9. PLANNING OF RIVER TRANSPORT

9. PLANNING OF RIVER TRANSPORT

9.1 Channel Planning

(1) Ship's Size

The following ship's dimensions are applied to the study of a navigation routing system for the river.

Length Over all	: 47.00 m
Maximum Breadth	: 11.00 m
Maximum Draft	: 3.00 m
Maximum Height	: 4.30 m above water line 7.30 m above keel
Maximum Speed	: 8.00 knots

(2) Navigation Routing System
(Width & Depth of the Water, Bottom & Head Clearance, Speed, etc.)

In terms of the safe navigation of the said vessels, minimum widths of channel for both one and two way traffic are estimated as 30 m and 40 m, respectively. The required minimum water depth is a sum of the draft and under keel clearance for the vessel. For the under keel clearance, 0.2 m at locks and 0.3 m in channels are adopted as normal practice. The river flow has a rate of 3.5 knots in the upstream area and of 2.0 knots on average. A ship of 8.00 knots can keep 4.5 knots against the strongest river flow of 3.5 knots and so satisfies the above requirement.

There are several sharp curves along the river. Careful maneuvering and steering shall be required in such places. Sand and/or mud are suitable as an anchorage of ships awaiting berth or awaiting another ship passing the lock or for a one-way passage. Removal of driftwood is to be recommended as circumstances may permit. Marking of underwater obstructions with buoys or other navigation aids shall be also recommended, if they exist. For the safe passage under overhead obstacles, only the limitation imposed by the lock should be considered. All the bridges in the river can maintain an overhead clearance more than 1.0 m. Height of electric cables shall be adjusted if necessary.

(2) Measures

A zone separating the traffic lanes in which ships are proceeding in opposite directions shall be recommended such as where a sand bar exists in the center of the river and navigable passages are available on both sides of the bar. A One-way passage system shall be recommended for channels narrower than 50 m in width where two-way navigation seems to be difficult. Waiting areas for one-way passage shall be required down stream of the channel where ship can wait for another ship's passage.

Some sonic signals shall be required, when a ship passes a curve where visible identification is difficult. To maintain enough depth for safe navigation, dredging or construction of a spur dike shall be recommended where the depth of the river in dry season is less than 1.3 m and where the width of the river is less than 30 m.

Judging from the past activity, navigation charts do not seem to be necessarily essential for a navigator with local knowledge when navigating in the daylight only. Even if navigation in the night is not essential, navigation aids such as buoys or markers shall be required.

Considering the difficulties involved with night navigation due to the nature of the river such as shallow water, narrow channels, rapid water flow and curved passages, daytime navigation shall be recommended. Navigators are also requested to be well trained and well taught especially about navigation along sand bars and bends typically identified in this river.

9.2 Operation Planning

(1) Operational Program and the Required Number of Vessels

To estimate the necessary number of ships, two situations were studied. In the first situation, designated as alternative 1, cargo other than soybeans and cargo passing the locks will be transported on average through the year considering the demand of consumer. In the second, alternative 2, some cargoes shall be adjusted so that number of ships shall become almost even throughout the year. Since the former shall require a large number of ships at the peak, the latter, namely alternative 2, has been studied as a preferable case in terms of safety and operational economy.

Table 9.3.2 shows the required number of vessels, transporting volumes and ship operation costs for each scenario in 2010 as studied in alternative 2.

Table 9.3.2 Ship Operation Cost in 2010

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Operation Section	Upper region - Parnaíba	Upper region - Teresina	Upper region - Floriano	Upper region - Floriano & Teresina
Number of Ship Required	53	46	31	40
Cargo Volume (ton.km/ship)	8,874,000	9,417,000	13,930,000	10,749,000
Operation Cost including capital cost (US$/ton.km)	0.0429	0.0388	0.0262	0.0272
Operation Cost excluding capital cost (US$/ton.km)	0.0281	0.0249	0.0168	0.0182

Source : JICA Study Team

(2) Distance and Trip Time for River Navigation

Table 9.2.4 shows the estimated distance and navigation hours between major ports along the Parnaíba river. It is estimated that it takes about 70 hours from Santa Filomena to Parnaíba for downward navigation and about 109 hours from Parnaíba to Santa Filomena for upward navigation.

Table 9.2.4 Distance and Navigation Hours (Main Ports)

Port to Port	Distance (km)	Navigation Hours			
		Downward		Upward	
		Hours	Days	Hour	Days
Santa Filomena to Floriano	585	36.0	3.0	52.0	4.3
Santa Filomena to Teresina	830	49.2	4.1	74.0	6.2
Santa Filomena to Parnaíiba	1,215	70.0	5.8	108.7	9.1
Floriano to Teresina	245	13.2	1.1	22.0	1.8
Floriano to Parnaíba	630	34.0	2.8	56.7	4.7
Teresina to Parnaíba	385	20.8	1.7	34.6	2.9

Source: JICA Study Team

Note : Distance was obtained by map of 1:200,000 scale.

10. PLANNING OF RESUMPTION OF BOA ESPERANÇA LOCKS

10. PLANNING OF RESUMPTION OF BOA ESPERANÇA LOCKS

10.1 Present Circumstances of the Boa Esperança Lock

Construction of the Boa Esperança Lock was started in 1974, and concreting works was completed in 1982, but the works stopped for financial reasons. Presently, due to the existence of no mechanical equipment such as gate structures and control equipment, the lock system does not work. A sectional arrangement of the Boa Esperança Lock System is shown in Fig. 10.1.1. Specifications of the lock system are as follows :

Effectivel Length	: 50m
Width	: 12m
Maximum Water Depth	: 26m
Minimum Water Depth	: 2.5m
Water Level Difference	: 23.5m(Maximum)

10.2 Comparison of Navigation Systems

(1) Type of Navigation System

From the Boa Esperança Dam to the Parnaíba river, the water level difference reaches 47m. To overcome this water level difference and enable the navigation of ships between the Boa Esperança Dam and the Parnaíba river, the following systems are to be considered.

- Lock System (see Fig.10.1.1.)
- Vertical Lift System (see Fig.10.2.2.)
- Inclined Lift System (see Fig.10.2.3.)

Sectional arrangements of respective systems are shown in Fig. 10.2.1.

(2) Comparison of the Systems

Comparison of the three systems, namely the lock system, the vertical lift system and the inclined lift system are made and summarized as shown in Table 10.2.1.

The significant characteristic of the special arrangement of navigation system is the fluctuation of water level. The maximum fluctuation of the surface water level upstream Boa Esperança Dam is 10m, and is similarly 12m downstream on the Parnaíba river. For the satisfactory overcoming of such a big water level difference and fluctuation of surface water levels, the planning of a vertical lift system or an inclined lift system needs fairly big initial investments, and must solve difficult problems of the spacial locations and technical difficulties.

On the other hand, a lock system has no substantial problems with the water level difference and is also advantageous in terms of economical aspects, and of faster and easier works, for the existing civil structures including lock chambers are applicable. It can be concluded that a lock system is definitely recommendable, as can be seen in Table 10.2.1.

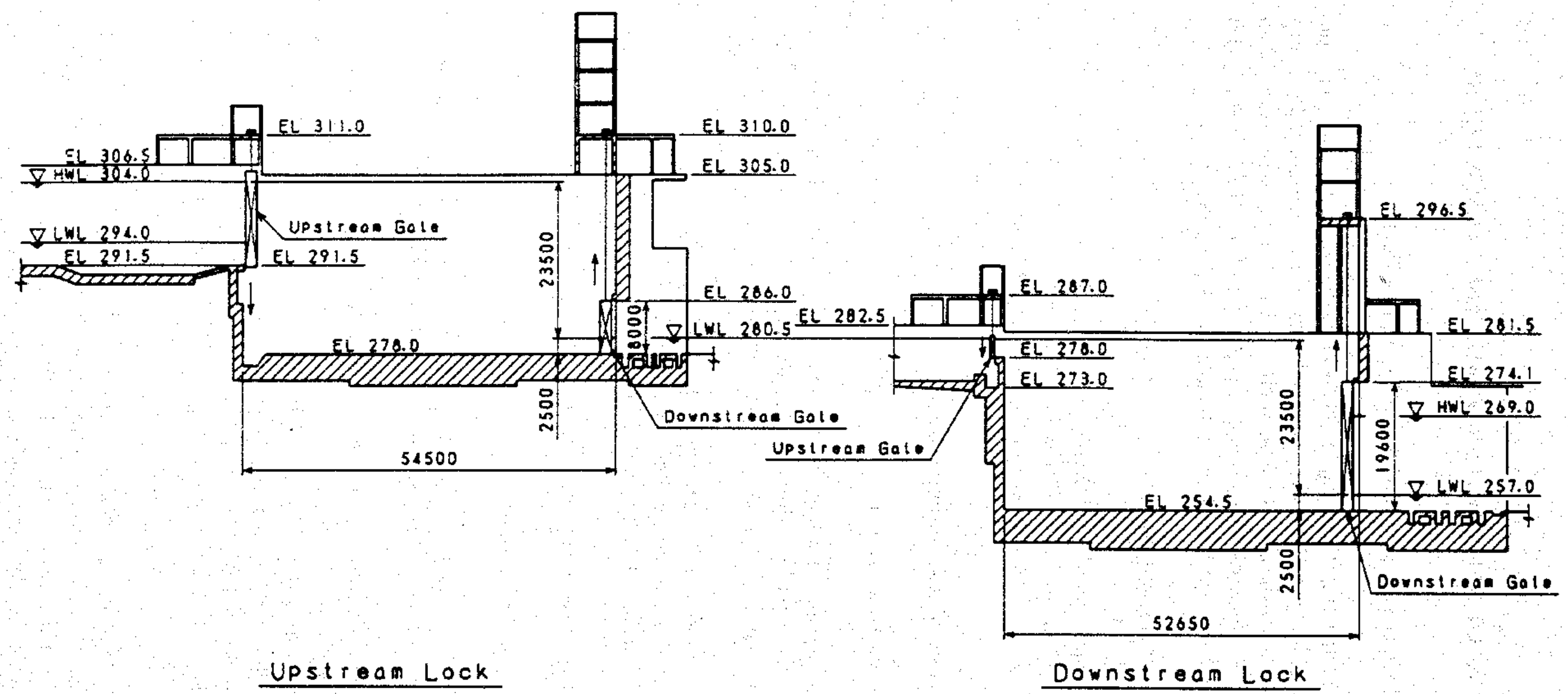


Fig.10.1.1 Sectional Arrangement of the Boa Esperanca Lock.

