. 1-4-1 Location of Sea Ports in Thailand

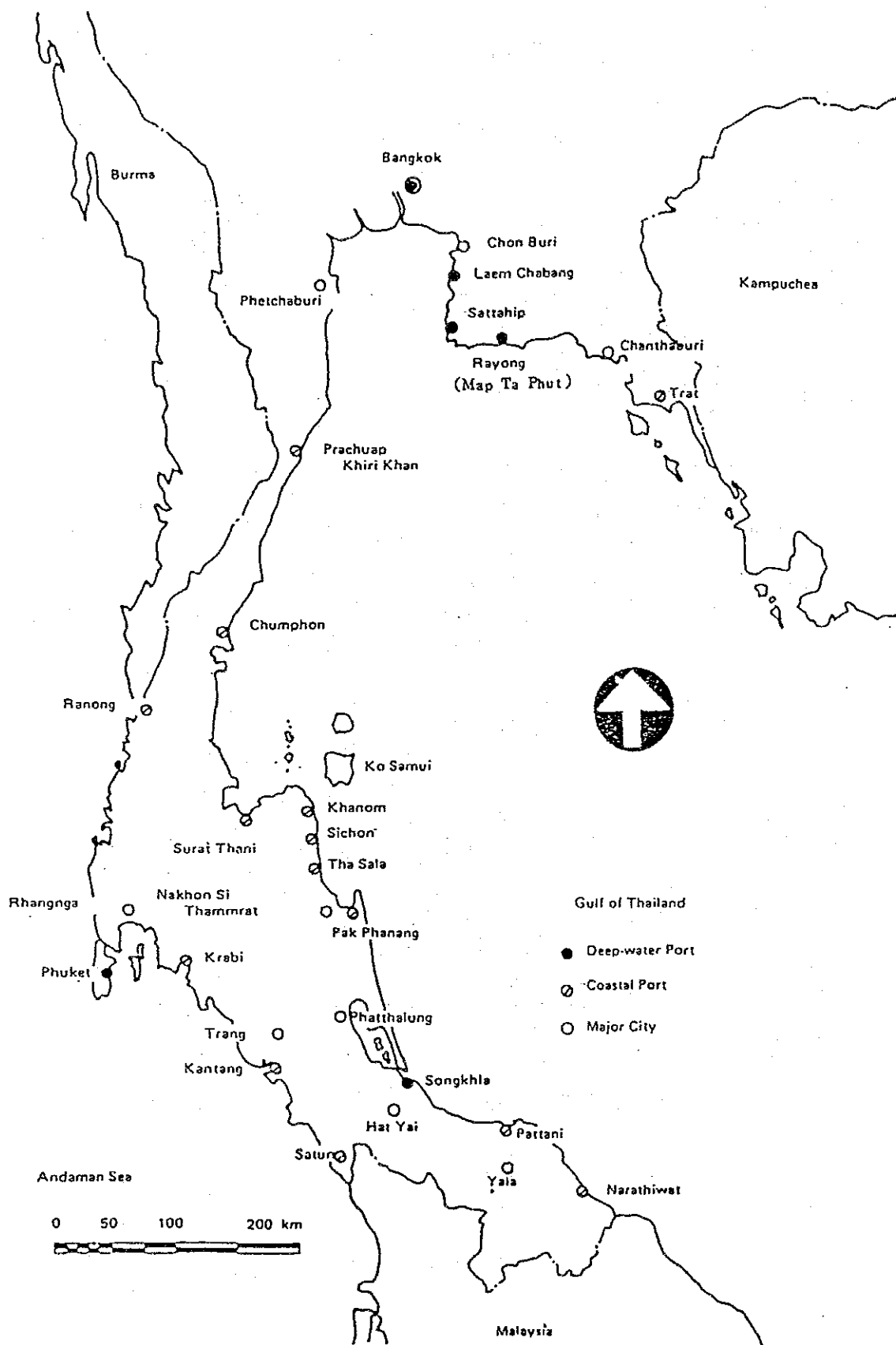


Fig. 1-4-2 Location of River Ports in Thailand

1.5 Trend of International Container Transport in Thailand

1.5.1 Outline of International Container Transport

In 1991, total foreign trade value (customs base) of Thailand amounted to 725.6 billion Baht for export (increase of 23.0% over 1990) and 958.8 billion Baht for import (increase of 13.5%) both showing high growth rates. In recent years, the volume of cargoes originating from or destined to South East Asia has increased remarkably along with the economic growth of the region. Reflecting the above, the number of container handled at the Klong Toei wharf of Bangkok Port, which has the largest container terminal in Thailand, amounted to about one million TEUs in 1990 and 1.3 million TEUs in 1992, respectively. Presently, Bangkok Port is ranked ninth in terms of number of containers handled among the ports in Asia and the Pacific.

1.5.2 Characteristics of the Liner Services for Containers in Thailand

(1) Services with Feeder

Most containers originating from or destined to Thailand are loaded or discharged at Bangkok Port at present. After or before being handled at Bangkok Port, long haul containers from/to the USA, Europe, etc. are transhipped from/to trunk liners at Singapore, Hongkong, Kaoshung, the ports in Japan, etc.; liner services with feeder connecting Bangkok Port and the trunk routes are in operation.

(2) Direct Liner Services

In addition to the above-mentioned liner services with feeder for containers, direct liner services from/to Bangkok Port are presently provided. In recent years, the number of vessel calls for direct shipping services shows an upward trend. The services on each route are summarized as follows:

- a. Routes For Japan, Korea, Hongkong, Taiwan and China
- b. Route for Singapore
- c. Routes for Other Areas comprising Europe, Bangladesh, South Africa, Durban Cambodia and UAE

1.6 Present Situation of Bangkok Port

1.6.1 Historical Background of the Port

Bangkok Port has been playing an important role as the main gateway of the international trade in Thailand.

In olden days, only vessels of medium tonnage and light draught could pass the channel to Bangkok. Since vessels of deep draught had to be discharged and loaded in the deep water anchorage about 80 km from Bangkok, cargo had to be sent up to Bangkok or brought down for shipment by lighters, which caused problems both in terms of time and expense.

