10.2 Master Plan for Handling Conventional Cargo

10.2.1 The Basic Concept of Modernization for the West Quay

In making the Master Plan for the west quay, the following various aspects concerning the port modernization are recognized:

- Present Conditions of the Berth Usage at the West Quay
  In 1991/1992, the berth occupancy rate of ten berths at the west quay which received mainly conventional vessels (87% of the total number at the west quay) and partly container vessels (13%) reached the value of 78%. In recent years the volume of conventional cargoes handled at the west quay has shown a downward trend reflecting the progress of containerization, and according to the result of the demand forecast (see Chapter 8), the volume of conventional cargo handled in the stage of the Master Plan will almost remain at the same level as at present. Furthermore, fully-cellular container vessels, some of which are presently received at the west quay, are planned to be received only at the east quay in the stage of the Master Plan as a result of the modernization of the east quay and the subsequent reduction of the total container number from the present level of 1.3 million TEUs to one million TEUs. This means all ten berths will be exclusively used by conventional vessels. Thus, the usage conditions of the west quay are expected to remain almost the same as at present without preparation of additional berths in the Master Plan.

- Mixed Usage of Sheds and Open Yards behind the Berths
  The sheds and open yards behind the berths at the west quay are presently used both for conventional and container cargoes, resulting in congested conditions. Such congestion is expected to be remarkably improved as a result of the complete separation of conventional and container cargoes based on the modernization plan for container-handling in Bangkok Port mentioned in Section 10.1.

- Traffic Congestion on the Roads behind the Berths
  Presently, serious traffic congestion is found on the roads behind the berths at the west quay due to intricate movements of various kinds of vehicles such as ordinary trucks, tractor-chassis units for containers, passenger cars and motorcycles. Passenger cars and trucks waiting for receiving import cargoes which are parking along the existing roads narrow the effective widths of the roads and also cause traffic congestion. Such congestion is expected to be

improved by the complete separation of conventional and container cargoes based on the modernization plan for container-handling and preparation of parking lots at proper places. The existence of various offices without direct linkage with cargo-handling operations inside the port also contributes to the traffic congestion.

- Warehouses and Open Yards Outside the Port
  Presently, there is the In-transit Warehouse and the Import Steel Open Storage outside the customs fences and near the Checking Post 1. The warehouse is mainly used for storing cargoes for Laos. The open yard is used for storing steel products.

- Dockside Cranes for Handling Conventional Cargo
  Although the 12 rail-mounted dockside cranes are installed on the apron of the west quay, almost all conventional cargoes are dis-charged or loaded by their own ship cranes or derrick cranes with-out using the dockside cranes. The reason is that the lifting capacities of those dockside cranes are small, in the range of 3-5 tons, and almost all conventional vessels are equipped with their own cranes with sufficient lifting capacities. In case of lighters/barges or lifting heavy cargoes, floating cranes or mobile cranes are used. Hence, the existing dockside cranes are a hindrance to dockside operations.

- Location of the Existing Warehouses and Open Yards for Dangerous Cargo
  The existing warehouses and open yards for dangerous cargoes are located along the boundary between the port and outside areas, namely customs fences without a sufficient buffer zone.

- Present Railway Operations inside the Port
  Presently, conventional cargoes such as bales of rubber are discharged from railway wagons at the east quay.

According to the above, the following concept of modernization for handling conventional cargo at the west quay is proposed in line with the modernization for container-handling at the east and west quays.

- Usage of Berths at the West Quay Exclusively for Conventional Vessels
  The berths at the west quay will be used exclusively for conventional vessels.

- Rearrangement of Usage of the Existing Sheds, Warehouses and Open Storage Yards for Conventional Cargo

The existing sheds No.1-No.6 and open storage yards behind them will be used exclusively for storing conventional cargo as a result of the modernization of container-handling and subsequent withdrawal of container cargoes from those sheds and open yards. Furthermore, along with the decrease of LCL cargoes, the existing Sheds Nos. 15-17 presently used for container-handling operations will be converted for use of conventional cargoes. Thus, cargoes which are presently stored at In-transit Warehouse and Import Steel Open Storage Yard outside the Checking Post 1 will be able to be stored inside the port. It is also proposed to convert the existing sheds No.7-No.9, the bonded warehouse and supplementary sheds behind sheds No1-No9 into open storage yards. The demolition of sheds No.7-No.9 to convert them into open yards is expected to improve efficiency of handling bulk cargo such as steel products. Such rearrangement of the usage of the existing sheds and yards will result in a reduction of traffic congestion in and around the port by streamlining cargo movements.

- Rearrangement and Expansion of the Existing Port Roads
  Corresponding to the above modernization of the port, rearrangement and expansion of the existing port roads is proposed. To expand the port roads, some of the existing offices must be transferred. Site of the existing supplementary shed No.1 will be used for the offices to be transferred.

- Dismantlement of the Existing Dockside Cranes
  It is proposed to dismantle the existing rail-mounted dockside cranes that are left without being used and hinder dockside operations.

- Relocation of the Existing Warehouses for Dangerous Cargo
  The existing warehouses for dangerous cargo will be transferred to a place with a sufficient buffer zone by expanding the present area for the storage beyond the existing customs fences. Open storage yards for dangerous cargo will be expanded and enclosed by buffer zone. Cotton, a type of dangerous cargo, which is presently stored in and around supplementary shed No.1 will be stored in the above area.

- Transferring Railway Operations to the West Quay
  Considering conventional cargoes are mainly transported by railways and that even in the future such conditions are expected to remain unchanged, it is proposed to transfer railway operations from the east quay to the west quay.

- Preparation of Parking Lots for Passenger Cars and Trucks/Chassis
  It is proposed to prepare a parking lot for passenger cars and trucks/chassis at the land near the Checking Post 2 that faces the Phra Kanong Canal so as to reduce traffic congestion inside the port. In that case, it is advisable to construct a flyover bridge for pedestrians connecting the parking lot with the inside the port. A parking lot for passenger cars will be prepared near Check-ing post 1. Moreover, a parking lot for trucks/chassis will be prepared behind the yard for dangerous cargo. The parking lot is allocated outside of the customs fences.

- Transferring the Offices Having no Direct Linkage with Cargo-Han-dling Operations
  It is proposed to transfer the offices that have no direct linkage with cargo-handling operations so as to reduce the traffic congestion inside the port.

10.2.2 Usage Plan for the Existing Storage Facilities

(1) Movements of Conventional Cargoes

To reveal movements of conventional cargoes within the west quay and pro-pose a usage plan for the existing storage facilities in the stage of the Master Plan, a computer simulation was conducted. In the simulation, the actual statistical distribution forms for ship arrivals and berthing periods at the west quay were used. Conventional vessels calling at the west quay are divided into two categories: vessels laden with various kinds of cargoes and vessels laden with steel products referring to the actual berthing records. The following premises are adopted considering the records of actual operations:

- Conventional vessel laden with various kinds of cargoes
  - Total volume of cargoes discharged: 1,029,000 tons
  - Average cargo-handling volume: 3,800 tons per vessel
  - Number of calling vessel: 271 vessels per year
  - Weighed gross cargo-handling productivity: 37 tons/hr/vessel
    - Shares between barge side and land side: 70%:30%
    - Barge side: 33 tons/hr/vessel (the same as the present one)
    - Land side: 45 tons/hr/vessel (expected to be improved by reparing transit sheds just behind the berths)
      - Lot size: 0.9 tons/lift
      - Net productivity per gang: 20 lifts/hr/gang
      - operational factor: 0.8

- Average number of gangs per vessel: 3 gangs/vessel
- 0.9 tons/liftx20 lifts/hr/gangx3 gangs/vesselx0.8 = 45 tons/hr/vessel

- Daily working hours: 24 hours (3 shifts)
- Average dwelling time in storage facilities: 7 days
- Storage sheds: 81%; open yards: 19% (mainly vehicles)
- Delivery by truck: 30%; by barge: 70%

- Conventional vessel laden with steel products
  - Total volume of cargoes discharged: 2,880,000 tons
  - Average cargo-handling volume: 5,550 tons per vessel
  - Number of calling vessel: 519 vessels per year
  - Weighed gross cargo-handling productivity: 80 tons/hr/vessel
    - Shares between barge side and land side: 70%:30%
    - Barge side: 70 tons/hr/vessel (the same as the present one)
    - Land side: 100 tons/hr/vessel (expected to be improved by preparing open storage yards just behind the berths)
      - Lot size: 2.0 tons/lift
      - Net productivity per gang: 20 lifts/hr/gang
      - operational factor: 0.8
      - Average number of gangs per vessel: 3 gangs/vessel
      - 2.0 tons/liftx20 lifts/hr/gangx3 gangs/vesselx0.8 = 100 tons/hr/vessel
  - Daily working hours: 24 hours (3 shifts)
  - Average dwelling time in storage facilities: 7 days
  - Storage: open yards: 100%
  - Delivery by truck: 30%; by barge: 70%

Resulting figures of the required areas for cargo storage during peak conditions were obtained from the simulation as follows:

- Required storage areas :
  for sheds: 18,000 sq.m (peak condition)
  for open yards: 62,500 sq.m (peak condition)

In the meantime, the following results were also obtained from the simulation:

- Percentage of berth occupancy: 80.6%
- Traffic volume of trucks each way:
  710 vehicles per day (peak condition)

As shown above, the percentage of berth occupancy in the stage of the Master Plan will remain almost at the same level as at present. To meet the above traffic demand within the port, improvement of the existing port roads is proposed in Chapter 12.

(2) Usage Plan for Sheds

Transit sheds No.1-No.6 with a total storage area of 32,460 sq.m are planned to store conventional cargoes excluding dangerous cargoes to meet the above demand and considering their locations just behind the berths.

Transit shed No.10 and supplementary shed No.2 will be used for auction and storage of overtime cargoes, respectively, as they are at present. Storage in Bonded Warehouse and In-transit Warehouse outside the port are planned to be replaced by that in sheds No.15-No.17. The usage plans for the exist-ing sheds and warehouses are summarized as follows (see Fig. 10-2-1):

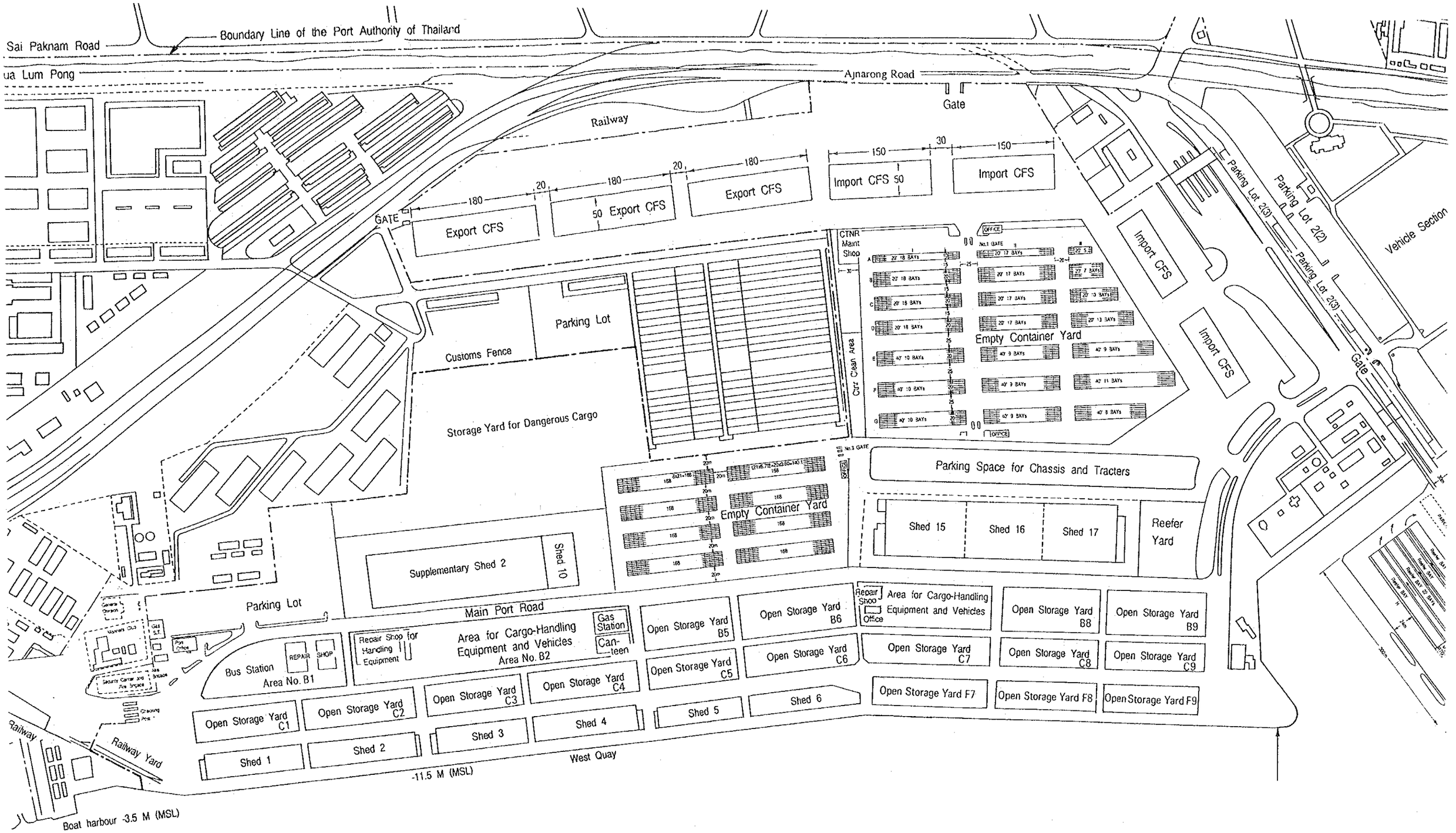


Fig. 10-2-1 Modernization Plan of the West Quay for Handling Conventional Cargo

Existing shed	Floor space (sq. m)	Usage plan in the Master Plan
Transit shed No.1	5,843	Transit shed
Transit shed No.2	5,843	Transit shed
Transit shed No.3	5,843	Transit shed
Transit shed No.4	5,843	Transit shed
Transit shed No.5	4,545	Transit shed
Transit shed No.6	4,545	Transit shed
Total	32,460	
Transit shed No.7	4,690	Conversion to an open yard
Transit shed No.8	4,800	Conversion to an open yard
Transit shed No.9	4,800	Conversion to an open yard
Transit shed No.10	3,550	Auction
Transit shed No.15	9,360	Bonded warehouse for domestic and foreign cargoes
Transit shed No.16	7,800	Bonded warehouse for domestic and foreign cargoes
Transit shed No.17	9,360	Bonded warehouse for domestic and foreign cargoes
Supplementary shed No.1	12,480	Conversion to office, parking lot, and road space
Supplementary shed No.2	20,280	Storage for overtime cargoes
Supplementary shed No.4	2,000	Conversion to an open yard
Supplementary shed No.5	2,000	Conversion to an open yard
Supplementary shed No.6	2,000	Conversion to an open yard
Supplementary shed No.7	2,000	Conversion to an open yard
Supplementary shed No.9	2,000	Conversion to an open yard
In-transit Warehouse	9,600	Conversion to commercial use

(3) Usage Plan for Open Storage Yards

Open storage yards with a total area of 118,600 sq.m are planned to store bulky cargoes such as steel products and vehicles so as to meet the above demand and considering their locations near the berths. The existing transit sheds No.7-No.9 and supplementary sheds No.4-No.9 will be demolished and converted into open yards to achieve efficient operations for handling the above bulky cargoes. Furthermore, storage in Import Steel Open Storage Yard outside the port is also planned to be replaced by the open storage yards near the berths mentioned above. Such replacement will streamline the present intricate cargo flow in and around the port. The existing open storage yards will be rearranged by the new port roads. Their areas are shown as follows (see Fig. 10-2-1):

Open Storage Yard	Floor space (sq. m)
Open storage yard No.F7	6,928
Open storage yard No.F8	5,840
Open storage yard No.F9	5,800
Open storage yard No.C1	6,660
Open storage yard No.C2	7,110
Open storage yard No.C3	6,300
Open storage yard No.C4	7,200
Open storage yard No.C5	5,985
Open storage yard No.C6	7,528
Open storage yard No.C7	8,248
Open storage yard No.C8	6,570
Open storage yard No.C9	6,525
Open storage yard No.B5	8,512
Open storage yard No.B6	10,752
Open storage yard No.B8	9,344
Open storage yard No.B9	9,280
Total	118,582

10.2.3 Storage Plan for Dangerous Cargoes

(1) Storage Plan for Cotton

Though cotton is a type of dangerous cargo, it is presently stored in and around supplementary shed No.1 apart from the existing dangerous cargo warehouses. In the Master Plan, cotton is planned to be stored at the new dangerous cargo yard together with other dangerous cargoes so as to ensure safe storage by concentrating dangerous cargoes in one place with a sufficient buffer zone. The actual record of cotton handled in 1992 is shown as follows:

- Volume of cotton handled per annum:
    - Total: 236,880 tons (100.0%); 15,000 TEUs
    - Conventional: 11,840 tons (5.0%)
    - FCL containers: 112,520 (47.5%); 7,500 TEUs
    - LCL direct delivery: 112,520 (47.5%); 7,500 TEUs

In the stage of the Master Plan, it is assumed that containers which are presently categorized into LCL direct delivery will be converted into FCL containers from the standpoint of swift and safe operations of dangerous cargoes. Storage plan for cotton in 2005 is summarized as follows:

- Volume of cotton to be handled per annum:
    - Total: 185,010 tons (100%); 11,540 TEUs
    - Conventional: 11,900 tons (6.4%)
    - FCL containers: 173,110 (93.6%); 11,540 TEUs

- Storage capacity in a shed: 1.5 tons/sq.m
- Effective floor space for storage: 50%
- Operational factor: 0.75
- Peaking factor: 2.0
- Average dwelling time:
    - Conventional: 7 days
    - Containers: 3 days
- Required floor space of a shed:
  11,900 tons/365 daysx7 daysx2.0/(1.5 tons/sq.m)/0.5/0.75 = 811 sq.m
- Required yard area for container-stacking:
  11,540TEUs/365daysx3 daysx2.0/(0.0212TEU/sq.mx2high)/0.75 = 5,970sq.m

(2) Storage Plan for Dangerous Cargoes Excluding Cotton

The actual record of dangerous cargoes excluding cotton handled in 1992 is shown as follows:

- Volume of dangerous cargoes handled per annum:
    - Total: 312,600 tons (100.0%); 24,750 TEUs
    - Conventional: 15,630 tons (5.0%)
    - Real LCL: 25,010 tons (8.0%); 2,080 TEUs
    - FCL containers: 57,830 tons (18.5%); 4,820 TEUs
    - LCL direct delivery: 57,830 tons (18.5%); 4,820 TEUs
    - FCL direct delivery: 156,300 tons (50.0%); 13,030 TEUs

In the stage of the Master Plan, it is assumed that containers which are presently categorized into LCL direct delivery will be converted into FCL containers. Storage plan for dangerous cargoes excluding cotton in 2005 is summarized as follows:

- Volume of dangerous cargoes handled per annum:
    - Total: 244,080 tons (100.0%); 19,040 TEUs
    - Conventional: 15,630 tons (6.4%)
    - Real LCL: 19,240 tons (7.9%); 1,600 TEUs
    - FCL containers: 88,980 tons (36.4%); 7,420 TEUs
    - FCL direct delivery: 120,230 tons (49.3%); 10,020 TEUs

- Storage capacity in a shed: 1.5 tons/sq.m
- Effective floor space for storage: 30%
- Operational factor: 0.75
- Peaking factor: 2.0
- Average dwelling time:
    - Conventional: 7 days
    - Containers: 3 days
- Required floor space of a shed:
  34,870 tons/365 daysx7 daysx2.0/(1.5 tons/sq.m)/0.3/0.75 = 3,960 sq.m
- Required yard area for container-stacking:
  7,420TEUs/365daysx3daysx2.0/(0.0212TEU/sq.mx2high)/0.75 = 3,840 sq.m

(3) Total Required Area for Storing Dangerous Cargoes

The total required area for dangerous cargoes including cotton is shown as follows:

- Total floor space of sheds: 5,000 sq.m
- Total storage area: 10,000 sq.m

Within the same storage yard, cotton and other dangerous cargo will be stored separately in the respective sheds and/or storing areas. In addition to the above storage areas, areas for buffer zone, passage for tractor-chassis units/trucks, offices, etc. need to be prepared in the dangerous cargo yard.

