

- (4) Optimum facilities planning has been made in due consideration of the geological survey results at the site and its natural environmental conditions.
- (5) Careful attention has been paid to the production system in the yard because the industries related to shipbuilding have not fully developed in Thailand.
- (6) Tug boats are to be chartered on lease condition because of less initial investment and their low operation ratio.
- (7) All work machines are preferably of the same type or make for the conveniences of parts interchangeability and maintenance.
- (8) With regard to yard service facilities such as compressors and dock draining pumps, each unit is preferably be of half or so in capacity in suitable numbers up to their required level to avoid overall failure.
- (9) The arrangements of the facilities have to be intended for possible expansion in future.
- (10) A jetty is to be built to secure suitable water depth at the site.

#### 3-4-2 Basic Plan of Shipyard Facilities

##### (1) Shipyard Site

The yard ground level is to be 3m above the mean sea level (MSL).

The repair shipyard has been planned to be located in the north of the reclaimed land under the consideration of adjacent agri-bulk jetty for the cargo handling and manoeuvring of big vessels. (Refer to Fig. 3-4-1)

##### (2) Type of Dock

There are two typical types of ship repairing docks namely; floating and graving. The alternative of 20,000 DWT floating dock is studied in Section 4-1.

A graving type has been adopted because of the good survey results as follows:-

- (a) The nature of the soil at the dock construction site is sufficiently solid for graving dock construction.

- (b) In this project, the sea depth has been taken at 7.5m in front of the repair shipyard. In the case of the floating type, the depth will need at least 13.65m at the dock site area and require huge amount of dredging.
- (c) Though generally the graving type dock is more expensive than the floating one, in this case the former is thought to be economically better than the latter because of the excellent nature of the soil will make the dock construction cost less expensive and durable almost forever. In addition to the above, the maintenance cost is far lower because of less maintenance cost; only for pumps and gate with their accessories.
- (d) The floating type dock requires far complicated operation because of its condition of being always subjected against strong winds and high waves especially at the time when the ships are placed on it.
- (e) Docking and undocking operations of the graving dock are easier than the floating one.
- (f) The efficiency of ship repairing in the dock is much higher in the graving dock than in the floating one.

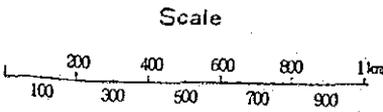
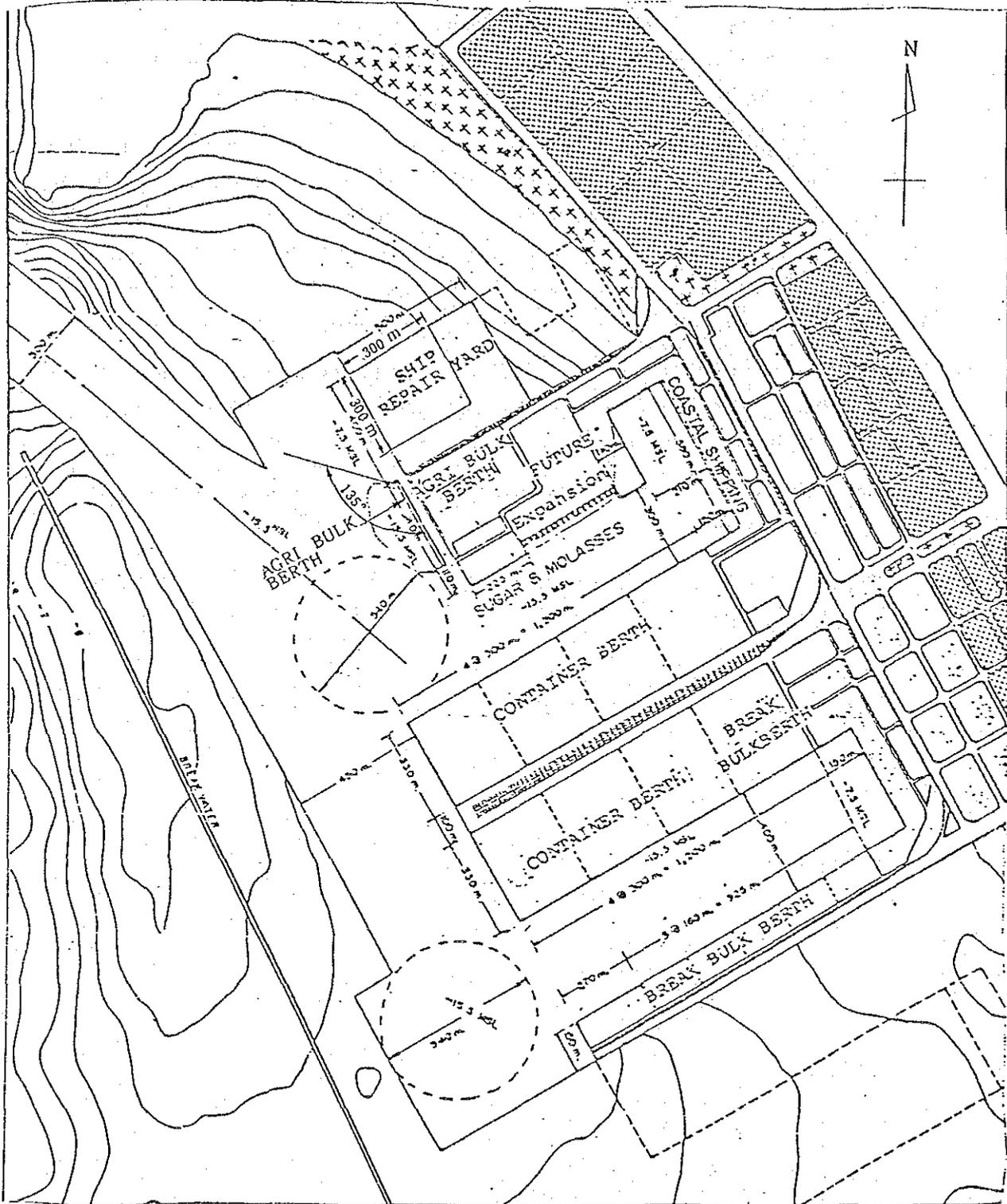


Fig. 3-4-1 Site of Large Repair Shipyard at Laem Chabang Area  
 (Source Study on The D.P.L.C.)

1) Dock Gate

Among many types of dock gates such as floating, flap, slide, the flap type is employed for its easy manipulation and quick action, under the consideration of high frequency of open and close operation.

2) Main Draining Pumps of the Dock

The capacity (Q) of a main draining pump is calculated as follows:

- Scheduled draining time ..... T
- Scheduled number of pumps ..... N
- Required draining quantity .....  $V=V_d - V_s$
- Quantity of the water in the dock  
without ships in it .....  $V_d$
- Displacement of the ship in the dock .....  $V_s$

$$Q = \frac{V/T}{N}$$

The draining time of a repair dock is scheduled to be 2 to 4 hours in most cases. As assuming the draining time for a 20,000 DWT ship in dock to be two hours (tide level MSL), the number of pumps is two, and the displacement of a 20,000 DWT is 9,000 m<sup>3</sup>, the pump capacity is calculated by means of the draining quantity estimated from Fig. 3-4-2.

$$\begin{aligned} V &= V_d - V_s = 175\text{m} \times 28\text{m} \times (1.6\text{m} + 0.5\text{m} + 4.5\text{m} + 1.5\text{m}) - 9,000 \text{ m}^3 \\ &= 39,690 \text{ m}^3 - 9,000 \text{ m}^3 \\ &= 30,690 \text{ m}^3 \end{aligned}$$

$$Q = \frac{V/T}{N} = \frac{30,690 \text{ m}^3/2}{2} = 7,670 \text{ m}^3/\text{hour}$$

3) Dockside Cranes

A crane is to be arranged at each side of the dock to carry out the efficient repairing job in a short time. A 20T level luffing crane is to be adopted for the south side side under the consideration of the weight of a screw propeller, a rudder, and a propeller shaft. A 10T level luffing crane is to be adopted for the north side considering the total weight of a "hull assembly block" with four to five shell plates attached to them.

(3) Dock Dimensions

The dry dock dimensions have been based on the average dimensions of a cargo vessel of 20,000 DWT (L=165m, B=23m),

Dock Length = 175m

Dock Breadth= 28m

Dock Depth = 11.1m

1) Dock length

The dock length has been decided to secure the necessary space for easy renewing and replacing rudders, propellers and propeller shafts.

2) Dock Breadth

The dock breadth has been decided to secure the sufficient dock bottom space, docking, undocking, and scaffolding for painting of outside shell.

3) Dock Depth

The dock depth has been decided taking into consideration the following items:

- The draft of the ships to be docked ..... 4.5m
- The height of keel and bilge blocks ..... 1.6m
- The height from the high tide level up to the ground level ..... 1.75m
- The height from the mean sea level up to the high tide level ..... 1.25m
- The clearance between keel block and hull bottom ..... 0.50m
- The height from the mean sea level up to the low tide level ..... 1.50m

Table 3-2-4 shows the relation between the tidal heights and the hours per year. Fig. 3-4-2 shows the figures related to dock depth decision.

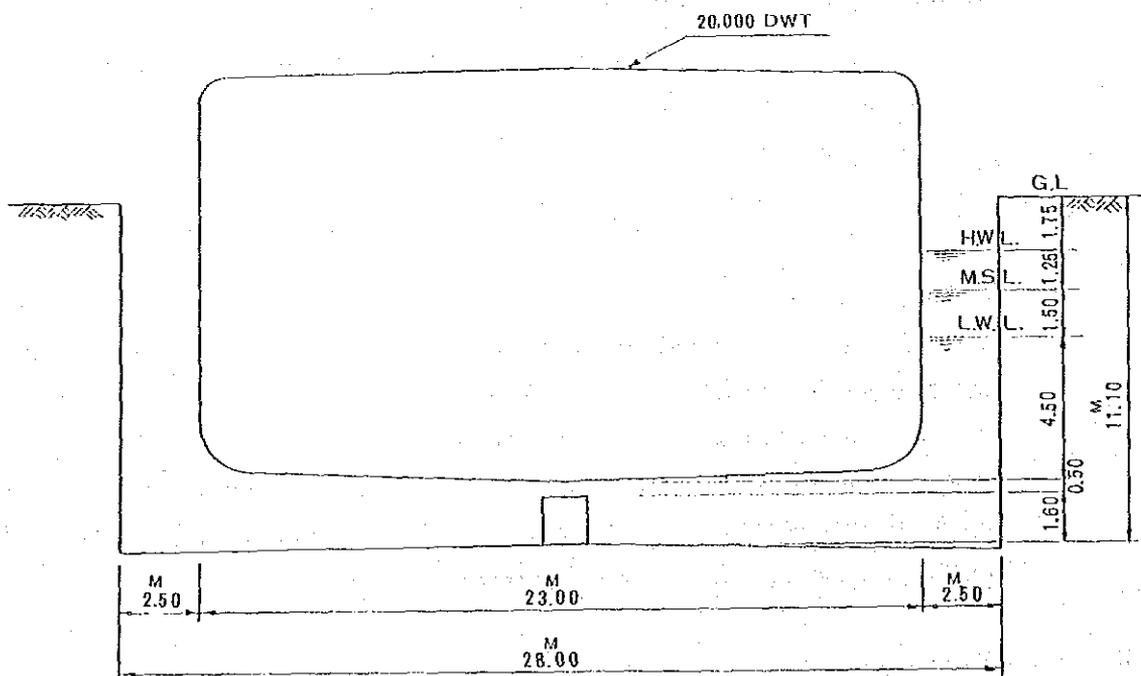


Fig. 3-4-2 Section of Dock for 20,000 DWT Vessel

(4) Service Facilities

1) Electricity

Electric power is supplied at 6.6 kV, 50 Hz from outside and a substation is to be built on the premises. The power is to be transformed and supplied through the substation and the transmission cubicles to the dock pump room, jetty and shops. It is preferred that the power is supplied at a high voltage of 6,600V or 3,300V to the dock pumps and the compressors. The power is to be supplied to other machines and tools at 380V or 220V. Various power distribution panels to the above as well as to ships are to be installed.

2) Water

Fresh water is supplied from outside. A water reserve tank is to be made. The water is to be distributed through the reserve tank.

3) Oxygen, Acetylene

Both are to be supplied from outside and stored at one place by means of pressure vessel and distributed through the pipe lines.

4) Compressed Air

Compressed air is to be supplied from the air compressors to the dock, jetty, and so on through pipe lines.

3-4-3 Layout of Repair Shipyard

Fig. 3-4-3 shows the arrangement of ship repairing facilities.

(1) Dock

A guard rail is to be laid on each side of the dock for the safety of docking worker's operation.

A level luffing crane of 5T/30m x 10T/20m, is to be installed on one side of the dock and one 10T/30m x 15T/20m on the opposite side, so that heavy materials such as rudder, propeller shaft, and propeller can be easily hoisted and lowered.

(2) Mooring Jetty

The jetty of 150m long is to be constructed at a right angle to the shore line for mooring ships. The level luffing crane of 5T/10T x 30m/45m type is to be

installed on the jetty which can reach the outside ship center line when two ships are moored side by side on one side of the jetty as shown in Fig. 3-4-3.

(3) Hull Fabrication Shop

The hull fabrication shop is to be located at the side of the dry dock to give priority to the repair of the damaged ships and also capable of handling various other works such as tanks, girders and bridges etc. Fig. 3-4-4 shows the inside layout.

(4) Work Shops

Various shops are located near the dock and the jetty.

1) Machinery Shop;

The machinery shop is to be arranged to do machining of tailshafts, propellers, and so on. Especially small lathes are to be available for bolt manufacturing. Fig. 3-4-5 shows the inside layout.

2) Carpenter Shop;

Various kinds of wood working machines are to be arranged to manufacture wooden articles. Fig. 3-4-6 shows the inside layout.

3) Sail Loft and Rigging Shop;

Sail loft is to consist of a marking floor place and a sewing shop where sewing machines are arranged. The rigging shop is to have work tables available for wire cutting and splice making. Fig. 3-4-6 shows the inside layout.

4) Engine Repair Shop;

A propeller pit is arranged for propeller job because the crane height is not sufficient. A chemical cleaning tank is to be made for the cleaning of engine parts.

5) Finishing Shop;

In the shop, work tables and grinders are to be arranged keeping as spacious floor area as possible to carry out efficient repair job of winches and others. Fig. 3-4-7 shows the inside layout.

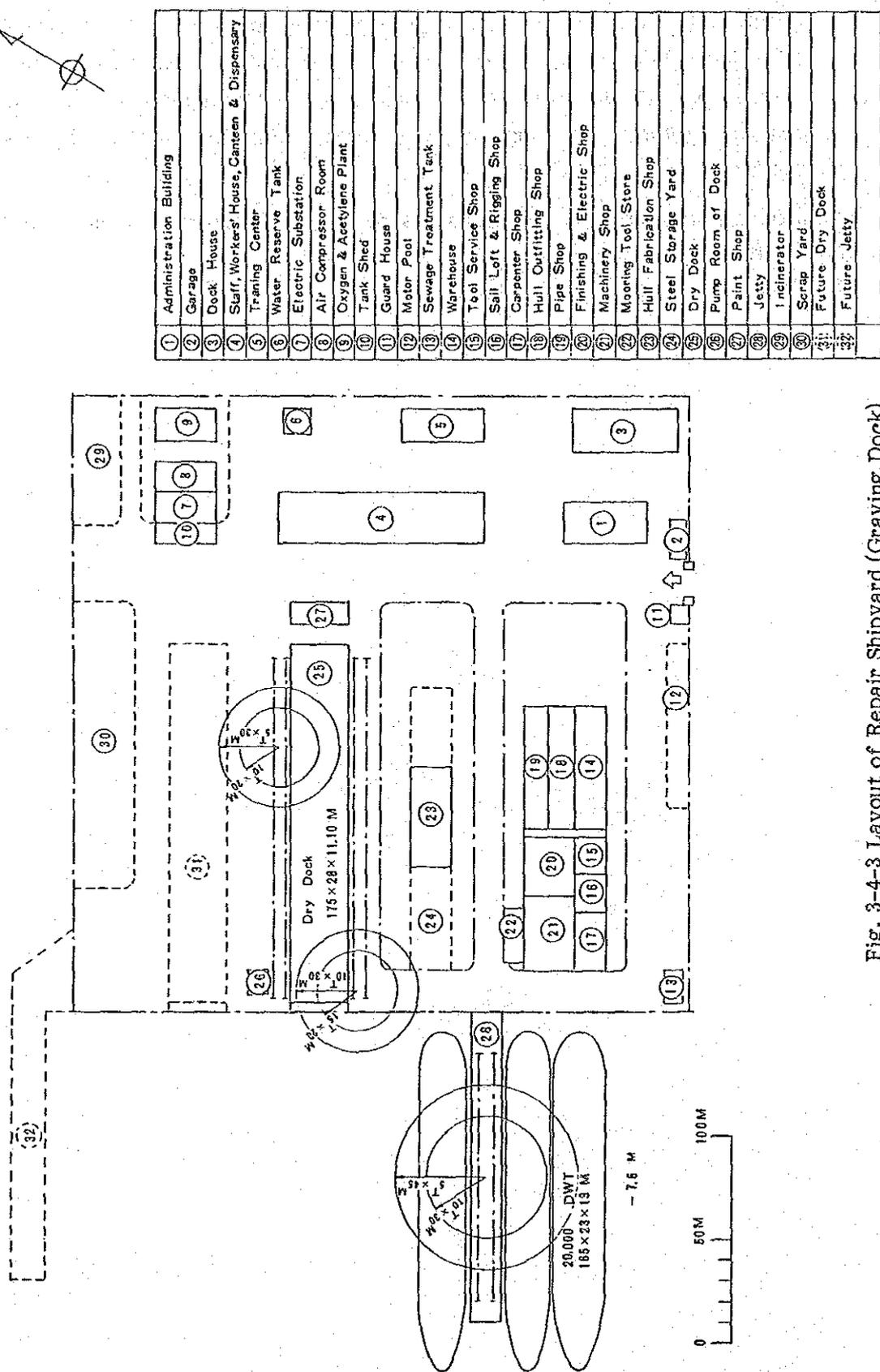
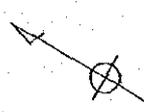
6) Electrical Shop;

A coil winding machine, a dryer, and a varnish treatment tank are to be arranged to repair electric motors. Fig. 3-4-8 shows the inside layout.

7) Hull Outfitting Shop;

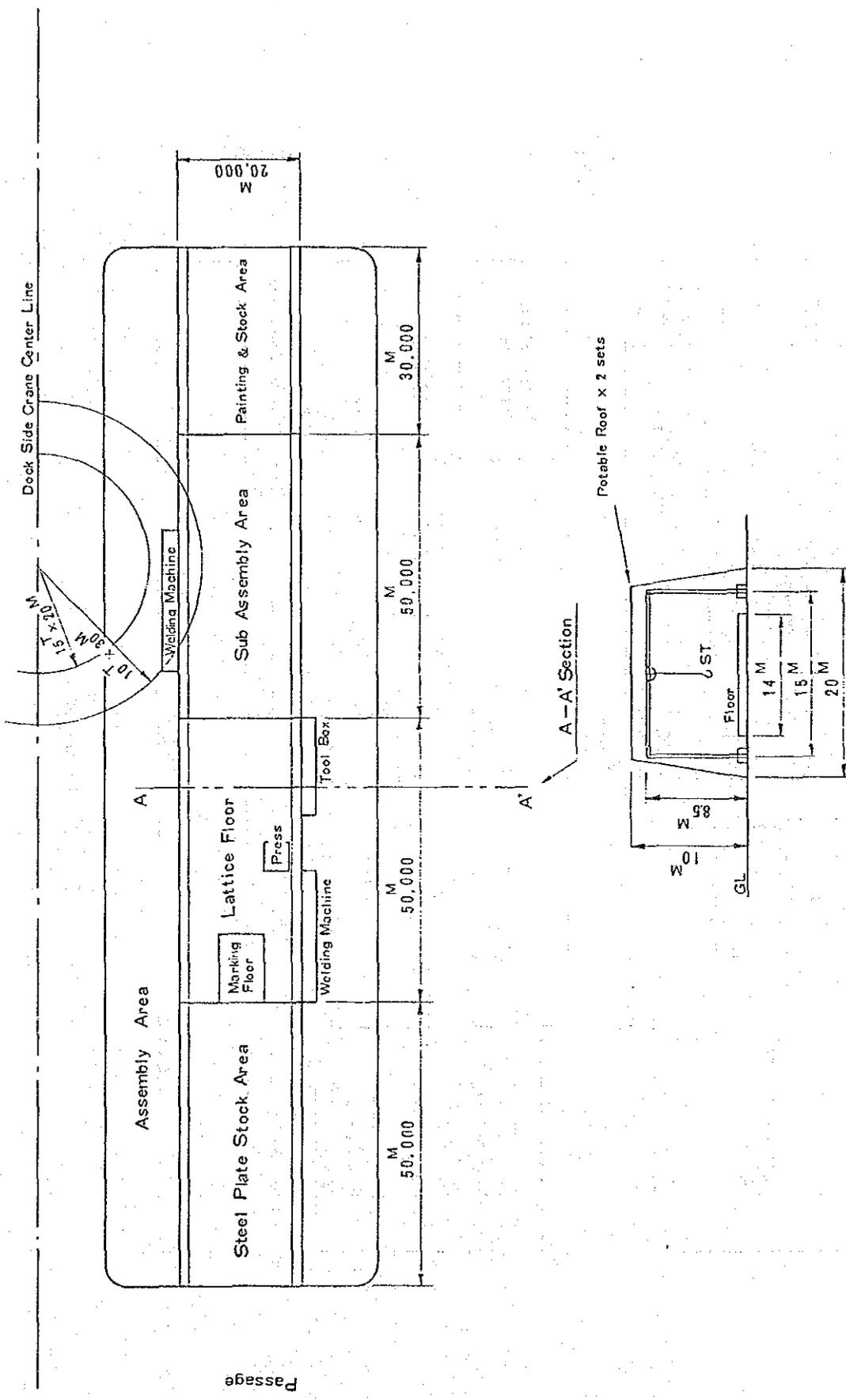
A material storage area, a marking area, a cutting area, and an assembly and welding yard are to be arranged one after another along in sequence of material processing flow. In a piping shop, a hydraulic testing place is arranged to carry out many hydraulic tests. Fig. 3-4-8 shows the inside layout.

In addition, a warehouse, a tool service shop and so on are to be arranged in to secure efficient job performances.



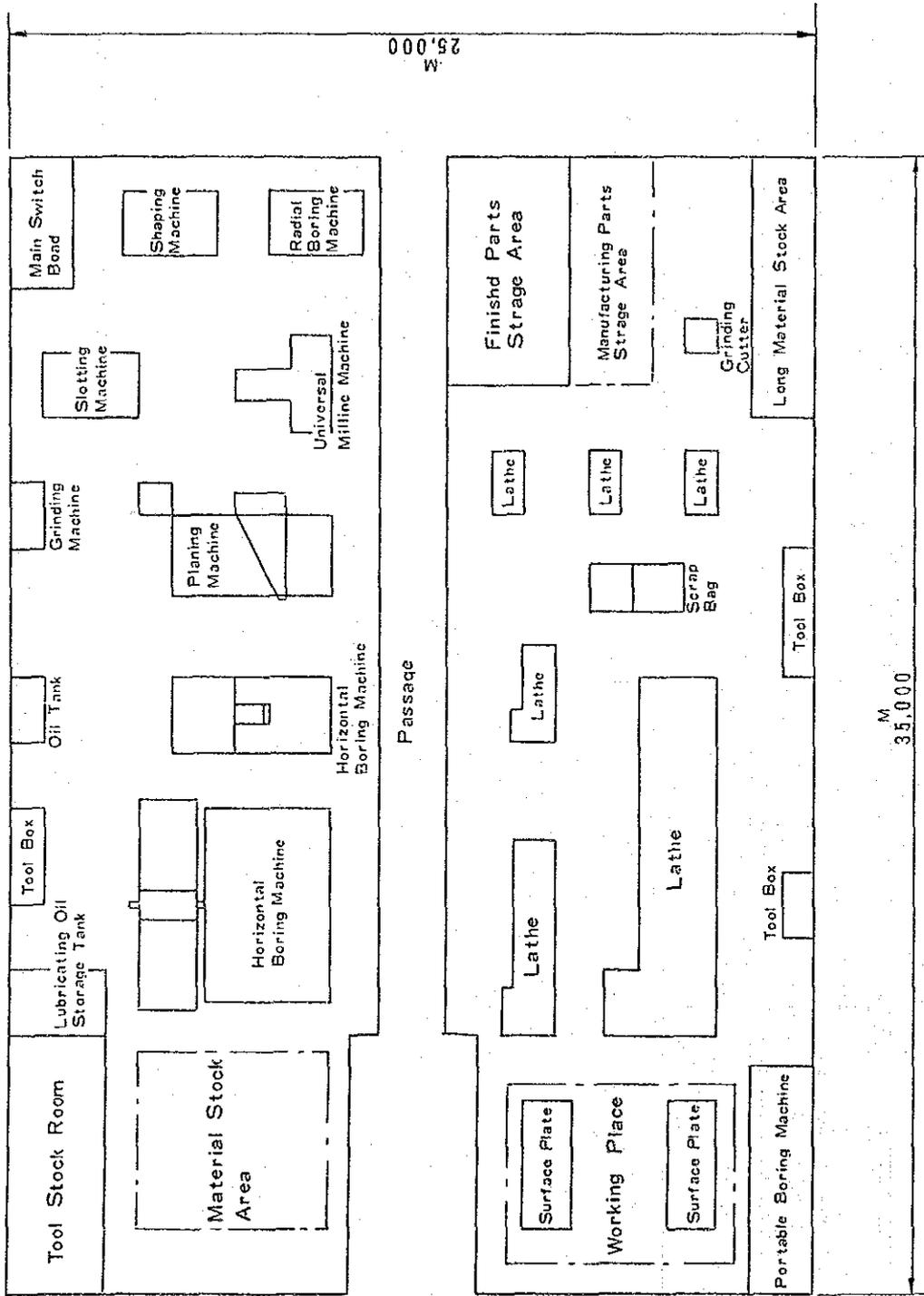
1	Administration Building
2	Garage
3	Dock House
4	Staff Workers' House, Canteen & Dispensary
5	Training Center
6	Water Reserve Tank
7	Electric Substation
8	Air Compressor Room
9	Oxygen & Acetylene Plant
10	Tank Shed
11	Guard House
12	Motor Pool
13	Sewage Treatment Tank
14	Warehouse
15	Tool Service Shop
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. 3-4-3 Layout of Repair Shipyard (Graving Dock)



