Guidelines for the Harmonization of Navigation Rules and Regulations

Volume 1. Aids to Navigation

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Preface

The ESCAP region is naturally endowed with rich navigable rivers, lakes and canals. Many countries have favourable natural conditions and great potential to develop inland water transport, such as Bangladesh, Cambodia, China, the Democratic People’s Republic of Korea, India, Indonesia, Kazakhstan, Kyrgyzstan, the Lao People’s Democratic Republic, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, the Philippines, the Republic of Korea, Sri Lanka, Thailand and Viet Nam. The total navigable length of inland waterways in the region exceeds 186,000 kilometres. On those inland waterways nearly 1 billion tons of cargo and half a billion passengers are moved each year. The fleet plying inland waterways is estimated to consist of more than 420,000 vessels with a carrying capacity of 27.5 million tons. In addition, millions of country boats carry both cargo and passengers to complement formal shipping services. Millions of people are employed on boats.

However, aids to navigation, as fundamental elements for safe navigation on inland waterways and an essential part of navigation rules and regulations, have not been safely provided on many inland waterways of the region. The systems of aids to navigation change in different countries, different rivers and even on the same river. Some of the systems are in complete conflict, which often causes traffic accidents on inland waterways and endangers people’s lives and properties.

The Greater Mekong River is an example of such an unfortunate situation. The Greater Mekong River flows through Cambodia, China, the Lao People’s Democratic Republic, Myanmar, Thailand and Viet Nam. It provides a low-cost, environmentally sound transport corridor for regional and international trade. River transport has acquired an important role in the Mekong Delta and has grown rapidly in the Upper Mekong area. However, no harmonized system of aids to navigation has been put in place. As a result, this is endangering the lives of passengers and the environment of the river. There is also a risk that investment in aids to navigation in the future could be wasted if they do not follow a harmonized aids to navigation system.

In order to promote safe navigation on the Greater Mekong River, the Economic and Social
Commission for Asia and the Pacific (ESCAP) and the Mekong River Commission (MRC), with funding support from the Governments of Finland and the Netherlands, jointly initiated a project on the harmonization of aids to navigation systems in 2000 to assist the riparian countries in formulating and implementing a harmonized aids to navigation system which will provide a common basis for safe navigation. This current publication was prepared by the Transport, Communications, Tourism and Infrastructure Development Division of ESCAP, based on the study on aids to navigation for implementing the ESCAP/MRC joint project. It is expected to demonstrate how the navigation rules and regulations, in particular aids to navigation, could be harmonized.

ESCAP would like to express appreciation to the organizations that provided indispensable information and replies to the questionnaire, and to all contact persons of the ESCAP/MRC joint project for their excellent collaboration.
DEFINITIONS AND ABBREVIATIONS

aid to navigation: Any object external to a vessel created to help mariners determine their position and safest course, not including landmarks.

ATON: Aid to navigation.

audible ATON: Any floating or fixed aid that sounds a bell, whistle, gong or horn.

beacon: Any fixed structure in or near water.

buoy: Unmanned floating marker anchored to the bottom, other than a lightship.

buoyage: A system of buoys.

cardinal system: Set of marks set at the cardinal points around a dangerous area, which needs to be used in conjunction with the mariner’s compass.

carrying capacity: Maximum amount of cargo and/or number of passengers that a vessel is capable of carrying within safety limits.


channel: Portion of a river, canal, lake or other stretch of water for navigation.

dwt: Deadweight tonnage.

ECAFE: Economic Commission for Asia and the Far East, predecessor of ESCAP.

ECE: Economic Commission for Europe.

ESCAP: Economic and Social Commission for Asia and the Pacific.

harmonization: To make something fit together well, to bring into harmony.

IALA: International Association of Marine Aids to Navigation and Lighthouse Authorities.

Lateral system: Marks indicating points along the area of safe water.

left/right sides: On rivers, the terms Aleft@ and Aright@ shall respectively mean to the left and to the right of an observer facing downstream; on canals and lakes, they are decided by competent authorities in the light of local conditions (used for buoyage on inland waterways).

light: Luminous or lighted aid to navigation.

mark: Visible object of known position serving as a guide or point of reference for navigation.

MRC: Mekong River Commission.

navigation aid: Instrument or device carried on board to assist the navigation of a craft.

port/starboard sides: Left/right hand sides of the mariner when approaching a harbour, river, estuary or other waterway from seaward, or determined by the proper authority in consultation with neighbouring countries (used for maritime buoyage).

radio ATON: Any floating or fixed aid that transmits a radio signal.

Regions A and B: Two regions in the IALA Maritime Buoyage System where lateral marks differ: Region A adopts a red colour for the port-hand side while Region B uses a green colour for the port hand side (Region B includes the American Continent, Japan, the Republic of Korea and the Philippines, and Region A covers the rest of the world).

seagoing vessel: Vessel which normally operates at sea, although it may ply inland routes.
<table>
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<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>shore mark</td>
<td>Conspicuous object, structure, or light established on shore to serve as an indicator for guiding or warning a craft</td>
</tr>
<tr>
<td>sign</td>
<td>Roadway-associated feature which provides information to passing vessels</td>
</tr>
<tr>
<td>signal</td>
<td>Sign given by a mechanical device or illuminator to convey a warning or other information for navigation</td>
</tr>
<tr>
<td>SIGNI</td>
<td>Signs and Signals on Inland Waterways, recommended by ECE</td>
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<tr>
<td>topmark</td>
<td>Characteristic shape secured at the top of a buoy or beacon to help in its identification</td>
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<tr>
<td>visual ATON</td>
<td>Simple arrangement of colours, shapes, numbers and light characteristics employed to mark a channel</td>
</tr>
<tr>
<td>waterway</td>
<td>River, canal, lake or other stretch of water that, by natural or man-made features, is suitable for navigation</td>
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I. BACKGROUND

The Greater Mekong River provides natural and economic transport access to vast areas of six riparian countries, Cambodia, China, the Lao People’s Democratic Republic, Myanmar, Thailand and Viet Nam. It also provides a low cost, environmentally sound transport corridor for regional and international trade. The further development of transportation on this river will greatly stimulate small scale industries and agricultural investment in this subregion and improve the living conditions of millions of people who are presently unable to gain access to even the most basic social services.

River transport has acquired an important role in the Mekong Delta and has grown rapidly in the Upper Mekong area. With the recent development of inter country trade along the Greater Mekong River, border-crossing river transport has also expanded gradually. China and the Lao People’s Democratic Republic and also China and Myanmar have signed bilateral agreements for commercial navigation on the Lancang-Mekong River. In April 2000, China, the Lao People’s Democratic Republic, Myanmar and Thailand signed a quadrangle agreement for commercial navigation on the Lancang-Mekong River. Cambodia and Viet Nam have also prepared an agreement for river navigation between the two countries. Approaches to an agreement for transit procedures for seagoing vessels are under process. All of these agreements will further promote international river transport among the six riparian countries.

With the growth of international and domestic river transport, most riparian countries are striving to rehabilitate their damaged aids to navigation or install new systems. However, the vital regulatory system and technical standards have not yet been established at the subregional level and no harmonized system of aids to navigation has been put in place. As a result, this is endangering the lives of passengers and the environment of the river. There is also a risk that investment in aids to navigation in the future could be wasted if they do not follow a harmonized aids to navigation system.

In order to promote safe navigation on the Greater Mekong River, the Economic and Social...
Commission for Asia and the Pacific (ESCAP) and the Mekong River Commission (MRC), with funding support from the Governments of Finland and the Netherlands, jointly initiated a project on harmonization of aids to navigation systems in 2000 to assist the riparian countries in formulating and implementing a harmonized aids to navigation system that would provide a common basis for safe navigation.

Many countries in the ESCAP region have not yet developed their aids to navigation systems. There are also several other international navigable rivers in this region. Common or well harmonized national and regional aids to navigation systems will be essential for efficient and safe navigation as well as cooperation among the riparian countries. This publication presents the information collected for the ESCAP/MRC project and methods applied for the study on the harmonization of aids to navigation systems on the Greater Mekong River to provide information and demonstrate the approaches for the development of such a system or harmonization of national systems or regional systems.
II. OVERVIEW OF THE STUDY PROCESS

A questionnaire covering waterway properties, waterway administration, waterway use, aids to navigation, education and training, and international cooperation, as shown in annex I, was prepared and dispatched to the six riparian countries. The replies to the questionnaire were carefully prepared by the countries.

Subsequently, an ESCAP/MRC team visited all the six riparian countries to acquire an overview of inland water transport systems, existing systems of aids to navigation and points of view on harmonization of aids to navigation from officials and professionals in the ministries responsible for transport, national Mekong committees, government authorities for inland waterways and inland water transport, port authorities, shipping companies, training schools, aids to navigation manufacturers and pilots. In total, the mission met 111 people from 48 organizations. The team also visited sites on and along the river to acquire field information on the conditions of the waterway, aids to navigation in use and their maintenance. The study reviewed the Maritime Buoyage System recommended by the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), the European Code for Inland Waterways (CEVNI) and Signs and Signals on Inland Waterways (SIGNI) by the ECE, the Uniform System of Buoys and Shore Marks for Inland Waterways in Asia and the Far East by the Economic Commission for Asia and the Far East (ECAFE, predecessor of ESCAP), and the aids to navigation systems in the United States of America and on Argun/Ergun He-Amur/Heilongjiang-Ussuri/Wusuli Rivers bounding China, Mongolia and the Russia Federation. It also reviewed the past studies relating to aids to navigation.

Based on all the information gathered, the quantified data were listed in a table as provided in annex II and the aids to navigation systems were summarized in a chart as given in annex III. The summary chart of aids to navigation systems covers the existing systems applied in the six riparian countries and other international/regional recommendations in which various types of aids to navigation are grouped on a comparative basis.
The comparison and analysis were undertaken to compare the commonality and differences in the aids to navigation in different countries in connection with the IALA Maritime Buoyage System and CEVNI/SIGNI. The possible conflict or confusion with other types of aids to navigation in different systems were also analysed in this process. Particular attention was paid to the fitness of various marks and buoys to the river conditions and countries=capabilities in production, maintenance and use of them.
III. PHYSICAL CHARACTERISTICS OF THE GREATER MEKONG RIVER

The source of the Greater Mekong River is some 5,060 metres above sea level in the Tanggulashan Mountains on the Tibetan Plateau of China. It flows about 4,800 kilometres to reach the sea in Viet Nam, of which roughly 2,130 kilometres are within the territory of China; some 30 kilometres as the boundary between China and Myanmar; around 230 kilometres as boundary of the Lao People’s Democratic Republic and Myanmar; about 1,660 kilometres partly as the boundary between the Lao People’s Democratic Republic and Thailand, and partly within the Lao People’s Democratic Republic; 500 kilometres in Cambodia; and 250 kilometres in Viet Nam. The sketch map of the river is shown in figure 1.

The river runs across plateau for 556 kilometres, through canyons for 821 kilometres, between medium-low mountains and through wide valley areas for 708 kilometres, hilly areas for 2,174 kilometres, and flood plains and delta for 545 kilometres. Its gradient is 0.323 per cent in mountainous regions, 0.023 per cent in plain areas and 0.0085 per cent in the delta area. As a result of the seasonal fluctuations, the water levels vary considerably between the high water season (September to November) and the low water season (February to April) by 14 metres in Luang Prabang, 13 metres in Vientiane and 8.5 metres in Phnom Penh. The maximum tidal range is 3.6 metres at the river mouth and the influence of the tide is felt up to Phnom Penh.

The average discharge of the river is 15,000 m$^3$/s. The sediment content is dense owing to severe bank erosion and bed scour. The water is brown in colour throughout the navigable sections of the river.

The sectional characteristics of the river are detailed as follows:

(a) From the spring to Nandeba

The river is called Lancang Jiang or the Lancang River in China. It leaves the Tibetan Plateau and races turbulently in deep, steep-sided canyons and valleys through the mountainous tracts of China. This section has nearly no commercial navigation. In the long-term plan of the Yunnan Province of China, the stretch between Yongbao Bridge and Nandeba, about 450 kilometres, will be opened for navigation through channel improvement.

(b) From Nandeba to the Friendship Triangle

This section passes through Yunnan Province of China and a short boundary section between China and Myanmar to the Friendship Triangle (also called the Green Triangle at a boundary between China, the Lao People’s Democratic Republic and Myanmar.
The river in this section runs through rolling mountains covered with dense subtropical forest and vegetation. For the past 20 years, China has been improving the river for navigation on the river stretch in China through rock blasting and channel regulating. Now, the regulated stretch is free from reefs and rapids and can accommodate ships of 150 - 300 tons the year round. One of the regulation works in this stretch is shown in figure 2.

In the river stretch of about 30 kilometres forming the border between China and Myanmar, eight rapids and shoals hinder navigation during the low water season. The navigation channel meanders by rock reefs and outcrops creating swift currents. Ships plying this stretch are restricted to 60 tons in the dry season and 150 tons in the high water season.

The free navigation area indicated in the quadrangle Agreement on Commercial Navigation on the Lancang-Mekong River starts from Simao in Yunnan Province, around 150 kilometres to the first border post on the river border between China and Myanmar. Three major ports, Simao, Jinghong and Guanlei, are being expanded and upgraded to increase their capacities in handling regional river traffic among the four upper countries, namely China, the Lao People’s Democratic Republic, Myanmar and Thailand. Two bridges spanning the river have been built in Jinghong, China.

(c) From the Friendship Triangle to the Golden Triangle

This part of the river forms the border between the Lao People’s Democratic Republic and Myanmar down to the Golden Triangle, a boundary area of the Lao People’s Democratic Republic, Myanmar and Thailand. The mountains along the river are rich in natural subtropical forest.

The river passes through rock formations and is littered with rock protrusions, outcrops, reefs and snags. Navigation is also hampered by sharp bends, eddies, strong currents and narrow passages. There are in total 57 rapids and hazardous places, three shallow shoals and two single-lane stretches in this section, which hinder safe and efficient navigation. One of the hazardous rapids is shown in figure 3. This river section is in its natural state and hauling assistance is required for ships to go over rapids in some places. It is navigable year round for vessels of up to 60 tons.
Myanmar has set up two ports at Wan Seng and Wan Pong, and the Lao People's Democratic Republic is constructing a port at Muang Mom to handle regional traffic among the upper four countries.

(d)  **From the Golden Triangle to Luang Prabang**

This section is partly the border of the Lao People's Democratic Republic and Thailand, and partly within the territory of the Lao People's Democratic Republic. The river goes through hilly areas with tropical forest and vegetation. Mostly the obstacles in this section are reefs and snags scattered in the river, outcrops, protruding rocky bed, sharp bends and narrow channels. In some stretches, the river has low sand islands and shallow shoals. In total there are 77 rapids and shoals in this river section. A river stretch with rapids is shown in figure 4.

