社会開発協力部報告書

FEASIBILITY STUDY REPORT
FOR
THE ESTABLISHMENT OF A LARGE REPAIR SHIPYARD
IN
THE KINGDOM OF THAILAND

May, 1985

Japan International Cooperation Agency

PREFACE

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to conduct the Feasibility Study for the Establishment of a Large Repair Shipyard and entrusted the study to the Japan International Cooperation Agency (JICA).

The JICA sent to the Thailand a study team headed by Mr. Masayasu TAKEBAYASHI, Instructor, Overseas Shipbuilding Cooperation Centre, in August 1984, under the guidance of the advisory committee chaired by Mr. Junichi MATSUMURA, Deputy Director of the Ship Building Division, Maritime Technology and Safety Bureau, Ministry of Transport.

The team held discussions with the authorities concerned of the Government of the Thailand on the project and conducted the field survey in the country.

After the team returned to Japan, further studies were made and the present report has been prepared.

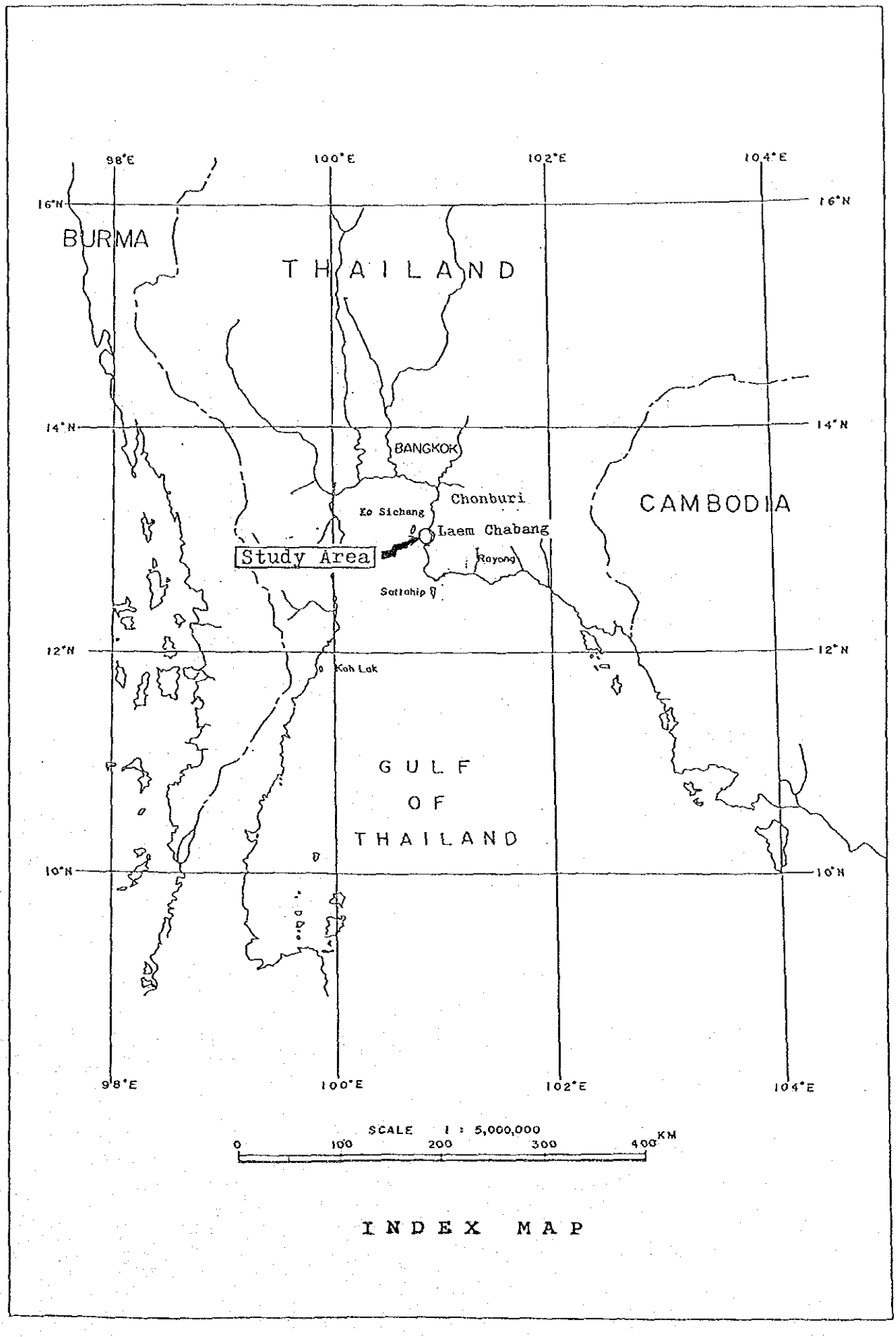
I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the authorities concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

May 1985

Keisuke Arita

Keisuke ARITA
President
Japan International Cooperation Agency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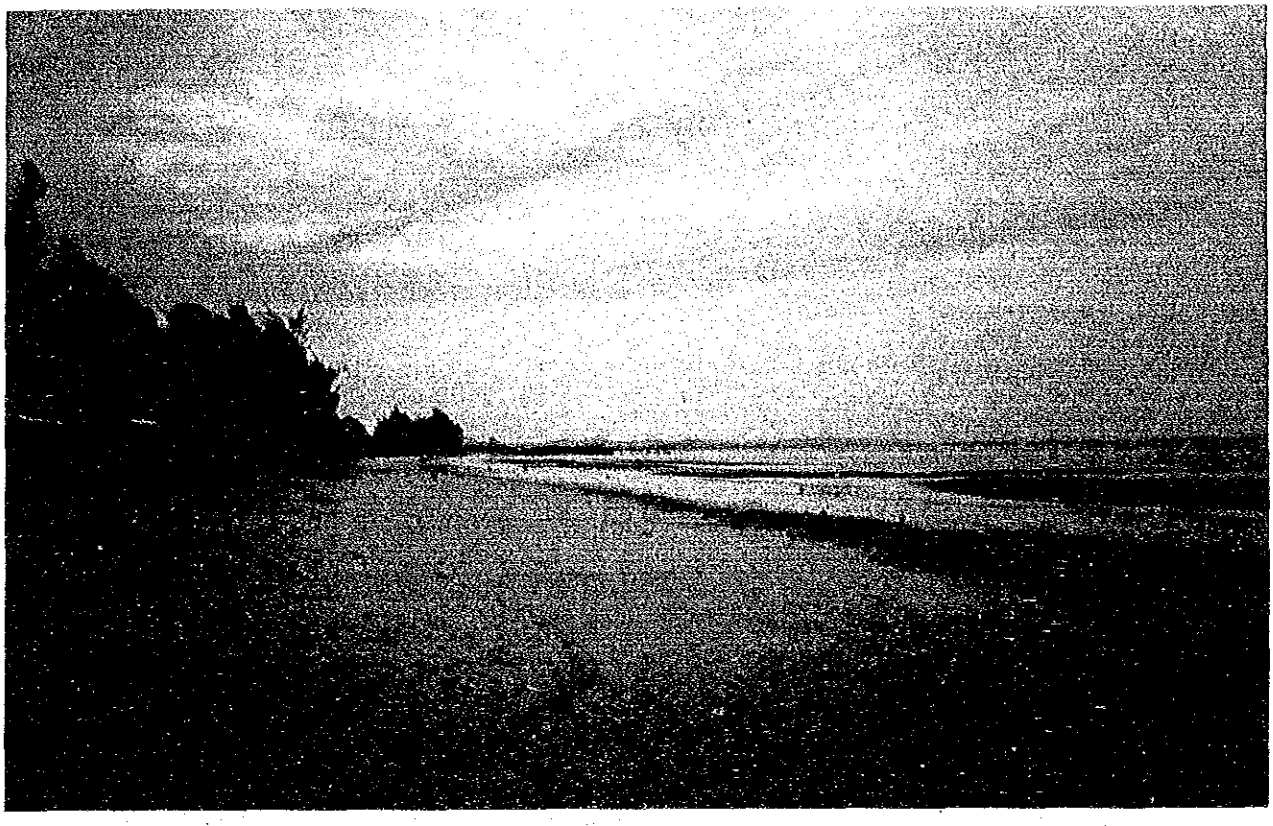
INDEX MAP



Laem Chabang

ABBREVIATIONS USED IN THE REPORT

ABS	American Bureau of Shipping
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
BM	Bench Mark
BDC	Bangkok Dock (1957) Co., Ltd.
BOI	Office of the Board of Investment
BOT	Bank of Thailand
BV	Bureau Veritas
CDL	Chart Datum Level
CIPO	Center for Integrated Plan of Operation
DTEC	Department of Technical Economic Cooperation
DOL	Department of Labour
DVE	Department of Vocational Education
DWT	Dead Weight Tonnage
F/S	Feasibility Study
GDP	Gross Domestic Product
GT	Gross Tonnage
HD	Harbour Department
IBRD	International Bank for Re-construction and Development (World Bank)
IEAT	Industrial Estate Authority of Thailand
JICA	Japan International Cooperation Agency
LRS	Lloyd's Register of Shipping
MMPC	Office of the Mercantile Marine Promotion Commission
MMTC	Merchant Marine Training Centre
MOCM	Ministry of Commerce
MOC	Ministry of Communications
MOE	Ministry of Education
MOF	Ministry of Finance
NESDB	National Economic and Social Development Board
NEDECO	Netherlands Engineering Consultants
NK	Nippon Kaiji Kyokai
PAT	Port Authority of Thailand
PTT	Petroleum Authority of Thailand
RTG	Royal Thai Government
RTN	Royal Thai Navy
DPLC	Development Project of Laem Chabang Coastal Area

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1. Summary and Conclusion

1-1 Summary

At present, Thailand's Shiprepairing industry has not been well developed to satisfy the growing demand of national merchant marine business.

In this connection, it is an urgent need to construct a new large repair shipyard to deal with such work for the purpose of meeting the growing national demand.

This report concerns the Feasibility Study of the establishment of repair shipyard capable of accommodating up to 20,000 DWT vessels.

Fundamental principles of the plan of approach to get appropriate conclusion of this Study is illustrated in the Flow Chart shown in Fig. 1-1-1.

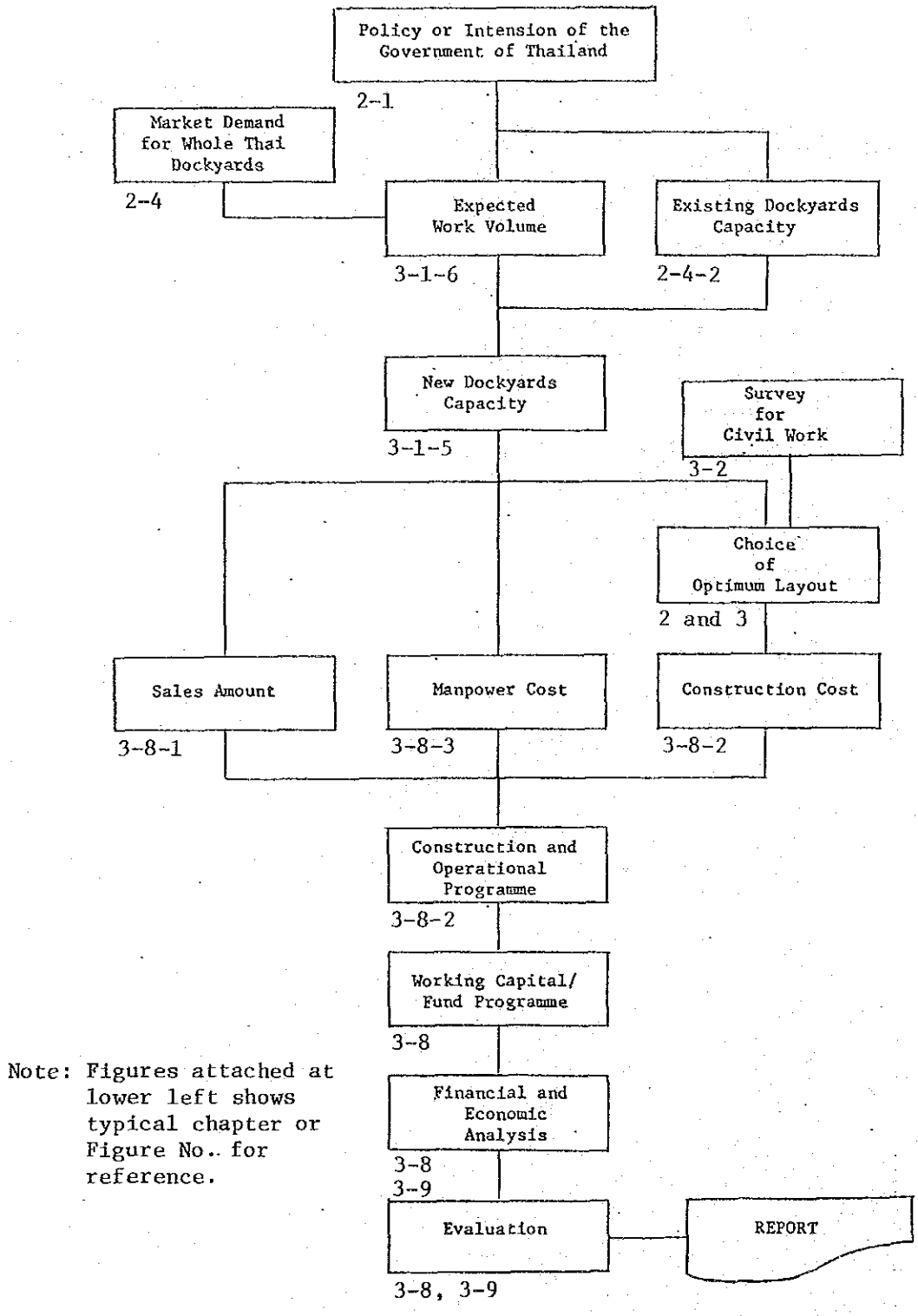
1-1-1 Shiprepairing Market and Demand Forecast

(1) Thai Flag Vessels

At present, total number and deadweight tonnage of Thai flag ocean going vessel are 45 units and 345,034 DWT (all vessels occupying 5,000 - 20,000 DWT size).

They are now engaged in carrying around 10% of all trade cargoes and the rest being carried by foreign flag vessels.

In the year 2000, these figures are estimated as 104 units and 1,055,372 DWT taking into account of national growth rate of Thailand's GDP, total trade volume, national merchant fleet tonnage and the total number of vessels.



Note: Figures attached at lower left shows typical chapter or Figure No.. for reference.

Fig. 1-1-1 Flow Chart of the Project

(2) Foreign Flag Vessels

As regards foreign flag vessels calling at Bangkok Port, there were 3,212 calls, that is, approximately 500 ocean going vessels visited Bangkok in 1982, and this number is assumed to increase year after year.

Judging from this and viewed from the topographical advantages of the new shipyard to be located near the Bangkok Port, it is considered that foreign flag vessels may more and more prefer docking at the new dock as the technical levels gradually improved and docking charges consequently reduced.

Table 1-1-1 Estimated Docking Demand for Repair of Thai Flag Vessels

Year	Fleet		Docking Demand for Repair	
	Vessels	Average DWT	Vessels	Aggregate DWT
1990	61	8,600	31	267,000
1991	65	8,746	32	280,000
1992	68	8,895	34	302,000
1993	72	9,046	36	326,000
1994	76	9,200	38	350,000
1995	80	9,357	40	374,000
1996	84	9,516	42	399,000
1997	89	9,677	45	435,000
1998	93	9,842	47	463,000
1999	98	10,009	49	490,000
2000	104	10,179	52	529,000

Relationship of docking demand for shiprepairing and capacity of repair shipyard are shown in Fig. 1-1-2 & Fig. 1-1-3 respectively.

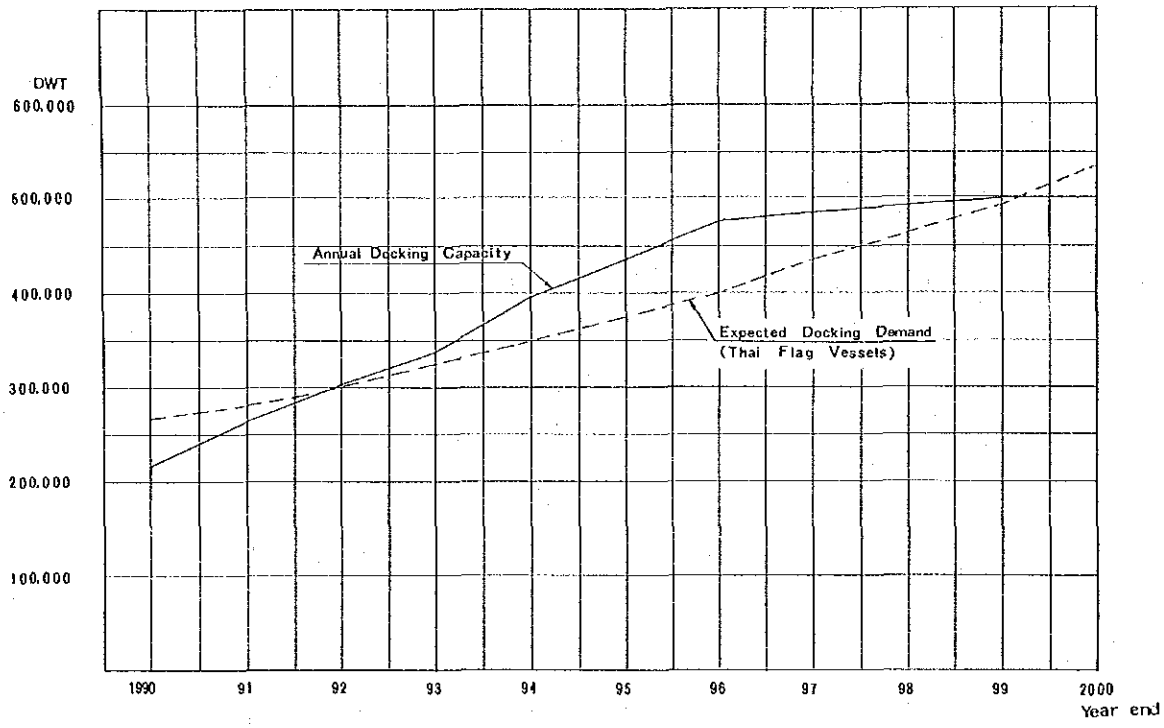


Fig. 1-1-2 Estimated Shiprepair Demand and Capacity in Terms of Tonnage

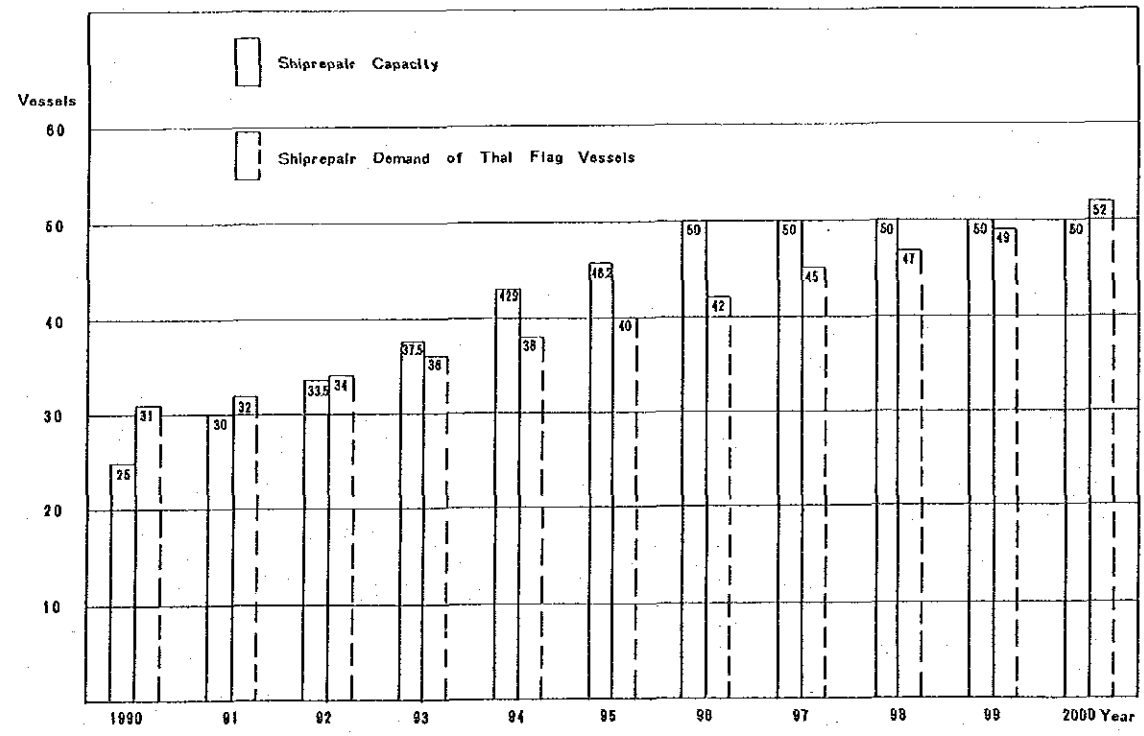


Fig. 1-1-3 Estimated Shiprepair Demand and Capacity in Terms of Number of Vessels

1-1-2 Natural Conditions

The natural conditions at the proposed site are considered favorable to the repair shipyard, because of the fact that subsoil conditions being comparatively solid and the waves being moderately calm.