Table 10.2.1 Comparison of Navigation System

Type of System / Item	Lock System	Vertical Lift System	Inclined Lift System
Major Composition	- Upstream chamber - Downstream chamber - Gates in the chamber - Filling & discharging facilities	- Vessel - Tower lift - Approach flume - Gates for vessel & approach flume	- Carriage with vessel - Inclined rail path - Control tower - Gates for vessel & Flume
Civil Work	Upstream and downstream lock chambers had been almost completed, except slight civil works remains.	Construction of towers and approach flume are needed. For the foundation of the tower, firstly a geological investigation must be made to find the most suitable foundation to support the heavily concentrated load for the system.	Construction of inclined rail path and control tower are needed. By reason that the heavy load acts along the inclined rail path, a geological investigation must be made to find out a suitable foundation to support the load
Structural Construction Work	Construction of lock gates, and filling & discharge facilities has been experienced in the Brazil, and no technical difficulties exist.	Vessel to contain ship and also towers with driving equipment are very complicated. Accordingly manufacturing and construction needs advanced techniques.	Carriage with vessel to contain ship and driving equipment are extraordinary large structures and manufacturing and construction needs advanced techniques and is difficult.
Control of Water Leve	Control of water level is possible by the matured technique applying with filling and discharging facilities, and no difficulty exist.	To comply with the fluctuation of surface water level in the Parnaiba River i.e."12m", height of vessel exceed 15m. For the approach flume of the system, height of flume wall exceed 13m to suit the fluctuation of surface water level of the dam. Both structures are extraordinary large.	To comply with the fluctuation of surface water level in the Parnaiba River i.e. "12m", height of vessel exceed 15m.
Navigability of Ship	Upstream chamber and downstream chamber are independent to each other, and accordingly, ship navigation becomes effective through the stand-by period at the intermediate reservoir.	Ship navigation become possible just after the navigation of former ship.	Identical to the description of vertical lift system.
Maintenance	Maintenance work is considered to be the same as for ordinary gate equipment.	A lot of maintenance works are needed for the driving equipment and in the towers. In addition there is the vessel and complicated operation mechanisms of the gate facilities.	Not only for the maintenance of the huge carriage with vessel and driving equipment, but also difficult maintenance must be made for the rail and wire rope of more than 1000m length.
Work Period	Remaining civil work is not so much, and work period for the steel structures can be shortened through the parallel performance of manufacturing and installation.	In addition to the civil works as well as the steel structural works, investigation and design work needs a long period.	Identical to the vertical lift system.
Work Experience	Work experiences commonly exist in Brazil.	Work experience do not exists in the Brazil and techniques must be transferred from foreign countries.	Identical to the vertical lift system
Weight ratio of the steel structures	1	6	7
Concrete volume	negligible	30,000m3 (excluding approach flume)	60,000m^3
Construction Cost	Approx. US $ 16 million	Approx. US $ 100 million (excluding approach flume)	Approx. US $ 120 million
Total evaluation	Recommendable	———	———

Note : Construction cost of this table is prepared for the comparison purpose.

10.3 Planning of Resumption of Boa Esperança Locks

(1) Necessary Equipment to Complete the Lock System

In order to facilitate the lock system, gate and filling/emptying equipment for lock chamber, stoplogs, control system and ancillary equipment are required (see Figs.10.3.1 and 10.3.2 for the general arrangements).

Table 10.3.1 Purpose and Function of Control Panel

Purpose	Qty	Function
Local Control Panel for Lock Gate	4	Local control of respective gates for lock chamber
Local Control Panel for Filling and Emptying Gates	8	Local control of respective filling and emptying gates
Remote Control Panel	2	Remote control of gates for lock chamber, filling and emptying gates from the control room of upstream and downstream locks.
Remote Control Panel for Emergency	1	Remote control of overall gates from the remote control room of upstream lock.

Components of the ancillary facilities are listed below:

- Elevator for the control room
- Floating bollards in the lock chamber
- Monorail hoist for the maintenance purpose of operating equipment
- Handrails on the lock chamber deck and staircase
- Ladders for the lock chamber and pit
- Pit cover in the hoisting room
- Mooring wharf in the reservoir

(2) Relevant Civil Works

Additional civil works are required as follows:

- Jetty on the right bank in the intermediate reservoir and access road
- Walls for hoisting room and control room
- Storage facility for stoplogs
- Removing of plants and bushes on the navigation line in the intermediate reservoir
- Removing of a concrete bulkhead in the upstream flume for the upstream lock chamber
- Removing of gravel and rocks which are interrupting the ship's navigation in the downstream flume and the Parnaíba river

(3) Control System

The operation of lock gates, filling and emptying gates could be made generally from the remote control panel in the control room, which is located independently to each upstream and downstream lock (see Figs.10.3.4 and 10.3.5).

An operator who always keeps staying in the control room can operate the lock gates, filling and emptying chambers, watching ship behaviors by ITV monitoring equipment. In case of emergency, the operation of gate equipments of the upstream and downstream locks are enabled at the remote control panel.

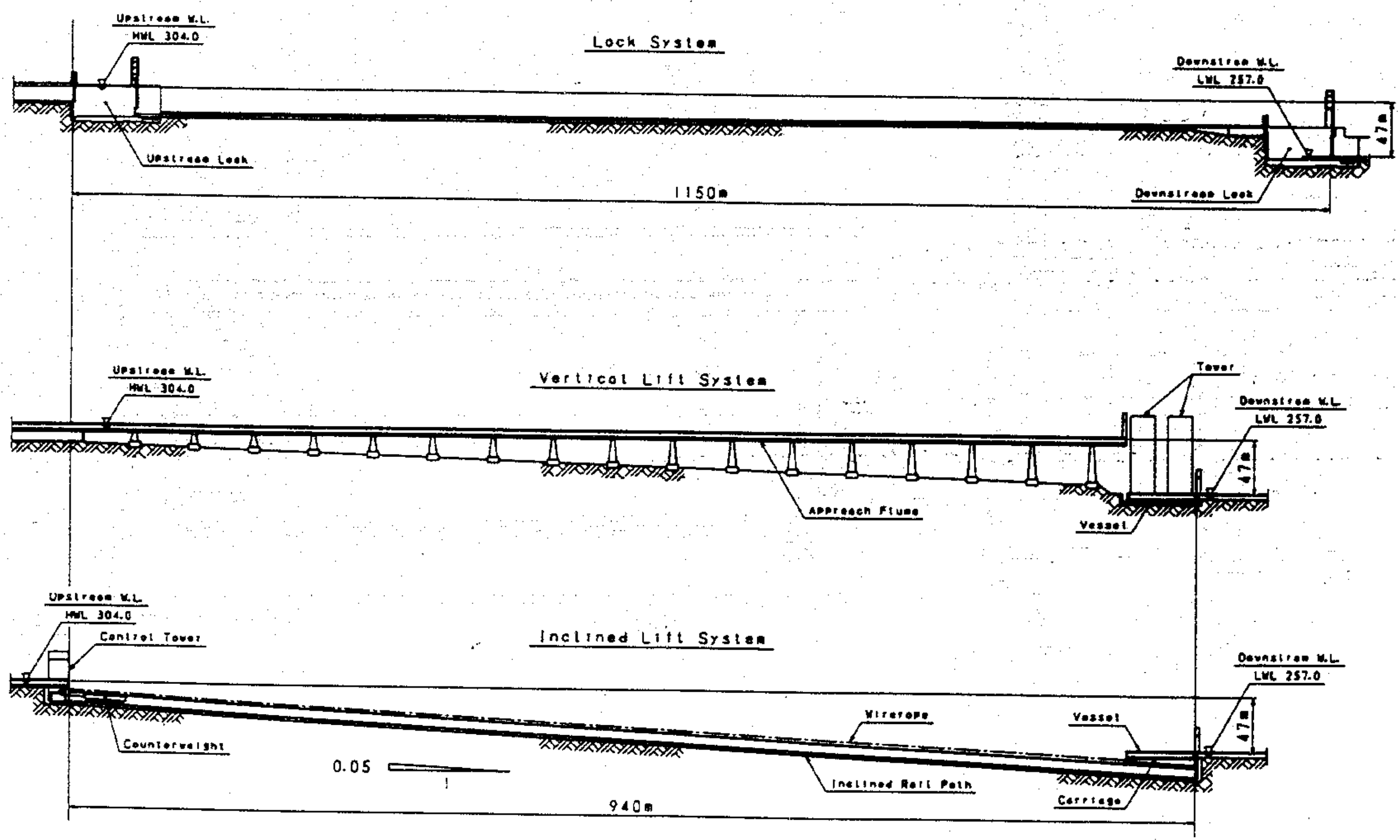


Fig.10.2.1 Sectional Arrangements of the Lock System, Vertical Lift System and Inclined Lift System