This section is also in a natural state without basic improvement. Year-round navigation is possible, but hampered by rocky passages, outcrops, sharp bends and rapids. Maximum boat capacity is 50 tons.
Under the quadrangle Agreement on Commercial Navigation on the Lancang-Mekong River, regional traffic can freely go down to Luang Prabang in the Lao People’s Democratic Republic. Thailand has newly built some terminals in Chiang Saeng and Chiang Khong to handle the regional traffic under this agreement.

(e) From Luang Prabang to Vientiane

This section is also partly the border of the Lao People’s Democratic Republic and Thailand and partly within the territory of the Lao People’s Democratic Republic.

It passes through hills and is in a natural state without improvement. Major obstructions to navigation are reefs, outcrops, narrow channels, rapids, braided courses and sharp bends. There is a total of 72 rapids and shoals in this river section. Floating logs also endanger safe navigation. A stretch of the river near Vientiane is shown in figure 5.

Figure 5: Stretch of the river with rapids near Vientiane

Navigation is possible for boats with a capacity of 80 tons during the mean and highwater season. During the dry season only boats with appropriate characteristics (maximum 30 tons) and skilled pilots can negotiate the swift currents combined with the sharp bends. Owing to the rapids about 40 kilometres downstream from Luang Prabang, goods and passengers going from Vientiane to Luang Prabang need to switch to trucks or buses at Pakkhon to complete the trip by road.

(f) From Vientiane to Savannakhet

This section is shared by the Lao People’s Democratic Republic and Thailand.

The river mainly goes through a flood plain with some hilly sections. Tropical vegetation covers the banks of this river section. Difficult passages owing to rock outcrops and sand bars are encountered at a number of places all the way on this section. Some of them may reduce channel width to 25 metres although the river is wide. During the low water season, depth may be restricted to 0.70 metres because of shallow sand bars and rocky outcrops, thereby preventing navigation, except for small boats. There are 10 reefs and shallow shoals.

It is possible for vessels of up to 300 tons in capacity to ply in the high water season. In
1986, a modern port with a design capacity of 200,000 tons per year was built at Keng Kabao, 27 kilometres from Savannakhet. This stretch of river was improved during construction of the port by rock blasting. Except for this stretch, this section is in its natural state. There is a bridge near Vientiane built to link the Lao People’s Democratic Republic with Thailand.

(g) From Savannakhet to Veune Kham

This section is partly bordering the Lao People’s Democratic Republic and Thailand, and partly within the Lao People’s Democratic Republic.

It passes through a mix of hilly areas and flood plains with tropical vegetation. There are 37 reefs, rapids and shallow shoals. Quite a number of rapids spreading over 60 kilometres in the vicinity of Khemmarat restrict navigation to the mean and high water seasons only. However, during the high water period, current velocity in some places may be as high as 4 to 5 m/s between narrow rocky gorges, hampering navigation.

The stretch between Savannakhet and Pakse was used for navigation in the old days during the high and mean water seasons. However, it was abandoned in 1935 upon the opening of the highway from Ho Chi Minh City to Savannakhet.

Regular navigation for vessels of up to 100 tons resumes downstream of Pakse to Khinak, upstream of the Khone Falls. In the past ships of up to 300 tons in capacity could be used on this stretch. Owing to the barrier of the Khone Falls, navigation ends at Khinak. In the past, goods were trans-shipped over Khone Island by means of a 5 kilometres long railroad track, to the river downstream of the falls. Commercial navigation between Pakse and Khinak has been abandoned. In the past, it was used for the transport of products imported from Cambodia. The fleet operation on this stretch includes only small craft used for local passenger traffic and some agricultural products for local markets.

A bridge crossing the river has been built at Pakse.

(h) From Veune Kham to Kampong Cham

The river starts to enter the flood plain area in Cambodia after it leaves Veune Kham, at the foot of the Khone Falls.

The section is in its natural state with wild tropical vegetation on its banks, see figure 6. The river gradually widens out to form multiple branches. The upper stretch of this section, from Veune Kham to Kratie, is characterized by rapids, rocky outcrops, scattered shoals, sand bars and multiple branching channels. At high water season, ships of 200 tons can pass. However, during the dry season, only small fast craft can go up through the rapids. This operation ceased when a road was constructed between Pakse and Kratie around 1925.

Figure 6: Section in the middle stretch of the river
The lower stretch of this section, from Kratie to Kampong Cham, has better conditions for navigation. The major obstacles to navigation are shallow shoals, sand bars, braided channels and fast shifting of thalwegs. During the low water season, the least available depth on the shoals is about 1.5 metres. Vessels with a capacity of 80 tons can ply this section.

(i) From Kampong Cham to Phnom Penh

This section is within the territory of Cambodia.

The riverbed in this section is generally made up of sand or gravel, with a few rocky stretches of higher current velocity where navigators must look out for protruding rocks. The conditions for navigation are quite favourable in this section. Normally the lowest water depth is about 4 m although the river section is in its natural state. The shallowest part of this stretch about 2.10 metres is located around Sdau. Seagoing ships of 1,500 - 2,000 dwt may reach Kampong Cham the year round.

(j) From Phnom Penh to the river mouth

The section has about 100 kilometres in Cambodia and 250 kilometres in Viet Nam. Downstream of Phnom Penh, the river forms two branches, the Lower Mekong River and the Bassac River. They are connected further downstream by the Vam Nao Pass. The two branches are basically in a natural state and quite wide.

The Bassac River is navigable for seagoing vessels with a draft of 6 metres over a distance of 188 kilometres from the junction with the Vam Nao Pass to the entrance at Cua Dinh A n. River maintenance works are being carried out regularly. The port of Can Tho is a large seaport in Viet Nam. The stretch between Phnom Penh and Vam Nao Pass is not navigable.
The Lower Mekong River branch is called the Tien Giang River in Viet Nam, and is about 195 kilometres long. The water depth at the entrance permits ocean going ships of up to 5 metres draft to pass the bar at high tide. The bridge at My Thuan has been constructed with a high water clearance of 37.5 metres.

Phnom Penh can be reached by seagoing ships of up to 6,000 dwt in the high water season and 2,500 dwt in the low water season. Some shallow passages are found at Chaktomuk in front of the town of Phnom Penh and at Chru A mpil in Cambodia, and at Tan Chau in Viet Nam. Pilot service is compulsory for seagoing ships in both Cambodia and Viet Nam. Vietnamese pilots guide foreign ships to the Cambodia-Viet Nam border and then allow ships to go freely for about one kilometre before they are taken over by Cambodian pilots.

The Mekong delta waterway network in Viet Nam carries seagoing and inland traffic, including some cargo traffic from Viet Nam to Cambodia. Domestic traffic is highly dense in the whole delta area. Hundreds of waterways varying in size (for vessels from 10 to 600 tons) interlace in this area, including main channels, tributaries, man-made canals and natural creeks. Most waterways have naturally favourable conditions for navigation, see figure 7. They amount to a total navigable length of 4,785 kilometres. The system connects Phnom Penh, Ho Chi Minh City, Kampong Cham, M y Th o, Vinh Long, Cao Lanh, Can Th o and Long Xuyen to the sea via the Lower Mekong and Bassac Rivers. Inland water transport plays a vital role in the economic and social life of the area.

There are three types of inland navigation in the Mekong Delta: local movement by 10-15 ton boats; inter-city movement by 15-600 ton ships; and inter-country movement by 600-3,000 ton barges or barge convoys, normally comprising one tugboat and three barges of 250 to 300 tons each.
Recent development

Since 1990, the upper four countries have undertaken several joint field investigations on the section between Simao, China, and Vientiane. In 1993, the upper four countries conducted a joint survey. The surveying team concluded that the river section can be opened for the navigation of:

- $100-300$ ton self-propelled barges after simple channel regulation
- $300-500$ ton self-propelled barges after further regulation
- $500-1,000$ ton barges or $2,000$ ton of barge convoys after a combination of regulation and damming.

Based on the conclusions, the development of the upper section was planned in three stages:

- **Stage I, By 2002**, minimum channel dimensions: $1.5$ (depth) x $30$ (width) x $260$ (bend radius) metres, suitable for $100$ ton vessels, $11$ ports, $4$ shipyards, and $2$ training centres developed for subregional training
- **Stage II, By 2006**, minimum channel dimensions: $2.0$ x $40$ x $300$ metres, suitable for $300$ ton vessels, upgrading of ports and shipyards, expansion of training centres
- **Long-term**, suitable for $4$ x $500$ ton barge tows

Recently the Government of China offered to provide financial support for the improvement of the river section of $331$ kilometres from the #243 border post of China and Myanmar to Houay Sai, the Lao People’s Democratic Republic, including the $56$ kilometres of boundary section between the Lao People’s Democratic Republic and Thailand.

Viet Nam is improving the navigability of inland waterways in the Mekong Delta. One ongoing project is the rehabilitation of two inland waterways of $662$ kilometres from Ho Chi Minh City to Ca Mau and from Ho Chi Minh to Kien Luong and Can Tho port. The total investment of US$84 million is financed by the World Bank (US$ 71 million) and the Government of Viet Nam (US$ 13 million). The project started in 1998 and is expected to be completed in 2003. In 1999, MRC completed a feasibility study on the access channel to the Bassac River to maintain navigability year round for ships of $5,000$ to $10,000$ tons.

In May 2001, MRC will finalize its study on the stabilization of the Chaktomuk area that will involve an action plan for the improvement of the access channel to Phnom Penh.

General information on inland waterways, inland water traffic, registered vessels and number of aids to navigation in the six riparian countries is summarized in annex II, General account of inland water traffic and inland waterways in the Greater Mekong subregion.
IV. REVIEW OF EXISTING AIDS TO NAVIGATION SYSTEMS

The aids to navigation on the Greater Mekong River are insufficient for safe navigation. Numerous rapids, shoals, dangerous waters and traffic constraint areas have not been marked yet. In Cambodia and the Lao People’s Democratic Republic, the beacons in use have deteriorated since being installed in 1910-1920. Myanmar and Thailand have not installed any aids to navigation on their sections of the river. Installation of aids to navigation has been recommended as one of the top priorities in all the studies on the development of inland water transport on the river. However, progress is extremely slow owing to the severe budgetary constraints faced by the inland water transport sector.

All the six countries along the Greater Mekong River have adopted different systems of aids to navigation for inland waterways. They are set out to suit the local configuration of banks and riverbed, traffic, availability of materials, installation and maintenance costs, and techniques of production. For coastal waters all the countries follow Region A of the IALA Maritime Buoyage System.

The major features of aids to navigation systems applied to inland waterways in these countries are illustrated in the annex III. Detailed information related to aids to navigation systems in the six countries is outlined below.

A. Cambodia

Cambodia has 261 beacons on the river section from its border with the Lao People’s Democratic Republic to Phnom Penh and 12 buoys on the section from Phnom Penh to its border with Vietnam.

Figure 8: Beacons used in Cambodia

Source: Mekong River Commission

There are no detailed national standards on aids to navigation for inland waterways. In principle, the colour black is used for the left side and the colour red for the right side. The unlighted beacons, called Apillars@ in Cambodia, are built with rock masonry or concrete on banks or rocks in water, as shown in figure 8. A round 400 beacons were built during the period 1910s-1920s
to mark safe channels in rapids or shoals. These beacons chiefly function as lateral marks. They were originally painted black for the left bank and red for the right bank. However, owing to a lack of maintenance, the colours on most beacons have worn off. The Waterways Department, Ministry of Public Works and Transport, which is responsible for aids to navigation on the river section from the Cambodia-the Lao People’s Democratic Republic border to Phnom Penh, produced two lists of aids to navigation on the section between the border and Kratie:

(a) For the section between the Cambodia-the Lao People’s Democratic Republic border and Stoeng Treng, there are 128 concrete pillars built in the river. Among them, 37 pillars are still good; 9 are totally broken; others have a broken top.

(b) For the section between Stoeng Treng and Kratie, there are 206 concrete pillars built in the river or on rocks. Among them, 80 are considered to be still good and 21 are broken 100 per cent. The rest are partly good.

For the section Kratie-Phnom Penh, there is no detailed information.

Figure 9: Broken beacon hindering navigation

Source: Mekong River Commission

The broken beacons have become additional hazards to navigation in the river (see figure 9). Steel lateral buoys (12) were placed between Phnom Penh and the Cambodia-Viet Nam border in 1996. Their design is shown in figure 10. The buoys are managed and maintained by the Port Authority of Phnom Penh. Since installation, nearly no maintenance work has been undertaken owing to a lack of budget. From information through surveying and pilotage, it is found that about four buoys are not in correct position owing to a shift of thalwegs.

The unlighted buoys were built in a conical shape, painted black for the left bank, and a can shape painted red for the right bank. The pilot station has proposed to light the buoys and add 14 more light buoys and two shore marks for night navigation from Phnom Penh to the Cambodia-Viet Nam border for seagoing ships (which include 13 lateral buoys, 1 pair of leading marks, 1 wreck buoy,
In Cambodia, two surveying teams work under the Waterway Department of the Ministry of Public Works and Transport, and the Port Authority of Phnom Penh. Aids to navigation are checked once a year. There is no buoy tender for the maintenance of aids to navigation. One of the two anchor lifting boats for dredgers is considered to be able to undertake the maintenance of aids to navigation. Owing to a severe shortage of budget for repair and maintenance, broken beacons cannot be fixed and aids to navigation cannot be maintained regularly. Minor groundings were often reported because of insufficient or incorrect aids to navigation. There is a workshop in the Port of Phnom Penh which has some spare parts available and can repair buoys. Cambodia has the capacity to produce buoys weighing 350-400 kilograms.

Pilotage is compulsory for seagoing ships on the river. There are 11 pilots stationed in the Port of Phnom Penh, 10 of whom were trained in the former Soviet Union and one in Viet Nam because there is no local navigation or waterway school. The crew on board ships longer than 20 metres are required to have knowledge on aids to navigation. Their experience is passed from the old to the young. Many are not aware of aids to navigation and have to remember locations and master skills to handle boats in dangerous places.
B. China

There are about 40,000 sets of various types of aids to navigation installed on inland waterways in China.

On the Lancang River, national standards for aids to navigation are applied. They were first promulgated in 1955 and revised in 1986 and 1993. They presently include National Standards on Aids to Navigation on Inland Waterways, Main Configuration Dimensions of Aids to Navigation on Inland Waterways, Colours of Light Signals of Aids to Navigation and Measurement of Luminous Intensity and Calculation of Luminous Range of Navigation Lights. In 1994, a National Technical Code on Maintenance of Inland Waterways was issued. In 1995 and 1996, the Regulations on Aids to Navigation and Regulations on Management of Aids to Navigation was promulgated.