Besides, the tidal currents are not so swift i.e. maximum velocity being 0.53 m/sec and the strong winds are rather rare and the occurence of earthquakes also quite seldom.

1-1-3 Outline of the Project Site

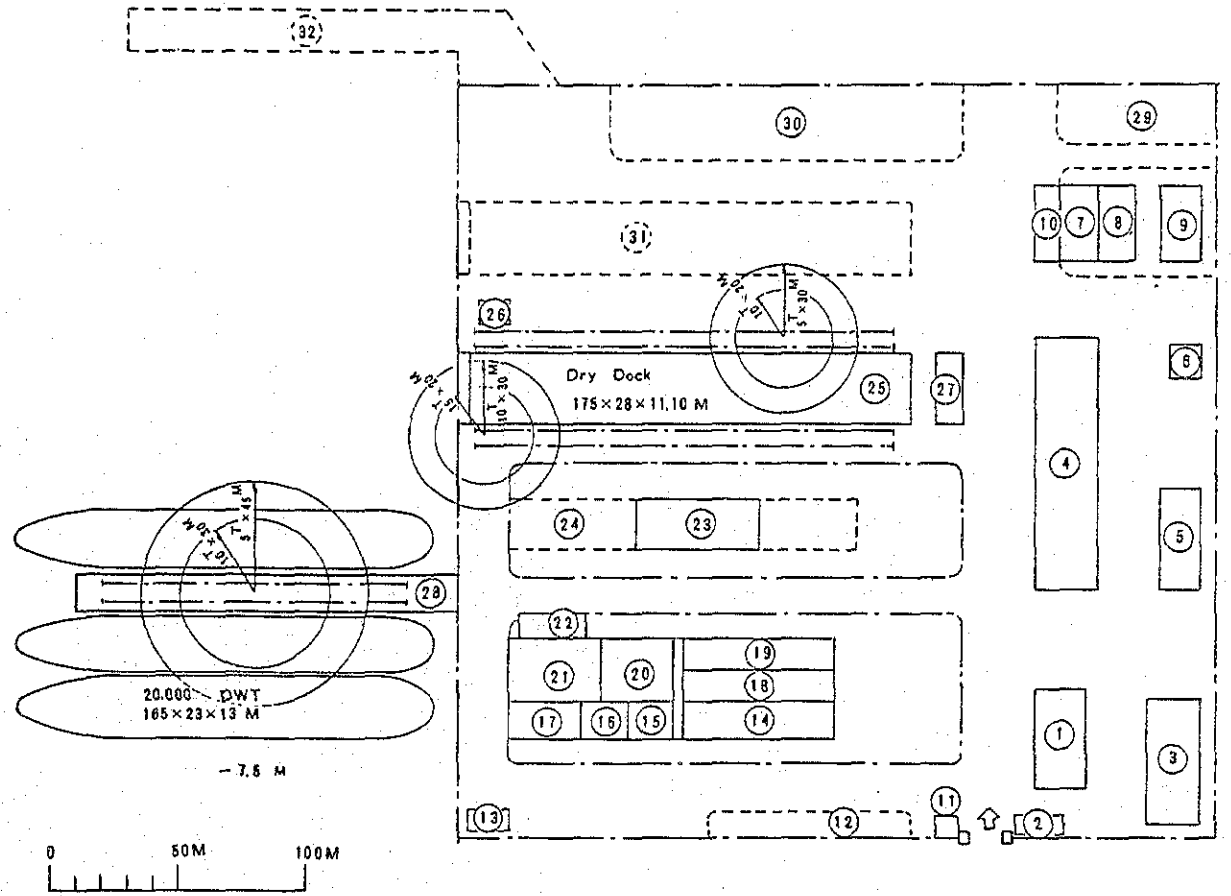
The proposed construction site for the repair shipyard is located on the newly reclaimed land about 200m off the shoreline of Laem Chabang area.

On this area, the implementation of the Deep Sea Port Project and the Hinterland Industrial Estate Development Project are going on. This repair shipyard is going to be constructed as a part of Deep Sea Port Project. According to the results of natural condition survey such as meteorology oceanography and subsoil conditions, the project area is suitable for a repair shipyard.

1-1-4 Envisaged Facilities and Equipment

The envisaged facilities and equipment are as set forth below.

1)	Site area	300m x 300m = 90,000m^2
2)	Dock size	175m x 28m x 11.1m (Length, Breadth, Depth)
3)	Type	Graving dock
4)	Mooring quay	Jetty 150m length
5)	Repair shipyard layout	Refer to Fig. 1-1-4



①	Administration Building
②	Garage
③	Dock House
④	Staff, Workers' House, Canteen & Dispensary
⑤	Traning Center
⑥	Water Reserve Tank
⑦	Electric Substation
⑧	Air Compressor Room
⑨	Oxygen & Acetylene Plant
⑩	Tank Shed
⑪	Guard House
⑫	Motor Pool
⑬	Sewage Treatment Tank
⑭	Warehouse
⑮	Tool Service Shop
⑯	Sail Loft & Rigging Shop
⑰	Carpenter Shop
⑱	Hull Outfitting Shop
⑲	Pipe Shop
⑳	Finishing & Electric Shop
㉑	Machinery Shop
㉒	Mooring Tool Store
㉓	Hull Fabrication Shop
㉔	Steel Storage Yard
㉕	Dry Dock
㉖	Pump Room of Dock
㉗	Paint Shop
㉘	Jetty
㉙	Incinerator
㉚	Scrap Yard
㉛	Future Dry Dock
㉜	Future Jetty

Fig. 1-1-4 Layout of Repair Shipyard

1-1-5 Plan for Repair Shipyard Construction

(1) Time Schedule

- Start of preparation for construction — January, 1986
- Start of construction work — September, 1987
- Start of operation — January, 1990
- Completion of construction work — March, 1990

(2) Estimated Shiprepair Demand and Capacity

The estimated progress in the coming years of the annual repair demand and capacity is as presented in Table 1-1-1. The annual docking capacity would be 267,000 DWT in 1990, to rise up to 490,000 DWT in 1999 through the improvement of productivity. When surplus capacity could be found the dock could well be intended to repair foreign ships.

(3) Project Cost

The estimated costs for implementing yard construction are given in Table 1-1-2, which represents the amounts evaluated at the price level of 1984.

Table 1-1-2 Construction Investment

Unit: 1,000 Baht

No.	Description	Total	Foreign currency portion	Domestic currency portion
1	Civil engineering work (Incl. the land cost 128,955/90,000 m^2)	455,377	192,683	262,694
2	Buildings	130,437	31,600	98,837
	Sub total (1) and (2)	585,814	224,283	361,531
3	Dock-related equipment	42,887	33,868	9,019
4	Jetty-related equipment	7,477	6,037	1,440
5	Cranes	88,032	84,613	3,419
6	Utilities equipment and pipe lines	20,424	14,132	6,292
7	Electric equipment	27,647	24,989	2,658
8	Vehicles and oil barges	8,123	6,149	1,974
9	Factory machines	125,909	111,151	14,758
10	Anti-pollution equipment	22,038	19,380	2,658
11	Telephone and others	3,521	2,913	608
12	Furniture for offices and so on	4,272	0	4,272
	Sub total (3) to (12)	350,330	303,232	47,098
	Sub total (1) to (12)	936,144	527,515	408,629
13	Engineering fee	60,066	52,425	7,641
14	Education and training	22,793	22,793	0
15	Contingency	44,475	44,475	0
	Grand Total (1) to (15)	1,063,478	647,208	416,270

Note: Employed exchange rate; See page 147.

1-1-6 Production Plan

The production plan envisaged for the years from the start of operation in 1990 to 2000 is as presented in Table 1-1-3, which is based on the estimated demand for the repair of Thai and foreign vessels. The estimates for steel structures and for running repairs have been drawn up envisaging gradual expansion of operations from the start of yard operation under the consideration of actual experiences in many repair shipyards in the world together with the Thailand's current national economic development policies.

This production plan will call for the employment of around 370 engineers & workers at the start of operation, and will gradually increased in keeping with the rising production.

Table 1-1-3 Annual Production Plan

Item / Year	Repair Ships Docked (DWT)	Steel Structures Manufactured (tons)	Running Repairs (Percentage of dock repairs in amount)
1990	215,000	500	5
1991	264,000	500	"
1992	298,150	550	"
1993	324,000	600	"
1994	349,600	650	"
1995	376,000	700	"
1996	475,000	700	"
1997	485,000	850	"
1998	490,000	900	"
1999	500,000	1,000	"
2000	500,000	1,000	"

Note: Ratio of Repair vessels DWT and Weight of Steel work in kg tons are taken from the lowest level in similar yard's in Japan

1-2 Conclusion

In order to confirm the viability of this Study, following two different cases serving the same purposes of shiprepair industry were carried out as the alternatives in addition to the sensitivity study of the Financial/Economic analysis for the original plan.

Alternative 1 Starting with 20,000 DWT Floating Dock instead of Graving type

Alternative 2 Starting with 10,000 DWT Graving Dock which can be expanded up to 20,000 DWT in future.

Merit and demerit of above two cases were studied and as a result, we are in the opinion that these two alternatives are rather inferior to the original plan in terms of technical as well as invested capital efficiency evaluation and cannot be recommended.

As to environmental aspects of this repair shipyard, studies were conducted on the prevention of air and water pollution, excess noise generation, and on the proper handling of waste matter disposal etc., and found that these are kept within the allowable limit.

The Financial Internal Rate of Return proves to be:

1) 3.4% for the case where the sales revenue excludes receipts from running repairs and steel structure fabrication and assembly.

2) 5.8% for the case where it includes these receipts.

The Economic Internal Rate of Return corresponding to the latter case is 11.4%, which leads to the conclusion that:

1) A purely financial evaluation may not be apposite to the present instance.

2) Viewed from a wider angle of expected economic and social benefits to the country as a whole, the envisaged Project is considered worth implementing with careful consideration of fund arrangement for the execution of this project.

The economic and social benefits to be expected are:

1) Increasing employment opportunities

2) Savings in outflow of foreign currency: increased inflow of the same

3) Raised level of technological capability

4) Greater convenience of shipowners

5) Subsequential or secondary beneficial repercussions on related industries

Since the project is considered eligible to be financed by the international development financing organization; this project is well worthy to be implemented as stated above for the sake of future development of Thailand's social and economic well-being as well as securing the national identities in a far more stable condition.

2. Background of the Project

2-1 History of the Feasibility Study

The necessity of establishing an appropriate repair shipyard was first adopted in the form of recommendation of the report entitled "Basic Study Report on Development of Shipbuilding and Repairing Industry in Thailand". The report was issued by the Japanese experts in July, 1980 in response to the request of the Government of the Kingdom of Thailand.

The Government of the Kingdom of Thailand has been carrying out the Fifth Five Year Plan (1982 - 1986) which has promoted and encouraged investment for the establishment of repair shipyard for 20,000 DWT ships.

In view of this national policy, the Government of the Kingdom of Thailand requested the Government of Japan to make a feasibility study to find viability of the project which envisioned the over-all scheme on the repair shipyard.

In response to this request, the Government of Japan entrusted JICA to undertake the study and, as a start, despatched a Preliminary Study Team to Thailand in order to make completely clear the scope of work with reference to services to be rendered by the feasibility study team. This was carried out, in October/November, 1982, by means of discussions with BOI, executing agency for this project.

In compliance with the Agreement concluded on November 4th, 1982, by the two parties, JICA sent a Feasibility Study Team to Thailand, in August 1984, to execute market and demand analyses, technical analyses, financial analyses, economic analyses, and a project implementation plan. The technical analysis was included a soil study and survey at Laem Chabng, the proposed project site situated half way down the eastern Gulf coast, approximately 10 kms north of the city of Pattaya. The site survey took a total of three months, finishing in October in 1984.

The feasibility study team continued its work and submitted the progress report to BOI in October, 1984 in which the team explained the progress of numerous works dealt with by the team.

The team succeeded to compiling the draft final report onward paying much attention to the comments from BOI in respect to the Progress Report during the period of December, January, and February in 1984.

The following shows all the parties joined in this study at either end and goes into background of the project commencing with Economic Situation of Thailand.

Members of the Teams

Advisory Committee Members

Name	Assignment	Title
Junichi Matsumura	Chairman	Deputy Director Shipbuilding Division Maritime Technology and Safety Bureau Ministry of Transport
Masao Wada	Demand Forecast	Deputy Director International Cooperation Division International Transport and Tourism Bureau Ministry of Transport
Masahiro Kubo	Ship repairing	Deputy Director Ship Machinery Industries Division Maritime Technology and Safety Bureau Ministry of Transport
Kooichiro Yoshikai	Dockyard planning	Chief International Affairs Section Shipbuilding Division Maritime Technology and Safety Bureau Ministry of Transport
Norio Fukushiro	Coordination	1st Development Survey Division Social Development Cooperation Department JICA

Study Team Members

Name	Assignment	Title
Masayasu Takebayashi	Overall Team Management	Team Leader: Naval Architect
Kenichi Nakao	Operation Planning	Sub Leader: Operation Planner
Shigeo Ogura	Demand Forecast	Shipping Expert
Masahiko Noma	Dockyard Construction Planning	Naval Architect
Yasuo Okayama	Economic & Financial Analysis	Economist
Takeyasu Kikuta	Survey & Tide	Geophysicist
Katsutoshi Suzuki	Soil Investigation & Civil Work	Soil Engineer

Board of Investment Members

Name	Title
Mr. Staporn Kavitanon	Deputy Secretary General
Mrs. Prani Yasasindhu	Director Planning Division
Mrs. Sirinthorn Paosila	Assistant Director Planning Division
Mr. Thalerngsok Snitwongse	Staff Member Planning Division
Mr. Veerasak Jittavereyapong	Staff Member Planning Division

2-2 Economic Situation of Thailand

2-2-1 General Trends

Thailand had long been a country based on agriculture of mainly rice. But, after 1961 it formulated five-year plans successively for the development of the national economy and social conditions and has carried out the economic and social development measures in the plans. Under the plans, various efforts have been worked out to emerge from the old "rice" dependent agriculture to multiple agriculture on one hand and to accelerate industrialization on the other. In 1970's, these plans proved successful, the proportion of agricultural products in GDP decreasing and that of industrial products increasing. The proportions of the respective items of GDP by industry are as shown in Table 2-2-1.

Although the proportion of the industrial production has increased, the economic structure is still occupying proportion of the agricultural products which marked the greatest share of more than 20% in 1983. The agricultural yield depends greatly on the weather conditions, while the prices of the primary products such as agriculture are subject to change greatly by the international market. These conditions were favorable and Thailand was able to manage the first oil crisis in 1970's due to steady increase in exports of primary products which were in great demand at that time.

Table 2-2-1 Gross Domestic Product at Current Prices

	1961		1970		1979		1980		1981		1982		1983*	
	Millions of Baht	As % of GDP	Millions of Baht	As % of GDP	Millions of Baht	As % of GDP	Millions of Baht	As % of GDP	Millions of Baht	As % of GDP	Millions of Baht	As % of GDP	Millions of Baht	As % of GDP
Agriculture	23,111	39.2	38,493	28.3	147,076	26.4	173,806	25.4	187,886	23.9	188,742	22.3	202,797	21.8
Crops	17,160	29.1	26,776	19.7	107,980	19.4	130,372	19.0	138,886	17.7	139,852	16.5	148,982	16.0
Livestock	3,001	5.1	4,843	3.4	16,954	3.1	21,717	3.2	24,727	3.1	23,608	2.8	27,922	3.0
Fisheries	1,039	1.8	4,074	3.0	13,017	2.3	11,984	1.8	13,183	1.7	14,150	1.7	14,998	1.6
Forestry	1,911	3.2	2,800	2.1	9,125	1.6	9,733	1.4	11,090	1.4	11,132	1.3	10,895	1.2
Mining and quarrying	682	1.2	2,759	2.0	12,614	2.3	14,493	2.1	13,373	1.7	14,807	1.7	16,303	1.8
Manufacturing	7,727	13.1	21,814	16.0	109,740	19.7	134,515	19.7	158,272	20.1	164,659	19.5	172,532	18.6
Construction	2,680	4.5	8,261	6.1	29,240	5.3	39,865	5.8	42,008	5.3	43,040	5.1	46,880	5.0
Electricity and water supply	304	0.5	1,625	1.2	6,075	1.1	6,284	0.9	10,743	1.4	14,454	1.7	16,390	1.8
Transportation and communication	4,258	7.2	8,588	6.3	37,844	6.8	45,261	6.6	57,281	7.3	63,133	7.5	73,043	7.9
Wholesale and retail trade	9,079	15.4	25,903	19.0	102,853	18.5	128,731	18.8	150,293	19.1	159,849	18.9	176,577	19.0
Banking insurance and real estate	1,245	2.1	5,626	4.1	31,396	5.6	41,891	6.1	52,025	6.6	61,021	7.2	71,991	7.8
Ownership of dwellings	1,615	2.7	2,934	2.2	6,297	1.1	7,378	1.1	8,411	1.1	9,912	1.2	11,138	1.2
Public administration and defence	2,649	4.5	6,146	4.5	21,623	3.9	28,263	4.1	30,645	3.9	37,349	4.4	42,261	4.5
Services	5,620	9.5	13,911	10.2	51,482	9.3	64,443	9.4	75,229	9.6	89,170	10.5	98,636	10.6
Gross Domestic Product (GDP)	58,970	100.0	136,060	100.0	556,240	100.0	684,930	100.0	786,166	100.0	846,136	100.0	928,548	100.0

Source: National Accounts Division, NESDB
* : Estimated

However, from the late 1970's to 1980's, the changes in the world economy, including the rise in energy price, international finance crisis, high inflation rate and low economic growth, had greatly affected the Thai economy. Moreover, the domestic agricultural products had decreased due to drought and reduced the total value of export. These resulted in aggravation of the trade balance as well as in a rapid raise of inflation in Thailand. Table 2-2-2 shows various types of growth rate of 1970 and after 1979.