10.2.4 Area for Cargo-Handling Machines

In the existing areas relevant to cargo-handling machines, various facili-ties such as repair and maintenance shops, garages, parking lots, offices, and a gas station are located. The areas for the existing facilities in the west and east quays are 42,100 sq.m and 12,400 sq.m, respectively, totaling 54,500 sq.m. In the Master Plan, most of the existing facilities for cargo-handling machines in the west quay will be kept intact. On the other hand, the area for the existing facilities for cargo-handling machines near transit sheds No.11 and No.12 in the east quay will be converted into the marshaling yard for containers, Terminal No.3. Instead, an additional area for cargo-handling machines will be allocated south of transit shed No.15. In the stage of the Master Plan, the following areas the same as the existing areas as a total, will be used for cargo-handling machines (see Fig. 10-1-10):

Area for Cargo-handling Machines	Area (sq. m)
Area No.B1	12,500
Area No.B2	29,800
Area No.B7	12,200
Total	54,500

A gas station for cargo-handling machines and a canteen will be prepared within the area No.B2. A repair shop with floor space of 1,200 sq.m for container-handling machines and relevant offices will be prepared within the area No.B7.

10.2.5 Parking Lots

Parking lots for passenger cars and trucks/tractor-chassis units will be prepared near Checking Posts 1 and 2. According to the field survey, the number of passenger cars parking inside of the port is estimated to be in the range of 1,500-2,000. Taking account of the current figure and an increase in that in the future, the following parking lots for passenger cars are planned (see Fig. 10-2-1):

- Unit area for a parking lot including passages:
  - Passenger car: 18.0 sq.m/vehicle
- Parking capacity:
  - Parking Lot No. 2-4 (near Checking Post 2): 22,500 sq.m: 1,250 passenger cars
  - Parking Lot No. 1 (near Checking Post 1): 24,200 sq.m: 1,340 passenger cars
  - Total capacity: 2,590 passenger cars

A gas station for passenger cars and a canteen will be prepared adjacent to the parking lot near Checking Post 1.

On the other hand, the required area of parking lots for trucks (mainly for ETO) which wait there before receiving import cargoes is estimated as follows:

- Number of arrivals of trucks to receive import loose cargoes in peak conditions:
  - LCL cargoes at Import CFSs: 660 arrivals/day
  - Conventional cargoes at sheds No. 1-No. 9 or open storage yards: 710 arrivals/day
- Average number of daily arrivals per one truck to deliver cargoes to the hinterland of the port: 3 trips/day/truck

- Total required parking capacity:
  (660+710)(arrivals/day)/3(arrivals/day/truck) = 450 trucks
- Unit area for a parking lot including passages:
  - Truck/tractor-chassis units: 91.0 sq.m/vehicle
- Parking capacity:
  - Parking Lot No. 2-1: 16,700 sq.m: 180 trucks
  - Parking Lot No. 2-2: 7,960 sq.m: 90 trucks
  - Parking Lot No. 3 (behind the dangerous cargo yard): 13,300 sq.m: 150 Trucks
  - Total planned capacity: capacity: 420 trucks

To connect Parking Lot Nos. 2-1 and 2-2 near Checking Port 2 with the port by means of a short cut, an additional gate will be prepared near Parking Lot No. 2-3 (see Fig. 10-2-1). Signals must be installed at the intersection crossing with the common road and the siding railway outside the port running along the customs fence. The new gate will be mainly used for trucks requiring access to sheds No.1-No.6 or the open storage yards at the west quay to receive import conventional cargoes. Trucks to receive LCL cargoes at the Import CFSs are planned to arrive there along Ajnarong Road without passing through the above new gate.

Furthermore, a parking lot for tractor-chassis units from outside of the port will be prepared as follows:

- Parking Lot No. 2-3: 3,070 sq.m: 80 tractor-chassis units (270m/3.25m)

It is planned to transferred Vehicle Section to an area neighboring Parking Lot No.2 near Checking Post 2 from the present area near Checking Post 1. Facilities containing a parking lot for vehicles including commuter buses, an office building, repair shops, a gas station and a canteen will be prepared within the new area of 46,640 sq.m for Vehicle Section.

10.2.6 Area for Offices near Checking Post 1

Along with relocation of Checking Post 1 and the port road through the post, the following offices must be also relocated:

	Floor space (sq.m)	Planned number of stories	Required site area (sq.m)
Fire Station	250	2	125
Common use building	2,300	3	767
Import Examination	(900)		
Export Inspection	(250)		
Harbor Section	(400)		
Others	(500)		
Craft Service	(250)		
Total	2,550		892

10.2.7 Railway yard

As mentioned in Section 10.2.1, the railway operations presently conducted at the east quay are planned to be transferred to west of the west quay. The actual record of cargoes which were delivered/received to/from the hinterland of the port by using siding railways in the port in 1992 is shown as follows:

- Volume of cargoes handled per annum by commodity:
  - Export:
    - Total: 45,592 tons (100.0%)
    - Raw rubber: 41,243 tons (90.5%)
    - Tobacco: 3,666 tons (8.0%)
    - Others: 684 tons (1.5%)
  - Import: 1,778 tons

- Volume of cargoes handled per annum by package type:
  - Export:
    - Total: 45,592 tons (100.0%)
    - Break bulk: 41,945 tons (92.0%)
    - Container: 3,647 tons (8.0%)
  - Import:
    - Total: 1,778 tons (100.0%)
    - Break bulk: 1,529 tons (86.0%)
    - Container: 249 tons (14.0%)
- Number of containers handled per annum including containers:
  - Export: 2,305 TEUs
  - Import: 2,043 TEUs
- Arrival frequency on the average: 2 times/day
- Typical length of railway wagons:

- Covered wagon: 6 m
- Flat car (bogey): 12 m (for loading containers of 2 TEUs)

- Average volume of laden cargo per one covered wagon:
  14 tons (in case of raw rubber bales)

In the stage of the Master Plan, the following conditions are adopted to estimate the required scale of the railway yard at the west quay considering the present operations and the reduction of the number of containers through the port from the present level to one million TEUs in 2005:

- Volume of cargoes handled per annum by package type:
  - Export:
    - Total: 35,070 tons (100.0%)
    - Break bulk: 32,265 tons (92.0%)
    - Container: 2,805 tons (8.0%)
  - Import:
    - Total: 1,368 tons (100.0%)
    - Break bulk: 1,176 tons (86.0%)
    - Container: 192 tons (14.0%)
- Number of containers handled per annum including empty containers:
  - Outbound: 1,773 TEUs
  - Inbound: 1,572 TEUs
- Daily peaking factor: 2.71 (refer Section 10.1.6 (3))
- Average volume of laden cargo per one covered wagon: 14 tons
- Number of covered wagons laden with break bulk cargo arriving at the railway yard a day during peak condition:
  32,265 tons/365 days x 2.71/(14 tons/wagon) = 17 covered wagons/day
- Number of flat cars laden with containers arriving at the railway yard a day during peak condition:
  1,773 TEUs/365 days x 2.71/(2 TEUs/wagon) = 7 flat wagons/day
- Composition of unit trains:
  - Covered wagon: 17 wagons/unit train
  - Flat car: 7 wagons/unit train
- Gross cargo handling productivity:
  - Break bulk cargo discharged from covered wagons: 0.85 hrs/wagon
  - Container box: 20 boxes/hr
- Number of gangs:
  - Break bulk: 2 gangs/unit train
  - Container: 1 gang/unit train
- Time for connecting/disconnecting a locomotive: 0.5 hr each

- Turnaround time per one unit train:
  - Unit train of covered wagons:
    17 wagons/unit train x 0.85hr/2 gangs (export)+0.3hr(import)+1hr = 8.5 hrs/unit train
  - Unit train of flat cars:
    0.5hr (outbound) + 0.4hr(inbound) + 1hr = 1.9 hrs/unit train

According to the above results, two unit trains are expected to arrive at the new railway yard to be prepared at the west quay; they will be composed of covered wagons and flat cars, respectively. Judging from the total turnaround time of 9.4 hours of the two unit trains, it is necessary to install one siding railway line of an effective length of 110 meters of which both ends must be connected to the existing siding railway line running along the customs fence and in the direction of the apron at the west quay.

Between the existing and new railway lines, a 20 meter wide yard for discharging/loading break-bulk or container cargoes from/into railway wagons will be prepared. Another a 20 meter wide yard for discharging/loading containers or break bulk cargoes from/into railway wagons will also be prepared behind the new railway line. Container cargoes brought into the port in break-bulk condition by railway covered wagons can be stuffed directly from the railway wagons to container boxes on chassis which are laid in touch with the railway wagons. Adding space necessary for installing railway tracks, the resulting dimensions of the railway yard are as follows:

- Length: 110 m
- Width: 50 m
- Area: 5,500 sq.m

The existing railway line which will face the 20 meter wide yard can receive a unit train laden with cargoes loaded/discharged at the above railway yard because trains toward the apron of the west quay will be expected to seldom pass on the line as at present. Thus, after the preparation of the new siding railway line, mostly two lines are expected to be available to receive the above mentioned unit trains.

10.2.8 System for Handling Conventional Cargo

(1) Handling of Steel Products

As mentioned previously, presently, imported steel products are discharged onto barges or directly onto trucks at the west quay of Klong Toei wharf. In the latter case, steel products are hauled to Import Steel Open Storage Yard outside the port. In case of

direct discharging onto trucks, the cycle time of cargo-handling is considerably long because it is not easy to lay down heavy steel products on a truck deck. That causes inefficient cargo-handling operations. To improve such inefficient operations on land side, it is proposed to prepare sufficient open storage yards behind berths of the west quay in the stage of the Master Plan. By the preparation of the above open storage yards, steel products can be discharged directly on the apron of the berths and then lifted and moved to the open yards by forklift (around 8 ton capacity) equipped with an attachment for a specific packing type such as bundle, sheet and coil.

In case that steel products are discharged on the apron near open yards No.F7-No.F9, the products can be received and moved to the yards by one-two forklifts. If the steel products are discharged on the apron near sheds No.1-No.6, the products need to be hauled from the apron to the open yards behind the sheds. In that case, swift operations can be achieved by laying down steel products on the apron once and then moving them onto trucks by forklifts.

Swift cargo-handling operations can also be achieved by using forklifts (around 5 ton capacity) inside ships' holds. It is also effective for the swift operations to introduce conventional vessels equipped with ship cranes of a lifting capacity over 10 tons. By adopting these measures, a lifting lot size could be increased from the present level of 2-3 tons to around 5 tons, resulting in swift operations.

On the contrary, as to discharging on a barge side, it seems difficult to improve cargo-handling productivity from the present level as long as small barges are used as at present.

(2) Handling of Various Kinds of Cargoes Stored in Sheds

As to the conventional cargoes excluding steel products, there are various kinds of package types such as bag, pallet, carton, roll, drum, barrel and wooden case. Such disunity of the package types of conventional cargoes causes low cargo-handling productivity. To improve the cargo-handling productivity, it is necessary to promote unitization of the package type such as containerization, palletization and use of returnable flexible big bags.

Both steel products and imported conventional cargoes excluding steel products are presently discharged onto barges or directly onto trucks at the west quay of Klong Toei wharf. In the latter case, those cargoes are once stored in transit sheds just behind the berths.

Swift cargo-handling operations can be achieved by using forklifts inside ships' holds as the case of steel products. It is also effective for the swift operations to introduce conventional vessels equipped with ship cranes. By adopting these measures, a lifting lot size could be increased from the present level of around 1 tons, resulting in swift operations. It is also effective to use appropriate slings for lifting cargoes for efficient handling.

As to discharging on a barge side, it seems also difficult to improve cargo-handling productivity from the present level as long as small barges are used as at present.

(3) Required Number of Forklifts

1) Forkl:fts

- Number of gangs per vessel: 3 gangs
  - Land side: 1 gang
  - Barge side: 2 gangs
- Total Number of vessels at berths in peak conditions: 10 vessels
  - Number of Vessels laden with steel products: 7 vessels
  - Number of Vessels laden with various kinds of cargoes: 3 vessels
- Required number of forklifts for handling steel products:
  - Forklifts for receiving on the apron (5-10 tons):
    2 units/gang x 1 gang/vessel x 7 vessels x = 14 units
  - Forklifts for delivery at the open yards (5-10 tons):
    2 units/gang x 7 gangs = 14 units
  - Forklifts in holds of a ship (5 tons):
    1 unit/hold x 2 holds / vessel x 7 vessels x = 14 units
    (One unit of forklift is assumed to be prepared by a vessel)
- Required number of forklifts for handling various kinds of cargoes:
  - Forklifts for receiving on the apron (3 tons):
    2 units/gang x 1 gang/vessel x 3 vessels x = 6 units
  - Forklifts for delivery at transit sheds No.1-No.6 (3 tons):
    2 units/gang x 3 gangs = 6 units
  - Forklifts in holds of a ship (3 tons):
    1 unit/hold x 2 holds / vessel x 3 vessels x = 6 units
    (One unit of forklift is assumed to be prepared by a vessel)

2) Tractor-trailer units/trucks hauling steel products at dock side

- Average velocity of a tractor-trailer within the port: 15 km/hr

- Average haul distance per cycle within the west quay: 1.0km
- Cycle time of lift on and lift off: 6 minutes
- Total cycle time of the operation: 10 minutes
- Cycle time of a ship crane/derrick crane: 3 minutes
- Operational factor: 0.7
- Number of vessels: 7 vessels
- Number of gangs at land side: 1 gang/vessel

Thus, the required numbers of machines for handling conventional cargoes in the stage of the Master Plan are summarized as follows:

	Required Nos.
- Forklifts (5-10 tons)	28
- Forklifts (5 tons)	14
- Forklifts (3 tons)	18
- Tractor-trailers/trucks	33

10.2.9 Usage Plan of PAT's Dolphins and Buoys

In considering a usage plan of Klong Toei and Bang Hua Sua dolphins, and Sathu Pradit buoys of PAT, the following various aspects are recognized:

- Commodities Loaded or Discharged at PAT's Dolphins and Buoys
  Klong Toei and Bang Hua Sua dolphins, and Sathu Pradit buoys of PAT receive conventional vessels onto which exports are loaded from barges onto ocean-going vessels or conversely from which imports are discharged onto barges from ocean-going vessels. Main export commodities are agricultural products such as tapioca, rice and maize. As to loading those export commodities, PAT's dolphins and buoys, however, are not the sole means. For example, a great part of tapioca is loaded at Siracha anchorages off Bangkok bar channel. Some portion of tapioca is loaded at private wharves on the river side of Chao Phraya River or PAT's dolphins/buoys. A great part of rice is loaded at private wharves on the riverside of Chao Phraya River. Some portion of rice is loaded at PAT's dolphins or buoys. Maize is mainly loaded at private wharves or PAT's dolphins/buoys.

  On the other hand, main import commodities discharged at PAT's dolphins/buoys are bulk cargoes such as steel products and wood. Those import commodities are discharged not only at PAT's dolphins/buoys but at Klong Toei wharf. Some portion of those commodities are discharged at

private wharves or the anchorages at Siracha.

- Cargo-Handling Capacity of the Dolphins and Buoys
  According to the actual cargo-handling records at Klong Toei dol- phins in 1991/1992, the average gross cargo-handling productivity of the dolphins is 33 tons per hour per vessel. There are seven berths at Klong Toei dolphins and their berth occupancy rate in the same period on an average reached around 90%, showing saturated conditions. By adopting the above figures, cargo-handling capaci-ties of the berths at the dolphins and buoys per annum are estimat-ed as follows:

Name of berths	Number of berths	Cargo-handling capacity (tons/year)
Klong Toei dolphins	7	1,820,000
Bang Hua Sua dolphins	8	2,080,000
Sathu Pradit buoys	5	1,300,000
Total	20	5,200,000

In 1991, imports of 2.3 million tons were discharged at the PAT's dolphins/buoys, accounting for 15% of the total conventional cargoes received at Bangkok Port. The remaining portion was discharged at Klong Toei wharf (25%) and private wharves (60%). On the other hand, in 1990, the volume of exports loaded at PAT'S dolphins/buoys is estimated as 2.9 million tons on the assumption that the above dolphins/buoys were used in saturated conditions through the year. The volume accounts for 15% of the total conventional cargoes shipped from Bangkok Port. The remaining portion was shipped from private wharves (85%).