The Standards on Aids to Navigation on Inland Waterways stipulates the types, functions, colours, shapes, and characters of light of aids to navigation. The types of aids are summarized in annex IV. Basically the aids to navigation system follows the colour white for the left bank the colour red for the right bank. In the case of a strong white background against white colour buoys/marks, black can be used to replace white. The basic shapes of lateral buoys/marks, in particular on waterways with maritime traffic, are cones for left banks and cans for right banks to keep consistency with maritime buoys. Owing to the variety of waterways in the country, a number of optional lateral marks are listed for use in different waterways according to specific conditions, tradition and traffic. The system includes both lighted and unlighted aids to navigation.

Figure 11: Buoys and marks on the Yangtze River

Use of the buoys and marks regulated in the Standards is classified as follows:

$ First class: All marks installed are lighted at night. Vessels can see marks from one to the next ahead in daytime and lights from one to the next at night
$ Second class: Lighted marks and unlighted marks are laid in separate stretches. It is not required to see marks from one to the next
$ Third class: Marks are unlighted. It is not required to see marks from one to the next
Fourth class: Marks are placed only in sections with difficult navigating conditions. Navigation must utilize the aids and other objects with the help of the mariner’s experiences.

Buoys and shore marks used on the Yangtze River are shown in figure 11. Marks are made of wooden planks or steel, which can be placed on land or dumb boats as buoys. On the wide river stretches, large floating buoys or light boats similar to sea buoys are used. In some places, steel and polyethylene are used to produce buoys and marks.

On major navigable rivers, aids to navigation are maintained by waterway stations responsible for 10 - 100 kilometre stretches of waterway. Waterway stations use buoystenders for the regular maintenance of aids to navigation and shoal surveying every day. The position of buoys is shifted from time to time according to the change of thalwegs. If shifting aids to navigation cannot meet channel depth and width requirements, blasting teams or dredgers can be called to remove the shallow points in channels. If new obstructions appear in channels, waterway stations place buoys or marks immediately. Major changes of aids to navigation and new channels are published through regular radio broadcasting and bulletins. Waterway authorities make thorough river hydrographic surveying once a year and update navigation charts every year. Ships navigate according to navigation charts and aids to navigation. If they find any missing or malfunctioning aids to navigation, they are obligated to contact a nearby waterway station for confirmation and repair.

China has producers of aids to navigation in Shanghai, Nanjing and Wuhan, which supply large aids to navigation and complicated parts. Each waterway authority has its own factory to produce and repair aids to navigation. Minor problems of aids to navigation can be fixed by waterway stations or the supervisory organization for the waterway section.

The Ministry of Communications is responsible for rules/regulations, technical standards, installation and maintenance of aids to navigation at the national level. Aids to navigation are directly managed and maintained by waterway authorities on different rivers.

There are 10 universities/colleges offering courses for design, installation, maintenance and use of aids to navigation. In addition, a number of professional schools and technical schools provide training on maintenance and use of aids to navigation.

On the Lancang River 291 devices of aids to navigation have been installed as part of the project for the improvement of the waterway. The installed aids to navigation include unlighted lateral buoys/marks, bifurcation buoys, hug bank marks, bridge marks, sound horn marks, location signs, shoal/rapids signs, and water depth signs. Some of the installed signs have been damaged because of a lack of maintenance.

Inland water transport is newly developed on the Lancang River. The maintenance system and aids to navigation are not well established. Crew members on board ships plying the river were recruited from other mountainous rivers in China. They were trained in the navigation schools in China and had practical experience on other rivers. They navigate international routes mainly with
their experience and information from trial navigation and local boatmen. However, four accidents were reported in 1999 owing to unmarked bad water areas and reefs on the boundary section between the Lao People's Democratic Republic and Myanmar.

C. Lao People's Democratic Republic

There are 541 unlighted beacons belonging to the Lao People's Democratic Republic in the river section from Bokeo to the Khone Falls. Among them, 540 beacons are lateral and one is bifurcation.

Figure 12: Beacons in the Lao People's Democratic Republic

Between 1910 and 1930, 600 beacons were built but some of them have disappeared. In the 1970s and 1980s, beacons were erected in the section between the Golden Triangle and the Khone Falls. Among the old beacons, 129 have fallen or are damaged. The old beacon system uses the colour black for left bank and red for the right bank. Most colouring has worn off because of a lack of maintenance. Since 1995, 28 beacons have been built and painted green for the left bank and red for the right bank as shown in figure 12. The design for new shore beacons is given in annex V. The concrete beacons were built on rocky outcrops and reefs in the form of stepped blocks.
The beacons designed to be seen in the low and mean water seasons and submerged in the high water period become a hazard to navigation. In this case, additional floating marks are provided with V-shaped bamboo floats carrying a small top-mark supported by a thin vertical bamboo stick of 40-50 cm high. In some places, bamboo rods or bamboo floats carrying flags or baskets are used to mark danger points or safe channels through rapids and reefs, as shown in figure 13. These kinds of floating marks are localized lateral buoys in a black cone shape for the left side and a red can shape for the right side. Normally the bamboo floats have no colour. In 1996, about 350 such floating
marks were laid on the section from Vientiane to the Khone Falls. Sometimes, crew members place empty bottles or plastic oil cans tied to sinkers to mark the channel. Collapsible beacons that consisted of a concrete base and wooden rod, and could rise and fall with a change of water level, as shown in figure 14, were also tested in 1975.

In April 2000, the Ministry of Communications, Transport, Post and Construction enforced the Regulations on River Traffic which included signs for bridges, overtaking, horning, anchoring, and speed limit etc., as attached in annex VI. The regulations adopt some signs from SIGNI. Based on this, black buoys are to be replaced by green ones.

In 1998, MRC undertook a study on the installation of aids to navigation on the river section in the Lao People’s Democratic Republic and Thailand. The consultant proposed the installation of 711 shore marks, 45 buoys, 129 beacons, 125 kilometre-markers, some water gauges, as well as the repair of 412 existing beacons with new top marks. The recommended aids to navigation include markers for cross-over, alignment, isolated danger, bankwise, one-way bifurcation, two-way bifurcation, kilometre and draft scale, lateral buoys, and beacons.

The Ministry of Communications, Transport, Post and Construction is responsible for the management and maintenance of aids to navigation at the national level. The maintenance of aids to navigation is implemented through subdivisions and special units, which have the capacity to paint and rebuild collapsed beacons. The organizations check the aids to navigation twice a year, before and after the rainy season. Aids to navigation is one of the priority areas in inland water transport development of the Lao People’s Democratic Republic. The Ministry has been trying to rehabilitate the existing beacons and install more beacons. However, the annual budget for aids to navigation is not even sufficient for painting buoys and marks.

A School of Communications and Transport used to conduct training for crew and technical staff in post. However, there has been no training for inland navigation since the school closed in 1988. All the skippers or crew members learn skills from the older generation and through practice. They have a basic understanding of aids to navigation, i.e., black/green colour beacons are on the Lao side and red ones on the Thai side. The operation of craft mainly relies on the experience of crew and ability to read the water owing to the natural state of the river and a lack of aids to navigation. Most skippers operate for a very limited distance, only a few can navigate for a long distance. They rely on local skippers as pilots to assist from stretch to stretch. In 1998-1999, three severe accidents were reported because of a lack of aids to navigation, which led to two deaths and the sinking of one high speed boat. There is no navigation chart but information on least available depth, obstructions, accidents and aids to navigation is available in the Ministry of Communications, Transport, Post and Construction.
D. Myanmar

In total, 15,000 floating marks and 9,000 shore marks have been installed in the country.

The national aids to navigation system has been used since 1964, and is illustrated in annex VII. It basically adopts the Uniform System of Buoys and Shore Marks for Inland Waterways in Asia and the Far East recommended by ECAFE (the predecessor of ESCAP) in 1957. Ten of the sixteen types of aids to navigation in the national system follow the recommended uniform system. Aids to navigation in the Myanmar system are categorized as seven types of floating marks (lateral, bifurcation, wreck, and rock/snag), and nine types of shore marks (hug bank, crossing, crossing transit, bifurcation, berth space, cable, danger near bank, danger off bank, and prohibitory shore). Left-side lateral buoys use a white-black strip spar and right-side buoys use a red colour spar. The wreck buoys are painted green and have different shapes for left and right sides, cone shape for the left side and can for the right side. Shore marks have no difference in shapes and colours between left and right sides. In addition, there are also signs for bridges which are not covered by the national system. The signs for bridges are included in the annex III. Myanmar plans to prescribe the necessary signs for waterways including mandatory, prohibitory, restrictive and informative signs.

Figure 15: Shore marks on the Ayeyarwady River

Figure 16: Bamboo buoy

The nationally standardized aids to navigation are mainly practised on the Ayeyarwady and Chindwin rivers. Buoys are used in low water and shore marks used in high water. Most of the buoys and marks are unlighted. The shore marks are made of wood, bamboo or cane pole topped with wood or bamboo frame wrapped with cloth, as shown in figure 15. Lateral floating marks are made of bamboo tied to a sinker as shown in figure 16. The green marks use enamel paints and lime washing is used for the white colour. The marks are low-cost, temporary in nature and easy to lay by buoy tenders. Owing to unsecured moorings they tend to drift or come loose because of collisions with rafts and vessels. They can be used in day time only and cannot be firmly placed with lanterns for night navigation.
There is one college for education in both sea and river navigation. In addition, there are five training schools affiliated to the Inland Water Transport, a state owned river shipping company, which mainly operates on the Ayeyarwady River.

A simple navigation chart showing direction, location, and position of shore marks is updated every year. Bulletins and notifications indicating the demarcation of hazards are also published as necessary. Notification of draft limitation in the low water season and warnings and necessary navigation bulletins are issued seasonally for the river users. Sometimes pilots are needed to assist ships passing through difficult areas.

The Directorate of Water Resources and Improvement of River Systems under the Ministry of Transport is responsible for the installation and maintenance of aids to navigation. Relevant divisions and state offices in the regions lay buoys and install shore marks. Working teams assigned to different reaches station at specific locations to monitor channel changes and to maintain marks. The Directorate operates 23 buoy tenders which check buoys and marks twice a month during the low water season. On some stretches of braided rivers where the navigation channel is liable to change frequently, stationary buoyage teams are assigned at those locations for day-to-day inspection. The stations also collect information from users.

Myanmar has no aids to navigation installed on its part of the Greater Mekong River. Because navigation on the river is a newly emerging business, organization for the management and maintenance of the waterway has not been set up.

E. Thailand

Thailand has 760 buoys on inland waterways throughout the country and has no aids to navigation installed on its section of the Greater Mekong River.

Aids to navigation system on inland waterways in Thailand were designed in 1985 along with waterway improvement of the Chao Phraya River. The main marks and signs of this system are shown in annex VIII.

The system consists of buoys, set on rivers within the sections equipped with groynes or bottom panels and in free-flow sections for marking channels, and signs on land, giving general indications. The buoys include black lateral buoys with a conical top for the left side and red lateral buoys with a cylindrical top for the right side, which are equipped with white and red coloured scotchlite reflecting tapes for night navigation. They are located on each side of the channel in front of the structures at a distance of about 10 metres from the channel. The maximum distance between buoys along one side of the channel is 500 metres. Land panels, composed of white square panels with an upright black triangle for the left side and an inverted red triangle for the right side, are set on the corresponding bank of the buoy to indicate that a buoy is set in the river to secure the marking should the buoy be missing (see figure 17).
In addition to lateral buoys and their indication panels, the system introduces six types of signs on land to indicate prohibited areas, channel direction, restricted channel ahead/end, sound signal and kilometres. The buoys and signs are combined together to mark the channel. A typical layout of buoys and signs on the Chao Phraya River is shown in figure 18.
The Harbour Department is the national authority in charge of both maritime and river aids to navigation. The Third Centre of River Dredging and Maintenance based at Chiang Rai, as the representative of the Harbour Department, has responsibility for the management of aids to navigation on the Greater Mekong River.

Knowledge of aids to navigation is required for all levels of crew and management staff related to aids to navigation. The Merchant Marine Training Centre in Bangkok and the Harbour Department offer training on design, installation and maintenance of aids to navigation. The Merchant Marine Training Centre also has crew training for inland navigation.

**F. Viet Nam**

There are in total 13,000 sets of aids to navigation on inland waterways in Viet Nam, which are chiefly placed on the Red River and its tributaries in the north and the Mekong Delta in the south.

Viet Nam has had national standards on aids to navigation on inland waterways since 1992. The regulations include three parts: types of aids to navigation, dimensions of aids to navigation, samples of channel marking. A summary chart of the Regulations is attached in annex IX. The regulations are complemented by a Luminosity Standard on Lights and Signals of Aids to Navigation.

The types of aids to navigation cover buoys for lateral marking, bifurcation and port area; shore marks for hugging banks, crossing over, crossing alignment, orientation, bifurcation, isolated danger and cable; traffic control signs and signals; bridge signs and signals; and also a wide range of road sign.

The system follows the principle of the colour white for the left side and the colour red for the right side. The lateral buoys use a cone shape for the left side and a can shape for the right side.

**Figure 19: Aids to navigation in Viet Nam**
The shore marks and floating buoys are mainly made of steel. Buoy are assembled with a mark and supporting float. The marks and buoys used in Vietnam are shown in Figure 19. There are three factories producing aids to navigation for inland waterways, including one producing marks and buoys, one producing electronic elements and one manufacturing parts. Some parts are imported.

An Inland Waterway Signalization System was prepared and designed by consultants as part of an inland waterway and port rehabilitation project co-financed by the World Bank and the Government of Vietnam, see annex X. The system was originally proposed to apply to the project area, covering two waterway routes from Ho Chi Minh City to Ca Mau and from Ho Chi Minh City to Kien Luong in the Mekong Delta, a total of 662 kilometres. It was approved by the Ministry of Transport for application to all inland waterways in December 2000, effective 1 April 2001.

Licences are compulsory for crew working on board (steering and engine) all kinds of craft. Knowledge of aids to navigation is required for to obtain a licence. There is one university and three professional training schools offering education and training of crew with courses on aids to navigation. There are also some local training schools under the provincial transport departments.

There are 400 various types of buoys and marks in the section of the Greater Mekong River in Vietnam, among which 100 are lighted. In addition, there are 100 aids on the tributaries of the river.

The Vietnam Inland Waterway Administration undertakes the installation and maintenance of aids to navigation through its waterway stations and substations. There are six waterway management stations in the Mekong Delta area for the maintenance of waterways and aids to navigation, which are managed by the southern department of the Inland Waterway Administration. Each substation is responsible for about 300 to 350 kilometres of waterways and responsible for reconnaissance surveys of canals and rivers to detect variations of the mainstream and provide notices to the public, maintenance of aids to navigation, and waterborne traffic regulation at civil works and dredging sites. The management staff of inland waterways are required to provide knowledge of aids to navigation. There are 11 substations maintaining the two main branches of the River, Tien Giang and Bassac. The stations use high speed launches and buoy tenders to make regular maintenance and patrol routes. Each station has a small group of workers to repair aids to navigation, battery charging etc.