Table 2-2-2 Growth Rates

ITEM	1970	1979	1980	1981	1982	P 1983
POPULATION	3.0	2.0	1.8	1.9	2.0	1.4
LABOUR FORCE	...	0.4	3.5	4.4	2.5	3.0
Employed	...	0.3	3.4	4.5	1.8	2.8
Agriculture	...	-0.03	2.1	6.6	1.2	2.3
Manufacturing	...	17.7	4.0	-6.2	5.9	7.0
Unemployed	...	7.3	11.2	-4.7	66.7	11.8
GDP, 1972 price	6.5	6.1	5.8	6.3	4.1	6.0
GROSS DOMESTIC SAVING	2.3	14.0	19.5	-1.5	1.7	2.8
GROSS DOMESTIC INVESTMENT	5.1	26.3	16.2	4.4	-8.6	26.9
INDEX OF PRODUCTION						
Agriculture	...	-2.8	5.9	7.6	0.8	2.9
Industry	...	11.0	4.8	7.9	4.4	7.2
EXPORTS	0.4	30.2	23.1	14.9	4.4	-8.3
IMPORTS	4.0	34.2	29.1	14.9	-9.3	20.8
WHOLE SALE PRICE INDEX	...	11.2	20.1	9.6	0.9	2.0
CONSUMER PRICE INDEX	-0.1	9.9	19.7	12.7	5.2	3.8
MONEY SUPPLY	...	16.2	12.5	2.6	6.8	4.4
EXTERNAL PUBLIC DEBT						
OUTSTANDING (Disburse only)	8.3	51.7	45.7	28.5	18.6	14.0

Source: Bank of Thailand

P: Preliminary

As seen from the Table 2-2-2, the wholesale and consumer price indexes once recorded high increase rate of 20.1 and 19.7 percent respectively in 1980 are calming down, and the world's economy which is now in an upward trend from the bottom brings the brighter prospects for the economy of Thailand.

The Gross Domestic Product at 1972 prices from First Five Year Plan and annual growth rates are shown in Table 2-2-3.

Table 2-2-3 Gross Domestic Product at 1972 Prices

First Five Year Plan

Year	1961	1962	1963	1964	1965	1966
GDP (Million Baht)	73,856	79,838	86,544	92,256	99,544	111,688
Annual Growth Rate(%)		8.1	8.4	6.6	7.9	12.2

Second Five Year Plan

Year	1967	1968	1969	1970	1971
GDP (Million Baht)	120,389	130,598	140,941	150,092	157,088
Annual Growth Rate(%)	7.8	8.5	7.9	6.5	4.7

Third Five Year Plan

Year	1972	1973	1974	1975	1976
GDP (Million Baht)	164,626	180,146	189,950	203,514	221,225
Annual Growth Rate(%)	4.8	9.4	5.4	7.1	8.7

Fourth Five Year Plan

Year	1977	1978	1979	1980	1981
GDP (Million Baht)	237,173	261,097	276,907	292,852	311,270
Annual Growth Rate(%)	7.2	10.1	6.1	5.8	6.3

Fifth Five Year Plan

Year	1982	1983^{E}	1984	1985	1986
GDP (Million Baht)	324,032	343,500			
Annual Growth Rate(%)	4.1	6.0			

Source: NESDB

E: Estimated

2-2-2 National Economic and Social Development Plans

Since 1961 when the First Five Year Plan started, four Five Year Plans were already carried out and the Fifth Five Year Plan is in operation at present.

The Thai economy made a remarkable progress during the twenty-year period through the First - Fourth Five Year Plans. Namely, GDP, per capita income and exports increased by 14, 8, and 16 folds respectively, during this period.

Even after such remarkable progresses, however, many problems such as urban congestion and uneven distribution of per capita income among urban and rural have come to be observed.

Furthermore, the changes in the world economy at present, are not always favorable to Thai economy.

To cope with such difficulties, a new guideline is shown in the Fifth Five Year Plan. Namely the national social stability and the economic justice are indispensable rather than mere economic growth. Thus, the following six targets are emphasized in the Fifth Five Year Plan.

1) Adjustment of the economic structure rather than the economic growth.
2) Equality in the national economic and social development effort.
3) Poverty alleviation for people in backward rural areas.
4) More closer coordination between the economic and social development efforts, and the national security management.
5) Implementation of the plan into operational plans.
6) Role and cooperation of the private sector.

2-2-3 Trade

(1) Outline of Trade

The foreign trade of Thailand has been in the form of exporting primary products such as rice, tapioca, rubber, maize and sugar and importing petroleum and petroleum products, consumption goods and industrial materials including base metal and chemicals. Both export and import are expanding, but the trade balance continues to be red, and the red amount is increasing year after year. And in 1983, the sum of the trade deficit was the greatest in the past. Change of Trade is shown in Table 2-2-4.

Table 2-2-4 Change of Trade

Value : Million Baht
Volume: Thousand Metric Ton

Year	Total			Export		Import		Balance of Trade
	Value	Volume	Growth Rate (%)	Value	Volume	Value	Volume	
1978	191,364	30,448	-5.8	83,065	12,866	108,299	17,582	-25,234
1979	254,340	31,109	2.2	108,179	12,867	146,161	18,242	-37,982
1980	326,815	32,067	3.1	133,197	13,206	193,618	18,861	-60,421
1981	372,027	32,808	2.3	153,001	15,795	219,026	17,013	-66,025
1982	356,344	35,556	8.4	159,728	20,001	196,616	15,555	-36,888
1983*	369,128			146,239		222,889		-76,650

Source: Customs Department
* : Estimated

(2) Export

Tables 2-2-5 and 2-2-6 show the changes of principal export items and principal export partners. Although considerable changes have occurred since 1970, the proportional changes in these years are not large, as a whole, both in export items and export partners.

Table 2-2-5 Principal Export Items as % of Total Exports in Value

Item	1970	1979	1980	1981	1982	1983
Rice	17.0	14.4	14.6	17.2	14.1	13.8
Tapioca Products	8.3	9.1	11.2	10.7	12.4	10.5
Rubber	15.1	11.4	9.3	7.1	5.9	8.0
Tin Metal	11.0	8.6	8.5	5.9	4.9	3.6
Maize	13.3	5.2	5.5	5.5	5.2	5.8
Sugar	0.6	4.4	2.2	6.3	8.1	4.3

Source: Bank of Thailand

Table 2-2-6 Principal Export Partners as % of Total Exports in Value

	1970	1979	1980	1981	1982
Japan	25.5	21.2	15.1	14.2	13.7
Netherlands	8.6	11.3	13.2	12.2	13.2
U.S.A.	13.4	11.2	12.6	12.9	12.7
Singapore	6.9	8.5	7.7	7.8	7.3
Hongkong	7.5	4.9	5.1	4.8	5.0
Malaysia	5.6	4.4	4.5	4.5	5.2

Source: Customs Department

On the other hand, although the export had been steadily expanding, Table 2-2-7 shows that the annual growth rate had decreased by 8.3% in 1983. Particularly, decreases in exports of sugar, tin, tapioca products and rice are prominent. The depression in exports of these products seems to be attributable to the slow recovery of the world economy and the change of trade patterns.

Table 2-2-7 Export of Principal Commodities

Commodity	Value in 1982 (Millions of Baht)	Value in 1983 P (Millions of Baht)	Percentage change from 1981		
			Volume	Price	Value
1. Rice	22,510	20,142	-8.2	-2.6	-10.5
2. Rubber	9,490	11,787	1.9	21.8	24.2
3. Maize	8,330	8,486	-6.1	8.5	1.9
4. Tapioca products	19,752	15,387	-33.5	17.2	-22.1
5. Fresh prawns	2,764	3,164	-0.1	14.4	14.5
6. Tin	7,773	5,263	-38.8	-4.9	-32.3
7. Sugar	12,932	6,338	-30.3	-29.6	-51.0
8. Taxtile products	14,005	14,346	-	-	2.4
Total 8 items	97,556	84,913	-	-	-13.0
Other exports	62,172	61,524	-	-	-1.0
Total exports	159,728	146,437	-	-	-8.3

Source : Customs Department
P : Preliminary figures

(3) Import

Tables 2-2-8 and 2-2-9 show the changes ratio of principal import items and principal import partners.

Table 2-2-8 Principal Import Items as % of Total Imports in Value

Item	1970	1979	1980	1981	1982	1983[P]
Petroleum & Petroleum Products	8.6	22.3	31.1	30.0	30.9	24.1
Base Metals	9.1	11.0	8.6	8.7	8.7	9.0
Chemicals	7.3	10.2	7.9	8.3	8.2	8.8
Electric Appliances	2.4	1.7	1.6	1.7	2.1	2.4
Paper and Paper Board	1.9	1.3	1.1	1.3	1.3	1.3
Dairy Products	2.0	1.0	0.8	1.1	1.0	1.0

Source: Bank of Thailand
P : Preliminary

Table 2-2-9 Principal Import Partners as % of Total Imports in Value

	1970	1979	1980	1981	1982
Japan	37.4	25.7	21.2	24.0	23.4
U.S.A.	14.9	15.6	14.4	13.4	13.3
Saudi Arabia	2.0	6.4	10.1	6.8	15.2
Singapore	1.0	4.7	6.5	3.2	6.3
West Germany	8.5	5.4	4.4	13.4	3.9
United Kingdom	7.5	3.2	2.7	3.2	2.6

Source : Customs Department

Table 2-2-4 shows the total value of import had been continuously increased before 1982 and after showing some decrease this year again showed increase in 1983 by 20.3% compared with the previous year.

This is considered that the development of domestic industry and subsequent increase in consumption demand are stimulating each other into ever greater volume of import.

As to fuels and lubricants including crude oil and refined products, however, although their import sums had been continuously increasing due to the sharp rise in the price of crude oil, it should be noted that in 1983 the annual growth rate of their import had decreased by 6.1% due to the development of domestic natural gas project while the OPEC price was decreased by 14.7% in 1983.

The changes in imports in 1983 are shown in Table 2-2-10.

Table 2-2-10 Movements in Imports in 1983

(Millions of baht)

Categories	1982	1983P	Percentage Change
Fuels and Lubricants	60,765	57,064	-6.1
- Crude oil	45,053	39,975	-11.3
- Refined products	15,712	17,089	8.8
Imports other than Fuels and Lubricants	135,851	179,385	32.0
- Consunmer goods	22,783	29,860	31.1
- Raw materials and intermediate products	48,596	59,513	22.5
- Capital goods	47,778	69,249	44.9
- Other imports	16,694	20,763	24.4
Total imports	196,616	236,449	20.3

Source : Customs Department
P : Preliminary figures

2-3 Current Situation of Shipping

2-3-1 Shipping Activities

The Thai merchant fleet has a long history. In olden times junks were mainly used to trade with neighbouring countries in addition to domestic trade. It is generally said that shipping activities by large oceangoing vessels were started after the First World War.

According to the MMPC data, the number of ocean going vessels including tankers is 153 units representing total tonnage of 688,450 DWT at the beginning of 1984. And the cargo share of total trade by Thai flag vessels is estimated at less than 10%. That is, more than 90% of the total trade cargo of Thailand is transported by foreign flag vessels, which showed a significant minus factor in the international balance of payment.

On the other hand, all cargoes of domestic trade are handled only by Thai flag vessels.

Using a different comparison, according to Lloyd's list, the changes in total tonnage more than 100 GT of steel vessels of Thailand and worldwide record are shown in Table 2-3-1.

Table 2-3-1 Change of Fleet

Year	Thailand			World Total		
	No. of Vessel	DWT	GT	No. of Vessel	DWT	GT
1979	136	585,492	361,669	71,129	681,489,737	413,021,426
1980	153	577,271	391,456	73,832	690,854,983	419,910,651
1981	184	606,819	402,705	73,864	697,188,113	420,834,813
1982	197	649,704	441,949	75,151	701,979,762	424,741,682
1983	219	868,076	566,654	76,106	694,512,141	422,590,317

Source: Lloyd's Register of Shipping

It should be noted particularly that the total tonnage of Thailand is steadily increasing despite the worldwide record of decrease in 1983, the year of dull world shipping activities.

Based on the available data on vessels in GT, we classified the size of Thai flag vessels between 3,000 - 15,000 GT, as shown in Table 2-3-2, which are regarded as almost equivalent to 5,000 - 20,000 DWT.

Table 2-3-2 Change of Thai Flag Vessels between 3,000 GT and 15,000 GT

	1979	1980	1981	1982	1983
No.	28	39	39	37	38
Thai Flag Fleet (GT)	162,494	187,534	200,253	207,360	218,685
Growth Rate (%)		15.4	6.8	3.5	5.5
Average Size of Vessele (GT)	5803	4809	5135	5604	5755
Growth Rate of Average Size (%)		-17.1	6.8	9.1	2.7

Source : Harbour Department
MMPC

In the later part of this report, we estimate the future trend of Thai flag vessels, referring to the past trend. In that case, the growth rates of Thai flag fleet and average size in GT between 3,000 - 15,000 GT in the above table may be regarded as same as those of fleet and average size in DWT between 5,000 - 20,000 DWT.

2-3-2 Shipping Companies

Thailand has many merchant marine companies. There are as many as 43 companies which are engaged in ocean transportation, except those engaged only in the tanker service. The number of their vessels at the beginning of 1984 was 85 which corresponds to 432,951 DWT or 298,993 GT.

These include a state enterprise and a semi-governmental company. All of the others are private companies.

Five big shipping companies of Thailand are listed below.

1) Thai Maritime Navigation Co., Ltd.
   State enterprise.
   Possessed of 4 vessels corresponding to about 28,000 DWT.
   Thailand-Japan route. (Occasionally engaged in Thailand-U.S. transportation of government cargo)

2) United Thai Shipping Co., Ltd.
   Semi-governmental.
   Possessed of 5 vessels corresponding to about 66,000 DWT.
   Thailand-Europe route.

3) Jutha Maritime Co., Ltd.
   Private.
   Possessed of 3 vessels corresponding to about 32,000 DWT.
   Thailand-Japan route.

4) Thai Merchantile Marine Ltd.
   Private.
   Possessed of 3 vessels corresponding to about 30,000 DWT.
   Thailand-Japan route.

5) Thai International Maritime Enterprises Ltd.
   Private.
   Possessed of 2 vessels corresponding to about 19,000 DWT.
   Thailand-Japan route.

Among the five companies listed above, United Thai Shipping is the member of the Thai-Europe and Europe-Far Eastern Conference, and the other four companies are the member of the Thai-Japan and Japan-Thai Conferences.

As for other shipping companies dealing with general cargo, most of them are mainly engaged in the trade within ASEAN countries.

With respect to the operations of tankers, 24 companies are engaged in the transportation of petroleum and petroleum products including LPG with 68 vessels of 255,499 DWT.

Two 70,000 DWT tankers are included in this tanker fleet. Both tankers, however, are chartered by foreign shipping companies and are not engaged in the trade of Thailand.

Of these Thai flag vessles, vessels between 5,000 DWT and 20,000 DWT are listed in Table 2-3-3.

Table 2-3-3 Ocean-going Vessels Registered under Thai Flag
(As of Jan., 1984)

(1) Dry Cargo vessels (5,000-20,000 DWT)

No.	Name of Vessel	Built	DWT	Gross Tonnage	Route
1	Kannikar	1971	13,375	11,143	Bkk-Europe
2	Intanin	1971	13,300	11,143	" "
3	Jumpa	1970	13,300	11,208	" "
4	Terk	1962	13,056	9,328	
5	Benjamas	1967	12,806	9,863	Bkk-Europe
6	Anchan	1967	12,753	9,865	" "
7	Jutha Malee	1973	10,851	6,622	Bkk-Japan
8	Pipat Samut	1966	10,844	8,858	" "
9	Pichai Samut	1966	10,804	8,856	" "
10	Jutha Phansiri	1969	10,780	6,582	" "
11	Jutha Rajata	1959	10,686	8,871	" "
12	Maritime Optimum	1961	10,320	6,451	" "
13	Nakorn Thon	1964	8,580	6,533	" "
14	Maritime Explorer	1960	8,211	6,374	" "
15	Bangkok	1970	8,100	5,523	Bkk-Asean
16	Pichit Samut	1966	8,057	5,788	Bkk-Japan
17	Srirchai Bulakul	1962	7,658	6,113	Bkk-Hongkong
18	Kim Ann	1956	7,656	6,762	" "
19	Mah 2	1962	7,375	5,220	" "
20	Nagaraj	1965	7,230	5,222	Bkk-Asean
21	Siri Bhum	1981	6,996	4,374	Bkk-S'pore
22	Naganin	1965	6,235	3,416	China-Korea

No.	Name of Vessel	Built	DWT	Gross Tonnage	Route
23	Bangluang	1970	6,042	3,922	S'pore-Indo-India-Japan
24	Bangsrakao	1969	5,905	3,843	Bkk-Asean
25	Naga Bhum	1973	5,751	4,381	Bkk-S'pore
26	Nagateep	1976	5,692	2,997	China-Korea-Taiwan
27	Bangkhun Prom	1968	5,687	2,985	Taiwan-Japan
28	Yahar Alsiam	1961	5,682	3,675	Bkk-Indo-Korea
29	Bangkachai	1968	5,666	2,995	Bkk-Asean
30	Nakorn Thai	1965	5,655	3,635	Bkk-Japan
31	Sri Thep	1965	5,655	3,635	" "
32	Asean Rose	1962	5,620	3,546	Bkk-S'pore
33	Boonkrong 2	1963	5,420	4,974	Bkk-Hongkong
34	Surat Nava	1958	5,265	3,366	Bkk-Asean
35	Samut Prakarn	1958	5,241	3,428	
36	Banglumpoo	1966	5,223	2,912	Bkk-S'pore
37	Kasem Sakorn	1957	5,204	3,416	
38	Span	1967	5,135	2,997	Bkk-Malay-S'pore-Indo
39	Sang Thai Steel	1958	5,130	3,598	Bkk-Asean
40	Poonsri Marine	1969	5,125	2,999	" "
41	Simali	1951	5,080	2,742	Bkk-Hongkong
	Total 41 Vessels		323,151	230,161	

(2) Tanker Vessels (5,000-20,000 DWT)

No.	Name of Vessel	Built	DWT	Gross Tonnage	Route
1	Kasetsuwan	1965	5,567	3,503	
2	Vachira	1972	5,500	3,156	Bkk-Sriracha-Sattahip
3	C.P. 17	1968	5,417	3,447	Bkk-Sriracha-Songkla
4	Visahakit 1	1971	5,399	2,894	Bkk-S'pore
	Total 4 Vessels		21,883	13,000	

(3) Total (5,000-20,000 DWT)

	Type and unit of Vessel	DWT	Gross Tonnage	
	Cargo Vessels (41 Vessels)	323,151	230,161	
	Tanker Vessels (4 Vessels)	21,883	13,000	
	Total (45 Vessels)	345,034	243,161	

Source: MMPC

2-3-3 Promotional Measures for Shipping

For promotion of the shipping in Thailand, the Mercantile Marine Promotion Act was promulgated in December 1978. By the Act, Mercantile Marine Promotion Commission under the chairmanship of the Minister of Communications was established to give recommendations and advices to the Cabinet concerning the shipping activities and their promotion. Simultaneously, Office of the Mercantile Marine Promotion Commission was established in MOC to implement the specific measures.

The Mercantile Marine Promotion Act also provides specific measures for mercantile marine promotion as follows.

(1) The Government may determine the volume and freight proportion of the trade to be transported by the Thai flag vessels.

(2) The Government may authorize reduction or exemption of the income tax for the share-holders' dividends of the Thai shipping companies.

(3) The Government may authorize income or profit reduction up to 50 percent of the freight cost for the traders using Thai flag vessels.