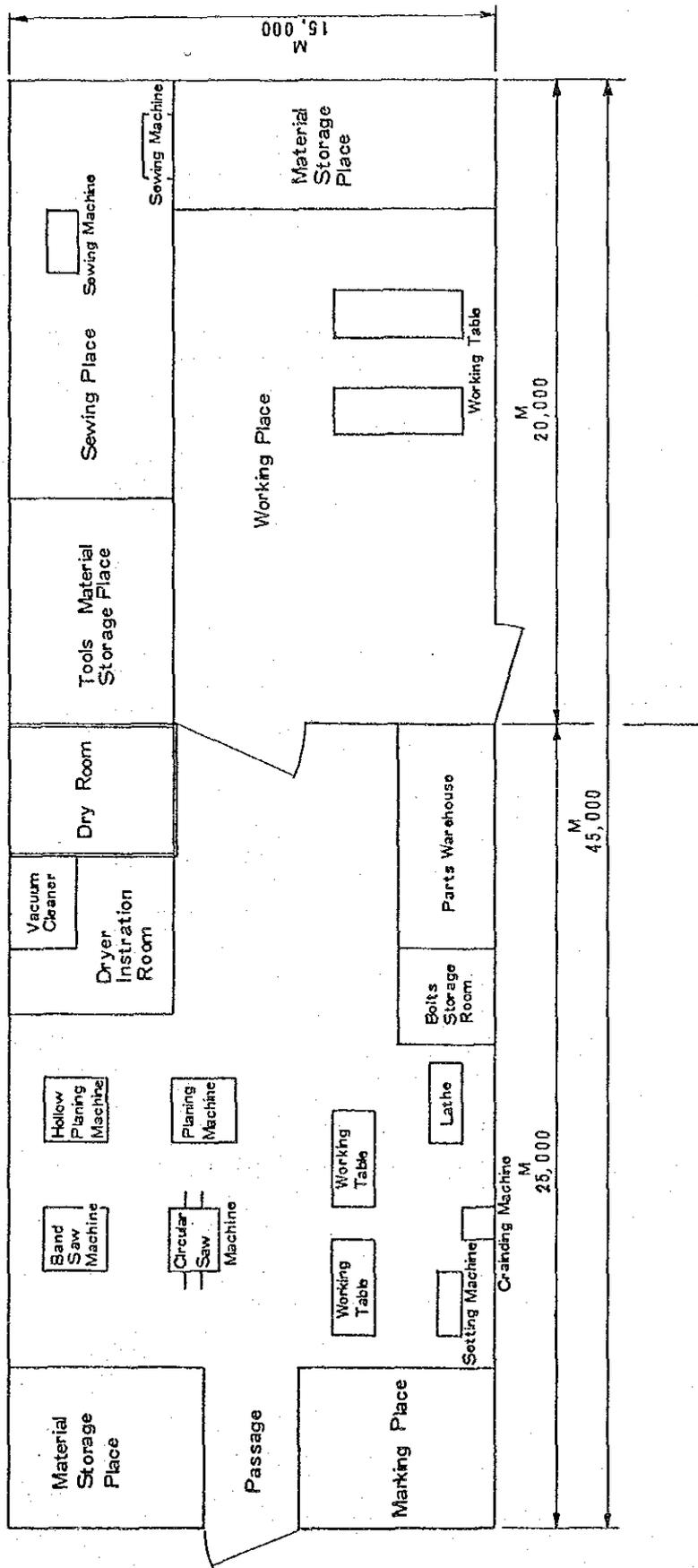
Note: ○ shows No. in Fig. 3-4-3

Fig. 3-4-4 (23) Hull Fabrication Shop



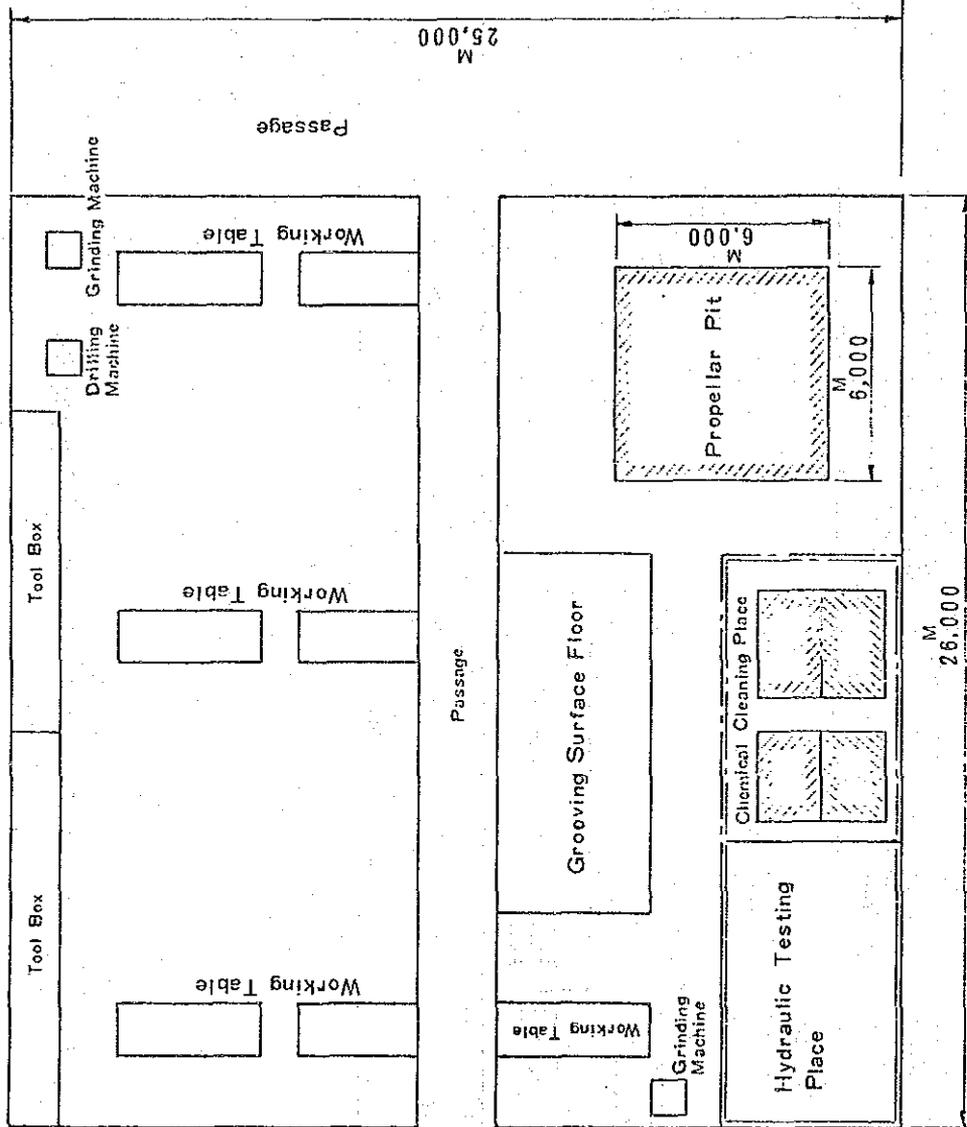
Note: ○ shows No. in Fig. 3-4-3

Fig. 3-4-5 (21) Machinery Shop



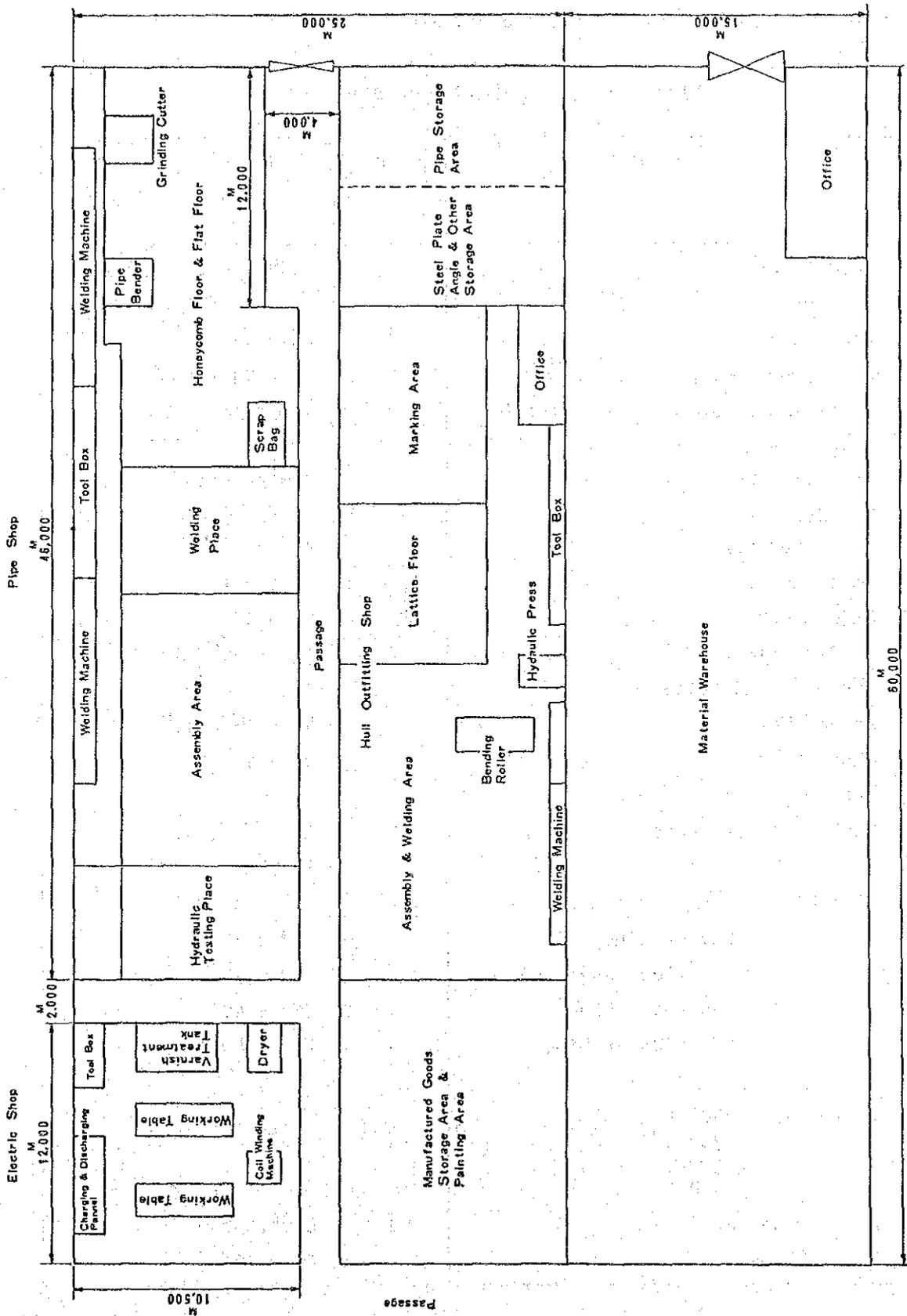
Note: ○ shows No. in Fig. 3-4-3

Fig. 3-4-6 ⑰ Carpenter Shop, Sail Loft and ⑱ Rigging Shop



Note: ○ shows No. in Fig. 3-4-3

Fig. 3-4-7 ② Finishing Shop



Note: ○ shows No. in Fig. 3-4-3

Fig. 3-4-8 19 Pipe Shop, Electric and 18 Hull Outfitting Shop

3-4-4 Specification of Facilities

Table 3-4-1 shows the specification of facilities.

Table 3-4-1 Specification of Facilities

No.	Item	No.	Main Particulars Principal Items
1	Yard Area		$300^M \times 300^M = 90,000^M2$
2	Dry Dock	1	$175^M \times 28^M \times 11.10^M$
	Dock Gate	1	Flap type
	Winch for Dock gate	2	$10^T \times 20$ M/Min
	Desilting Arrangement at Dock Gate	1	Water jet system
	Main Pumps	2	$8000^T/H \times 10^M$
	Auxiliary Pumps	2	$200^T/H \times 14^M$
	Sea Water Pump	1	$100^T/H \times 45^M$
	Sea Water Line	-	$4''\phi \times 300^M$
	Keel blocks	180	Load 60T
	Side Blocks	80	Load 40T
	Hauling Winchs	2	$10^T \times 20^M/Min$
	Carriers and Rails	2	$185^M \times 2$ pcs
	Access Tower	1	$4^M \times 5^M \times 10^M$
	Shore Ladder	3	$6^M - 10^M$
	Rubber Fender	4	
	Level Luffing Crane	2	$5^T/30^M \times 10^T/20^M$ $10^T/30^M \times 15^T/20^M$
	Pipe Line compressed Air Line	-	$4''\phi \times 400^M$
	Oxygen Line	-	$2''\phi \times 400^M$
	Acetylene Gas Line	-	$2''\phi \times 400^M$
	Sea Water Line	-	$4''\phi \times 400^M$
	Fresh Water Line	-	$4''\phi \times 400^M$
	Power Line 3300 V		
	380 V		
	220 V		
	110 V		
	A/C Arc Welders	50	500A. 300A
	Toilet Room	1	$4^M \times 10^M$

No.	Item	No.	Main Particulars Principal Items	
3	Jetty	1	150 <sup>M</sup> x 15 <sup>M</sup>	
	Mooring Winches	2	10 <sup>T</sup> x 20 <sup>M</sup> /Min	
	Rubber Fenders	52		
	Bits	12		
	Access Tower	2	4 <sup>M</sup> x 6 <sup>M</sup>	
	Shore Ladder		4	4 <sup>M</sup> x 2pcs
				6 <sup>M</sup> x 1pc
				10 <sup>M</sup> x 1pc
	Level Luffing Crane	1	5 <sup>T</sup> /45 <sup>M</sup> x 10 <sup>T</sup> /30 <sup>M</sup>	
	Pipe Line Compressed Air Line		4"∅ x 150 <sup>M</sup>	
	Oxygen Line	-	2"∅ x 350 <sup>M</sup>	
	Acetylene Line	-	2"∅ x 350 <sup>M</sup>	
	Fresh Water Line	-	3"∅ x 350 <sup>M</sup>	
	Sea Water Pump	1	100 <sup>T</sup> /H x 15 <sup>M</sup>	
	Sea Water Pipe		2"∅ x 150 <sup>M</sup>	
	Power Line 380 V			
		220 V		
A/C Arc Welder	30	500 <sup>A</sup> . 300 <sup>A</sup>		
Toilet	1	2" x 6 <sup>M</sup>		
4	Hull Fabrication Shop	1	20 <sup>M</sup> x 150 <sup>M</sup>	
	(Portable Roof)		Roof 20 <sup>M</sup> x 40 <sup>M</sup> x 2 pcs	
	Lattice Floor	1	14 <sup>M</sup> x 50 <sup>M</sup>	
	Hydraulic Press		500 <sup>T</sup>	
	Power Line 380 V			
		220 V		
	A/C Arc Welder	30	500 <sup>A</sup> . 300 <sup>A</sup>	
	Pipe Line Oxygen Line		-	2"∅ x 50 <sup>M</sup>
		Acetylene Line	-	2"∅ x 50 <sup>M</sup>
	Compressed Air Line	-	2"∅ x 50 <sup>M</sup>	
	Fresh Water Line	-	2"∅ x 50 <sup>M</sup>	
	Portal Crane	1	5 <sup>T</sup> H - 8 <sup>M</sup>	

No.	Item	No.	Main Particulars Principal Items
5.	Machinery Shop	1	35 <sup>M</sup> x 40 <sup>M</sup>
	Lathes	3	400 x 700
	Lathe	1	500 x 1,250
	Lathe	1	600 x 2,000
	Lathe	1	1,500 x 12,000
	Floor Type Horizontal Boring Machine	1	Main shaft 100 $\phi$
	Table Type Horizontal Boring Machine	1	Main shaft 80 $\phi$
	Planing Machine	1	Stroke 2 <sup>M</sup>
	Shaping Machine	1	" 0.6 <sup>M</sup>
	Slotting Machine	1	" 0.3 <sup>M</sup>
	Universal Milling Machine	1	Table size 350 <sup>MM</sup> x 1,500 <sup>m</sup>
	Radial Drilling Machine	1	3HP
	Grinding Machine	1	1HP
	Abrasive Cut off Machine	1	1HP
	Bench Drilling Machine	1	1/2 HP
	Working Beds	4	1,500 x 2,000
	Portable Boring Machine	1	
	Tool Cabinet	-	
	Over Head Crane	1	5 <sup>T</sup> x 20 <sup>M</sup> /Min
	Cabinet	-	
	Tool (for cutting)	-	
	Tool (for measuring)	-	
	Tool Boxes		
	6.	Carpenter Shop	
Band Saw Machine		1	26 inch $\phi$
Circular Saw Machine		1	10 inch $\phi$
Planing Machine		1	Table size 1,520 <sup>M</sup> x 27.9 <sup>CM</sup>
Hollow Planing Machine		1	
Lathe		1	
Drying Room		-	4 <sup>M</sup> x 5 <sup>M</sup>
Marking Place		-	3 <sup>M</sup> x 6 <sup>M</sup>
Setting Machine		1	
Vacuum Cleaner		1	2HP

No.	Item	No.	Main Particulars Principal Items
	Cabinets	-	
	Working Bench	2	1,200 <sup>M</sup> x 3.5 <sup>M</sup>
	Tools		
	Tool Cabinet		
	Overhead Crane	1	5 <sup>T</sup> x 20 <sup>M</sup> /Min
7.	Painting Bench	2	1,500 <sup>M</sup> x 3,000 <sup>M</sup>
	Spray Gun and Tools		
	Cabinet		
8.	Sewer Shop		15 <sup>M</sup> x 20 <sup>M</sup>
	Working Floor		5 <sup>M</sup> x 13 <sup>M</sup>
	Sewing Machines	2	
	Cabinet	-	
9.	Tool Service Shop Tool Cabinet		15 <sup>M</sup> x 20 <sup>M</sup>
	Hand Tools	-	
	Measuring Tools	-	
	Cable	-	150 x 50 <sup>M</sup> = 7,500 <sup>M</sup>
	Air Hose	-	2,500 <sup>M</sup>
	Gas Hose	-	7,500 <sup>M</sup>
	Oxygen Hose	7,500 <sup>M</sup>	
	Consumable Tools		
10.	Engine Repair Shop		25 <sup>M</sup> x 26 <sup>M</sup>
	Propeller Pit		6 <sup>M</sup> x 6 <sup>M</sup>
	Chemical Cleaning Tank	-	4 <sup>M</sup> x 8 <sup>M</sup>
	Hydraulic Testing Place	-	4 <sup>M</sup> x 6 <sup>M</sup>
	Grooving Surface Floor		4 <sup>M</sup> x 8 <sup>M</sup>
	Working Tables	6	1.2 <sup>M</sup> x 3 <sup>M</sup>
	Grinding Machine	2	
	Tool Cabinets		
	Overhead Crane	1	10 <sup>T</sup> x 20 <sup>T</sup> x 20 <sup>M</sup> /Min
	Piping		2"∅ x 60 <sup>M</sup>
	Compressed Air Line		1"∅ x 60 <sup>M</sup>
	Oxygen Line		1"∅ x 60 <sup>M</sup>
	Acetylene Gas Line		1"∅ x 60 <sup>M</sup>
	Fresh Water Line		2 1/2"∅ x 60 <sup>M</sup>

No.	Item	No.	Main Particulars Principal Items
11	Electrical Shop		12 <sup>M</sup> x 12
	Dryer		1 <sup>M</sup> x 1 <sup>M</sup>
	Coil Winding Machine		
	Charging and Discharging Pannel		0.5KVA - 1KVA
	Working Table	1	1.2 <sup>M</sup> x 3 <sup>M</sup>
	Varnish Treatment Tank		1.5 <sup>M</sup> x 1.5 <sup>M</sup>
	Tool Cabinet		
12	Hull Outfitting Shop		12.5 <sup>M</sup> x 60 <sup>M</sup>
	Hydraulic Press	1	50T
	Bending Roller		Capacity 6.5 <sup>M</sup> x 2 <sup>M</sup>
	Shearing Machine	1	Max. T = 3 <sup>MM</sup>
	Lattice Floor		8 <sup>M</sup> x 7 <sup>M</sup>
	Working Floor (Steel Plate)		8 <sup>M</sup> x 16 <sup>M</sup>
	A/C Arc Wedlers	10	
	Argon Gas Welders	2	
	Piping		
	Compressed Air Line		2 1/2"∅ x 60 <sup>M</sup>
	Oxygen Line		2"∅ x 60 <sup>M</sup>
	Acetylene Gas Line		2"∅ x 60 <sup>M</sup>
	Fresh Water Line		2 1/2"∅ x 60 <sup>M</sup>
	Power Line 380 V		
	220 V		
	Cabinet	-	
	Hoists	4	2T
13	Piping Shop		12.5 <sup>M</sup> x 46 <sup>M</sup>
	Grinding Cutter	1	
	Pipe Bender	1	
	Honeycomb Floor and Flat Floor		9 <sup>M</sup> x 14 <sup>m</sup>
	Welding Place	-	8 <sup>M</sup> x 8 <sup>M</sup>
	Hydraulic Testing Place		
	A/C Arc Welders	10	500A, 300A
	Piping		
	Compressed Air Line		2 1/2"∅ x 60 <sup>M</sup>
	Acetylene Gas Line		2"∅ x 60 <sup>M</sup>
	Oxygen Line		2"∅ x 60 <sup>M</sup>
	Fresh Water Line		2 1/2"∅ x 60 <sup>M</sup>

No.	Item	No.	Main Particulars Principal Items
	Tool Cabinet	-	
	Hoists	4	2T
14.	Stage Center		20 <sup>M</sup> x 40 <sup>M</sup>
	Wooden Stages	1500	50 <sup>MM</sup> x 300 <sup>MM</sup> x 4 <sup>M</sup> -2 <sup>M</sup>
	Convertible Steel Pipes	200 set	
	Stage Tower for Rudder	2	2 <sup>M</sup> x 4 <sup>M</sup> x 8 <sup>M</sup>
	Painting Stage	2	2 <sup>M</sup> x 4 <sup>M</sup> x 10 <sup>M</sup>
15.	Vehicles		
	Trucks	3	10 <sup>T</sup> x 1 2 <sup>T</sup> x 2
	Fork Lifts	3	3 <sup>T</sup> x 1 2 <sup>T</sup> x 2
	Motor Trucks	4	1T
	Fire Engine	1	
	Ambulance Car	1	
	Business Cars	2	
16.	Vessels		
	Oil Barge	1	200T
	Ferry Boat	1	50HP
17.	Pollution Preventive Equipment		
	Incinerator		
	Oil Fence		
	Sewage Treatment Plant		
18.	Main Piping Line		
	Drinking Water Line (with Tank)		3 <sup>"</sup> ∅ x 1,000 <sup>M</sup> 200 <sup>T</sup>
	Industrial Water Line		5 <sup>"</sup> ∅ x 1000 <sup>M</sup>
	Compressed Air Line		3 <sup>"</sup> ∅ x 500 <sup>M</sup>
	Oxygen Line		2 1/2 <sup>"</sup> ∅ x 500 <sup>M</sup>
	Acetylene Gas Line		3 <sup>"</sup> ∅ x 500 <sup>M</sup>
19.	Service Utilities		
	Air Compressors	2	84 <sup>M3</sup> /Min x 7 Kg/cm2
	Substation	1	
	Transmission Cubicle	12	66KV/380 <sup>V</sup> or 220 <sup>V</sup>
	Power Supply Panels	2	380 <sup>V</sup> 50HZ
	Emergency Generator	1	
	Light and Other	-	

No.	Item	No.	Main Particulars Principal Items
20.	<p>Tools</p> <p>Hand Tools</p> <p>Measuring Tools</p> <p>Lifting Tools</p> <p>Pneumatic Tools</p> <p>Electrical Tools</p> <p>Welding Tools and Gascutting Tools</p> <p>Protectors</p> <p>Fire Fighting and Safety Appliances</p> <p>Other Tools</p> <p>Other (Office supplies)</p>	<p>1 set</p>	<p>Hammer, Chisel Center Punch, File, Electrical Spanner, etc.</p> <p>Dial Gauge, Micrometer, Pressure Gauge, Torque Wrench, Caliper, Level, etc.</p> <p>Journal Jack, Chain Block, Turnbuckle, Steel Wire Rope Nylon Sling Belt, etc.</p> <p>Air Drill, Air Grinder, Screw Driver, Air Hammer, Impact Wrench, Jet Chisel, etc.</p> <p>Electric Drill, Disc Grinder, etc.</p> <p>Drying Oven, Auto- conductor Wire Brush, Gas Cutter Torch, etc.</p> <p>Helmet, Glove, Gas Mask, etc.</p> <p>Portable Fire Extinguisher Gas Detector, etc.</p> <p>Tool Box, Tool Cabinet Vise, Spray Gun, Mask Draftsman's Tools, etc.</p> <p>Telephone &amp; Loud-speaker</p> <p>Tables, Desks, Chairs, Sofas &amp; Other</p>
21.	Communication System	1 set	Telephone & Loud-speaker
22.	Office's Furniture	1 set	Tables, Desks, Chairs, Sofas & Other

### 3-4-5 Design of Civil Constuction and Building

The repair shipyard is planned to be constructed on the ground where the offshore at depth of 4 to 6m is to be reclaimed. It is clear from the results of soil investigation conducted this time that the foundation is comparatively favorable condition. Since the reclaiming work is scheduled to be performed, it is necessary to presume the characteristics of reclaimed soil layer. The site preparation will be made using materials taken out by dredging the navigation route. These materials are mainly composed of sandy soil. However, a small amount of clayey soil, which is not suitable for reclaiming materials, has been locally included in dredged soil. The design of civil and building facilities is conducted on condition that improper materials for reclamation are not used around the dock, and the site preparation is favorably performed using sandy soil.

#### (1) Dock

##### 1) Particulars of Planned Dock

- |                     |                               |
|---------------------|-------------------------------|
| (a) Vessel size     | 20,000 DWT (max. draft: 4.5m) |
| (b) Dock dimensions | Depth = 11.1 m                |
|                     | Breadth = 28 m                |
|                     | Length = 175 m                |

##### 2) Dock Structure and Type

According to the results of the soil investigation, the bottom slab of each structure is located around the boundary line of a poor silt or silty sand layer accumulated to 2 to 3m deep outer layer from the existing sea bottom and silty sand layer with N-value of 10 to 20 distributed under such poor silt or silty sand layer. It is difficult to evaluate whether direct foundation or pile foundation is applied to structures. However, it is planned that pile foundation is employed for each structure owing to the fact that the distance of borehole is long and there may be any change in soil layer at the intermediate points of borehole.