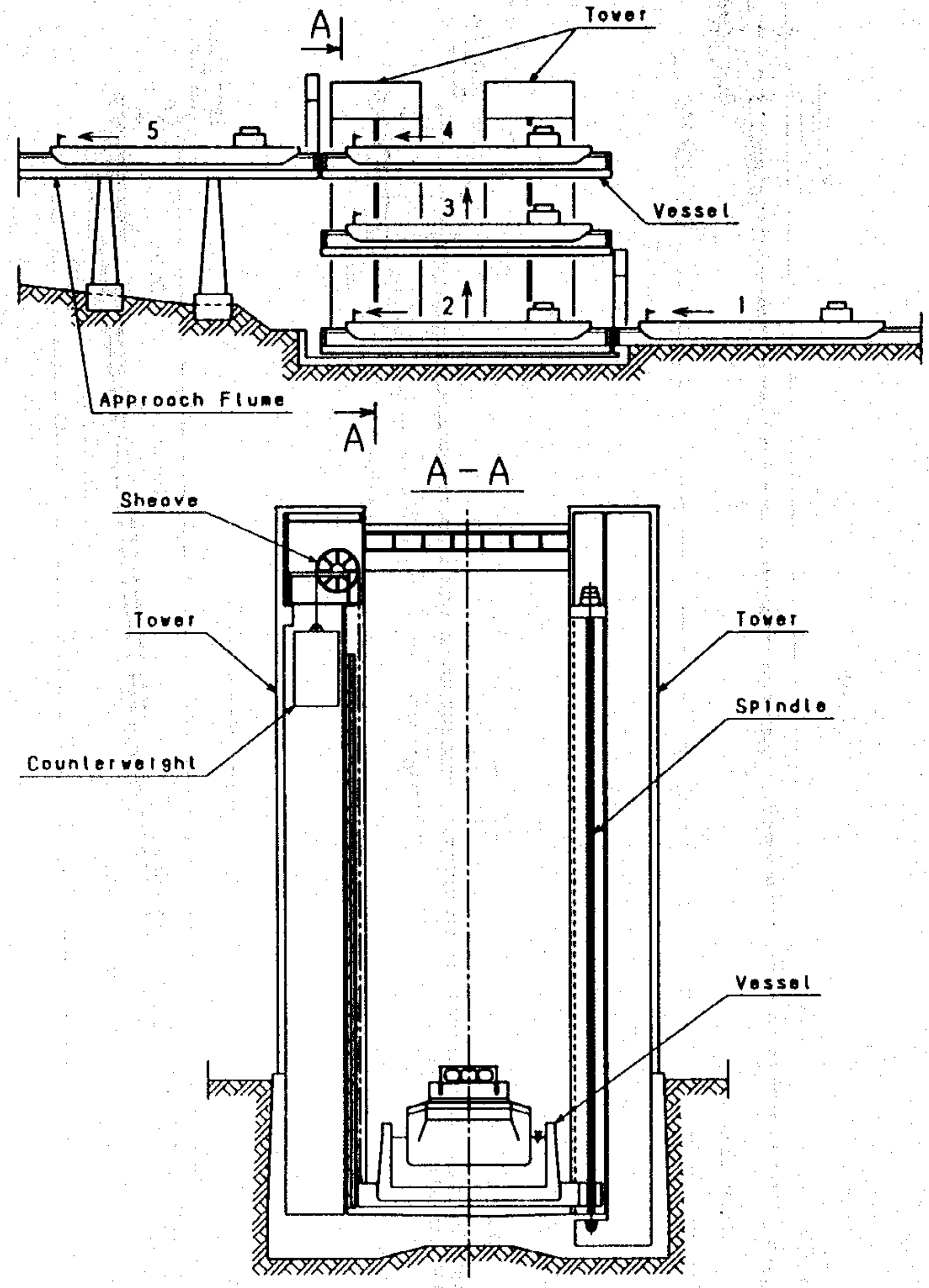
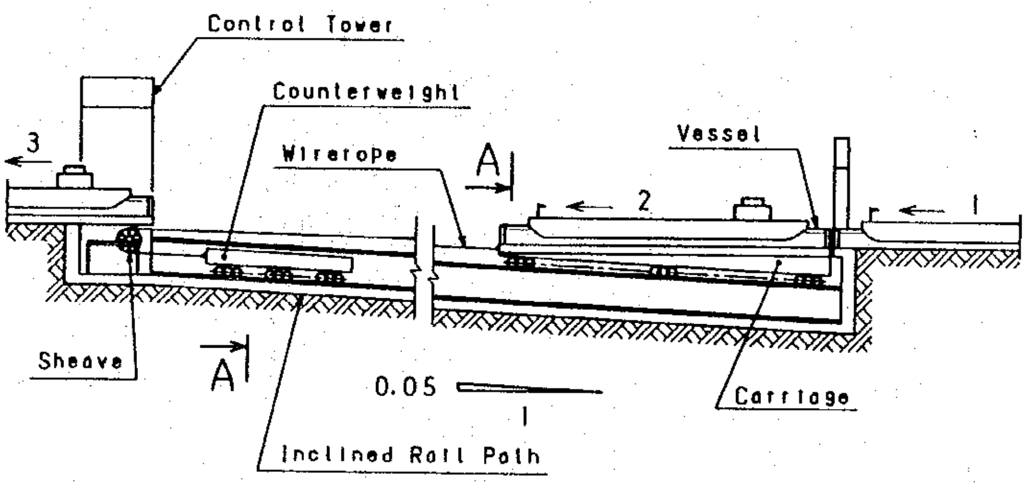