(4) The Minister of Communications may bind the use of Thai flag vessels as a rule, in any of the following cases.

1) Imports by the government units, government organizations or agencies or state enterprises.

2) Imports to be made by the persons borrowing governmental funds or an agreement with the government organizations.

3) Specially designated proportions of specific cargo during designated period.

2-3-4 Current Situation of Ports

Bangkok Port and Sattahip Commercial Port are the main ports in Thailand which have cargo facilities for ocean going vessels. Bangkok Port is devided into two parts, one is Klong Toei area under the direct control of PAT and other is area of numerous private wharves. The facilities of these ports under PAT direct control are shown in Table 2-3-4.

Table 2-3-4 Facilities of Bangkok Port and Sattahip Commercial Port

	Length (m.)	Number of berths	Limited length/ draught of vessels (m.)
BANGKOK PORT			
1. West Quay	1,660	10	172/8.5
2. East Quay			
- Quay for Container Vessels	1,240	6	172/8.5
- Quay for Lighters	288	2	-
3. 36 Dolphins	-	7	172/8.5
4. 6 Buoys	-	6	135/ -
SATTAHIP COMMERCIAL PORT			
5. West Quay	540	3	180/10.5
6. North Quay	350	2	150/7.8

Source: PAT

As clearly seen from the above, Bangkok Port has far more facilities than Sattahip Commercial Port. In fact, the volume of the cargo handled at Bangkok Port in 1982 was 34,307,000 tons, occupying 95.5% of the Thailand's total trade volume of 35,556,000 tons.

As to the number of calls in 1982, 3,212 calls at Bangkok Port were made by foreign flag vessels and 799 by Thai flag vessels, while 111 calls at Sattahip Commercial Port were recorded by Thai and foreign flag vessels. For reference, the number of calls at Bangkok Port in 1982 is classified by nationality in Table 2-3-5.

Table 2-3-5 Number of Calls by Foreign Flag Vessels Classified by Nationality at Bangkok Port in 1982

Nationality	No.	Nationality	No.
American	1	Kuwait	2
Argentine	6	Liberian	228
Bangladesh	7	Malaysian	116
Belgian	2	Maldivian	35
British	75	Moroccan	1
Bulgarian	2	Norwegian	38
Burmese	2	Pakistani	7
Chinese	198	Panamanian	880
Cuban	6	Philippino	29
Cypriot	6	Polish	16
Danish	6	Qatari	2
Dutch	19	Rumanian	15
French	4	Russian	104
German	33	Saudi Arabian	20
Greek	131	Singaporean	515
Honduras	3	Somalian	3
Hungarian	5	Spanish	3
Indian	6	Swedish	3
Indonesian	26	Swiss	1
Iranian	21	Turkish	1
Italian	1	Vietnamese	6
Japanese	364	Yugoslav	32
Korean	231	Total	3,212

Source: Customs Department

The number of the vessels entering into Bangkok Port is increasing from year to year.

Therefore, PAT is making an effort to expand the facilities of Bangkok Port, and at the same time, new deep sea port is planed to be constructed in Laem Chabang around 100 km south of Bangkok.

2-4 Current Status of Shipbuilding and Shiprepairing in Thailand

2-4-1 Overview

There are 107 shipyards in Thailand today, but they are almost exclusively engaged in building and repairing small crafts. These crafts are largely of wooden construction, and are currently in the stage of replacement by steel vessels.

Newbuilding of ships is largely in sizes below 100 GT, though some 20 vessels above this size are being built every year, and very rarely some are above 1,000 GT. But ships above 3,000 GT are imported.

As to shiprepairing, the largest shipyard is Bangkok Dock having graving dock of 3,000 GT capacity. Vessels above this size are repaired abroad (Singapore, Malaysia, Japan, Europe, ...).

Apart from the Bangkok Dock which is financed by Government, all Thai shipyards are privately owned. About one half of them are located in the central part of Thailand and major yards are located in or around Bangkok. Their facilities equipment are mostly outdated and calls for renovation to raise productivity.

2-4-2 Principal Shipyards

The following description covers the 5 principal shipyards in Thailand, all located on the banks of the Chao Phraya River, in or around Bangkok.

(1) Bangkok Dock (1957) Co., Ltd.

The Bangkok Dock was established in 1914 by British interests, and has been operating under its present corporate form since 1957. Largest in Thailand, the shipyard is equipped with 2 graving docks — the only examples of this type of dock in the country. The yard is situated 17 km upstream of Bangkok Port, not far from midtown, in a locality surrounded by commercial and residential zones and encumbered by heavy road traffic. The location is thus today far from ideal for a shipyard.

Notable ships built at the Dock include a Naval vessel of 1,100 tons displacement completed in 1980, followed in 1981 by an oceanographic research vessel of 1,000 tons displacement. Other ships constructed comprise patrol boats, tugs and fishing vessels, and a large variety of other craft, mostly below 200 GT size.

In shiprepair work, 45 vessels — Naval, public service, mercantile (17 vessels) — were undertaken in 1983, for which the two graving docks were occupied during a total of 671 days and the slipway 99 days.

Other figures representing shipyard activity during 1983 are:-

- Aggregate gross tonnage of vessels repaired	21,040
- Aggregate number of days worked in shiprepair	308
(of which, days of dock utilization	247)

The number of vessels repaired in the past years has been around 50, of which about 1/3 were merchant ships.

(2) Italthai Marine Co., Ltd.

This shipyard was established in 1978, equipped with a cradle and rail installation of 480 ton capacity, modern auxiliary facilities and engineers, workers and a staff of high technological level.

The yard works mainly in newbuilding, mostly for the Royal Thai Navy. Very little shiprepair work is undertaken. A record of the firm's activities in recent years is reproduced in Table 2-4-1.

Table 2-4-1 Vessels Built by Italthai Marine Limited

Year	Type	Length (metres)	No.	Owner
1978	Survey Boat	9.76	1	Port Authority
1978	Fishers Inspection	9.75	1	Fisheries Dept.
1979	Patrol Boat	16.76	1	Customs Dept.
1980-1981	Patrol Craft Fast (PCF)	19.59	6	Royal Thai Navy
1982	Motor Yacht	14.32	1	Private
1982	Patrol Craft Fast (PCF)	20.80	5	Royal Thai Navy
1983	Patrol Craft Fast (PCF)	20.80	3	Royal Thai Navy
1981-1984	Patrol Gun Boat (PGB)	50.14	4	Royal Thai Navy
1983-1985	Patrol Gun Boat (PGB)	50.14	1	Royal Thai Navy

Source : Italthai Marine Co., Ltd.

(3) *Harin Shipbuilding Co., Ltd.*

This yard was established in January 1948, with a slipway of 1,500 DWT capacity. The firm is currently constructing in nearby but detached premises a 2,000 DWT slipway for repair, to enter service in 1985.

During 1983, the yard repaired 18 vessels, representing the following yard activities:-

- Aggregate gross tonnage of vessels repaired 10,500
- Aggregate number of days worked 551
  (of which, days of dock utilization 233)

In other past years, 20 - 25 vessels have been repaired annually.

(4) Asian Marine Services Co., Ltd.

Established as a joint venture with a Danish shipyard, this firm started operation in January 1984, with a floating dock of 3,000 ton lifting capacity. By end August of the same year, 30 vessels had been repaired, this number being expected to have risen to 45 by the end of 1984.

(5) Sahaisant Shipbuilding Co., Ltd.

Situated about 40 km upstream of Bangkok, the shipyard possesses a 400 GT slipway and a 50 GT side slipway, using both of which 6 vessels can be built or repaired in parallel.

The yard is staffed by highly qualified personnel.

In newbuilding, five naval vessels of 200 ton displacement have been constructed. The construction of six 10 GT vessels in a year has been recorded. In shiprepair, about 30 vessels a year can be handled.

Particulars concerning the foregoing five major shipyards are summarized in Table 2-4-2.

Table 2-4-2 Summary Particulars of Five Major Shipyards in Thailand

Shipyard	Location	Notable Equipment	Capacity	Employees
Bangkok Dock	Bangkok	No.1 Graving Dock	2,000 GT LxBxD 108.5M x 15.42M x 6.15M	Approx. 150 full-time workers
		No.2 Graving Dock	3,000 GT LxBxD 114.07M x 170.5M x 6.71	Approx. 250 subcontracted workers
		1 slipway	300t max. capacity	Total 400
Ital Thai	389 Taiban	1 cradle and rail installation	480t capacity	310
	Samtprakan	1 floating dock under construction	3,000t lifting capacity (to be extended in future to 6,000t capacity)	
Harin	Bangkok	1 slipway	1,500 DWT maximum building capacity	110
		1 slipway under construction	2,000 DWT maximum building capacity	
Asian	Bangkok	1 floating dock	3,000t lifting capacity; 80m x 24m x 6.5m deep	70
		1 crane	3t/10t x 30m/11m	
Sahaisant	Patumtanee	1 slipway	400 GT maximum building capacity	130
		1 side slipway	Simultaneous repair possible up to 6 ships	

Source: Information gathered by Expert on visits to respective shipyards

2-4-3 Aggregate Newbuilding and Shiprepairing Capacity and Records

The number of shipyards are given in Table 2-4-3, classified by the location and scope of services; Table 2-4-4 gives the number of yards capable of building and repairing ships above 100 GT size; shipbuilding capacity is shown in Table 2-4-5; actual records of their activity are presented in Table 2-4-6 for newbuilding and Table 2-4-7 for shiprepairing.

Table 2-4-3 Number of Shipyards by Location and Nature of Activity

Region	Shipbuilding	Shipbuilding and Shiprepairing	Shiprepairing	Total
Central	11	25	15	51
Eastern	5	5	2	12
Southern	5	16	23	44
Total	21	46	40	107

Source: BOT (1979)

Table 2-4-4 Number of Shipyards Capable of Building and Repairing Ships above 100 GT Size

Gross Tonnage	Number of Yards	Aggregate Capacity (GT)
101 - 500	36	5,820
501 - 1000	4	1,600
1001 - 3000	8	12,100
Total	48	19,520

Source: MMPC Report in MAY 1982

Table 2-4-5 Shipbuilding Capacity

Gross Tonnage	Production Capacity (No. of Vessels per year)
8 - 10	288
10 - 25	435
25 - 80	144
80 - 150	50
150 - 500	12
500 - 800	4
800 - 1000	2
1000 - 2000	2
Total	937

Source: BOT (MMPC Report in MAY 1982)

Table 2-4-6 Annual Newbuilding Records by Ship Size

Gross Tonnage	Number of Vessels Built		
	1978	1979	1983
8 - 10	80	48	32
10 - 25	145	87	33
25 - 80	62	33	94
80 - 150	18	8	12
150 - 500	6	2	13
500 - 800	3	1	1
800 - 1000	1	-	-
1000 - 2000	1	-	-
Total	316	179	185

Source : BOT (1978 - 1979)
MMPC (1983)

Table 2-4-7 Annual Shiprepairing Records by Ship Size

Gross Tonnage	Number of Vessels Repaired		
	1978	1979	1983
8 - 80	15,281	12,954	12,683
80 - 150	1,351	1,081	1,420
150 - 500	334	286	-
500 - 800	41	36	16
800 - 1000	12	9	14
More than 1,000	9	7	23
Total	17,028	14,373	14,156

Source : BOT (1978 - 1979)
MMPC (1983)

2-4-4 Current Status of Shipyard Facilities, Equipment, Technology, Labor Force

(1) Facilities and Equipment

The sole shipyard having well-balanced and relatively modern facilities and equipment is Italthai Marine. All the remaining shipyards would require some modernization to improve their productivity.

(2) Technologies

Wooden crafts are being built on traditional methods. The growing shortage of suitable wooden materials for shipbuilding and present social circumstances are calling for conversion from wooden shipbuilding to steel shipbuilding.

With the exception of Bangkok Dock, which started repairing steel ships in 1914, all the existing Thai shipyards have only started steel shipbuilding in the past 20 years or so, or have been newly established in the past 10 years. These yards are thus handicapped by their relatively short years of experience in the construction and repair of steel ships.

(3) Labor Force

Shipbuilding and repair require labour-intensive operations, which employ a large number of relatively highly qualified or specialized workers, but at present, such labor force are not abundantly available in Thailand.

Table 2-4-8 gives the estimated progress of labour supply and demand in the country during the Fifth Five-Year Plan.

Table 2-4-8 Progress of Labour Supply and Demand During the Fifth Five Year Plan

(Units: 1,000 persons or %, whichever relevant)

	1981	1982	1983	1984	1985	1986
Total labour force	23,756	24,503	25,267	26,024	26,766	27,505
Employed labour force	23,495	24,192	24,906	25,605	26,282	26,955
Unemployed labour force	261	311	360	419	484	550
Unemployment rate	1.1	1.3	1.4	1.6	1.8	2.1

Source: NESDB

2-4-5 Related Industries

The related industries supplying the materials and components required in shipbuilding and repairing are currently in the stage of development. Their rapid progress is considered indispensable for the successful accomplishment of transition now under way from small wooden shipbuilding to larger steel shipbuilding for inland and coastal trade.

Currently, almost all steel materials for shipbuilding over 100 DWT are imported. Table 2-4-9 presents the shares of domestically-produced material and imported key materials intended to shipbuilding and repair.

Table 2-4-9 Shares of Domestically-Produced and Imported Key Materials Used in Shipbuilding and Repair

Item	Imported (%)	Domestically Produced (%)
Steel plate, section	95	5
Steel pipe	100	0
Valves	100	0
Main/auxiliary machinery	100	0
Electrical equipment	100	0
Welding rods	0	100
Paint	50	50

1) Steel materials

Steel materials produced in Thailand during 1982 amounted to:

451,000 tons of round bars
128,000 tons of sections
69,000 tons of wire rod
123,400 tons of galvanized sheet
63,000 tons of tinned steel sheet
222,600 tons of welded pipe

Of the above products, the round bars are limited to 30 mm diameter, and sections to 10 mm thickness equal-angle, all of which can only be used for outfittings purpose.

2) Welding rods

Production of welding rods amounted in 1982 to 13,900 tons, of which 90 percent was for mild steel, and the remainder for a wide variety of uses including 50 kg/mm^2 high-tensile steel, stainless steel and cast iron.

3) Paint

In 1982, 39,000 tons of paint were produced in Thailand, but mostly for general use, or for the building, automovile or wooden ship. Only a very small portion is intended to steel ships.

2-4-6 Education and Training

The consistent and vigorous efforts spent by the Government of the Kingdam of Thailand in extending general education has resulted in the attainment of 95 percent school attendance rate at compulsory education. There are about 50 higher-level vocational schools, including branch institutions, for training technicians in specialized field, many of which are very well organized. Technical training schools are cultivating skilled workers in the field of electrical and gas welding, machining, metalworking, carpentry and electrical job.

3. Feasibility Study of the Project

3-1 Demand Forecast

We have investigated and studied the recent economic, trade and shipping situations of Thailand, and the Fifth Five Year Plan as well as the fleet expansion plan elaborated by MMPC.

Furthermore, we visited NESDB, MOC, MMPC, major shipping companies and other related organizations, exchanged various opinions, and conducted a hearing on the actual condition, perspective, etc. of the Thai economy and shipping industry.

On the basis of these results, we forecasted the demand for ship repairing from 5,000 DWT to 20,000 DWT by the year 2000 under the following conditions.

3-1-1 Economic Growth Rate

The GDP used in general was used as the economic growth rate. The average real annual growth rate of the GDP from the Second to the Fourth Five Year Plans was 7.1%, and in the Fifth Five Year Plan beginning in 1982 a growth rate of 6.6% was initially planned. The Macro Economic Targets of the Fifth Five Year Plan announced by NESDB was as shown in Table 3-1-1.

According to this plan in detail, for example, the manufacturing industry is supposed to grow at 7.6% annually as a whole, but industrial export is expected to rise at least 15%, while oil imports is planned to decline by at least 3% per year by speeding up the development of domestic energy resources, such as natural gas, lignite and hydro-electric power.

This indicates the significance of the policy of reducing import dependence ratio and increasing exports, and that this is an indispensable policy to improve the trade unbalance and to lead the national economy in a favorable direction.

Table 3-1-1 Macro Economic Targets of the Fifth Five Year Plan

	Fourth Plan (1977-1981)	Fifth Plan Target (1982-1986)
1. Trade deficit (current prices)		
1.1 Average value per year (million baht)	45,300	78,400
1.2 Trade deficit/GDP (%)	7.6	5.9
2. Current account deficit (current prices)		
2.1 Average value per year (million baht)	37,400	53,000
2.2 Current account deficit/GDP (%)	6.3	4.1
3. Exports of goods and services		
3.1 Value growth rate (% p.a.)	23.7	21.9
3.2 Volume growth rate (% p.a.)	12.1	10.9
4. Export of goods		
4.1 Value growth rate (% p.a.)	21.9	22.3
4.2 Volume growth rate (% p.a.)	10.5	11.3
4.3 Average value per year (million baht)	110,900	309,400
5. Income from tourism (current prices)		
5.1 Value growth rate (% p.a.)	36.2	21.5
6. Imports of goods and services		
6.1 Value growth rate (% p.a.)	25.4	18.1
6.2 Volume growth rate (% p.a.)	10.1	7.2
7. Import of goods		
7.1 Value growth rate (% p.a.)	26.3	18.1
7.2 Volume growth rate (% p.a.)	10.9	7.3
7.3 Average value per year (million baht)	156,200	387,800

	Fourth Plan (1977-1981)	Fifth Plan Target (1982-1986)
8. Economic expansion (% p.a. at constant prices)		
8.1 Agriculture	3.5	4.5
8.2 Manufacturing	9.3	7.6
8.3 Mining (including natural gas)	12.6	16.4
8.4 Natural gas (million cubic feet per day)	200[1]	525[2]
8.5 GDP	7.3	6.6
9. Expenditure growth (% p.a. at constant prices)		
9.1 Private sector	7.3	5.2
- Consumption	6.2	4.8
- Investment	12.0	6.9
9.2 Public sector	9.3	6.8
- Consumption	8.5	7.9
- Investment	11.0	4.9
10. Savings and investment shares in GDP (%)		
10.1 Savings	23.1	27.0
- Public	1.5	4.3
- Private	21.6	22.7
10.2 Investment	29.4	31.1
- Public	7.9	8.1
- Private	21.5	23.0
Government revenue/GDP (%)	14.0	18.0
	(1981)	(1986)
Population growth rate (% p.a.)	2.1	1.5
	(1981)	(1986)

Source: Fifth Five Year Plan, NESDB

1 From October 1981 onwards.

2 In 1986.

Note: GDP deflator is assumed to rise at an annual rate of 10.6 per cent during the Fifth Plan period compared with the corresponding figure of 11.2 per cent per annum during the Fourth Plan period.

However, although the world economy has begun to show signs of recovery, a considerable time may be required for substantial recovery. Furthermore, Thai export is presently in a state of "top-heavy", due to the slack in prices of primary products. Under such condition, NESDB modified the GDP growth rate downward in the Fifth plan from 6.6% to 5.5%, and the GDP growth rate in the Sixth Five Year Plan starting from 1987 is estimated to be from 5.2% to 5.5% or 5.8%.

Such a downward modification and the subsequent slightly suppressed growth are considered a sign of the policy anticipating future steady growth from now on.

Therefore, when forecasting the demand for ship repairing, it is preferable to employ a conservative criteria to an optimistic ones. We forecast that the GDP growth rate is 5.5% as modified by NESDB in the Fifth Five Year Plan until 1986 and 5.3% in the Sixth Five Year Plan, and will remain at 5.3% until 2000.