As to conventional cargoes handled at PAT's dolphins/buoys, the volume of imports has increased year by year. Considering the fact that the dolphins/buoys have been used in almost saturated conditions, such an increase in the volume of imports seems to have been achieved by replacing some portion of exports by imports.

According to the above, the following usage plan for handling conventional cargoes at PAT's dolphins/buoys in the stage of the Master Plan is proposed as follows:

- Usage of the Dolphins/Buoys for both Imports and Exports

  Considering that the volume of imports received at the dolphins/buoys has

increased by replacing exports handled there, and a great portion of conventional export cargoes are shipped from private wharves or Siracha anchorages, as opposed to imports in which a considerable portion is discharged at public facilities of PAT, it is proposed that priority be placed on import cargoes in the usage of the dolphins/buoys. As mentioned in Chapter 8, Section 8.7, the volume of import cargoes in 2005 is estimated as 3.5 million tons. Compared with the cargo-handling capacity of 5.2 million tons of the facilities mentioned above, exports of 1.7 million tons can be received there in the target year.

10.2.10 Beyond the Target Year of the Master Plan

In this section, the concept of Modernization of Bangkok Port is presented beyond the target year of the Master Plan.

(1) Container-Handling

In the Master Plan with the target year of 2005 proposed in this study, the capacity of the proposed container terminal of Bangkok Port is estimated as one million TEUs in the conditions of using both small and large RTGs, and the capacity is almost the same as the number of those containers which come to Bangkok Port rather than Laem Chabang Port, namely containers for Europe through Singapore, etc. Beyond the target year of the Master Plan, however, the forecast number of containers is expected to exceed the above capacity of one million TEUs per annum of the container terminal along with the future development in and around the Bangkok Metropolis. In the distant future, the present traffic conditions in Bangkok Metropolis might be improved by the preparation of road and railway infrastructures such as road express ways, subways, etc. If such improvement of the traffic conditions in Bangkok Metropolis is realized, it might be required to increase the capacity of the container terminal beyond one million TEUs per annum. In such a case, the capacity could be increased by introducing larger RTGs instead of the existing small RTGs.

(2) Handling conventional cargo

Beyond the target year of the Master Plan, demand of handling conventional cargoes at PAT's berths comprising Klong Toei wharf and the dolphins/buoys mentioned above is also expected to exceed the capacity of conventional berths as long as the barge-side handling is predominant over land side handling as at present. To increase the capacity of handling conventional cargoes, it is necessary to promote land side handling. If such promotion is realized, it is proposed to take necessary countermeasures to increase

cargo-handling productivities. From this standpoint, it is advisable to study the following measures:

- Further demolition of transit sheds to prepare open storage yards just behind the berths
- Feasibility of introducing dockside cranes with heavy lifting capacity
- Promotion of introducing conventional vessels with ship cranes of heavy lifting capacity

If conventional berths can be converted into container berths by the above increase of cargo-handling productivity, it is also possible to increase container-handling capacity of Bangkok Port from one million TEUs.

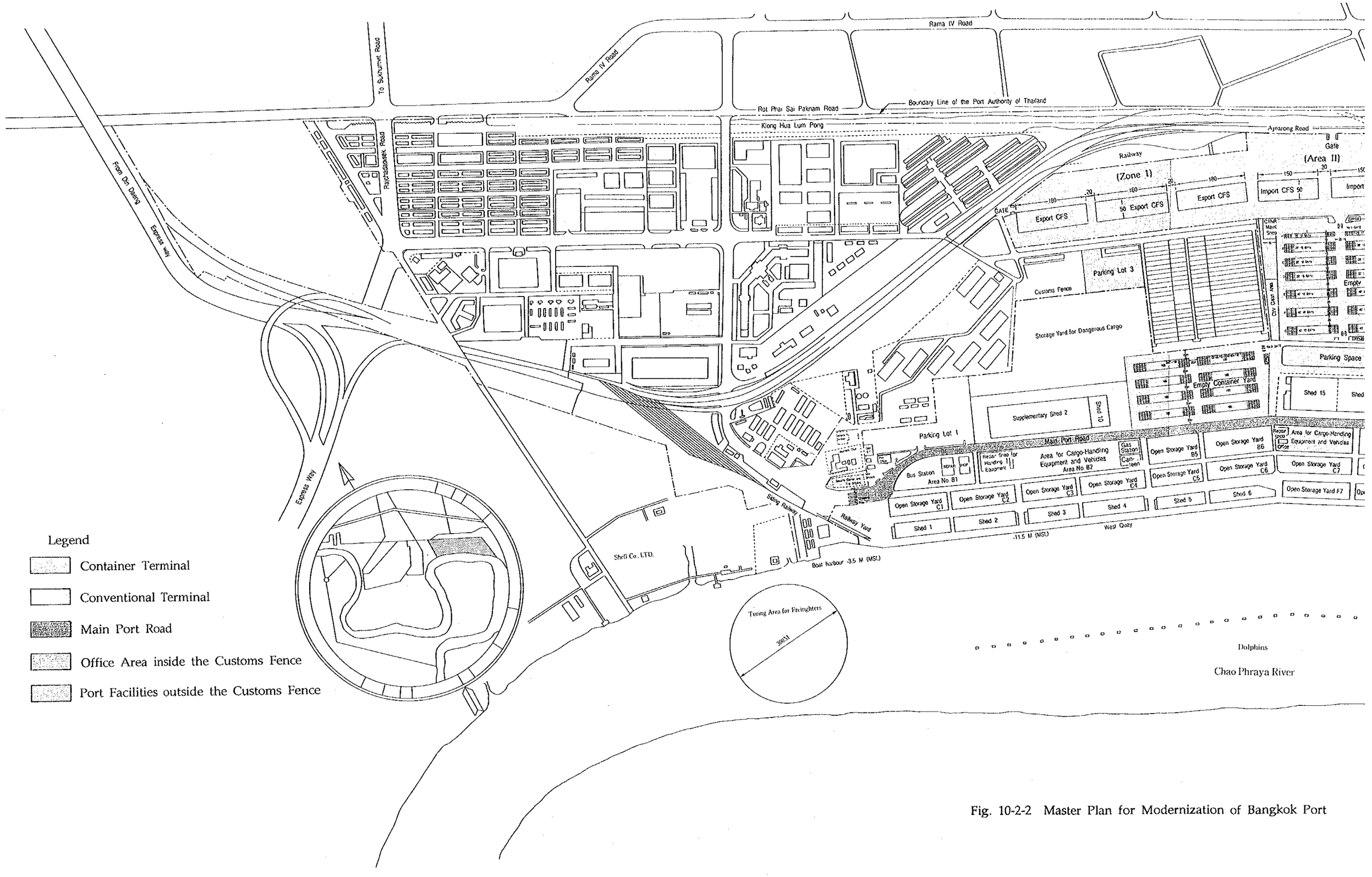


Fig. 10-2-2 Master Plan for Modernization of Bangkok Port

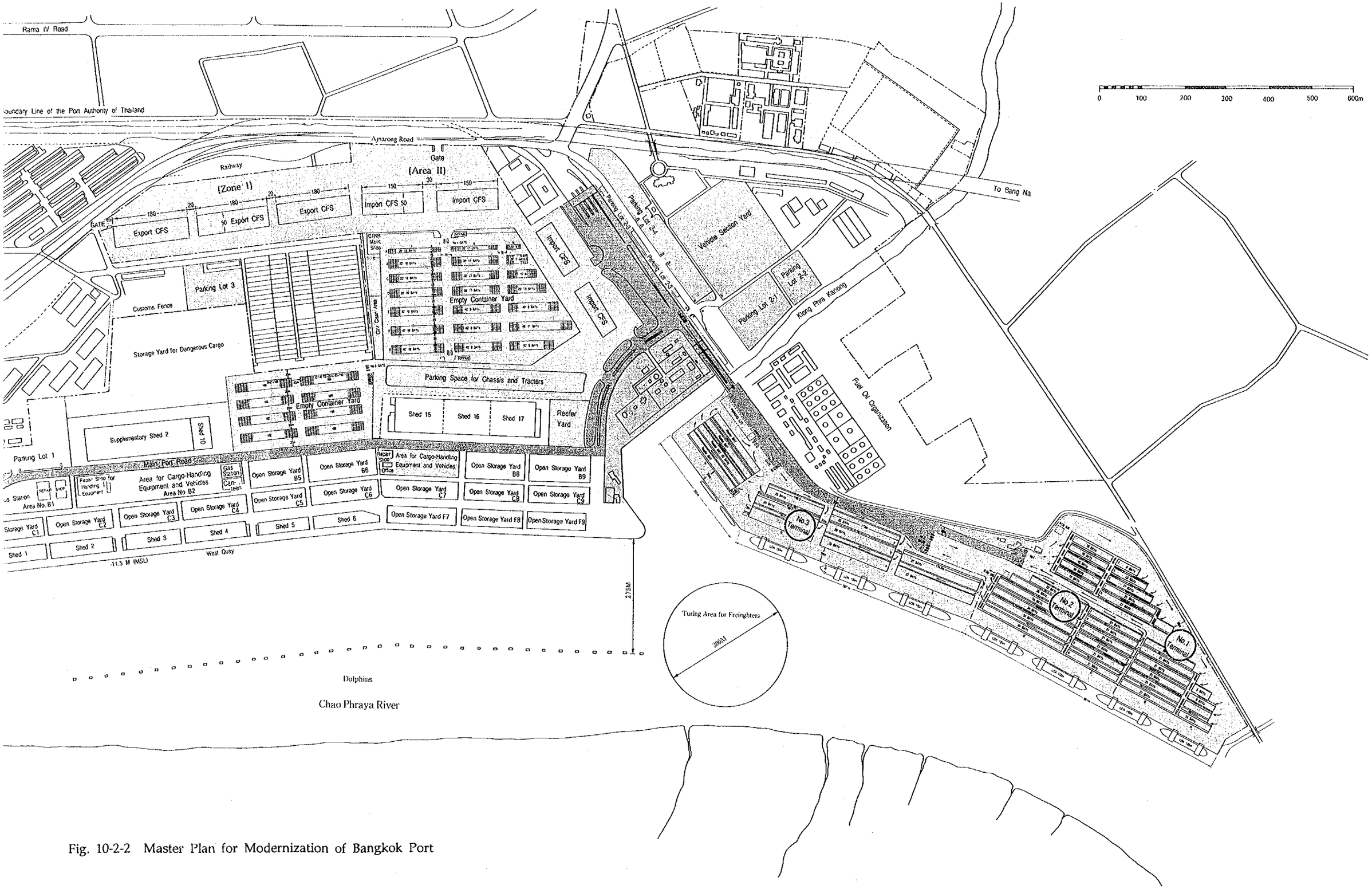


Fig. 10-2-2 Master Plan for Modernization of Bangkok Port

10.3 Master Plan relevant to the Waterway-Widening the Bar Channel

The waterway from the Bangkok Bar Pilot Station to the Inner Port through the bar channel and river channel is detailed in Chapter 6.8;

- a far leg of 25 mile which takes more than four hours sailing by seagoing vessel
- a restricted waterway either in terms of depth or width
- a meandering waterway with inherent sharp bends
- a highly congested waterway with seagoing / coastal service / fishing / lighters in tow and miscellaneous vessels
- a falling tide likely generates currents greater than three knots during spring tide
- navigational obstacles such as fish stakes project in close proxim-ity to the fairway.

The layout of the waterway is such that ship handler are continuously confronted with inconvenient or even hazardous conditions.

Though countermeasures to control sea accidents, e.g. navigational aids such as transit leading lights indicating center line of the fairway and lateral light buoys indicating boundary of the fairway, are properly arranged, maintenance dredging has been periodically executed, and compulsory pilotage for all vessels more than 50m long is being enforced, according to MOTC's information, 95 cases of collision and 46 cases of sinking are recorded (1983-1992).

Although the report has already mentioned a tendency for calling vessel to increase both in size and number in line with the socioeconomic growth in Bangkok metropolitan area, even if the current vessel traffic were to remain unchanged in future, planning a strategy for preventing loss of lives and property from sea accidents is an important issue for Bangkok port. Accordingly, to improve the present hydrographical conditions, we feel that the following factors should be borne in mind;

- Any improvement works pertaining to the river channel between the estuary and the inner port will not be feasible
- Improving present bar channel conditions between the entrance buoy and the

estuary is strongly urged among users, and a problem recog-nized by the authority concerned as well. Accordingly, widening the navigable width, dredging a new channel for lighters use, straightening the curved channel line, and deepening the channel have been studied. Among these countermeasures, widening the stretch sections from 100m to 135m is being adopted as an action programme.

- although we support the above widening plan of 135m, fundamentally, we recommend widening the stretch to 150m, as a better, feasible and necessary plan for improving the bar channel. Our reasoning is as follows;

1) Assuming that the maximum calling vessel is 172.2m long, 25m wide and drawing 8.23m, which is controlled by the port regulations, the ves-sel's maneuverability while proceeding along the bar channel would worsen considerably.
While a vessel is proceeding on a restricted waterway(narrow and shallow), the smooth flow of water from the bow to the stern is hindered along bottom/sides, and consequently, the mass of the vessel and the additional mass of the water, which being pushed aside, increases remarkably, thus the vessel's ability to adjust speed and turn grows worse.

2) Moreover, the other agent of a restricted waterway known as 'bank suction' affects the behavior of a vessel. When a vessel is moving through a narrow and shallow waterway, she is not always able to keep her position along the center line of the waterway, and thereby is likely to proceed on unsymmetrical water about a vertical plane through this line, consequently, the pressure on the bow on the side of the near bank will cause the bow to be repelled from this bank, whereas the suction on the same side below the bow of the vessel will attract the stern, thus, the vessel would turn and head for the opposite bank. As she approaches the opposite bank the pressure on the bow and the suction will progressively increase and the ship will be slued in the opposite direction. The subse-quent yawing that results-unless it is checked by the helm-increases in amplitude until ultimately the head will strike the bank.

3) Even if the bar channel is widened to 150m, it will be impossible for large vessels to pass each other on the channel because of the lack of safe clearance between two vessels, and from the bank, too.
Avoiding encounters of large vessels by adjusting the arrival/departure time will be the only way around this difficulty.
Furthermore, even when mid-size vessels engage in passing/overtaking on a narrow channel, the repulsive force at approaching stage, followed by suction force at parallel stage and repulsive force at leaving stage affect the behavior of both vessels. These

'suction' forces change the directions owing to the relative situation of the vessels, thereby this might trigger a collision, especially in overtaking cases, in which it takes more time than that of passing.

Although encounters of large vessels on the channel can be prevented by adjusting the scheduled time, the dense traffic of lighters in tow should be borne in mind; their maneuverability is rather poor (similar to large vessels) and they have frequently been involved in sea accidents.

4) Although a deeper and wider channel is desirable from the viewpoint of safe ship-handling, regarding the Bangkok bar channel, deepening the channel would not be feasible because of its detrimental effect on the environment, consequently, widening the bar channel would be the only practical solution.
Based on past experience, if a channel's width is more than six times that of the passing vessel's, the inconvenience from the narrowness disappears.

5) The team has recommended a plan of widening the Bar Channel to the extent of 150m as a part of the Master Plan as mentioned above. However, based on further long-term planning of the Bar Channel, a width of 150m is not quite enough to achieve safe and smooth two way vessel traffic at anytime to/from the Port of Bangkok Complex, the largest gateway of this country.

According to the latest paper on the appropriate width of an approach channel to port, the value is derived from a theory of vessel maneuvering, summing up the following three elements of vessel's behavior in a narrow channel:

a) Maneuvering lane --- Wm
The necessary width for maintaing an intended course is comprised of the following factors i) navigator's perceptible range for the deviation from a course, ii) vessel's meandering range under proceeding, iii) the kick of stern while altering her courses, iv) leeway owing to wind and tide.

b) Bank clearance --- Wb
The necessary distance between a vessel and a bank to counterpoise the bank effect by a certain checking helm.

c) Ships' clearance --- Ws
The necessary distance between two meeting/overtaking vessels in a narrow channel, to counterpoise the suction effect

According to the results of actual observations and experiments, the values of the above three elements are as follows:

Wm : 1.7B (B: Breadth of a vessel)

Wb : 1.8B

Ws : L of the larger vessel (L: Length of a vessel)

Since the necessary channel width = Wm + Wb + Ws, therefore, in case of one way traffic 1.7B + 2x1.8B = 5.3B = 0.9L

---------- two ---------- 2x1.7B + 2x1.8B + L = 2.2L

providing that the meeting vessels are the same size, and 6B = L.

Consequently, in case of the Bangkok Bar Channel, the width will be 172m x 2.2 = 372.4m, assuming the length of model vessel is 172m, which is permissible under the existing port regulations.

However, the above width is more than three times that of the present channel. Therefore it will not be practical to widen the channel at stretches beyond the target year of the Master Plan.

Furthermore, prior to the above widening work of the channel, it will be indispensable to conduct relevant studies on the current port regulations, number/size of main calling vessels, width of the river channel, environmental assessment including erosion around the estuary and financing.

A phase plan will have to be set up to realize safe two-way traffic of the bar channel minding the above mentioned ideal width.

10.4 Phase Plans for Modernization of Bangkok Port

It is necessary to implement the entire project proposed in the Master Plan according to phase plans. The first phase project is that proposed in the Short-Term Plan with the target year 1997 (cf.Vol.2 Short-Term Plan). The remaining project will be realized in the second phase plan with the target year 2005 the same as the Master Plan (see Fig.10-4-1).