In order to solve these problems, the government considered the possibility of dredging the channel through the bar and constructing a new port with modern facilities.

The construction of the new wharf at Klong Toei began in 1938 and was partly completed in 1940. In 1979, the east quay was constructed to handle increasing cargo in Kong Toei Wharf.

As international trade has been booming together with the modernization of transportation methods and Thailand's gradual emergence as an international country, the annual container handling volume of Klong Toei Wharf has increased in these 15 years from 73 thousand TEUs in 1997 to 1.3 million TEUs in 1992. The rapid increase of container cargoes in the past years has resulted in severe congestion at Klong Toei Wharf.

1.6.2 Land and Water Area Use within the Port

(1) Land Area Use within the Port

Klong Toei area where Klong Toei Wharf is situated has come to be surrounded by urban facilities and housings. The land area owned by PAT is about 3.6 sq.km and is situated between the River Chao Phraya and At Narong Street.

About 40% of the area including riverside is surrounded by a customs fence and is used mainly for port activities. Of the remaining 60%, yards used for port activities, customs office, PAT offices, private offices, housings including, oil tanks and so on are randomly located.

(2) Water Area Use within the Port

Bangkok Port is situated on the left bank of the Chao Phraya River between 26km to 29km of Klong Toei sub-district, Bangkok.

The approach to the port is made through a ten-mile bar channel following by a fifteen-mile river channel.

1) Location of the main berths

- * Bangkok port, the core of Bangkok Port Complex, consisting of the east quay (container terminal) and the west quay (mainly for import cargoes by conventional ships) lies 15 miles above the estuary.
- * Klong Toei Dolphins, a row of 36 dolphins, which can accommodate seven conventional vessels for conventional cargoes, are on the south side of the river opposite Klong Toei Wharf.
- * Bang Hua Sua Dolphins, a row of 25 dolphins, that can accommodate eight vessels, are on the NE side of the river about seven to eight miles above the estuary.
- * Sathupradit Mooring Buoys, a row of five mooring buoys, which can accommodate five vessels, are on the midstream about five miles above the west quay.
- * Seventy-two private wharves lie scattered from the vicinity of the estuary to 41km upstream on both banks of the river.