In 1998, the Ministry of Transport promulgated the Economic and Technical Norms for Regular Maintenance of Inland Waterways, which stipulates requirements for route checks, regular maintenance of aids to navigation, regular maintenance of routes, dredging, maintenance training works and removal of obstacles.

On the two branches of the Greater Mekong River, the Tien Giang between My Tho and the sea and the Bassac between Can Tho and the sea, the IALA Maritime Buoyage System (A) has been implemented and is managed by the Vietnam National Maritime Bureau. The sections of the Tien
Giang between the Cambodia-Viet Nam border and My Tho, and Hau Giang between Vam Nao Pass and Can Tho, implement the national standards under the direction of the Inland Waterway Administration. The two administrations have common and overlapping responsibilities for the aids to navigation on some river stretches. Therefore, two different systems co-exist on some river sections, which may lead to confusion by users.
V. REVIEW OF STUDIES ON AIDS TO NAVIGATION

Visual aids to navigation are composed of three important elements, colour, shape and light. Shape and colour of marks and their related factors such as contrast to background, dimensions and luminance can significantly affect the probability of correct and quick recognition. In the case of night navigation, colour, rhythm, illuminance and contrast against a background of light are vital to mariners.

IALA and the International Commission on Illumination have made specific studies on colours, shapes and lights which can be used for aids to navigation. Some countries with extensive water transport and capability in research have also made complementary studies on the application of international recommendations to their countries and the development of their indigenous systems.

The 1998 IALA Guidelines on Surface Colours Used as Visual Signals on Aids to Navigation indicates:

$\text{The colour red can achieve a very high probability of correct recognition and has been proved to be quite practicable with glossy surfaces of marks. However, the probability of correct recognition of red will be significantly reduced when it is painted on matt or even semi-matt surfaces}$

$\text{When orange/red or orange/yellow subtend small visual angles, they are very likely to be confused. The probability of correct recognition of orange is usually not as high as that of red or yellow. However, orange is an appropriate colour for conspicuity against the sea, and it should preferably be reserved for those objects for which detection in the water is more important than recognition of their colours, such as life-jackets, life rafts and other emergency equipment}$

$\text{Discrimination between yellow and white is not practicable when they subtend very small visual angles so they should not be considered as separate colours. At sea, the probability of recognizing white on its own will often below}$

$\text{Green does not usually show well at sea. It may be desirable, if green is required as a background colour on signs with symbols or alphanumeric characters, to use a special dark colour}$

$\text{Blue may prove to be a useful signal colour at close range, but at a distance, particular at sea, it is unlikely to be easily recognized. It may be desirable if blue is used as a background colour on signs with symbols or alphanumeric characters}$

$\text{The probability of correct recognition of black is lower than that of green. Black can be used with proper value of the luminance factor}$

Therefore, the colours used as visual signals on aids to navigation are recommended to be red, white, green, yellow, blue and black.
A surface colour is usually seen in relation to other colours, and the perception of the colour can be quite markedly influenced by the presence of other colours. Therefore, IALA recommends checking the appearance of a mark colour at a distance among the surrounding colours.

Figure 20: Colour test in 1979 and 1980

![Colour test in 1979 and 1980](image)

Source: Minor aid presentation on beacons/History of buoys and tenders (Washington, U.S. Coast Guard, 1999)

Tests on mark colours and their matches have been made in some countries. A typical colour test in 1979 and 1980 is shown in figure 20. The test proved that light green-coloured marks were more visible than black-coloured marks against a dark vegetation background. These tests led to the change of traditional black marks to green.

A similar study on mark colours and background colours is shown in table. This study found that the best mark colours on various natural backgrounds such as green vegetation, grey sky, light dark sky etc. are white, yellow, red and black, and the second best mark colours are red green and black. In light of the most common backgrounds of aids to navigation on inland waterways, the study recommended the use of red, white, black and yellow as core colours of aids to navigation on inland waterways.
In some cases, more than one colour needs to be used on one mark to provide more information. However, studies by IALA found that the use of more than one colour on a navigation mark will reduce the visibility of the mark from a distance because of the interruption of the outline of each coloured area. Therefore, the area for each colour on the multi-colour marks should be as large as possible.

Studies undertaken by IALA also found that the use of horizontal bands on marks can cause problems, especially on floating marks. Aquatic plants can cover the bands or form black lines on marks to confuse navigators. This may particularly cause a problem to fixed standing marks in tidal areas. The black line may be small or disappear in high tide but it could be very large in the period of low tide.

Studies on the shapes of aids to navigation found that the shapes quickly recognized could be ranked as rectangle, square, trapezium, circle, rhombus and triangle on a plain background. However, the quickness of recognition is also related to the background of the shapes. Against the background of structures or trees, triangles and circles would be more easily found. The shape has insufficient surface area so that the distance in which it can be recognized is short.

Three dimensional marks may increase visibility and ease of recognition. When colours of marks deteriorate or cannot be seen against sunlight, the shapes of marks will be key features for recognition and three dimensional marks will ensure correct recognition at a distance. They will also increase safety in case of change of directions by natural forces, such as wind, tide and current.

<table>
<thead>
<tr>
<th>Background Colour</th>
<th>Best Mark Colour</th>
<th>Second Best Mark Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>White or Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>Grey Sky</td>
<td>Black or Red</td>
<td>Yellow or White</td>
</tr>
<tr>
<td>Light Dark Sky</td>
<td>Yellow or White</td>
<td>Black</td>
</tr>
<tr>
<td>White</td>
<td>Black</td>
<td>Green or Red</td>
</tr>
<tr>
<td>Black</td>
<td>White or Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>Red</td>
<td>White or Yellow</td>
<td>Green or Black</td>
</tr>
</tbody>
</table>

VI. REVIEW OF INTERNATIONAL AND REGIONAL RECOMMENDATIONS

A. IALA Maritime Buoyage System

There were more than 30 different maritime buoyage systems in use worldwide before the IALA Maritime Buoyage System was first agreed in 1976. Many of these systems had rules in complete conflict with one another. Some used the colour red to mark the port hand side of a channel and others to mark the starboard side. Many countries adopted the principle of the lateral system, but some favoured using the principle of cardinal marks.

Attempts were made to solve these differences but without success. An early attempt to unify the systems was initiated by the League of Nations, which resulted in the recommendations on Uniform System of Maritime Buoyage in 1929 and its approval in 1936. The unified maritime buoyage system was signed by 12 countries and used by 28 countries. This agreement proposed the use of either cardinal marks or lateral marks but separated them into two different systems. It provided for the use of the colour red on port-hand marks and the colour black on starboard-hand ones, and largely reserved the colour green for wreck marking. Unfortunately, the agreement was not widely ratified owing to the outbreak of the Second World War.

Some new systems emerged in several countries after the War. International mariners had to remember all the systems adopted in different countries. In 1965, IALA set up an international technical committee to examine the problem and to suggest a solution. Attempts to bring complete unity had little success until a series of disastrous wrecks in the Dover Strait area happened in 1971. The Inter-Governmental Maritime Consultative Organization, the predecessor of the International Maritime Organization, and IALA decided to jointly unify the maritime buoyage systems.

The difficulties faced for this unification were mainly as follows:

$ The use of a lateral or cardinal system
$ Definition of direction
$ The colour green being reserved for wreck marking
$ Diversified buoy shapes
$ Different buoy colours
$ Many special buoys

In view of the different climates, environment, economic and social background and traditions of different countries, the new system focused on a simple and easy-to-adopt style. It was believed that carefully maintained simple devices were more important than badly maintained delicate devices for mariners. The philosophy used in the formulation of the system was to use limited types of marks.

To meet the conflicting requirements, it was thought necessary as a first step to formulate two systems, one using the colour red to mark the port side and the other using the colour red to mark the starboard side. These were called System A and System B respectively.
Other solutions adopted were as follows:

- Combination of lateral and cardinal systems
- Lateral lights corresponding to Aide@colours
- Only one Apoint of interest@marking for cardinal systems
- Introduction of yellow as special mark colour for both light and surface
- No white lights for Alateral purpose@
- No bifurcation or junction marks in system A.

The use of black for lateral marks was changed to green because black was less visible than green and did not correspond to its green colour light.

The rules for System A, which included both cardinal and lateral marks, were completed in 1976. The rules for System B were completed in early 1980. System A has been adopted by Africa, most Asian countries, Europe, the Gulf countries, Australia and New Zealand. System B has been used by American Continent, Japan, the Philippines and the Republic of Korea. The two similar systems were combined as one system with two regions in 1980, Region A and Region B, and the boundaries of the regions were also agreed. Region A uses the colour red for port marks and green for starboard marks. In Region B, these colours are switched to red for starboard and green for port.

All the maritime buoyage systems were quickly converted to the new IALA system around the world because it is simple and easy to adopt.

Basic rules embodied in the IALA Maritime Buoyage System include the definition of direction, colour, shape and topmark of marks, colour and rhythm of light. The marks of the System are provided in annex XI.

As shown in annex XI, the System provided five types of marks for use in combination of all or only some of them, i.e., lateral, cardinal, isolated danger, safe water and special marks:

- Lateral marks indicate the port and starboard sides of the navigation route to be followed. Where a channel divides, a modified lateral mark may be used to indicate the preferred route
- Cardinal marks indicate where the mariner may find navigable water, used in conjunction with the mariner’s compass
- Isolated danger marks placed on a dangerous small area which has navigable water all around it
- Safe water marks indicate there is navigable water all around them but do not mark a danger
- Special marks not primarily intended to assist navigation but to indicate a special area or feature whose nature may be apparent from reference to a chart or other nautical document, such as anchor mark, mooring buoy mark, ocean data acquisition system mark, spoil ground mark, military exercise zone mark, fishing mark, pumping station mark etc.
The rules for the surface colours and shapes of the marks in Region A are:

- **Port hand lateral marks**, red colour, cylindrical (or can) shape, or pillar or spar with topmark of single cylinder (or can)
- **Starboard hand marks**, green colour, conical shape, or pillar or spar in shape with topmark of single cone with point upward
- **Cardinal marks**, black and yellow colour, pillar or spar in shape with topmark of two black cones
- **Isolated danger marks**, black colour with horizontal red band(s), optional in shape but not conflicting with lateral marks, pillar or spar with topmark of two black spheres preferred
- **Safe water marks**, red and white vertical stripes, spherical or pillar/spar with spherical topmark
- **Special marks**, yellow colour, optional in shape but not conflicting with navigational marks, single \( \mathcal{A} \mathcal{X} \) shape as topmark

With regard to the use of light, the system provides red, green, white and yellow for light colours. Red and green colours are used for lateral marks; white light is specially used for cardinal, isolated danger and safe water marks; and yellow is dedicated to special marks.

**B. CEVNI/SIGNI**

ECE adopted the provisional recommendations on standardization of signalling systems on inland waterways in 1957, which was amended as Signs and Signals on Inland Waterways (SIGNI) in 1966 and 1975. This system combined the tradition of the West European countries with the Uniform Systems of Maritime Buoyage laid down in the Agreement of the League of Nations in 1936, and tried to follow the uniform maritime system as far as possible.

The main features of the system were as follows:

- The terms **left** and **right** for rivers respectively mean to the left and to the right of an observer facing downstream
- Black conical buoys for the left-hand side of channel and red cylindrical buoys for the right-hand side
- Only the spherical shape (possibly with a spherical topmark) was adopted for bifurcation buoys because the maritime system for bifurcation was considered too complicated for inland waterways
- Wreck marking in the maritime system was not adopted because it was thought unsuitable for inland navigation
Cardinal marks in the maritime system were not introduced because the compass was not used for positioning by river navigators.

Two sets of crossing marks were laid down, taking the traditions of different countries into account.

Light characters:

5) Rhythmic green light or white with odd-number characters for the left-hand side and rhythmic red light or white with even-number characters for the right-hand side;
6) Rhythmic white light for bifurcation;
7) Yellow light for cross-channel marks;

Yellow buoys were used to mark prohibited or restricted zones and white buoys for miscellaneous purposes.

More than 40 signs, extracted from the existing signs were included.

The philosophy for this system was to provide sufficient types of marks for selected use by the countries. Therefore, some of the marks have duplicated or overlapping functions. For some types of mark which were difficult to unify, options are provided, such as lateral marks and crossing marks.

An important principle was that marks placed on the banks should exhibit some similarity to the corresponding buoys on water. The colours of the marks followed the principle: black to the left and red to the right of the river. The light colours of the marks and buoys also followed the principle: green/white to the left and red to the right of the river. However, the shore marks for channel limits were different from the lateral floating buoys both in shapes and surface colours, which followed the tradition of the European inland waterways.

The system also permitted some substitutes for the standardized marks. It recommended that shore marks of lath assemblies, of the same colour or simply painted white to improve their visibility against certain backgrounds, be adopted when using simpler and cheaper marks rather than the ideal ones comprising painted boards. The choice of appropriate dimensions for buoys and boards were in each case left to the competent authorities who would take account of local conditions.

This system was amended again in November 1982 to adapt to the new IALA Maritime Buoyage System. This new system is still valid with minor amendments.

The major changes contained in this new SIGNI are as follows:

- The colour green is to be used instead of black
- Red/black and black/white spars are omitted
- Green/white spars with green conical topmarks and red/white spars with cylindrical red topmarks are added to mark obstacles and danger
White colour lights for lateral floating buoys and shore marks are omitted

Special marks in yellow are added to mark a special area or feature, such as military exercise zones and recreation zones

Cardinal, isolated danger and safe water marks in the maritime system are introduced for lakes and very broad waterways

The colour yellow is specified for special marks in the new maritime system. The yellow crossing marks in the new SIGNI were not changed for various reasons. The crossing marks are normally used for inland waterways only so that they are not specified in the maritime system. European inland waterways had traditionally used these marks to indicate channel positions. Any improper change of these important marks might cause safety problems.

In the later amendments, bifurcation buoys were extended to one-way bifurcation through adding topmarks on two-way bifurcation buoys to indicate on which side it was preferable to pass.

The system is now incorporated into the European Code for Inland Waterways (CEVNI). The buoyage and marks recommended in CEVNI/SIGNI are provided in annex XII. In 1990, ECE adopted a resolution to bring the text of SIGNI in line with CEVNI and decided to amend and supplement the text of SIGNI by the text and signs contained in CEVNI.

