Contents

Introduction 1
Conclusions and Recommendations 2
1. Overview of Previous Development
   1.1 Development in the ESCAP Region 4
   1.2 Three Directions of Development 5
   1.3 Systematic Survey 6

2. Inland Water Transport in Thailand
   2.1 Inland Waterway Network 7
   2.2 Chao Phraya River System 7
   2.3 Navigability 8

3. Inland Waterway Craft in Thailand
   3.1 Preliminary Investigation 11
   3.2 Survey Questionnaire and Findings 12
   3.3 Roles of the Government 15

4. Craft Design Improvement 18

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Note: This document was first issued in 1985 for the Expert Group Meeting in ESCAP.
INTRODUCTION

Under a Special Service Agreement No. CAP/85/009, Mr. Panya Songcharoen (the Consultant from the Harbour Department, Ministry of Transport and Communications, Royal Thai Government) was assigned to carry out a study on the Improvement of Design and Construction of Inland Waterway Craft as necessary preparations for the on-coming expert group meeting. The assignment was from 25 January 1985 to 8 February 1985.

Several documents were reviewed in order to find out previous works by the Inland Transport Committee and the Inland Waterway Sub-Committee relating to the design of inland waterway craft. Documents such as Sub-Committee Reports to the Inland Transport Committee from the first to the tenth session were found useful and brief enough to go into the subject quickly. Technical details of inland waterway craft were found in several Sub-Committee meeting papers.

The Consultant had visited various sites which had considerable inland water transport activity in Thailand, namely:

(a) Lower Chao Phraya River up to Pratum Thani to inspect wooden barge, steel barge, sand barge, tug boat and other craft. Several photographs were taken. Interview with operator were carried out.

(b) The Chin River to inspect craft typically used in the region. Several photographs were taken.

(c) Canals in Min Buri and adjacent towns which are north and east of Bangkok to inspect passenger craft, long-shaft boat and country boat. Several photographs were taken. An interview with an operator was carried out.

(d) Songkhla Lake to inspect mechanized country boats as well as other country boats in the muslim community. Several photographs were taken. Interview with operator and owner were carried out.

Survey questionnaires were used for the interview. Information received during the field trips as well as old data were classified systematically. Specifications and sample drawings of barges and lighters were prepared.

Due to time limitation, detail analysis of existing inland waterway craft design and construction was not possible. Nevertheless, the present study may be judged as useful data for further studies involving particular type of craft.

CONCLUSION AND RECOMMENDATIONS

1. CONCLUSIONS

1.1 Information on inland waterway craft in countries in the ESCAP region are needed to be updated. Tasks carried out by the Secretariat as reflected in several Sub-Committee papers in connection with the improvement of craft design involved mainly three subjects. They were the design and operation of push-towing flotillas, mechanization of country boats, and the feasibility study on the use of modern high speed craft in inland waterways.

1.2 Inland waterways craft in Thailand have not been fully developed. Improvement in the design and construction of the craft is linked closely with the waterway improvement carried out by the Government. The past 10 years were the years of transition period where wooden barges are being replaced by larger steel barges, but there were no substantial improvement in tug boats.

1.3 It is expected that transport fleet in the form of push-towing flotillas will replace the conventional pull-towing convoys in the improved Chao Phraya River eventually.

1.4 There is no direct support from the Government to shipyards, not even a technical support in providing better and safer design. Shipyards and craft owners have to rely on past experience when investing in the craft.

1.5 Classification of inland waterway craft by the Government has not been carried out in a meaningful way.
2. **RECOMMENDATIONS**

2.1 Drafting of construction rules for inland waterway craft should be carried out as soon as possible in order to ensure safety.

2.2 Information on local shipyard capacity including inventories of building yards should be collected.

2.3 Detail engineering study should be carried out in order to provide standard design for high speed craft, slow speed cargo vessel, barge and tug boat.

2.4 New method of craft classification should be adopted by the Harbour Department. Registration of craft by the Department should be computerized. This should involve the engagement of experienced system analysts and programmers in setting up the system.