Fig.10.2.2 Schematic Arrangement of the Vertical Lift System



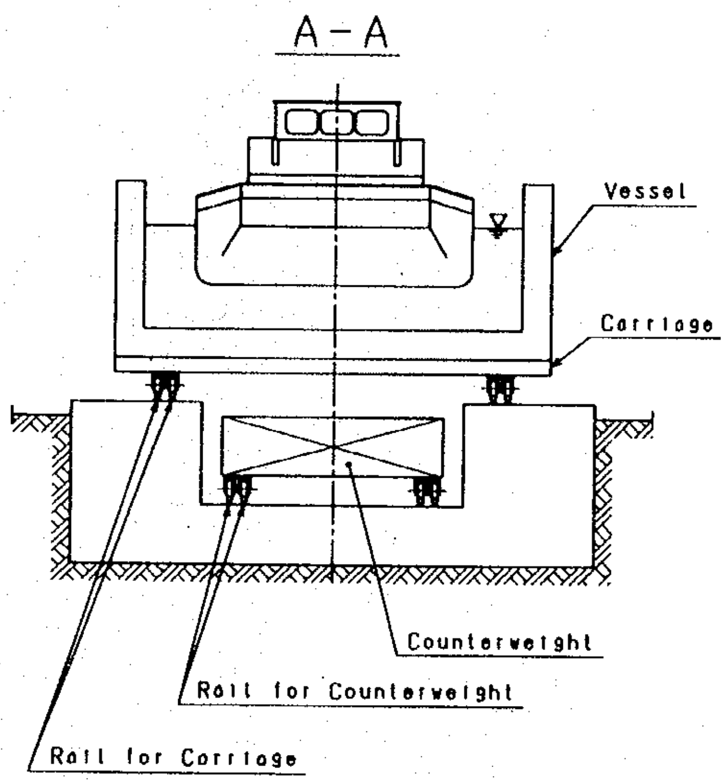


Fig.10.2.3 Schematic Arrangement of the Inclined Lift System

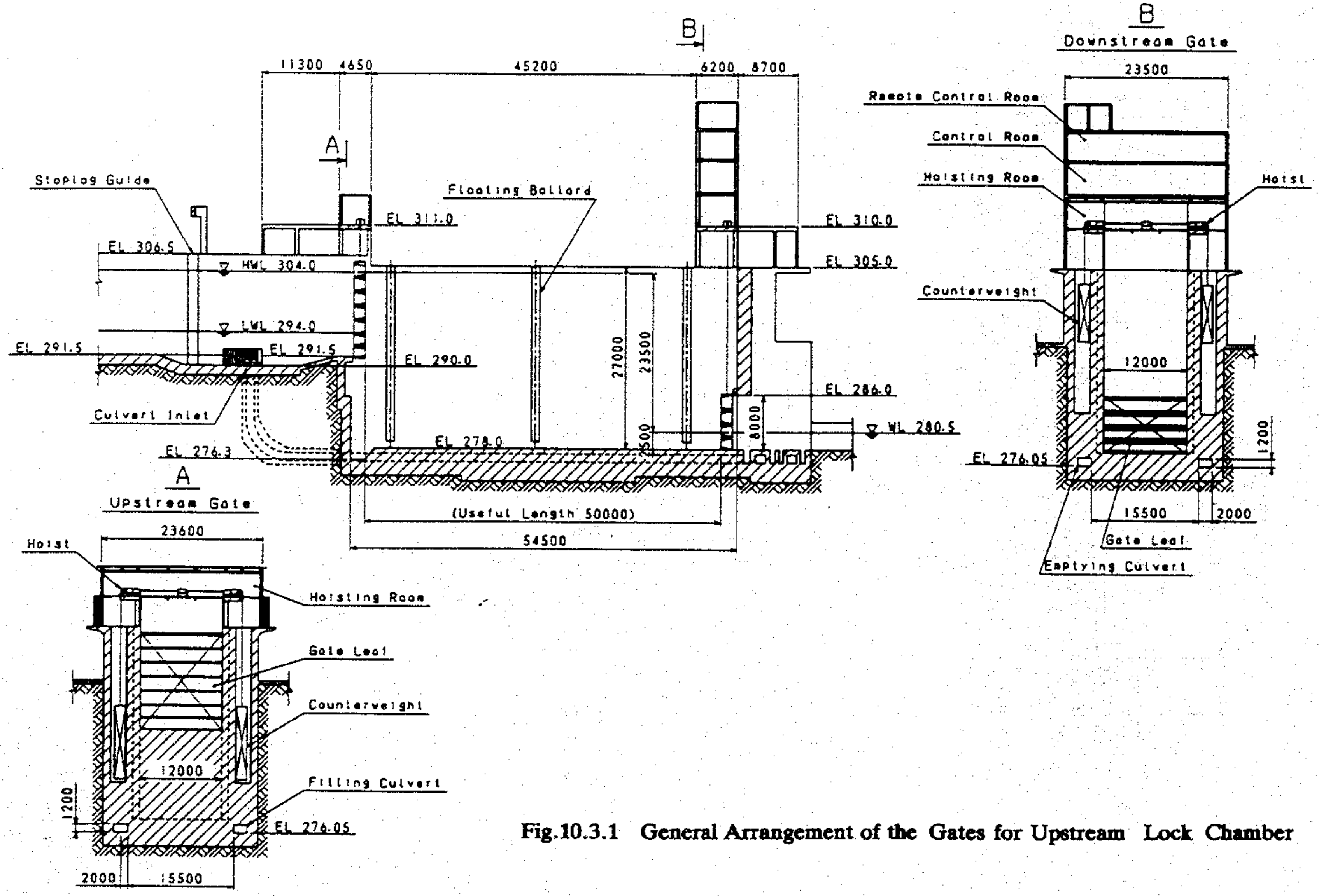


Fig.10.3.1 General Arrangement of the Gates for Upstream Lock Chamber

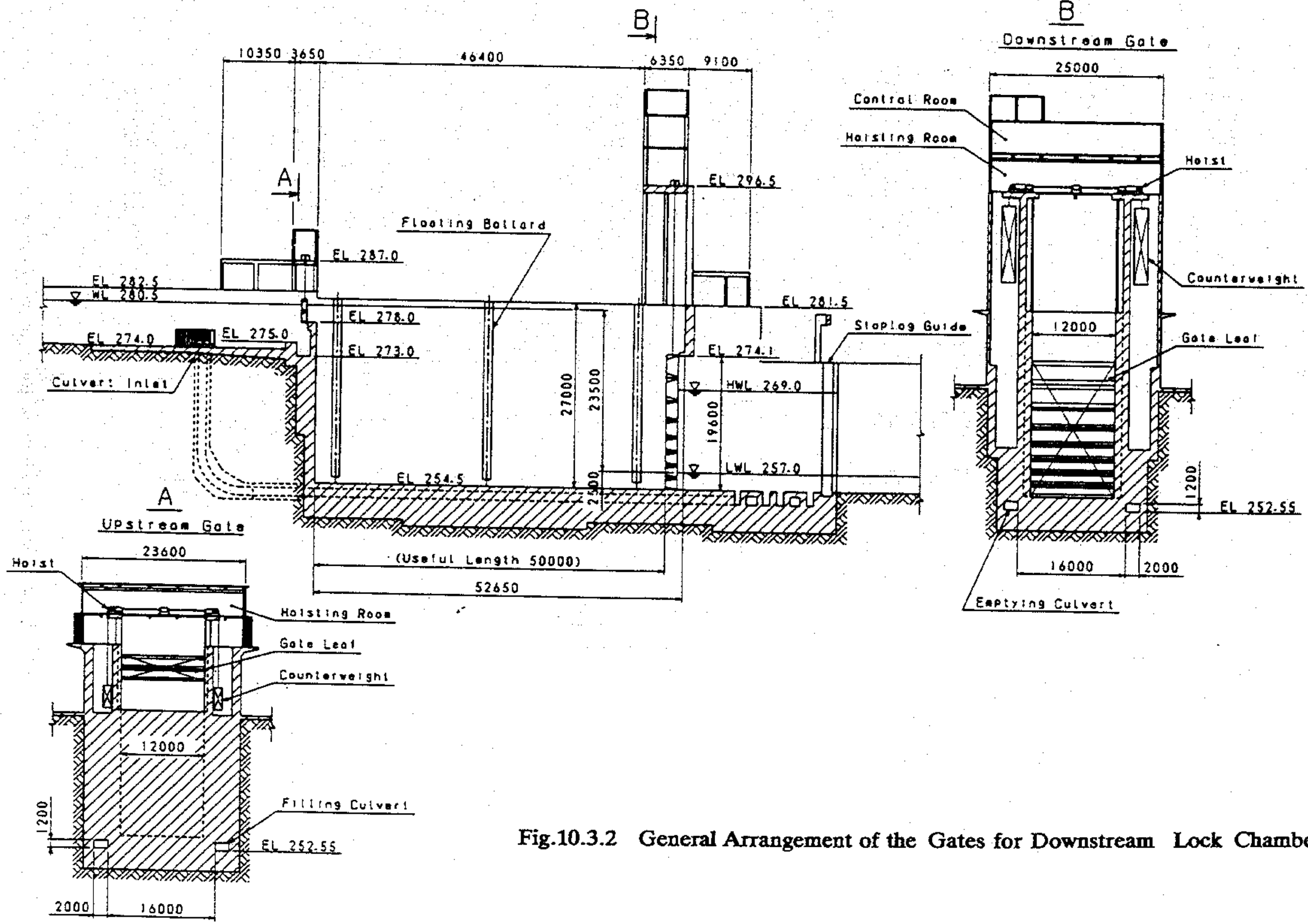


Fig.10.3.2 General Arrangement of the Gates for Downstream Lock Chamber

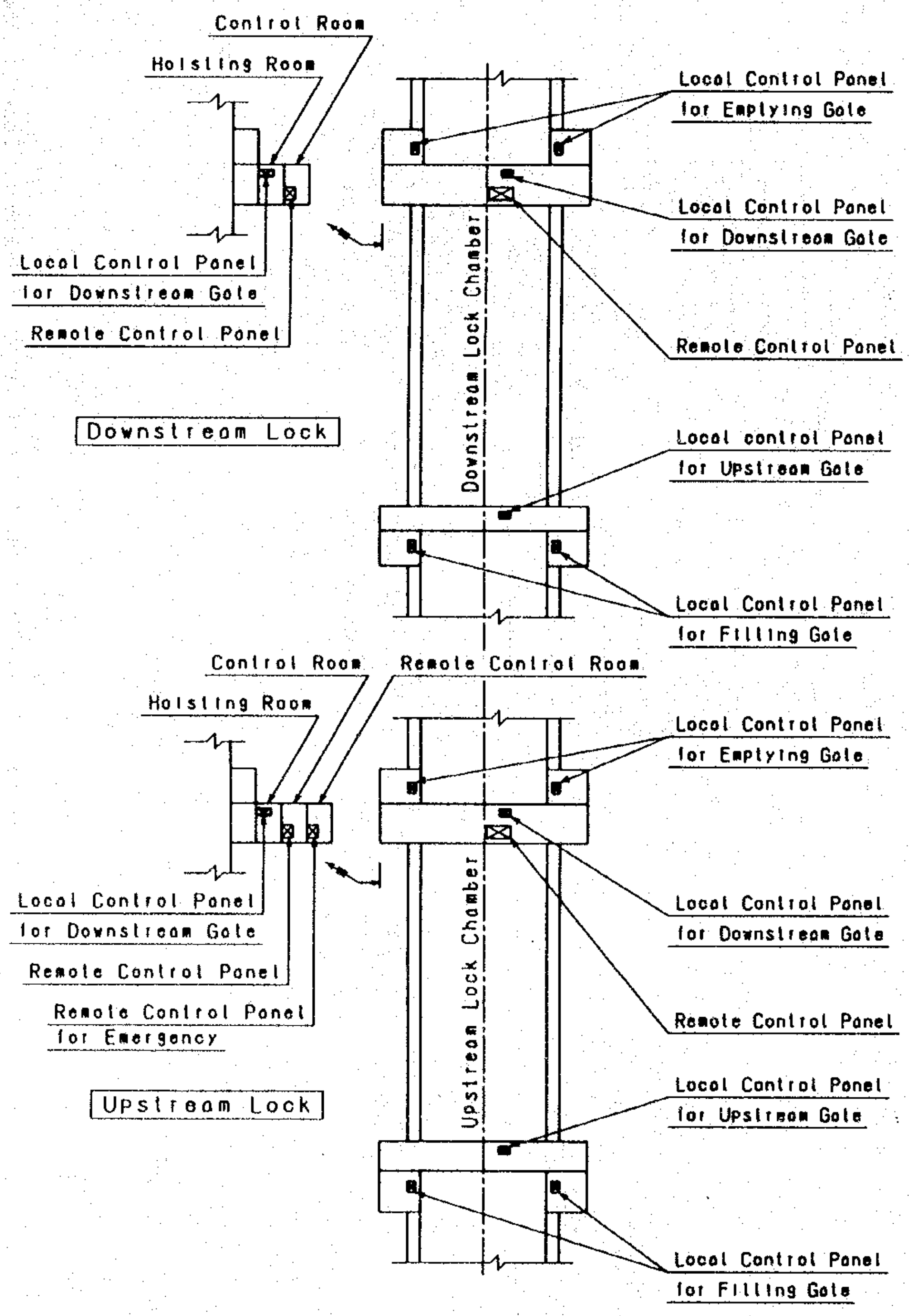


Fig.10.3.4 Arrangement of the Control Panels

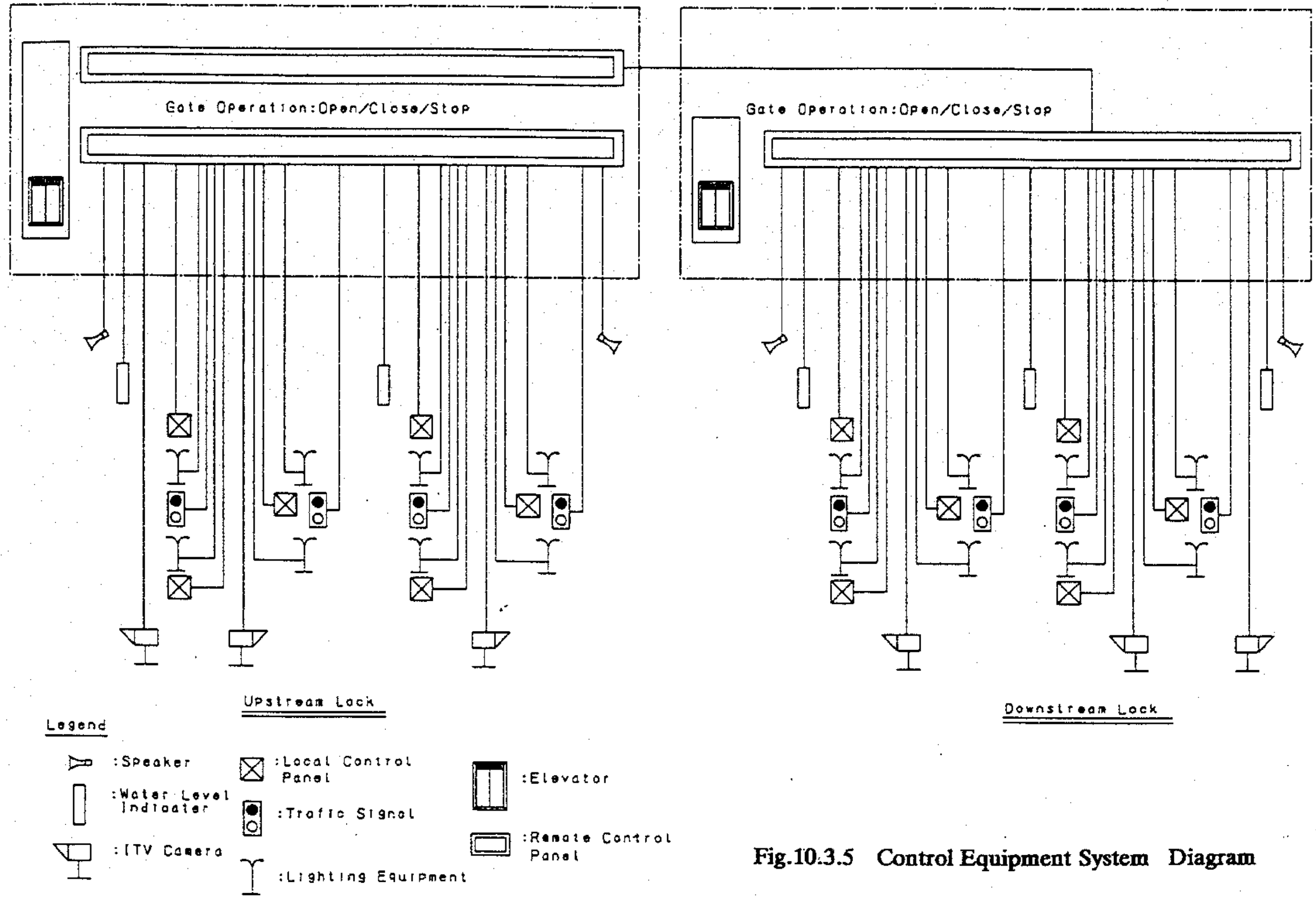


Fig.10.3.5 Control Equipment System Diagram

11. PLANNING OF THE PORT FACILITIES

11. PLANNING OF THE PORT FACILITIES

11.1 River Ports Location

The total number of ports planned along the Parnaíba river basin in each scenario is 13 for scenario 1, 8 for the second, 5 for the third and 8 for the last scenario 4 (see Table 11.1.1).

Table 11.1.1 Required River Ports Location in Each Scenario

Location	Scenario 1	Scenario 2	Scenario 3	Scenario 4
1. Parnaíba	x	-	-	-
2. Luzilandia	x	-	-	-
3. Porto	x	-	-	-
4. Miguel Alves	x	-	-	-
5. Uniao	x	-	-	-
6. Teresina	x	x	-	x
7. Palmeiras	x	x	-	x
8. Amarante	x	x	-	x
9. Floriano	x	x	x	x
10. Guadalupe	x	x	x	x
11. Urucui	x	x	x	x
12. Ribeiro Goncalves	x	x	x	x
13. Santa Filomena	x	x	x	x
Total	13	8	5	8

Source : JICA Study Team
Note : x : Required ,
- : Not required

11.2 Cargo Handling Volume in the River Ports

The annual handling cargo volumes in each scenario along the Parnaíba river basin obtained by the cargo transportation planning are summarized in the following Table 11.2.1.

Table 11.2.1 Annual Handling Cargo Volumes in Each Scenario at 2010

Unit : Tons/year

Location	Scenario 1	Scenario 2	Scenario 3	Scenario 4
1. Parnaíba	170,000	-	-	-
2. Luzilandia	114,300	-	-	-
3. Porto	26,300	-	-	-
4. Miguel Alves	52,900	-	-	-
5. Uniao	33,200	-	-	-
6. Teresina	786,200	736,200	-	514,700
7. Palmeiras	40,000	40,000	-	20,000
8. Amarante	59,400	59,400	-	37,500
9. Floriano	387,400	380,700	1,188,100	560,300
10. Guadalupe	85,200	85,200	170,850	85,200
11. Urucui	363,950	363,950	510,600	363,950
12. Ribeiro Goncalves	421,000	421,000	421,000	421,000
13. Santa Filomena	85,650	85,650	85,650	85,650
Total	2,625,500	2,172,100	2,376,200	2,088,300

Source : JICA Study Team

11.3 Required Port Facilities

In this study, all the agricultural products are assumed to be transported as bulk cargoes and to be handled by loader/unloader at the ports. Household commodities are also to be bagged as general cargoes and to be handled by cargo gears equipped on the vessels, assuming their capacity as 20 ton/hr. The required port facilities at each river port in scenario 1 are presented in Table 11.3.1, since all the river ports are included in the scenario (see the main volume for other scenarios).