3-1-2 Foreign Trade

Foreign trade is very closely interrelated with the gross domestic product. Therefore, the annual growth rate of trade and that of GDP are also interrelated. That is to say, the Thai GDP increases when agricultural and industrial products increase. When the domestic economy becomes active, national industries develop and consumption demands increase. Reflecting these conditions, imports goods such as raw materials becomes prosperous. In this way, when GDP increases, the export and import trades also increase. If these are viewed in a macro way, GDP and trade are generally interrelated as has been widely accepted by the worldwide economists at the time of making such forecasts. Therefore, the trade growth rate forecast is made employing the estimated GDP growth rate as the base since the both are considered to be proportional.

By the way, MMPC published a report titled "The Tendency of Mercantile Marine Development", which described the Thai merchant marine development plan as well as the estimated trade growth.

So far as trade activities are concerned, there are two kinds of indication factors: amount of money and the volume in metric ton. The latter by "volume" was employed in MMPC report.

In the report, it is estimated that the annual average trade growth rate from 1978 to 86 is 3.3%, while looking at Table 2-2-4, the actual results for five years from 1977 to 82 were 2.0% of annual average, and for the four years from 1978 to 82 they were 4.0%. And MMPC's forecast can therefore be considered fairly reasonable.

From Table 2-2-3 it was determined that the average GDP growth rate from 1978 to 82 was the actual results of slightly less than 5.6%. Since we estimated 5.5% GDP growth rate until 1986, we estimate the trade growth rate until 1986 to be 3.3%, the same as MMPC's forecast. For trade growth from 1987 to 91, MMPC report forecasts the same 3.3% annual average, but since we estimated 5.3% annual GDP growth rate during that period, we estimate that the trade growth rate will be 3.2%.

In a similar way, we estimated that the trade growth rate until 2000 as being 3.2%, under the consideration of the estimate of 5.3% annual GDP growth rate during that period.

3-1-3 Vessels

When trade increases, it is clear that the required fleet of Thai and foreign vessels must increase as a means of transport.

The required fleet mainly depends not only on the trade volume but also on the trade pattern, i.e., trade items and trade partners, and on operational efficiency of vessels.

However, as described in 2-2-3, principal export and import items as well as the principal trading partners have not changed so much in these several years. When Thai industrialization progresses in the future to export the products and when oil imports are reduced through the increased utilization of Thai natural gas, the trade pattern may change a little bit, but a big change is hardly anticipated for the time being. Furthermore, the operational efficiency may be improved as a result of technical innovations for vessels in the future, but this will have little influence on the increase of transport volume.

Therefore, since the required fleet for the transportation of trade cargoes changes little due to the change of trade pattern and the operational efficiency, the required fleet may be considered solely influenced by the trade volume.

(1) Thai Flag Vessels

According to MMPC report, Thai flag vessels transported 5% of Thai trade cargoes in 1978, and approximately 7 to 8% in 1983. Although the percentage is increasing year by year, still more than 90% depends on foreign flag vessels. Therefore, the Government of the Kingdom of Thailand is now keen on the increase of Thai flag vessels transportation share, especially the reinforcement of oceangoing marine transportation, and the following items are shown in the Fifth Five Year Plan as international shipping targets.

1) Expand the transportation of merchandise exports and imports by Thai flag vessels at an annual rate of 15%. The proportion of goods using Thai flag vessels will rise from 5% of exports and imports volume using ocean transportation at present to 10% in 1986 with the size of the merchant marine fleet expanding by 358,000 DWT.

2) Expand and improve the state enterprises' merchant marine fleet.

3) Open new shipping routes which have no Thai flag vessels at present, particularly the American and Australian routes.

In compliance with the above-mentioned plan, MMPC has already announced the trade volume forecast and fleet expansion plan until 1991 in its report "The Tendency of Mercantile Development." The following table summarizes the contents of the report.

Table 3-1-2 Target of Expansion of Thai Flag Vessels

	1978	-	1986	-	1991
No. of Vessel	58	(+28)	86	(+41)	127
DWT	458,442	(+358,000)	816,442	(+556,000)	1,372,442
Annual Growth Rate of DWT (%)		7.5		10.9	
Average Size of Vessel (DWT)	7,904		9,494		10,807
Annual Growth Rate of Average Size (%)		2.4		2.6	
Trade Volume (Million Ton)	27.96		36.27		41.55
Growth Rate of Trade Volume (%)		3.3		3.3	

Source: MMPC report on "The Tendency of Mercantile Marine Development"

As shown in the Table 3-1-2, Thai fleet is expected to be double by 1986 and triple by 1991, taking 1978 as the base year.

The MMPC report aims at the expansion of foreign trade vessels, ie. developing large size vessels than smaller domestic trade vessels of under 5,000 DWT. Large vessels greater than 20,000 DWT may be almost unable to enter Bangkok Port at present because of their draft limit, so their number is few.

However, to attain this fleet expansion target, MMPC considers it necessary that the establishment of governmental subsidy systems to assist shipping companies, especially for obtaining vessels, and that Thai participation in the U.N. Convention on a Code of Conduct for Liner Conference, but neither has been established yet.

If the fifty-fifty transportation share of trade cargoes between trade partner and Thai flag vessels were accomplished, it may be possible to expand more than five times greater than the present fleet volume since the share of Thai flag vessels at present is less than 10%.

However, when forecasting the expansion of Thai flag vessels, a suitable amount should be employed, which accounts for the recent increase rate of Thai flag vessels and the increase rate of trade volume and GDP which are proportional to the fleet increase rate.

According to Table 2-3-2, the annual average increase rate from 1979 to 83 of 5,000 to 20,000 DWT vessels was calculated as 7.8%, being very close to 7.5% forecast value of 1978 to 86 by MMPC.

Based on the actual past results, we forecasted GDP and the trade volume increase rates until 1986 to be 5.5% and 3.3%, respectively, under the consideration of the validity of MMPC's forecast. And also referring to MMPC's forecast, we fixed the increase rate of 5,000 -20,000 DWT vessels as 7.5% annually until 1986.

Since we assumed the increase rate of fleet is proportional to that of the trade volume, which is also proportional to the GDP increase rate, we forecasted that the fleet increase rate for 1987 - 2000 will be reduced from 7.5% to 7.2%, employing identical proportional reductions from 5.5% to 5.2% and from 3.3% to 3.2%, respectively, for the increase ratios of GDP and trade volume, compared with the preceding period.

As to the size of vessel, it is generally said that vessel size (DWT per vessel) increases annually to promote efficiency.

From Table 2-3-2, the average increase rate was 0.4% from 1979 to 83 and 6.2% from 1880 to 83.

Although some fluctuation of figure in the ratio being observed in the increase rate of the DWT per vessel, we consider that various kinds of forecast values of MMPC through 1986 were fairly adequate for the analysis, and adopted 2.4% as the increase forecast rate which was employed in MMPC report.

Average vessel size does not become greater in direct proportion to fleet increase. As a matter of fact, in MMPC report, the fleet increase rate is 7.5% for 1978 to 86 and 10.9% for 1987 to 91, while the average increase rate of vessel size is 2.4% and 2.6% respectively. This means that the ratio of vessel size increase rate against fleet increase rate becomes smaller as the fleet increases. Based on this trend and since MMPC forecasts 2.6% average increase rate of vessel size after 1987 against 10.9% of fleet increase rate, we applied the same ratio (10.9/2.6) and obtained 1.7% at the forcasted 7.2% of fleet increase rate.

Table 3-1-3 summarizes these various increase rates we forecasted.

Table 3-1-3 Forecast of Each Annual Growth Rates
(Trade volume, Thai Flag Fleet and Average Size)

(Unit: %)

	1984 - 1986	1987 - 1991	1992 - 2000
GDP	5.5	5.3	5.3
Trade Volume (Metric Ton)	3.3	3.2	3.2
Thai Flag Fleet (DWT)	7.5	7.2	7.2
Average Size Thai Flag Vessel (DWT)	2.4	1.7	1.7

Table 3-1-4 was obtained on the basis of Thai flag vessels of 5,000 to 20,000 DWT at the beginning of 1984 in Table 2-3-3, employing the increase rate obtained in Table 3-1-3.

Based on this factor, we can calculate the total fleet tonnage and the average DWT per vessel in each year and obtain the number of vessels by dividing the fleet by the average DWT per vessel.

Table 3-1-4 Prospect of Thai Flag Vessels between 5,000 DWT and 20,000 DWT

Year	No. of Vessel	Average DWT	Fleet (DWT)
1984	45	7,667	345,034
1990	61	8,600	526,572
1991	65	8,746	564,485
1992	68	8,895	605,128
1993	72	9,046	648,698
1994	76	9,200	695,404
1995	80	9,357	745,473
1996	84	9,516	799,147
1997	89	9,677	856,685
1998	93	9,842	918,367
1999	98	10,009	984,489
2000	104	10,179	1,055,372

(2) Foreign Flag Vessels

Since most incomming foreign vessels entering Thailand call at Bangkok Port (Table 2-3-4), forecast was conducted based on this trend.

According to the information obtained from PAT, in spite of the fact that the share of trade cargoes carried by Thai flag vessels increases year by year, still the number of calls by foreign flag vessel and their average DWT per vessel are increasing year by year.

We conducted the forecast based on 3,066 calls of foreign vessels and an average of 7,746 DWT per vessel in 1980, and 3,212 calls and 8,046 DWT in 1982 as obtained from Customs Department information.

Based on the number of calls and the average DWT per vessel in 1980 and 1982, we obtained their annual increase rates as 2.3% and 1.9% respectively.

Employing these increase rates, and the number of calls and the average DWT in 1982, Table 3-1-5 was obtained.

Table 3-1-5 Prospect of Number of Calls by Foreign Flag Vessels at Bangkok Port

Year	No.of Calls	Average DWT
1982	3,212	8,046
1990	3,853	9,353
1991	3,941	9,531
1992	4,032	9,712
1993	4,125	9,897
1994	4,220	10,085
1995	4,317	10,276
1996	4,416	10,472
1997	4,518	10,671
1998	4,622	10,873
1999	4,723	11,080
2000	4,837	11,291

However, the same vessel frequently navigates the same route and enters the same port, and the frequency of which depends on the route length, cruising pattern, etc. The number of foreign flag vessels must be estimated considering such multiple entries per year, in order to find the demand for ship repairs. Furthermore, at present, only vessels of less than 15,000 DWT can freely enter Bangkok Port, and as they are engaged in foreign trade, the number of small vessels less than 5,000 DWT is assumed to be small.

Based on the data and information from PAT, shipping companies, etc., we estimate the number of foreign vessels is approximately 20% of the number of calls, and approximately 80% of these vessels are larger than 5,000 DWT.

Considering the above, the number of foreign vessels between 5,000 to 20,000 DWT in 1982 was approximately 500. And this number increases year by year as the proportion of vessels of more than 5,000 DWT increases year by year.

The repair shipyard we are now planning should handle all of Thai flag vessels between 5,000 and 20,000 DWT. The dock is also capable of handling foreign vessels to fill up the vacancy of the Yard's work load. As mentioned later, a maximum number of vacancy is 8 vessels per year.

3-1-4 Docking Demand for Shiprepair and Capacity of Repair Shipyard

The ships envisaged to be served by the projected Repair Shipyard are Thai flag vessels and vessels of foreign flag calling at Bangkok and Satahip ports, and at the projected new port at Laem Chabang.

The mission of a repair shipyard is to undertake maintenance of ships in condition such as to ensure the safety at sea of their crew, cargo and navigation, and in conformity with applicable national laws and regulations and with the rules and codes prescribed to this end by the ship classification societies with which the ships are registered. All classification societies require registered ships to undergo special surveys every 4 years and annual surveys every year. Docking surveys are subject to possible extension not exceeding 2 years, and the present estimates are based on the assumption that vessels will dock only once in 2 years. The annual docking demand for shiprepair was estimated on the basis of these requirements applied to all ships.

(1) Estimated Docking Demand for Repair of Thai Flag Vessels

The estimated docking demand for shiprepair of Thai flag vessels is as presented in Table 3-1-6. Start of yard operation is envisaged for 1990, following which, the demand is expected to rise gradually.

Table 3-1-6 Estimated Docking Demand for Repair of Thai Flag Vessels

Year	Fleet		Docking Demand for Repair	
	Vessels	Average DWT	Vessels	Aggregate DWT
1990	61	8,600	31	267,000
1991	65	8,746	32	280,000
1992	68	8,895	34	302,000
1993	72	9,046	36	326,000
1994	76	9,200	38	350,000
1995	80	9,357	40	374,000
1996	84	9,516	42	399,000
1997	89	9,677	45	435,000
1998	93	9,842	47	463,000
1999	98	10,009	49	490,000
2000	104	10,179	52	529,000

Note: The fleet estimates are cited from Table 3-1-4.

(2) Repair of Foreign Flag Vessels

The envisaged repair shipyard would primarily aim at repair of Thai flag vessels, but with progress of the yard's technological capability, and upon generation surplus shiprepair capacity after filling orders for the repair of Thai flag vessels, those of foreign flag vessels might well be considered taking in hand, as discussed further on.

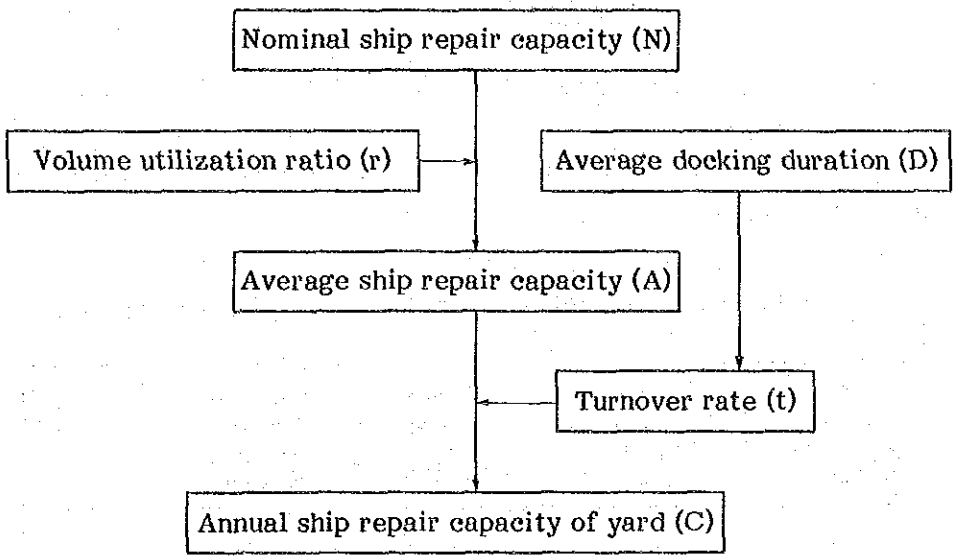
In this regard, the envisaged location of Laem Chabang is very favourably situated - diectly facing a channel of busy international shipping traffic, 100 km downstream of Bangkok and an equal distance upstream of Sattahip Port, both frequently served by foreign flag vessels.

To take full advantage of this circumstances, however, the repair shipyard must compete with other yards in the neighbouring countries, in terms of both price and quality of work it can offer prospective customers. The shipyard will be well placed in respect of labour cost, but concentrated efforts by management and employees require to be directed to enhance the yard's technological capability to the extent of covering its unfavourable position in respect of experience in large-scale shiprepairs.

3-1-5 Docking Capacity of Repair Shipyard

The annual docking capacity of a repair shipyard is estimated from the volume utilization ratio (ratio to nominal dock capacity presented by average tonnage of vessels occupying the dock) and the average duration of dock occupation by one vessel.

The procedure of estimation is as described in Fig. 3-1-1.



$$C = N \times r \times t = A \times t$$

Fig. 3-1-1 Procedure for Estimating Annual Repair Capacity of Repair Shipyard

The premises adopted in the present instance are as follows:

(a) Nominal shiprepair capacity, N:

20,000 DWT (1 dock)

(b) Volume utilization ratio, r:

$$r = \frac{\text{Average DWT of Thai Flag Vessel}}{N}$$

43 - 50% (a level that is internationally current;
higher the better)

(c) Average repair capacity, A

$A = N \times r$

(d) Average docking duration, D:

12 days for 1st year of operation, to gradually shorten with accumulation of operating experience.

(e) Turnover rate, t:

Derived from average docking duration and number of effective working days per year (assumed to be 300)

$$t = \frac{\text{Effective working days/year (300)}}{D}$$

Based on the above premises, the annual docking capacity of the repair shipyard is estimated as given in Table 3-1-7.

Table 3-1-7 Annual Docking Capacity of Repair Shipyard

Year	Nominal Ship Repair Capacity N (DWT)	Volume Utilization Ratio r(%)	Average Ship Reapair Capacity A(DWT)	Average Docking Duration D(Days)	Turnover Rate t	Annual Ship Repair Capacity C(DWT)
1990	20,000	43	8,600	12	25	215,000
1991	20,000	44	8,800	10	30	264,000
1992	20,000	44.5	8,900	9	33.5	298,100
1993	20,000	45	9,000	8	37.5	337,500
1994	20,000	46	9,200	7	42.9	394,700
1995	20,000	46.5	9,400	6.5	46.2	434,300
1996	20,000	47.5	9,500	6	50	475,000
1997	20,000	48	9,700	6	50	485,000
1998	20,000	49	9,800	6	50	490,000
1999	20,000	50	10,000	6	50	500,000
2000	20,000	50	10,000	6	50	500,000

3-1-6 Estimated Shiprepair Demand and Capacity

From the estimates for docking demand of Table 3-1-6 and for docking capacity of Table 3-1-7, the shiprepair demand and capacity is estimated to be as shown in Fig. 3-1-2 in terms of tonnage, and in Fig. 3-1-3 in terms of number of vessels.

In the first year of commercial operation, the Shipyard's repair capacity will cover only about 80 percent of the current shiprepair demand by vessels of Thai flag; in the ensuing years, with increasing productivity accompanying familiarization by the employees, the shiprepair capacity will gradually rise, until in the 4th year of operation, it will exceed by a slight amount the current demand.

The vessels to be repaired by the Shipyard is however envisaged to be limited to those of Thai flag until 1995; from 1996, when the Shipyard is expected to attain full installed capacity, foreign vessels are envisaged to be repaired to permit the Shipyard's production capacity to be fully used.