1. **OVERVIEW OF PREVIOUS DEVELOPMENT**

1.1 **DEVELOPMENT IN THE ESCAP REGION**

Inland water transport plays an important role in the domestic transport in many countries in the ESCAP region. Works on river training in each country have been periodically reported to the Inland Transport Committee. Development in inland water transport involved at least three basic elements: the improvement of waterways by dredging and river training, the improvement of inland port facilities and the improvement of inland waterway craft design.

Previous development in the field of inland waterway and the design of craft may be found in various reports of Inland Waterway Sub-Committee. Summary of the reports related to the design of inland water way craft submitted during the first to the ninth Inland Transport Committee session.

Works carried out by the Inland Waterway Sub-Committee up to the Third Inland Transport Committee meeting (1956) involved data collection on operational trials of push-towing flotillas carried out as a pilot project in India, Pakistan, Viet Nam and Myanmar. Transportation of goods by shallow draught barges using push-towing method was introduced. Recommendations were given to carry out hydrographic surveys in the waterways that would be used trial sites in order to analyze the effect of channel depth/draught ratio. In setting up such pilot project, financial problem was encountered. As in the case of such experiment in Pakistan, the project had to be delayed and finally modified substantially.

Mechanization of country craft and improvement of construction method was introduced following several studies during the sixties. An important point recommended by the Sub-Committee during the period was the comprehensive data collection on plans of inland waterways craft. The data collection was for small and medium size craft for shallow waters including tug boats, dumb and self-propelled barges.

Development as reported during the fourth to the ninth Inland Transport Committee session showed a marked improvement in various subjects. This included:
- successful experiment in push-towing technique;
- feasibility study on the use of hydrofoil craft in inland waterways;
- data collection on hovercraft and its application in the ESCAP region;
- mechanization of country craft including preparation, typical drawings and undertaking model tank test of such craft, and;
- comprehensive study on the use of long-tail outboard motors for small country craft.
1.2 THREE DIRECTIONS OF DEVELOPMENT

Judging from the previous development carried out by individual country in the ESCAP region, three completely different directions were apparent. The first is the gradual modernization and mechanization of existing country craft. This involves the installation of outboard motor with long propeller shaft to increase running speed. This type of craft are commonly found in canals and lakes where road transport is not available. The adoption of small portable gasoline engine that is also used for driving water pumps in paddy field makes this type of craft popular among farmers. Development in this direction is at a stage where more powerful diesel engines driving long propeller shafts are commonly used. The engine installed is no more portable and is for only one purpose that is for propulsion. This type craft are widely used in Thailand, and known as “long-tail boat”.

The second direction involves the gradual modernization of tug-barge system. With successful operation in many countries in Europe, the push-towing technique was introduced in Asian waterways. The key to the success operation may be the superior maneuvering quality of push-towing as compared to conventional pull towing technique. However, reports also shows that in some waterways where river training works are limited, conventional pull towing technique is still more suitable.

The development in this second direction seems to be geared toward obtaining greater barge cargo capacity in the confined/water depth. Modern flat bottom steel barges of about 500 d.w.t. with about 1.3 m draught may be the largest size barge to be tested successfully.

The third direction involves the comprehensive study in using more specialized passenger craft such as hydrofoil and hovercraft in the ESCAP region. Judging from the hydrographical condition in these countries where there are many shallow reaches in rivers, several swamps and limited landing facility, hovercraft may be the ideal craft for several applications. But so far, little information is available on the economical point of view. There is no comprehensive records on trials and operations of hydrofoil craft in the ESCAP at the moment.

1.3 SYSTEMATIC SURVEY

It is recommended that, judging from the present state of development, comprehensive data collections in the first and the second direction of development in the ESCAP region should be carried out. This may be done through a series of visits to important waterways. Depth interview of craft operator, owners, builders and controlling agencies should be carried out. Collections of drawings, photographs and other relevant data are essential. The main goals of such survey are:

(a) to provide a systematic pictorial collection of all inland waterway craft relevant to individual nation;
(b) to update on inland waterway craft design;
(c) to identify common characteristics of craft in order to draw up a classification in line with the classification of inland waterways and;
(d) to pave way for drafting of design guidelines, regional craft construction rules such as rules issued by ship classification societies and unified safety rules.

