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WORLD MARITIME UNIVERSITY

Malmö, Sweden

**AN INVESTIGATION OF CHINESE
MARITIME EDUCATION & TRAINING
INSTITUTIONS:
THE INTRODUCTION OF NEW
TECHNOLOGY, METHODOLOGIES AND
QUALITY ASSURANCE PROGRAMS**

BY

GAO DEYI

People's Republic of China

A dissertation submitted to the World Maritime University in partial fulfilment of the requirements for the award of the degree of

MASTER OF SCIENCE
in
**MARITIME EDUCATION AND TRAINING
(NAUTICAL)**

1995

DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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I specially thank all the officials of MET institutions and organisations in Sweden, Norway, Germany, France, United Kingdom and United States for providing valuable information and experience during the field studies.

Abstract

This dissertation is a study of various aspects of Chinese maritime education and training (MET). Especially, it highlights the current weaknesses and makes an attempt to improve education by using new technology, methodologies and a quality assurance system.

A brief review is made of the development of the Chinese economy and MET system. An examination is made of the two kinds of maritime institutions called high and vocational education, which provide the different levels of qualification, including why these institutions cannot meet the needs of the maritime industry both for the quantity and quality of seafarers.

A comparison is made of MET systems and course programmes in different countries, noting their advantages and disadvantages with a view to improving the Chinese MET system in future.

In looking at the development of the international and national economy, many problems in Chinese MET are identified. The impact of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1995 (STCW) in relation to international minimum safety standards, the application of new technology, the introduction of quality assurance and other requirements are considered.

In the development of maritime training technology, the use of simulation as a cost-effective method is now almost universally recognised, and the paper discusses the role of such technology in the Chinese MET system. In addition, the impact of developments in PC-based simulation and computer aided learning for modern education and training is evaluated.

There is a need not only for a supply of new seamen on board ships, but also a need for good quality and experienced officers and ratings who meet the requirements

of the STCW Convention. In this regard, quality assurance is one of the most important factors for MET. This paper discusses the implementation of the STCW Convention, the establishment of a revised Chinese MET system, new course development and introduction of quality evaluation systems including construction of a Self-Assessment Model, an internal quality assessment process and an external quality audit.

A number of recommendations is made to improve and enhance the Chinese maritime education and training system.

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1. The Maritime Framework and Maritime Education System In China

1.1 Review Development of the Chinese Economy Relevant to Maritime Transport

Since the 1980s, as China was proceeding positively with an open-door policy, the Chinese economy has been growing quickly. In 1993, China's GDP rose over 13 per cent, and almost 12 per cent in the following year. It was also observed that China's seaborne trade and maritime transport were developing quickly. A brief introduction about the Chinese economy relevant to maritime transport is given.

1.1.1 Maritime Geography

China is a big continental country with vast territorial waters. Its mainland coastline is 18,400 kilometres long, and 14,000 kilometres long around its islands. There are many rivers that are linked to the seas for sailing ships. The total inland route is more than 110,000 kilometres, and there are three major river routes: Yangtze River, Yellow River and Jing Hong Grand Canal. Water transport in China may be divided into three categories: inland river transport, coastal sea transport and ocean transport.

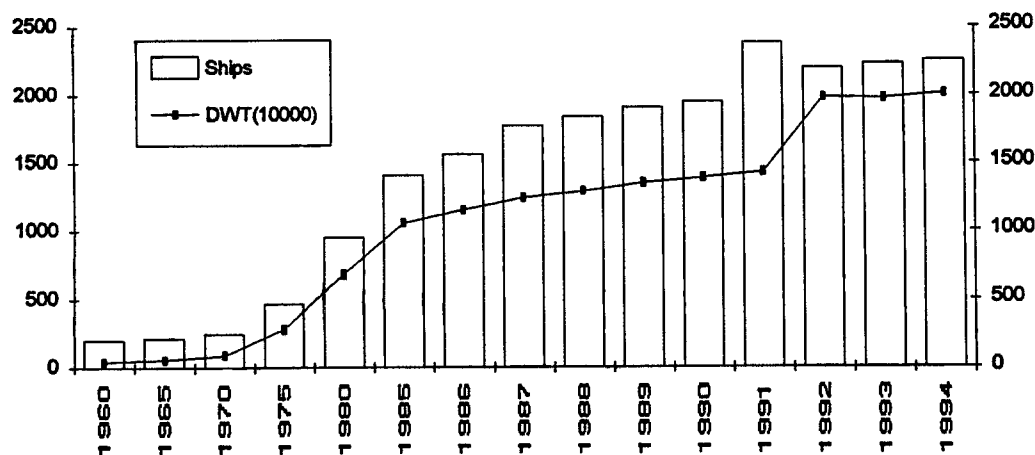
Since 1979, China's ports have been developing speedily. Nowadays there are over 190 ports and harbours along the Chinese coast with 340 wharves which are berths capable of taking ships over 10,000 tonnes. Sixty of these ports are open to foreign ships which are from about 160 different countries. Shanghai, Guangzhou, Tianjing, Dalian and Qingdao, which are major ports in China, have established friendly twinning relationships with more than twenty ports in America, Japan, Belgium, Canada, Australia, Sweden, Holland and other countries.