C. Uniform System of Buoys and Shore Marks for Inland Waterways in Asia and the Far East

At its third session in October 1955, the Inland Waterway Sub-Committee of ECAFE recommended the adoption of a *Uniform System of Buoys and Shore Marks for Inland Waterways in Asia and the Far East* by governments of the region. The recommendation of the Sub-Committee was approved by the Inland Water Transport Committee at its fifth session and endorsed by the Commission at its twelfth session in 1957. After its approval, it was adopted by Myanmar in 1964.

The system is provided in annex XIII. It can be noted that the system accords with the Uniform System of Maritime Buoyage of 1936. The lateral buoys, mid-channel buoys (or safe water buoys) and marking of wrecks follow the rules of the maritime system. Shore marks were laid down according to the conditions of inland waterways in the region, which were not specified in the maritime system. The bifurcation marks in this system are quite different with the maritime system in shapes, colours, lights and topmarks, which indicate two equally important channels while the bifurcation marks in the maritime system indicate a preferred channel in junction. These marks were also different from those in SIGNI. After the IALA Maritime Buoyage system was agreed in 1980, this system for Asia has not been updated.
VII. COMPARISON AND ANALYSIS

All the riparian countries belong to Region A of the IALA Maritime Buoyage System. The river aids to navigation follow the basic principles of the IALA Maritime Buoyage System to a certain extent. The definition on left and right sides of a river is well coordinated with the maritime system so that the red coloured marks remain on the same side from river to sea. Another encouraging fact is that all the six countries basically adopted the lateral buoyage system for their inland waterways. The marks adopted by the countries have some similarity and also some specific differences.

An analysis of the existing systems in comparison with the IALA Maritime Buoyage System, CEVNI/SIGNI and ECAFE 1957, as well as past studies on aids to navigation has been made. An illustrated comparison of the existing systems and systems with international or regional recommendations is shown in annex III. The main conclusions of the analysis are provided in the following sections.

A. Lateral buoys

A cylindrical mark or topmark is used for the right-hand side in all the countries and the conical mark or topmark is used for the left-hand side in all the countries except for Myanmar. In fact, the spars adopted by Myanmar are the simplest components of the cone-can system. Many pillars in Cambodia and beacons in the Lao People's Democratic Republic function like lateral marks in mean and high water levels.

Right-hand side marks are painted red in all the countries. Black, green and white colours are used for left-hand side marks in different countries. It is obvious that the black colour followed the old maritime system of 1936. The colour test presented in chapter VI has proved that the colour green is more visible than black against a dark background.

Studies have also shown that the colour white is better than others where contrasting to green and dark backgrounds. Green and white as two close competing colours have their advantages and disadvantages for their application to marks on inland waterways, in particular for the Greater Mekong River, where water is brown in colour and banks are green with various subtropical and tropical vegetation. The lower section of the river is wider than the upper. It may have a chance to use the colour green for marks. In addition, the lower section has maritime traffic. Use of marks close to maritime system can facilitate river navigation of seagoing ships in Cambodia and Viet Nam.

Only China and Viet Nam have lighted buoys. The light characters follow the recommendations of IALA, in green and red, and in distinguishing rhythm. One of the recommended rhythms, single flashing, is the same in the two countries.
B. Isolated danger buoys

At least four countries have no special buoys to mark isolated dangers. Myanmar adopted the recommendation of ECAFE which followed the outdated uniform maritime buoyage system of 1936. In some countries, isolated obstacles near channel edges are marked with lateral buoys and isolated obstacles in the centre of channels are marked with bifurcation buoys.

IALA specifies marks to indicate a small dangerous area or object to avoid full marking of sea routes with lateral or bifurcation marks on vast water areas. Inland navigation is always within a very limited channel on water which is much smaller than sea. There is much less chance to use isolated danger buoys. Small dangerous areas or objects can be marked either with lateral marks or bifurcation marks. Otherwise they must be removed.

CEVNI/SIGNI uses marks similar to lateral buoys to mark isolated dangers near channel edges. The isolated danger buoys are recommended for lakes and very broad waterways only.

C. Bifurcation buoys

Three countries, China, Myanmar and Viet Nam, have bifurcation marks. China uses a white/red striped conical mark on boats or pillars for bifurcation. Myanmar uses white/red horizontal band spar. Viet Nam uses one point upward conical mark (red) and one point downward conical mark (white) in its old system. In its new system effective in April 2001, seven types of buoys are used to indicate one-way bifurcation, two-way bifurcation and canal entrance.

The IALA Maritime Buoyage System recommends horizontal band lateral marks to indicate the preferred route in bifurcation. It does not provide marks for bifurcation with two equally important navigable routes. CEVNI/SIGNI provides three basic types of bifurcation marks, sphere, truncated cone and spar with horizontal red/green bands. The system recommended by ECAFE in 1957 provides sphere and spar with red/white bands to mark bifurcation.

Sphere buoy and spar with sphere topmark are used as mid-channel or safe water marks in the maritime system. The use of them as bifurcation marks on rivers may confuse sea mariners when they navigate on rivers or shift to river navigation. The truncated cone is easily distinguished from the shapes adopted for other marks such as cone, can, pillar and spar. It is also simple and easy to produce. From the studies on shapes referred to chapter VII, the trapezium can be easily recognized by navigators.

In addition, from the studies referred to in chapter VII, horizontal bands on marks can be covered by aquatic plants. Therefore, vertical strips should be more favourable. As the upper section of the river has no seagoing ships, there is no need to coordinate the colours with the maritime buoyage system. Use of mixed colours for lateral marks will facilitate maintenance.

The sphere topmark is used in mid-channel marks in the IALA maritime system and in bifurcation marks in CEVNI/SIGNI and ECAFE 1957. The addition of the sphere topmark on a
truncated cone would further enhance its clear meaning and correct the understanding of both river wheelmen and sea mariners.

**D. Mid-channel or safe water buoy**

Mid-channel or safe water marks are used to indicate land approaching, centre line of channel, mid-channel and landfall in the IALA maritime system. They should be used in large open navigable water areas. Usually they are placed near the harbour to draw the attention of ships sailing for a long time at sea that they are approaching harbour. In some cases, this mark is used to separate channels.

All six countries have no mid-channel marks in their existing systems. The new Viet Nam system adopts the maritime mid-channel marks with the addition of two more types of marks.

**E. Bankwise marks on land**

A basic principle of the IALA maritime system and CEVNI/SIGNI is to use the same colour for the same side of marks and the same shape for marks with the same function.

The lateral marks in Cambodia and China follow the principle of the IALA maritime system. The new Viet Nam system based on SIGNI uses two optional rhombus boards, one in half green and half white, and one in green with a white border for the left side and a square board with horizontal red/white bands for the right side. In this system, these lateral marks have the same shapes as the crossing marks in their system, the left-side rhombus and the right-side square, which might cause confusion or mis-understanding owing to colour deterioration or with strong sunlight or bright backgrounds.

Three countries have traditionally used round marks to indicate a hug bank as recommended by ECAFE 1957. This mark does not follow the principle of the IALA maritime system. Furthermore, it may be confused with special signs in the same shape, such as horning, no entry, cable, off bank danger, near bank danger, and structure limit.

Conical and cylindrical shapes are the ideal solution for lateral marks. The use of light characters for lateral buoys will maintain consistency of all the lateral marks, both on water and on land.

The hug bank mark is used in China, Myanmar and Viet Nam. The mark has the same shape as some signs such as horning and no entry in the Chinese system, bifurcation, cable and danger marks in the Myanmar system, and left-side obstacle mark in the Vietnamese system. IALA and CEVNI/SIGNI have no recommendation for this type of mark. It is not recommended that the hug bank mark should be used on this river.
F. Crossing marks

Three countries have crossing marks, namely, China, Myanmar and Viet Nam. China uses the colours red and white for crossing, leading, transitional leading, and double crossing marks to indicate navigable routes on complicated natural river regimes for large barges, that require precise positioning of marks and extensive maintenance. The fundamental marks in this system are crossing, composed of two square boards facing upstream and downstream respectively, which can be seen from both upstream and downstream directions. The system adopted by Myanmar is one recommended by ECAFE in 1957, which uses a white diamond shape for cross over and aligned cross over. The old Viet Nam system uses the same crossing marks as China and square boards with white/black and red/white stripes as leading marks. The new system in Viet Nam adopts one set of recommended crossing marks in SIGNI.

The IALA maritime system has no recommendation on crossing marks. The ECAFE recommendations in 1957 did not differentiate between the left and right sides in either shape and colour.

The recommended crossing marks in CEVNI/SIGNI use the colour yellow for both surface and light colour. The left side has two options, a rhombus board with vertical black bar or an \( \text{A@} \) shape. The right side also has two options, a square board with a vertical black bar or a \( \text{A@} \) shape. In fact, \( \text{A@} \) and \( \text{A@} \) shapes are not recommended in the studies on marks because they have less visible areas and are not easily found from a distance. Furthermore, the \( \text{A@} \) shape is used as a topmark of special purpose marks in the IALA maritime system. The square or rhombus board always faces one direction so that they are not easily fixed to be seen well from upstream and downstream and navigators cannot see the marks from a distance. The colour yellow is used for special purpose marks in the maritime system. The use of the color yellow colour for cross over may conflict with maritime special marks in some countries.

G. Obstacle and danger marks

There are a number of shore marks used for marking obstacles and dangers. China has marks on flooded bank and drift current. Myanmar uses two types of marks to indicate dangers near bank or off bank. Viet Nam employs an upward triangle to mark a left-side danger point or obstacle and a downward triangle to mark the right side.

All the marks currently employed or to be employed have some problems. The flooding bank mark used in China is difficult to distinguish from the left-side bankwise mark from a distance and the drift current mark conflicts with cross-over marks in the new Vietnamese system. The round board used in Myanmar may be misunderstood as a bifurcation or cable mark from a distance or if the colours have deteriorated. The upward green triangle board used in the new Vietnamese system conflicts with the conical bankwise mark.

IALA has no recommendation for these markings. CEVNI/SIGNI uses point downward and point upward triangles to mark danger points and obstacles. Adoption of this system conflicts with bankwise marks.
Use of these marks in the regional or subregional system may lead to safety problems. In fact, those marks are used to indicate dangers in combination with lateral marks, bifurcation marks and cross-over marks. They can be replaced with lateral marks, bifurcation marks and crossing marks in combination with information signs.

**H. Signs/signals for restricted passage**

1. **One-way traffic control**

   Traffic control signs/signals are used on one-way channels in China and Viet Nam. The system used in China is the same as the one adopted in the old system of Viet Nam, which used the combination of black rectangular and red arrow boards to control upbound or downbound traffic. This system has the distinction of signs for upbound and downbound traffic.

   The new system of Viet Nam uses a combination of rectangular boards with red/white horizontal bands and green/white vertical bands. The signs have no difference in shape, which may cause misunderstanding or confusion at a distance, or in strong sunlight or on a bright background.

   Light characters for this purpose are the same for all the systems adopted in China and Viet Nam.

   This one-way traffic control is used in narrow channels, a necessity for the upper section.

   IALA and CEVNI/SIGNI have no recommendation for this purpose.

2. **Sign for sound signals**

   China uses a round white panel with a Chinese character which means "horning". This sign has limited recognition because of the use of the Chinese character. In addition, it can be confused with the hug bank mark and prohibited entry sign in shape. The Lao People’s Democratic Republic and Viet Nam adopt a red bordered white panel with a black dot in the centre in their new systems, which is the same shape as bankwise marks and special signs.

   IALA does not specify a sign for the sound signal. CEVNI/SIGNI recommends the use of a red bordered white panel with a black dot in the centre. It may be confused with bankwise marks and other square signs in shape, in particular if maintenance is insufficient.

   This sign is vital for the Greater Mekong River which is in a natural state with narrow meandering channels and blocked sight, in particular for the upper mountainous part of the
river. This sign should be treated as a navigation mark and also with light if there is night navigation.

As traffic signs should be illustrated and easily understood, a red bordered white panel with a trumpet should be a solution for use in a multinational situation as it can be easily understood by all the crew even without any training.

3. Prohibited entry sign

The prohibited entry sign adopted by China is a post with a red bordered white round panel with a ship figure crossed by a red slant. The use of a post may constrain wide application of this illustrated sign. In fact, this sign may be required to be placed on a float or structure in some cases.

The sign for prohibited entry employed in the Lao People’s Democratic Republic is a white rectangular board with red border and black line as recommended by SIGNI. This usage may be easily confused with other rectangular information signs.

The sign for this purpose used in Myanmar is a red coloured post with an \text{AX@} shape topmark. The deficiencies of this sign is that the \text{AX@} shape mark conflicts with the special purpose marks in the IALA maritime system and it is not easily recognized of a distance because of its similar surface area.

The sign of prohibited entry used in Thailand and in the new Viet Nam system is a red/white horizontal rectangular board. This sign is close to the right-side lateral mark in shape and colour and close to the right side crossing mark in shape in the new Viet Nam system.

Use of an illustrated sign with some flexible use on water, land and structure can make this important sign easily understood and applied.

IALA has no specific recommendations for this purpose.

4. Signs and signals for bridges

Signs and signals for bridges are quite diversified among the countries. China and Viet Nam adopt a principle of marking the passage side only, that means the side of the bridge without marks is not passable. Based on this principle, the two countries have no signs for \text{No pass}. In China, one red square is for passage by large ships and a white circle with a green centre is for the passage of small ships. In Viet Nam, the new system uses the colour yellow, squares for both motorized and non-motorized ships, rhombus for motorized ships and a circle for non-motorized ships.

A difficulty of the signs on bridges used in China is the definition of large ships and small ships. Another difficulty is that the colours used for signs conflict with normal thinking, \text{Red} = \text{stop} \hspace{1cm} \text{Green} = \text{go}. The deficiency of the signs recently adopted by Viet Nam is that they use the reserved yellow colour for special marks in the IALA maritime system.
system, which may confuse sea mariners, in particular, during night when they use yellow lights to navigate.

The signs for bridges approved in 2000 in the Lao People’s Democratic Republic are introduced from SIGNI, a red circle for no pass, one yellow circle for two-way traffic and two yellow circles for one-way traffic. The shortfall of the signs is that there is no distinction in shape between no pass and two-way traffic signs.

The bridge signs in Myanmar have direct illustrated meaning, a red cross on a round white board for no pass and a green triangle (arrow) on a round board for pass. The deficiency of the signs is that there is no difference in shape.

The best solution for this complicated situation is to combine the good sides of the signs in different countries. Appropriate modifications to the signs are necessary to form a set of signs with unique shape and colour for every sign.

Signs and signals for bridges are not included in the IALA Maritime Buoyage System, but in the Recommendations for the Marking of Fixed Bridge over Navigable Waters (in 1998). IALA recommends the use of a green point upward triangle panel and a red square panel to mark the limit of the most appropriate passage under a bridge. It also recommends the use of special yellow marks as prescribed in the IALA Maritime Buoyage System to mark the span(s) for very small craft other than the span(s) indicated with green/red marks.