To achieve the goal under item (d) above, a team of expert in the field of Naval Architecture, Marine Engineering as well as Navigation should be set up. This may involve conceptual design of selected craft type. The tasks may also involve craft model tank test as well as actual trials of similar craft in operation.

The present study contains some of relevant data for inland waterway craft in Thailand only. A suggested classification of craft is made. Other data and remarks may be found in each section.
2. INLAND WATERWAY TRANSPORT IN THAILAND

2.1 INLAND WATERWAY NETWORK

Inland water transport activities in Thailand are concentrated in the Northern and the Central Regions. There are three important river basins which are of interest to the present study. They are the Chao Phraya River, the Mae Klong River and the Bang Pakon River basins. Each basin has one major inland waterway network that serves as a transport route between agricultural-rich regions to Bangkok and the Gulf of Thailand.

The Chao Phraya River basin cover about one-third of the nation’s total area. This basin covers the Northern and the Central Region. Important waterways in the basin are Ping, Wang, Yom, Nan, Upper Chao Phraya, Lower Chao Phraya, Suphan, Noi, and Pasak River. These rivers are either inter-connected or tributaries to other major rivers.

The Mae Klong River basin covers the south-western part of the Central Region. The basin is drained by the Kwae Noi and Kwae Yai Rivers which are the tributaries of the Mae Klong River. The river system originates near the Thai-Burmese border and flow southward to the Gulf of Thailand through a major fishery town of Samut Songkhram. The Band Pakong River basin covers the south-eastern part of the Central Region. The basin is drained by the Nakhon Naiyok and the Prachin Rivers which are the tributaries of the Bang Pakong River. The river runs in the south-westward to the Gulf of Thailand through the town of Chachoengsao. These latter river basins are less important in relation to inland waterways transport. Due to time limitation the present study will concentrate on the most important waterway only, which is the Chao Phraya River basin.

2.2 CHAO PHRAYA RIVER SYSTEM

The inland waterway network in the Chao Phraya River system, consists of the navigable waterways in the Chao Phraya River and its tributaries stretching over a distance of about 735 kilometers from the Gulf of Thailand up to the town of Uttaradit in the Northern Region. Interconnecting the waterways in the system are irrigation canals with several small size navigation locks.

The Chao Phraya River basin, which is served by the Chao Phraya River system, has a tropical climate influenced by the monsoon. There are two distinctive seasons of approximately equal duration: the wet summer generally last from May until November; the rest of the year consists of a dry winter season. The average annual rainfall is 1,200 millimeters over the basin.

The natural conditions of the waterways are characterized by a period of high waters lasting about five months from August to December. Then follows by a period of low waters lasting about five months from January to May. From May to August, there is a period of moderate flow.

Presently, the waterways are controlled by a series of dams and navigation locks. The Ping River, which is one of the tributaries of the Chao Phraya River, is controlled by the Bhumiphol multi-purpose dam. The average annual inflow is 6,000 million cubic meters, and its reservoir capacity is 13,500 million cubic meters. The Nan River is controlled by the Sirikit Multi-purpose Dam. The average annual inflow is 5,660 million cubic meters, and its reservoir capacity is 9,000 million cubic meters. There are these important diversion dams in the system. The Chao Phraya Dam, located in Chainat 267 km. From the Chao Phraya River estuary, diverts water into regulated rivers and irrigation canals. The dam is provided with a navigation locks. The size of the lock is 170.5 m long, 14.0 m wide, 2.0 m depth, and the lock gate width is 14.0 m.

For navigation purpose, the minimum discharge has been set at 80 cubic meters per second. The Pasak River is regulated by a diversion dam, Rama VI, located in Tha Rua. A small-sized navigation lock is provided, the Nan River is regulated by a newly finished diversion dam at Phrom Phiram. All diversion dams regulate waters into irrigation area.