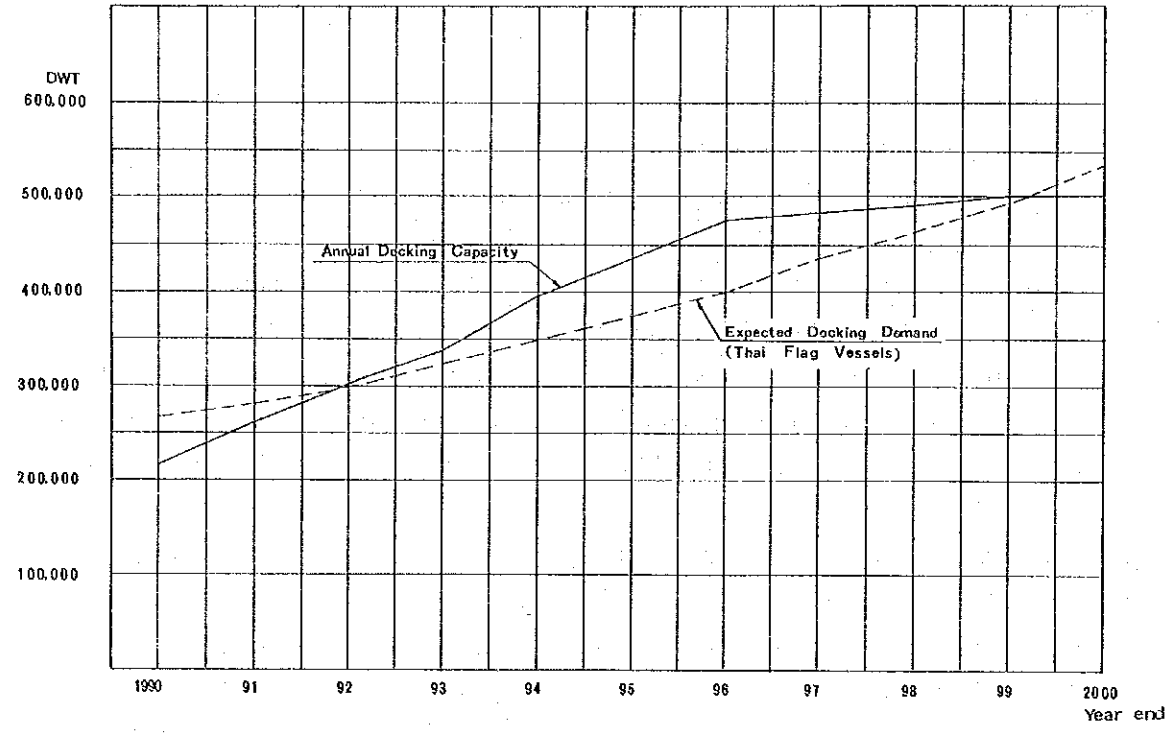


Fig. 3-1-2 Estimated Shiprepair Demand and Capacity in Terms of Tonnage

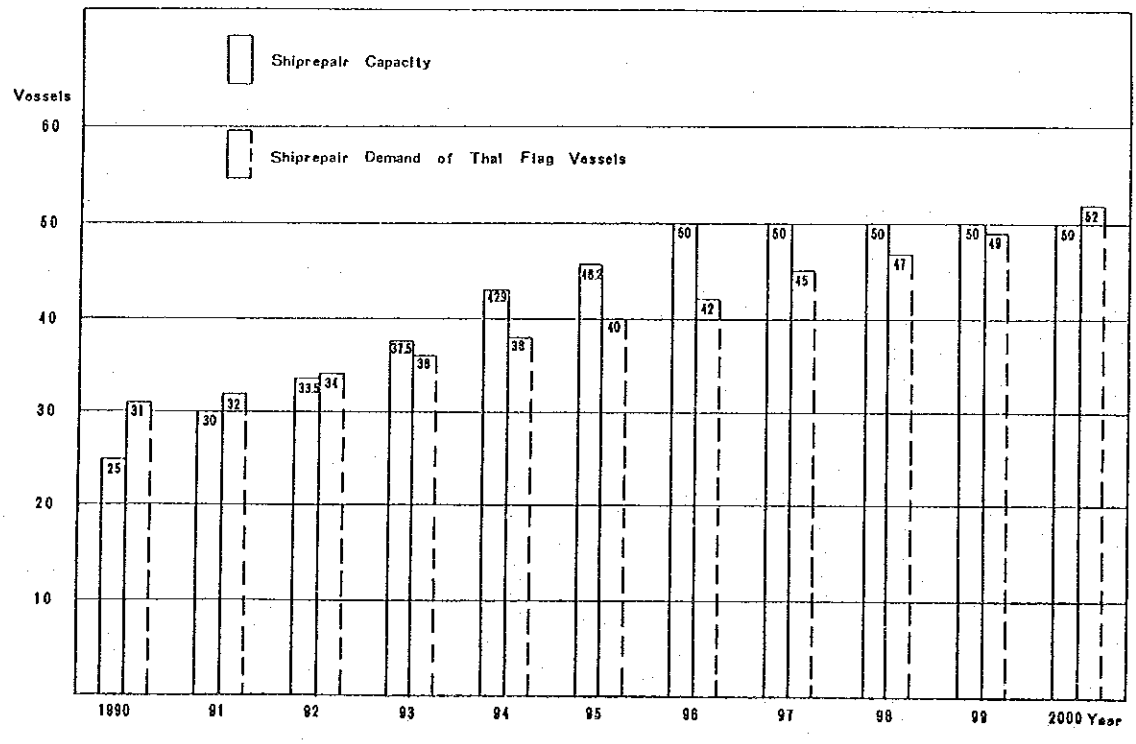


Fig. 3-1-3 Shiprepair Demand and Capacity in Terms of Number of Vessels

3-2 Natural Conditions

3-2-1 Geography

The study area is located on the east coast of the Bay of Bangkok which is the upper part of the Gulf of Thailand and is a distance of about 100 kilometers from Bangkok along the Route 3, and is situated at the south east of Laem Chabang as shown in Fig. 3-2-1.

The geographic co-ordinates of the study area roughly are between longitude 100° 52.5' E and 100° 53.5' E, and between latitude 13° 03.5' N and 13° 05' N.

The most prosperous city on this area is Siracha in Chonburi Province which is located at 12 kilometers north northeast of the study area.

At about 10 kilometers north west of Laem Chabang, Ko Sichang (Sichang Island) which is one of the biggest islands in the Bay of Bangkok is located with the area of about 7 square kilometers.

3-2-2 Topography

(1) Land Area

The study area is characterized by a cape named Laem Chabang which is the abrupt end of a range of rocky hills between 100 and 200 meters high running southwards along the coast, and by a large and slightly sloping plain which extends on the east side of Laem Chabang.

The coastal line extending southwards from Laem Chabang consists of a wide sand beach and curves smoothly. The proposed port is situated in this coastal area and the proposed repair shipyard is a part of the port.

One small river, which is called Huai Yai, discharges itself into the sea near the cape and village of Laem Chabang at the northern end of the study area. The quantity of water of the Huai Yai is very small and therefore the injection of erosion materials into the sea is limited.

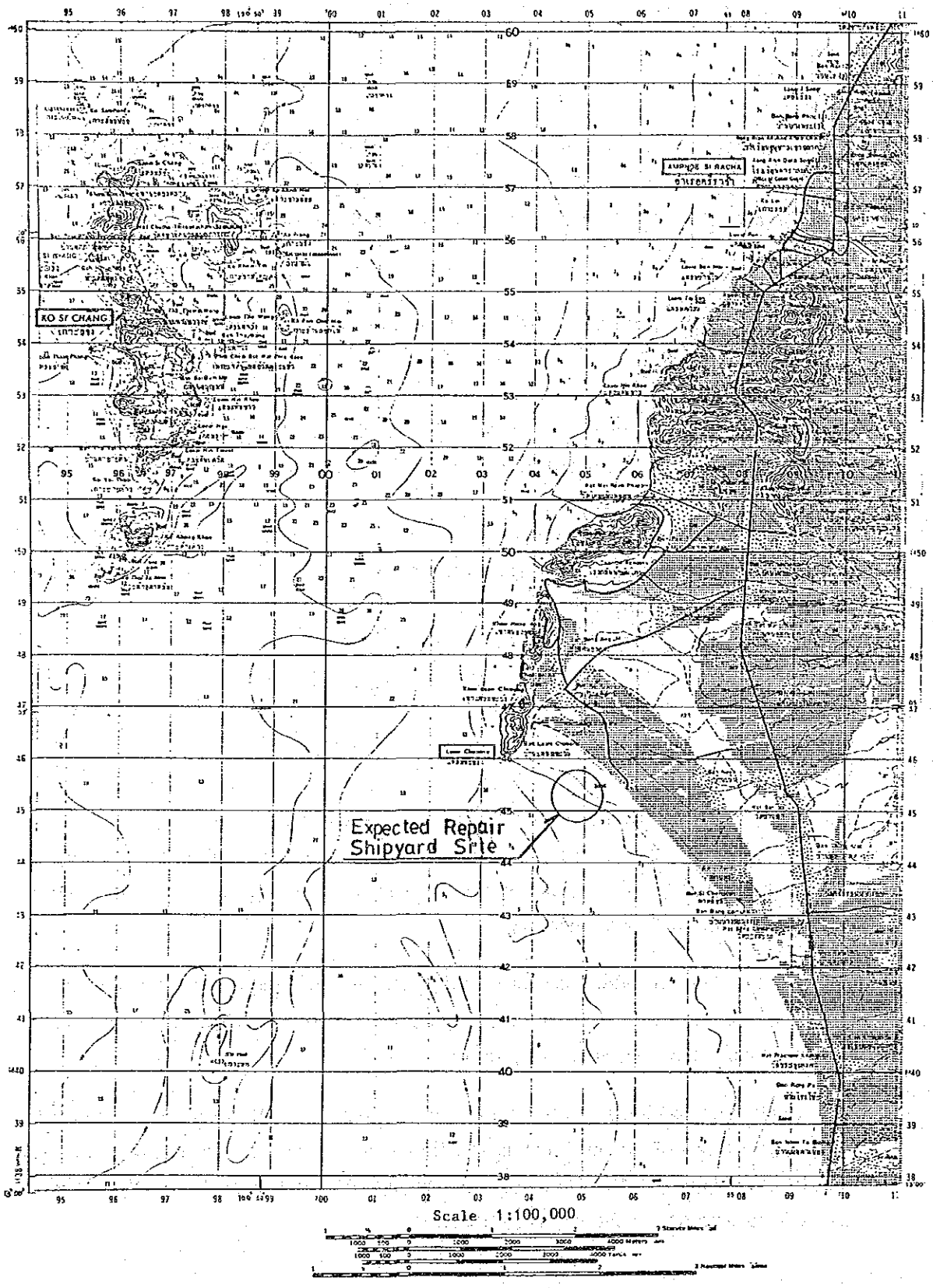


Fig. 3-2-1 Location Map

The existing topographical map on the area concerned is published by the Royal Thai Survey Department at scale of 1:50,000 and another is at scale of 1:2,000 of the Department of Town and Country Planning, Ministry of Interior. The Port Authority of Thailand was also surveying the area in the period of our field survey to make a topographical map at scale of 1:4,000.

(2) Offshore Area

The available hydrographical maps are unsuitable for this study purposes because of thier large scale and therefore a hydrographic survey was executed by the study team using an echo sounder. The survey results are shown in Fig. 3-2-2 "Topographical Map" on a reduced scale at about 1:6,350 from the original map at scale of 1:2,000 including the topography of the coastal land area. On this map, the elevation and/or depth are reduced to Lowest Low Water in meters, that is 2.48 meters below Mean Sea Level (Ko Lak Standard).

The topographic feature of the sea-bed in the survey area is divided broadly into four morphologic sections. The first morphologic section is a tidal zone along the shoreline to the water depth of zero meter with the datum of CDL. On this section, the depth contour lines are parallel to the shoreline and the average grade is about 1/100. A zero meter contour line extends about 320 meters off the shoreline.

The second morphologic section is an escarpment below the lowest low water level with a steep slope of the average grade about 1/60 with the width around 120 meters.

The third morphologic section is, so to speak, a wave-cut terrace with a gentle slope of the average grade around 1/250 from the water depth of two meters to five meters CDL. A five meters contour line is about 1.0 to 1.3 kilometer off the shoreline.

The last morphologic section is situated in the offshore area of the above-mentioned third morphologic section. This section is subdivided into two tracts. One is characterized by the long depression of eight to twelve meters water depth with strikes N30° W which is found in the offshore area of Laem Chabang. On the other hand, the other tract is a shoal distributing in the south part of the above-mentioned depression having the water depth less than four meters.

Fig. 3-2-2
Topographical Map

3-2-3 Subsoil Conditions

According to the results of soil investigation, it can be said that subsoil conditions of the project area are comparatively good for the following reasons;

1) The subsoil mainly consists of sandy soil, and clayey layer involving a problem of consolidation settlement could not be found.

2) The bearing layer for the pile foundation appears at a shallow part.

(1) Soil Profile

Fig. 3-2-3 shows the soil profile of the project area. The subsoil of the project area is composed of two soil layers from a geological point of view, namely alluvial sediment layer and residual soil layer (highly weathered rock).

1) Sediment Layer

The sedimentary soil has been deposited with a thickness of 3 to 7 meters from sea bed. This layer mainly consists of fine sand including large amount of silt or clay containing small shell fragments. The N-value, which indicates relative density or stiffness, of this layer ranges from 0 to 5. It means that the layer is very loose to soft. However, it may not be any problem because the major part of this layer is composed of sandy soil even though thin layer of soft sandy clay exsists.

2) Residual Soil Layer

This layer is assumed to be highly weathered rock (granite). The layer mainly consists of silty or clayey sand, but locally contains a considerable amount of clay. The soil particle is medium to coarse quartz sand, and the shape is not rounded. This layer can be divided into silty sand and clayey sand according to the stiffness and the amount of clay particle contained, in spite of the fact that each boundary is not clear.

(a) Silty Sand Layer

The upper part of residual soil layer is composed of silty sand layer which contains a few clayey particle than the lower part. The color of the soil layer is light gray and soil particles are relatively homogeneous. The N-value of this layer ranges from 15 to 30, and the layer is medium dense.

(b) Clayey Sand Layer

The lower part of the layer is composed of clayey sand which includes a lot of clay and gravels. The color of the soil is light gray or light brown. The N-value of the layer ranges from 40 to 50 or more, and this layer is very dense to hard. Hence, the layer has sufficient bearing capacity for various strucutures.

(2) Soil Property

Table 3-2-1 indicates soil properties. Fig. 3-2-4 shows comparative chart of grain size distribution and depth distribution of soil index.

Table 3-2-1 Soil Property

Soil Layer		Sediment Layer	Residual Layer	
		Silty or Clayey Sand	Silty Sand	Clayey Sand
Natural Moisture Content %		10 - 30	10 - 20	10 - 20
Fraction Content	Sand %	50 - 80	60 - 70	40 - 70
	Silt %	40 - 20	20 - 30	20 - 30
	Clay %	2 - 10	10 - 20	10 - 40
Unified Classification		SM - SC	SM - SC	SC
Specific Gravity		2.62	2.62	2.62

1) Grain Size Distribution

In Fig 3-2-4 shows the results of mechanical analysis test. The major features of the grain size distribution in each soil layer are as follow;

(a) Sedimentary Layer

The soil contains 20 to 50 percent of silt and clay smaller particles than 74 μ and 10 percent of clay smaller particle than 2 μ . Diameter of 60 percent finer are ranged 0.08 to 0.5 mm and diameter of 10 percent finer are ranged 0.007 to 0.04 mm, consequently coefficient of uniformity can be calculated as 10 to 12. This soil materials are classified as SM-SC by the Unified Classification System.

(b) Silty Sand Layer

The soil contains 30 to 40 percent of silt and clay particles and 10 to 20 percent of clay particle, and 5 percent of gravels. Since each distribution curve of soils has similar range, the soil materials are considered to be homogeneous, and this layer is classified as SM-SC by the Unified Classification System.

(c) Clayey Sand Layer

The soil contains 30 to 60 percent of silt and clay particle, 10 to 40 percent of clay particle and 10 to 30 percent of gravels. Since the distribution curves are spread in wider range, the soil material is considered to be not homogeneous. Because the soild contains clay with high plasticity the soil is classified as SC by the Unified Classification System.

In Fig 3-2-4 shows the depth distribution of each soil particle in percentage. Since dredging depth is planned upto LLW -12.5m, the reclaimed materials are assumed to be such soil which contains less than 40 percent of silt and clay and less than 20 percent of clay fraction.

2) Natural Moisture Content

Fig 3-2-4 shows the depth distribution of natural moisture content (Wn). Sedimentary layer has a Wn of 20 to 30 percent. Because this layer consists of a large amount of silt, the soil has relatively high water content as sandy soil. Wn of residual soils ranges from 10 to 20 percent. This layer also includes a large amount of silt and clay. However, silt and clay which are contained in this layer are very hard with low water content, therefore, the Wn of this soil is assumed to be low.