##### (a) Dock Bottom Slab

A system for reducing uplift shall be provided under the bottom slab to decrease the volume of bottom slab concrete. The dock bottom slab should be designed to safely support wood blocks' load, and should be transversally sloped at 1:200.

(b) Dock Wall

Since the construction of this dock will be commenced after site preparation by filling with a suitable soil, it is possible to execute the work of dock wall through open excavation. Owing to the fact that there are much achievements of work as the dock wall, the reliability as structures is high, and it is economically favorable, most commonly used reinforced concrete of buttress type retaining wall should be applied. The dock wall should be united with the part of crane foundation.

(c) Dock Entrance

A vertical sill serving both as a pumping facility, winch room for the gate and crane foundation should be provided on both sides of the dock entrance. The starboard serves for a pump room, too. As a result, the pump room shall be built of reinforced concrete half in the ground. A gateless portion in front of the dock should be concrete-paved with consideration given to the prevention against erosion, and a slope protection work covered with gravels should be executed around the gateless portion.

(d) Sheet Pile Revetment

A tie-rod type of sheet pile revetment should be provided between facilities on either sides of gate front and riprap revetment, so as to secure the depth of water in front of the dock.

Fig 3-4-9 to Fig 3-4-11 show the plan, standard cross section and longitudinal section of the dock.

(2) Mooring Jetty

1) Particulars of Planned Mooring Jetty

(a) Vessel class 20,000 DWT

(b) Dimensions

Planned water depth: MSL-7.5m

Overall length: 150m

Breadth: 15m

(c) Appurtenant facilities

Crane ..... 10 t LLC

Bollards, fenders

## 2) Structural Type of Mooring Jetty

The structure of jetty can be broadly divided into a sheet pile type and a gravity type such as caisson. Since extensive fabrication yard and large crane are required for the construction of gravity type of jetty, general steel pipe pile type of jetty should be adopted because of simple execution of work. Jetty should be of structure to be supported by direct piles to vertical load such as crane, vehicle, etc. exerted on the jetty, and to be supported by oblique piles to horizontal force exerted at the time of ship berthing and mooring. There are big stones used for the riprap revetment, and piles cannot be placed. Hence, a steel girder bridge should be provided to enable cranes, vehicles, etc. enter. Reinforced concrete girder and slab should be provided on top of the piles to connect pile heads and to enable cranes, etc. travel.

Fig. 3-4-12 represents structural drawing of jetty.

## (3) Administration Building

In order to enhance the building's function as an office area capable of adapting to a wide diversity of office spatial needs, the number of pillars has been reduced to a minimum, and movable partitions have been adopted between rooms. A simplified structure has been selected to pare down building costs.

Structure:	Two-storey RC building with wooden truss roof	
Total floorspace:	1,600 m <sup>2</sup>	
Exterior finish:	Wall	: brick masonry
	Roof	: asphalt lining, corrugated steel plate
Interior finish:	Doors, windows	: aluminum sash
	Floors	: mortar base, vinyl tile
	Walls	: mortar base, vinyl paint
	Ceilings	: asbestos sound-insulated board

Fig 3-4-13 shows plan and section of the administration building.

(4) Shops

The shops have been planned to offer maximum versatility in order to adapt to the needs of each production line, and to offer an optimally favorable working environment for each shop's employees.

Structure:	Steel-frame 1-storey structure with steel-truss roof	
Exterior finish:	Walls	: block masonry, painted steel, ventilation louvre on crane top
Interior finish:	Roof	: asphalt lining, corrugated steel plate
	Floors	: mortar trowel finish
	Ceiling	: none (heat insulating material below roof)

Fig 3-4-14 shows plan and section of machinery and carpenter shop



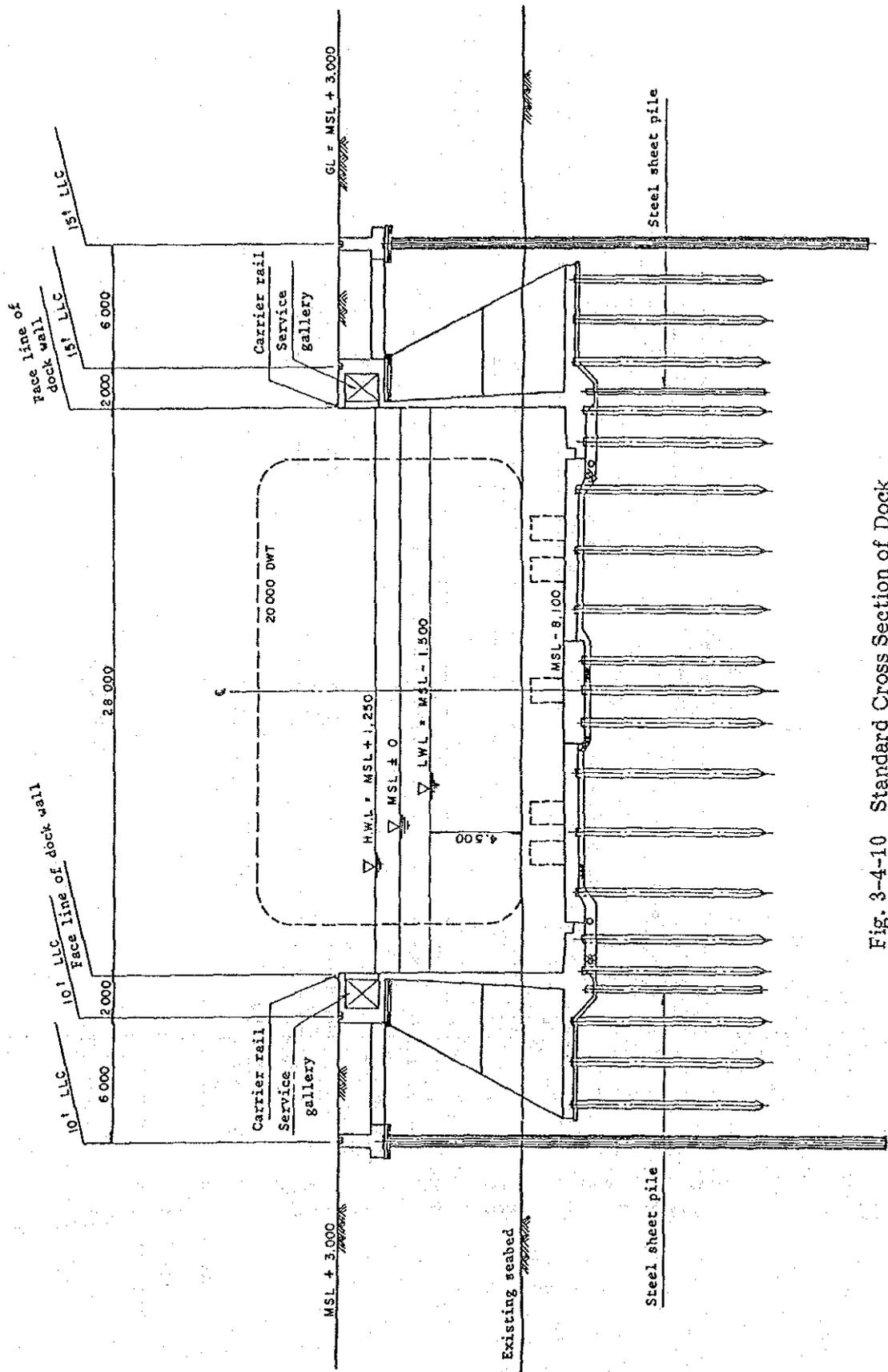


Fig. 3-4-10 Standard Cross Section of Dock

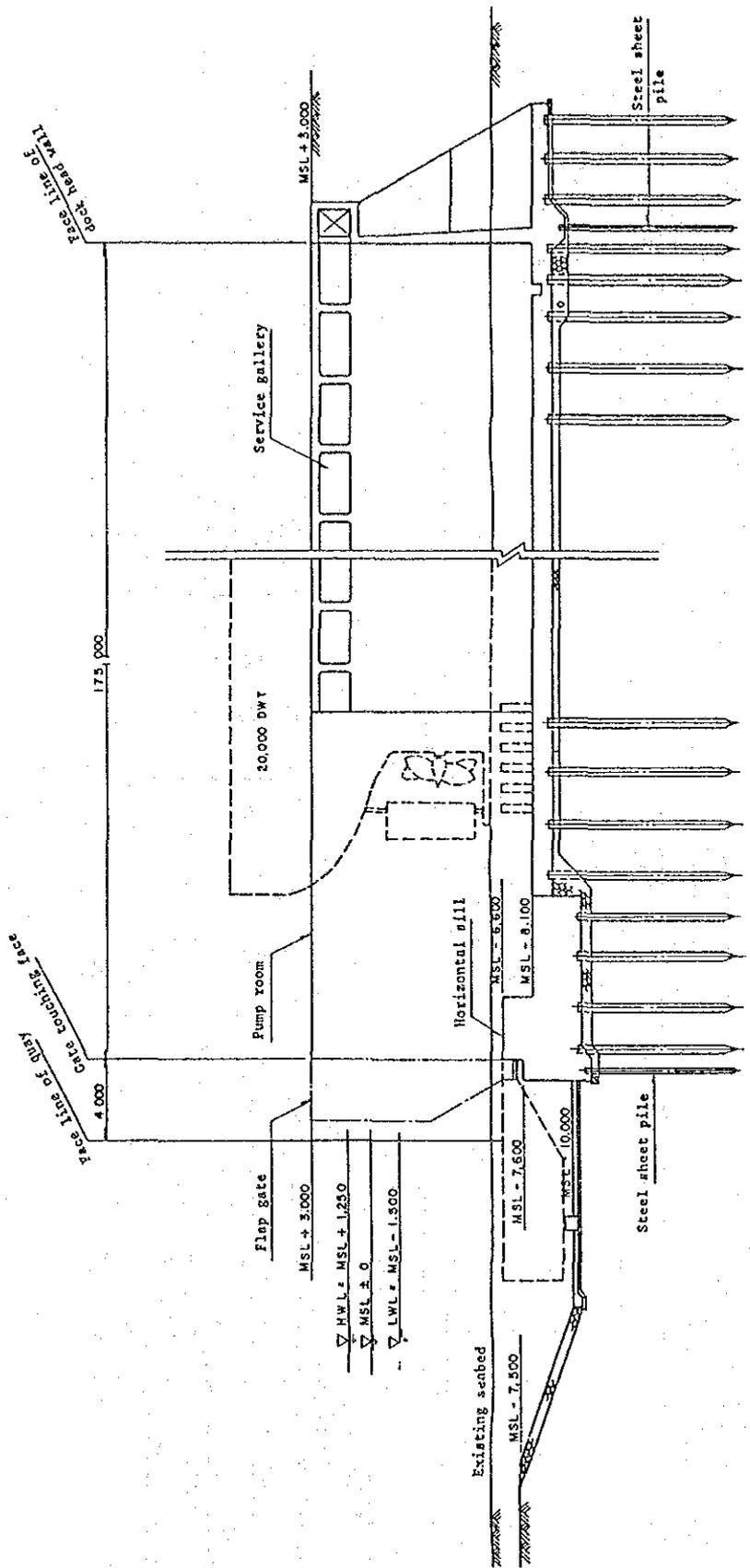
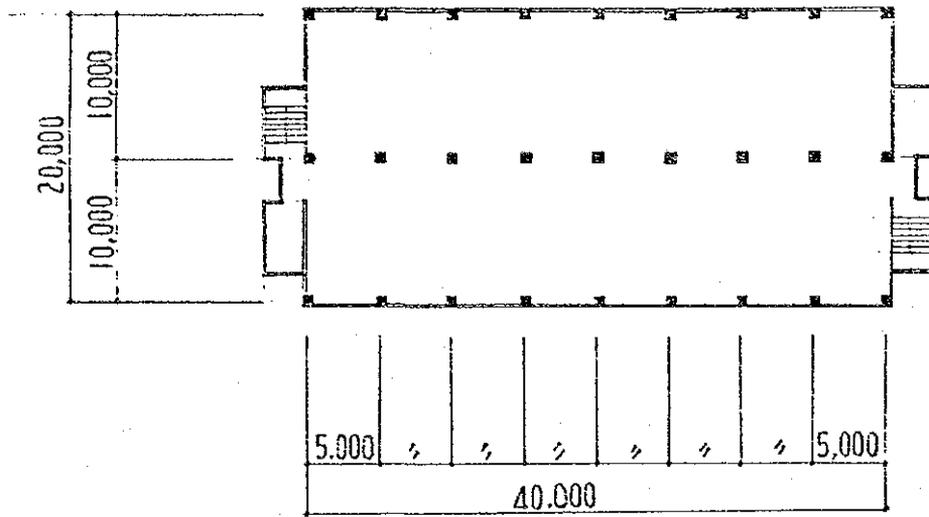
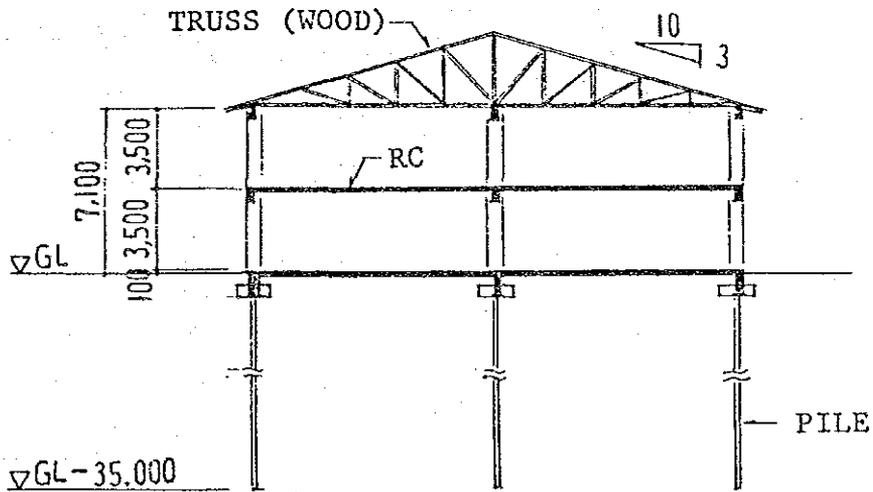


Fig. 3-4-11 Longitudinal Section of Dock



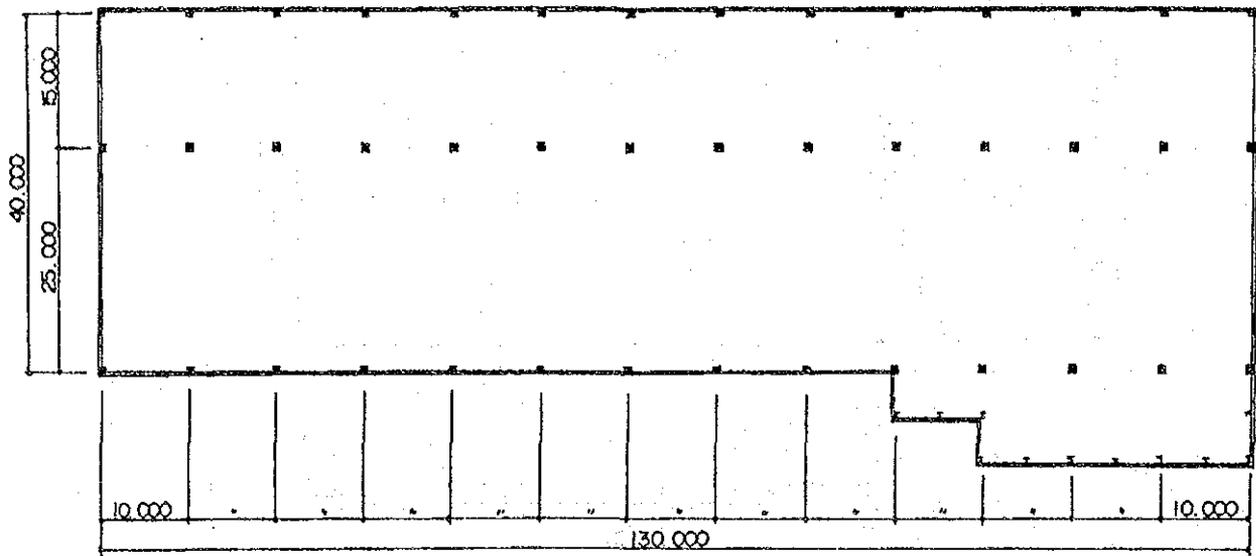


PLAN

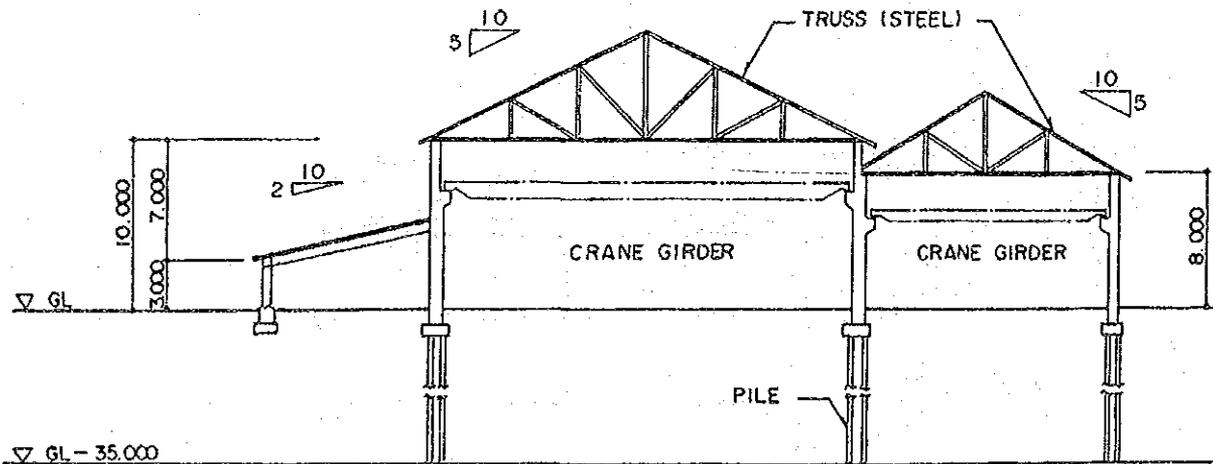


SECTION

Fig. 3-4-13 Administration Building



PLAN



SECTION

Fig 3-4-14 Machinery and Carpenter Shop

3-5 Construction Implementation Plan

3-5-1 Progress Schedule

Progress schedule of the project has been made on the following conditions.

January, 1986	Start of preliminary arrangements for construction
September, 1987	Start of construction
March, 1990	Completion of construction

(However, the yard operation is to start in January, 1990, when its major construction work will be finished.)

Table 3-5-1 shows the master progress schedule for construction, training, operation and so on.

Table 3-5-1 Master Progress Schedule

Item \ Year	1986	1987	1988	1989	1990	1991
Master Schedule	Preliminary arrangement		Construction		Education and training	
					Operation	
1. Civil engineering work						
Road pavement				↔		
Jetty			↔			
Dock		↔				
2. Buildings						
Factory shops			↔			
Offices			↔			
Other houses				↔		
3. Dock-related facilities						
Filling and draining facilities			↔			
Dock gate			↔			
Others			↔			
4. Jetty-related facilities				↔		
5. Cranes						
Dock side cranes				↔		
Jetty crane				↔		
Factory overhead crane				↔		
6. Power facilities			↔			
7. Factory machines			↔			
8. Electric facilities			↔			
9. Sewage treatment tank			↔			
10. Manufacturing facilities and so on				↔		
11. Engineering	↔					
12. Education and training (Overseas)				↔		
13. Education and training (Domestic)					↔	

3-5-2 Construction Investment

Table 3-5-2 and Table 3-5-2(A) show the construction investment of this project based on the prices in 1984.

Table 3-5-2 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 <sup>2</sup> )	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.

Table 3-5-2(A) Construction Investment (Details)

Prices in 1984  
Unit: 1,000 Baht

No.	Description	Estimated cost	Funds	
			Foreign portion	Domestic portion
1	Civil engineering work	455,377	192,683	262,694
	Land purchasing (90,000 m <sup>2</sup> )	128,955	63,705	65,250
	Road pavement	10,442	0	10,442
	Jetty (pier)	65,332	37,804	27,528
	Dock	250,648	91,174	159,474
2	Buildings	130,437	31,600	98,837
	Offices and other houses	36,308	4,859	31,449
	Factories	76,419	22,571	53,848
	Power supply equipment and warehouse	16,149	4,103	12,046
	Others	561	67	494
3	Dock-related equipment	42,887	33,868	9,019
	Dock gate (incl. winches for its opening and closing)	24,172	20,403	3,769
	Filling and drainage equipment (pumps)	8,335	7,338	997
	Wooden blocks	2,525	0	2,525
	Ship pulling-in guard rails and pits	6,617	5,782	835
	Bridges and towers	570	0	570
	Others	668	345	323
4	Jetty-related equipment	7,477	6,037	1,440
	Ship-mooring equipment (including winches)	6,112	5,592	520
	Passages for up-and-down	446	0	446
	Ballast pump and pipe lines	587	445	142
	Others	332	0	332
5	Cranes	88,032	84,613	3,419
	Dock and jetty cranes	62,417	60,708	1,709
	Overhead crane	18,263	17,123	1,140
	Portal crane	5,193	5,003	190
	Hoists	2,159	1,779	380
6	Utilities equipment and pipe lines	20,424	14,132	6,292
	Water supply equipment	4,157	2,224	1,933
	Compressors and pipe lines	14,003	11,630	2,373
	Oxygen and acetylene pipes and ducts	1,749	0	1,749
	Others	515	278	237

No.	Description	Estimated cost	Funds	
			Foreign portion	Domestic portion
7	Electric equipment	27,647	24,989	2,658
	Distribution panel and switch board	19,582	18,680	902
	Electric cables, wiring	1,923	1,306	617
	Lighting apparatus	6,142	5,003	1,139
8	Vehicles and oil barges	8,123	6,149	1,974
	Vehicles	4,817	4,314	503
	Oil barges and others	3,306	1,835	1,471
9	Factory machines	125,909	111,151	14,758
	Hull fabrication shop	8,297	6,525	1,772
	Machinery shop	58,303	50,809	7,494
	Finishing shop (hull, engine)	4,088	2,807	1,281
	Carpenter shop	1,902	1,612	290
	Sail loft and rigging shop	259	212	47
	Piping shop	3,374	3,013	361
	Hull outfitting shop	1,934	1,459	475
	Tool service shop	8,228	8,228	0
	Warehouse (excluding stock material)	28,575	28,575	0
	Welders and cabtyres	4,197	4,197	0
	Stage center	3,038	0	3,038
	Others	3,714	3,714	0
10	Anti-pollution equipment	22,038	19,380	2,658
	Sewage treatment tank	18,050	15,677	2,373
	Oil fences and othes	923	923	0
	Incinerator	3,065	2,780	285
11	Telephone and others	3,521	2,913	608
12	Furniture for offices and so on	4,272	0	4,272
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

Table 3-5-3 shows the construction material procurement (domestic or import) program.

Table 3-5-3 Construction Material Procurement Program

No.	Item	Description	Procurement		
			Imports	Domestics	
1	Civil engineering work				
	(1) Design		o		
	(2) Material	<u>Dock, jetty</u>			
		Steel sheet piles		o	
		Steel pipe piles		o	
<u>Reinforced concrete</u>					
	Steel bars			o	
	Cement			o	
	Molds			o	
	Steel molds	o			
	Pitts, fenders	o			
	<u>Roads</u>				
	Asphalt			o	
	Road base material			o	
	<u>Buildings</u>				
	Steel frames	o			
	Corrugated sheets			o	
	Bricks			o	
	Lighting apparatus	o		o	
	Furnitures	o		o	
	(3) Construction machines			o	
	(4) Labor force	Labor force for construction		o	
2	Machines and electric facilities				
	(1) Design		o		
	(2) Manufacturing		o		
	(3) Labor force	Labor force for installation		o	

No.	Item	Description	Procurement	
			Imports	Domestics
3	Wiring, piping			
	(1) Design		o	
	(2) Manufacturing		o	o
	(3) Labor force	Labor force for installation		o
4	Vehicles and oil barges			
	(1) Design		o	o
	(2) Material		o	o
	(3) Labor force	Labor force for construction		o
5	Anti-pollution facilities			
	(1) Design		o	
	(2) Material		o	o
	(3) Labor force			o

### 3-5-3 Execution of Construction Work

In the execution of the construction work of this Project, locally procured materials and local labor force in Thailand should be employed as far as possible. Prior to the construction work of the dock, the surroundings of the repair shipyard shall be encircled with riprap revetment and the reclamation work should be executed using dredged soil. Most commonly used open excavation will be applied to the construction of dock. Thus, in the site preparation, the repair shipyard site necessitates to be reclaimed with sandy soil, which the open excavation using well point method is possible.

#### (1) Dock

In the execution of dock, a temporary cofferdam with cut-off steel sheet piles shall be provided at sea area in front of dock entrance to enable open excavation for the dock. The excavation shall be made to the desired depth simultaneously when the drainage of ground water shall be made according to well-point construction method. Upon completion of excavation, foundation piles and steel sheet piles for cut-off shall be placed using a pile hammer. Then, pipes for reducing uplift shall be embedded on the dock bottom and then compacted leveling gravels shall be placed. After the completion of foundation work, each structure shall be finished to a desired shape by using cast-in-place reinforced concrete. After the back side of the dock wall shall be backfilled by well-grained sandy soil. Steel pipe piles for crane foundation shall be placed, and top of pile shall be finished to a desired shape of beam by using cast-in-place reinforced concrete. Riprap revetment of the dock entrance shall be removed during the excavation of the dock, and tie-rod steel sheet piles of jetty shall be provided on the both sides of the dock entrance to secure the depth of water in front of the dock entrance.

Since the dock construction work as mentioned above is planned to execute on land, a stability of temporary cofferdam and reliability of drainage construction method of excavation surface will greatly influence the certainty of the execution.

#### (2) Mooring Jetty

Steel pipe piles shall be placed on a piling ship. Pile heads shall be cut off after such piles are placed to a desired depth, and concrete forms and stages shall be provided for pile heads by means of welding, etc. Cast-in-place reinforced concrete shall be placed by a concrete pump truck on land, and the upper beam and concrete slab shall be finished. Upon completion of the superstructure, a

superstructure, a steel girder shall be erected by the crane on land at a space (about 20m) between the revetment and jetty, and it will be completed by paving the surface of the jetty with the reinforced concrete.