2.3 NAVIGABILITY

The waterways in the main network are characterized by very broad, flat, alluvial valleys in the upper Nan River. They become narrow and meandering in the lower Nan River and several other places in the Chao Phraya River.
(a) **Nan River**
Several shoals and outcrop rocks are found in the Nan River. These make the navigation channel very shallow. Generally, the average water depth in the low water period is between 1.2 and 1.7 meters. But in some reaches, the minimum water depth becomes less than one meter. A river training project is to be implemented soon by the Harbour Department. This project involves dredging of channels as well as constructing bank protection in the Nan River. The guaranteed minimum water depth will be 1.70 meters. Navigation by conventional pull-towing or push-towing method after completion of works is feasible provided that suitable navigation aids are installed, and correct maintenance dredging works are performed.

(b) **Chao Phraya River**
In the Chao Phraya River, six main sandbanks are found upstream of the Chao Phraya Dam where the effect of the backwater cannot reach. The average width of the river is 300 meters; the minimum curve radius is about 250 meters. The minimum water depth in the low water period is about 1 meter. Downstream of the Chao Phraya Dam, seven main sandbanks are found causing the minimum water depth in the low water period to be between 0.7 to 1 meter. The average width of the river ranging from 40 to 300 meters, the sharpest bend in the reach has a radius of only 150 meters, which may be the main restriction for navigation by push-towing flotillas. The average current speed is between 0.5 to 1.3 meters per second in the period of high waters. In some areas where large quantities of sand have been dredged by private firms, the sudden change of river cross-section has resulted in greater current speed up to 2 meters per second. Tidal effect also causes great current speed in lower reach of the river where the width of the river becomes narrow. A river training project carried out by the Harbour Department is nearly completed where dredging of above-mentioned shoals has been substantially done. Construction of groynes, bank protection and installation of navigation aids are also being carried out. The minimum guaranteed water depth is 1.7 meters.

Restriction for navigation by barges and other vessels from the North to Bangkok area using the Nan and Chao Phraya route is obviously due to the followings:
- The natural navigation channels are not stable. Erosion had caused sand banks in several reaches.
- The rivers are meandering with several sharp bends.
- Sand dredging in the lower reach of the river has caused sudden changes in river cross-section. Consequently, the profile of the river is locally reduced to a dangerous level.

During the high water season (September-December) most barges carrying agricultural products from the North to Bangkok use the Chao Phraya River route which is the shortest route with only one navigation lock. The size of the lock and lock gate is large enough to accommodate fully loaded barges. But during the low water season (January-March) about 70 percent of the barge traffic have to use the regulated Suphan River, Chao Chet Canal and the Noi River route which have several small-sized navigation locks. The estimated travel speed of a fleet of conventional tug-barge during the high water season using the Chao Phraya River route is 3.7-7 km/hour downstream and 4.1-4.3 km/hour upstream. While using the alternative Suphan River-Chao Chet Canal route, the corresponding travel speed would be 2.2-3.0 km/hour and 4.0 km/hour respectively.

As the waterways in the main networks are not fully regulated, amount of water-borne traffic varies according to the seasonal changes and the availability of water depth. In the next section, we will concentrate on the main characteristics of inland waterway craft found in several important waterways.

### 3. INLAND WATERWAY CRAFT IN THAILAND

#### 3.1 PRELIMINARY INVESTIGATION

A preliminary investigation on typical inland waterways and coastal vessel was carried out by the Consultant during site visits to main towns in the Chao Phraya River, the Pasak River and various canals outskirt of Bangkok. Several photographs were taken. Interview with vessel owners and operators were also carried out.
The purpose of the site visit and the interview is to pave way for future classification of craft and to identify problems related to the existing design and operation. To classify inland waterways craft in a meaningful way, it is suggested that self-propelled and non self-propelled craft should be classed separately. Furthermore, the craft should also be classed according to type of cargo they usually carry. It is to be noted that many craft classified by the Harbour Department as coastal vessel are in fact regarded as inland waterway craft also because they are utilized as lighter rather than the real coastal vessels.