10.4.1 The First Phase Project

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

(1) Container-Handling

Project components for container-handling are listed as follows:

1) Introduction of a closed container terminal system
2) Expansion of the marshaling yard of the east quay:
    - Total storage capacity: 9,942 TEUs (4,128 ground slots)
    - Demolition of sheds Nos.11 and 12 to provide an open yard
3) Introduction of 9 large RTGs (6 rows + 1 lane) to be used partly at the marshaling yard
4) Construction of a concentrated reefer yard at the west end of the marshaling yard:
    - Number of plugs: 352 units
    - Reefer-handling equipment: RTGs of small size
5) Adding one traffic lane to the bridge connecting the east and west quays
6) Construction of 2 Import CFSs with the total floor space of 15,000 sq.m at Area II
7) Improvement of sheds Nos.13 and 14 as Import CFSs
8) Preparation of a yard specialized for stuffing export container cargo:
    - Ground slots of 912 TEUs
    - Container-handling equipment: toplifters
9) Preparation of yards for storing empty containers west and behind sheds Nos.15-17:
    - Total storage capacity: 7,272 TEUs (2,424 ground slots)
    - Container-handling equipment: toplifters
10) Preparation of other main facilities:
    - Marshaling yard:
        - Terminal office near gate No.3
        - Repair yards for RTGs
        - 3 terminal gates (No.1-No.3)
    - West quay:
        - Maintenance shop for container boxes
        - Cleaning area for container boxes
        - Parking lot for tractors/chassis
        - Area of container-handling equipment
11) Introduction of Modernized Information System Using Electronic Computer:
    - Review and modification of the current documentation forms to meet the requirements of the new terminal operation system
    - Development of required software through purchase of package software and improvement of it by trained PAT staffs to minimize a lead time

(2) Handling Conventional Cargo

Project components for handling conventional cargo are listed as follows:

1) Transference of the storage yard for import steel products to inside the port from outside:
   - Preparation of storage yards behind the conventional berths
   - Conversion of the site of existing Import Steel Open Yard located outside the port into commercial use
2) Demolition of the existing supplementary sheds Nos.1, 4-7, 9 and the Bonded Warehouse to provide open yards
3) Realignment and expansion of the existing port roads
4) Modification of sheds Nos.1-9 to create additional port roads
5) Dismantlement of the existing dockside cranes at the west quay
6) Relocation of the existing warehouses and yards for dangerous cargoes including cotton to an area with a sufficient buffer zone
7) Transference of railway operations to the yard west of the west quay from the east quay
8) Preparation of parking lots for passenger cars and trucks/tractor-chassis units:
   - Parking Lot No.1 near Checking Post 1 for passenger cars
   - Parking Lot No.3 behind the planned dangerous cargo area for trucks
   - Parking Lot No.2 near Checking Post 2 for trucks/tractor-chassis units
9) Transference of offices having no direct linkage with cargo-handling operations from inside the port to outside

(3) Navigational Safety

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

(4) Management, Operations and Institutional Matters

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

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

(5) Environmental Consideration

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

10.4.2 The Second Phase Project

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

(1) Container-Handling

Project components for container-handling are listed as follows:

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

(2) Handling Conventional Cargo

Project components for handling conventional cargo are listed as follows:

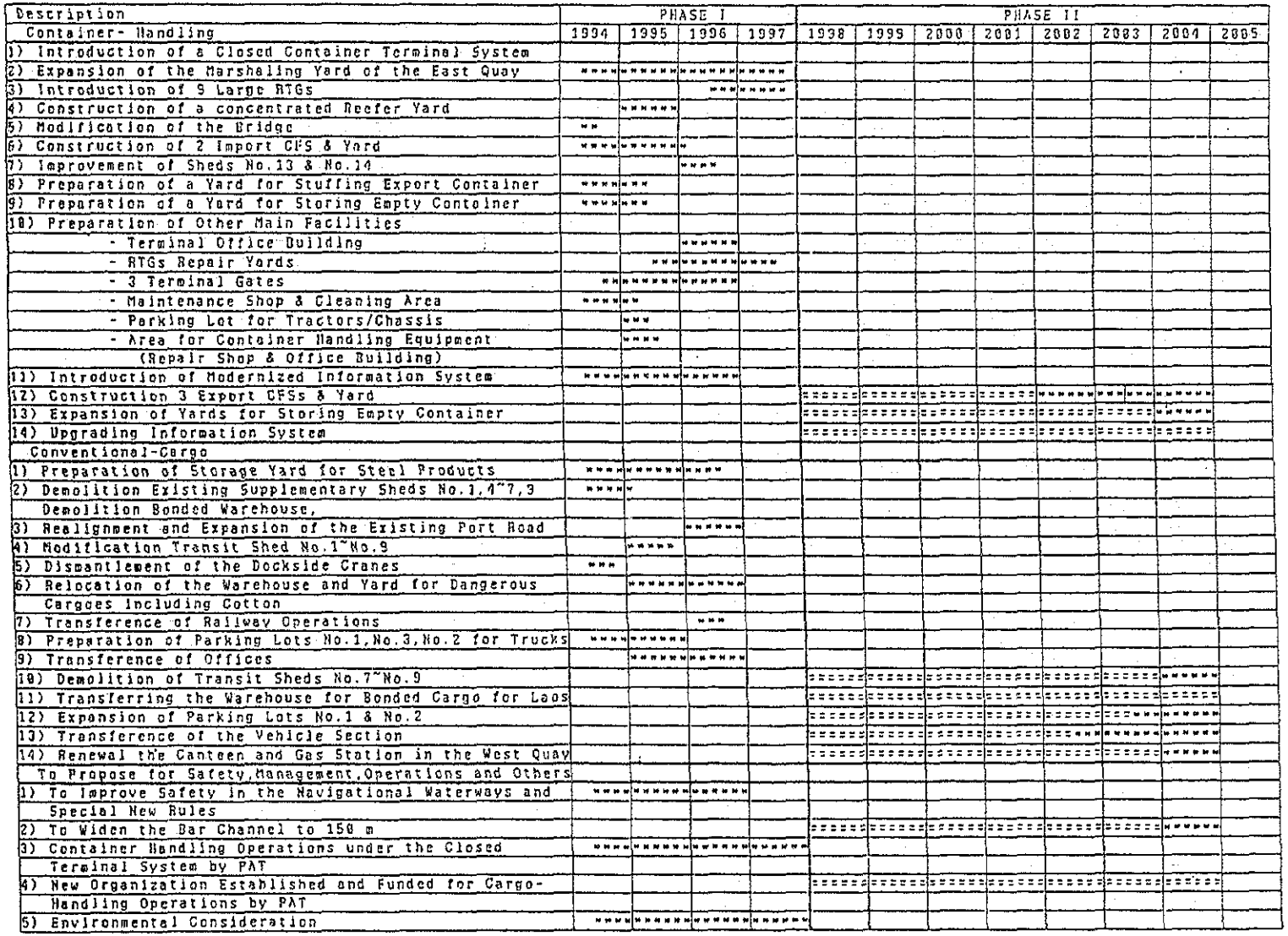
1) Demolition of sheds Nos.7-9 to provide open storage yards
2) Transferring the warehouse for bonded cargo for Laos to inside the port from outside:
   - Preparation of sheds Nos.15-17 to store the boned cargo
   - Conversion of the site of existing In-Transit Warehouse located outside the port into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

(3) Navigational Safety

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

(4) Management, Operations and Institutional Matters

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



Notes ****** : Implementation Schedule
====== : Period for Arrangement of Implementation

Fig. 10-4-1 Phase Plan for Modernization of Bangkok Port

Chapter 11 Information System

11.1 Electronic Data Processing

Computers can be used in highly integrated business systems. A computer is a machine that can perform logical and arithmetic operations. It can also record the results for immediate or future reference. With the use of IC and LSI technology, computers have become more and more precise in computations. As a result, it is now possible for a large volume of information to be processed with a shorter span of time. Integration of computer systems means that computers can do many tasks much more quickly and correctly than if these tasks were not integrated.

In business, it is usually not practical or economical to use a computer to do a single, simple, isolated task. Computers are very expensive and time-consuming. Preparing input data in a form that a computer can read is also an expensive process. All together, the expense of running a computer is not worthwhile if the compute is doing only a single, simple business task. In business, computers usually work on a whole series of related tasks.

11.1.1 Strengths and Weaknesses of Computer

Computers have had the three strengths or capabilities such as: data processing at electronic speeds, maintaining great accuracy, and processing many different types of symbols into useful information. In addition, a computer can store internally a program of instructions, and it can be programmed to modify this sequence. It can also make logical decisions.

Designing computer systems is a time-consuming process. Errors sometimes happen in a computerized data-processing system, perhaps because input data are not correct, and these errors can be difficult to find and nearly impossible to correct. Mistakes in computer programs are sometimes hard to find and correct even though experienced programmers may have fewer problems than beginning programmers.

11.1.2 Programming

For computer processing, there are two important factors. One is data-processing, in which first consideration should be given to the data. The other is end-user interface, in which first consideration should be given to users.

Once a valid need has been determined, a feasibility study is begun. Main objective of the feasibility study is determination of whether such a needed or suggested system is worth having and if it can be justified economically.

The first step in creating a program is to decide what is required as output from computer run. The second step is to examine the available data to see what can be used for processing. Based upon the input available and the output desired, it is necessary to decide what must be done to the input to create the output, that is, what processing must occur.

Programming activities are usually administered by several programmers during a software development project. Coordination of these activities is a significant task.

Once the data is captured, a computer can be programmed to do most of the logical and arithmetic operations normally required by programmers. When a procedure is not well defined as to an appropriate plan to follow with a given set of circumstances, that is, if human judgment is required, then people are still required. If the procedure is well defined and the response to a situation is always chosen from a fixed number of choices, the computer can operate as or more effectively than any other alternative.

Computers can not tell the difference between right and wrong.
They follow an incorrect instruction just as fast and as faithfully as a correct instruction.
It is the programmer's responsibility to verify that all instructions are correct.

11.2 Software Developing Plan of PAT in Near Future

PAT plans to begin computerizing 13 more areas of its operations in a project which is scheduled for completion in 1994. The project will embrace computer programs for ship service, container service, cargo service, warehouse service, and equipment service system. PAT is also in the process of hiring another three program development systems for ship, cargo and warehouse service. PAT may also purchase additional computers for use with these three systems.

Details of PAT's computer system developing plan are described as follows.

11.2.1 Application of Software

Software application system for developing Computer Systems to improve the operations of PAT in 1994 can be classified as follows:

(1) Package Software Applications

Cargo container services system, second phase (container slot control: ship planning, yard planning, material handling equipment utilization) to be introduced in near future, shall be used by Data Processing Department for best result.

(2) Self-developed Software System

The Data Processing Department shall develop Software Application in 1994, including the system developed in 1992-1993, namely manpower system, welfare system, salary disbursements system and other systems as follows:

1) General Income Software System

This system would handle data concerning income derived from leasing of lands, buildings, and structures owned by PAT, and income derived from services of electricity, water supply, telephones which currently are recorded in the computer system. These shall be developed into on-line system for generating convenience and speed in issuing invoices and creating an account system.

2) General Software Supporting System and Management

The Management Information System and Decision Support System will be employed in various functions, and will be comprised of complete basic data from the various work systems. Therefore, in developing this working system, it is necessary to first complete the various basic structures. The Software Program is forecasted to be functional in early 1994.

(3) Software Program to be handled by Private Company

To get various computer systems for developing various working systems to be completed within stipulated schedules, PAT would hire a private company to handle eight Software Systems after analyzing present working systems and a new structure. The Software Systems to be carried out by the private company are as follows:

1) Software System for Servicing Vessels

Software system for servicing vessels is designed to allocate facilities to vessels from time of arrival at the mouth of Chao Phraya River covering entire period of berthing, changing berth and leaving the port via the channel into the sea. Introduction of computers would ensure having complete data, reduction of repetition works, and quick preparation of reports and statistics. Moreover, data obtained from vessel services can be used for invoicing with convenience and speed.

2) Cargo Software Program

Cargo software program is designed for handling receipt of goods from vessels and storing in warehouses, cargo inspection and storage, closing cargo accounts and so on, and delivering cargo to owners. Introduction of computer system would be useful in searching for goods within a short period of time, thereby making it possible for closing vessels accounts, maintaining accounts of unclaimed goods and making reports fast, and doing cargo invoicing speedily.

3) Warehouse Software Program

Normally, goods discharged from vessels must follow warehouse handling procedures. Warehouses are entrusted with maintenance of the goods until owners take them away. Volume of goods stored in each warehouse is excessive and data on goods received for storage come from the cargo sheds, with the warehouse having to receive the goods again, it is inconvenient for the warehouse. On the other hand, there is a need to trace goods for delivery, inquiring, checking and reporting of cargo balances in hand. Introduction of computer system would be effective in reducing and eliminating unnecessary procedures, while at the same time enhancing capacity for tracing goods, closing cargo accounts, creating a report for goods remaining in warehouses and reporting statistics.

4) Software Program For Labor-Saving Equipment

Labor-saving equipment services system is designed for speed and accuracy, and is capable of making various reports in a short period of time. Introduction of Computer System could help PAT utilize its labor-saving equipment with high efficiency. It is capable of collecting data and making reports and statistics concerning labor-saving tools and equipment, and it could hasten the invoicing system.

5) General Maintenance System

The program is designed to perform maintenance and repair equipment, machines, engines, vehicles, electrical appliances, power, telephones, tools and equipment for general repairs and construction. The system shall be responsible for effecting registration of property and maintenance of records of repairs to the equipment. Introduction of Computer System would enable recording of history of repairs and thus maintenance would be easy and checkable at all times. This could help section management plan for procurement of tools more accurately and also help in fixing demand of requirements at a suitable level, while facilitating efforts for compiling data and reporting correctly with speed. It also can help the accounting system, facilitate efforts for filing statistics and make reports.

6) Procurement and Inventory System

A procurement and inventory system is responsible for purchases, hiring, receipt, storage and distribution of materials. Introduction of Computer System could help facilitate the job of recording and controlling works, purchases, hiring systems of PAT. Introduction of computers for handling inventory and storage system of PAT under First In First Out system would enable PAT to monitor and controll procurement system while assisting efforts for collecting procurement data for use in other systems such as, Creditor's Accounts System. It helps financing, unit costs of the ware-house, and accounting system that is capable of showing movements of materials in accordance with available budgets, for checking efficiency of the units.

7) Warehouse Operation Program

A warehouse operation program involves the introduction of a Computer System to assist in recording receipts and payments of money and the calculation of various taxes. It facilitates monitoring and controlling of receipts-payments with speed and accuracy, decreases costs of calculations of taxes of the Division, as well as reducing of paper work and enhancing financial management efficiency.

8) Creditors Accounts System

A creditors accounts system involves the introduction of computer system to assist in recording of data, checking, adjusting entries and closing credi-tor accounts of all types. It allow convenient monitoring and checking payment of cargo fees or services to sellers or service givers and checking of accuracy and completeness of cargo receiving documents, so the data can be finely summarized for various accounts correctly and receipt of goods can be made in accordance with the conditions of contracts. It also

assist PAT for managing with speed and accuracy, reducing steps that have become complicated and for correct maintenance of filing system.

11.2.2 Using Computer System Link with the Relevant Section

Marine transportations data which PAT uses mostly concerns the cargo ship and containers. This data is used for service, finance and administration. Currently, a document system is employed to record some data. This can lead to errors, delays and repeated work.

If PAT can link its computer to the relevant sections by Data Communication or EDI (Electronic Data Interchange) or other system e.g. diskette, will not only increase efficiency and accuracy but also save money and time. Therefore, PAT plans to use this system at the end of 1994 and this system can connect the followings:

(1) The Network Computer System between PAT and the Agent

The agent can use his monitor to follow up the vessel, cargo and container from PAT's computer easily. PAT also receives the data e.g. Inward-Outward Container List, Manifest and Berth Application from the agent. For this interchange, network will make both PAT and the agent able to manage their cargo, container and provide the proper handling equipment.

(2) The Network Computer System between PAT and the Government Unit

Currently, the relevant sections are Transportation and Communication Department, Office of the Commercial Navy, the Customs Department, Harbour Department and PAT. If all sections can use the interchange network (every section has computer), it will be useful especially to the Customs Department and PAT which need cargo manifest.

(3) The Network Computer System between PAT and Foreign Ports

The direct network computer system with the foreign port is very useful especially concerning the Inward-Outward Container List or the manifest which will arrive at Bangkok Port(BKP). PAT will know in advance (one-two days) the volume of cargo to be handled and this data will help in arranging the container yard and handling equipment.

On the other hand, foreign ports will also need PAT's data so that exchanging data will be good to everyone. At present, PAT have already exchanged vessel departure in EDI with Singpore. PAT will consider other data at the end of 1994.

11.3 Container Cargo Movement and Necessary Documents

The level of computerization in the container handling operation at PAT is not so advanced compare with other container terminal in the world. The information processing function of the computer become indispensable to ensure smooth, accurate and efficient handling of intermodal containerized cargo. On the other hand, computerization of conventional cargo handling operation is not so advanced even in the developed countries because of its trading and cargo pattern. So that, the study team has limited the Scope to the basic design of the computer system which focuses on the cargo container service system.

Shipping companies/agents submit the following documents to PAT for handling inbound and outbound containers at present time.

For inbound

- Inbound container list
- Tally sheet
- Document No. 313.1.1 Application for releasing inbound container out of PAT
- Document No. 313.1.3 Application for deliver and open the container directly out of PAT
- Document No. 306 The form asking for moving bare cargo out of Bangkok Port (BKP)
- Document No. ICD 313.1.1 Application for conveying inward container out of PAT to ICD
- Cargo manifest
- Dangerous cargo list
- Dangerous container list
- Botanical/zoological container list, if any

For outbound

- Outbound container list
- Tally sheet
- Document No. 308.2.2 Application for passing container into PAT

These documents include some of the necessary information, however PAT can not get enough information for operating container yard from the documents. The study team recommends that PAT study what kind of information should be submitted to PAT for terminal operation, and realign the format of documents under consideration with related bodies. The document flow that accompanies container movement is described below.

11.3.1 Container Documents

Figs. 11-3-1 and 11-3-2 show the necessary document flow accompanying the cargo and container movement among the port management body, the marine terminal, shipping company/agent, shipper/consignee/forwarding agent, Customs, and ship, for both import and export.

(1) Import

The documents and information flow accompanying import container cargo movement are explained below.

1) The shipping company sends import container documents such as manifest (M/F), stowage plan, special container list, reefer list, dangerous cargo list, botanical/zoological container list, etc. to marine terminal. Shipping company/agent notifies marine terminal of the vessel's estimated time of arrival (ETA).