### 3-6 Business Management and Operation Scheme

#### 3-6-1 Production Scheme

##### (1) Ship Repairing

The work load in ship repairing is to be estimated based on deadweight tons of vessels to be repaired as shown in Fig. 3-1-2.

The plan has been made on condition that repair period will reach the normal level in 1996, taking into consideration the work achieving ability of employees because of their unfamiliarity to the facilities and their insufficient communication among themselves in the beginning of the operation.

##### (2) Steel Structure Fabrication and Assembly

The expanding market expected for building and bridge construction in Thailand, with progress of infrastructure development under the current national policy, will favour the effective utilization of the hull fabrication shop and yard for fabricating and assembling such steel structures.

The production scheme for steel structure fabrication and assembly has been drawn up to match the capacity of the hull fabrication shop, and with guidance sought in examples of Japanese shipyards.

##### (3) Running Repairs

Profitable running repairing is to be carried out because of the geological condition that the repair shipyard is to be located in Laem Chabang that is a trading port.

The production scheme has envisaged running repairs amounting to 5% minimum in value of the shiprepair work envisaged under section (1), based on examples of Japanese shipyards.

##### (4) Production planning

Table 3-6-1 shows the annual production amount for each item, (1), (2) and (3).

Table 3-6-1 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	"

Various materials are necessary for the running of the repair shipyard to follow production schedule. A detailed material procurement schedule must be prepared for its practical operation because most of the necessary materials will have to be imported. Careful attention will have to be paid to usual grasp of the inventory in order to keep the total stock to the adequate level.

Table 3-6-2 shows the standard spare parts and the stock materials.

Table 3-6-2 Standard Spare Parts and Stock Materials

Item	Description
Steel	Steel plates, Steel shapes, Flat bars, Round bars, Stainless steel, etc.
Secondary steel products and non-ferrous material	Wires, Wire Nets, Expanded metals, Ropes, Copper sheets, Copper bars, Brass materials (round bars), Aluminum sheets, Brass sheets, etc.
Pipe and pipe-related material	Steel pipes, Galvanized steel pipes, Valves, Flanges, Bolts, Nuts, Pipe joints (elbows, reducers), etc.
Electric material	Electric cables, Insulation materials, Wiring materials, Electric parts, etc.
Parts for hull and engine repair	Bearings, Sealing materials, Rings, Packings, Cleaning oil, Zinc plates, Shackles, Turnbuckles, Chains, etc.
Others	Tiles, Pavement materials, Carpenter-use metal pieces (locks, door opening and shutting pieces), Insulation materials, Canvas, etc.

### 3-6-2 Manpower Program

#### (1) Working Hours

The number of the employees has been estimated based on the above-mentioned production schedule and the below-mentioned conditions. The age-structure of the workers, however, has not been taken into consideration. Careful attention will have to be paid in order to prevent any kind of trouble caused by the mass retirement of the skilled workers and so on.

In consideration of eventual approach to conditions of work currently prevailing in advanced countries, working hours were envisaged as follows:

Annual working hour/head ----- 1,968 hours

Formula of this calculation is:

$$\text{Annual working hour/head} = 12 \times (\text{Daily working hour} \times \text{Monthly working day} \times \text{Attendance rate} + \text{Average monthly overtime working hour})/\text{head}$$

Where, Daily working hour/head = 8 hours

Monthly working day/head = 20 days

(Based on five working day week system)

Average monthly overtime working hour/head = 20 hours

(Based on 1 hour/day)

Attendance rate = 90%

The schedule shows that 300 workers will be necessary in the first year of the operation. The number of the workers will be increased year by year with production enlargement, intending to have an adequate age structure.

(2) Working Hours Schedule

Table 3-6-3 shows the annual working hours based on which the required number of the workers are estimated. In this planning the required number has been estimated and used as the basic of the manpower program on condition that productivity will be improved year by year taking into consideration the special circumstances in its first operation year.

Table 3-6-3 Estimated Annual Working Hours

Year	Productivity	(1)	(2)	(3)	Estimated annual working hours
		Ship repair in dock 2H x DWT	Steel structure 200 H/T	Running repair (1) x 5%	
1990	1	430,000	100,000	21,500	551,500
1991	1.1	528,000	100,000	26,400	594,909
1992	1.1	596,300	110,000	29,815	669,195
1993	1.2	648,000	120,000	32,200	667,500
1994	1.2	699,200	130,000	34,960	720,133
1995	1.3	752,000	14,000	37,600	715,076
1996	1.4	950,000	140,000	47,500	812,500
1997	1.5	970,000	170,000	48,500	792,333
1998	1.5	980,000	180,000	49,000	806,000
1999	1.5	1,000,000	200,000	50,000	833,333
2000	1.5	1,000,000	200,000	50,000	833,333

Note: Estimated annual working hours =  $\frac{(1) + (2) + (3)}{\text{Productivity}}$

In this schedule, the required number of the workers is estimated on condition that productivity will be improved year by year because of the especially bad circumstances in the first operation year; the productivity in 1997 will be one and a half times as high as the one in the first operation year.

(3) Manpower Program

The required number of the workers is estimated based on Tabel 3-6-3 and shown in the following annual manpower program. Table 3-6-4 shows the number of the necessary workers for education and training before operation start and managerial staff for attendance of construction of the repair shipyard. The ratio of the number of the indirect to that of the direct is most important in the manpower program. Especially careful attention must be paid to this ratio because the higher it becomes, the worse the earning power. The ratio is generally 15% to 30% though it varies from enterprise to enterprise. In this

program the desirable ratio has been taken at 20% at operation start. It is thought best and recommended to ask the developed countries to send out their engineers to the yard because they will kill various difficulties occurring in its managerial and technical matters during the early period of the operation.

Table 3-6-4 Annual Manpower Program

Year \ Item		Managers & higher rank persons	Clerks & engineers	Indirect workers	Direct workers	Total
1986		2	1			3
1987		2	1			3
1988		2	1			3
1989	Item	Managers & higher rank persons	Clerks & engineers	Indirect workers	Direct workers	Modified total member
	1 Year					
	1/3				Worker 174	174
	1/2	8	18	Worker 4	Junior Engineer 35	65
	1/1	5	16	Worker 10	Forman 26	57
Total		13	34	14	235	296
1990		13 (9)	45 (9)	19	290 (35)	367 (53)
1991		13 (9)	45 (7)	24	300 (35)	382 (51)
1992		13 (6)	50 (7)	24	340 (10)	427 (23)
1993		13 (6)	50 (4)	31	340 (10)	434 (20)
1994		13 (6)	50 (4)	31	365	459 (10)
1995		13 (6)	50 (4)	36	365	459 (10)
1996		13 (4)	50 (2)	36	410	509 (6)
1997		13 (4)	50 (2)	36	410	509 (6)
1998		13 (4)	50 (2)	36	410	509 (6)
1999		13 (4)	50 (2)	36	420	519 (6)
2000		13	50	36	420	519

Note: The number shown in parentheses shows the number of the engineers from abroad.

### 3-6-3 Organization

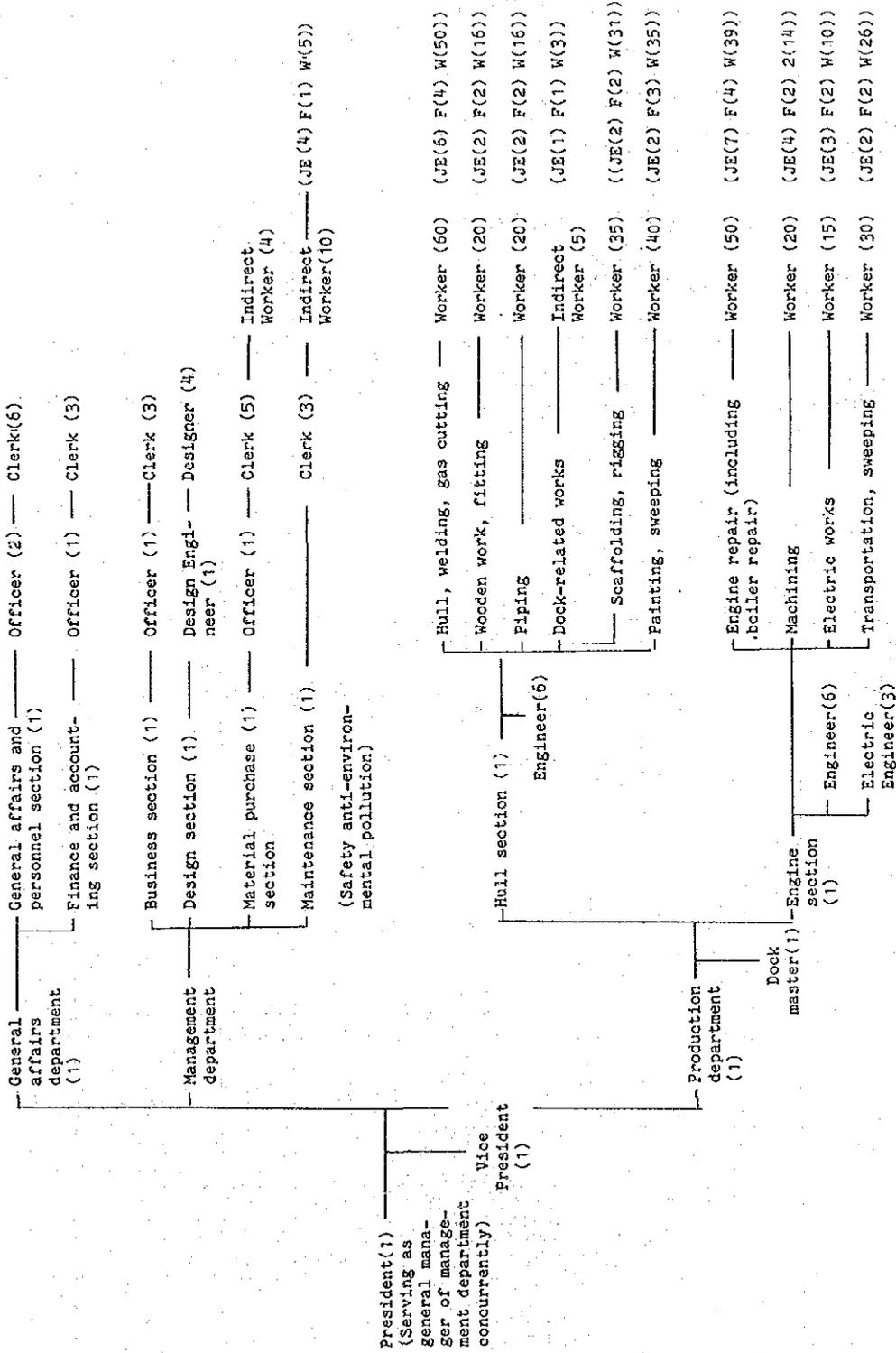
The simpler the organization is, the better. Recently it has been recommended to make workers multi-functionally skilled. If it is ideally achieved, every work will be done by the workers of only one craft. It is, however, practically impossible and many crafts are still needed. In this plan the workers of the same profession are to be gathered into one section in order to perform various works efficiently. It is still suspected to realize it as planned, and it is desirable to receive managerial and technical aid from abroad. Efficient work execution will be achieved by accepting 10% as many skilled foreigners as the three hundreds direct workers at the operation start. Then in this plan the foreign engineers are to be invited. Full technical mastery of local employees will have been quickly achieved by on-the-job training. The training is to be exercised for four years from 1990 to 1993.

The organization at the operation start (1990) is shown in Table 3-6-5 as an example.

### 3-6-4 Education and Training Program

The Thai workers have not yet experienced repairing on large ships because there is no large-scale repair shipyard in Thailand. It is necessary to educate and train newly employed workers in various matters such as ship construction, methods of ship repair, ship-related regulations, roles of each personnel in the organization, other necessary knowledge for some time before the operation start in order to start the operation as smoothly as possible. Some engineers who will play a vital role in future are to be sent to some shipyards in the developed countries to get training in various technical matters including operational flows in order to raise their technical level. The engineers in the developed countries are to be invited to establish a structure sufficiently good for the operation start. The program is shown in Table 3-6-6.

Table 3-6-5 Organization



Note: JE ..... Junior Engineer  
 F ..... Foreman  
 W ..... Worker

Table 3-6-6 Education and Training Program

Item	Year	1987	1988	1989	1990	1991	1992	1993	1994
<b>Main stages</b>									
Construction									
Operation									
Education and training									
<b>Education and training in the developed countries</b>									
Training of the engineers sent to the developed countries									
Hull				2	August				
Engine				2	August				
Electric				2	August				
Workers sent to the developed countries									
Hull works				4	4				
Engine workers				2	2				
Electric workers				2	2				
Dock-related				2					
Plumber				2	2				
Welders				2	2				
Painters					2				
<b>Engineers from the developed countries</b>									
Managers									
President (holding the management department concurrently)					1				
General manager of production department							1		
Finance and accounting section manager					1				
Business section manager							1		
Material purchase section manager							1		
Design section manager					1				
Hull section manager							1		
Engine section manager							1		
Engineers from abroad									
Hull, engine, electric, design						7		3	
Junior Engineers									
Junior Engineers						35		10	
<b>Employees</b>									
				Sent to the developed countries					
				175					
				Domestic training					
							On-the-job training		

### 3-6-5 Safety Measures

#### (1) Accidents

None of superior facilities can perfectly prevent accidents. Individual human mischiefs may cause accidents. The accidents in the repair shipyard generally take place as follows with some exceptions;

##### 1) Fall, Drop

Something falling down from the higher working places from one cause or another, may cause accidents, careless dropping of tools or parts from the higher places may injure the workers in the lower places. Sometimes something heavy may drop and cause extremely miserable troubles.

##### 2) Explosion, Fire

The explosion caused by the fire used near fuel oil tanks during the repair may result in both human and physical damages. The fire during welding or gas cutting or the remaining fire after such a work may cause big fires in the adjacent compartments of the ship.

##### 3) Oxygen Shortage

The oxygen shortage in ballast or fuel tanks may cause the accidental death of the workers in them.

Generally the above-mentioned accidents may take place most often. In addition many other kinds of accidents may take place by various reasons.

#### (2) Safety Measures

No safety measures can prevent accidents perfectly. Any of them can only play a partial role in accident prevention. No accident can be prevented without individual worker's careful attention to its prevention.

##### 1) Organization

Every line-organization headed by its section manager can be available for safety measures. Every group leader is to make sure the safety before every work is started.

##### 2) Work performing procedures must be prepared and all the workers must be educated during the training period in order to acquire a habit of following those procedures.

For example, no one can enter any tank without gas-detection beforehand. Every fuel tank must be noticed clearly with warning in order to prevent fire

from being used. The bilge water in the engine room must be cleaned off immediately after the ship arrival.

- 3) Every worker must put on a safety helmet, a pair of gloves, dust glasses, a life-line (for the workers on the high places) and so on; or some of them according to their working situations.
- 4) Every section must make sure the safety of its working procedures.

(3) Proposal

Every worker must be thoroughly trained to do his work most safely, having his mottoes "Never be injured, and never injure others". The idea can serve as an aid for accident prevention that no accident can be perfectly prevented even by all the means that can be thought of. All the safety trainings must be continued patiently and untiringly.

### 3-7 Anti-Pollution Measures

#### 3-7-1 Background

The Guidelines for Preparation of Environmental Impact Evaluation, published April 1979 by the National Environment Board, indicates strong concern shown by the Thai Authorities for preventing the destruction and pollution of the country's natural environment, and betokens a growing interest in conserving the beauty of the country's natural landscape that constitutes a valuable source of tourist revenue, as well as in preventing soil erosion and in protecting and enriching the marine resources of the country.

The present project for newly establishing a repair shipyard will call for the appropriation of a tract of reclaimed coastline. Pertinent measures for preventing water pollution will require to be applied. The following Sections describe the measures that are applied in Japan, where a number of international conventions, laws and regulations are currently enforced, with appreciable beneficial effect in preventing the pollution of environmental water, particularly since the strengthening of regulatory laws in 1970.

The site envisaged for the new repair shipyard is situated on a piece of land protruding into sea, and this will be very advantageous from considerations of environmental conservation: The principal factor requiring to be controlled to ensure expanding shipyard operation without polluting the environment or conflicting with the surrounding interests should be limited to appropriate treatment of the effluent water.

#### 3-7-2 Measures for Preventing Water Pollution

##### (1) Household and Shipyard Sewage

The population exceeding 500 that will be inhabiting the site (yard employees, crews of ships under repair, etc.) will generate household sewage. Together with the industrial sewage resulting from cleaning, cooling and other yard operations, the total sewage generated should reach 200 - 300 tons/day. This sewage must be treated before release, to prevent environmental water pollution.

The sewage requiring treatment will thus include:-

- Household sewage
- Drain from pickling operations in engine finishing shop
- Drain from lavatory, component washing operations, etc.

The effluent water treatment facility envisaged for processing this sewage will comprise mainly a 500 ton treatment tank, where the effluent water will be processed by repeated cycling through stages of filtering (activated charcoal), aerating and settling, to reduce below prescribed levels the acidity, biological oxygen demand, suspended solids, dissolved oxygen, number of coliform bacillus clusters. This tank will be connected by appropriate ducting and pumps to tanks for supernatant water, for sludge and for activated charcoal.

Before release, the water will be measured by pertinent instrumentation to ascertain satisfaction of prescribed effluent quality requirements.

(2) Dry Dock Effluent

Seawater pumped out of dock after a ship is docked will be released into sea without treatment, since it is water originally drawn from the surrounding sea and has not been artificially polluted. This release of untreated water from tank, however, will be contingent upon the dock floor having been cleared of all pollutants like paint and grease that may have dropped from operations on ship. Bottom paint, in particular, contains harmful ingredients. Consequently, before each undocking, the dock floor must be thoroughly cleaned of all droppings from the ship that has been occupying the dock, and the collected rubbish properly disposed of by incineration.

(3) Fuel Oil while Bunkering and Engine Room Bilge Water

1) Fuel Oil while Bunkering

To avoid spread into surrounding waters of any fuel that may be accidentally spilled while bunkering in readiness for undocking, an oil fence is run around the ship. Upon completion of the bunkering operations, all oil that may be found floating within the fence is scooped up or blotted with adsorbent and properly disposed of on land, or else neutralized with emulsifier.

For applying the foregoing measures, the following equipment and supplies are envisaged:-

- Oil fence (800 m long)
- A supply of emulsifier
- A supply of adsorbent.

2) Engine room bilge water

Once a ship enters port, the bilge water accumulated on engine room floor is not allowed to be disposed of into sea, and must be stored in bilge well. If the bilge well is not affected by the repair work to be done, the bilge water can be left stored on board until the ship's departure, but if not, the accumulated bilge water (usually 10 - 20 tons per ship) has to be disposed of in dock, either by scooping up for treatment on land, or else transferred by portable pump to an oil barge to be carried to a centralized disposal facility. Incoming ships for repair are notified beforehand that disposal into sea of bilge water is prohibited, and upon arrival in port, their bilge pump and scupper are locked off.

For the present project, the provision of a portable bilge pump (10 t/h capacity) for drawing the accumulated bilge water, and an oil barge (100t capacity) for carrying it away, are envisaged.

(4) Effluent from Boiler Cleaning

1) Water drum interior

The scale accumulated in the water drum of boiler requires to be cleaned off by circulating water containing detergent, followed by water containing neutralizing agent.

The effluent is then drained and transferred to oil barge for bilge water.

2) Effluent from Boiler Exterior

The cinder and scale deposited around the boiler fire door is scraped off, then washed down.

The scrapings are collected, disembarked and disposed of. The drain from washing is filtered, neutralized, then disposed of as engine room bilge water.

3-7-3 Other Anti-Pollution Measures

(1) Noise

Noise from sand blasting and hammering, likely to generate complaints from neighbouring population — particularly during night work liable to be enforced in shiprepair in efforts to keep schedule — should not present problems in this instance, on account of the remoteness of yard site from populated district.

(2) Atmospheric Pollution

The relatively small amount of incinerator effluent, added to the remoteness of yard site, should dispense with the need for any particular measures against atmospheric pollution, at least for the time being.

(3) Solid Wastes

Flammable waste generated in yard operations can be disposed of by incineration. Non-flammable waste will require disposal as landfill. In proceeding with disposal as landfill, however, due attention will require to be paid to avoid immixture of substances harmful to soil or liable to generate soil pollution.

### 3-8 Financial Analysis

Financial analysis is to evaluate the feasibility of the present project purely from its financial aspects without taking account of its economical or social consequences. Thus, the financial elements of:

- 1) Revenue from sales
- 2) Expenditures for production
- 3) Plan of investment

were taken up for study, based on the assembled data and information, postulating 30 years as duration of project. Likewise, the financial soundness of the project was examined on the basis of profit and loss as well as cash flow analyses. Profitability was evaluated in reference to the financial internal rate of return (FIRR) and through sensitivity analysis. For guidance in financing, a funding plan has also been prepared.

The assumptions and premises adopted in the study were:-

- 1) All prices expressed in currency values prevailing as of November, 1984 (after the devaluation); inflation not taken into account
- 2) Conversion rates set between

Baht and Yen at	Yen 100	:	Baht 11.11875
Baht and US\$ at	US\$ 1	:	Baht 26.88
Yen and US\$ at	US\$ 1	:	Yen 243

#### 3-8-1 Estimated Revenue from Sales

The principal source of revenue envisaged will be from shiprepairing, undertaken both-

- 1) in dry dock, comprising such work as special and annual surveys, repair of damage, and
- 2) afloat, i.e. running repairs performed with ship moored to quay or anchored offshore.

For secondary revenue, the shipyard will undertake fabrication and assembly of steel structures -

- 1) for buildings, and
- 2) for bridges,

to utilize any spare production capacity that may be generated after filling all orders obtained for shiprepair.

(1) Estimated Revenue from Shiprepairing

1) Special and Annual Surveys

Price paid for shiprepair vary widely with type, size and age of the ship, as well as with the substance of repair work. Repair prices are also influenced by the position of shipping and shiprepair markets, of the backlog of orders carried by the shipyards, and further by such factors as the national policies covering shipping and shipbuilding, and the technological level of the particular shipyard and of the state of shiprepairing technology at large.

Holding in view these circumstances affecting fluctuations in shiprepair prices, the records of special and annual surveys, as well as of damage repairs, performed at foreign shipyards on about half the number of ships under Thai flag during the 5 years to August 1984, is as presented in Table 3-8-1. The figures indicate an average repair price of Baht 460.33 per deadweight ton of repaired ship. By ship age category, the prices are Baht 569 per DWT for ships aged 11 to 20 years, and Baht 275 per DWT for ships aged 21 to 26 years. This relation between ship age and unit repair price is contrary to the general tendency of unit repair price to increase with ship's age, and can be understood to reflect the intention of shipowners to have repairs done more thoroughly on relatively new ships, and to be more sparing for the repair of older vessels.

Table 3-8-1 Docking Record of Thai Flag Vessels

DWT	GT	Age of Ship	Repair Duration (Days)	Repair Price (Baht)	Where Repaired
12,806	9,173	17	10	5,960,375	Singapore
12,806	9,173	17	7	3,787,745	Spain
12,806	9,173	17	22	15,346,080	Singapore
12,806	9,173	17	11	13,287,686	"
13,300	11,143	13	12	8,625,904	"
13,300	11,208	14	15	8,341,471	"
13,300	11,148	13	12	8,500,000	"
12,806	9,173	17	7	6,426,557	"
12,806	9,173	17	7	6,500,000	"
10,674	8,858	18	5	1,118,000	Japan
5,666	2,994	16	7	1,300,000	"
5,666	2,994	16	7	1,500,000	Singapore
5,987	3,842	15	10	3,500,000	Japan
10,686	8,871	25	5	1,120,000	"
10,686	8,871	25	10	1,923,000	"
10,686	8,871	25	7	3,200,000	"
10,686	8,871	25	13	2,652,000	"
10,686	8,871	25	37	8,291,732	Singapore
8,211	6,374	24	9	5,027,684	Japan
10,320	6,451	23	6	2,146,909	"
10,320	6,451	23	16	3,000,000	Singapore
5,466	3,765	19	8	2,032,180	Japan
6,008	4,591	25	7	1,200,857	Singapore
13,056	9,328	22	7	1,109,462	Malaysia
5,398	2,895	13	13	1,641,353	Singapore
5,398	2,895	13	15	3,197,118	"
5,398	2,895	1	15	3,523,817	"
5,142	3,427	26	5	630,000	Not indicated
5,142	3,427	26	9	1,124,000	"
5,285	3,367	26	12	2,100,000	"
5,285	3,367	26	9	1,000,000	"
5,714	3,635	19	8	870,000	"
5,714	3,635	19	10	2,000,000	"
5,655	3,635	19	9	1,700,000	"
5,655	3,635	19	10	4,300,000	"
8,568	6,533	20	10	2,000,000	"
8,568	6,533	20	83	21,000,000	"
8,568	6,533	20	7	1,400,000	"
8,100	5,523	14	12	9,000,000	"

Source: MMPC

### Average Shiprepair Prices

Age of Ship	DWT	Price (Baht)	Ave. Unit Price Baht/DWT
11 to 20 years	222,931	126,858,286	569
21 to 26 years	130,410	35,794,272	275
Total	353,341	162,652,558	460.33

The envisaged repair shipyard will aim principally at securing orders for special and annual surveys. For purposes of the present study, the overall average price cited above of Baht 460.33 per DWT of ship repaired has been adopted as basic unit price at 1984 currency value.

2) Running Repairs

Running repairs, performed with ship moored to quay or anchored offshore, has been estimated to amount to 5% of the survey and damage repair work covered in the preceding Section 3-8-1, (1), 1), based on past records in Japanese shipyards.

(2) Estimated Revenue from Steel Structure Fabrication and Assembly

For the present study, the sales price of steel structures has been estimated at Baht 37,632 per ton at 1984 currency value.

(3) Estimated Revenue from Sales

Based on the foregoing premises, and on the production plan presented in Table 3-6-1, the revenue from sales has been estimated as given in Table 3-8-2.

The data had been collected before the devaluation of Thai currency on November 5, 1984. The above Baht 460.33 is slided up to:

$$\text{Baht } 538.57 = \text{Baht } 460.33 \times 26.88/22.975$$

Baht 22.975 is the exchange rate to \$1 as of September, 1984.