The lower section of the river may need to further harmonize the signs for bridges with the recommendations of IALA.

I. Others

Some particular marks used in a country can be either replaced with the internationally recognized ones or used as long as they have no conflict with other recommended marks.
VIII. PRINCIPLES AND FEATURES OF THE AIDS TO NAVIGATION SYSTEM
ON THE GREATER MEKONG RIVER

In view of the economic level, traffic volume, river conditions, existing aids to navigation systems, resources available for installation and maintenance of aids to navigation, education and training of crew and waterway staff, capacity in producing aids to navigation in the six riparian countries and international and regional recommendations on aids to navigation, the principles, which could be adopted for harmonization of aids to navigation systems on the Greater Mekong River, are as follows:

- Safe
- Simple
- Low cost
- Easily adopted
- Easily understood
- Harmonized with IALA as far as it can be applied to inland waterways
- Adoption of the approach of IALA
- Compatible with international/regional recommendations, in particular CEVNI/SIGNI use of limited types to regulate key navigation marks and signs which can sufficiently mark the Greater Mekong River
- Minimized use of similar shapes or colours for different marks
- Consistent for marks on water and those on land with the same function
- Sufficient consideration of the conditions of the Greater Mekong River, existing systems and traditions, and capacity in installation, maintenance and training of crew

Audible aids to navigation are complicated to produce and difficult to maintain. Normally they are employed in very broad waterways, in particular at sea. Radio aids to navigation are more expensive than visual ones and require radar equipment on board. Nearly all river barges have no radar equipment in this subregion. Therefore, audio and radio aids to navigation should not be recommended. Taking some maritime traffic downstream from Kampong Cham, Cambodia, into account, radar reflectors may be fixed on the recommended marks in accordance with the relevant recommendations by IALA.

The visual aids to navigation to be adopted for the Greater Mekong River are recommended in the form of:

- Overall harmonization throughout the river in fundamental elements, definition of types of marks, basic shapes of marks, light characters, surface colours for the right side, and marking method
- Coordination with the IALA Maritime Buoyage System Region A definition of types of marks, basic shapes of marks, light characters, shapes of lateral marks, bifurcation marks and special purpose marks, surface colour of right side marks
- Compatibility with CEVNI/SIGNI in definition of light character, shapes of lateral, bifurcation and special purpose marks, surface colour of right side marks
The most important facts identified in the study are as follows:

- Navigation is interrupted at the Khone Falls
- The upper section of the river is narrow and mountainous, where marks usually need to be placed against abundant green vegetation
- The upper section of the river is not accessed by seagoing ships
- The lower section of the river is wide and plain, where marks may be placed in open areas
- The lower section is open to maritime traffic from Kampong Cham in Cambodia to the river mouth in Viet Nam

The features of the possible systems should be as follows:

- No internal conflict within the systems and external conflict with other systems
- Unique shape for each type of mark to ensure functioning of marks in case of deterioration of colour owing to insufficient maintenance
- Compatible with IALA and CEVNI/SIGNI recommendations
- Suitable to the natural states of the Greater Mekong River
- Well harmonized between the systems for the Upper and Lower Mekong River
- Simple and easy for application and maintenance
- Low cost for installation and maintenance
IX. IMPORTANT ISSUES TO BE CONSIDERED IN THE HARMONIZATION OF AIDS TO NAVIGATION SYSTEMS

The standard process for harmonization of regional or national systems of aids to navigation is as follows:

1. Collection of data and information
2. Analysis of collected data and information
3. Preparation of draft recommendations
4. Collection of comments on draft recommendations
5. Refining and finalization of draft recommendations

The fundamental steps of this process are the collection of data and information and analysis of collected data and information.

The data and information to be collected should include reference systems of aids to navigation, theories and studies, and river specific conditions. Visits to waterways and all organizations concerned are necessary to acquire first-hand information and points of view of different people and various organizations.

The reference systems of aids to navigation must include the IALA Maritime Buoyage System and CEVNI/SIGNI, and also the national systems of China, the Russia Federation and the United States.

The basic theories and studies related to aids to navigation on inland waterways include researches and tests on surface colours, shapes and light characters of visual marks. The researches and tests are usually also extended to colours of marks against various backgrounds and illumination. Many studies have been summarized in the guidelines and recommendations by the relevant organizations. The following informative publications are important for a review of the past studies on aids to navigation on inland waterways:

1. IALA Navguide
2. IALA Recommendations for the Surface Colours Used as Visual Signals on Aids to Navigation
3. IALA Recommendations for the Rhythmic Characters of Lights on Aids to Navigation
4. Colours of Light Signals by the International Commission on Illumination

The river-specific information is crucial for the successful selection of appropriate systems of aids to navigation. The following factors should be considered in the formulation or harmonization of aids to navigation systems:

1. River configuration
2. Flow patterns
Key river sections must be visited to obtain direct impressions of river conditions. Relevant organizations and people should be interviewed to collect information of the river from their experiences and their views to issues to be considered and aids to navigation systems. The organizations to be visited should include the ministries for transport and inland waterways, authorities for inland water transport and inland waterways, waterway stations or teams for maintenance of aids to navigation, pilot associations, research institutes for aids to navigation, shipping companies, shipowners associations and training schools. Individual captains, skippers, pilots and workers for the installation and maintenance of aids to navigation should also be interviewed.

In the analysis of collected data and information, it must be noted that the IALA Maritime Buoyage System is an internationally recognized standard for aids to navigation. This system has been widely used at sea around the world. However, the system was developed for use at sea, not for use on inland waterways. Some marks recommended in the system are not well suited to inland waterways, such as cardinal marks and safe water marks. In addition, some marks particularly required by inland waterways are not provided by this system such as cross-over and alignment marks as well as other land marks.

It should also be noted that there is no global uniform aids to navigation system for inland waterways. Mostly aids to navigation systems on inland waterways are country oriented. Only on regional inland waterway networks or international rivers, were regional aids to navigation, such as CEVNI/SIGNI, systems formulated. In this situation, many national and regional aids to navigation systems were formulated on the basis of the IALA Maritime Buoyage System because of the access of maritime traffic to inland waterways on the lower parts of rivers. Although the IALA Maritime Buoyage System cannot be fully applied to inland waterways owing to the differences of sea and river characteristics, the basic principles and key elements of the IALA Maritime Buoyage System are applied to the aids to navigation on inland waterways to facilitate sea-river through traffic and ensure their navigation safety. The examples are CEVNI/SIGNI, the aids to navigation system of the United States and the national aids to navigation system on inland waterways of China which adjusted the IALA Maritime Buoyage System according to the specific requirements of
inland navigation, their waterway conditions and tradition. They adopted elements of the IALA Maritime Buoyage System.

Minimum use of the IALA Maritime Buoyage System for the aids to navigation systems should include:

- Direction definition
- Shapes and topmarks of lateral marks
- Colour of one-side lateral marks
- Light characters of lateral marks.

One-way bifurcation marks in the IALA Maritime Buoyage System are recommended for stable channels of inland waterways, but not for unstable natural channels. If one way is preferred for navigation at a bifurcation, lateral marks should be used to mark the channel open for navigation. If both ways are equally navigable, two two-way bifurcation marks should be placed at the ends of the channel. However, this two-way bifurcation mark should show similarity with the one-way bifurcation marks in the IALA Maritime Buoyage System, but also some differences to remind navigators of the similar function of the mark with a one-way bifurcation mark and to avoid misunderstanding of it as the one-way bifurcation mark.

Isolated danger marks in the IALA Maritime Buoyage System may be applied to inland waterways. An isolated danger in an inland waterway should be removed. If they cannot be removed in a reasonable time, lateral marks and bifurcation marks should be placed as appropriate.

Safe water marks in the IALA Maritime Buoyage System serve to indicate that there is navigable water all around the mark, including the centre line of a channel and mid-channel. They also serve to indicate a landfall. They are rarely used on natural inland waterways that always have a very limited navigable width and land in sight.

The special marks recommended in the IALA Maritime Buoyage System include a number of marks which are not specifically indicated in this system, such as spoil ground marks, military exercise zone marks, cable and pipeline marks and recreation marks. IALA only recommends a uniform colour (yellow) and topmark (shape). The mark shape is optional. If other marks in the IALA Maritime Buoyage System are adopted, the special marks should also be adopted to maintain the consistency of an aids to navigation system.

On very broad waterways, such as lakes, reservoirs and river mouths, the IALA Maritime Buoyage System can be fully adopted.

Many river estuaries or deltas in Asia are open for both seagoing and river-going vessels. Use of the IALA Maritime Buoyage System or aids to navigation for inland waterways is often controversial in the management of aids to navigation. In fact, it depends on specific river conditions. If the maritime traffic accessible section does not require river
marks such as cross-over and alignment, the maritime aids to navigation system can be applied. Otherwise, river aids to navigation system should be employed. In this case, a boundary of sea and river systems should be clearly established and the river aids to navigation system should be harmonized with the IALA Maritime Buoyage System.

CEVNI/SIGNI was formulated by ECE for European inland waterways. It is quite successful on the Western European inland waterway network centred on the Rhine. Nowadays some Asian countries also employ this system if there are no national aids to navigation systems for their inland waterways. The system recommends a large number of navigational marks and directive signs.

The lateral marks of CEVNI/SIGNI follow the recommendations of the IALA Maritime Buoyage System for Region A. All the other marks are different from the recommendations of the IALA Maritime Buoyage System. The use of topmarks on isolated danger and bifurcation marks follow the principle of the IALA Maritime Buoyage System, that is a green cone for the left side and a red can for the right side.

CEVNI/SIGNI was formulated on the basis of the regulated and well-developed inland waterways of Western Europe, in particular the Rhine. Most inland waterways in Asia are still in their natural state without improvement and some countries have already promulgated their national standards for a long period. When CEVNI/SIGNI is to be applied to the inland waterways in Asia, studies should be undertaken to select appropriate navigational marks. On the lower reaches of rivers, CEVNI/SIGNI is appropriate because the navigation channels in those areas are usually wide and stable and waterways are developed, which are quite similar to the channel conditions of Western Europe. On the upper or sometimes middle reaches, CEVNI/SIGNI may not be appropriate because the navigation channels are always narrow and unstable and extensive maintenance of aids to navigation cannot be justified owing to less traffic.

CEVNI/SIGNI recommends some marks for the training structures of waterways, such as marks for danger points and obstacles. They are usually used in combination with lateral or bifurcation buoys. They may be misapplied on inland waterways in Asia as bankwise marks if they have no training structures. Use of these marks should be carefully based on specific analysis as to the functions of the marks, coordination of these marks with others, and river conditions.

Signs on inland waterways are less sensitive than navigational marks. The signs recommended in CEVNI/SIGNI include a wide range of selection. They are used as day marks without lights for night navigation. Some of them can be selected for a specific river or country. Some signs may be vitally important for natural inland waterways in Asia, such as prohibitory entry and horning. Usually the prohibitory entry sign is placed on the structures crossing waterways in Western Europe, such as dams, sluices and hydropower stations, where the current is not very strong and the structure is obvious day and night. This sign needs to be placed on both the structure and in the water of inland waterways in Asia to
indicate restricted areas, dangerous places and closed channels etc. which are not like the fixed structures in Europe that have lights during the night. Additional light is required for this type of sign in Asia. Therefore, this sign should be considered as an important navigational mark in Asia. Horning at places with sharp bends and narrow channels in the mountainous river sections is crucial for safe navigation. The regular sign for this purpose is not sufficient. It should also be considered as a navigational mark. Light should be installed in places with night navigation.

ECAFE recommended a uniform system of aids to navigation on inland waterways in Asia in 1957, when ECE proposed SIGNI. It was based on the recommendations of the uniform maritime buoyage system of the League of Nations in 1936 as the old SIGNI. This system has not been widely applied throughout the region owing to insufficient promotion and updating. In particular, it was not updated immediately after the adoption of the IALA Maritime Buoyage System in 1980. This system should be not pursued until its further refinement with the IALA Maritime Buoyage System and the latest developments of technology.
Annex I

QUESTIONNAIRE USED IN THE ESCAP/MRC PROJECT ON HARMONIZATION OF AIDS TO NAVIGATION ON THE GREATER MEKONG RIVER

QUESTIONNAIRE

Objective: This questionnaire is prepared for the review of the existing aids to navigation systems along the Lancang-Mekong River and the collection of relevant information from the riparian countries for the harmonization of aids to navigation systems to promote safe navigation on the entire Lancang-Mekong River.