Table 11.3.1 Required Port Facilities at Each River Port in Scenario 1

	Mooring Basin	Berthing Facilities	Loading Equipment	Unloading Equipment	Silo	Shed or Warehouse
1. Parnaiba	x	x	x	x	x	x
2. Luzilandia	-	x	x	-	x	-
3. Porto	-	x	x	x	x	x
4. Miguel Alves	-	x	x	x	x	x
5. Uniao	-	x	x	x	x	x
6. Teresina	x	x	x	x	x	x
7. Palmeiras	-	x	x	-	x	-
8. Amarante	-	x	x	-	x	-
9. Floriano	x	x	x	x	x	x
10. Guadalupe	x	x	x	x	x	x
11. Urucui	x	x	x	x	x	x
12. Riberio Goncalves	x	x	x	x	x	x
13. Santa Filomena	-	x	x	x	x	x

Source : JICA Study Team
Note : x : Required
- : Not required

11.4 Requirements of the River Ports

(1) Berth Requirements

Berthing facilities are the most important infrastructure at the port. Therefore, berth requirements at each river port are estimated based on the forecasted cargo volume and cargo handling system with the following assumptions. Table 11.4.1 shows the results of the estimation for bulk berth and general cargo berth in Scenario 1.

- Working hours per day : 12 hr
- Number of working days : 350 days
- Maximum loading and unloading capacities : 20 ton/hr for general cargo berth
  : 100 to 700 ton/hr for bulk berth
- Berth occupancy ratio (BOR) : 50 - 70 %

Table 11.4.1 Number and Type of Berth at Each River Port

River Ports	Number of Berth	Type of Berth
1. Parnaíba	1	Bulk with general cago berth
2. Luzilandia	1	Bulk berth
3. Porto	1	Bulk with general cago berth
4. Miguel Alves	1	Bulk with general cago berth
5. Uniao	1	Bulk with general cago berth
6. Teresina	3	One bulk and two general cargo berths
7. Palmeiras	1	Bulk berth
8. Amarante	1	Bulk berth
9. Floriano	3	One bulk and two general cargo berth
10. Guadalupe	2	One bulk and one general cargo berth
11. Urucui	3	One bulk and two general cargo berth
12. Ribeiro Goncalves	2	One bulk and one general cargo berth
13. Santa Filomena	2	One bulk and one general cargo berth

Source : JICA Study Team

11.5 River Port Plan

From the successive examination, the ports are classified into 4 types and assigned as shown in Table 11.5.1.

Table 11.5.1 Type of Each River Port

Type	Berth Type	River Ports
1	Bulk berth	Luzilandia, Palmeiras, Amarante
2	Bulk with general cargo berths	Parnaíba, Porto, Miguel Alves, Uniao
3	Bulk and general cargo berths	Guadalupe, Ribeiro Goncalves, Santa Filomena
4	Bulk and two general cargo berths	Teresina, Floriano, Urucui

In Figs.11.5.1 to 11.5.4, a general arrangement plan for each type is presented. All the design water depths at the berths are planned as - 3.5 m. The overall total length of the berth is 15 m for type 1, 25 m for type 2, 15 and 50 m for type 3, and 15 and 100 m for type 4.