2) The shipping company sends arrival notice (A/N) to importer(consignee).

3) The consignee shows B/L to shipping company office, and exchanges it for delivery order (D/O).

4) After arrival of the container ship, discharged containers are transported to container yard (C/Y) of marine terminal. Marine terminal prepares boat note (B/N) in which container number and weight are listed, and it is signed by the ship's master acknowledging receipt of containers.

5) The marine terminal submits M/F, container list, B/N and transhipment container list (if any) to Customs, this procedure confirms completion of discharge and bringing in of containers. Consignee submits declaration of bonded transportation (DBT) to Customs.

6) The consignee/forwarding agent completes delivery request and submits it to marine terminal.

7) After giving delivery schedule of cargoes to marine terminal, consignee / forwarding agent presents D/O to marine terminal, and then takes cargoes out by truck.

8) The driver of road tractor, on behalf of consignee/forwarding agent, presents D/O to gate office. While delivering container at gate office, equipment interchange receipt (EIR) is signed by both gate clerk and driver who is entrust to carry DBT and related

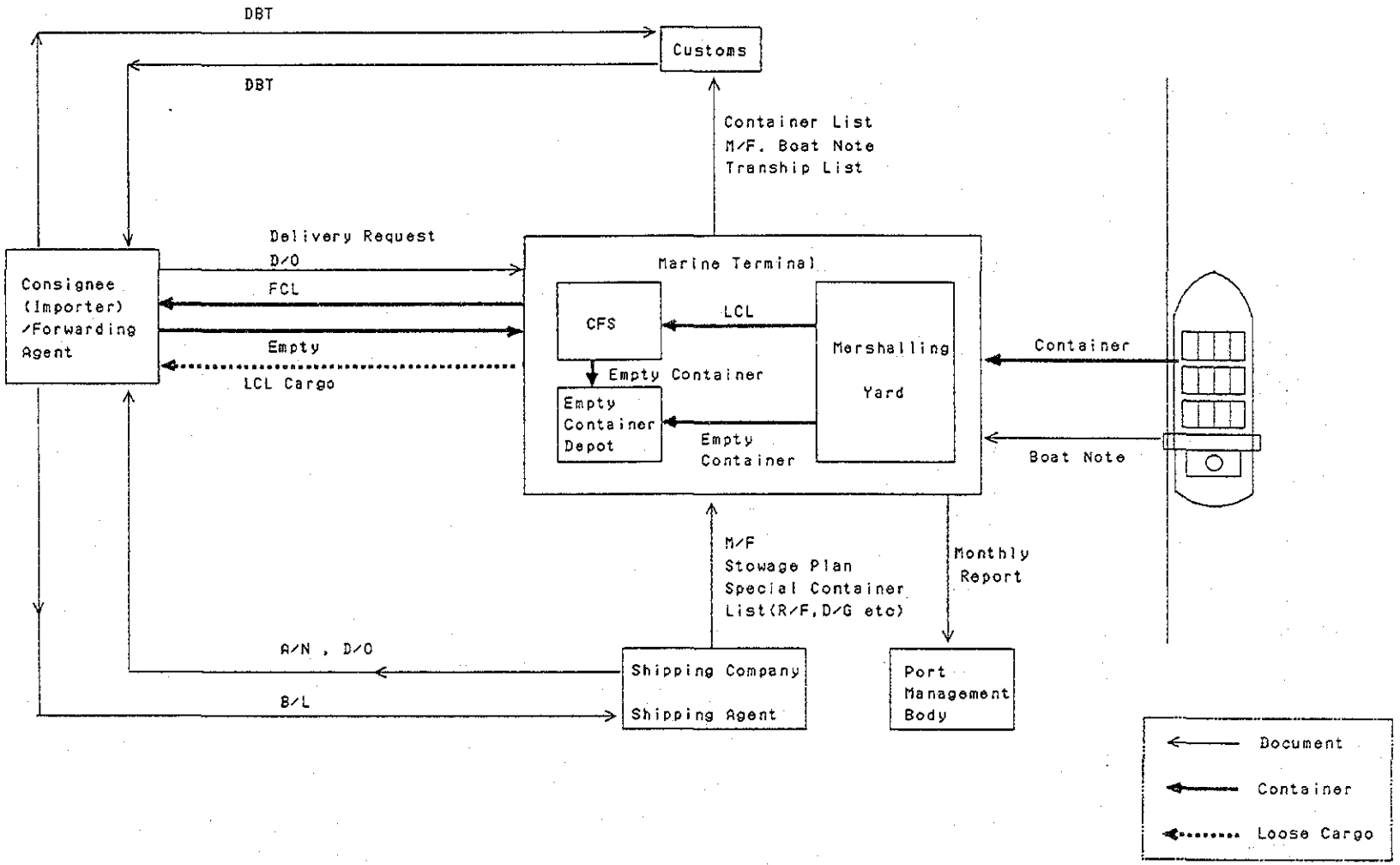


Fig. 11-3-1 Flow of Container Cargoes and Documents (Import)

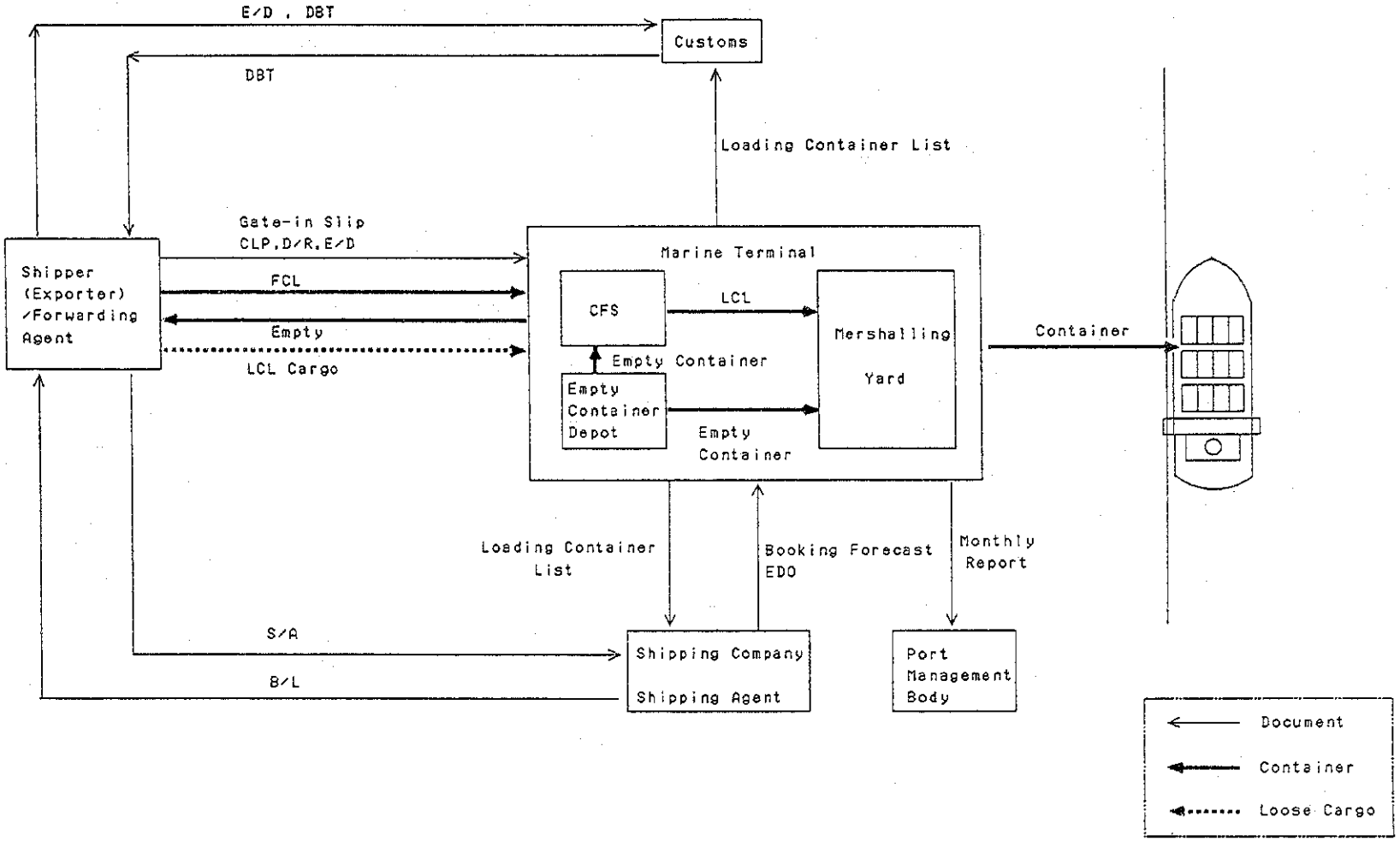


Fig. 11-3-2 Flow of Container Cargoes and Documents (Export)

documents.

9) At the warehouse of consignee/forwarding agent, container is unstuffed according to container unstuffing instructions. Consignee/forwarding agent submits DBT to Customs, and Customs verifies it.

10) Some of the empty containers, after being unstuffed, are transferred to empty container depot.

11) The marine terminal operator submits monthly reports of containers and cargoes to port management body.

(2) Export

The documents and information flow accompanying export container cargo movement are explained below.

1) The exporter (shipper) sends shipping application (S/A) to shipping company in order to book ship's space.

2) Shipping company sends booking forecast to marine terminal.

3) Shipping company sends equipment dispatch order (EDO) to empty con-tainer depot. Shipping company arranges road tractor-chassis and receives empty containers.

4) After packing containers with export cargoes, shipper/forwarding agent submits export declaration (E/D) and DBT to Customs and affixes customs seals to containers.

5) The Shipper/forwarding agent sends container load plan (CLP), dock re-ceipt (D/R), and E/D to marine terminal.

6) The Shipper/forwarding agent arranges road tractor-chassis and delivers containers into marine terminal. Driver of road tractor presents gate-in slip to gate clerk. Container is checked at gate office for several items such as seal, outside condition, weight, temperature of reefer containers, labels of dangerous cargoes, etc. EIR is counter-signed by both gate clerk and driver.

7) The shipper/forwarding agent submits DBT to Customs, and Customs verifies it.

8) The Container is stacked in marshalling yard and loaded onto container ship.

9) The marine terminal presents loading container list to Customs.

10) The shipping company issues B/L in exchange for the original D/R and the prepaid freight.

11) The marine terminal keeps D/R, CLP, E/D and collective container list for future reference.

12) The marine terminal submits monthly reports of containers and cargoes to port management body.

11.4 Computer System Among the Container Terminal

The evolution of container terminal operations and management has been accelerated by up to date computer and communication technologies which are penetrating rapidly into the business world and the activities of individuals.

11.4.1 Out Line of Container Terminal Operation

The marine container terminal is the connecting point for land and sea transportation of containers. The typical facility is a common-user container terminal consisting of container stacking storage with vessel berthing facilities. It has in and out gate way with multiple truck lanes where the gate booth is equipped with computer data entry units, which is a key to the high level of service and turn-around time.
The functions are:

- Receiving of containers from shippers
- Delivering of containers to consignees
- Loading of containers to ships
- Discharging of containers from ships
- Storage of containers in container yard

11.4.2 Computerized Container Terminal Operation

To ensure smooth, accurate and efficient handling of integrated intermodal containerized cargo, the information processing function of the computer is indispensable. Thus, the use of the computer, which has functional capaci-ties surpassing those of man both quantitatively and qualitatively, has become a "must".

Figs. 11-4-1 ~ 11-4-5 show the basic functions of container terminal using computer system.