1. Waterway properties
   1.1 Total length of navigable inland waterways in your country
   1.2 Length of the Lancang-Mekong River section in your country
   1.3 Total length of the Lancang-Mekong River tributaries in your country
   1.4 Physical limitations of the Lancang-Mekong River section in your country (such as locks, bridges, natural constraints)
   1.5 Particular navigational problems of the Lancang-Mekong River section in your country (such as current velocities, shifting channel, shallows, floods)

2. Waterway administration
   2.1 Agency responsible for maritime aids to navigation at the national level
   2.2 Agency responsible for inland waterway aids to navigation at the national level
   2.3 Agency for aids to navigation on the Lancang-Mekong River basin/section in your country
   2.4 Legal aspects
      2.4.1 Rules and regulations on aids to navigation (please indicate titles, promulgated organization, effective date, and provide a copy of all relevant rules and regulations*)
      2.4.2 Rules and regulations on navigation safety applicable to the Lancang-Mekong River section in your country (please indicate titles, promulgated organization, effective date, and provide a copy of all relevant rules and regulations*)
      2.4.3 Please provide national standards on the classification of waterways if any*
   2.5 Pilot aspects
      2.5.1 Availability of river pilot service on the Lancang-Mekong River section in your country
      2.5.2 Conduct of piloting on the Lancang-Mekong River section in your country (compulsory or voluntary, private or public, organized or individual, and legal status)
2.5.3 Required qualification, experience and examination for pilots on the Lancang-Mekong River section in your country

3. Waterway use

3.1 Transport on the Lancang-Mekong River section in your country

3.1.1 Annual traffic volume (in tonne)

<table>
<thead>
<tr>
<th></th>
<th>Cargo</th>
<th>Passenger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing</td>
<td>Projected</td>
</tr>
<tr>
<td>Domestic</td>
<td>Domestic</td>
<td>Inter’l</td>
</tr>
<tr>
<td>Inter’l</td>
<td>Domestic</td>
<td>Inter’l</td>
</tr>
</tbody>
</table>

3.1.2 Major traffic flow direction

3.2 Navigation activities on the Lancang-Mekong River section in your country

3.2.1 Government owned/operated vessel number

3.2.2 Registered private owned/operated vessel number

3.2.3 Existence of non-registered private owned/operated vessels (for instance fishing boats and small boat operators for cargo and passenger ferry services)

3.3 Fleet and personnel structure on the Lancang-Mekong River section in your country

3.3.1 Fleet composition

<table>
<thead>
<tr>
<th></th>
<th>Tug</th>
<th>Pusher</th>
<th>Dumb Barge</th>
<th>Cargo boat</th>
<th>Passenger boat</th>
<th>Passenger/cargo boat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average crew per vessel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.3.2 General description on outfit of vessels (such as compass, searchlight, radar, GPS, radio, VHF, depth sounder)

3.4 Names of major river ports and terminals on the Lancang-Mekong River section in your country

3.5 Navigation accidents on the Lancang-Mekong River section in your country

3.5.1 Number, location and causes of navigation accidents in 1998 and 1999

3.5.2 Total loss of cargo and people caused by navigation accidents in 1998 and 1999

4. Aids to navigation

4.1 Standard for aids to navigation applied to the sea approaches and port access channels

4.1.1 Is the Maritime Buoyage System recommended by the International Association of Lighthouse Authorities (IALA) or a national standard applied in your country? If a national standard is applied, please provide a copy.*
4.1.2 Indication of deviations of your aids to navigation from IALA

4.1.3 Boundary between maritime and inland waterway buoyage administration

4.2 Standards for aids to navigation applied on the Inland Waterways in your country

4.2.1 What standards are applied in your country, IALA - Maritime Buoyage system, CEVNI - European Code for Inland Waterways, or SIGNI - Uniform buoyage and signalization system for European Inland Waterways, or a national standard? If a national standard is applied, please provide a copy*

4.2.2 Is IALA fully applied on the inland sea-going ship routes for national and/or international traffic?

4.2.3 Is IALA fully applied on the inland waterways for national and/or international traffic?

4.2.4 Deviations or additions of national standards from IALA

4.3 Status of achieved and projected aids to navigation implementation

4.3.1 Estimated number of aids to navigation on all inland waterways in your country

4.3.2 Estimated number of aids to navigation on the Lancang-Mekong River section in your country

4.3.3 Estimated number of aids to navigation on the Lancang-Mekong River tributaries in your country

4.3.4 Estimated number of aids to navigation for day/night navigation on the Lancang-Mekong River section in your country

4.4 Aids to navigation management on the Lancang-Mekong River

4.4.1 Organization structure (including main office, field stations and area of control)

4.4.2 Physical means available (workboat and equipment) at stations

4.4.3 Repair facilities at station (workshop, tools and spare parts)

4.4.4 Brief description of the system for data collection on channel status (channel patrol) and mapping

4.4.5 Brief description of the system for periodical check on aids to navigation (scheduled maintenance)

4.4.6 Brief introduction to the availability of information to navigators (least available depth, obstructions, accidents, aids to navigation failures)

4.4.7 River police system (enforcement of rules & regulations, aids to navigation theft and vandalism prevention and investigation)

4.4.8 Cooperation with other agencies (search and rescue, pollution combat, environment protection, police, customs)

4.5 Aids to navigation fabrication and repair on the Lancang-Mekong River
4.5.1 Are aids to navigation produced by domestic manufacturers or imported?
4.5.2 Are there aids to navigation repair and fabrication facilities in your country?
4.5.3 Please indicate the availability of spare parts and distribution
4.5.4 Please briefly introduce the materials applied to aids to navigation (steel, GRP, polyethylene, bamboo, other)
4.5.5 Please list the principal national and international suppliers and subcontractors
4.6 Aids to navigation details (applicable to the case of no national standard provided)
4.6.1 Overview of aids to navigation objects in use with related chart symbols
4.6.2 Classification and dimension sketches of buoys
4.6.3 Classification and dimension sketches of shore beacons and light towers
4.6.4 Classification and dimension sketches of shore signs (including civil structures)
5. Education and training
5.1 Barge crews
5.1.1 Education/training on aids to navigation systems and recognition
5.1.2 Knowledge on aids to navigation compulsory for which levels of crew
5.1.3 Any refreshment courses for barge crews
5.2 Aids to navigation management staff
5.2.1 Education/training on aids to navigation systems and technology
5.2.2 Knowledge on aids to navigation compulsory for which levels of staff
5.2.3 Any refreshment courses for management staff
5.2.4 Training national and/or abroad (including at suppliers premises)
5.3 Education and training institutions for aids to navigation
5.3.1 Number of universities/colleges offering courses on design, installation and maintenance of aids to navigation
5.3.2 Number of universities/colleges offering courses for inland ship crew
5.3.3 Number of schools offering training courses for inland ship crew and aids to navigation
6. International cooperation
6.1 Is your country a regular member of IALA?
6.2 International Hydrographic Organization - IHO

6.2.1 Is your country a regular member of IHO?

6.2.2 Has your country adopted the IHO recommendations relating to Symbols and Abbreviations on Marine Charts?

6.3 Bilateral arrangements

6.3.1 Has your country signed any agreement with other countries on aids to navigation on international rivers? If signed, please provide a copy of the agreement*

6.3.2 Does your country have any plan to sign any agreement with other countries on aids to navigation on international rivers?

******

*Note: If no English version available, the national language version is also acceptable.
<table>
<thead>
<tr>
<th>Country</th>
<th>Total length of inland waterway (km)</th>
<th>Section length of Greater Mekong River (km)</th>
<th>Length of tributaries of Greater Mekong River (km)</th>
<th>Total number of inland aids to navigation on Greater Mekong River</th>
<th>Total number of aids to navigation on Greater Mekong River</th>
<th>Annual traffic on Greater Mekong River</th>
<th>Registered vessel number on Greater Mekong River</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cargo (ton)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Existing Domestic</td>
<td>Int'l Domestic</td>
</tr>
<tr>
<td>Cambodia</td>
<td>855</td>
<td>500</td>
<td>1,242</td>
<td>Beacon: 261 Buoy: 12</td>
<td>Beacon: 261 Buoy: 12</td>
<td>6,020</td>
<td>600,000</td>
</tr>
<tr>
<td>China</td>
<td>116,000</td>
<td>2,130</td>
<td>1,300</td>
<td>40,000</td>
<td>291</td>
<td>27,500</td>
<td>130,000</td>
</tr>
<tr>
<td>Lao People’s Democratic Republic</td>
<td>1,612</td>
<td>1,898</td>
<td>2,686 (rainy)</td>
<td>Beacon: 540</td>
<td>Beacon: 540</td>
<td>783,000</td>
<td>NA</td>
</tr>
<tr>
<td>Myanmar</td>
<td>6,650</td>
<td>265</td>
<td>NA</td>
<td>Floating: 15,000 Shore: 9,000</td>
<td>None</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Thailand</td>
<td>Dry season: 1,150 Rainy season: 1,750</td>
<td>NA</td>
<td>760</td>
<td>None</td>
<td>None</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>19,000</td>
<td>463</td>
<td>310.5</td>
<td>13,000</td>
<td>400</td>
<td>36,600,000</td>
<td>2,000,000</td>
</tr>
</tbody>
</table>
Annex IV

SUMMARY OF CHINA NATIONAL STANDARDS ON AIDS TO NAVIGATION ON INLAND WATERWAYS

1. Lighted and unlighted lateral marks and buoys
2. Lighted crossing marks

3. Lighted bankwise marks

4. Lighted mid-ground marks and buoys

5. Lighted flooding marks

6. Lighted drift marks and buoys

7. Lighted leading marks

8. Lighted transitional leading marks
9. Lighted double crossing marks


14. Traffic control signal mark  15. Water depth display signal mark
16. Position indication mark

17. Bridge opening mark
Annex V
Design drawing of beacon in the Lao People’s Democratic Republic
Annex VII

AIDS TO NAVIGATION SYSTEM ON INLAND WATERWAYS IN MYANMAR

[Diagram of various navigation marks, including channel marks, shore marks, and danger marks, with corresponding symbols and descriptions.]
Signs on Land

Warning: Section with restriction ahead

Indication: End of section with restriction

Mandatory instruction: Proceed in this direction

Prohibitory instruction: Prohibited channel
Signs on Land

Warning: Narrow & curve channel ahead

Kilometre Board

ป้ายหลักกิโลเมตร

เตือนให้ใช้วิทยุวิทยุกระจายเสียงในการเดินทาง

เนื่องจาก ป้ายนี้พักผาแทนและมีความมืดมาก

เมื่อเริ่มเดินทางจึง ควรเตรียมตัวอย่างน้อย ต้องทำการ์ดีที่สุดต้องถูก
Annex XI

IALA MARITIME BUOYAGE SYSTEM

RULES

1. GENERAL

1.1. Scope

This system provides rules which apply to all fixed and floating marks (other than lightouses, sector lights, leading lights and marks, lightships and large navigational buoys) serving to indicate:

1.1.1. The lateral limits of navigable channels.

1.1.2. Natural dangers and other obstructions such as wrecks.

1.1.3. Other areas or features of importance to the mariner.

1.1.4. New dangers.

1.2. Types of marks

The system of buoyage provides five types of marks which may be used in combination:

1.2.1. Lateral marks, used in conjunction with a “conventional direction of buoyage”, generally used for well defined channels. These marks indicate the port and starboard sides of the route to be followed. Where a channel divides, a modified lateral mark may be used to indicate the preferred route. Lateral marks differ between Buoyage Regions A and B as described in Sections 2 and 6.

1.2.2. Cardinal marks, used in conjunction with the mariner’s compass, to indicate where the mariner may find navigable water.

1.2.3. Isolated Danger marks to indicate isolated dangers of limited size that have navigable water all around them.

1.2.4. Safe Water marks to indicate that there is navigable water all around their position, e.g. mid-channel marks.

1.2.5. Special marks not primarily intended to assist navigation but to indicate an area or feature referred to in nautical documents.

1.3. Method of characterising marks

The significance of the mark depends upon one or more of the following features:

1.3.1. By night, colour and rhythm of light.

1.3.2. By day, colour, shape, topmark.
2. LATERAL MARKS

2.1. Definition of "conventional direction of buoyage"

The "conventional direction of buoyage", which must be indicated in appropriate nautical documents, may be either:
2.1.1. The general direction taken by the mariner when approaching a harbour, river, estuary or other waterway from seaward, or
2.1.2. The direction determined by the proper authority in consultation, where appropriate, with neighbouring countries. In principle it should follow a clockwise direction around land masses.

2.2. Buoyage Regions

There are two international Buoyage Regions A and B where lateral marks differ. These buoyage regions are indicated in Section B.

2.3. Description of Lateral Marks used in Region A

<table>
<thead>
<tr>
<th>2.3.1. Port hand Marks</th>
<th>2.3.2. Starboard hand Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Colour</strong>: Red</td>
<td><strong>Colour</strong>: Green</td>
</tr>
<tr>
<td><strong>Shape (Buoya)</strong>: Cylindrical (can), pillar or spar</td>
<td><strong>Shape (Buoya)</strong>: Conical, pillar or spar</td>
</tr>
<tr>
<td><strong>Topmark (if any)</strong>: Single red cylinder (can)</td>
<td><strong>Topmark (if any)</strong>: Single green cone, point upward</td>
</tr>
<tr>
<td><strong>Light (when fitted)</strong>: [ Colour: Red ]</td>
<td><strong>Light (when fitted)</strong>: [ Colour: Green ]</td>
</tr>
<tr>
<td><strong>Rhythm</strong>: Any, other than that described in section 2.3.3.</td>
<td><strong>Rhythm</strong>: Any, other than that described in section 2.3.3.</td>
</tr>
</tbody>
</table>

2.3.3. At the point where a channel divides, when proceeding in the "conventional direction of buoyage", a preferred channel may be indicated by a modified Port or Starboard lateral mark as follows:

2.3.3.1. Preferred channel to Starboard:
| Colour: Red with one broad green horizontal band |
| Shape (Buoya): Cylindrical (can), pillar or spar |
| Topmark (if any): Single red cylinder (can) |
| Light (when fitted): Red |
| Rhythm: Composite group flashing (2 + 1) |

2.3.3.2. Preferred channel to Port:
| Colour: Green with one broad red horizontal band |
| Shape (Buoya): Conical, pillar or spar |
| Topmark (if any): Single green cone, point upward |
| Light (when fitted): Green |
| Rhythm: Composite group flashing (2 + 1) |
2.4. Description of Lateral Marks used in Region B

2.4.1. Port hand Marks

Colour : Green
Shape (Buoya) : Cylindrical (can), pillar or spar
Topmark (if any) : Single green cylinder (can)
Light (when fitted) : Green
Rhythm : Any, other than that described in section 2.4.3.

2.4.2. Starboard hand Marks

Colour : Red
Shape (Buoya) : Conical, pillar or spar
Topmark (if any) : Single red cone, point upward
Light (when fitted) : Red
Rhythm : Any, other than that described in section 2.4.3.

2.4.3. At the point where a channel divides, when proceeding in the “conventional direction of buoyage”, a preferred channel may be indicated by a modified Port or Starboard lateral mark as follows:

2.4.3.1. Preferred channel to Starboard:

Colour : Green with one broad red horizontal band
Shape (Buoya) : Cylindrical (can), pillar or spar
Topmark (if any) : Single green cylinder (can)
Light (when fitted) : Green
Rhythm : Composite group flashing (2 + 1)

2.4.3.2. Preferred channel to Port:

Colour : Red with one broad green horizontal band
Shape (Buoya) : Conical, pillar or spar
Topmark (if any) : Single red cone, point upward
Light (when fitted) : Red
Rhythm : Composite group flashing (2 + 1)

2.5. General Rules for Lateral Marks

2.5.1. Shapes
Where lateral marks do not rely upon cylindrical (can) or conical buoy shapes for identification they should, where practicable, carry the appropriate topmark.

2.5.2. Numbering or lettering
If marks at the sides of a channel are numbered or lettered, the numbering or lettering shall follow the “conventional direction of buoyage”.
3. CARDINAL MARKS

3.1. Definition of Cardinal quadrants and marks

3.1.1. The four quadrants (North, East, South and West) are bounded by the true bearings NW-NE, NE-SE, SE-SW, SW-NW, taken from the point of interest.