2) Navigable depth/width and bends of the channels

Navigable width is rather narrow throughout the channels. Assuming that the maneuvering depth of water for a loaded 10,000 DWT seagoing vessel is deeper than eight meters, the width of the river channel is almost less than 300m while the bar channel is 100m in the reaches and 250m on the bends.

Water depth is maintained at -8m MSL within the bar channels, -8m LLW within the river channel and -9m LLW around the berths for seagoing vessels.

Moreover, sharp bends of more than 30 degrees which call for prudent maneuvers exist at nine points in the river channel.

3) Obstacles to navigation

Several fish stakes, which further reduce the already narrow passage, are found in the midstream close to the fairway.

4) Present situation of vessel traffic within the port area

According to a vessel traffic survey off the west quay conducted by the study team, 214 vessels passed the gate line in 24 hours, furthermore, 1,518 small crafts in motion were observed on the survey day. From the above, it can be concluded that Bangkok Port is seriously congested.

1.6.3 Cargo Volume Handled in the Port

About 19.5 million tones of imports in 1991 (an average growth rate of 12.6% between 1981 and 1991) and about 22.4 million tons of exports in 1990 (an average growth rate of 5.5 per cent between 1981 and 1990) were handled within the limits of Bangkok Port. In 1991, 54.0% of the total imports were handled at PAT's facilities containing Klong Toei Wharf and dolphins and buoys in the Chao Praya River. As to exports, in 1990, 26.7% of the total were handled at Klong Toei Wharf.

At Klong Toei Wharf, the most significant increase in the above traffic has been in the handling of containers. In 1981 the volumes of imports and exports of containers were about one million tons each, and by 1991, the volumes of imports and exports had increased to 4.4 million tons (an average increase rate of 14.8%) and 7.2 million tons (an increase rate of 21.8%) respectively. The total container volume handled in 1992 is 1.3 million in terms of TEU.

On the other hand, the volume of general cargo imported through Klong Toei Wharf in 1991 is about 3.8 million tons showing an average increase rate of 3.5% between 1981 and 1991 showing a moderate increase compared with that of containers.

1.6.4 Calling Vessels

(1) Vessels Calling at the East Quay

The records of 714 container vessels which called at the east quay from October, 1991 to March, 1992 were analyzed in terms of container-handling productivity at the dockside, berthing time per vessel, the number of containers discharged/loaded per vessel, principal dimensions of container vessels and berth occupancy ratios.

Furthermore, the total number of containers transported during the period was broken down by shipping route.

The averages of gross container-handling productivity, berthing time and the number

of containers discharged/loaded in the six months are 18 boxes/hr, 33 hours/vessel and 805 TEUs/vessel, respectively.

As to principal dimensions of container vessels which called at the east quay, reflecting the maximum permissible length of 565 ft. (172.2 meters) and draft of 27 ft. (8.2 meters) within the limits of Bangkok Port, the maximum length (L.O.A.) and draft of container vessels which actually called at the east quay in the record period does not exceed 555 ft. (169.2 meters) and 26 ft. (7.9 meters), respectively.

The average berth occupancy ratio at the east quay in the record period is 75%.

As to the number of containers transported in the record period by shipping route, the Singapore route takes the largest percentage of 62.5%, followed by the Japan route (18.8%) and Hong Kong route (16.9%). The portion of the other routes is negligibly small.

(2) Vessels Calling at the West Quay

The records of 445 vessels from/onto which cargoes were discharged/loaded at the west quay during the same period mentioned above were also analyzed. Out of the 445 vessels, 385 vessels are conventional vessels and the remaining 60 vessels are container vessels with ship cranes for container handling. Some of the conventional vessels, which called at the west quay in the record period, transported a small number of containers together with break-bulk cargoes.