By observation, inland waterway craft in Thailand may be classified in different categories as follows:

(a) **Self-propelled vessel**
- mechanized country boat (Figure 5)
- wooden river freigher (Figure 6)
- wooden tug boat (Figure 7)
- steel tug boat (Figure 8)
- cross canal/river passenger ferry (Figure 9)
- cross canal/river passenger/car ferry (Figure 10)
- long-tail boat (Figure 11)
- high speed passenger boat (Figure 12)

(b) **Non self-propelled vessel**
- wooden river barge (Figure 13)
- steel river sand barge (Figure 14)
- steel river dry cargo barge (Figure 15)
- steel river cement/oil barge (Figure 16)
- steel lighter (Figure 17)
- wooden lighter (Figure 18)
- sampan (Figure 19)
- country boat (Figure 20)

Random survey of river craft in the form of interview were carried out by the Consultant in February 1985. Several photographs were taken. Four types of inland waterway craft were concentrated upon. They were:

- craft for passenger transport in lakes and small canals
- craft for dry agricultural product transport
- craft for sand dredging activities, and
- tug boat

### 3.2 Survey Questionnaire and Findings

In order to obtain useful information concerning the inland waterway craft, a basic questionnaire was prepared. It consisted of general information about the craft concerned as well as the information on operation.

The contents in the questionnaire are as follows:

(a) **General information**

1. Type of craft
2. Hull dimensions
3. Type of engine
4. Cargo deadweight/working capacity
5. Name of building yard
6. Cost of hull
7. Cost of machinery
8. Age of craft
(b) Information on operation

1. Type of cargo carried
2. Operating area
3. Expenses for:
   - Fuel oil;
   - crew;
   - tug boat fees;
   - others
4. Ownership of the craft
5. Accident in the past
6. Sexes of crew members
7. Relationship among crew members
8. Educational level
9. Net income
10. Main obstacle to the operation

Findings during the survey and interview can be summarized as follows:

3.2.1 Craft for passenger transportation in lakes and small canals and rivers

Most of these craft are installed with long propeller shaft engine. In Songkhla Lake, where roads are not fully developed, the craft are used for passenger transport as well as for shallow water fishing industries (see Figure 5). Some of them are dug-out canoes installed with a 10 h.p. gasoline engine. But in the Central region, such craft takes the form of stepped hull high speed boat known as long-tail boat. Engines installed on these craft have become bigger. Usually they are 6-cylinder, 60 h.p. automotive diesel engine adapted for marine uses.

Various types of hull shape are found but almost all of them have poor seakeeping quality, very loud noise and not safe. The present Government has tried to impose heavy penalty on operator of long-tail boats with loud noise. An 85 decibel noise level limit is being imposed upon. More and more craft of this type will be made of glass fiber reinforced plastic (GRP) because this type of material become more well known to local people.

3.2.2 Craft for dry agricultural product transport

Two types of craft are commonly used. They are wooden barge or steel barge. Most of wooden barges are 15-20 m long. 3-6 m wide and 1-3 m deep. The carrying capacity is between 50-120 tons. They are usually fitted with a light grade galvanized steel hatch cover. Navigation in shallow rivers often found dangerous due to under water groynes.

Steel barges are of many different sizes. The average size of steel barge operated in improved Pasak River is 35 m long. 8-10 m wide and 3-4 m deep. But in the Chao Phraya River, much smaller barge are found.

Crew on board the barges are usually from the same family, and their educational level are often in the range of elementary school level 4. The average income is 1,800 Baht/month.

There is a tendency toward building more steel barges to replace wooden ones due to the fact that woods for shipbuilding are more difficult to obtain. All steel barges are made for conventional pull towing method. Most of the barge operator do not believe that push-towing method would be possible in rivers. This may be from the fact that no demonstration project using pusher tug and barge system has been implemented yet. However private and public agencies such as the Electricity Generating Authority of Thailand (EGAT) have shown interest to adopt push-towing method for their transport fleet provided that suitable navigation aids are installed.

Improvement in the design of barges should be geared towards better deadweight/draught ratio, simpler construction method and safer towing technique. More details discussion of such design improvement are given in the next section.
3.2.3 Craft for sand dredging activities

Sand dredging activities in the Central region are found in various rivers. In the Chao Phraya River, dredging of sand to be used as construction material is concentrated in Ayutthaya and Nakor Sawan Province. The estimated amount of sand dredged yearly in this province is close to 500,000 tons. There are about 24 units of bucket and suction dredgers, all of them belong to private companies.