Receiving

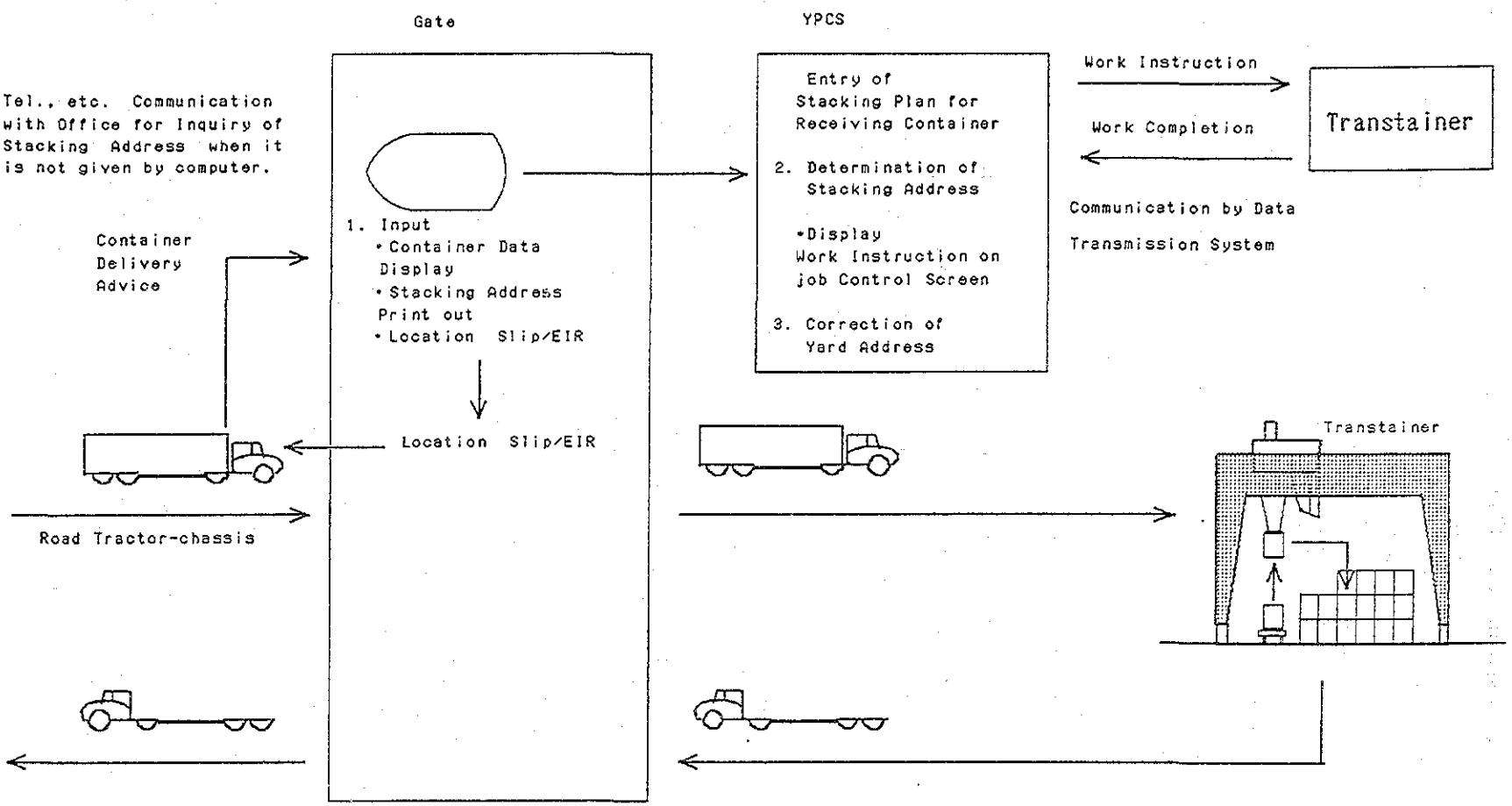


Fig. 11-4-1 Outline of Container Terminal Operation

Delivery

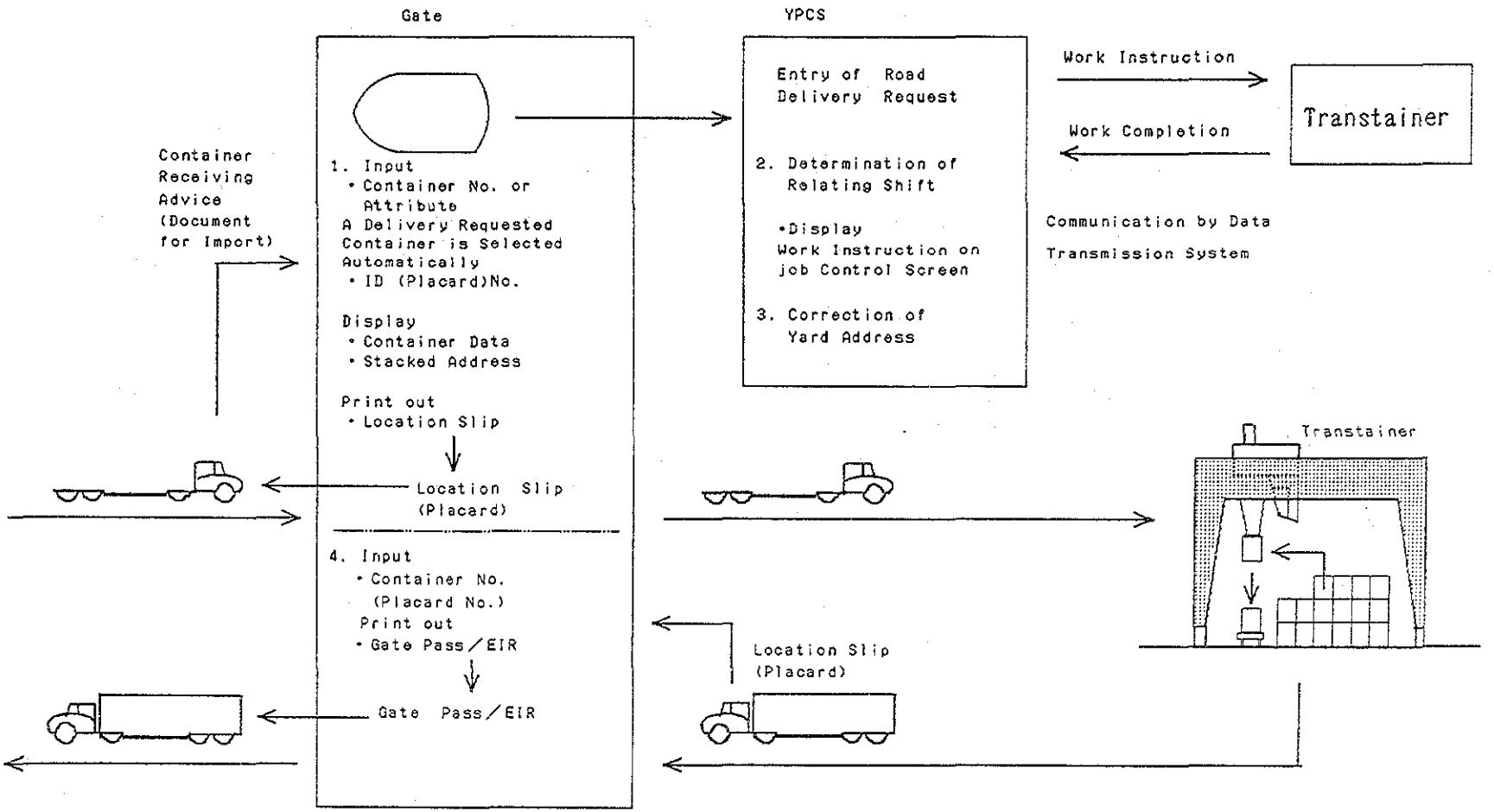


Fig. 11-4-2 Outline of Container Terminal Operation

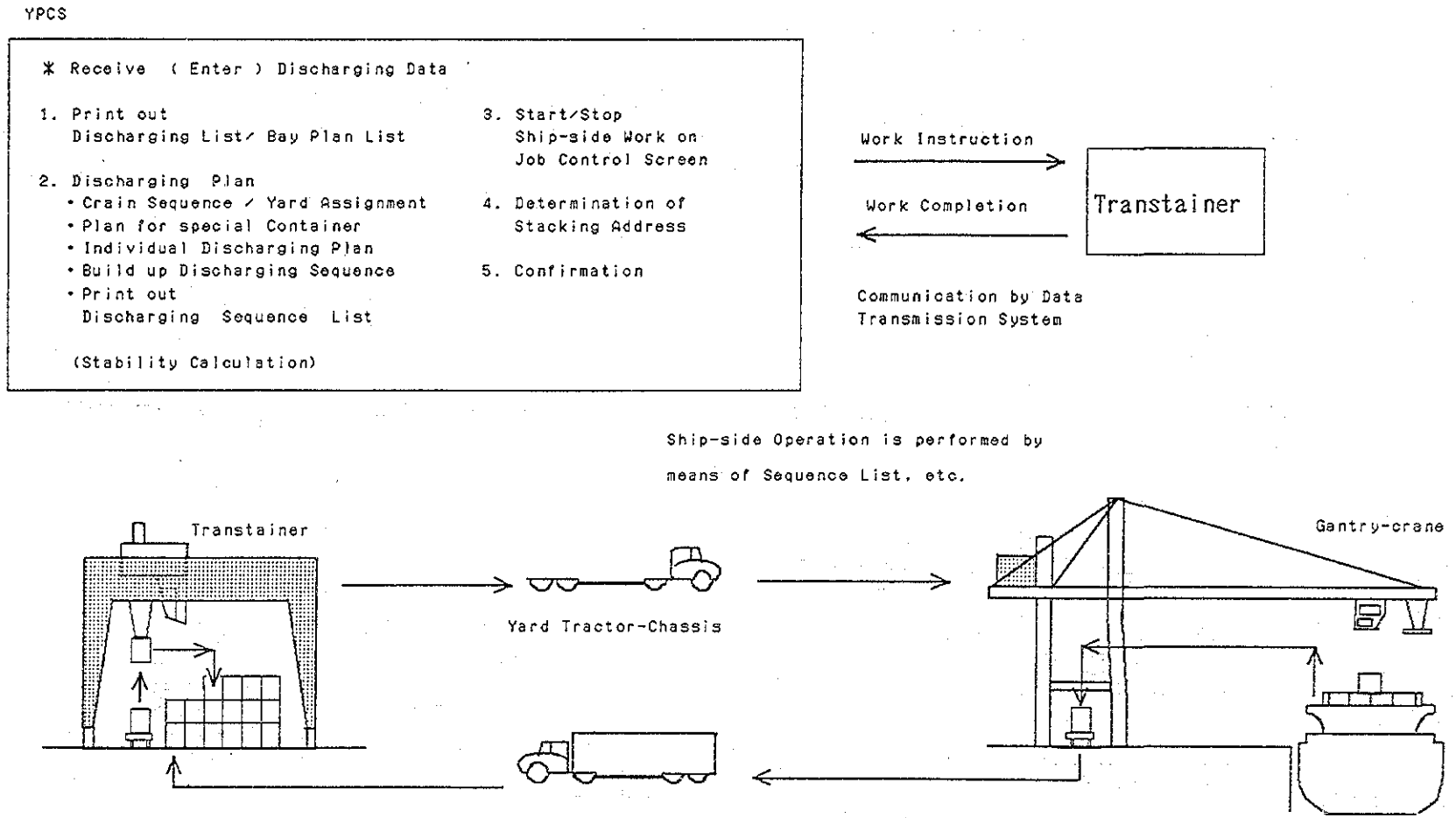


Fig. 11-4-3 Discharging from ships

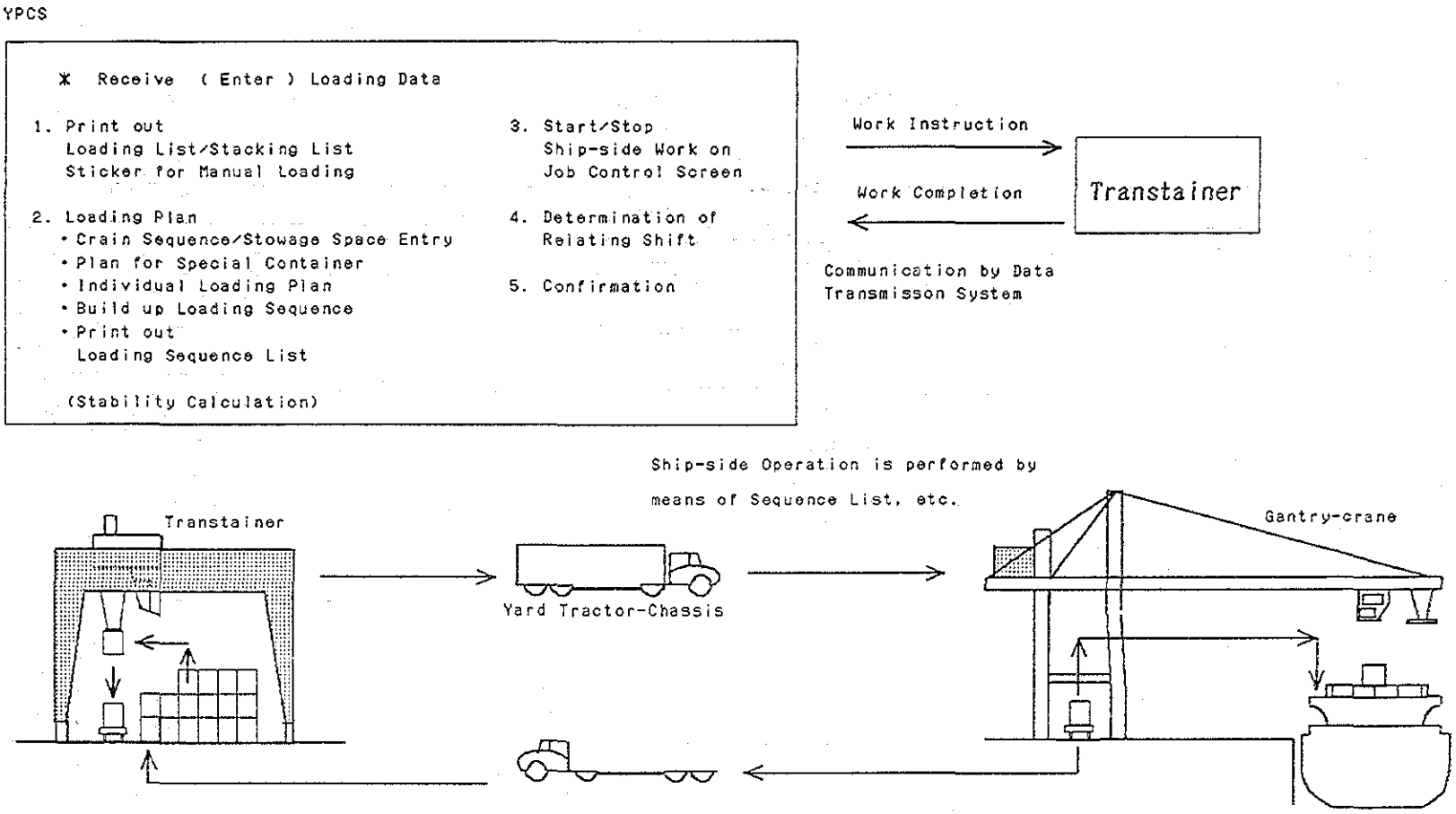


Fig. 11-4-4 Loading to ships

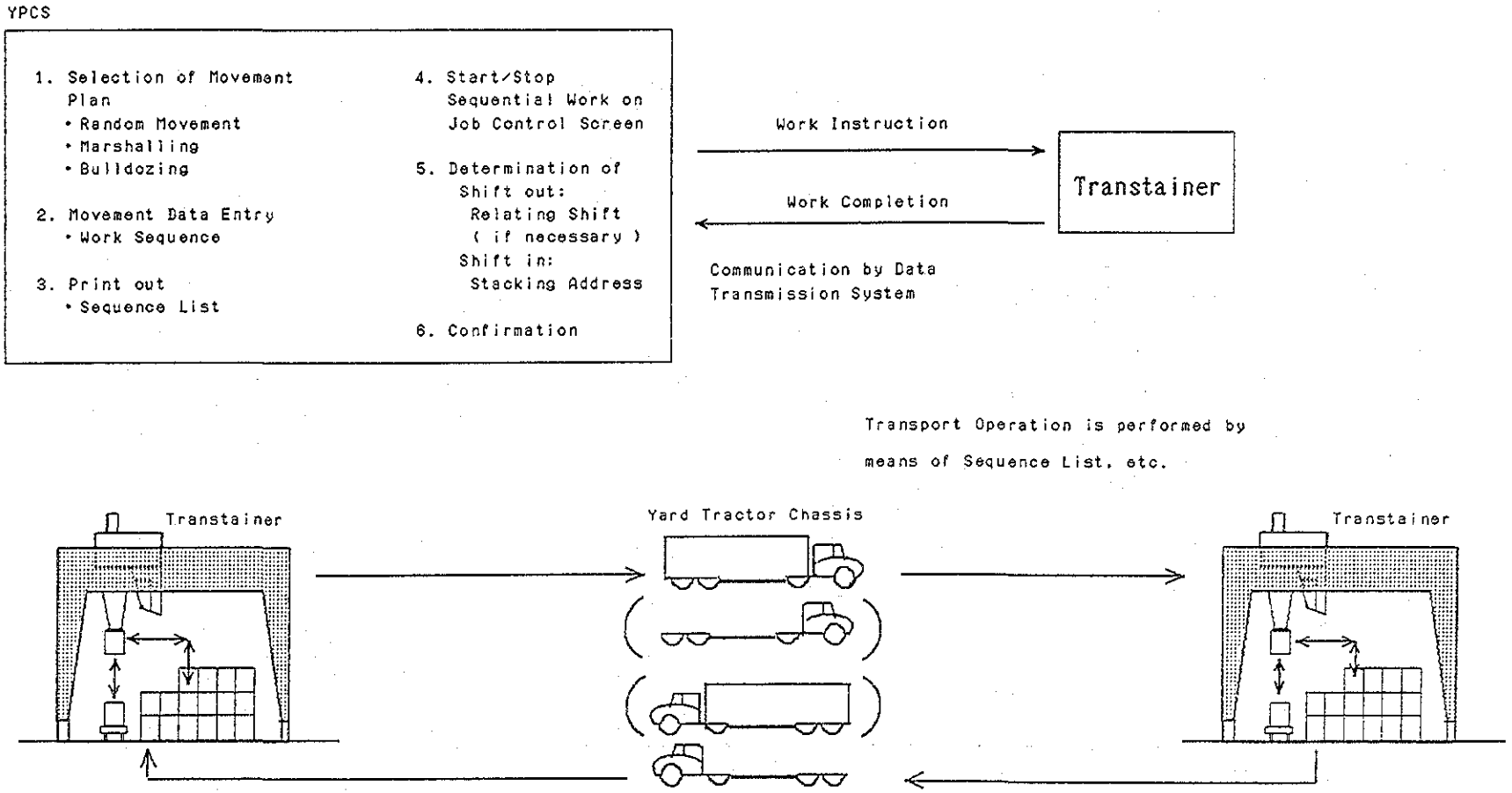


Fig. 11-4-5 Transporting inside Container Yard

11.4.3 Yard Plan Computer System

The data entry units at the gate way interface with the Yard Plan Computer System (YPCS), a main computer system which is an essential part of the total computerized equipment control data base. The YPCS provides a high degree of efficiency for daily operations, improves storage and equipment utilization, maintains inventory records and provides timely management information.

Fig. 11-4-6 shows the Yard Plan Computer System.

11.4.4 Effectiveness of Computerization

The following functions are expected to be achieved after installing a computer system in the container terminal.

- On-line gate control and EIR printing
- Container tracking and yard inventory control
- Ship loading and discharging operation support
- Inquiries, report and billing
- Electronic Data Interchange (EDI) with trading partners

11.4.5 Other Systems

Advantage of computerized container terminal operation is shown in Appendix A.8.5 and A.8.6.

11.5 Strategy of Software Development

Improved computer and communications system contribute to more effective approaches to problem solving, new jobs and services, and enhanced PAT competitiveness across broad areas of terminal operation.

On top of the above, it is expected that PAT computing and communication program will accelerate significantly the availability and utilization of the computer and networks.

There will be barriers which PAT should surmount at an early stage of computerization. This happens to all people when to accept new technologies because of high initial cost, new and unfamiliar jobs, sometimes inadequate and user-unfriendly software, and lack of standards.

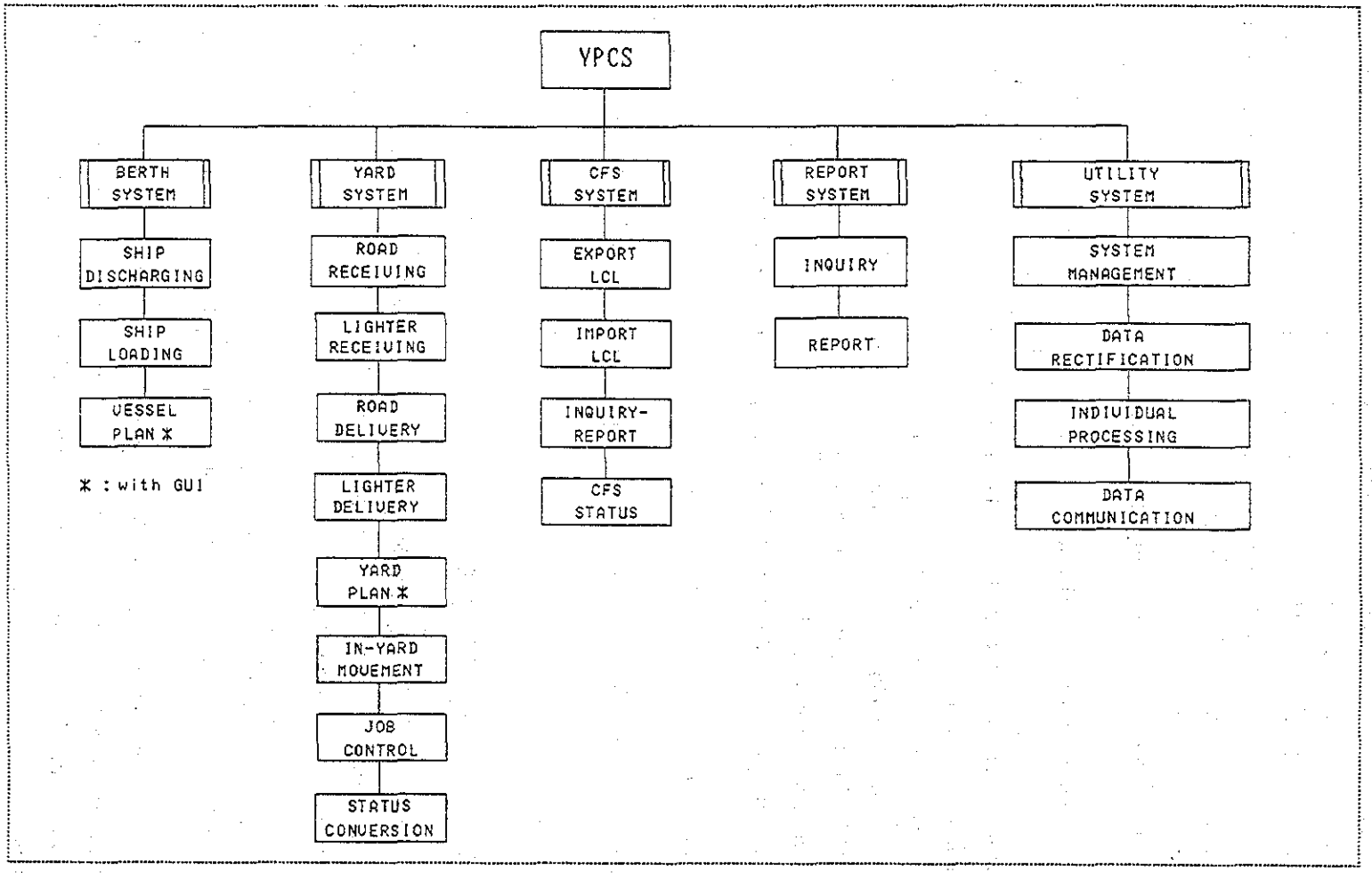


Fig. 11-4-6 Yard Plan Computer System (YPCS)

There are many choices for developing softwares. Anyway, PAT should clarify its role, have knowledge and experience on the job, and have experts who can supervise implementation of each job.