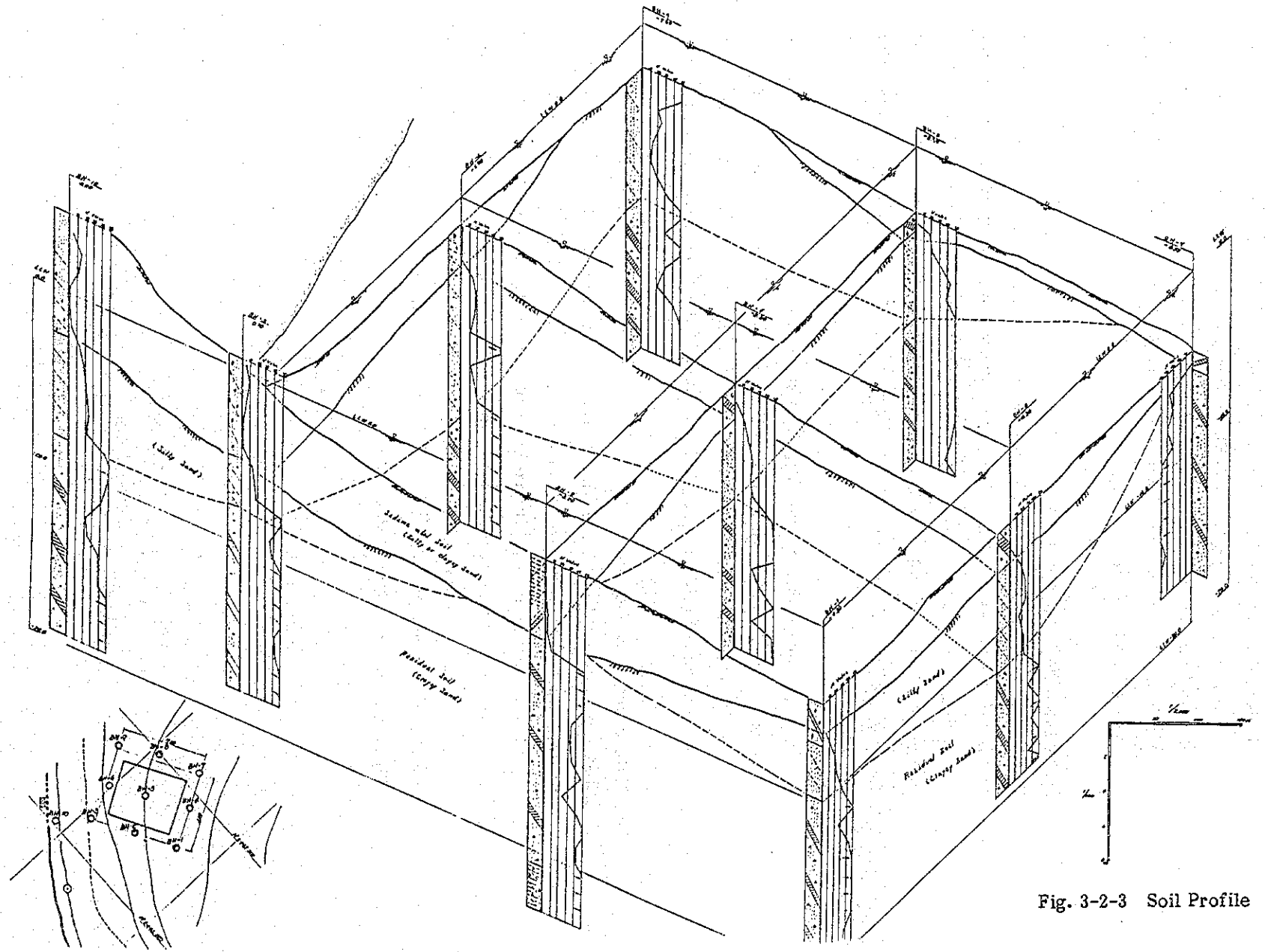


Fig. 3-2-3 Soil Profile

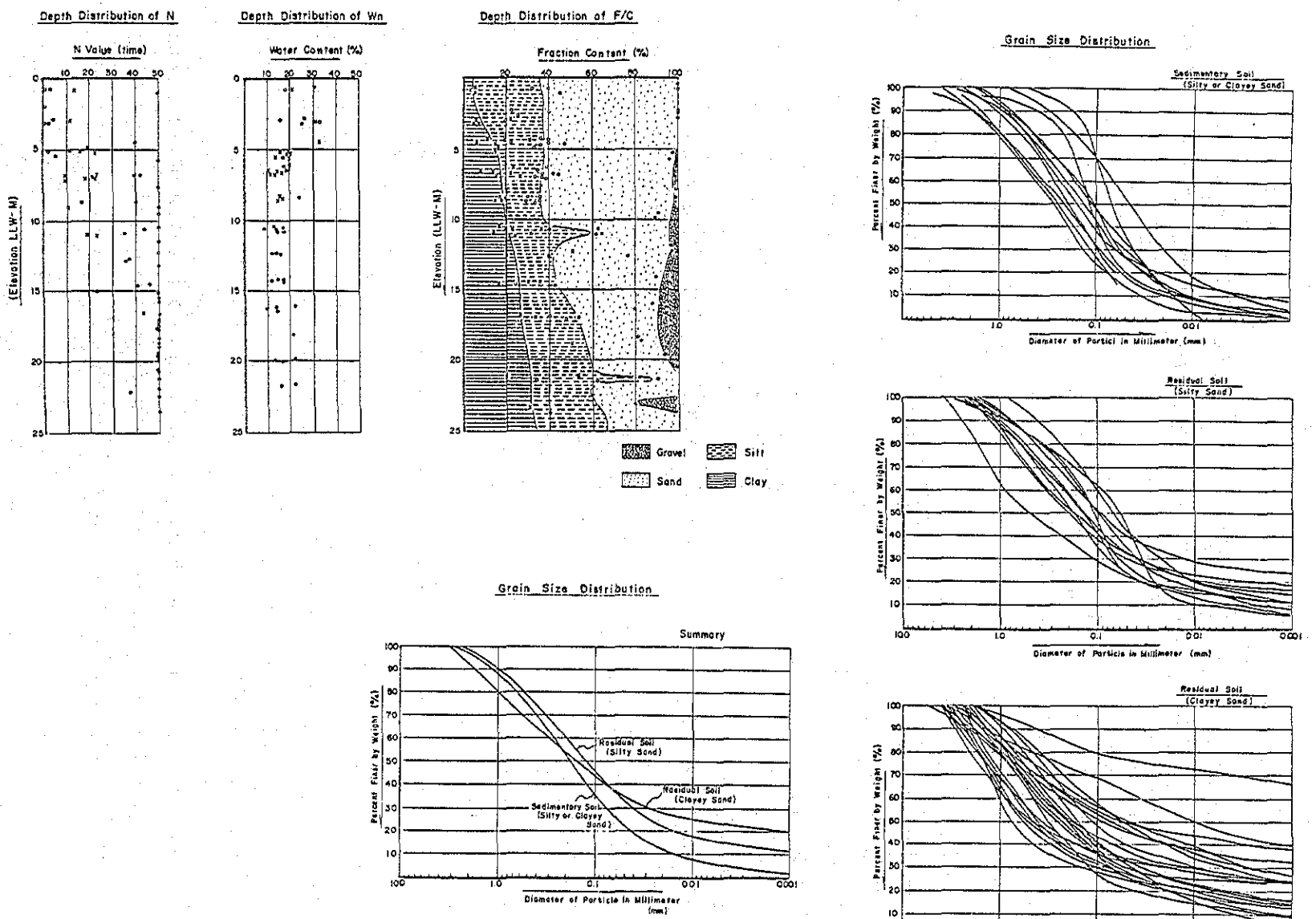


Fig. 3-2-4 Summary of Soil Tests

3-2-4 Oceanographic Phenomena

(1) Tides

The nearest existing tide station to the study area is Ko Sichang, which is under the management of PAT. Tidal characteristics at Ko Sichang is shown in Table 3-2-2.

Table 3-2-2 Characteristics of Tides at Ko Sichang

Water Level		Height
Highest High Water	H.H.W.	+1.84 m (1982)
Mean Higher High Water	M.H.H.W.	+0.95 m
Mean High Water Spring	M.H.W.S.	+0.88 m
Mean High Water	M.H.W.	+0.73 m
Mean High Water Neap	M.H.W.N.	+0.57 m
Mean Sea Level (Ko Lak Standard)	M.S.L.	0.00 m
Mean Tide Level	M.T.L.	-0.06 m
Mean Low Water Neap	M.L.W.N.	-0.75 m
Mean Low Water	M.L.W.	-0.85 m
Mean Low Water Spring	M.L.W.S.	-0.97 m
Mean Lower Low Water	M.L.L.W.	-1.32 m
Lowest Low Water	L.L.W.	-2.48 m (1951)

These data were determined by non-harmonic analysis method and the period of records for Highest and Lowest is 1940 to 1982. All heights of water levels are refered to Ko Lak MSL.

The results of tidal harmonic analysis using recent data of one month of August 1984 at Ko Sichang station are shown in Table 3-2-3 together with the existing harmonic constants of Laem Chabang by NEDECO.

Table 3-2-3 Results of Tidal Harmonic Analysis

Station : Ko Sichang

Duration : one month (August 1984)

No.	Constituent	Ko Sichang		Laem Chabang	
		Height in cm	G in degree	Height in cm	G in degree
1	S	229.0	0.0		
	1) Long Period Tide				
2	Mm	5.8	254.7	3.7	279
3	MSf	3.2	282.4	1.0	107
	2) Diurnal Tide				
4	Q_1	9.2	93.6	8.4	98
5	O_1	43.5	114.5	43.4	117
6	M_1	2.1	158.8	1.7	173
7	K_1	65.2	160.7	66.1	166
8	J_1	2.8	169.2	2.5	240
9	OO_1	4.1	222.5	2.9	217
10	P_1	21.6	157.2	17.2	168
	3) Semi-Diurnal Tide				
11	μ_2	1.6	354.7	1.1	119
12	N_2	9.8	119.3	9.3	110
13	M_2	47.7	134.8	50.6	140
14	L_2	3.3	152.0	3.5	155
15	S_2	29.4	208.0	24.3	211
16	$2SM_2$	1.3	124.4	2.0	290
17	K_2	8.0	213.9	8.8	188
18	ν_2	1.9	121.4	0.8	209
19	T_2	1.7	205.0	0.9	29
	4) Third Diurnal Tide				
20	MO_3	0.9	297.8	1.0	281
21	M_3	0.8	230.4		
22	MK_3	0.8	67.4	0.7	284
	5) Quarter-Diurnal Tide				
23	MN_4	0.1	5.6		
24	M_4	0.4	68.6	0.3	188
25	SN_4	0.3	267.6		
26	MS_4	0.9	39.2	0.3	243
	6) Sixth-Diurnal Tide				
27	$2MN_6$	0.2	260.0		
28	M_6	0.1	37.8	0.1	258
29	MSN_6	0.2	233.9		
30	$2MS_6$	0.2	148.4	0.1	134
31	$2SM_6$	0.6	68.7		
	7) Annual and Semi- Annual Tide				
32	Sa	-	-	38.1	295
33	Ssa	-	-	12.2	240

The results show that diurnal tide constituent K_1 prevails in relevant water, followed by M_2, O_1, S_2 and P_1. The tide type is given from :

$$(K_1 + O_1)/(M_2 + S_2) = 1.41 - 1.46.$$

This means the tide type in the study area is a mixed tide of a single day tide and a double day tide.

The monthly variation of Mean Tide Level (MTL) at Ko Sichang is shown in Fig. 3-2-5 for recent data.

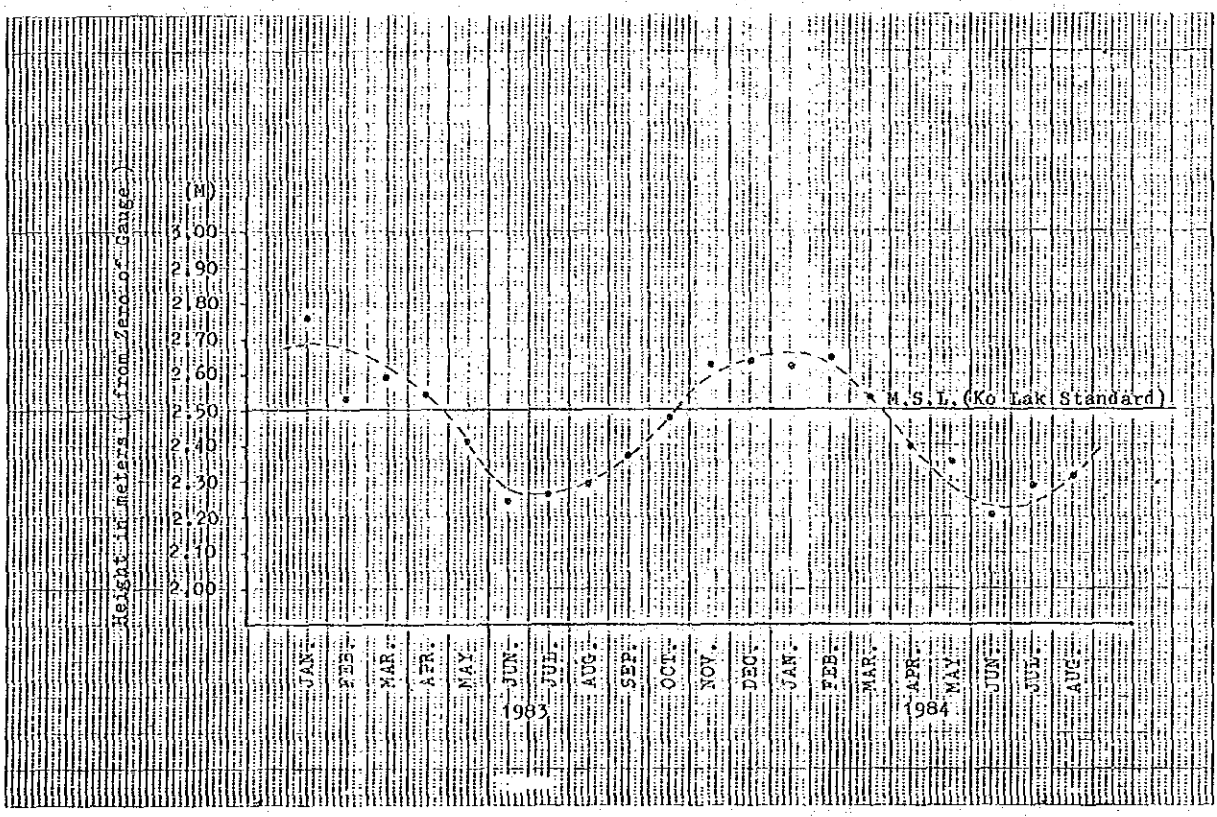


Fig. 3-2-5 Monthly Mean Tide Level (MTL)
at Ko Sichang

Next, a statistical analysis for tide levels was performed about the frequency of occurence of water levels using the hourly predicted levels at Ko Sichang from Tide Tables, 1984 by the Hydrographic Department of Royal Thai Navy.

The frequencies of the water levels at Ko Sichang are summarized as shown in Table 3-2-4.

Table 3-2-4 Frequency of Water Levels at Ko Sichang

Level above MSL (m)	Numbers of Frequency		Level below MSL (m)	Numbers of Frequency	
	Nos.of Hour per year	Percentage (%)		Nos.of Hour per year	Percentage (%)
			2.25-2.01	5	0.1
			2.00-1.76	89	1.0
1.75-1.51	33	0.4	1.75-1.51	259	3.0
1.50-1.26	142	1.6	1.50-1.26	414	4.7
1.25-1.01	422	4.8	1.25-1.01	401	4.6
1.00-0.76	747	8.5	1.00-0.76	506	5.8
0.75-0.51	1,286	14.6	0.75-0.51	544	6.2
0.50-0.26	1,320	15.0	0.50-0.26	706	8.0
0.25-0.00	1,083	12.3	0.25-0.01	827	9.4
Sub-Total	5,033	57.2	Sub-Total	3,751	42.8
TOTAL	8,784 Hours (366 Days) (100%)				

Considering the results of the tidal harmonic analysis and simultaneous observations of tides at Ko Sichang and Laem Chabang, the characteristics of tides at Ko Sichang and Laem Chabang can be said to be nearly same.

(2) Tidal Currents

The results of the tidal current observation at the offshore area of Laem Chabang by the Harbour Department show that the maximum velocity is 53.0 cm/sec with the direction of 210 degrees (SSW).

A harmonic analysis was done using the above-mentioned existing data and the results are shown in Table 3-2-5 and Fig. 3-2-6 regarding the representative observation station, which was situated at about 1.7 kilometer west off Laem Chabang.

The results of the harmonic analysis show that Semi-Diurnal Current and Diurnal Current are predominant on this area, and the velocity of Constant Current, namely Residual Current, is less than 10 cm/sec with the direction of 254 degrees (WSW).

The tidal current ellipse shows that the principal direction of tidal currents is norht northeast - south southwest as shown in Fig. 3-2-6.

Table 3-2-5 Harmonic Analyzed Results of Tidal Currents

Area : Laem Chabang
Position : 1.7 km west of Laem Chabang (St. No.1)
Co-ordinate : 13° 4.65' N, 100° 51.63' E
Depth : 1.0 m below sea surface
Duration : 25 hours from 9 : 00 of May 23, 1974

CONSTITUENT	NORTH		EAST		MAJOR			MINOR		
	VEL. (cm/s)	KAPPA (°)	VEL. (cm/s)	KAPPA (°)	DIR. (°)	VEL. (cm/s)	KAPPA (°)	DIR. (°)	VEL. (cm/s)	KAPPA (°)
Constant	-1.14	-	-4.01	-	254	4.17	-	-	-	-
Diurnal	16.93	27	7.78	35	24	18.61	28	114	1.03	118
Semi-Diurnal	30.08	315	11.70	315	21	32.27	315	111	0.05	45
Quarter-Diurnal	6.84	355	2.78	28	19	7.24	359	109	1.43	89

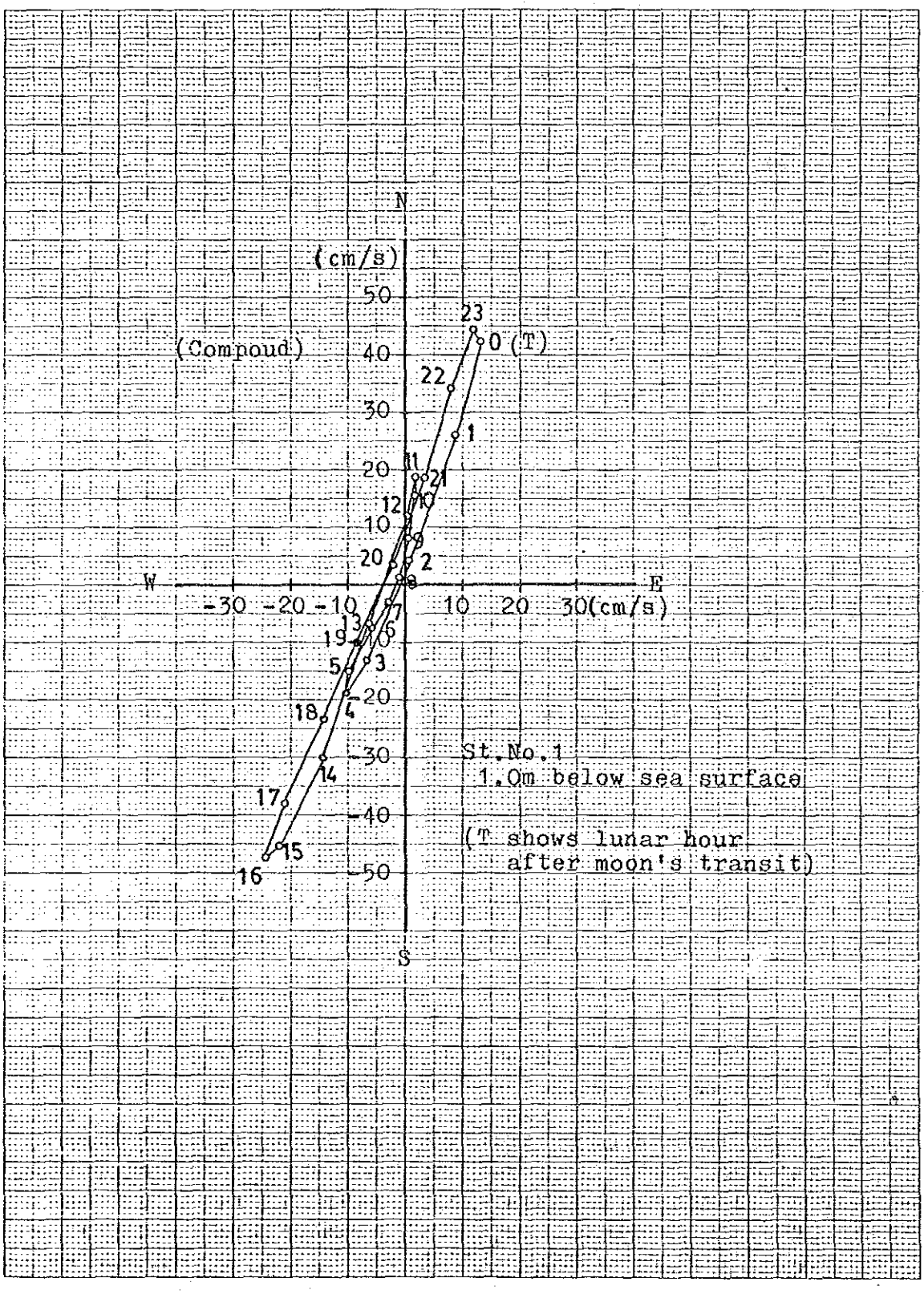


Fig. 3-2-6 Tidal Current Ellipse

(3) Waves

The waves were observed by NEDECO at approximate two kilometers south off Laem Chabang. The wave prediction was also computed using wind data. As a result, the followings are reported.

The waves which may be expected at Laem Chabang are almost exclusively generated in the Bay of Bagnkok by local winds. Significant wave heights exceeding two meters seem hardly possible.

The period of the waves varies between two and four seconds with only very few exceeding four seconds and none exceeding five seconds.

The coastal area development study team of Laem Chabang proposes a wave height of two meters as a design wave for port planning.

3-2-5 Water Qualities and Sea Bottom Materials

(1) Water Qualities

The Hydrographic Department of Royal Thai Navy conducted the cruise as being a part of five years oceanographic research project (1978 - 1982).
The results on the offshore area of Laem Chabang on February 1 to 26, 1981 show the following distributions.

Temperature is around 28°C and becomes lower as the depth increases, and Salinity is 32.2 to 32.5 o/oo and becomes higher as the depth increases contrary to temperature.

On the other hand, Density (σ_t) ranges 20.4 to 20.6 and Dissolved Oxygen ranges 4.6 to 4.8 ml/l.