The average size of sand dredger is 15-20 m. long, 5-7 m. wide, and 1.5-2 m. deep. The dredging capacity is not clearly known. All dredgers are locally built. The normal engine installed in dredgers are two 90 H.P. diesel engines, one for propulsion and one for dredging equipment.

Dredged sand is usually discharged to hopper barges along side and transshipped to shore from the barges by conveyors. Hopper barges are of simple design. The usual size of the barge is 22 m. long, 6-7 m. wide, and 2 m deep. The hopper capacity is about 200 Cu.m. (see Figure 24)

Craft for sand dredging activities, even though very few in numbers, contribute substantially to the inland water transport. Many barges are built exclusively for carrying dredged sand from deports near the dredging site downstream to Bangkok. These type of barge are usually found heavily loaded with negative freeboard. Often enough, the loaded waterline is up to the hatch coaming level with 90% of the hull submerged. (see Figure 14) Sand barge pulled by tug boats in a convoy 3-4 barges are found dangerous to navigation. Typical shape of sand barge is similar to Figure 45. They are slightly shorter than dry cargo barges.

3.2.4 Tug Boat

Tug boats operating in important rivers and canals are mainly wooden tug boat of about 8-12 m. long, 2-2.5 m. wide and 0.5-0.8 m. deep. The average size is 3-6 grt (see Figure 7 and 22). The hull construction is rather simple with one common space for living and for propulsion engine. Therefore, there is absolutely no protection for noise and vibration from engine. There are marked different in the bow design for tug boats operating in Bangkok Port area and the ones operating in narrow rivers. The former has ship shape bow to negotiate small wave, while the latter has wide and flat bow for landing. The common main engine installed is 150-250 H.P. diesel engine. Presently there are about 1,000 river tug boat registered in Thailand. Very few are steel tug boats. The market for building such small tug boats is limited.

As the size of barges and lighters tends to increase, many tug boat owners renew their tug boat main for higher power in order to obtain higher bollard pull. This is undoubtedly limited by the availability of propeller – hull clearance. No kort nozzle has been used successfully on such tug boat. The main objection to the use of kort nozzle is that there are too much water hyacinth in various waterways. Most wooden tug boats are fitted with a trimming board at the stern above the propeller. This simple fitting give relatively good flow at stern and seems to give better propeller efficiency. Like other wooden craft, most wooden tug boats are made of popular hard wood “Hopea Odorata”. However, this kind of wood becomes more difficult to find.

3.3 ROLES OF THE GOVERNMENT

3.3.1 GOVERNMENT’S SUPPORT

The Harbour Department and the Royal Irrigation Department are the main government offices directly responsible for the inland waterway transport. The Harbour Department plays an important role in the safety of navigation in major waterways, while Royal Irrigation Department operates navigation locks and regulates the water discharge from several dams. The two departments although working under different ministry, have fairly good coordination in providing suitable waterway maintenance. Several waterway improvement projects were carried out by both departments independently. The Harbour Department will complete the third phase of inland waterways improvement project shortly. Under this project, a 1.7 m minimum guaranteed channel depth in the Chao Phraya River is expected, provided that proper control of rate of discharge is obtained. Two small river ports will be constructed to handle mainly the agricultural products. A pilot convoy of 500 H.P. pusher tug and 4 x 700 DWT. barges will be built and tried out in the improved waterways.
3.3.2 INLAND WATERWAY CRAFT STATISTICS

According to the Thai Vessel Act B.E.2481 (1938), the Harbour Department, Ministry of Communications is the Government office responsible for registration of Thai vessel. The Act requires that non self-propelled craft of 50 grt and upwards, and self-propelled craft of 10 grt and upwards need to have a Certificate of Nationality and Tonnage. All motorized craft and non self-propelled craft of over 1.5 grt are also required to be duly surveyed by the Government surveyor in accordance with related national safety regulations. Craft survey form and certificate contain some information which are regularly collected. Similarly, random surveys of cargo traffic at navigation locks and free flow check points are regularly carried out. Judging from the above survey the following conclusion can be drawn:-

(a). Total water-borne cargo traffic from the North to Bangkok is about 1-1.3 million tons yearly. Sand still represents the biggest items (400,000-500,000 tons/year). Maize is the second most important cargo from the North (about 250,000-380,000 tons/year). Paddy and rice also important cargo from the North (about 200,000-380,00 tons/year of paddy, and about 100,000-200,000 tons/year of rice)

(b). The present in land waterway fleet comprises about 10,074 self-propelled craft totaling 50,095 grt; and about 7,758 non self-propelled craft totaling 358,158 grt.