Table 3-8-2 Estimated Revenue from Sales

unit: Baht 1000

Items	Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Thai Flag - Survey/Damage Repair		115,792	142,182	160,547	174,496	186,284	202,502	214,669	235,055	246,065	263,899	269,265
Foreign Flag - Ditto.								40,931	20,120	15,833	5,365	
All Flag - Running Repair		5,789	7,109	8,027	8,724	9,414	10,125	12,791	13,060	13,195	13,464	13,464
Ship Repairing	Sub	121,581	149,291	168,574	183,320	197,698	212,627	268,611	274,265	277,093	282,748	282,749
Steel Structure Fab./ Ass'ly.		18,816	18,816	20,697	22,579	24,460	26,342	26,342	31,987	33,868	37,632	37,632
Total		140,397	168,107	189,271	205,799	222,158	238,969	294,953	306,252	310,961	320,380	320,381

### 3-8-2 Estimated Flow of Invested Funds

#### (1) Flow of Initial Investment

The flow of initial investment has been estimated on the basis of the Construction Schedule presented in Table 3-5-1. In this estimation, a lead time of 6 to 12 months has been postulated for all equipment and materials to be ordered abroad.

The resulting plan of initial investments during the first 5 years of project implementation is as given in Table 3-8-3.

#### (2) Reinvestment

The varied installations equipping a shipyard are varied also in their service lives. For maintaining proper operating efficiency of the equipment, as well as overall production capacity of the shipyard as a whole, some of the installations should call for renewal investment from the 5th year of yard operation. Reinvestment to cover equipment renewal is planned to be the amount of depreciation completed on the relevant equipment on the year following its completion.

The plan of reinvestment covering 30 years of project life is presented in Table 3-8-4.

Table 3-8-3 Plan of Initial Investments during  
First 5 Years of Project Implementation

Unit: 1,000 Baht

Item	Year	Total investment in 5 years (Baht)	1986	1987	1988	1989	1990
1 Civil engineering work (Incl. the land cost 128,955/90,000 m <sup>2</sup> )		455,377		136,600	136,600	136,600	45,577
2 Buildings		130,437			39,000	78,000	13,437
3 Dock-related equipment		42,887		4,487	12,800	25,600	
4 Jetty-related equipment		7,477		700	2,250	3,750	727
5 Cranes		88,032			27,000	54,000	7,032
6 Utilities equipment and lines		20,424			6,000	12,000	2,424
7 Electric equipment		27,647			8,000	17,000	2,647
8 Vehicles and oil barges		8,123				8,123	
9 Factory machines		125,909			62,954	62,955	
10 Anti-pollution equip- ment		22,038			8,000	12,000	2,038
11 Telephone and others		3,521				3,521	
12 Furniture for offices and so on		4,272				4,272	
13 Engineering fee		60,066	22,240	12,600	12,600	12,626	
14 Education and training		22,793				22,793	
15 Contingency		44,475				40,000	4,475
Grand Total		1,063,478	22,240	154,387	315,204	493,240	78,407

Table 3-8-4 Plan of Reinvestment during 30 Years of Project Life

Unit: 1,000 Baht

Item \ Year	Cycle (years)	1995	2000	2005	2010	2015
1 Dry dock	45					
Road pavement	10		10,442		10,442	
Jetty	10		65,332		65,332	
2 Buildings	20				130,437	
3 Dock-related equipment	10		42,887		42,887	
4 Jetty-related equipment	10		7,477		7,477	
5 Cranes	10		88,032		88,032	
6 Utilities equipment & pipe lines	10		20,424		20,424	
7 Electric equipment	10		27,647		27,647	
8 Vehicles and oil barges	5	8,123	8,123	8,123	8,123	8,123
9 Factory machines	10		125,909		125,909	
10 Anti-pollution equipment	10		22,038		22,038	
11 Telephone and others	5	3,521	3,521	3,521	3,521	3,521
12 Furniture for offices and so on	5	4,272	4,272	4,272	4,272	4,272
Total		15,916	426,104	15,916	556,541	15,916

### 3-8-3 Cost Estimation

The estimated annual expenditures for shiprepair in accordance with the production and investment plans described earlier are given in Table 3-8-5, covering the envisaged project life of 30 years.

(1) Personnel Expenses

Personnel expenses have been estimated to cover also the 4 years from 1986 to 89 for the period of the shipyard construction, and are to be included in the establishment expenses and not in the personal expenses of the regular operation. The figures in this Table are based on the average salaries or wages by categories of grade.

The production is envisaged to rise gradually from start of commercial operation in 1990 until 1995, when full capacity of installed equipment is expected to be attained through familiarization of the personnel with their tasks.

The number of employees is to progress through the years as given in Table 3-8-6. The total work force is envisaged to reach constant level in 1999.

The figures of Table 3-8-6 are separated in Tables 3-8-6(A) and (B) into the numbers of Thai and foreign employees.

Table 3-8-7 lists the amounts of starting monthly pay by grade, for Thai and foreign employees. Average pay is envisaged to increase annually by 3% to cover advances by seniority and promotions. This rate of annual increase was derived as a net value cleared of factors associated with inflation, by correcting the average salary increases (9.7%) published by the Japanese Chamber of Commerce and Industry in Bangkok to subtract the rise in consumer price index (6.3%) published by the Department of Business Economics, Ministry of Commerce from 1981 to 1983.

A bonus pay equivalent to 2 month's salary is added to the normal remuneration covering 12 months.

Table 3-8-7 First Salaries and Wages per Month for Each Grade

		Baht/month
Grade	Year	Salary/wage
(L) Managerial staff		15,000 - 100,000
(L) Engineer and officer		4,400
(L) Clerk, drafts man and workers		2,000 - 2,700
(F) Foreign employee		100,000 - 190,000

Note: (L) .... Local employer      (F) .... Foreign employee

(2) Fringe Benefits

An amount corresponding to 6% of the personnel expenses given above has been added to cover fringe benefits, including:-

- Provident fund (3%)
- Medical service compensation
- Daily travel allowance

(3) Cost of Materials

Cost of materials for shiprepair operations include:-

- Steels (plates, sections, ....)
- Piping, pipe fittings, valves
- Paint
- Welding rods
- Machinery parts

Materials required for steelwork fabrication/assembly are much the same as for shiprepair.

The cost of materials is estimated to amount to approximately 20% of sales revenue for shiprepairing, and 50% for steelwork fabrication/assembly.

Imported materials are estimated to account for 90% in value up to 1999, beyond which the proportion is envisaged to reduce to 80%. This large proportion of imports required will call for a running stock inventory covering 6 months of operation up to 1992, and covering 4 months thereafter.

(4) Incidental Production Expenses

Incidental production expenses, amounting to 10% of sales revenue, will cover, among other items:-

- Tug service
- Commissions
- Inspection fees
- Consumables
- Tooling
- Equipment maintenance/repair
- Utilities
- Personnel travel
- Communication
- Taxes, insurance premiums.

(5) Sales and Administration Expenses

Sales and administration expenses are envisaged to account for 3% of the sales revenue estimated for 1996, when the number of vessels repaired is to reach the saturation level of 50 per year. The same amounts per year are appropriated for the preceding period of 1990 to 95, as fixed charges independent of fluctuations in sales revenue.

The corresponding expenses to cover the period preceding start of commercial operation is estimated at 10% of the personnel expenses for the relevant years.

(6) Depreciation and Amortization

Depreciation of Shipyard facilities and equipment is calculated in conformity with the allowance stipulated in applicable Thai regulations, as cited in Table 3-8-8. Exceptions are the graving dock, on which depreciation is set at 2-2/9% in accordance with relevant Japanese regulations, as well as durable equipment/machinery.

The depreciation schedule is presented in Table 3-8-9. Amortization as shown in Table 3-8-9(A) is reckoned to cover expenses incurred during the period preceding commercial operation for personnel, frings benefits, engineering, instruction/training and other necessary expenditures.

(7) Establishment Expenses

Establishment expenses are to cover expenditures for:-

- Personnel
- Sales and administration
- Engineering
- Instruction and training
- Contingencies

Table 3-8-8 Depreciation Rate

Categories Assets	Depreciation Allowance
(1) Buildings	
Durable buildings	5 percent
Temporary buildings	100 percent
(2) Aircraft and aircraft accessories	33-1/3 percent
(3) Cost of acquisition of depletable natural resources	5 percent
(4) Cost of acquisition of lease rights	
If there is no written lease agreement, or if there is a written lease agreement containing a renewal clause whereby continual renewals are permitted.	10 percent
If there is a written lease agreement containing no renewal clause, or containing a renewal clause but restricting renewal periods to a definitely limited duration	100 - divided-by-the-sum-of-years-of-the-original-and-renewable-lease-periods percent
(5) Cost of acquisition of the right in a process, formula, good-will, trade-mark, business licence, patent, copyright or any other right	
If the period of use is not limited	10 percent
If the period of use is limited	100 - divided-by-the-number-of-years-of-use percent
(6) Any properties not above mentioned, but excluding land and stock-in-trade	20 percent

Information Handbook on Taxiation in Thailand, Revised Edition,  
Ministry of Finance ; Page 22.

### 3-8-4 Financial Evaluation

Financial evaluation for the envisaged Project is made on the basis of the financial analysis presented earlier. Profitability is evaluated on the criterion of Internal Rate of Return (IRR) and sensitivity analysis. Project soundness is also examined on the basis of cash flow and of funding schedule, from which the payback period and break-even point on cumulated losses are derived.

#### (1) Criterion for Project Profitability Evaluation

Among the different criteria used for evaluating the profitability of a project, the IRR is adopted in this instance, in consideration of the weight accorded to timing of cash inflow and outflow in the appraisal, which is a factor of highest importance in evaluating projects of such duration and scale.

The IRR is a discounted rate functioning to reduce to zero the aggregate differences in net current value between cash inflows and outflows. The formula applied is

$$\sum_{t=1}^n \frac{CI_t - CO_t}{(1+r)^t} = 0$$

where,  $CI_t$  = Cash Inflow in the  $t'$  th year

$CO_t$  = Cash Outflow in the  $t'$  th year

$r$  = IRR

The equation implies that the equilibrium will be maintained between income and expenditure by the use of funds incurring an interest equivalent to the IRR. In other words, the IRR represents the criterion for the rate of interest at which funds should be raised in order to let the project pay. The value of IRR utilized in such manner as criterion for financial evaluation is the "Financial Internal Rate of Return" (FIRR).

#### (2) Cash Flow

Cash flow is estimated on the basis of:-

- Sales revenue forecast (Table 3-8-2)
- Cost estimation (Table 3-8-5)
- Construction investment/reinvestment (Tables 3-8-3/-4)
- Establishment cost covering personnel, instruction/training, administration, etc.

The cash flow estimate is presented in Table 3-8-10, which compares with the annual total inflow (sales revenue) the corresponding annual total outflow, constituted of expenditures on different items; the difference between the two represents the net cash flow of the relevant year, which is cumulated from one year to the next.

(3) Profit and Loss Statement

The two cases of estimated annual profit and loss statements associated with each of the fund plans are presented in Table 3-8-11 covering the Project life of 30 years.

The profit and loss statements include coverage of:-

- Depreciation and amortization (Table 3-8-9)
- Interest on short- and long-term loans (Table 3-8-12)
- Corporation income-tax.

Corporation income tax is exempted during a period of 8 years from start of commercial operation\*. Beyond the 8th year, i.e. from 1993, the envisaged corporation income tax is envisaged to be 30%\*\*.

Dividend is envisaged to be distributed at the rate of 10% of the equity capital in any year in which this amount can be paid out of the cumulative retained earnings.

---

\*) Corporation income tax exemption: In accordance with the Office of the Board of Investments Announcement No. 1/1984.

\*\*\*) Corporation income tax of 30%: Based on Revenue Code of Thailand, Chapter III-(2):

"For juristic companies and partnerships :

(a) Tax on net profits -

(1) for registered companies : 30 percent

(2) for juristic companies and partnerships other than (1) : 35 percent.

(4) Funding Plan

The capital investments required to finance the envisaged Project will have to be covered by long-term loans, calling for repayment within prescribed terms. The funding plan presented below provides the schedule for these repayments. Loans will also be required to cover initial investment for construction, personnel, instruction/training and material stock buildup, together with other incidental expenses incurred during the establishment period before sales revenue begins to flow in.

Short-term loans will further have to be obtained to cover operating funds and inventory maintenance.

The funding plan presented in Tables 3-8-12 (A) and (B) give two representative cases envisaging different apportionments of funds between equity capital and long-term loan, and different rates of interest for foreign currency loans, as tabulated below:

Average interest rate on foreign currency loans	Apportionment of funds (Equity capital : Long-term loan)	
	50 : 50	60 : 40
11.44 %	Case 1	—
8 %	—	Case 2

Note: 60 : 40 division between equity capital and long-term loan :  
Optimized division from standpoint of profitability.

Terms of the long-term loan adopted are as follows:

1) Foreign Currency Funding

Terms postulated are 8% interest and repayment in 7 years after a 1-year grace period. The scheduling has been drawn up on the basis of the cash flow estimates given earlier.

2) Local Currency Funding

The terms postulated are 14.5% interest\*, to be repaid in 7 years after a grace period of 1 year.

---

\*) 14.5% interest on local loans: This is the current level of interest applied to long-term loans obtained by Industrial Finance Corporation of Thailand (IFCT).

3) Short-Term Loans

Short-term loans for periods are postulated to be obtained at 16.5% interest\*.

4) Sales and Administration

Expenses for sales and administration during the establishment period preceding commercial operation, together with interest and other incidental expenses incurred during this period, are to be paid off in amortization within 5 years after start of commercial operation.

The funding plan is summarized in Table 3-8-12 which also gives an indication of the conditions under which implementation of the envisaged Project would be justifiable

---

\*) 16.5% interest on short loans: This is the current level of interest applied to short-term loans obtained by commercial banks in Thailand.

Table 3-8-12 Summary of Fund Plan (Case 1 and Case 2)

Unit: Baht 1,000

	Case 1	Case 2
Equity capital: Long-term loan	50 : 50 580,000 : 567,000	60 : 40 688,000 : 459,000
Long-term loan	IFCT	Bank abroad
Interest rate	14.5%	8%
Grace period	1 year	1 year
Repayment period	7 years after grace	7 years after grace
Limit of loan	300,000  Bank abroad 267,000	459,000
Average interest rate	11.44%	
Short-term loan interest rate	16.5% by overdraft	

(5) Break-even Point

The break-even points are derived from cumulative balances;

The break-even point proved to occur 15 years after start of commercial operation, in 2004.

(6) Payback Period

The payback period for both cases — required to recuperate the original investment outlay through profit after tax and after restoring the costs of financing and depreciation — is :

- 10 years after start of commercial operation, i.e. in 1999.

(7) Financial Internal Rate of Return (FIRR)

FIRR computed as the most conservative case for decrease of sales revenue by an amount corresponding to that envisaged to accrue from running repairs and steel structure fabrication/assembly as given in Table 3-8-2 results in 3.4%.

FIRR computed on the basis of estimated cash flow as given in Table 3-8-10 proves from the calculation presented in Table 3-8-14 to be 5.8%.

(8) Sensitivity Analysis

Sensitivity was analyzed for fluctuations of the factors considered to present the uncertainties residing in the estimates and forecasts i.e.:-

- Cash in-flow to +10% and -10%
- Cash out-flow =
  - = +10% in material cost
  - = +10% in investment/re-investment costs.

The ranges of fluctuation considered above have been adopted in view not only of the uncertainties residing in the cash flow data but also of assessing the viability of the Shipyard in terms of competitiveness (possibility of lowering the process offered) and of adaptability to rise in material costs and in investment/reinvestment outlay.

The results of the sensitivity analyses corresponding to the latter case of FIRR are presented in Table 3-8-15, which gives the effects on FIRR brought by the envisaged variations in the factors considered.

Table 3-8-15 Sensitivity Analysis on FIRR

Factors varied	Variation	FIRR %
Base		5.8
Cash in-flow	10% increase	8.0
	10% decrease	3.1
Material cost	10% increase	5.2
Investment and re-investment	10% increase	4.9

(9) Evaluation

A figure of 5.8% has been indicated as FIRR for this Project, as given in Table 3-8-15. Thus, from purely financial aspects, the Project cannot be considered promising under the currently prevailing levels of interest: Loan rates for industrial capital in Thailand are 16.5% in the market and 14.5% minimum for loans by the Industrial Finance Corporation. For deposit, banks offer up to 14% fixed interest for 2-year term, to which a 0.75% business tax is imposed.

The break-even point and the payback period indicate long period respectively.

The two cases of profit and loss statements and the fund statements (Case 1, and Case 2) also prove the project is unsound on the basis of commercial finance.

A purely financial evaluation may not, however, be apposite in the present instance, in view of the possible economic and/or social benefits that may be expected from effective implementation of the Project. Analysis of the economic aspect of the Project is presented in the following Section.

### 3-9 Economic Analysis

In what follows, an examination is made of the benefits expected to result from the various effects of industrialization brought upon implementation of the envisaged Project.

#### 3-9-1 Economic effects

The economic effects to be expected include the following:

- 1) Enhanced employment opportunities
- 2) Savings in outflow of foreign currency; increased inflow of same
- 3) Raised level of technological capability
- 4) Greater convenience of shipowners.

The first two of the above items will produce beneficial repercussions on associated industries and activities.

#### 3-9-2 Economic Evaluation

Quantitative analysis of the first two items of economic effect cited in the preceding section result in the following.

##### (1) Economic Benefits

- 1) Enhanced employment

New or additional income earned by unemployed or underemployed workers will be 5 times more than they are earning now.

- 2) Foreign currency saving/earning

The payments in foreign currency being made by Thai under employed to foreign shipyards will be saved; payments in foreign currency will be newly received from foreign shipowners for shiprepairs undertaken on their ships by the Repair Shipyard.

(2) Economic Costs

The economic costs, that is, the outflow of foreign currency to be incurred in the implementation of the envisaged Project are the following:

1) Personnel expenses

Portion of salaries paid to foreign personnel that will be remitted or taken home, summarized to amount to 2 months pay.

2) Fringe Benefits

Portion of fringe benefits for foreign personnel remitted or taken home, sum account for half the amounts paid, or 3% of the total salaries paid.

3) Material Costs

To cover payments for imported materials.

4) Production, sales and administration expenses

To account for 10% of the total sum of these expenses, which is the portion to be paid in foreign currency as envisaged in the calculation of FIRR.

5) Establishment Expenses

Portion of personnel expenses and fringe benefits to be paid in foreign currency, summarised along the same lines as given in 1) and 2) above. Charges for engineering, instruction/training, and contingencies as specified in Table 3-5-2 as payments in foreign currency.

Other economic costs would include outlays for investment and reinvestment.

(3) Criteria for Economic Evaluation

The benefits and costs cited above are reflected in the Economic Internal Rate of Return (EIRR) derived using the same formula as for the FIRR (Section 3-8-4).

(4) Economic Internal Rate of Return (EIRR)

The Estimated Economic Benefits and Costs evaluated in terms of EIRR covering the entire Project life is presented in Table 3-9-1, which indicates as shown in Table 3-9-2 that:

$$\text{EIRR} = 11.4\%$$

Sensitivity analysis on this EIRR is given in Table 3-9-3, for the factors indicated in the same Table.

Table 3-9-3 Sensitivity Analysis on EIRR

Factors varied	Variation	EIRR(%)
Base		11.4
Cash in-flow	10% increase	13.1
	10% decrease	9.5
Material cost	10% increase	11.0
Investment and re-investment	10% increase	10.4

(5) Profit and Loss Statement; Funding Plan

Profit and loss statements are presented for information in Table 3-9-5, and the relevant funding plan in Table 3-9-6.

The funding plan is summarized in Table 3-9-4, which also gives an indication of the conditions under which implementation of the envisaged Project would be justifiable.

Table 3-9-4 Summary of Fund Plan (Case 3)

Unit: Baht 1,000

	Case 3
Equity capital: Long-term loan	50 : 50 580,000 : 567,000
Long-term loan	
Interest rate	5%
Grace period	10 year
Repayment period	20 years after grace
Short-term loan interest rate	16.5% by overdraft

(6) Evaluation

The foregoing results of EIRR calculation would indicate the envisaged Project to be worth implementing, when considered from the economic and social benefits to be expected for the nation as a whole, in view of the criterion applied by the World Bank for projects to benefit industrializing countries, of 8 to 10% in terms of the ratio of "Opportunity Costs of Capital".

The profit and loss statement and the fund statement (Case 3) prove the repair shipyard could not be operated without the specified loan, as shown in Table 3-9-4, with the support of the government.

Table 3-8-5 Cost Estimation (1/2)

Unit: Baht/000

Item	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	
Personnel				68,713	68,638	55,748	52,556	39,158	40,938	35,056	36,106	37,196	38,304	39,452	40,642	41,860		
Fringe Benefit				5,323	5,318	5,345	5,153	2,349	2,454	2,105	2,166	2,232	2,298	2,371	2,451	2,512		
Material				52,265	43,531	46,212	43,548	54,161	57,229	70,881	74,714	75,430	78,908	77,909	77,909	77,909	70,909	
Production Expenses				14,040	16,611	16,921	20,590	22,216	23,697	29,495	30,625	31,096	32,038	32,038	32,038	32,038	32,038	
Production Cost				160,339	154,298	126,232	119,871	117,884	124,488	137,555	143,611	145,956	151,548	151,766	153,028	147,359		
Sales and Administration				8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	
Cost				169,188	163,147	135,081	128,696	126,733	133,337	146,384	152,460	154,605	160,397	160,615	161,877	156,168		

Table 3-8-5 Cost Estimation (2/2)

Unit: Baht/000

Item	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Personnel	43,120	44,438	45,738	47,110	48,524	49,980	51,478	53,032	54,614	56,252	57,946	57,682	61,474	63,308	65,212	67,172	69,851
Fringe Benefit	2,587	2,664	2,744	2,827	2,911	2,999	3,089	3,182	3,271	3,371	3,477	3,581	3,688	3,798	3,913	4,030	4,190
Material	70,909	77,909	77,909	77,909	77,909	77,909	77,909	77,909	77,909	77,909	77,909	77,909	77,909	77,909	77,909	77,909	77,909
Production Expenses	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038
Production Cost	148,654	157,019	158,429	159,864	161,382	162,926	164,514	166,161	167,838	169,574	202,370	171,210	175,109	177,053	179,072	181,149	183,968
Sales and Administration	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649	8,649
Cost	157,503	165,668	167,278	168,733	170,231	171,775	173,365	175,010	176,687	178,425	211,219	180,059	183,958	185,902	187,921	189,996	192,617

Table 3-8-6 Manning Plan

Unit: 1 Person

Grade	Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
(F) General Manager	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
(L) V. Gen. Manager	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
(L) Dept. Manager	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
(F) Ditto.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
(L) Dock Master	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
(L) Sec. Manager	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
(F) Ditto.	3.5	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
(L) Engineer	6.0	8.0	8.0	8.0	10.0	13.0	13.0	13.0	13.0	13.0	13.0	15.0	15.0	15.0	15.0
(F) Ditto.	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
(L) Officer	4.0	4.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
(F) Ditto.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
(L) Design Engineer	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
(F) Ditto.															
(L) Clerk	1.0	5.0	20.0	20.0	20.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
(L) Craftsman	1.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Management & Staff	3.0	3.0	5.0	34.0	58.0	58.0	65.0	65.0	66.0	66.0	66.0	65.0	65.0	65.0	65.0
(F) Junior Eng'r				17.5	35.0	35.0	10.0	10.0	10.0	10.0					
(L) Foreman (10)				2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
(L) Worker (10)				12.0	17.0	22.0	22.0	22.0	29.0	29.0	34.0	34.0	34.0	34.0	34.0
(L) Foreman (D)				24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0
(L) Worker (D)				56.0	231.0	241.0	306.0	306.0	306.0	341.0	341.0	386.0	386.0	386.0	396.0
Jr. Eng'r & Worker				113.5	305.0	324.0	364.0	364.0	364.0	396.0	401.0	446.0	446.0	446.0	456.0
Grand Total	3.0	3.0	5.0	147.0	367.0	362.0	427.0	427.0	434.0	459.0	464.0	509.0	509.0	509.0	519.0

Table 3-8-6(A) Manning Plan for Local Employees

Unit: 1 Person

Grade	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
V. General Manager	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Department Manager														
Deck Master				0.51	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Section Manager	1.01	1.01	1.01	1.01	1.01	1.01	4.01	4.01	4.01	4.01	6.01	6.01	6.01	6.01
Engineer				6.01	8.01	8.01	10.01	13.01	13.01	13.01	15.01	15.01	15.01	15.01
Clerk				1.01	5.01	20.01	20.01	25.01	25.01	25.01	25.01	25.01	25.01	25.01
Officer				4.01	4.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01	5.01
Design Engineer						1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
Draftsman				1.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01	4.01
Management Staff Sub	2.01	2.01	4.01	19.51	37.01	42.01	50.01	53.01	55.01	55.01	57.01	57.01	57.01	57.01
Indirect Foreman				2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01	2.01
Indirect Worker				12.01	17.01	22.01	22.01	29.01	29.01	34.01	34.01	34.01	34.01	34.01
Direct Foreman				24.01	24.01	24.01	24.01	24.01	24.01	24.01	24.01	24.01	24.01	24.01
Direct Worker				58.01	31.01	41.01	296.01	281.01	331.01	366.01	366.01	366.01	386.01	396.01
Foreman/Worker Sub				96.01	77.01	89.01	344.01	336.01	386.01	386.01	446.01	446.01	446.01	456.01
Total	2.01	2.01	4.01	115.51	114.01	131.01	364.01	389.01	459.01	499.01	503.01	503.01	503.01	513.01

Table 3-8-6(B) Manning Plan for Foreign Employees

Unit: 1 Person

Grade	Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
General Manager		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Department Manager															
Section Manager					3.5	7.0	7.0	4.0	4.0	4.0	4.0	2.0	2.0	2.0	2.0
Engineer					7.0	7.0	7.0	7.0	4.0	4.0	4.0	2.0	2.0	2.0	2.0
Officer					1.0	1.0									
Design Engineer					1.0	1.0									
Management Staff	Sub	1.0	1.0	1.0	14.5	18.0	16.0	13.0	10.0	10.0	10.0	6.0	6.0	6.0	6.0
Junior Engineer					17.5	35.0	35.0	10.0	10.0						
Total		1.0	1.0	1.0	32.0	55.0	51.0	23.0	20.0	10.0	10.0	6.0	6.0	6.0	6.0

Table 3-8-9 Depreciation Schedule (1/2)

Unit: Baht'000

Category / Allowance / Dep. Amount/Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Dory Dock 2 2/9%	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570
Building 5%	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522
Machinery etc. 10%	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019
Vehicle etc. 20%	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183
Total	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294

Table 3-8-9 Depreciation Schedule (2/2)