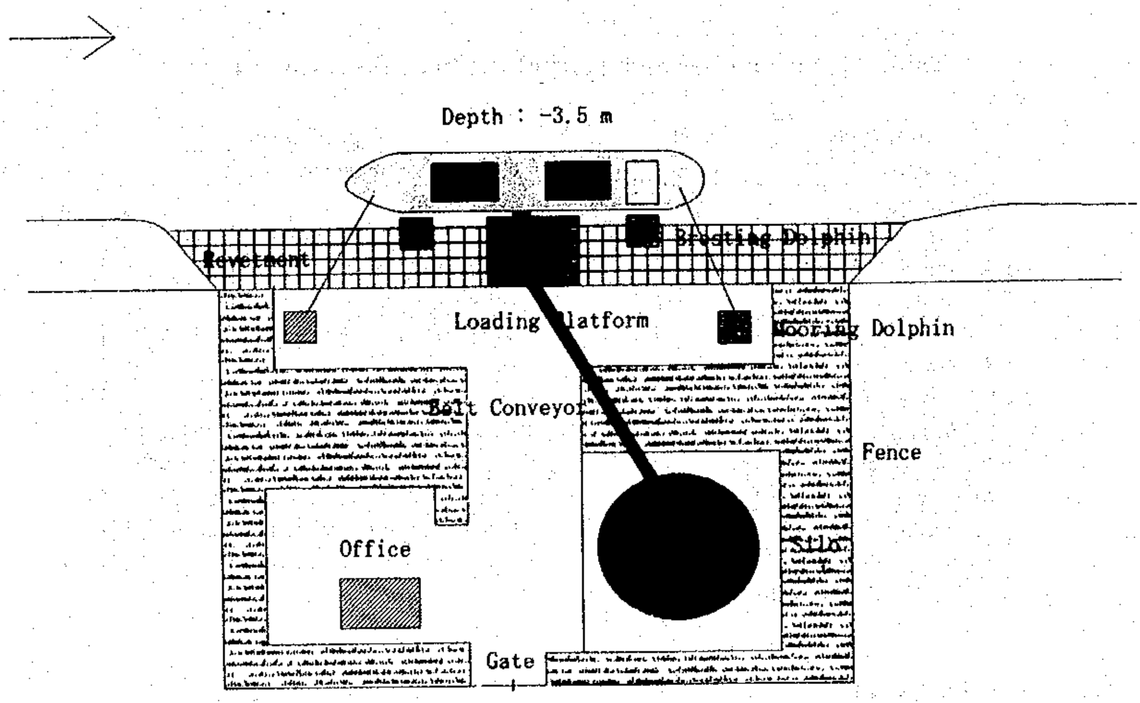


Fig. 11.5.1 River Port Layout - Type 1

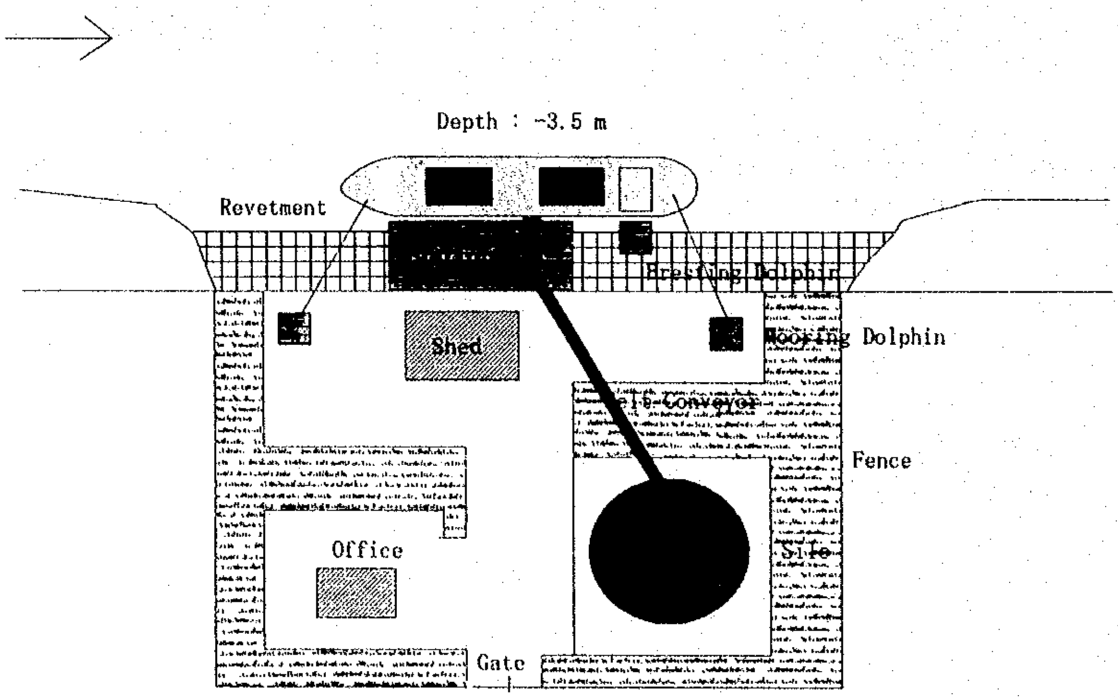


Fig. 11.5.2 River Port Layout - Type 2

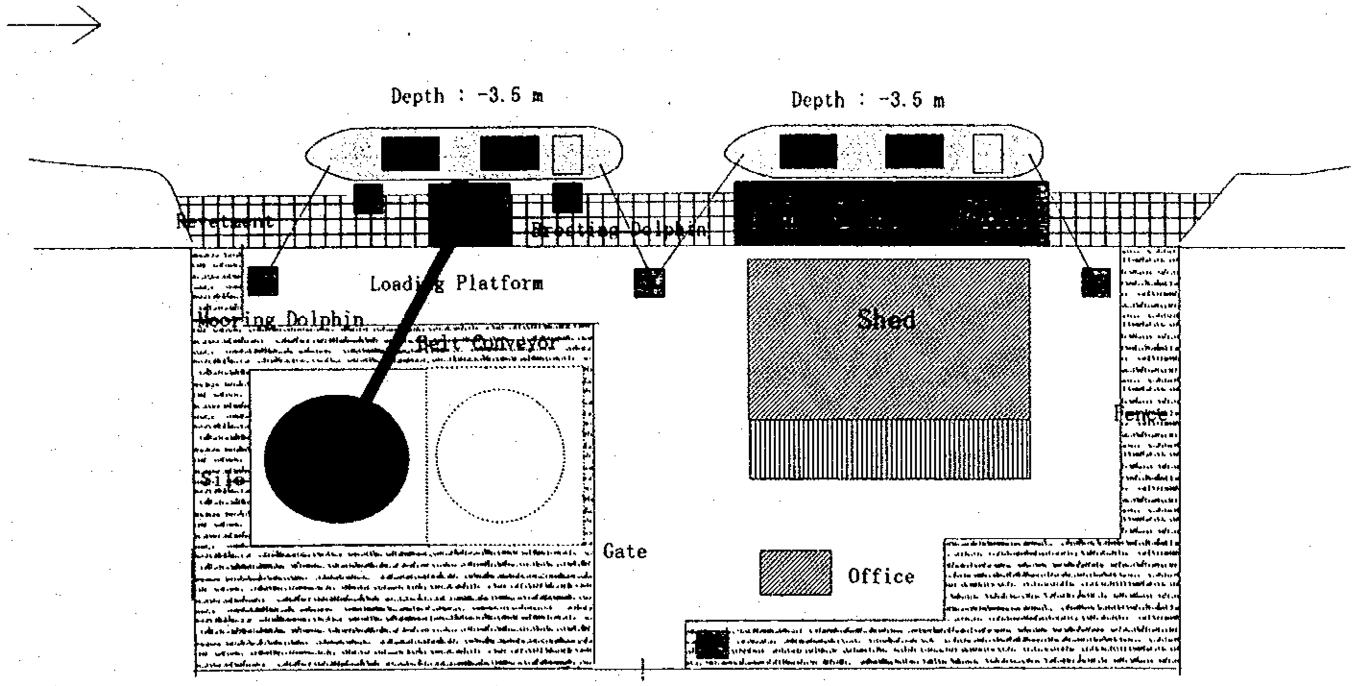


Fig. 11.5.3 River Port Layout - Type 3

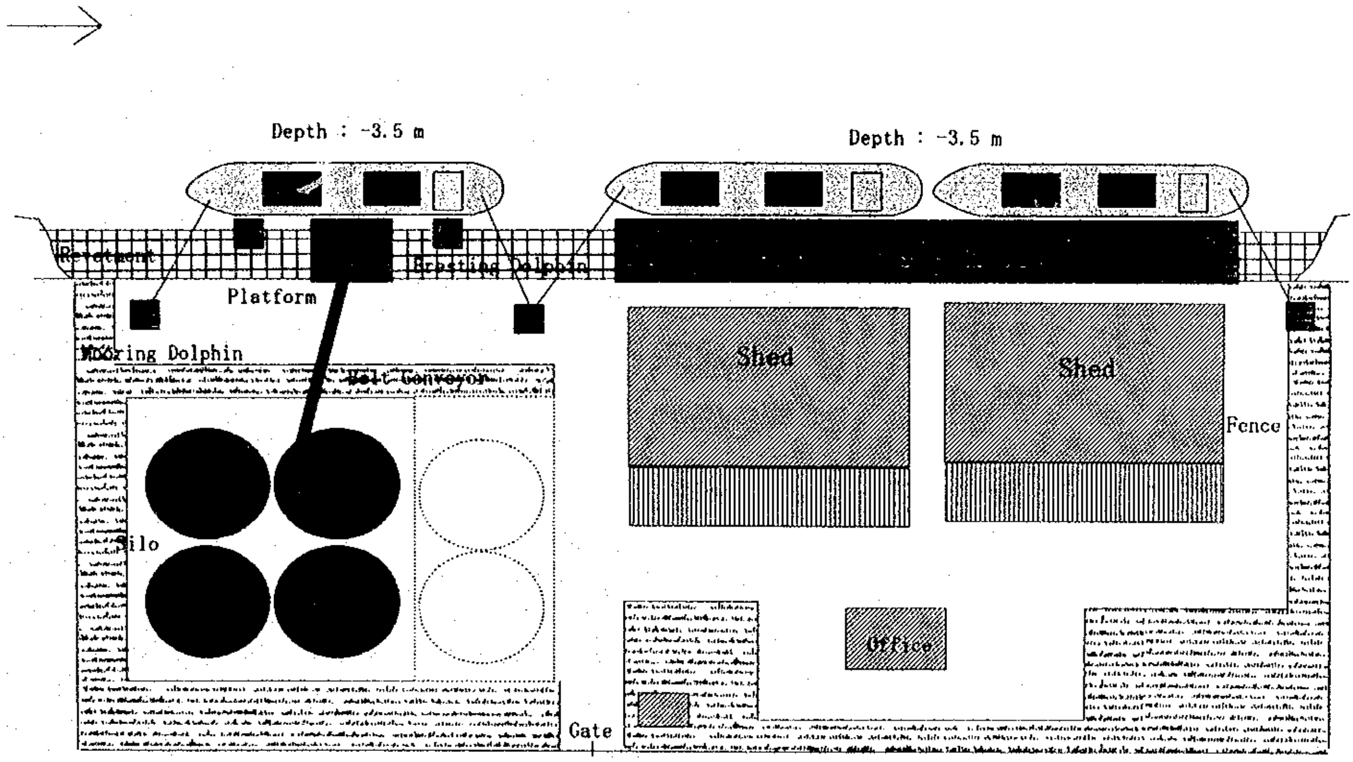


Fig. 11.5.4 River Port Layout - Type 4

12. NAVIGATION AIDS PLANNING

12. NAVIGATION AIDS PLANNING

12.1 Type of the Navigation Aids

As previously presented, maneuvering in daytime is principally assumed in the studied operational plans. Navigation aids are indicated signal boards of a beacon color and shape in accordance with the regulations of "Permanent International Association of Navigation Conference (PIANC)" (see Fig.12.3.1).

Table 12.3.1 shows the required number of navigation aids in each scenario (see Table 12.3.2 for the required number of navigation aids along the Parnaíba river basin in each area). The required number of navigation aids in the tables is estimated based on the aerial photography taken by the JICA Study Team and topographic maps.

Table 12.3.1 Required Number of Navigation Aids