11.5.1 Self Developing

System development does not mean only programming. There are three important factors, analyzing/designing, programming, and testing. The points of system development are as follows:

- To clarify the purpose of system
  All of the users should discuss and clarify for what purpose system is needed and in what way the business should develop. In addition, PAT clarify the conditions of success.
- To re-examine the business flow
  PAT examines unreasonable or fruitless aspects of the current business flow. It also a good opportunity to reform business practices.
- To start from the simple system
  PAT has to start the system from the foundational part of busi-ness thenafter extend it to other parts gradually.
- To reflect users demand
  People who have thorough knowledge are end-users, therefore Data Processing Department staff analyze end-user's request.
- To obtain information concerning new technology
  New technology is being developed rapidly, PAT has to gather information concerning new technology and utilize it to improve the system.
- To control the progress
  PAT has to control the progress of developing. This means not only time schedule but also how many problems have been solved through developing new system. Remember that each factors (analyzing/designing, programing, testing) require almost same period of time.
- To test a new system
  The Data Processing Department has to verify the system that all instructions are correct before they turn the program for operation.

PAT will improve and enhance his computing programs, coordinate its activities with other parties related to cargo handling operation, and will share common resources to develop the program. The program will be beneficial by adopting the interest, advice and specific recommendation that will come from parties related to cargo handling operation, and will be planned and managed to ensure that fruits of the program are brought into PAT's operation as rapidly as possible.

11.5.2 Package Software

In analyzing the marine container terminal operation, there are lots of types of fixed patterns, for example, receiving containers at the gate, custody containers inside the container yard, loading containers onto the ship, discharging containers from the ship, and delivering containers at the gate. Package Software has been developed under these circumstances and utilized at many container terminals in the world. However, on evaluation of applicability of the package software, PAT staffs have to analyze following functions before purchase:

- How has the software been received by actual users ? PAT has to seek opinions from several actual users.
- Is the function of the software appropriately applicable to the terminal condition, and applicable to requirement of PAT ?
- At the intermediate period between existing system and new system, will both systems be able to operate ? Should existing data-file be left as it is or be modified for a new format ? How long will maker's support be able to expected during the starting stage ?
- How many portions of the package program should be modified for adaption of the program for PAT terminal operation, and at that time, how much cost is needed for modification ? PAT has to certify modification of the program needed for appropriate application to the terminal, and confirm functions which should be added to present package software.
- To supervise implementation of the package software, PAT staffs will have to inspect that the software company excute modification of the program exactly in accordance with specification, and PAT has to also administrate the procedure and schedule strictly.
- The verification of the package program should be carried out strictly.

11.5.3 Hiring the Private Software Company

Almost all failures in system developing projects in the past have resulted from imcomplete plans.

In case that contents of planned application are unsatisfactory, user has made alternations many times during development. PAT has to clarify its requirements to the software company for the purpose of ordering software developing concerning several kinds of tasks. The points of making definitions of requirement are as follows:

- The required processing has certain effectiveness, moreover, it will be realized

by present level of technology.
- The required processing will be applicable by the computer.
- The requirement has possibilities of verification.
- Freedom of design should not be limited.
  The requirement has the flexibility to produce some ideas in the system.
- There is no contradiction in the requirement.
- All expression have been written exactly.

It is recommended that PAT ask the private software company to submit following lists:

- A plan which clarifies period and a method for reviewing each important task or at the completion of each phase
  This review will give PAT a good opportunity to check progress, quality control, and give detailed instruction to the software company.
- The table which describes the system function and/or working sequence
  This table will help PAT to command a view of the whole system and to estimate the cost of development.

11.5.4 Computer Network

Nowadays, commercial transactions are crossing not only the business firm of the company group, different field of business, but also borders. Thus EDI (Electronic Data Interchange) has become a common information infrastructure for people around the world. With the advance of economy, business deals have become active internationally, and it is getting difficult that the traditional ways, based on the documents, manage work flow even using computer. In addition, cargo transportation by air is not a special case anymore and shipping, trucking and railway transportation have been advanced remarkably in speed and volume. Combined transports, such as land-bridge and sea-air transports, have been high ratio. In this circumstance, management of business and communication must be quick and simple. Interchanging these large quantities of data accurately and quickly realizes less documents and certain business transaction, that is, why EDI has become so general.

PAT Data Processing Department's staff has been assigned to take overall responsibilities for the committee of computer network system.

When utilizing computer network system, PAT will form a policy committee to examine network issues such as security and privacy, intellectual property rights, and network access, interoperability, and technology transfer.

11.5.5 Introduction of Electronic Data Interchange (EDI)

EDI is defined as a means of exchanging commercial transaction data which apply standardized rules among computers through communication line.

(1) Preparation of Environment for Introduction of EDI

The important things during exchanging transaction document using EDI are preparation of various related rules in addition to standard format. Various related rules are classified into four levels as follows:

- First level: Information Transmission rules
  First level is rules related to information and communication, and generally called as communication protocol.

- Second level: Information Expression rules
  Second level is rules related to data code and format, and generally called as business protocol in the narrow sense.

- Third level: Operation rules
  Third level is rules related to operation of business management system.

- Fourth level: Basal Transaction rules
  Fourth level is rules related to legislation. For example it is a rule to decide a point of time that the transaction come into effect under using EDI.

(2) EDIFACT (UN Rules for the Electronic Data Interchange For Administration Commerce and Transport)

Global activities of government/private enterprises develop and internationalize rapidly in all respects such as international specialization, international cooperation, procurement, marketing and distribution. Considering the distance and time, EDI is expected to produce more benefit in international trade. However, if the standard form of the transaction document is not settled, government/private enterprises must deal with respective document forms. To resolve this problem, international common standards are settled and that is EDIFACT.

(3) Utilization of EDI Provider

Introduction of EDI always needs partners and is not concluded inside PAT. Therefore

PAT should consider the utilization of EDI provider. In a case of transmission and/or receiving of a message are interrupted or an obstruction occurs during data interchange, an interest party should respond to the requirement of parties and resolve such problems. EDI service provider can offer whole service such as consulting service related to EDI, introduction and starting EDI, supplying medium resources, operating service, etc. PAT, as a container terminal operator, will be required to utilize EDI in near future. However, the level of knowledge and experience of PAT staffs as EDI user is not sufficient to develop and operate EDI by themselves. It is recommended that PAT and related bodies utilize EDI service provider while introduction and operation of EDI.

11.6 Maintenance of Computerization

The level of knowledge and experience on PAT staffs as container terminal operators is not enough at present. PAT will have to train his staffs in his job and gradually extend the limit of his job and duty in accordance with up-graded skill of staffs. Employees who have a thorough knowledge of the job are indispensable for future software development.

To ensure smooth and efficint handling of container, the traditional information interchange based on the documents is not suitable for modern container terminal. PAT will amend form of the documents to utilize full potential of computing and networking system.

Software technology have been developing rapidly day by day, PAT will assign his staffs to study new technology at the colledge or software company.
Realizing the full potential of computing and networking system will require advanced software and people educated and trained to use these tools. PAT has to maintain a steady progress for educating and training PAT staffs to adapt computerized port management and operation. Significant improvements in software technology are essential to achieve sustained high levels of computing system performance.

Chapter 12 Port Traffic Planning

12.1 General

In this Chapter, based on traffic volume projected in the Master Plan (target year 2005), sections of port roads in Bangkok Port are set up, and then affects of port traffic on roads around Bangkok Port are considered. Furthermore, based on limited container handling capacity in Bangkok Port, container-related traffic volume may divert from/to Laem Chabang port to/from around Bangkok Metropolis.

12.2 Forecast of Traffic Volume

Traffic volume generated from port operations in Bangkok Port is forecast according to the following two types:

a. Container and conventional cargo traffic
b. Business traffic (motorcycles and passenger cars)

Traffic volume of cargo transport is indicated in Chapter 10.1 and 10.2. Business traffic is based on the results of the traffic investigation study team on May 12, 1993. In addition, assuming that the following measures are implemented, total traffic volume will decrease from its present level.

a. To decrease transport of documents by motorcycles through introduction of computerization

b. To control passenger cars at entrance gates with traffic passes and to ban private cars

c. To limit workers in Bangkok Port to those only involved in port activities by moving administration facilities outside of port area

d. To operate round trip bus service in Bangkok Port and to conduct "Park and Ride System"

From above-mentioned items and calculation, traffic volume is summarized as follows.

a. Container and conventional cargo traffic

a.1 Traffic volume of container cargo (unidirectional)

*Peak volume/day----------3,350 Vehicles/day
*Peaking factor/hour----------3
*Peak volume/hour----------420 Vehicles/hour

Remarks: The above peak volume includes empty trucks and excludes passenger cars and motorcycles. Volume/day and peaking factor/day are taken from the results of simulation mentioned in Chapter 10. Peaking factor/hour is taken from the traffic investigation by the study team. Average volume/day includes general trucks passing through truck side gates at the CFSs.

a.2 Traffic volume of conventional cargo (unidirectional)

*Peak volume/day----------710 Vehicles/day
*Peaking factor/day----------1.50
*Average volume/day----------470 Vehicles/day
*Peaking factor/hour----------2.5
*Peak volume/hour----------70 Vehicles/hour

Remarks: The above peak volume includes empty trucks and excludes passenger cars and motorcycles. Volume/day and peaking factor/day are taken from the results of simulation mentioned in Chapter 10. Peaking factor/hour is taken from the traffic investigation by JICA Study Team.

b. Business traffic (motorcycles and passenger cars)

b.1 Traffic volume of motorcycles (unidirectional)

*Peak volume/hour----------140 Vehicles/hour

Remarks: The above peak volume/hour is expected to decrease to 10% of the present peak volume/hour investigated by the study team due to the reduction in document transfer for container cargo which is presently conveyed by motorcycles and will be replaced by communication using computers in the stage of the Master Plan.

b.2 Traffic volume of passenger cars (unidirectional)

*Peak volume/hour(Checking Post1)-----650 Vehicles/hour
*Peak volume/hour(Checking Post2)-----490 Vehicles/hour

Total 1,030 Vehicles/Hour

Remarks: The above peak volume is 90% of the present peak volume investigated by the study team, according to decrease in percentage of total cargo volume in 2005 from 1993.

c. Traffic through main gates (Checking Posts), the bridge connecting the west and east quays and truck side gates at CFSs

From above-mentioned traffic volume, following peak volumes/hour by vehicle type are found at each location (unidirectional).

c.1 Main gate 1 (Checking Post 1)

*Tractor-trailer units and trucks-- 70 Vehicles/hour
*Passenger cars----------650 Vehicles/hour
*Motorcycles----------140 Vehicles/hour

Total 860 Vehicles/Hour

c.2 Main Gate 2 (Checking Post 2)

*Tractor-trailer units and trucks--230 Vehicles/hour
*Passenger cars----------490 Vehicles/hour

Total 720 Vehicles/hour

c.3 Bridge connecting the west and east quays

*Tractor-trailer units----------160 Vehicles/hour
*Passenger cars----------250 Vehicles/hour

Total 410 Vehicles/hour

c.4 Truck side gate at Import CFSs
*General trucks----------80 Vehicles/hour

c.5 Truck side gate at Export CFSs
*General trucks----------110 Vehicles/hour

12.3 Port Traffic Facility Plan

(1) Number of Lanes

Sections for number of lanes are considered on W-Section, E-Section and B-Section. W-Section is on the main road from the main gate 1 (Checking Post 1), E-Section is near the main gate 2 (Checking Post 2) and B-Section is on the bridge (see Fig.12-3-1).

In terms of volume of each section, peak traffic volume per side is 770 vehicles/hour on W-Section, 720 vehicles/hour on B-Section and 410 vehicles/hour on B-Section. There are currently three lanes on W-Section, and it is necessary to expand to four lanes to accommodate the above peak volume/hour. As B-Section is near terminal gates of the container terminal at the east quay, two lanes are necessary for vehicles waiting at the gates and one lane for ordinary traffic, totaling three lanes. It is possible to expand to one more lane without constructing a new bridge, so a total of three lanes will be available in the direction of the terminal. In opposite direction, there are presently two lanes, one which runs in a straight direction and another which forks to the left and those will be used in the stage of the Master Plan. The existing four lanes of E-Section are sufficient. Based on the above, the required number of lanes is shown as follows (both directions):

	Present Lanes	Planned Lanes
W-Section----------	3 Lanes	4 Lanes
E-Section----------	8 Lanes	8 Lanes
B-Section----------	4 Lanes	5 Lanes

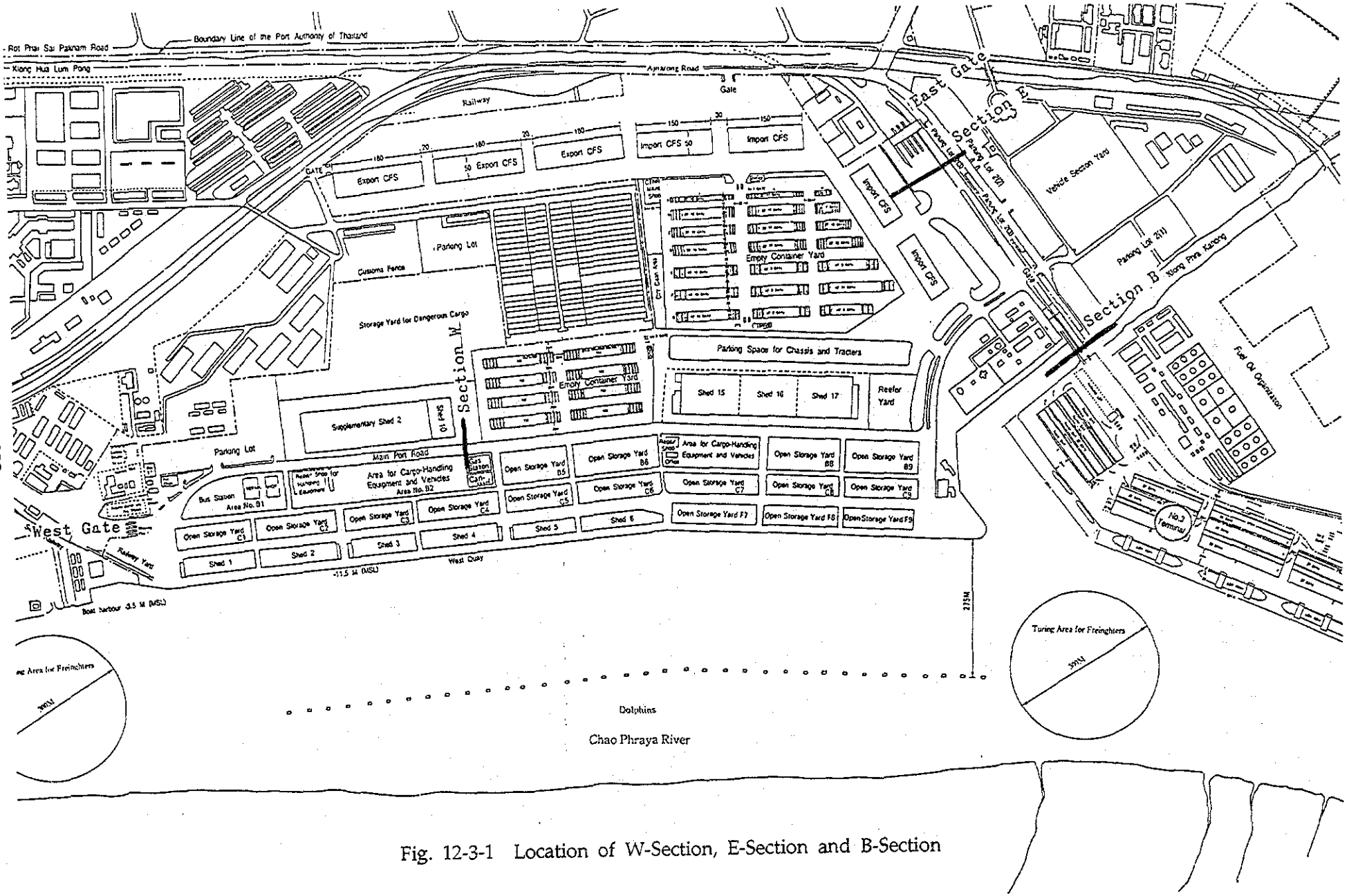


Fig. 12-3-1 Location of W-Section, E-Section and B-Section

(2) Typical cross section

According to above number of lanes, cross sections are shown in Fig.12-3-2 and Fig.12-3-3.

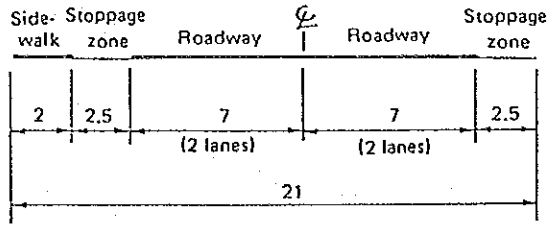


Fig. 12-3-2 Cross Section of Main Road at West Quay (W-Section)

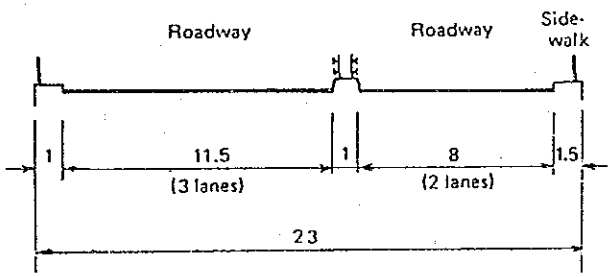


Fig. 12-3-3 Cross Section of Bridge (B-Section)

(3) Observance of Traffic Regulation

Bangkok Port has traffic regulations to ease traffic congestion, i.e, one way routes, no U-turn, no thoroughfare for limited vehicles, and traffic control of policemen, however, traffic regulations are not strictly observed; many cargoes are placed on sidewalks, stoppage zones and even roadways, while cars are parked on roadways. Hence, it is necessary to strictly observe traffic regulations for smooth port traffic.

12.4 Main Roads from Bangkok Port

According to the traffic survey conducted by the study team in May 1993, 50% of cargo-related vehicles from/to Bangkok Port used the expressway which runs in three directions from the tollgates near Bangkok Port, namely Bang Na, Ding Daeng and Dea

Kanong. Shares of the above traffic from/to Bangkok Port through the expressway in the three directions, Bang Na, Ding Daeng and Doa Kanong are 40%, 30% and 30%, respectively (see Fig.12-4-1).