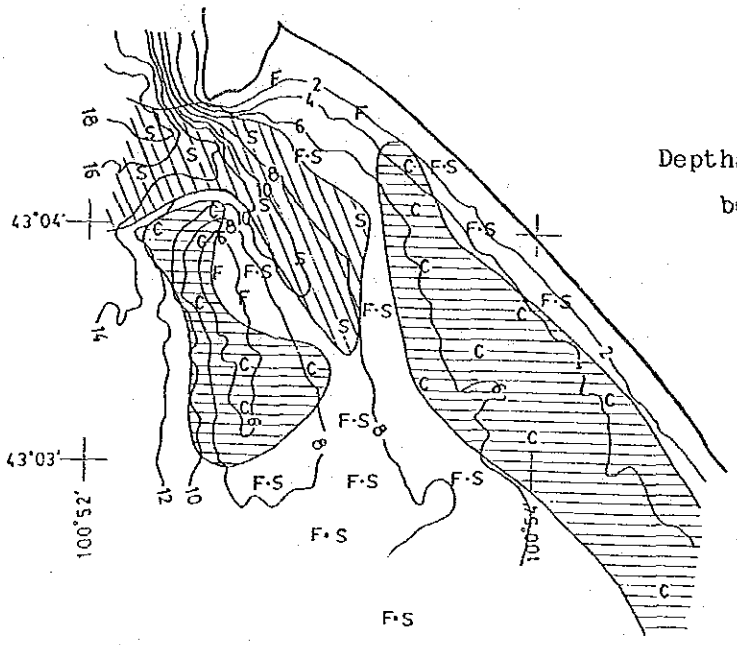
(2) Sea Bottom Materials

The composition of the upper layer of the sea bottom on the offshore area of Laem Chabang is reported by NEDECO as shown in Fig. 3-2-7.

The main composition are coarse sand, fine sand, fine sand with silt, and pure silt. The coarse sand distributes around the shoal at the offshore area and in depth of 2.0 to 3.5 meters CDL off the shoreline.

The very fine silt has been found in the channel off Laem Chabang more than 4.5 meters in depth.

Fine sand and mixtures of fine sand and silt appears in the transition between these extremes and in a narrow strip below low water along the shore.



S : silt mud with shells & some sand

F : fine sand with some silt & shells

C : coarse sand with some silt & shells

(after NEDECO, 1972)

Fig. 3-2-7 Distribution of Sea Bottom Materials

3-2-6 Meteorology

(1) Winds

The climate over the study area is of the monsoon type with northeasterly winds during November to February and southwesterly winds during May to September.

The velocity of winds is generally weak. Monthly average velocities vary from 1 to 4 m/sec and the daily maxima are three to four times as high.

Strong winds are rare and occur mainly in the transitional period of the monsoon. The velocities may exceed 20 to 30 m/sec during short periods.

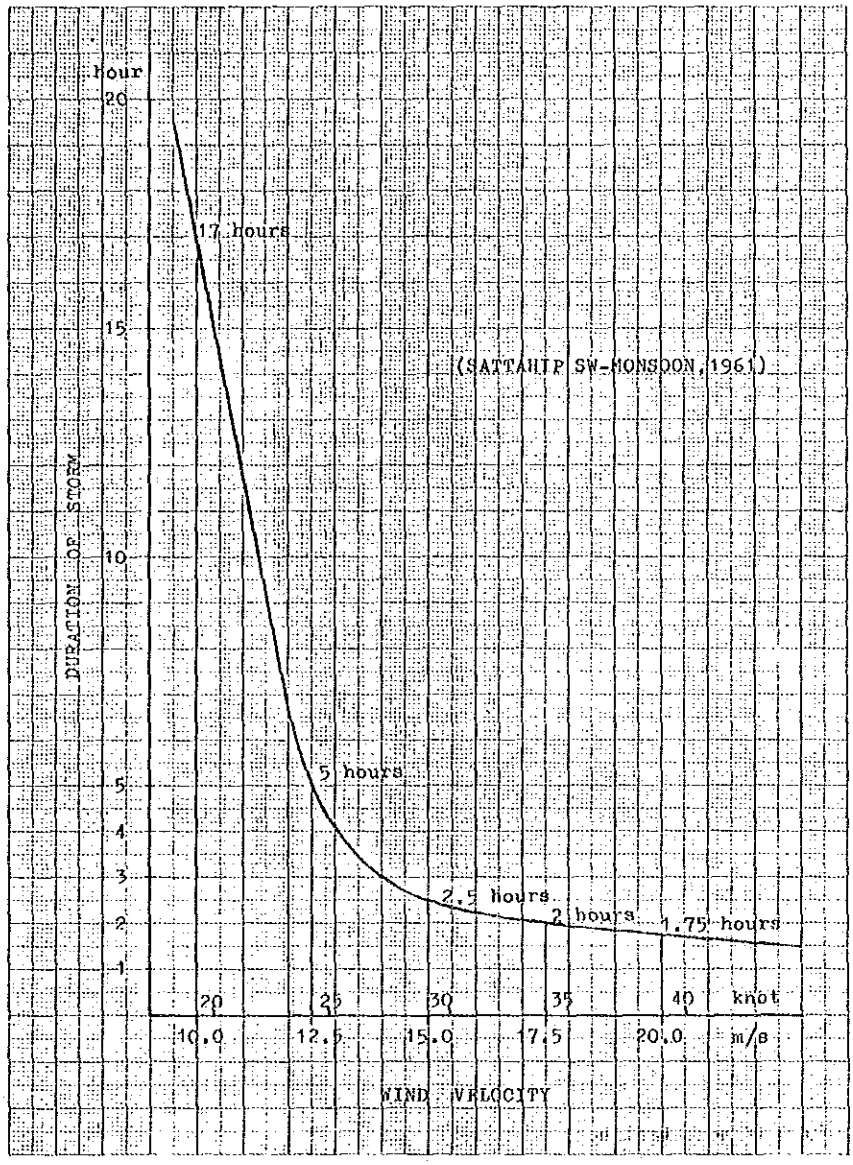
The nearest meteorological stations, of which long records are available, are situated at Ko Sichang and Chonburi. The monthly maximum wind velocities at both stations are shown in Table 3-2-6 in the period of 1951 to 1980.

It should be emphasized that the stronger winds are of relatively short duration as shown in Fig. 3-2-8.

Table 3-2-6 Monthly Maximum Wind Velocity (1951 - 1980)

Unit : Knot

Month	Chonburi Station		Ko Sichang Station	
	Wind Vel.	Wind Dir.	Wind Vel.	Wind Dir.
Jan.	40	NE	30	NE
Feb.	36	S,SW	27	NE
Mar.	37	NNE,SW	33	N,WNW
Apr.	50	ENE	40	NE
May	47	S,SSW,W,NW	50	W
Jun.	55	SW,W	45	W
Jul.	55	W	50	W
Aug.	55	SW	50	W
Sep.	60	W	48	W
Oct.	63	S	30	E
Nov.	40	NE,S	28	NNE,NE
Dec.	37	NE	32	E
Max.	63	S	50	W



(modified from NEDECO)

Fig. 3-2-8 Duration of Strong Winds

(2) Rainfalls

Monthly and annual average rainfalls at Chonburi station and Ko Sichang station are shown in Table 3-2-7 as well as extreme rainfalls in a year. The period of the average and extreme is 1951 to 1983 at Chonburi and 1959 to 1983 at Ko Sichang.

Table 3-2-7 Monthly and Annual Rainfalls

Unit: mm

St.	Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
CHONBURI	Average	12.0	24.9	37.7	78.7	162.8	128.8	162.0	170.8	296.0	215.5	62.9	8.7	1,360.8
	Extreme (Year)	90.2 ('76)	172.1 ('58)	163.6 ('52)	301.7 ('74)	373.9 ('54)	453.9 ('82)	442.0 ('51)	408.6 ('83)	657.9 ('63)	557.8 ('57)	238.5 ('51)	60.1 ('70)	1,744.3 ('63)
KO SICHANG	Average	6.7	29.8	87.7	41.9	169.4	114.7	125.4	122.6	296.1	271.4	62.1	13.8	1,261.6
	Extreme (Year)	62.6 ('78)	190.2 ('78)	139.0 ('82)	106.2 ('74)	391.6 ('64)	263.1 ('78)	389.1 ('83)	430.3 ('71)	638.4 ('81)	736.5 ('74)	196.1 ('70)	137.5 ('70)	1,892.9 ('74)

(3) Others

Other climatological data, namely Pressure, Temperature and Relative Humidity, at Chonburi station and Ko Sichang station are shown in Table 3-2-8.

3-2-7 Earthquakes

A seismic probability map for Thailand and neighbouring regions is shown in Fig. 3-2-9.

The eastern sea board in Thailand is an area of no seismic activity.

Table 3-2-8 Climatological Data for Period 1951 - 1980

Station : CHONBURI

Latitude : 13° 22' N
Longitude : 100° 59' E

Elevation of station above MSL : 1 m
Height of barometer above MSL : 2 m
Height of thermometer above ground : 1.50 m

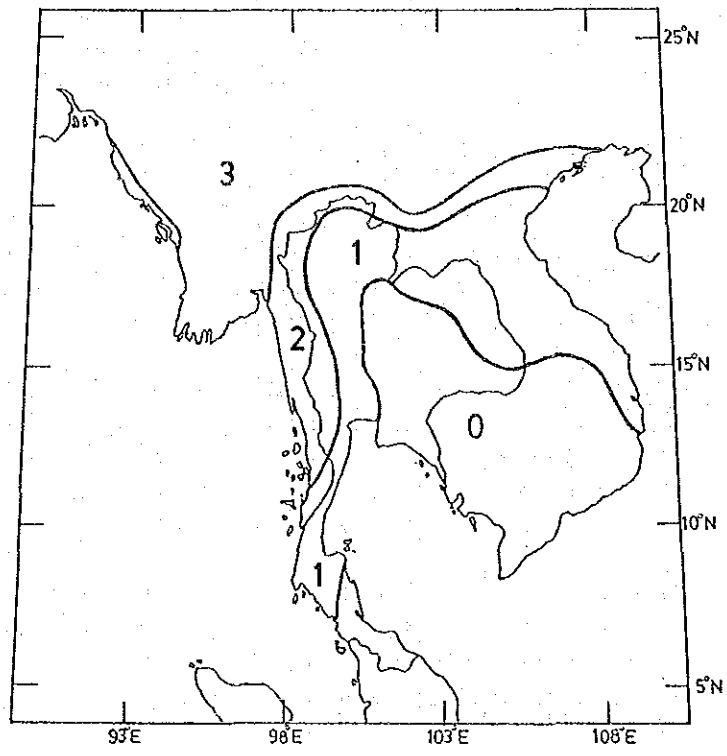
Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
PRESSURE (+1000 or 900 mbs.)													
Mean	12.44	11.25	10.15	8.74	7.17	6.67	6.82	6.85	7.74	9.92	11.61	12.52	9.32
Ext. Max.	25.28	20.65	19.80	18.00	14.29	13.39	14.89	13.49	15.79	17.79	21.09	21.89	25.28
Ext. Min.	3.74	3.04	2.44	1.14	99.44	97.44	98.72	99.44	98.74	99.49	4.27	3.50	97.44
Mean Daily Range	4.61	4.67	4.72	4.61	4.25	3.67	3.50	3.76	4.23	4.42	4.33	4.48	4.27
TEMPERATURE (℃)													
Mean	25.9	27.4	28.8	29.6	29.3	28.9	28.6	28.3	27.8	27.4	26.6	25.8	27.9
Mean Max.	31.5	32.2	33.3	34.2	33.4	32.6	32.0	31.7	31.5	31.6	31.4	31.5	32.2
Mean Min.	20.2	22.5	24.3	25.5	25.5	25.5	25.1	25.0	24.5	23.8	22.1	20.4	23.7
Ext. Max.	37.5	37.6	37.8	38.4	38.2	37.1	35.9	35.8	35.5	35.9	36.2	36.7	38.4
Ext. Min.	9.9	16.5	17.5	20.4	21.2	21.0	20.5	20.9	20.6	17.9	14.2	12.0	9.9
RELATIVE HUMIDITY (%)													
Mean	68.0	72.0	72.0	73.0	76.0	75.0	76.0	77.0	81.0	81.0	74.0	67.0	74.0
Mean Max.	85.0	87.8	87.5	87.4	88.6	87.7	88.6	89.6	92.3	92.6	88.6	84.4	88.3
Mean Min.	51.2	55.5	56.1	56.2	60.4	61.3	62.4	63.4	66.6	65.4	55.9	48.6	58.6
Ext. Min.	20.0	22.0	19.0	26.0	32.0	42.0	43.0	43.0	46.0	32.0	24.0	22.0	19.0

Station : KO SICHANG

Latitude : 13° 10' N
Longitude : 100° 48' E

Elevation of station above MSL : 25 m
Height of barometer above MSL : 26 m
Height of thermometer above ground : 1.20 m

Item	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
PRESSURE (+1000 or 900 mbs.)													
Mean	12.49	11.54	10.41	9.00	7.24	6.80	6.77	6.83	7.70	9.78	11.38	11.81	9.31
Ext. Max.	22.25	20.21	20.04	17.05	14.36	13.32	13.43	13.73	14.62	17.33	19.77	20.66	22.25
Ext. Min.	5.43	4.76	3.42	1.89	99.68	98.19	98.60	0.14	98.79	1.95	4.62	4.34	98.19
Mean Daily Range	4.37	4.39	4.61	4.53	4.08	3.45	3.27	3.54	4.10	4.34	4.23	4.23	4.09
TEMPERATURE (℃)													
Mean	26.7	27.8	29.0	30.2	29.9	29.5	29.0	28.9	28.2	27.7	27.2	26.7	28.5
Mean Max.	28.7	30.6	31.7	33.0	32.3	31.8	31.3	31.2	30.7	30.4	30.1	29.8	31.1
Mean Min.	22.3	24.2	25.7	26.9	26.7	26.7	26.3	26.0	25.2	24.5	23.8	22.5	25.1
Ext. Max.	34.8	34.4	35.8	36.9	36.2	35.4	34.5	33.7	34.8	33.0	33.6	33.2	36.9
Ext. Min.	15.2	18.4	20.0	21.2	22.5	21.8	21.6	21.9	21.8	19.0	15.5	15.0	15.0
RELATIVE HUMIDITY (%)													
Mean	67.0	71.0	72.0	72.0	74.0	73.0	74.0	75.0	74.0	79.0	71.0	65.0	73.0
Mean Max.	80.4	84.5	84.4	83.0	83.8	81.5	82.8	83.6	87.9	88.4	81.3	77.4	83.3
Mean Min.	56.0	61.0	63.4	62.1	65.7	65.8	67.0	67.1	70.1	69.7	62.0	55.5	63.8
Ext. Min.	29.0	31.0	31.0	39.0	43.0	52.0	54.0	52.0	49.0	39.0	34.0	29.0	29.0



(after B.Tanittiraporn, 1983)

LEGEND

Zone 0 - No damage

Zone 1 - Minor damage

Zone 2 - Moderate damage

Zone 3 - Major damage

Fig 3-2-9 Earthquake Probability Map

3-3 Environmental Conditions

The repair shipyard is scheduled to be constructed as a part of the Laem Chabang Deep-Sea Port Project, and it will be constructed on the reclaimed land where is the sea waters of 4 to 5m depth at present. In connection with such port project, the survey team of JICA is just about to complete the feasibility study for a hinterland industrial estate development project (Study on the Development Project of Laem Chabang Coastal Area, hereinafter referred to as development project) in 1984. The infrastructure improvement for Laem Chabang area is planned in compliance with the above development project. There appears no problem for the repair shipyard infrastructure if the above development project proceeds on schedule.

Thus, the following points are necessary for smooth the planning of this repair shipyard project:
A reclamation work should be completed by early 1987, since the construction of the repair shipyard will be started, and the infrastructure should be improved by 1990, under the consideration of actual repair shipyard operation.

3-3-1 Land

The site prepration of the repair shipyard will be made as a part of the Deep-sea Port Project planned by PAT. The allocated area is 200,000m^2 (400m x 500m). Out of such area, 90,000m^2 (300m x 300m) will be used for the repair shipyard, at the time of begining and the remaining areas will be reserved for the future expansion. The site will be reclaimed by dredged soil on the sea route after it is encircled with a riprap revetment with a slope of 1 : 2.

3-3-2 Road

4-lane highway between Bangkok and Laem Chabang is nearly completed, 3km randomly paved road with a width of approx. 4m is currently connected between the above highway and proposed repair shipyard area. In the development project, the improvement of a road network having a sufficient width between the highway and port is planned.

3-3-3 Water Supply

The feasibility study for supply of raw water to Laem Chabang from Nong-Koh reservoir has been completed by JICA. In the development project, there is a plan for supplying filtrated water to each factory of the industrial estate and also to the repair shipyard. The required quantity for the repair shipyard is shown below and all of it being supplied from outside,

Peak load per day ..... 800 Ton
Average required quantity per month ..... 10,000 Ton

3-3-4 Power Supply

115 kV and 230 kV transmission lines from Ao Phai Substation (to be located about 5km north of the project area) to the proposed development area are presently installed. 1,800 MW thermal power plant is planned at Ao Phai area, thus power supply will be sufficient. The required quantity for the repair shipyard is shown below and all of it will be supplied from outside,

Peak load per hour ..... 2,600 kW
Average required quantity per month ..... 235,000 kW

3-3-5 Oxy-Acetylene Gas

(1) Acetylene Gas

Acetylene gas is used for steel fabrication in the Thai shipyards at present. The required quantity per day for the repair shipyard is 120 m^3 and all of it will be supplied from outside.

(2) Oxygen

The required quantity per day is 500 m^3 and all of it will be supplied from outside easily.

3-3-6 Tug Boat, Floating Crane, and Mobile Crane

(1) Tug Boat

Tug boats will be hired or leased from the PAT that governs the Leam Chabang Sea Port for the efficient operation of the repair shipyard.

(2) Floating Crane and Mobile Crane

Floating cranes and mobile cranes will be hired and leased for the construction and operation of the repair shipyard.

3-3-7 Communication

Though electrical communication facilities are not so in satisfactory condition at present, they have rapidly developed in these ten years. Now a continuing expansion program is under way to achieve far efficient communication services.

The repair shipyard will be able to sequre excellent communication facilities because of the site being constructed in the area included in the Development Project of Laem Chabang Coastal Area.

3-3-8 Labor Force

It is necessary to employ engineers and skilful workers preferably from Bangkok area but unskilled workers will be employed in the near-by Chon Buri and Si Racha.

3-3-9 Miscellaneous

(1) Housing

The Development Project of Laem Chabang Coastal Area include the development of industrial parks and new towns. The housing project is planned in the housing areas. These projects are scheduled to be executed by the repair shipyard operation commencement.

(2) Ship Inspection Agency

The HD executes ship inspection for the Government of the Kingdom of Thailand. The ships to be repaired by the repair shipyard will have to be surveyed or inspected by the relevant classification societies since almost all vessels are "Class-Boats". The inspection will be carried out smoothly since there are branch offices of NK, LRS, ABS, BV, available in Bangkok.

(3) Regulations

The regulations mentioned below will have to be applied during the construction and operation of the repair shipyard.

1) Labor-related
   A) Minimum wage, dismissal allowance, overtime extra pay
   B) Working hours
   C) Compensation for workmen's accidents
   D) Labor union

2) Anti-pollution measures
   Manual of NEB;
   Guidelines for Preparation of Environmental Impact Evaluations
   National Environment Board: April, 1979

3-4 Facilities Planning

3-4-1 Basic Principles

In ship repairing, an adequate system must alway be established to meet the actual situation of vessels because the details of job are obtained only after arrival of ships to the repair shipyards or the ship owners inform the yard in advance. Possiblities of hazardous accidents are existent in ship repairing, so, previous careful arrangements must be made to prevent them by all means. Particular attention must be paid well in advance of the job start because insufficient arrangements may result in the unexpected disasters, serious damage to the owner, and sometimes even human injuries.

To this yard highly efficient layout in a comfortable environment has been planned to secure the best result with the minimum investment, under the considering of the above.

(1) The initial investment has been reduced to minimum because of the fact that ship repairing needs very big capital investment and its pay back period takes a long time.

(2) Under the consideration of diversity and complexity of ship repair details, some machines and tools are preferably obtained on lease to reduce the initial investment.

(3) The hull fabrication shop necessary for the repair of damaged ships has to be constructed with the capacity of handling steel members of land structures such as bridges and buildings to improve the rate of business activities.