(c) Classification of craft by the Harbour Department seems to be for the purpose of registration and survey fees collection only. Types of craft included in the non self-propelled inland waterway craft are wooden lighter, wooden barge, and steel barge. Types of craft included in the self-propelled inland waterway craft are passenger boat, passenger/tug boat, passenger/cargo boat, cargo boat, pleasure vessel, dredger and oil tanker. It is suggested that a more systematic classification of registered craft using the current informations be carried out

(d ) The followings represent the most common sizes of inland waterway craft:-

<table>
<thead>
<tr>
<th>Type of Craft</th>
<th>Length (m)</th>
<th>Breadth (m)</th>
<th>Depth (m)</th>
<th>GRT</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Passenger Boat</td>
<td>8.5-9.7</td>
<td>1.2-2.0</td>
<td>0.5-0.6</td>
<td>1.1-3.0</td>
</tr>
<tr>
<td>- Passenger/Tug boat</td>
<td>9.7-12.4</td>
<td>2.0-2.5</td>
<td>0.6-0.7</td>
<td>3.1-6.0</td>
</tr>
<tr>
<td>- Passenger/Cargo Boat</td>
<td>8.5-9.7</td>
<td>1.2-2.0</td>
<td>0.5-0.6</td>
<td>1.1-3.0</td>
</tr>
<tr>
<td>- Cargo Boat</td>
<td>8.5-9.7</td>
<td>1.2-2.0</td>
<td>0.5-0.6</td>
<td>1.1-3.0</td>
</tr>
<tr>
<td>- Pleasure Vessel</td>
<td>12.4-18.0</td>
<td>2.5-3.0</td>
<td>0.7-0.8</td>
<td>6.1-10.0</td>
</tr>
<tr>
<td>- Dredger</td>
<td>22.0-24.0</td>
<td>4.5-5.3</td>
<td>1.9-2.1</td>
<td>40.1-60.0</td>
</tr>
<tr>
<td>- Oil Tanker</td>
<td>18.0-19.0</td>
<td>3.0-3.5</td>
<td>0.8-1.5</td>
<td>10-20</td>
</tr>
<tr>
<td>- Wooden Lighter</td>
<td>25.2-32.2</td>
<td>7.2-8.4</td>
<td>2.9-3.7</td>
<td>100-200</td>
</tr>
<tr>
<td>- Wooden Barge</td>
<td>18.0-19.0</td>
<td>3.0-3.5</td>
<td>0.8-1.5</td>
<td>10-20</td>
</tr>
<tr>
<td>- Steel Barge</td>
<td>25.2-32.2</td>
<td>7.2-8.4</td>
<td>2.9-3.7</td>
<td>100-200</td>
</tr>
</tbody>
</table>

3.3.3 LONG-TERM PLAN

In the past 20 years, the Government had not put sufficient interest in the inland waterway transport. From the total length of 5,900 km of waterways, only about 1,000 km is now navigable all year round. The present fifth National Economic and Social Development Plan reflects the Government’s attention to the water transport. The following targets are to be reached by 1986:-

- The total amount of inland water transport traffic, not including construction materials, is to increase from 1,549,000 tons in 1978 to 2,200,000 tons in 1986
- Two new river ports in the Chao Phraya and Nan River are to be completed.
- Transport of goods by pusher tug and barge convoy of 4 x 700 DWT are to be possible all year round from Bangkok to Nakorn Sawan Province.

It is to be noted that the long term targets do not include any project related to small ship yard improvement which, in the Consultant’s view, needs to Government support substantially. This can be in the form of technical studies for the improvement of craft building method, or in the form of subsides to the yard in building standard craft.
4. CRAFT DESIGN IMPROVEMENT

As stated in the last section, improvement of inland waterway craft design can only be achieved by the initiation of the Government. At the present time, there is no definite guideline or standard in the designing of such craft. High speed passenger craft or long-tail boats are fully developed to the point that safety of human on board is questionable. This due to failure of the Government to control the size of engine installed and the noise pollution involved. There should be a special regulation for such craft.