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Required Number of Navigation Aids	475	213	109	213

12.2 Installation Example

Fig.12.3.2 shows the example of the installation of the navigation aids.

Table 12.3.2 Required Number of Navigation Aids

Port	Distance (km)	Number of Sand Bar	Navigation Aids		Kind of Navigation Aids		
			Quantity	Average Distance (km)	Navigation	Obstruction	Bridge
S. FILOMENA							
	275		60	4.6		60	
R. GONCALVES							
	100		25	4.0		25	
URCUI							
	140		0				
GUADALUPE							
	70		24	3.5		20	1 (4)
FLORIANO							
	75		5	15.0		5	
AMARANTE							
	50	1	5	10.0		5	
PALMEIRAIS							
	120	27	94	1.3	90		1 (4)
TERESINA							
	70	70	64	1.2	60		1 (4)
UNIAO							
	65	40	40	1.6	40		
M. ALVES							
	45	30	35	1.3	35		
PORTO							
	85	60	55	1.6	53	2	
LUZILANDIA							
	120	80	68	2.0	60		2 (8)
PARNAIBA							
TOTAL	1,215	308	475	2.7	338	117	5 (20)

Source : Topographical Map (Sata Filomena - Urcui)
Aerial Photography (Guadalupe - Parnaiba)

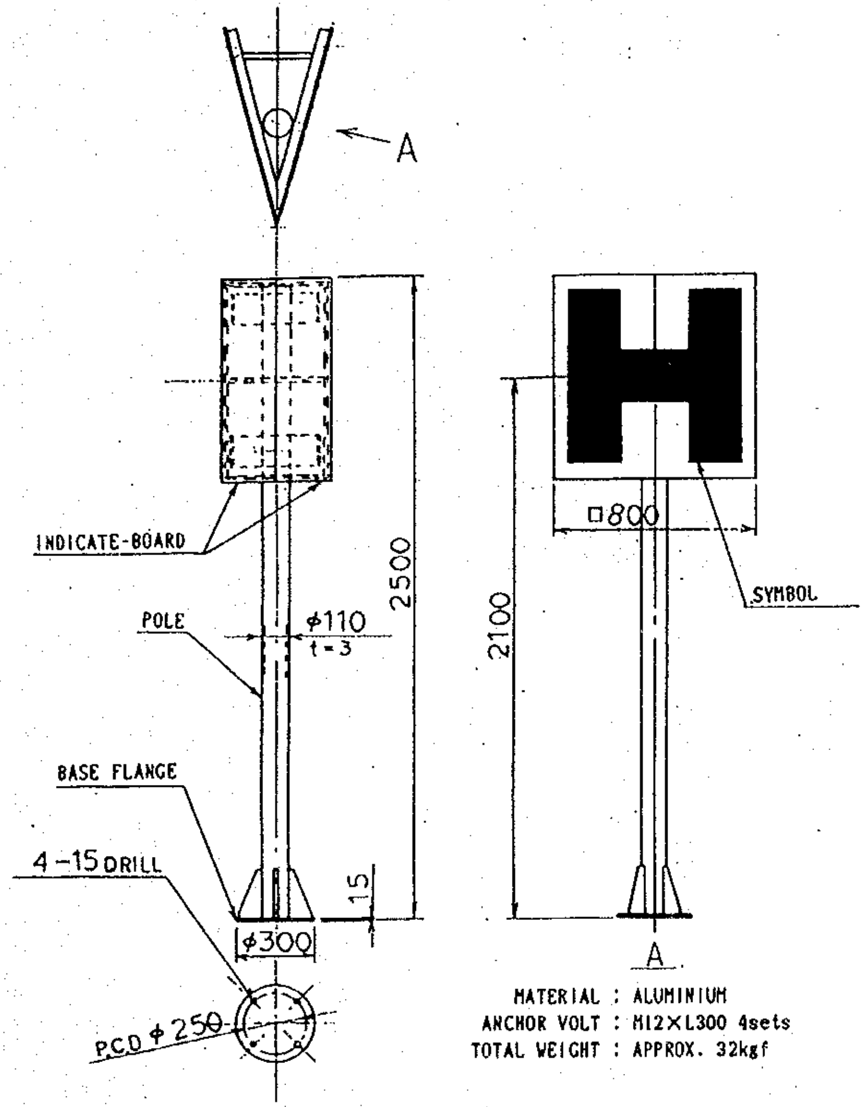
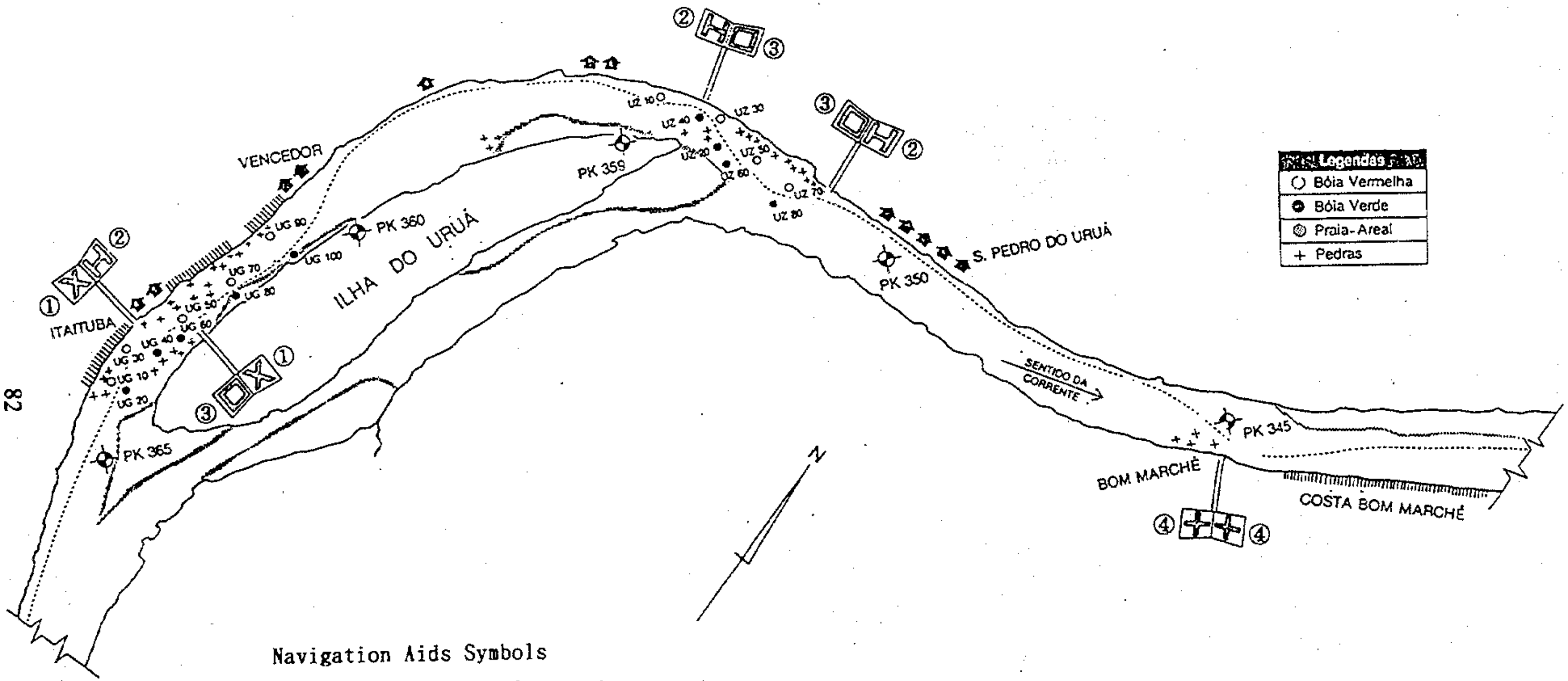