The traffic survey conducted by the study team also shows that the port traffic from/to Bangkok Port split into those through main roads such as Rama IV (18% of the total port traffic), Bang Na-Trad (11%), Vipadi-North (9%) and Old Railway-Sumpavut (8%), some of them passing through the expressway.

Assuming that vehicles from/to Bangkok Port and through the expressway will account for 50% of the total port traffic and will split into the above three directions, Bang Na, Doa Kanong and Ding Daeng with the shares of 40%, 30% and 30%, respectively in the stage of the Master Plan as they do at present, the percentage of the port traffic in the above three directions, Bang Na, Doa Kanong and Ding Daeng are 2% of the traffic capacity. According to the standard in Japan, the capacity is estimated to be 36,000 vehicles/day per one side. On the other hand, assuming that 18% of the total port traffic volume will pass Rama IV Road as at present, the volume through the road accounts for 3% of the capacity of the road. The capacity is estimated to be 24,000 vehicles/day per one side.

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

The expressway development plan is composed of three stages, namely, Second Stage Expressway (completion year 1995), Third Stage Expressway (completion after year 1998) and Atnarong-Ram Inthra route (completion year 1996) that will connect with the existing expressway (see Fig.12-4-1). And on Rama IV route, Sky Train plan is under preliminary investigation, and construction work is expected to be commenced in 1994 and be completed in 1998. In addition to these plans, the Elevated Way (see Appendix 3 and Fig.12-4-1) has started which will construct elevated ways for vehicles and passenger trains connecting the outskirts with the center of Bangkok. A branch way having access to Mae Nam near the port will be also constructed. The project is scheduled to be completed by 1999.

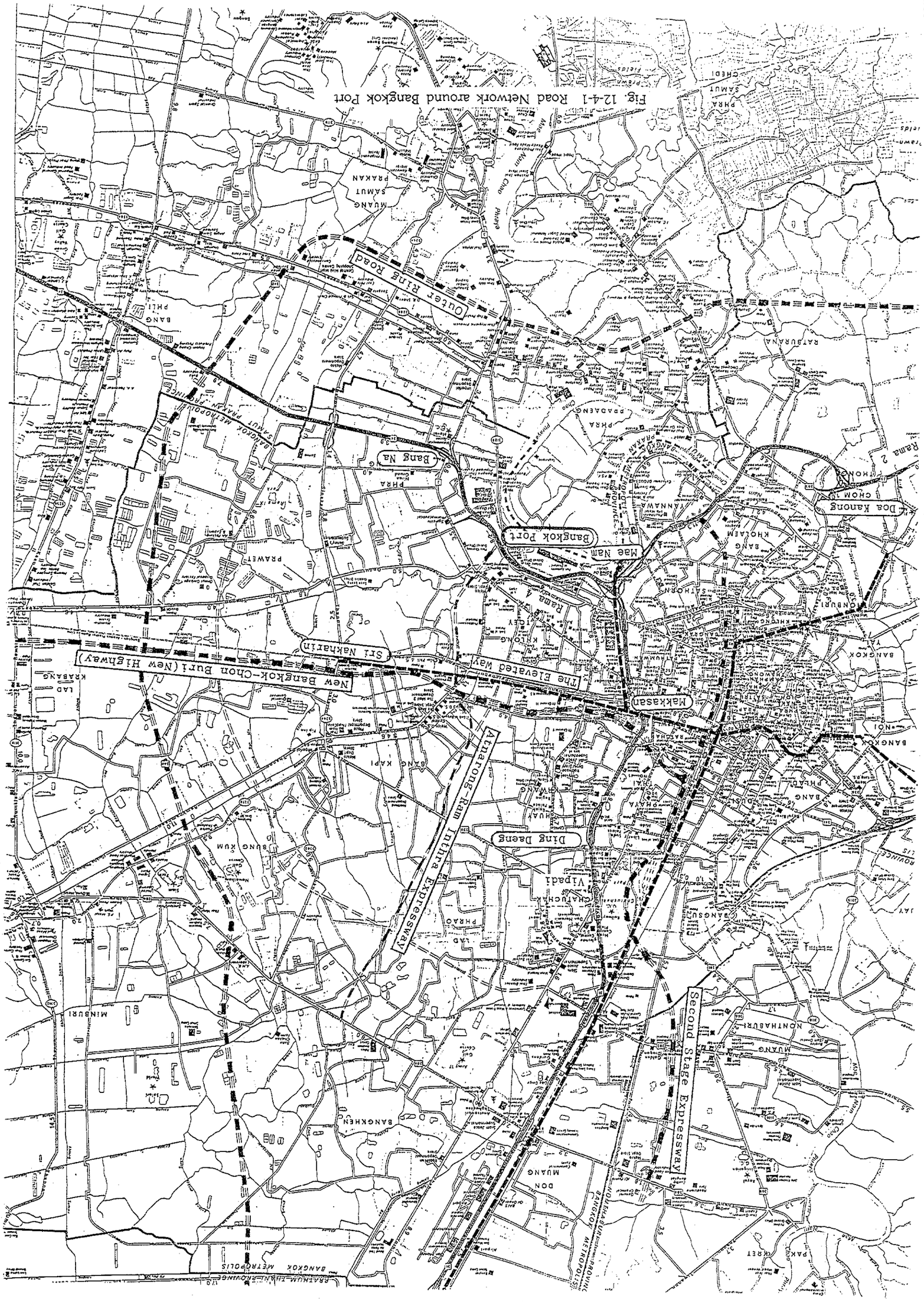


Fig. 12-4-1 Road Network around Bangkok Port

12.5 Traffic Development Plan between Bangkok and Laem Chabang Port

(1) Road

As mentioned in Chapters 8 and 9, in the stage of the Master Plan, a great part of the traffic volume of 2,190,000 TEUs will be transported between Bangkok Metropolis and Central Region, and Laem Chabang Port. In addition, container-related vehicles from/to other regions (excluding Bangkok Metropolis and East Region) are expected to pass through Bangkok Metropolis, because most main roads originate from Bangkok Metropolis.

Outer Ring Road which is expected to be constructed by 2005, and then existing National Highway Routes No.34, No.3 or Bangkok-Chon Buri New Highway (81.7km) along the eastern road network (see Fig.12-5-1) connecting with the Outer Ring Road will be able to be used. That highway runs from Bangkok through three prefectures, Samut Prakhan, Chachoingsao and Chon Buri which include large-scale industrial estates and the new airport site, and links with the Chon Buri-Pattaya New Highway, traffic volume of which is forecast at 16,500-39,700 vehicles/day in the year 2000, and 25,800-61,300 vehicles/day in the year 2008 (referred to Road Development Study in the Central Region made by JICA in 1989).

(2) Railway

Railway transports container cargo between Bang Sue Terminal and Laem Chabang Port on a contract between SRT and APL, however, transport capacity of railway is limited due to its single track. SRT does not plan to construct double tracks in East Region in 7th railway development plan, but there is a plan to construct of double tracks with a length of 2,744 km in its long-term plan. It is desirable to construct between Bangkok Metropolis and Laem Chabang Port to be completed along with the development of Lard Krabang ICD.

(3) Transport Share of Road and Railway

As mentioned in Chapters 8 and 9, 2,190,000 TEUs of containers will be transported to/from Laem Chabang Port in the stage of the Master Plan, and this cargo volume is expected to be shared by road and railway considering the capacity of the existing single track railway as follows:

Road transport---2,123,000TEUs, Railway transport---67,000TEUs

Total volume of 2,123,000TEUs for road transport is estimated to be 6,150 vehicles/day per side.

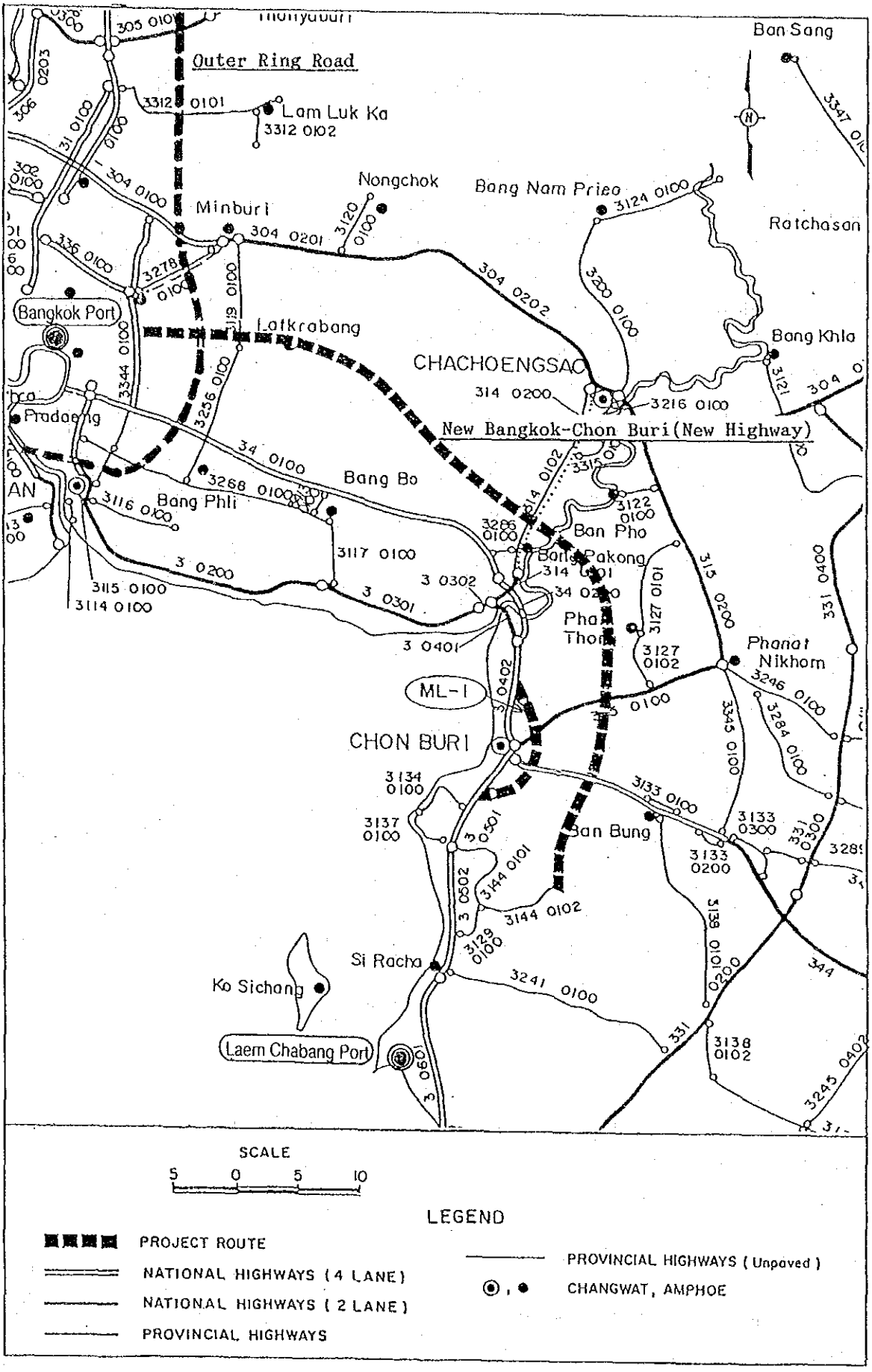


Fig. 12-5-1 Road Network between Bangkok Port and Laem Chabang Port

Chapter 13 Design and Cost Estimates

13.1 General

In the Master Plan, the following existing facilities shown in "A: Demolishing Works" are going to be demolished and the new facilities shown in "B: New Construction Works" will be constructed and the existing facilities shown in "C: Modification Works" are required to be improved.

A: Demolishing Works

1. West Quay
    1) Checking Post No.1
    2) Police Station
    3) Harbor Service Sec.
    4) Craft service Sec.
    5) Import Control & Immigration Office
    6) Export Inspection Office
    7) Vehicle Section
    8) Supplementary Sheds No.1,4,5,6,7 & 9
    9) Transit sheds No.7,8 & 9
    10) Bonded warehouse
    11) Bangkok Port Heat Office
    12) PAT O.B. Building
    13) Quay Side Cranes No.1 to No.12
2. East Quay
    1) Repair Shop for Handling Equipment
    2) Gas Station
    3) Cargo Warehouse
    4) Transit Sheds No.11 & 12
    5) Reefer Container Storage Yard
    6) Railway

B: New Construction Works

1. West Quay
    1) 2 Import CFS Sheds
    2) 3 Export CFS Sheds
    3) Maintenance Shop
    4) Container Cleaning Area
    5) Gates & Fence of CFS & Empty Container Storage Yards
    6) Container Handling Equipment & Vehicle Area

7) Port Office Building
8) Gas Station
9) Canteen
10) Fire Station
11) Trunk Road
12) Open Storages
13) Checking Post No.1
14) Railway
15) Parking Lots No.1.2.3
16) Repair Shop and Office for Container Handling Equipment
17) Vehicle Section Yard
18) Access Road and Additional Gate for Parking Lot No.2
19) Utilities

2. East Quay
1) Container Marshaling Yard
- Existing Building Area
- Surrounding Area
2) Reefer Container Storage Yard
3) 4 Transtainer Repair Areas
4) Terminal Office Building
5) Gates & Fence of Container Terminals
6) Gas Station
7) Utilities

C: Modification Works
1. West quay
1) Transit Sheds No.13 & 14
2) Transit Sheds No.1 to 6
2. East Quay
1) Bridge

MAJOR CONSTRUCTING STRUCTURE

: PAVING AREA (Without Demolished Facilities Yard)

: CONSTRUCTING STRUCTURE

1. EXPORT CFS
2. IMPORT CFS
3. CHECKING POST 1
4. GAS STATION
5. CANTEEN, FIRE VEHICLE GARAGE
6. PORT OFFICE BUILDING
7. REPAIR SHOP FOR HANDLING EQ.
8. OFFICE FOR HANDLING EQ. DIV
9. MAINTENANCE SHOP
10. EMPTY CONTAINER YARD GATE 1
11. EMPTY CONTAINER YARD GATE 2
12. EMPTY CONTAINER YARD GATE 3
13. VEHICLE SECTION YARD
14. MODIFICATION TRANSIT SHED No. 13, 14
15. TERMINAL OFFICE BUILDING
16. TERMINAL GATE 3 (EXIT)
17. TERMINAL GATE 3 (ENTRANCE)
18. TERMINAL GATE 2
19. GAS STATION
20. TERMINAL GATE 1
21. RAILWAY

Fig. 13-1-1 General Site Plan

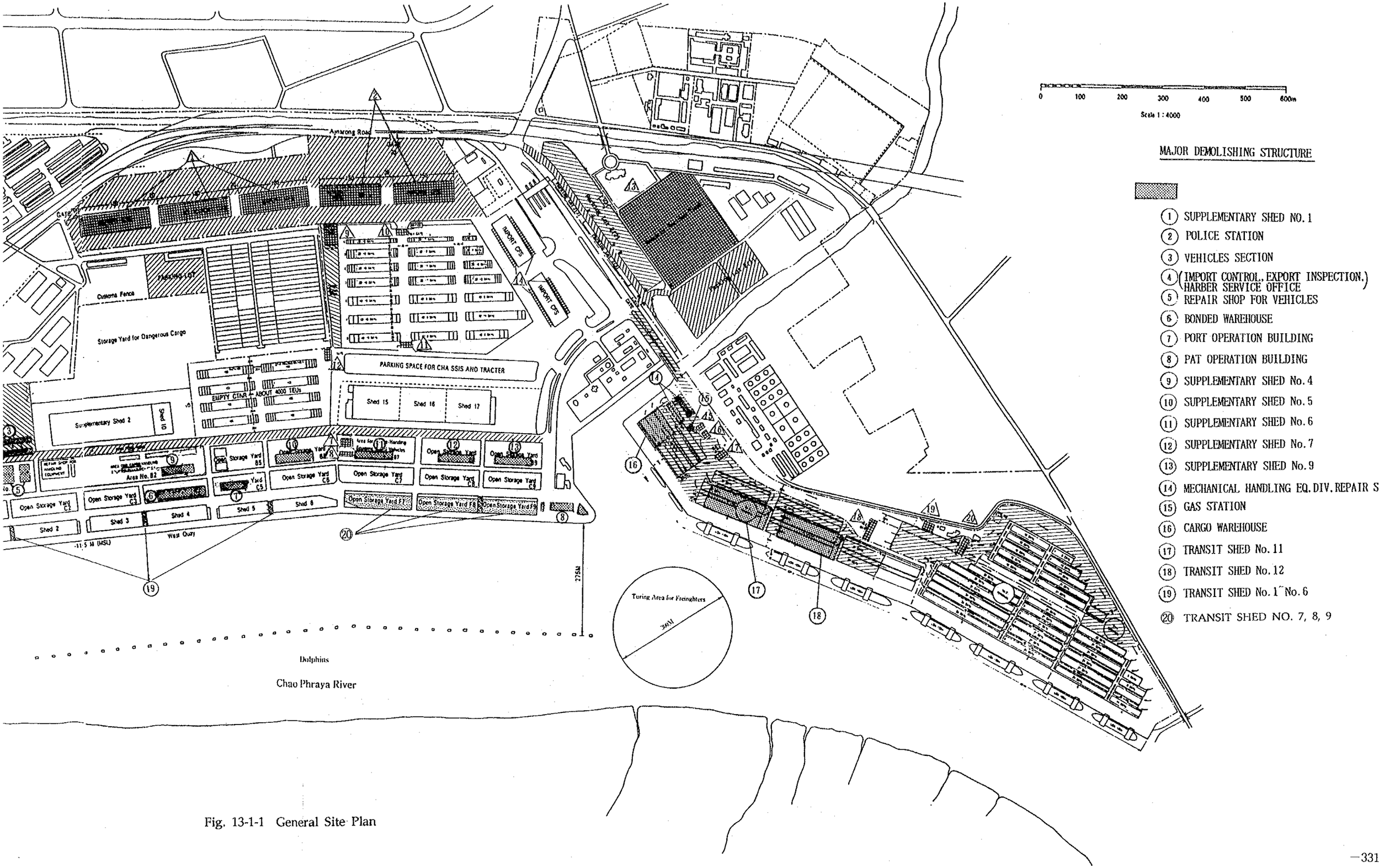


Fig. 13-1-1 General Site Plan