Unit: Baht'000

Category / Allowance / Dep. Amount/Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Dory dock 2 2/9%	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570	5,570
Building 5%	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522	6,522
Machinery etc. 10%	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019	41,019
Vehicle etc. 20%	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183	3,183
Total	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294

Table 3-8-9(A) Amortization Schedule (1/2)

Unit: Bah:1000

Category / Allowance / Amr. Amount\Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Establishment 20%	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533
Total of Amortization	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533	41,533

Table 3-8-9(A) Amortization Schedule (2/2)

Unit: Bah:1000

Category / Allowance / Amr. Amount\Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Establishment 20%															
Total of Amortization															

Table 3-8-10 Cash Flow Estimation (1/2)

Unit: Baht 1000

* Cash In/Out-flow per Year *	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sales Revenue	+				140,397	168,107	199,271	205,899	222,158	238,869	294,953	306,252	310,961	320,380	320,381	320,381	320,381
Cash In/low	Sub				140,397	168,107	189,271	205,899	222,158	238,869	294,953	306,252	310,961	320,380	320,381	320,381	320,381
Personnel	-				68,713	88,638	55,748	52,556	39,158	40,998	35,056	36,106	37,198	38,304	39,452	40,642	41,860
Fringe Benefit	-				5,325	5,318	3,345	3,153	2,349	2,454	2,103	2,166	2,232	2,298	2,367	2,439	2,512
Material	-				52,263	43,531	48,212	43,548	54,161	57,229	70,881	74,714	75,430	78,908	77,909	77,909	70,909
Production Expenses	-				14,040	16,811	18,927	20,590	22,216	23,897	29,495	30,625	31,096	32,038	32,038	32,038	32,038
Production Cost	Sub				160,339	154,298	126,232	119,847	117,884	124,488	137,555	143,611	145,956	151,548	151,766	153,028	147,319
Sales and Administration	-				8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849
Cost	Sub				169,188	163,147	135,081	128,696	126,733	133,337	146,384	152,460	154,805	160,397	160,615	161,877	156,168
Establishment	-	27,078	17,583	18,018	140,526	4,475											
Investment	-		141,787	302,604	617,821	73,932											
Re Investment	-									15,916					426,104		
Establishment & Investment	Sub	27,078	159,370	320,622	558,345	78,407				15,916					426,104		
Cash Outflow	Sub	27,078	159,370	320,622	558,345	247,595	163,147	135,081	128,696	126,733	146,384	152,460	154,805	160,397	160,719	161,877	156,168
Net Cash Flow		-27,078	-159,370	-320,622	-558,345	-107,198	4,960	54,190	77,203	89,716	148,569	153,792	156,156	159,983	-266,338	158,504	164,213
Cumulative Net Cash Flow		-27,078	-186,448	-507,070	-1,065,415	-1,172,613	-1,167,653	-1,113,463	-940,835	-851,119	-702,550	-548,758	-392,602	-232,619	-698,957	-340,453	-176,240

Table 3-8-10 Cash Flow Estimation (2/2)

Unit: Baht,000

Cash In/Out-Flow	Year *	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019		
Sales Revenue	+	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	
Cash Inflow	Sub	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	
Personnel	-	43,120	44,408	45,738	47,110	48,524	49,980	51,478	53,022	54,614	56,252	57,946	57,682	61,474	63,308	65,212	67,172	69,831		
Fringe Benefit	-	2,387	2,664	2,744	2,827	2,911	2,999	3,089	3,182	3,277	3,375	3,477	3,581	3,688	3,798	3,913	4,030	4,190		
Material	-	70,909	71,909	71,909	71,909	71,909	71,909	71,909	71,909	71,909	71,909	71,909	71,909	71,909	71,909	71,909	71,909	71,909	71,909	
Production Expenses	-	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	32,038	
Production Cost	Sub	148,654	157,019	158,429	159,884	161,382	162,926	164,514	166,161	167,838	169,574	202,370	171,210	175,109	177,055	179,072	181,149	183,988		
Sales and Administration	-	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	
Cost	Sub	157,503	165,868	167,278	168,733	170,231	171,775	173,363	175,010	176,687	178,423	211,219	180,059	185,958	185,902	187,921	189,998	192,817		
Establishment	-																			
Investment	-																			
Reinvestment	-			15,916					556,541					15,916						
Establishment & Investment	Sub			15,916					556,541					15,916						
Cash Outflow	Sub	157,503	165,868	183,194	168,733	170,231	171,775	173,363	175,551	176,687	178,423	211,219	180,059	199,874	185,902	187,921	189,998	192,817		
Net Cash Flow		162,878	154,513	137,187	151,648	150,150	148,606	147,018	-411,170	143,694	141,958	109,162	140,322	120,507	134,479	132,460	130,383	127,564		
Cumulative Net Cash Flow		-13,362	141,151	278,338	429,986	580,136	728,742	875,760	1,026,930	1,183,624	1,345,582	1,512,744	1,685,016	1,862,423	2,045,002	2,232,532	2,425,115	2,622,759	2,825,463	3,033,227

Table 3-8-11 Profit and Loss Statement - Case 1 (1/2)

Unit: Baht1000

* Item	** Year *	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
01 Sales						140,397	168,107	189,271	205,891	223,151	238,969	294,951	306,252	310,961	320,380	320,381	320,381	320,381
02 Production Cost						160,339	154,298	126,232	119,874	117,884	124,488	137,599	145,678	146,016	151,936	152,160	153,426	147,731
03 Deprec't'n & Amort't'n						110,600	110,800	110,800	110,800	110,800	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294
04 Production Profit						-130,742	-96,991	-47,761	-24,775	-6,529	58,187	101,040	106,280	108,651	112,156	111,927	110,461	116,356
05 Sales & Administration						8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849
06 Operation Profit						-139,591	-105,840	-56,610	-33,624	-15,375	49,338	92,211	97,431	99,802	103,307	103,071	101,812	107,507
07 Interest						-73,453	-86,110	-100,489	-110,953	-119,791	-129,188	-135,699	-137,419	-141,609	-138,708	-173,267	-214,125	-223,581
08 Profit before Tax						-213,044	-191,950	-157,099	-144,579	-135,166	-79,850	-43,398	-39,988	-41,807	-35,401	-70,182	-112,313	-116,074
09 Corporation Tax																		
10 Net Profit						-213,044	-191,950	-157,099	-144,579	-135,166	-79,850	-43,398	-39,988	-41,807	-35,401	-70,182	-112,313	-116,074
11 Cumulative Net Profit						-213,044	-404,994	-562,093	-706,672	-841,638	-921,688	-965,086	-1,005,075	-1,046,881	-1,082,282	-1,152,464	-1,264,777	-1,380,852
12 Dividend																		
13 Director's Remuneration																		
14 Retained Earnings						-213,044	-191,950	-157,099	-144,579	-135,166	-79,850	-43,398	-39,988	-41,807	-35,401	-70,182	-112,313	-116,074
15 Cumulative Ret'd Earnings						-213,044	-404,994	-562,093	-706,672	-841,638	-921,688	-965,086	-1,005,075	-1,046,881	-1,082,282	-1,152,464	-1,264,777	-1,380,852

Table 3-8-11 Profit and Loss Statement - Case 1 (2/2)

Unit: Bakt1000

Item	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
01 Sales	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381
02 Production Cost	149,074	158,884	160,358	161,846	161,864	163,471	165,028	166,678	168,380	170,133	171,938	175,714	175,714	177,713	179,719	181,813	183,968
03 Deprec'n & Amort'n	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294
04 Production Profit	115,013	105,203	103,729	102,241	102,223	100,616	99,061	97,409	95,707	95,954	92,149	90,289	88,373	86,374	84,368	82,274	80,119
05 Sales & Administration	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849
06 Operation Profit	106,164	96,354	94,880	93,392	93,374	91,767	90,212	88,560	86,858	85,105	83,300	81,440	79,524	77,525	75,519	73,425	71,270
07 Interest	-24,345	-248,021	-266,740	-289,029	-313,892	-343,500	-378,716	-470,599	-579,306	-657,826	-753,574	-866,688	-999,125	-1,155,905	-1,339,806	-1,557,148	-1,814,023
08 Profit before Tax	-128,181	-151,668	-171,660	-195,637	-220,518	-251,733	-289,504	-382,039	-492,448	-572,721	-670,274	-785,243	-919,601	-1,078,380	-1,264,287	-1,483,723	-1,742,753
09 Corporation Tax																	
10 Net Profit	-128,181	-151,668	-171,660	-195,637	-220,518	-251,733	-289,504	-382,039	-492,448	-572,721	-670,274	-785,243	-919,601	-1,078,380	-1,264,287	-1,483,723	-1,742,753
11 Cumulative Net Profit	-1,509,033	-1,660,701	-1,832,561	-2,028,198	-2,248,716	-2,500,449	-2,786,953	-3,170,992	-3,663,440	-4,236,161	-4,906,435	-5,691,683	-6,611,284	-7,689,664	-8,953,950	-10,437,674	-12,180,426
12 Dividend																	
13 Director's Remuneration																	
14 Retained Earnings	-128,181	-151,668	-171,660	-195,637	-220,518	-251,733	-289,504	-382,039	-492,448	-572,721	-670,274	-785,243	-919,601	-1,078,380	-1,264,287	-1,483,723	-1,742,753
15 Cumulative Retained Earnings	-1,509,033	-1,660,701	-1,832,561	-2,028,198	-2,248,716	-2,500,449	-2,786,953	-3,170,992	-3,663,440	-4,236,161	-4,906,435	-5,691,683	-6,611,284	-7,689,664	-8,953,950	-10,437,674	-12,180,426

Table 3-8-13 Fund Statement - Case 1 (1/2)

Unit: Baht 1000

Item	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
02 Net Cash Flow	-27,078	-159,370	-320,622	-558,345	-55,265	4,960	54,190	77,203	95,425	89,716	148,589	153,792	156,156	159,983	-266,338	158,504	164,213
03 Tax/Dividend																	
04 Net Cash Flow (02 - 03)	-27,078	-159,370	-320,622	-558,345	-55,266	4,960	54,190	77,203	95,425	89,716	148,589	153,792	156,156	159,983	-266,338	158,504	164,213
05 Equity Capital	30,000	160,000	320,000	70,000													
06 Long-term Loan				567,000													
07 * Repayment						-81,000	-81,000	-81,000	-81,000	-81,000	-81,000	-81,000					
08 * Loan Balance				567,000	567,000	486,000	405,000	324,000	243,000	162,000	81,000						
09 * Interest Payable				-64,865	-64,865	-55,598	-46,332	-37,066	-27,799	-18,533	-9,266						
10 Balance (04+05+06+07+09)	2,922	630	-622	13,790	-98,131	-131,638	-75,142	-40,863	-13,374	-9,617	58,303	72,792	156,156	159,983	-266,338	158,504	164,213
11 Short-term Loan					104,098	161,647	124,960	114,220	105,202	121,022	89,127	65,134	-14,352	-20,809	439,616	55,726	58,895
12 * Loan Balance					104,098	265,745	390,705	504,925	610,127	731,150	800,277	865,411	851,059	830,250	1,269,666	1,325,592	1,384,485
13 * Interest Payable					-8,588	-30,512	-54,157	-73,889	-91,992	-110,655	-126,343	-137,419	-141,609	-138,788	-173,260	-214,125	-223,581
14 Total Loan (08+12)				567,000	671,098	751,745	795,705	828,925	853,127	893,150	881,277	865,411	851,059	830,250	1,269,666	1,325,592	1,384,485
15 Total Interest (09+13)				-64,865	-73,453	-86,110	-100,489	-110,955	-119,791	-128,188	-135,689	-137,419	-141,609	-138,788	-173,260	-214,125	-223,581
16 Surplus/deficit	2,922	630	-622	13,790	-2,621	-503	-2,339	-532	-164	550	1,087	506	195	466	18	105	-476
17 Cumulative S/D	2,922	3,552	2,930	16,720	14,099	13,596	11,257	10,725	10,561	11,111	12,199	12,701	12,900	13,366	13,385	13,490	13,014

Table 3-8-13 Fund Statement - Case 1 (2/2)

Unit: Baht 000

Item	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
02 Net Cash Flow	162,878	154,513	134,187	151,648	150,150	146,606	147,018	-411,170	143,694	141,958	109,162	140,322	120,507	134,479	132,460	130,383	127,564
03 Tax/Dividend																	
04 Net Cash Flow (02 - 03)	162,878	154,513	134,187	151,648	150,150	146,606	147,018	-411,170	143,694	141,958	109,162	140,322	120,507	134,479	132,460	130,383	127,564
05 Equity Capital																	
06 Long-term Loan																	
07 * Repayment																	
08 * Loan Balance																	
09 * Interest Payable																	
10 Balance (04+05+06+07+08)	162,878	154,513	134,187	151,648	150,150	146,606	147,018	-411,170	143,694	141,958	109,162	140,322	120,507	134,479	132,460	130,383	127,564
11 Short-term Loan	71,578	94,207	132,670	137,502	163,867	195,023	231,830	881,906	435,752	516,013	644,561	726,519	878,176	1,021,588	1,207,514	1,426,938	1,686,694
12 * Loan Balance	1,456,063	1,550,270	1,682,940	1,820,442	1,984,309	2,179,332	2,411,162	3,293,068	3,728,820	4,244,833	4,889,394	5,615,914	6,494,690	7,516,278	8,725,722	10,150,730	11,637,423
13 * Interest Payable	-234,345	-248,022	-266,740	-289,029	-313,692	-343,500	-378,716	-470,599	-579,306	-657,826	-753,574	-866,688	-999,125	-1,155,905	-1,339,868	-1,557,148	-1,814,023
14 Total Loan (09+12)	1,456,063	1,550,270	1,682,940	1,820,442	1,984,309	2,179,332	2,411,162	3,293,068	3,728,820	4,244,833	4,889,394	5,615,914	6,494,690	7,516,278	8,725,722	10,150,730	11,637,423
15 Total Interest (09+13)	-234,345	-248,022	-266,740	-289,029	-313,692	-343,500	-378,716	-470,599	-579,306	-657,826	-753,574	-866,688	-999,125	-1,155,905	-1,339,868	-1,557,148	-1,814,023
16 Surplus/deficit	111	697	117	121	125	129	132	137	140	145	150	153	158	162	168	173	231
17 Cumulative S/D	13,125	13,822	13,940	14,061	14,186	14,315	14,447	14,584	14,724	14,869	15,018	15,172	15,330	15,492	15,660	15,833	16,068

Table 3-8-11 Profit and Loss Statement - Case 2 (1/2)

Unit: Baht 1000

Item	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
01 Sales		140,397	168,107	189,271	215,899	222,158	238,999	294,953	306,252	310,961	320,580	320,581	320,581	320,581	320,581	320,581	320,581
02 Production Cost		160,359	154,298	126,232	119,874	117,884	124,488	137,599	143,678	146,016	151,930	152,160	153,426	147,751			
03 Deprec'n & Amort'n		105,171	105,171	105,171	105,171	105,171	105,171	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294
04 Production Profit		-125,113	-91,362	-42,132	-19,146	-8971	58,187	101,060	106,280	108,651	112,158	111,927	110,661	116,356			
05 Sales & Administration		8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849
06 Operation Profit		-135,962	-100,211	-50,981	-27,995	-9,740	49,338	92,211	97,431	99,802	103,307	103,678	101,812	107,507			
07 Interest		-40,247	-47,397	-56,421	-60,589	-61,951	-62,554	-58,800	-48,168	-54,920	-12,833	-24,748	-38,906	-16,851			
08 Profit before Tax		-174,209	-147,608	-107,402	-88,584	-71,697	-13,216	33,611	49,263	64,882	90,474	78,330	62,906	90,656			
09 Corporation Tax																	
10 Net Profit		-174,209	-147,608	-107,402	-88,584	-71,697	-13,216	33,611	49,263	64,882	90,474	78,330	62,906	90,656			
11 Cumulative Net Profit		-174,209	-321,816	-429,218	-517,782	-589,479	-602,696	-519,822	-454,940	-364,466	-286,156	-225,250	-132,573				
12 Dividend																	
13 Director's Remuneration																	
14 Retained Earnings		-174,209	-147,608	-107,402	-88,584	-71,697	-13,216	33,611	49,263	64,882	90,474	78,330	62,906	90,656			
15 Cumulative Ret'd Earnings		-174,209	-321,816	-429,218	-517,782	-589,479	-602,696	-519,822	-454,940	-364,466	-286,156	-225,250	-132,573				

Table 3-8-11 Profit and Loss Statement - Case 2 (2/2)

Unit: Baht 1000

Item	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
01 Sales	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381
02 Production Cost	149,074	158,884	160,358	161,846	161,846	165,471	165,026	166,678	168,380	170,133	171,938	173,798	175,714	177,715	179,719	181,813	183,968
03 Depreciation & Amort'n	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294
04 Production Profit	115,013	105,233	103,729	102,241	102,223	100,616	99,061	97,409	95,707	93,954	92,149	90,289	88,373	86,374	84,368	82,274	80,119
05 Sales & Administration	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849
06 Operation Profit	106,164	96,384	94,880	93,392	93,374	91,767	90,212	88,560	86,858	85,105	83,300	81,440	79,524	77,525	75,519	73,425	71,270
07 Interest	-2,327																
08 Profit before Tax	103,837	96,354	94,880	93,392	93,374	91,767	90,212	88,560	86,858	85,105	83,300	81,440	79,524	77,525	75,519	73,425	71,270
09 Corporation Tax		20,285	28,454	28,018	28,012	27,530	27,064	26,568	26,057	25,532	24,990	24,432	23,857	23,258	22,656	22,023	21,381
10 Net Profit	103,837	76,069	66,426	65,374	65,362	64,237	63,148	61,992	60,801	59,573	58,310	57,008	55,667	54,267	52,863	51,397	49,889
11 Cumulative Net Profit	-28,736	47,332	115,748	179,123	244,485	308,722	371,870	433,862	494,663	554,236	612,546	669,554	725,221	779,488	832,352	883,749	935,638
12 Dividend			68,800	68,800	68,800	68,800	68,800	68,800	68,800	68,800	68,800	68,800	68,800	68,800	68,800	68,800	68,800
13 Director's Remuneration																	
14 Retained Earnings	103,837	76,069	-2,384	-3,426	-3,438	-4,563	-5,652	-6,808	-7,999	-9,227	-10,541	-11,922	-13,333	-14,733	-16,133	-17,533	-18,911
15 Cumulative Retained Earnings	-28,736	47,332	44,948	41,523	38,085	33,521	27,870	21,062	15,063	8,836	2,436	-4,041	-10,354	-17,421	-25,232	-33,797	-42,108

Table 3-8-13 Fund Statement - Case 2 (1/2)

Unit: Baht1000

* Item	* Year *	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
02 Net Cash Flow		-27,078	-159,570	-320,622	-550,345	-55,266	4,960	54,190	77,203	95,425	89,716	148,569	155,792	156,156	159,983	-266,338	158,504	164,213
03 Tax/Dividend																		
04 Net Cash Flow (02 - 03)		-27,078	-159,570	-320,622	-550,345	-55,266	4,960	54,190	77,203	95,425	89,716	148,569	155,792	156,156	159,983	-266,338	158,504	164,213
05 Equity Capital		30,000	160,000	320,000	178,000													
06 Long-term Loan					439,000													
07 * Repayment							-65,571	-65,571	-65,571	-65,571	-65,571	-65,571	-65,571	-65,571				
08 * Loan Balance					439,000	439,000	393,429	327,858	262,287	196,716	131,145	65,574						
09 * Interest Payable					-36,720	-36,720	-31,474	-26,229	-20,983	-15,737	-10,492	-5,246						
10 Balance (04+05-06+07+09)		2,922	630	-622	41,935	-9,986	-92,085	-37,618	-9,351	14,117	13,653	77,792	88,218	156,156	159,983	-266,338	158,504	164,213
11 Short-term Loan						62,747	107,504	65,463	48,405	31,934	38,960	-23,311	-39,543	-121,040	-166,684	291,104	-119,493	-147,838
12 * Loan Balance						42,747	150,251	215,714	264,119	296,155	355,012	311,701	272,158	151,118	4,434	295,538	176,044	28,206
13 * Interest Payable						-3,527	-15,922	-30,192	-39,586	-46,214	-52,063	-53,354	-48,168	-34,920	-12,833	-24,748	-38,906	-16,851
14 Total Loan (08+12)					439,000	501,747	543,680	543,572	526,406	497,691	466,157	377,275	272,158	151,118	4,434	295,538	176,044	28,206
15 Total Interest (09+13)					-36,720	-40,247	-47,397	-56,421	-60,569	-61,951	-62,554	-58,600	-48,168	-34,920	-12,833	-24,748	-38,906	-16,851
16 Surplus/Deficit		2,922	630	-622	41,935	-30,766	-503	-2,339	-532	-164	550	1,087	506	195	466	18	105	-476
17 Cumulative S/O		2,922	3,552	2,930	44,865	14,099	13,596	11,257	10,725	10,561	11,111	12,199	12,705	12,900	13,366	13,385	13,690	13,014

Table 3-8-13 Fund Statement - Case 2 (2/2)

Unit: Baht1000

Item	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
02 Net Cash Flow	162,878	154,513	134,187	151,648	150,150	148,606	147,018	-41,170	143,694	141,998	109,162	140,322	120,507	134,479	132,460	130,393	127,564
03 Tax/Dividende			20,285	97,264	96,818	96,812	96,350	95,864	95,368	94,871	94,374	24,990	93,232	92,657	92,058	91,456	22,028
04 Net Cash Flow (02 + 03)	162,878	154,513	113,902	54,384	53,332	51,794	50,668	-507,034	48,326	47,101	14,830	115,332	27,275	41,822	40,402	38,927	105,536
05 Equity Capital																	
06 Long-term Loan																	
07 * Repayment																	
08 * Loan Balance																	
09 * Interest Payable																	
10 Balance (04+05+06+07+09)	162,878	154,513	113,902	54,384	53,332	51,794	50,668	-507,034	48,326	47,101	14,830	115,332	27,275	41,822	40,402	38,927	105,536
11 Short-term Loan	-28,206																
12 * Loan Balance																	
13 * Interest Payable	-2,327																
14 Total Loan (08+12)																	
15 Total Interest (09+13)	-2,327																
16 Surplus/deficit	132,345	154,513	113,902	54,384	53,332	51,794	50,668	-507,034	48,326	47,101	14,830	115,332	27,275	41,822	40,402	38,927	105,536
17 Cumulative S/D	145,359	299,872	413,773	468,157	521,490	573,284	623,972	116,938	165,264	212,365	227,195	342,521	369,802	411,624	452,026	490,954	596,490

Table 3-8-14 Calculation of FIRR

TFS (FIRR) - Base Case

Year	D. Rate	N. C. F.	P. V.	C. P. V.
1986	1.000	-27,078	-27,078	-27,078
1987	0.945	-159,370	-150,676	-177,754
1988	0.894	-320,622	-286,594	-464,348
1989	0.845	-558,345	-471,861	-936,210
1990	0.799	-107,198	-85,652	-1,021,860
1991	0.755	4,960	3,747	-1,018,110
1992	0.714	54,190	38,703	-979,412
1993	0.675	77,203	52,131	-927,281
1994	0.638	95,425	60,920	-866,361
1995	0.604	89,716	54,151	-812,210
1996	0.571	148,569	84,781	-727,428
1997	0.540	153,792	82,974	-644,454
1998	0.510	156,156	79,654	-564,801
1999	0.482	159,983	77,154	-487,647
2000	0.456	-266,338	-121,438	-609,085
2001	0.431	158,504	68,328	-540,757
2002	0.408	164,213	66,927	-473,829
2003	0.385	162,878	62,762	-411,067
2004	0.364	154,513	56,291	-354,777
2005	0.344	137,187	47,252	-307,525
2006	0.326	151,648	49,384	-258,141
2007	0.308	150,150	46,228	-211,913
2008	0.291	148,606	43,257	-168,656
2009	0.275	147,018	40,460	-128,196
2010	0.260	-411,170	-106,983	-235,179
2011	0.246	143,694	35,348	-199,831
2012	0.233	141,958	33,016	-166,814
2013	0.220	109,162	24,004	-142,811
2014	0.208	140,322	29,172	-113,639
2015	0.197	120,507	23,686	-89,953
2016	0.186	134,479	24,990	-64,962
2017	0.176	132,460	23,272	-41,690
2018	0.166	130,383	21,658	-20,032
2019	0.157	127,564	20,034	1

Unit of N. C. F.: Baht1000

Discount Rate: 5.77007 %

Table 3-9-1 Estimated Economic Benefits and Costs Evaluated in Terms of EIRR (1/2)

Unit: Baht1000

* Cash In/Out-Flow ** Year * +/-	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sales Revenue				140,397	168,107	189,271	205,899	222,158	238,969	254,955	270,951	286,952	310,961	320,380	320,381	320,381	320,381
Cash In/Out				140,397	168,107	189,271	205,899	222,158	238,969	254,955	270,951	286,952	310,961	320,380	320,381	320,381	320,381
Personnel				70,755	70,750	34,542	31,081	18,168	18,713	12,275	12,275	12,643	13,022	13,413	15,815	14,230	14,657
Frings Benefit				2,122	2,101	1,036	932	545	581	368	379	391	402	414	427	441	440
Material				47,012	39,178	43,391	39,193	43,745	51,506	63,795	67,431	67,431	67,887	71,071	62,327	62,327	62,327
Production Expenses				1,404	1,681	1,893	2,059	2,221	2,390	2,910	2,910	3,063	3,110	3,204	3,204	3,204	3,204
Production Cost				121,273	113,690	80,862	75,265	69,680	75,170	79,346	85,328	84,410	88,036	88,036	79,760	80,188	80,628
Sales and Administration				885	885	885	885	885	885	885	885	885	885	885	885	885	885
Cost				122,158	114,575	81,747	74,150	70,565	74,055	80,231	80,231	84,213	85,295	88,921	80,645	81,073	81,513
Establishment	24,564	12,453	12,925	117,028	4,475												
Investment		141,787	502,664	417,821	75,932												
Reinvestment										15,916						426,194	
Establishment & Investment	24,564	154,240	515,129	534,849	78,407					15,916						426,194	
Cash Outflow	24,564	154,240	515,129	534,849	200,565	114,575	81,747	74,150	70,565	89,971	80,231	84,213	85,295	88,921	506,749	81,073	81,513
Net Cash Flow	-24,564	-154,240	-515,129	-534,849	-60,168	53,532	107,524	131,749	151,593	148,998	214,722	222,091	225,666	231,459	-186,368	239,308	239,868
Cumulative Net Cash Flow	-24,564	-178,804	-493,933	-1,028,782	-1,088,950	-1,035,418	-927,894	-796,145	-644,552	-495,554	-280,832	-58,793	166,873	398,332	211,964	451,272	690,140