3.1.2. A Cardinal mark is named after the quadrant in which it is placed.

3.1.3. The name of a Cardinal mark indicates that it should be passed to the named side of the mark.

3.2. Use of Cardinal Marks

A Cardinal mark may be used, for example:

3.2.1. To indicate that the deepest water in that area is on the named side of the mark.

3.2.2. To indicate the safe side on which to pass a danger.

3.2.3. To draw attention to a feature in a channel such as a bend, a junction, a bifurcation or the end of a shoal.

3.3. Description of Cardinal Marks

3.3.1. North Cardinal Mark

<table>
<thead>
<tr>
<th>Topmark ( ^{a1} ) :</th>
<th>2 black cones, one above the other, points upward</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour :</td>
<td>Black above yellow</td>
</tr>
<tr>
<td>Shape :</td>
<td>Pillar or spar</td>
</tr>
<tr>
<td>Light (when fitted) :</td>
<td></td>
</tr>
<tr>
<td>Colour :</td>
<td>White</td>
</tr>
<tr>
<td>Rhythm :</td>
<td>VO or Q</td>
</tr>
</tbody>
</table>

3.3.2. East Cardinal Mark

<table>
<thead>
<tr>
<th>Topmark ( ^{a1} ) :</th>
<th>2 black cones, one above the other, base to base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour :</td>
<td>Black with a single broad horizontal yellow band</td>
</tr>
<tr>
<td>Shape :</td>
<td>Pillar or spar</td>
</tr>
<tr>
<td>Light (when fitted) :</td>
<td></td>
</tr>
<tr>
<td>Colour :</td>
<td>White</td>
</tr>
<tr>
<td>Rhythm :</td>
<td>VO(3) every 5s or Q(3) every 10s</td>
</tr>
</tbody>
</table>
3.3.3. South Cardinal Mark
Topmark: 2 black cones, one above the other; points downward
Colour: Yellow above black
Shape: Pilar or spar
Light (when fitted):
Colour: V0(61) + Long flash every 10s or Q(6) + Long flash every 15s

3.3.4. West Cardinal Mark
Topmark (aff): 2 black cones, one above the other, point to point
Colour: Yellow with a single broad horizontal black band
Shape: Pilar or spar
Light (when fitted):
Colour: White
Rhythm: V0(9) every 10s or Q(9) every 15s

4. ISOLATED DANGER MARKS

4.1 Definition of Isolated Danger Marks
An Isolated Danger mark is a mark erected on, or moored on or above, an isolated danger which has navigable water all around it.

4.2. Description of Isolated Danger Marks
Topmark (aff): 2 black spheres, one above the other
Colour: Black with one or more broad horizontal red bands
Shape: Optional, but not conflicting with lateral marks; pilar or spar preferred
Light (when fitted):
Colour: White
Rhythm: Group flashing (2)

5. SAFE WATER MARKS

5.1. Definition of Safe Water Marks
Safe Water marks serve to indicate that there is navigable water all round the mark; these include centre line marks and mid-channel marks. Such a mark may also be used as an alternative to a Cardinal or a Lateral mark to indicate a landfall.

5.2. Description of Safe Water Marks
Colour: Red and white vertical stripes
Shape: Spherical; pilar or spar with spherical topmark
Topmark (if any): Single red sphere
Light (when fitted):
Colour: White
Rhythm: Isophase, occulting, one long flash every 10s or Morse “A”

(aff) The double cone topmark is a very important feature of every Cardinal mark by day, and should be used wherever practicable and be as large as possible with a clear separation between the cones.

(aff) The double sphere topmark is a very important feature of every isolated Danger mark by day, and should be used wherever practicable and be as large as possible with a clear separation between the spheres.
6. SPECIAL MARKS

6.1. Definition of Special Marks
Marks not primarily intended to assist navigation but which indicate a special area or feature referred to in appropriate nautical documents, for example:

6.1.1. Ocean Data Acquisition Systems (ODAS) marks.
6.1.2. Traffic separation marks where use of conventional channel marking may cause confusion.
6.1.3. Spoil ground marks.
6.1.4. Military exercise zone marks.
6.1.5. Cable or pipeline marks.
6.1.6. Recreation zone marks.

6.2. Description of Special Marks

| Colour     | Yellow                  |
| Shape      | Optional, but not conflicting with navigational marks |
| Topmark (if any) | Single yellow 'X' shape |
| Light (when fitted) | |
| Colour | Yellow |
| Rhythm | Any, other than those described in sections 3, 4 or 5 |

6.3. Additional Special Marks
Special marks other than those listed in paragraph 6.1 and described in paragraph 6.2 may be established by the responsible administration to meet exceptional circumstances. These additional marks shall not conflict with navigational marks and shall be promulgated in appropriate nautical documents and the International Association of Lighthouse Authorities notified as soon as practicable.

7. NEW DANGERS

7.1. Definition of New Dangers
The term “New Danger” is used to describe newly discovered hazards not yet indicated in nautical documents. “New Dangers” include naturally occurring obstructions such as sandbanks or rocks or man made dangers such as wrecks.

7.2. Marking of New Dangers

7.2.1. “New Dangers” shall be marked in accordance with these rules. If the appropriate Authority considers the danger to be especially grave at least one of the marks shall be duplicated as soon as practicable.

7.2.2. Any lighted mark used for this purpose shall have an appropriate Cardinal or Lateral VQ or Q light character.

7.2.3. Any duplicate mark shall be identical to its partner in all respects.

7.2.4. A “New Danger” may be marked by a beacon, coded Morse “D” showing a signal length of 1 nautical mile on the radar display.

7.2.5. The duplicate mark may be removed when the appropriate Authority is satisfied that information concerning the “New Danger” has been sufficiently promulgated.

8. INTERNATIONAL BUOYAGE REGIONS A AND B

There are two international Buoyage Regions A and B where Lateral marks differ as described in Section 2. The geographical divisions of these two Regions are indicated in the Annex which will, if necessary, be updated from time to time.
Annex XII

European Code for Inland Waterways/Signs and Signals on Inland Waterways

1. **BUOYAGE OF CHANNEL LIMITS IN THE WATERWAY**

1. Right-hand side of the channel

   ![Diagram of red buoyage](fig. 1)

   Colour: red
   Form: cylindrical buoy or buoy with a topmark, or spar
   Topmark (if any): red cylinder
   Light (when fitted): rhythmic red light
   Generally with radar reflector

2. Left-hand side of the channel

   ![Diagram of green buoyage](fig. 2)

   Colour: green
   Form: conical buoy or buoy with a topmark, or spar
   Topmark (if any): green cone, point upwards
   Light (when fitted): rhythmic green light
   Generally with radar reflector
3. Bifurcation of the channel

Colour: horizontal red and green bands
Form: spherical buoy or buoy with a topmark, or spar
Topmark (if any): sphere with horizontal red and green bands
Light (when fitted): continuous scintillating white light, or isophase white light
(may be the group-flashing white light with a group of three flashes)

Generally with radar reflector
Where necessary, a red cylindrical topmark or green conical topmark placed above the bifurcation mark indicates on which side it is preferable to pass (main channel). The mark shall then bear a rhythmic red light or a rhythmic green light, as appropriate.

4. A letter "P" painted in white on the buoys described in paragraphs 1 and 2 indicates that the channel is adjacent to a berthing area. If the buoys showing the letter "P" carry a light, its rhythm shall be different from that of the lights of other buoys placed along the channel limit.
II. MARKS ON LAND INDICATING THE POSITION OF THE CHANNEL

A. Marks on land indicating the position of the channel in relation to the banks

These marks indicate the position of the channel in relation to the bank and, together with the buoyage of the waterway, mark the channel at points where it approaches a bank; they also serve as landmarks.

1. Channel near the right bank

![Channel near the right bank diagram](image)

(fig. 5)

Colour: red/white

Form: post with topmark

Topmark: square board (sides horizontal and vertical), red, with two horizontal white stripes; or square frame (sides horizontal and vertical), painted red

Light (when fitted): rhythmic red light
2. Channel near the left bank

Colour: green/white

Form: post with topmark

Topmarks: square board (diagonals horizontal and vertical), upper half painted green and lower half white; or square frame (diagonals horizontal and vertical), painted green

Light (when fitted): rhythmic green light

3. Use of marks

(fig. 7)
II. Marking of cross-overs

These marks indicate at what point the channel passes from one bank to another and also give the axis of this cross-over.

I. Right bank

(fig. 8)

Colour: yellow/black

Form: post with topmark

Topmark: square yellow board (sides horizontal and vertical), with a central vertical black stripe; or a lath-assembled St. George's Cross painted yellow

Light (when fitted): yellow light, flashing or occulting, with an even-number characteristic other than the group-flashing rhythm with a group of two flashes
2. **Left bank**

![Fig. 9](image)

**Colour:** yellow-black

**Form:** post with topmark

*Topmark:* square yellow board (diagonals horizontal and vertical), with a central vertical black stripe; or a later-assembled St. Andrew's Cross painted yellow

*Light* (when fitted): yellow light, flashing or occulting, with an odd number characteristic other than the group-flashing rhythm with a group of three flashes

3. **Use of marks**

3.1 **Mere indication of cross-over**

![Fig. 10](image)
III. BUOYAGE AND MARKING OF DANGER POINTS AND OBSTACLES

A. Fixed marks

1. Right-hand side
   Colour: red
   Form: post with topmark
   Topmark: red cone, point downwards
   Light (when fitted): rhythmic red light
   (fig. 12)

2. Left-hand side
   Colour: green
   Form: post with topmark
   Topmark: green cone, point upwards
   Light (when fitted): rhythmic green light
   (fig. 13)

3. Bifurcation
   Colour: red/green
   Form: post with topmark
   Topmark: red cone, point downwards, above a green cone, point upwards
   Light (when fitted): continuous scintillating white light
   or isophase white light
   (may be the group-flashing white light
   with a group of three flashes)
   (fig. 14)

   The above cones may be replaced by triangular panels with a white background and a red or green border.

4. Secondary arms of the waterway, mouths of waterways and entrances to harbours

   On the approach to secondary arms of the waterway, to mouths of waterways and to harbour entrances, the bank walls on both sides of the waterway may be marked as far as the head of the dividing mole by the fixed marks described in 1. and 2. above, figures 12 and 13. Vessels entering the harbour are regarded as upstream traffic.
B. **Buoys**

1. Right-hand side

   ![Diagram](image1)

   **(fig. 15)**

   Colour: horizontal red and white bands
   
   Form: spar-buoy or spar
   
   Topmark: red cylinder
   
   Light (when fitted): rhythmic red light. Generally with radar reflector.

2. Left-hand side

   ![Diagram](image2)

   **(fig. 16)**

   Colour: horizontal green and white bands
   
   Form: spar-buoy or spar
   
   Topmark: green cone, point upwards
   
   Light (when fitted): rhythmic green light. Generally with radar reflector.
Annex XIII

UNIFORM SYSTEM OF BUOYS AND SHORE MARKS FOR INLAND WATERWAYS IN ASIA AND THE FAR EAST, RECOMMENDED BY ECAFE IN 1957

I. Buoys
MID-CHANNEL MARKS

TOPMARK (EXAMPLES ONLY)

SHAPE

OPTIONAL, BUT NOT CONE WITH POINT UPWARDS, CAN OR SPHERE

MARK (EXAMPLES ONLY)

SHAPE

DISTINCTIVE WHERE POSSIBLE

COLOUR

BLACK AND WHITE VERTICAL STRIPES OR RED AND WHITE VERTICAL STRIPES

LIGHT

DIFFERENT FROM NEIGHBOURING LIGHTS

MARKING OF WRECKS

TO BE LEFT ON THE PORT HAND

TOPMARK

SHAPE

CAN

MARK

SHAPE

CAN OR SPAR

COLOUR

GREEN OR GREEN LOWER PART RED

LIGHT

GREEN, DOUBLE FLASHING

TO BE PASSED ON EITHER SIDE

TOPMARK

SHAPE

SPHERE

MARK

SHAPE

SPHERICAL OR SPAR

COLOUR

GREEN OR GREEN

LIGHT

GREEN, SINGLE OCCULTING

TO BE LEFT ON THE STARBOARD HAND

TOPMARK

SHAPE

CONICAL OR SPAR

MARK

SHAPE

CONICAL OR SPAR

COLOUR

GREEN OR GREEN LOWER PART BLACK

LIGHT

GREEN, TRIPLE FLASHING
II. Shore Marks

1. Crossing Transit Marks
   One flat diamond. To be used in pairs, the rear one being on a higher pole.

2. Crossing Mark
   One flat diamond, used singly.

3. Main Bank Mark (Port Hand when proceeding inland or with the main stream of the flood tide)
   One square.

4. Main Bank Mark (Starboard Hand when proceeding inland or with the main stream of the flood tide)
   Two horizontal battens.

Both the marks described under 3 and 4 may, if required, be made more conspicuous by placing sheets of white or reflecting material, in any desired shape, under the mark.

* Colour is optional, except where red is indicated.

II. Signaux de Rive

1. Alignements Axiaux
   Un lozange plat. Ces voyants doivent être utilisés deux par deux, le lozange arrière étant placé sur une pérche plus élevée.

2. Traversées de Chenal
   Un lozange plat, utilisé seul.

3. Suivre la Rive
   (A babord pour un bateau qui se dirige vers l'intérieur ou qui suit le courant principal de la marné montante) Un carré.

4. Suivre la Rive
   (A tribord pour un bateau qui se dirige vers l'intérieur ou qui suit le courant principal de la maree montante) Deux barres horizontales.

Les deux voyants décrits à 3 et à 4 peuvent être rendus plus visibles, s'il le faut, au moyen d'écrans blancs, ou en matière réfléchissante, de la forme voulue placés sous le voyant.

* Couleur au choix, sauf pour le rouge.
5. MARK INDICATING BANK TO HUG ONE SPHERE

6. CABLE MARK. ONE RED DISC WITH A WHITE HORIZONTAL BAND IN WHICH IS WRITTEN "CABLE," BOTH IN ENGLISH AND IN THE NATIONAL LANGUAGE OF THE COUNTRY CONCERNED. MARKS ARE TO BE USED ONE ON EACH BANK AT EITHER END OF THE CABLE.

5. RIVE A SERRER UNE SPHERE

8. TRAVERSE DE CABLE. UN DISQUE ROUGE, AVEC BANDE HORIZONTALE BLANCHE PORTANT LES MOTS "CABLE" EN ANGLAIS ET DANS LA LANGUE VERNACULAIRE. CES VOYANTS DEVRAIENT ETRE UTILISES DEUX PAR DEUX, UN SUR CHAQUE RIVE, AUX DEUX EXTREMITES DU CABLE.

7. MARK INDICATING PROHIBITED ENTRANCE, OR "DANGER." ONE RED "X" THE MARK MAY BE USED FOR MARKING WRECKS OR UNDER-WATER OBSTACLES NEAR BANKS AS WELL.

7. SIGNAL DE SENS INTERDIT, OU SIGNIFIANT "DANGER." UNE CROIX DE ST ANDRE ROUGE. CE SIGNAL POURRA ETRE UTILISE POUR INDOUER LES EPAVES, AUSSI BIEN QUE LES OBSTACLES SOUS-MARINS PRES DE LA RIVE.
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