Fig. 12.3.1 General Arrangement of Beacon



Navigation Aids Symbols

① Change of navigation route

② Navigation through the middle of the river

③ Navigation following the shore

④ Isolated danger

Source : RIO MADEIRA, GUIA DE NAVEGACAO
AHIMOC, PORTOBRAS, Ministerio dos Transportes

Fig. 12.3.2 Example of the Installation of the Navigation Aids

13. OPERATION AND MAINTENANCE PLANNING

13 OPERATION AND MAINTENANCE PLANNING

13.1 Present Situation of the Operation and Maintenance

In Brazil, rivers crossing either the National border or states borders are under the control of the Federal government. The Parnaíba river is under the Federal government, for it passes across the state boundary to Maranhão State and therefor falls into the above category.

The actual operation and maintenance program of the channel is administered by the north-east channel authority at São Luis city, abbreviated as AHINOR, and is responsible for provision of any structures installed in the channel, including navigation aids and groins, etc. Vessels maneuvering in the Parnaíba river and in the surrounding sea area are registered at the Port Authority of Parnaíba city, abbreviated as CPPI. The authority organizes the overall administration of vessels utilizing the channel with the help of their patrolling boats.

On the other hand, CHESF possesses seven field stations for the observation of the water depth along the Parnaíba river. These stations warn of possible rises in the high water levels to the nearby towns/villages in the case of discharging water during reservoir operations. They are responsible for safety precautions in the channel resulting from the operation/maintenance of Boa Esperança Dam.

13.2 Organization for the Maintenance, Administration and Operation

The action plan to achieve a practical transport network in the Parnaíba river requires an executing organization. The organization will be preferably based around the State of Piauí and shall be responsible for the preparatory works, such as the financial arrangements, the communication with other relevant authorities, the design of the facilities, tendering and the construction programming/management as well as the formation of a new organization required for maintenance/administration/operation of the river navigation. After the completion of the facilities in the project, the organization will function as the governing body as shown in Table 13.2.1.

Table 13.2.1 General Structure of the Organization

Responsibility	Construction Phase	Operation Phase	Maintenance/Administration Phase
1 Vessels	Private Firms	Private Firms	Private Firms
2 Locks	State government of Piauí or the Ministry	CHESF	CHESF
3 Ports in the Channel	State government of Piauí	Concerned City/Towns	Concerned Towns/Villages
4 Navigation Aids	State government of Piauí or of the Federal	-	Government of the Federal (AHINOR)
5 Management of the Channel	-	-	AHINOR (existing)

(1) Location of the Proposed Offices

In the following Table 13.2.2, the proposed allocation of the offices responsible for the maintenance and operation is shown in accordance with Scenario 1. For other scenarios, the allocation should be rearranged considering the navigation route.

Table 13.2.2 Location of the Offices for Maintenance/Operation

Location	Division			
	Vessels	Ports	Locks	Channel
1 Parnaíba	×	v	-	v
2 Luzilandia	v	v	-	v
3 Porto	v	v	-	-
4 Miguel Alves	v	v	-	v
5 Uniao	v	v	-	-
6 Teresina	×	×	-	× v
7 Palmeiras	v	v	-	-
8 Amarante	v	v	-	v
9 Floriano	×	×	-	-
10 Guadalupe	v	v	×	-
11 Urucui	×	×	-	v
12 Libeiro Goncalves	v	v	-	
13 Santa Filomena	v	v	-	v

Symbols : × : main offices
v : liaison offices or site offices

(2) Functions of the Maintenance/Operation Office

The functions and responsibilities of each division are summarized in Table 13.2.3.

Table 13.2.3 Functions and Responsibilities of each Division

Division	Functions and Responsibilities
1 Vessels	1) marketing and operation 2) safety and security control of vessels and assignment of crew members 3) shipbuilding and maintenance of vessels
2 Locks	1) operation, maintenance and management of the facility 2) statistics data collection and recording of operational status for the facilities 3) communication and negotiation with private shipping companies
3 Ports	1) communication, information exchange and arrangements with other ports 2) maintenance, operation and management of handling equipment and machineries 3) maintenance, operation and management of the port and harbour
4 Channels	main office at Parnaíba 1) bulletin of the channel condition 2) project planning and budget management 3) supply of materials and equipment 4) arrangement with other authorities liaison or site offices 1) patrolling and inspection of structures in the channel, i.e., navigational aiding signals/markers, groins, etc. 2) maintenance and rehabilitation 3) storage of materials and equipment 4) monitoring chanel conditions, information arrangement and transmission

(3) Assignment of the Staff Members

The assignment of divisional staff members at each office in scenario 1 is shown in Table 13.2.4. It should be noted that some adjustments will be required in other scenarios.

Table 13.2.4 Staff Allocation of Each Office in Scenario 1

Liaison Offices	Vessels	Ports	Locks	Channel
1 Parnaíba	6	17	-	10
2 Luzilandia	3	16	-	10
3 Porto	1	11	-	-
4 Miguel Alves	1	11	-	10
5 União	1	11	-	-
6 Teresina	9	31	-	20,10
7 Palmeiras	1	11	-	-
8 Amarante	1	11	-	10
9 Floriano	7	26	-	-
10 Guadalupe	3	16	6	-
11 Urucui	6	26	-	10
12 Libeiro Goncalves	4	26	-	-
13 Santa Filomena	1	16	-	10
Total	44	130	6	90

Note that crew members of the vessel, 8 members each, are excluded in the above assignement.

14. IMPLEMENTATION SCHEDULE AND COST ESTIMATION

14. IMPLEMENTATION SCHEDULE AND COST ESTIMATION

14.1 Implementation Schedule

There are four stages in the development of the project, i.e., engineering stage, tendering stage, construction stage, and operation stage. Fig. 14.1.1 shows the overall implementation schedule during the project year. The major work items of each stage are shown in the following table.

Stages	Period	Work Items and Executing Agencies in Operation
1. Engineering	3 years	Survey for and design of the locks, ports, vessels and navigational aiding signals/markers, preparation of tender documents and budget allocation
2. Tendering	1 year	Tendering of the locks, ports, vessels and navigational aiding signals/markers, the corresponding evaluation and selection of the contractors
3. Construction	3 years	Construction of the locks for 3 years, of the ports for 2 years, of the navigational aiding signals/markers for a year and of the vessels for 10 years
4. Operation		Vessels : private firms Locks : Hydro Electric Company of Sao Francisco, as abbreviated CHESF Ports : related city/town/village councils Channel : the North-east Channel Authority at Sao Luis city , as abbreviated AHINOR

14.2 Cost Estimation

(1) Basic Assumptions

1) The basic unit cost data obtained from the market price in September 1994 is used for the estimation. The exchange rate of R$ 0.86 = US$ 1.00 in September 1994 is also used.
2) No price escalation thereafter is considered.
3) Handling and storing facilities of agricultural products, such as loaders, unloaders, silos, etc., are not included in the estimates. Such investments shall be dued by the producers.
4) Eight crew members on board is assumed for a vessel for manoeuvring.
5) Five percent of interest per annum is assumed for the fabrication.
6) Engineering servicing fees of about 10 percent of total construction cost is included.
7) Physical contingency is 5 percent of the total construction cost.

(2) Project Cost

Table 14.2.1 Project Cost in Each Scenario

Unit : US$

Project	Scenario 1	Scenario 2	Scenario 3	Scenario 4
A. Construction and Procurement Cost				
1 Lock Resumption	15,480,000	15,480,000	15,480,000	15,480,000
2 Port Construction	57,130,000	46,200,000	33,920,000	46,200,000
3 Vessel Procurement	60,420,000	52,440,000	35,340,000	45,600,000
4 Navigation Aids	830,000	360,000	200,000	360,000
sub-total	133,860,000	114,480,000	84,940,000	107,640,000
B. Engineering Fee	13,380,000	11,442,000	8,490,000	10,760,000
C. Physical Contingency	6,760,000	5,778,000	4,370,000	5,400,000
Total	154,000,000	131,700,000	97,800,000	123,800,000

Source : JICA Study Team

(3) Running Cost for the Vessel Operation

Table 14.2.2 shows the running cost of vessel operation in 2010 and office administration costs for vessel operation, port operation, and river maintenance for each scenario.

Table 14.2.2 Running Cost in each Scenario

Unit : US$

		Scenario 1	Scenario 2	Scenario 3	Scenario 4
1	Vessel Operation Cost	13,207,600	10,777,800	7,263,300	7,812,000
2	Office Administration Cost				
	1) Vessel Operation Office	2,802,000	1,809,600	1,148,400	1,589,200
	2) Port Operation Office	4,131,600	2,776,800	1,820,400	2,458,000
	3) River Management Office	2,961,600	1,736,400	1,574,400	1,682,400
	Subtotal	9,895,200	6,322,800	4,574,400	5,729,600
	Total	23,102,800	17,100,600	11,837,700	13,541,600

Source : JICA Study Team

Fig. 14.1.1 Implementation Schedule