Many wooden and steel barges, which represent important element in the transport industry, are built without any acceptable standard or drawings. Scantling of such craft are found irregular. Some part of the hull are found under scantling, and some part are over designed as compared to any construction rules issued by international ship classification societies such as Lloy’d Register of Shipping (LR) or American Bureau of Shipping (ABS).

To provide foundation for design improvement, the following steps are suggested:-
(a). A comprehensive study on shipyard capacity should be carried out in order to identify main problem involving design and construction of inland waterway crafts. The study should include inventories of craft building and repairing facilities.

(b). Classification of inland waterways and craft by the Government should be adjusted to a more systematic way.

(c). Detail study on the design of high speed craft, slow speed cargo vessel, barge and tug boat should be carried out simultaneously. The study should involve purely technical analysis including:-
   - towing tank test of selected models
   - propulsion test
   - structural design analysis using computer to optimize the structural strength. Standard design of the above craft should be provided free of charge to prospective craft owners and shipyards in order to anchorage them to use standardized design.

(d). Drafting of inland waterway craft construction rules should be carried out both in English and Thai through technical collaboration between the Harbour and ESCAP. Since there is no such special rule existed.

As an initial step towards a more systematic design of craft, it is suggested that details of conditions and requirements should be obtained.

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Figure 5: Mechanized Country Boat

Figure 6: Wooden River Freighter
Figure 7: Wooden Tug Boat

Figure 8: Steel Tug Boat
Figure 9: Cross Canal / River Passenger Ferry

Figure 10: Cross Canal / River Passenger / Car Ferry
Figure 11: Long – Tail Boat

Figure 12: High Speed Passenger Boat
Figure 13: Wooden River Barge

Figure 14: Steel River Sand Barge
Figure 15: Steel River Dry Cargo Barge

Figure 16: Steel River Cement / Oil Barge
Figure 17: Steel Lighter

Figure 18: Wooden Lighter
Figure 19: Sampan

Figure 20: Typical Country Boat
Figure 21: General Cargo Barge in Pasak River

Figure 22: Typical River Tug Boat
Figure 23: Main Engine Installed in River Tug Boat

Figure 24: Typical Sand Hopper Barge
Figure 25: Typical Sand Hopper Barge (con't)

Figure 26: Typical Sand Section Dredger
Figure 27: Unloading of Dredged Sand to Shore

Figure 28: 600 D W T Barge in Pasak River
Figure 29: Wooden River Barge in Narrow River

Figure 30: Sand Barge in Narrow River
Figure 31: Bow View of Wooden Barge

Figure 32: Galvanized Steel Hatch Cover Fitted on Wooden Barge
Figure 33: Typical Cargo Hold in Wooden Barge

Figure 34: Typical Private Sand Bucket Dredger
Figure 35 : Engine Installation in Sand Suction Dredger

Figure 36 : Bow View of Sand Barge
Figure 37: Hopper Arrangement in Sand Barge

Figure 38: Mechanized Wooden Barge
Figure 39: Barge Being Built in Panels

Figure 40: Typical Bow Structure of Steel Barge
Figure 41: Various Types of Bow for Lighter

Figure 42: Typical Wooden Barge Repairing Yard
Figure 43: Typical Steel Barge Repairing / Building Yard

Figure 44: Typical Steel Barge Framing System
After receiving a bachelor degree in Naval Architecture and Marine Engineering from U of Michigan, Ann Arbor and a master degree in Naval Architecture from University of California, Berkeley, U.S.A. under Thai Government scholarship, Panya worked in the Thai Marine Department, Ministry of Transport as a ship surveyor and the Chief of Plan Approval Section for about 18 years. He set his own consulting firm after resigning from the government carrier. His past achievement included various design of general cargo ships, container ships, passenger ferries, tug boats, shipbuilding and repairing yards, etc. He is now the chief naval architect in Navis Consult Ltd., Part. With his government surveyor background, Panya can contribute greatly to ship / yacht design work with ship classification society standard.