Table 3-9-1 Estimated Economic Benefits and Costs Evaluated in Terms of EIRR (2/2)

Unit: Baht/1000

* Cash In/Out-flow ** Year * +/-	2005	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sales Revenue	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381
Cash Inflow	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381
Personnel	-	15,096	15,549	16,016	16,496	16,991	17,501	18,026	18,567	19,124	19,697	20,288	20,877	21,524	22,169	22,835	23,520
Fringe Benefit	-	453	466	480	495	510	525	541	557	574	591	609	627	646	665	685	706
Material	-	62,327	62,327	62,327	62,327	62,327	62,327	62,327	62,327	62,327	62,327	62,327	62,327	62,327	62,327	62,327	62,327
Production Expenses	-	3,204	3,204	3,204	3,204	3,204	3,204	3,204	3,204	3,204	3,204	3,204	3,204	3,204	3,204	3,204	3,204
Production Cost	Sub	81,080	81,546	82,027	82,521	83,032	83,557	84,098	84,655	85,229	85,819	86,428	86,955	87,701	88,365	89,051	89,757
Sales and Administration	-	885	885	885	885	885	885	885	885	885	885	885	885	885	885	885	885
Cost	Sub	81,965	82,431	82,912	83,407	83,917	84,442	84,983	85,540	86,114	86,704	87,313	87,820	88,586	89,250	89,936	90,642
Establishment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Investment	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Reinvestment	-	-	15,916	-	-	-	-	-	-	-	-	-	-	15,916	-	-	-
Establishment & Investment	Sub	-	15,916	-	-	-	-	-	-	-	-	-	-	15,916	-	-	-
Cash Outflow	Sub	81,965	82,431	98,828	85,407	83,917	84,442	84,983	62,081	86,114	86,704	87,313	87,820	104,502	89,250	89,936	90,642
Net Cash Flow		238,416	237,950	221,553	236,974	236,464	235,939	235,398	-321,700	234,267	233,677	233,068	232,561	215,879	231,131	230,445	229,739
Cumulative Net Cash Flow		928,556	1,166,506	1,368,059	1,625,033	1,861,497	2,097,436	2,332,834	2,011,134	2,245,401	2,479,078	2,712,146	2,944,787	3,168,586	3,391,777	3,622,162	3,851,901
																	4,080,914

Table 3-9-2 Calculation of EIRR

TFS (EIRR) - Base Case

Year	D. Rate	N. C. F.	P. V.	C. P. V.
1986	1.000	-24,564	-24,564	-24,564
1987	0.898	-154,240	-138,471	-163,035
1988	0.806	-315,129	-253,987	-417,022
1989	0.724	-534,849	-387,005	-804,028
1990	0.650	-60,168	-39,085	-843,113
1991	0.583	53,532	31,219	-811,894
1992	0.524	107,524	56,296	-755,598
1993	0.470	131,749	61,927	-693,671
1994	0.422	151,593	63,970	-629,701
1995	0.379	148,998	56,447	-573,254
1996	0.340	214,722	73,029	-500,225
1997	0.305	222,039	67,797	-432,429
1998	0.274	225,666	61,860	-370,569
1999	0.246	231,459	56,961	-313,608
2000	0.221	-186,368	-41,175	-354,783
2001	0.198	239,308	47,466	-307,317
2002	0.178	238,868	42,535	-264,781
2003	0.160	238,416	38,114	-226,667
2004	0.144	237,950	34,151	-192,517
2005	0.129	221,553	28,547	-163,970
2006	0.116	236,974	27,412	-136,558
2007	0.104	236,464	24,556	-112,002
2008	0.093	235,939	21,997	-90,005
2009	0.084	235,398	19,703	-70,302
2010	0.075	-321,700	-24,173	-94,476
2011	0.067	234,267	15,804	-78,672
2012	0.061	233,677	14,152	-64,520
2013	0.054	233,068	12,672	-51,847
2014	0.049	232,561	11,352	-40,495
2015	0.044	215,879	9,460	-31,035
2016	0.039	231,131	9,093	-21,942
2017	0.035	230,445	8,139	-13,803
2018	0.032	229,739	7,285	-6,518
2019	0.028	229,013	6,519	1

Unit of N. C. F.: Baht1000

Discount Rate: 11.3879 %

Table 3-9-5 Profit and Loss Statement - Case 3 (1/2)

Unit: Bank1000

* Item	** Year *	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
01 Sales						140,397	188,107	189,271	206,163	223,372	240,525	294,953	306,252	310,961	320,380	320,381	320,381	320,381
02 Production Cost						160,339	154,298	126,232	119,946	118,248	124,955	137,599	143,678	146,016	151,930	152,160	153,426	147,731
03 Deprec't'n & Amort't'n						103,497	103,497	103,497	103,497	103,497	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294
04 Production Profit						-123,439	-69,688	-40,458	-17,280	1,627	59,276	101,060	106,280	108,651	112,156	111,927	110,661	116,356
05 Sales & Administration						8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849
06 Operation Profit						-132,288	-98,537	-49,307	-26,129	-7,222	50,427	92,211	97,431	99,802	103,307	103,078	101,812	107,507
07 Interest						-30,371	-34,814	-35,501	-31,058	-28,350	-28,350	-28,350	-28,350	-28,350	-26,933	-25,515	-24,098	-22,680
08 Profit before Tax						-162,659	-133,351	-84,808	-57,187	-35,572	22,077	63,861	69,081	71,452	76,375	77,563	77,715	84,827
09 Corporation Tax																		28,872
10 Net Profit						-162,659	-133,351	-84,808	-57,187	-35,572	22,077	63,861	69,081	71,452	76,375	77,563	77,715	64,015
11 Cumulative Net Profit						-162,659	-296,011	-380,818	-438,005	-473,577	-451,500	-387,639	-318,558	-247,106	-170,732	-93,169	-15,454	48,561
12 Dividend																		
13 Director's Remuneration																		
14 Retained Earnings						-162,659	-133,351	-84,808	-57,187	-35,572	22,077	63,861	69,081	71,452	76,375	77,563	77,715	64,015
15 Cumulative Ret'd Earning						-162,659	-296,011	-380,818	-438,005	-473,577	-451,500	-387,639	-318,558	-247,106	-170,732	-93,169	-15,454	48,561

Table 3-9-5 Profit and Loss Statement - Case 3 (2/2)

Unit: \$art1000

Item	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
01 Sales	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381	320,381
02 Production Cost	149,074	158,884	160,358	161,846	161,864	165,471	165,026	166,678	168,380	170,133	171,938	173,792	175,714	177,713	179,719	181,813	183,968
03 Deprec'n & Amort'n	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294	56,294
04 Production Profit	115,013	105,203	103,729	102,241	102,223	100,616	99,061	97,409	95,707	93,954	92,149	90,289	88,373	86,374	84,388	82,274	80,119
05 Sales & Administration	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849	8,849
06 Operation Profit	106,164	96,354	94,880	93,392	93,374	91,767	90,212	88,560	86,858	85,105	83,301	81,440	79,524	77,525	75,519	73,425	71,270
07 Interest	-21,263	-19,845	-18,428	-17,010	-15,993	-14,175	-12,758	-11,540	-9,923	-8,505	-7,088	-5,670	-4,253	-2,835	-1,418		
08 Profit before Tax	84,902	76,509	76,453	76,382	77,382	77,592	77,455	77,220	76,936	76,600	76,213	75,770	75,272	74,690	74,102	73,425	71,270
09 Corporation Tax	25,470	22,953	22,936	22,915	23,334	23,278	23,236	23,166	23,081	22,980	22,864	22,731	22,581	22,407	22,230	22,028	21,381
10 Net Profit	59,431	53,556	53,517	53,467	54,047	54,314	54,218	54,054	53,855	53,620	53,349	53,039	52,690	52,283	51,871	51,397	49,889
11 Cumulative Net Profit	107,992	161,548	215,065	268,532	322,979	377,294	431,512	485,566	539,421	593,041	646,390	699,429	752,119	804,492	856,273	907,670	957,559
12 Dividend	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000	58,000
13 Director's Remuneration																	
14 Retained Earnings	1,431	-4,444	-4,483	-4,533	-5,553	-3,686	-3,782	-3,946	-4,145	-4,330	-4,651	-4,961	-5,290	-5,717	-6,129	-6,603	-8,111
15 Cumulative Ret'd Earnings	49,992	45,548	41,065	36,552	32,979	29,294	25,512	21,566	17,421	13,041	8,390	3,429	-1,119	-6,402	-13,673	-22,276	-31,387

Table 3-9-6 Fund Statement - Case 3 (1/2)

Unit: \$ant:1300

Item	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
02 Net Cash Flow	-27,078	-159,370	-328,622	-558,345	-33,266	4,940	54,190	77,203	95,425	89,716	148,589	133,792	156,156	139,983	-286,338	158,504	164,215
03 Tax/Divident																	
04 Net Cash Flow (02 - 03)	-27,078	-159,370	-328,622	-558,345	-33,266	4,940	54,190	77,203	95,425	89,716	148,589	133,792	156,156	139,983	-286,338	158,504	164,215
05 Equity Capital	30,000	160,000	320,000	70,000													
06 Long-term Loan				567,000													
07 * Repayment																	
08 * Loan Balance				567,000	567,000	567,000	567,000	567,000	567,000	567,000	567,000	567,000	567,000	538,650	510,300	481,950	453,600
09 * Interest Payable				-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-26,933	-25,515	-24,098	-22,680
10 Balance (02+05+06+07+09)	2,922	630	-622	30,305	-61,616	-23,391	25,840	48,853	67,075	61,368	120,219	125,442	127,806	104,701	-320,203	106,657	113,183
11 Short-term Loan				24,501	29,351	29,351	-21,028	-32,824									
12 * Loan Balance				24,501	55,852	55,852	32,824										
13 * Interest Payable				-2,021	-6,464	-7,151	-2,708										
14 Total Loan (08+12)				567,000	591,501	620,852	599,824	567,000	567,000	567,000	567,000	567,000	567,000	538,650	510,300	481,950	453,600
15 Total Interest (09+13)				-28,350	-30,371	-34,814	-35,301	-31,058	-28,350	-28,350	-28,350	-28,350	-28,350	-26,933	-25,515	-24,098	-22,680
16 Surplus/Deficit	2,922	630	-622	30,305	-39,136	-503	-2,339	15,321	67,075	61,368	120,219	125,442	127,806	104,701	-320,203	106,057	113,183
17 Cumulative S/D	2,922	5,352	2,930	53,235	14,099	13,596	11,257	24,578	91,653	153,019	273,238	398,680	526,486	631,186	310,983	417,040	530,223

Table 3-9-6 Fund Statement - Case 3 (2/2)

Unit: \$aht1000

* Item	* Year *	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
02 Net Cash Flow		162,878	154,513	134,187	151,648	150,150	148,606	147,018	-411,170	143,694	141,956	109,162	140,322	120,507	134,479	132,460	130,383	127,564
03 Tax/Divident		20,812	83,470	80,933	80,936	80,915	81,354	81,278	81,236	81,766	81,081	80,980	80,864	80,731	22,501	80,407	80,250	80,028
04 Net Cash Flow (02 - 03)		142,066	71,043	53,254	70,712	69,235	67,272	65,740	-492,406	62,928	60,877	28,182	59,458	39,776	111,898	52,053	50,153	47,536
05 Equity Capital																		
06 Long-term Loan																		
07 * Repayment		-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350	-28,350
08 * Loan Balance		425,250	396,900	368,550	340,200	311,850	283,500	255,150	226,800	198,450	170,100	141,750	113,400	85,050	56,700	28,350		
09 * Interest Payable		-21,263	-19,845	-18,428	-17,010	-15,593	-14,175	-12,758	-11,340	-9,923	-8,505	-7,088	-5,670	-4,253	-2,835	-1,418		
10 Balance (02+05+06+07+09)		92,454	22,648	6,457	25,352	25,293	24,747	24,633	-532,096	24,251	24,022	-7,256	25,438	7,173	80,713	22,285	21,803	47,536
11 Short-term Loan																		
12 * Loan Balance																		
13 * Interest Payable																		
14 Total Loan (08+12)		425,250	396,900	368,550	340,200	311,850	283,500	255,150	226,800	198,450	170,100	141,750	113,400	85,050	56,700	28,350		
15 Total Interest (09+13)		-21,263	-19,845	-18,428	-17,010	-15,593	-14,175	-12,758	-11,340	-9,923	-8,505	-7,088	-5,670	-4,253	-2,835	-1,418		
16 Surplus/deficit		92,454	22,648	6,457	25,352	25,293	24,747	24,633	-532,096	24,251	24,022	-7,256	25,438	7,173	80,713	22,285	21,803	47,536
17 Cumulative S/D		622,676	645,324	651,981	677,333	702,626	727,372	752,005	219,909	244,164	268,187	260,931	286,370	293,543	374,256	396,541	418,341	445,880

#### 4. Alternative Plans

As alternatives to the 20,000 DWT graving dock described in the foregoing pages, two plans for (4-1) a 20,000 DWT floating dock instead of graving dock, and (4-2) a 10,000 DWT graving dock envisaging eventual extension to accommodate 20,000 DWT ships, have been examined and compared with the original plan for 20,000 DWT graving dock. The criteria adopted in the comparison included (1) expected shiprepair demand, (2) required capital investments, (3) safety and ease of operations.

##### 4-1 20,000 DWT Floating Dock

###### 4-1-1 Layout

As shown in Fig. 4-1-1, the floating dock will be installed at a distance of 195m from the boundary with AGRI Bulk Berth, oriented at right angles to the quay of the envisaged shiprepair yard site. The 35m of water separating the dock from quay will be linked by a pontoon bridge devised to moderate the slope that will be created by differences in tide level.

On both sides of the dock will be provided level luffing tower cranes, one of 10 t/30m x 15 t/20m and the other of 5 t/40m x 10 t/28 m lifting capacity.

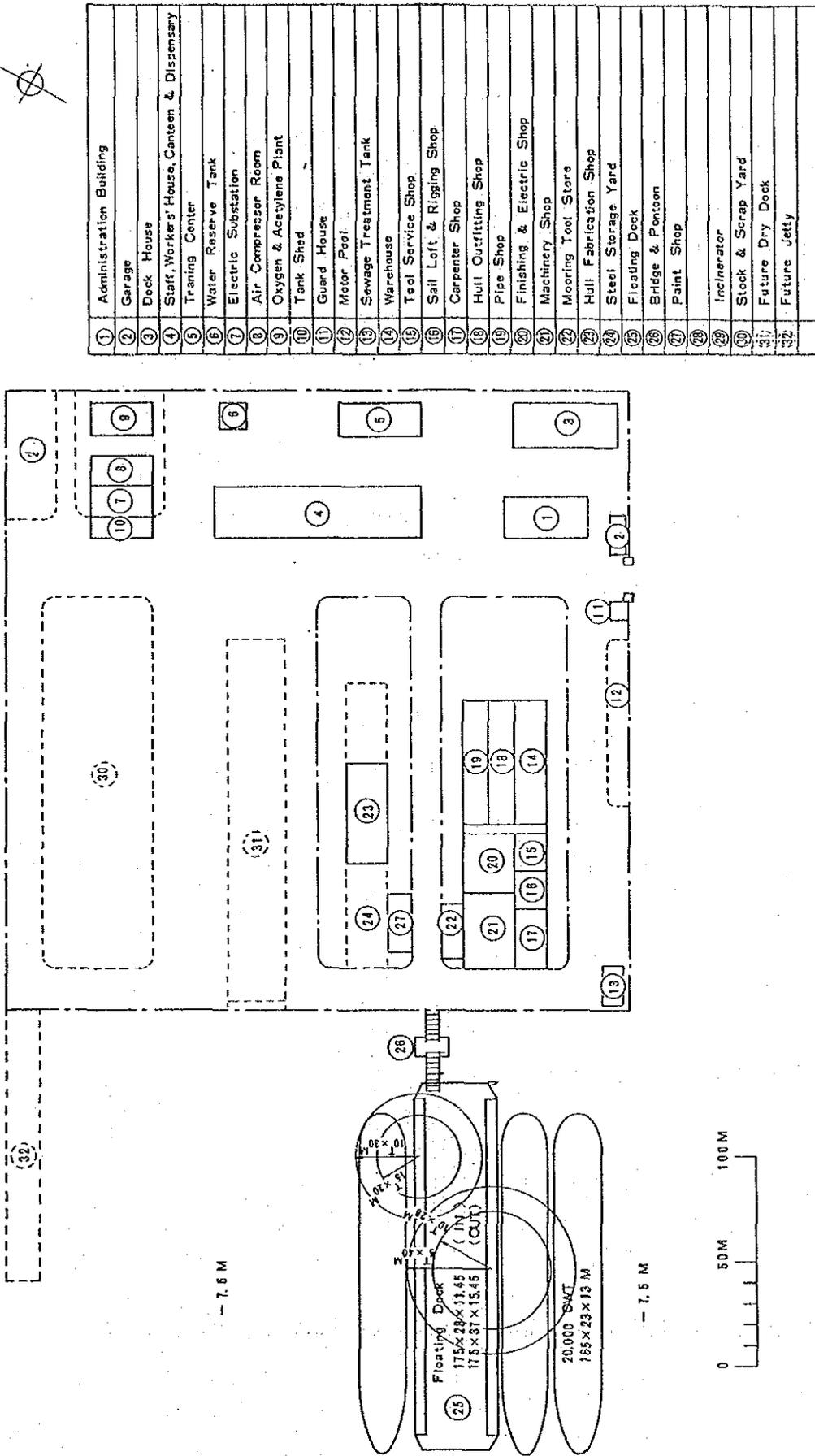
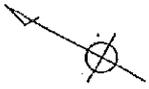
###### 4-1-2 Particulars

###### (1) Dock Dimensions

To correspond to the dry dock capacity given in Section 3-4-4, the size of the alternative dry dock was envisaged to accommodate a 20,000 DWT cargo ship.

The dock is shown in cross section in Fig. 4-1-2. The dock will measure:-

- 1) Length 175m
- 2) Breadth 28m inside, 37m outside
- 3) Depth 11.45m inside, 15.45m outside.



1	Administration Building
2	Garage
3	Dock House
4	Staff, Workers' House, Canteen & Dispensary
5	Training 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
26	Floating Dock
27	Bridge & Pontoon
28	Paint Shop
29	Inclinator
30	Stock & Scrap Yard
31	Future Dry Dock
32	Future Jetty

Fig. 4-1-1 Layout of Repair Shipyard (Floating Dock)

(2) Equipment

The principal items of equipment envisaged are:-

- |   |                                |
|---|--------------------------------|
| 1) Capstans                                   | 2 x 4t x 15 m/min              |
| 2) Winches                                    | 4 x 10t x 15 m/min             |
| 3) Ballast pumps                              | 2 x 3,000 t/h                  |
| 4) Pipework and valves                        | As requisite                   |
| 5) Keel and side blocks                       | 258 sets                       |
| 6) Incoming panel, switchboard                | 650 kW 50 Hz                   |
| 7) Floating dock mooring equipment            | 4 x 10t, 4 x 15t sinker blocks |
| 8) Dock distortion measuring instrument, etc. |                                |

(3) Dredging

The envisaged site for installing the floating dock is shallow, and calls for dredging work to ensure a basin measuring:-

242m x 104m x 13.65m .

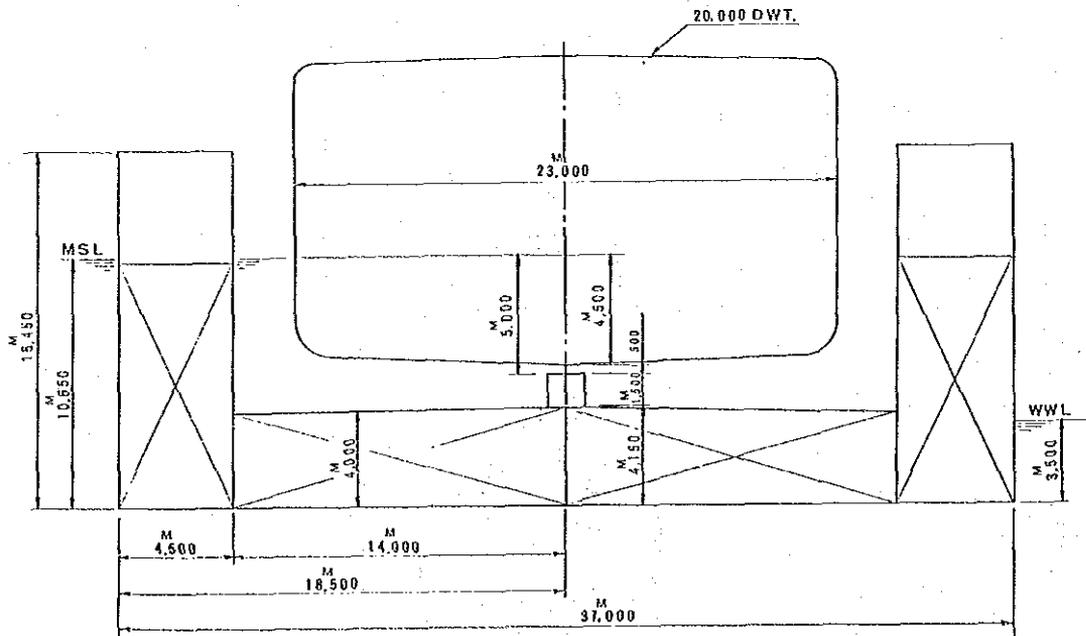


Fig. 4-1-2 Section of Floating Dock for 20,000 DWT Vessel

4-1-3 Construction Investment

Table 4-1-1 show the construction investment of floating dock installation.

Table 4-1-1 Construction Investment

Price in 1984  
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 <sup>2</sup> )	156,197	63,705	92,492
2	Buildings	130,437	31,600	99,837
Sub total (1) and (2)		287,634	95,305	192,329
3	Floating dock	407,000	397,717	9,283
4	Jetty-related equipment	0	0	0
5	Cranes	25,615	23,905	1,710
6	Utilities equipment and pipe lines	17,251	11,908	5,343
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)		641,376	598,112	43,264
Sub total (1) to (12)		929,010	693,417	235,593
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)		1,056,344	813,110	243,234

Note: Employed exchange rate; See page 147

Table 4-1-1(A) Construction Investment (Details)

Prices in 1984  
Unit: 1,000 Baht

No.	Description	Estimated cost	Funds	
			Foreign portion	Domestic portion
1	Civil engineering work	156,197	63,705	92,492
	Land purchasing (90,000 m <sup>2</sup> )	128,955	63,705	65,250
	Road pavement	10,442	0	10,442
	Dock	16,800		16,800
2	Buildings	130,437	31,600	99,837
	Offices and other houses	36,308	4,859	31,449
	Factories	77,419	22,571	54,848
	Power supply equipment and warehouse	16,149	4,103	12,046
	Others	561	67	494
3	Floating dock	407,000	397,717	9,283
	Floating dock	407,000	397,717	9,283
4	Jetty-related equipment	0	0	0
5	Cranes	25,615	23,905	1,710
	Overhead crane	18,263	17,123	1,140
	Portal crane	5,193	5,003	190
	Hoists	2,159	1,779	380
6	Utilities equipment and pipe lines	17,251	11,908	5,343
	Water supply equipment	4,157	2,224	1,933
	Compressors and pipe lines	11,304	9,406	1,898
	Oxygen and acetylene pipes and ducts	1,275	0	1,275
	Others	515	278	237
7	Electric equipment	27,647	24,989	2,658
	Distribution panel and switch board	19,582	18,680	902
	Electric cables, wiring	1,923	1,306	617
	Lighting apparatus	6,142	5,003	1,139

No.	Description	Estimated cost	Funds	
			Foreign portion	Domestic portion
8	Vehicles and oil barges	8,123	6,149	1,974
	Vehicles	4,817	4,314	503
	Oil barges and others	3,306	1,835	1,471
9	Factory machines	125,909	111,151	14,758
	Hull fabrication shop	8,297	6,525	1,772
	Machinery shop	58,303	50,809	7,494
	Finishing shop (hull, engine)	4,088	2,807	1,281
	Carpenter shop	1,902	1,612	290
	Sail loft and rigging shop	259	212	47
	Piping shop	3,374	3,013	361
	Hull outfitting shop	1,934	1,459	475
	Tool service shop	8,228	8,228	0
	Warehouse (excluding stock material)	28,575	28,575	0
	Welders and cabtyres	4,197	4,197	0
	Stage center	3,038	0	3,038
Others	3,714	3,714	0	
10	Anti-pollution equipment	22,038	19,380	2,658
	Sewage treatment tank	18,050	15,677	2,373
	Oil fences and othes	923	923	0
	Incinerator	3,065	2,780	285
11	Telephone and others	3,521	2,913	608
12	Furniture for offices and so on	4,272	0	4,272
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

#### 4-1-4 Comparative Evaluation

Comparisons between the alternative 20,000 DWT floating dock and the original plan for a graving dock of equal capacity have been made in terms of construction cost, and of other factors relevant to dock operation.

The number of employees, work capacity and other factors common to the two alternative plans have been omitted from the following considerations.

##### (1) Construction Costs

The construction costs are compared item by item in Table 4-1-2.

Table 4-1-2 Construction Costs Compared between 20,000 DWT Graving and Floating Dock Installations

Unit: 1,000 Baht

No.	Description	(1) 20,000 DWT Graving dock	(2) 20,000 DWT Floating dock
1.	Civil engineering work	* 455,377	* 156,197
2.	Building	130,437	130,437
3.	Dock-related equipment	* 42,887	* Floating dock 407,000
4.	Jetty-related equipment	* 7,477	* 0**
5.	Cranes	* 88,032	* 25,615
6.	Utilities equipment and pipe lines	* 20,424	* 17,251
7.	Electric equipment	27,647	27,647
8.	Vehicles and oil barges	8,123	8,123
9.	Factory machines	125,909	125,909
10.	Anti-pollution equipment	22,038	22,038
11.	Telephone and others	3,521	3,521
12.	Furniture for offices and so on	4,272	4,272
13.	Engineering fee	60,066	60,066
14.	Education and training	22,793	22,793
15.	Contingency	44,475	44,475
	Total	1,063,478	1,056,344
	Total saving realized with floating dock alternative		7,134

Note: \*) Values marked with asterisk are those where differences are indicated between the two alternatives.