Non-containerized general cargoes with various package conditions such as bagged and palletized are discharged from or loaded onto conventional vessels using their ship cranes/derrick cranes at the west quay. Bulky and heavy cargoes such as steel products and vehicles are also handled at the west quay. Almost all conventional cargoes are imports, and exports are few, except for a small number of exported containers transported on decks of the conventional vessels.

As to conventional vessels, the averages of gross cargo-handling productivity, berthing time and the volume of discharged/loaded cargoes in the record period are 51 tons/hr, 3.5 days/vessel and 4,230 tons/vessel, respectively.

On the other hand, as to container vessels which called at the west quay equipped with ship cranes in the same record period, the averages of gross container-handling productivity, berthing time and the number of containers discharged/loaded are 12 boxes/hr, 39 hours/vessel and 660 TEUs/vessel, respectively.

The average berth occupancy ratio at the west quay in the record period is 78%.

As to the volume of cargoes transported by conventional vessels in the same record period by shipping route, the Japan route takes the largest percentage of 53.3%, followed by the China route (17.0%), the Singapore route (6.9%), Hong Kong route (6.5%), the Europe route (4.1%) and the Korea route (3.3%). The portion of the other routes is negligibly small.

1.6.5 Port Facilities

(1) Mooring Facilities

In Bangkok Port, there are 5 mooring facilities, i.e., West quay, East quay, Klong Toei Dolphin, Bang Hua Sua Dolphin and Sathu Pradit buoy. The dimensions and constructed year of each mooring facility are summarized as shown in table below.

Mooring Facilities of Bangkok Port

Facilities	Total Length or No. of Dolphins	Number of Berths	Depht from M S L	Constructed Year
1. West Quay				
Main quay	1,660m	10	-11.5m	1951
Boat Harbor quay	130m	-	-3.5m	1951
2. East Quay				
Main quay	1,228m	8	-11.5m	1979
Lighter quay	300m	-	-6.0m	1979
3. Klong Toei Dolphin	36 (1.377m)	7	-11.5m	1968
4. Bang Hua Sua Dolphin	25 (1.535m)	8	-9.5m	1984
5. Sathu Pradit Buoy	5 (1.555m)	5	-9.0m	1972

Note: MSL-LLW=1.72m

(2) Cargo Sorting and Storage Facilities

The cargo sorting and storage facilities of Bangkok Port are summarized as shown in the table below. The figures indicated in this table include the space for offices and passages, so therefore, the effective storage space will be 60% to 80% of these figures.

Cargo Sorting / Storage Facilities

Facilities	West Quay	East Quay	Outside of Fence	Total
1. Transit Shed	99,060m ²	18,000m ²	0m ²	117,060m ²
2. Warehouse	34,830m ²	5,150m ²	9,000m ²	48,980m ²
3. Container Yard	178,200m ²	124,000m ²	35,700m ²	337,900m ²
4. Open Storage	176,860m ²	40,590m ²	42,080m ²	259,530m ²

(3) Operation supporting Facilities and Port Office Buildings

The operation supporting facilities, such as repair shops, parking lots, gas stations, stores for maintenance material, pump houses, substations, canteens, etc. and the port office buildings, such as PAT's operation building, Bangkok Port operation building, Comptroller's department, Law division, Container division, Computer center, etc. occupy the space as shown below.

Operation Supporting Facilities and Port Office Buildings

Facilities	West Quay	East Quay	Outside of Fence	Total
1. Operation Support. F'ties	38,000m ²	12,500m ²	50,000m ²	100,500m ²
2. Port Office Buildings	19,000m ²	2,800m ²	11,500m ²	33,300m ²

(4) Utilities

The water supply system for Bangkok Port consists of the water supply from the municipal water supply system and the water supply from its own well water supply system. The water supply taps for ships are installed on the apron of west quay and east quay. The average water consumption of the port is approximately 80,000 m³/month.

The electricity for the port is received from the Metropolitan Electricity Authority (MEA). The present electricity receiving capacity is 800A at 12,000V and at the end of 1994 another 481A at 12,000V will be available. This electricity supply system is supported by an emergency supply system which consists of 4 diesel engine generators of 2,875KVA in total.