\*\* ) As ships are moored side by side on one side of floating dock as shown Fig. 4-1-1, mooring jetty is not necessary.

(2) Shipyard Facilities and Equipment

All the factors relevant to shipyard facilities and equipment are compared in Table 4-1-3.

Table 4-1-3 Factors Relevant to Shipyard Facilities and Equipment Compared between 20,000 DWT Graving and Floating Dock Installations

Item	Graving dock	Floating dock	Remarks
1 Construction cost	High	Low	Cf. Table 4-1-2.
2 Maintenance cost	Low	High	Floating dock (FD) will requires repair of ballast line approx. every 5 years
3 Service life	Almost ever-lasting	15 - 20 years	FD will corrode.
4 Dock/dedocking manipulation	Easy, safe	Intricate, hazardous	FD requires calculation of water volume to be pumped in/out.
5 Operating efficiency	Good	Bad	FD lacks space for temporary deposit of landed ship fittings.
6 Mooring of repair ship	Requires separate mooring quay	Mooring quay not required	FD can have ships moored directly on its sides.
7 Cranes	Requires separate cranes for dockside and quay	Dockside crane universally utilized	FD will dsipense with at least 1 crane.
8 Security	Good	Bad	FD will require to be kept under observation at all times.
9 Trimming for docking	Required	Not required	FD can be trimmed to match the ship.
10 Security under inclement weather	Secure	Insecure	FD requires submerging upon approach of cyclone.
11 Disturbance of moored ship	No	Yes	Work on moored ships require suspension during docking/ dedocking.

4-1-5 Conclusion of This Case

The installation of a 20,000 DWT floating dock instead of graving dock will not alter the shiprepair capacity, nor the number of employees, so that these two factors have been eliminated from the comparative study. Comparison of the remaining principal factors of construction cost and maintenance expenses incurred during the first 10 years of operation is presented in Table 4-1-4.

Table 4-1-4 Comparison of Construction and Maintenance Costs between 20,000 DWT Floating and Graving Docks

Unit: B1,000 (1984 value)

Item		1986 - 1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total
20,000 DWT floating dock (A)	(1) Construction cost	1,056,344												1,056,344
	(2) Maintenance expenses		2,061	2,061	2,061	2,061	2,061	2,061	2,061	2,061	2,061	2,061	20,611	41,221
	(3) Ballast line repair cost							474	474	474	474	474	20,611	22,981
	(A) (1)+(2)+(3)	1,056,344	2,061	2,061	2,061	2,061	2,061	2,535	2,535	2,535	2,535	2,535	41,222	1,120,546
20,000 DWT graving dock (B)	(1) Construction cost	1,063,478												1,063,478
	(2) Maintenance expenses		379	379	379	379	379	379	379	379	379	379	3,335	7,125
	(3) Ballast line repair cost		94	94	94	94	94	94	94	94	94	94	94	1,034
	(B) (1)+(2)+(3)	1,063,478	473	473	473	473	473	473	473	473	473	473	3,429	1,071,637
(A)	1,056,344	2,061	2,061	2,061	2,061	2,061	2,535	2,535	2,535	2,535	2,535	46,223	1,120,546	
(B)	1,063,478	473	473	473	473	473	473	473	473	473	473	3,429	1,071,637	
(A) - (B) Difference between (A) & (B)	- 7,134	1,588	1,588	1,588	1,588	1,588	2,062	2,062	2,062	2,062	2,062	37,793	48,909	

As the conclusion, while the graving dock will cost more to construct initially, the aggregate construction and maintenance expenditure will amount to Baht 48,909 thousand more for the floating than for the graving dock. It is for this reason recommended to adopt the graving dock as the type of installation to be constructed.

4-2 Graving Dock: 10,000 DWT Expandable to 20,000 DWT

4-2-1 Demand Forecast

(1) Thai Flag Vessels

According to Table 2-3-3, the number of Thai flag vessels between 5,000 DWT and 10,000 DWT was 33 units, which corresponds to 202,159 DWT at the beginning of 1984, and almost all these vessels are engaged in international trade.

For the ocean going vessels between 5,000 DWT and 20,000 DWT, we made the prospect with growth rates in Table 3-1-3. Therefore, we used the same growth rates in Table 3-1-3 as the growth rates for the vessels between 5,000 DWT and 10,000 DWT, because the group of these vessels is a part of the oceangoing vessels between 5,000 DWT and 20,000 DWT and we estimated the growth rates of both categories are the same.

Based on this estimation, we made the prospect as shown in Table 4-2-1.

Table 4-2-1 Prospect of Thai Flag Vessels between 5,000 DWT and 10,000 DWT

Year	No. of Vessel	Average DWT	DWT
1984	33	6,126	202,159
1990	45	6,872	308,524
1991	47	6,988	330,738
1992	50	7,107	354,551
1993	53	7,228	380,079
1994	55	7,351	407,444
1995	58	7,476	436,780
1996	62	7,603	468,228
1997	65	7,732	501,941
1998	68	7,864	538,081
1999	72	7,997	576,822
2000	76	8,133	618,354

(2) Foreign Flag Vessels

We estimated the number of foreign flag vessels between 5,000 - 20,000 DWT calling at port of Bangkok in 3-1-3 (2). The result was that more than 500 vessels are roughly expected to call in each year until the year 2,000. Based on the same way of thinking in 3-1-3 (2), taking into account the informations obtained from PAT, shipping companies, etc., we estimate the number of foreign flag vessels between 5,000 - 10,000 DWT is approximately 40% or 50% of the number of foreign flag vessels between 5,000 - 20,000 DWT.

Considering the above, the number of the calling vessels between 5,000 -10,000 DWT in 1982 was assumed approximately 250 at least. And using Table 3-1-5, we estimate the number will be 300 at least, and this is assumed the minimum number from 1990 to 2000.

4-2-2 Demand Forecast and Capacity of Repair Shipyard

Based on the estimated demand for shiprepair presented in Section 3-1, the demand that can be expected in the case of a 10,000 DWT capacity graving dock is examined in what follows.

(1) Estimated Docking Demand by Thai Flag Vessels

The demand for repair estimated for Thai flag vessels that could be accommodated in a 10,000 DWT graving dock is as listed in Table 4-2-2.

Table 4-2-2 Estimated Docking Demand for Repair of Thai Flag Vessels in 10,000 DWT Graving Dock (Vessels between 5,000 and 10,000 DWT)

Year	Fleet		Docking Demand for Repair	
	Vessels	Average DWT	Vessels	Aggregate DWT
1990	45	6,872	22	151,000
1991	47	6,988	24	168,000
1992	50	7,107	25	178,000
1993	53	7,228	26	188,000
1994	55	7,351	28	206,000
1995	58	7,476	29	217,000
1996	62	7,603	31	236,000
1997	65	7,732	33	255,000
1998	68	7,864	34	267,000
1999	72	7,997	36	288,000
2000	76	8,133	38	309,000

Note: The fleet estimates are cited from Table 4-2-1.

(2) Annual Repair Capacity of 10,000 DWT Graving Dock

Using the formula set forth in Section 3-1-5 for 20,000 DWT graving dock, the annual repair capacity was estimated for the 10,000 DWT graving dock, as reproduced in Table 4-2-3.

Table 4-2-3 Annual Docking Capacity of 10,000 DWT Graving Dock

Year	Nominal Ship Repair Capacity (N(DWT))	Volume Utilization Ratio r(%)	Average Ship Repair Capacity A(DWT)	Average Docking Duration D(Days)	Turnover Rate t	Annual Ship Repair Capacity (DWT)
1990	10,000	69	6,900	12	25	172,500
1991	10,000	70	7,000	10	30	210,000
1992	10,000	71	7,100	9	33.5	237,900
1993	10,000	72	7,200	8	37.5	270,000
1994	10,000	74	7,400	7	42.9	317,500
1995	10,000	75	7,500	6.5	46.2	346,500
1996	10,000	76	7,600	6	50	380,000
1997	10,000	77	7,700	6	50	385,000
1998	10,000	79	7,900	6	50	395,000
1999	10,000	80	8,000	6	50	400,000
2000	10,000	81	8,100	6	50	405,000

4-2-3 Estimated Docking Demand and Supply

From the estimated docking demand given in Table 4-2-2 and for docking capacity in Table 4-2-3, the shiprepair demand and supply is estimated to progress as shown in Fig. 4-2-1 in terms of number of vessels.

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.

The shaded area in Fig. 4-2-1 displays the dead weight tons of vessels to be repaired from 1990 to 2000. Estimated revenue from sales in Table 4-2-10 utilizes this tons.

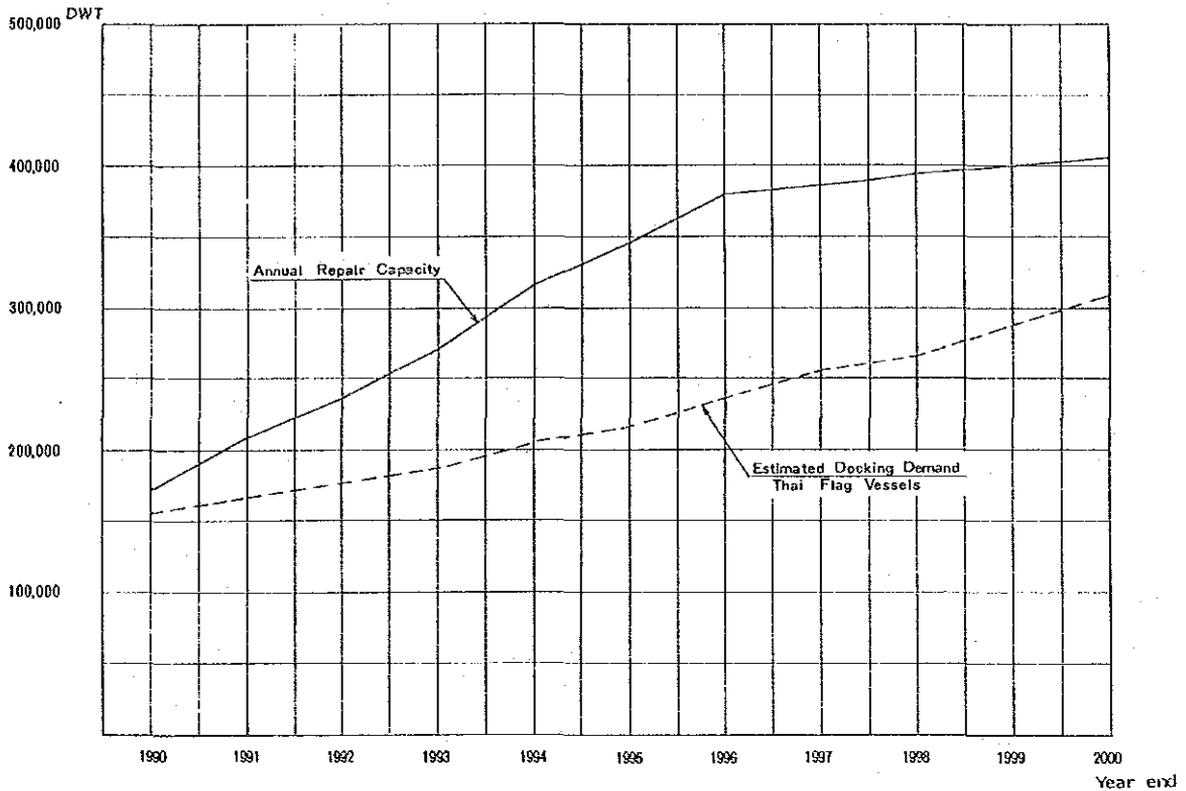


Fig. 4-2-1 Estimated Progress of 10,000 DWT Graving Dock Shiprepair Capacity and Utilization, 1990 - 2000

Estimated progress of 10,000 DWT graving dock shiprepair capacity and utilization is as presented in Table 4-2-4,

Table 4-2-4 Estimated Progress of 10,000 DWT Graving Dock  
Shiprepair Capacity and Utilization

Year	Thai Flag Vessel		Foreign Vessel		Total (DWT)
	Vessels	Total (DWT)	Vessels	Total (DWT)	
1990	22	151,000	-	-	151,000
1991	24	168,000	-	-	168,000
1992	25	178,000	-	-	178,000
1993	26	188,000	-	-	188,000
1994	28	206,000	-	-	206,000
1995	29	217,000	-	-	217,000
1996	31	236,000	19	144,000	380,000
1997	33	255,000	17	130,500	385,500
1998	34	267,000	16	128,000	395,000
1999	36	288,000	14	112,000	400,000
2000	38	309,000	12	96,000	405,000

#### 4-2-4 Facilities

##### (1) Dock Dimensions

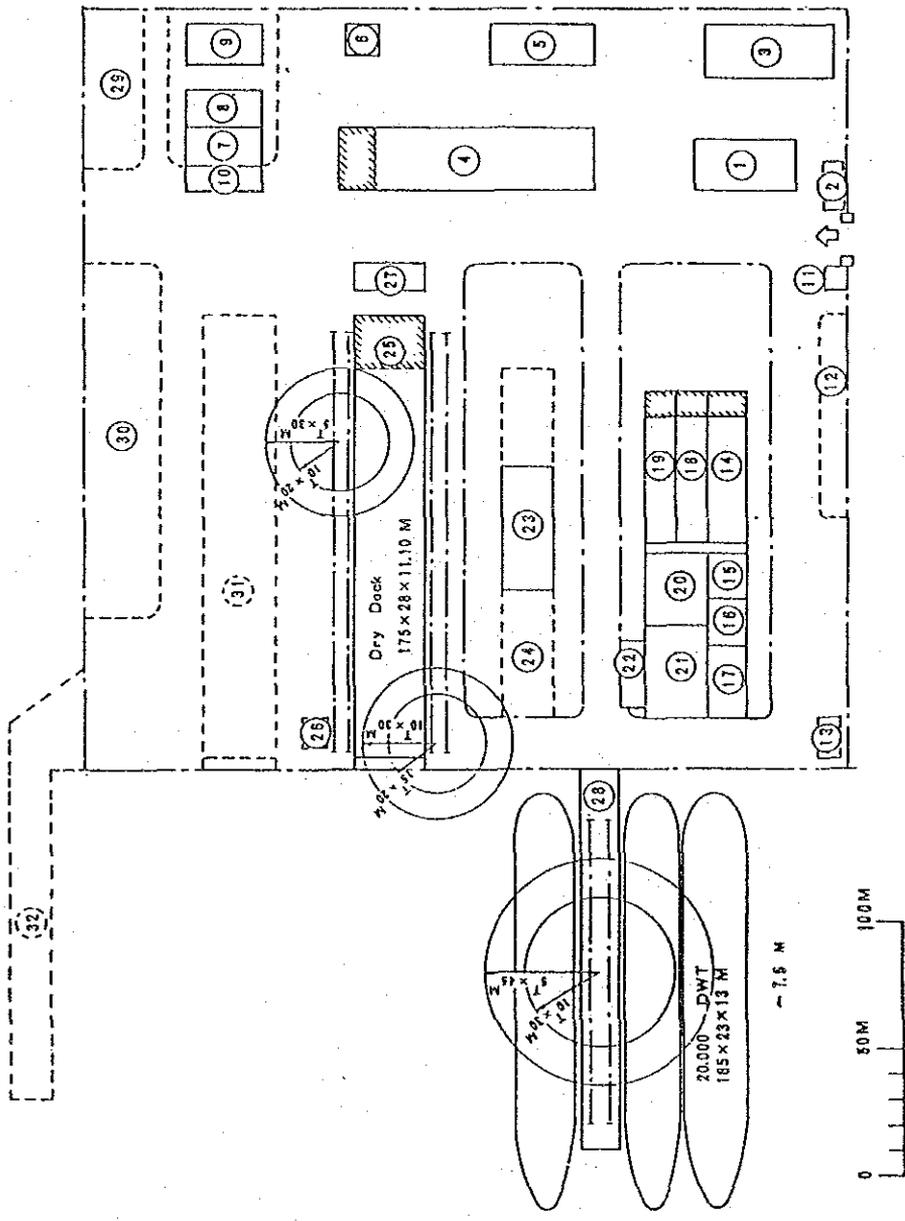
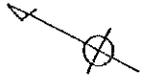
The 10,000 DWT graving dock will be designed with breadth to permit eventual extension to accommodate 20,000 DWT vessels. Hence, compared with the 20,000 DWT graving dock described in Section 3.4.4, the length alone will be shortened, and the dock will measure:

- 145m in length
- 28m in breadth, and
- 11.1m in depth.

##### (2) Other Facilities

The staff workers' house will be shortened in length by 10m in view of the smaller size of work force that will be engaged, and in keeping, the Hull Outfitting and Piping Shops, and also the Warehouse, by 6m each. The other facilities are envisaged to be of same size as for the 20,000 DWT dock installation.

The layout is shown in Fig. 4-2-2.



1	Administration Building
2	Garage
3	Dock House
4	Staff, Workers' House, Canteen & Dispensary
5	Training 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	Inclinator
30	Scrap Yard
31	Future Dry Dock
32	Future Jetty

Note : Mark show reduce area for 10,000 DWT Graving dock

Fig. 4-2-2 Layout of Repair Shipyard (for 10,000 DWT Graving Dock)

4-2-5 Production Scheme

The production scheme for the alternative 10,000 DWT graving dock installation has been drawn up in the same manner as for the 20,000 DWT dock shipyard described in Section 3-6-1.

The scheme is presented in Table 4-2-5.

Table 4-2-5 Annual Production Plan

Item Year	Repair Ships Docked (DWT)	Steel Structures Manufactured (tons)	Running Repairs (Percentage of dock repairs in amount)
1990	151,000	500	5
1791	168,000	500	"
1992	178,000	550	"
1993	188,000	600	"
1994	206,000	650	"
1995	217,000	700	"
1996	380,000	700	"
1997	385,500	850	"
1998	395,000	900	"
1999	400,000	1,000	"
2000	405,000	1,000	"

4-2-6 Manpower Program

(1) Working Hours Schedule

The estimated working hours, derived as in Section 3-6-2, is presented in Table 4-2-6.

Table 4-2-6 Estimated Annual Working Hours

Year	Productivity	(1)	(2)	(3)	Estimated annual working hours
		Ship repairs in dock 2H x DWT	Steel structures 200 H/T	Running repairs (1) x 5%	
1990	1	302,000	100,000	15,100	417,000
1991	1.1	336,000	100,000	16,800	411,636
1992	1.1	356,000	110,000	17,800	439,818
1993	1.2	376,000	120,000	18,800	429,000
1994	1.2	412,000	130,000	20,600	468,833
1995	1.3	434,000	140,000	21,700	458,230
1996	1.4	760,000	140,000	38,000	670,000
1997	1.5	771,000	170,000	38,550	653,033
1998	1.5	790,000	180,000	39,500	673,000
1999	1.5	800,000	200,000	40,000	693,333
2000	1.5	810,000	200,000	40,000	700,333

Note: Estimated annual working hours =  $\frac{(1) + (2) + (3)}{\text{Productivity}}$

(2) Manpower Program

The estimated manpower requirement derived as in Section 3-6-2, is presented in Table 4-2-7.

Table 4-2-7 Annual Manpower Program

Year \ Item	Managers & higher rank persons	Clerks & engineers	Indirect workers	Direct workers	Total
1990	13	45	19	212	289
1991	13	45	24	209	291
1992	13	50	24	223	310
1993	13	50	24	218	310
1994	13	50	31	238	332
1995	13	50	36	233	332
1996	13	50	36	340	439
1997	13	50	36	340	439
1998	13	50	36	342	441
1999	13	50	36	352	451
2000	13	50	36	356	455

Note: The number shown in parentheses shows the number of the engineers from abroad.

4-2-7 Comparative Evaluation

(1) Construction Cost

The construction cost is compared item by item in Table 4-2-8.

Table 4-2-8 Construction costs Compared between 20,000 DWT  
and 10,000 DWT Graving Dock Shipyards

Unit: 1,000 Baht

No.	Description	(1) 20,000 DWT Graving dock	(2) 10,000 DWT Graving dock
1	Civil engineering work	* 455,377	* 437,465
2	Buildings	* 130,437	* 124,532
3	Dock-related equipment	* 42,887	* 42,350
4	Jetty-related equipment	7,477	7,477
5	Cranes	88,032	88,032
6	Utilities equipment and pipe lines	20,424	20,424
7	Electric equipment	27,647	27,647
8	Vehicles and oil barges	8,123	8,123
9	Factory machines	* 125,909	* 124,274
10	Anti-pollution equipment	22,038	22,038
11	Telephone and others	3,521	3,521
12	Furniture for offices and so on	* 4,272	* 3,417
13	Engineering fee	60,066	60,066
14	Education and training	22,793	22,793
15	Contingency	44,475	44,475
Total		* 1,063,478	*1,036,634

Note: \*) Values with asterisk are those where differences are indicated between the two alternatives.

(2) Manpower Requirements

Estimated manpower requirements are compared in Table 4-2-9 between the two alternatives.

Table 4-2-9 Estimated Manpower Requirements Compared between 20,000 and 10,000 DWT Graving Dock Shipyards

Item	Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	1 20,000 DWT graving dock		367	382	427	434	459	459	459	509	509	519
2 10,000 DWT graving dock		289	291	310	310	332	332	439	439	441	451	455
Total saving realized with floating dock alternative		78	91	117	124	127	127	70	70	68	68	64

(3) Comparison of Sales Revenue

The alternative cases of starting with 20,000 DWT and with 10,000 DWT graving dock are compared in Table 4-2-10, in terms of yearly sales revenue.

Table 4-2-10 Comparison of Estimated Revenue from Sales between Cases of 20,000 DWT and 10,000 DWT Graving Docks

Unit: Baht1000

***** Items *****	Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Thai Flag - Survey/Damage Repair +		115,792	142,182	160,547	174,496	188,284	202,502	214,889	235,085	248,065	263,899	269,285
Foreign Flag - Ditto. +								40,931	26,120	15,833	5,385	
All Flag - Running Repair +		5,789	7,109	8,027	8,724	9,414	10,125	12,791	13,060	13,195	13,464	13,464
Sub-total for Ship Repairing Sub		121,581	149,291	168,574	183,220	197,698	212,627	268,611	274,265	277,093	282,748	282,749
Steel Structure Fab./ Ass'ly. +		18,816	18,816	20,697	22,579	24,460	26,342	26,342	31,987	33,868	37,632	37,632
Total for 20000 Dwt Drydock Sub		140,397	168,107	189,271	205,899	222,158	238,969	294,953	306,252	310,961	320,380	320,381
Thai Flag - Survey/Damage Repair -		81,322	90,478	95,863	101,249	110,943	116,867	127,100	137,332	143,795	155,105	166,415
Foreign Flag - Ditto. -								77,552	70,282	68,935	60,318	51,701
All Flags - Running Repair -		4,066	4,523	4,793	5,062	5,547	5,843	10,232	10,380	10,636	10,771	10,986
Sub-total for Ship Repairing Sub		85,388	95,001	100,656	106,311	116,490	122,710	214,884	217,994	223,366	226,194	229,022
Steel Structure Fab./ Ass'ly. -		18,816	18,816	20,697	22,579	24,460	26,342	26,342	31,987	33,868	37,632	37,632
Total for 10000 Dwt Drydock Sub		104,204	113,817	121,353	128,890	140,950	153,334	241,226	249,981	257,234	263,826	266,654
Balance between both the Totals		36,193	54,290	67,918	76,909	81,208	89,917	53,727	56,271	53,727	56,554	53,727

4-2-8 Conclusion of this case

Starting with a 10,000 DWT graving dock will reduce the initial construction cost compared with a 20,000 DWT dock, but when eventually extending the installation to accommodate ships of 20,000 DWT, the additional expenses incurred will be as given in Table 4-2-11.

Besides, during the extension work, the shiprepair operations that will have just come to set on its way will be seriously disturbed in order to adjust the operations to the newly extended installation. This disturbance will affect the Shipyard employees to immeasurable degree by the disruption of their daily routine.

It is for this reason recommended to adopt the 20,000 DWT graving dock as installation to be constructed from the outset.

Table 4-2-11 Comparison of Construction Costs between 10,000 and 20,000 DWT Graving Docks

Unit: Baht 1,000 (1984 value)

	Item	1986 - 1990	For extending capacity to 20,000 DWT	Total
10,000 DWT graving dock (A)	1 Civil engineering work	437,465	30,915	468,381
	2 Buildings	124,532	6,969	131,501
	3 Dock-related equipment	42,350	474	42,824
	4 Factory machines	124,274	1,545	125,819
	5 Furniture for office and so on	3,417	854	4,271
	(A) Total		732,038	40,758
20,000 DWT graving dock (B)	1 Civil engineering work	455,377	-	455,377
	2 Buildings	130,437	-	130,437
	3 Dock-related equipment	42,887	-	42,887
	4 Factory machines	125,909	-	125,909
	5 Furniture for office and so on	4,272	-	4,272
	(B) Total		758,882	0
(A)		732,038	40,758	772,796
(B)		758,882	0	758,882
(A) - (B) Difference between (A) & (B)		-26,844	40,758	13,914

NOTE: The cost items compared are limited to those that are affected by the difference between 10,000 and 20,000 DWT capacities of the graving dock.

5. Eventual Expansion of Shiprepairing Capacity  
(Additional Installation of Second Graving Dock)

The observations presented below on the conditions that should call for eventually considering the installation of a second graving dock, and points requiring to be held in view in this connection, have been compiled on the basis of information and data on hand from the past survey.

These observations are added on the express request received from the office of the Board of Investment.

5-1 Criterion for Considering Expansion

In so far as judged from Fig. 3-1-2, further addition to the 20,000 DWT graving dock should not be called for during the current century. Shipyard expansion would justify consideration when the estimated annual demand for shiprepair can be reliably expected to exceed 80 vessels.

The nominal capacity of the eventual second graving dock should be considered to range between 10,000 and 20,000 DWT, but such considerations as dock size could well await further evolution of circumstances.

5-2 Shipyard Facilities

A suggested layout for the eventual second 20,000 DWT graving dock and jetty is shown in Fig. 3-4-2.

The principal facilities that would require extension are:-

- 1) Administration building
- 2) Dock house
- 3) Staff/workers' house
- 4) Substation
- 5) Air compressor room
- 6) Oxygen/acetylene supply facility
- 7) Hull outfitting shop
- 8) Pipe shop
- 9) Finishing/electrical equipment shop.

Space to permit the requisite extensions will be provided in the initial layout.

5-3 Personnel Organization

The personnel organization will probably not require modification, but the increased work force should call for enhanced personnel management capability on the part of management and middle management.

The newly recruited personnel would be systematically trained beforehand, to permit their integration into the existing organization with minimum disturbance to the running productive activities.