1.1.2 Seaborne Trade

Before the mid-1970s, around 65 per cent of the seaborne trade was with South-East Asia countries and the Soviet Union with a trade turnover of US\$ 4 billion. In the 1980s, the growth of seaborne exports and imports increased quickly. The volume of turnover went up to US\$ 83 billion. It increased to US\$ 220 billion in 1994 and the total throughput of the ports was more than 1,500 million tons.

1.1.3 National Fleet

Before 1960, there was no any national ocean shipping fleet, and China had only 150 ships of 760,000 dwt for coastal transport. In 1960, after great effort, the China Ocean Shipping Company (COSCO) was formed under the Ministry of Communications. From 1966 to 1975, the slow growth of the national fleet was partly due to the politics of the Cultural revolution. Since 1980, the national fleet has increased quickly. It increased from 955 ocean ships of 10 million dwt in 1983 to 2197 ocean ships of 19.8 million dwt in 1992. There were more than 2200 ocean vessels of 20 million dwt in 1994 (see figure 1-1).



Source : (1) ISM Yearbook, 1992 and 1993. (2) ISM Review, 1995.

Figure 1-1 Development of the National Fleet in China

Apart from COSCO, there are over 190 shipping companies which are run by coastal provinces, cities and private enterprises. COSCO is the largest shipping company in China at 600 vessels and more than 15 million dwt. It has ten branch companies based at Beijing, Shanghai, Guangzhou, Tianjin, Qindao, Dalian, Lianyungang, Shenzhen, Xiamen and Hong Kong. The Group has three other main areas of operation: China Ocean Shipping Agency, China Marine Bunker Supply Company and China Road Transport Company, and more than 300 subsidiaries world-wide.

1.1.4 Shipbuilding Industry

As an open-door policy was adopted by the Chinese government after 1980, the national shipbuilding industry has developed quickly, and new building tonnage went up to 2.5 million dwt in 1990 and it was over 4 million in 1994.

Many large shipyards not only built vessels for national shipping companies, but also for foreign shipping companies. Today, Chinese shipyards can build many kinds of ships such as big tankers, bulk ships, container ships, passenger ships, multi-purpose ships and other special ships.

1.2 Chinese Maritime Safety Administration Relating to Maritime Education and Training

The maritime safety administration in China relating to Maritime Education and Training (MET) is directly under the authority of the Ministry of Communications. Its structure consists of the maritime safety administration authority and the maritime education authority.

1.2.1 The Ministry of Communications

The Ministry of Communications plays a role in the top administration in the field of Chinese MET, and it has a quite comprehensive authority which functions in many aspects. The Ministry not only has control of the budget control to support maritime institutions, but also makes many rules, regulations and decisions dealing with MET in accordance with the SOLAS, STCW, MARPOL and other international conventions.

1.2.2 The Bureau of Education

The Bureau of Education, which is under the ministry of communications, is responsible for the administration of MET in the Chinese maritime institutions and mariner training centres.

The Bureau has a project of developing MET every five years depending on the needs of the shipping industry, and in the area of maritime safety in co-operation with the Bureau of Maritime Safety Administration. The Bureau examines and approves the budget of each institution which is directly under the Ministry of Communications before starting new year. It regulates the overall direction of course programs of MET for the different levels of the maritime institutions and mariner training centres.

1.2.3 The Bureau of Maritime Safety Administration

The Bureau of Maritime Safety Administration is in charge of maritime safety administration and its major responsibilities include drafting regulations and making decisions relating to the maritime safety and MET in accordance with the national laws and the international conventions. It is also responsible for administration in the field of the survey and inspection of ships, registration of ships, examination and issue of certificates of competency, ships' safe manning, conducting inquiries and investigation of shipping casualties, etc. .

A very important responsibility of this Bureau is to advise on MET in Chinese maritime institutions. The detailed maritime education programs are made by the individual institutions in co-operation with the Bureau of Maritime Safety Administration. The Bureau supervises the examinations of the courses relating to marine officers, though these examinations are generally organised by the maritime universities and college. Graduates will obtain appropriate certificates of competency if they pass all the examinations in the maritime universities and satisfy sea service of at least one year.

1.3 The Maritime Education System

The maritime education system in China is divided into two kinds of education in accordance with different function levels in the field of the MET. They are the high maritime education and vocational maritime education. The high maritime education is open to all people and the basic entrance requirement is that students must pass the national examinations. Normally these students have no sea experience. There are three kinds of vocational maritime education: higher vocational maritime education, middle vocational maritime education and short courses of maritime training (see figure 1-2).

1.3.1 Maritime Institutions

There are three kinds of maritime institution in China. They are the maritime institutions of highest level, vocational maritime institutions and seafarer training centres.

1.3.1.1 Maritime Institutions of Highest Level

Apart from Zhousan Fishery Institute which has navigation and marine engineering departments which is under the Ministry of Agriculture, three Maritime institutions of highest level, Dalian Maritime university, Shanghai Maritime University and Jimei Maritime Institute, are under the Ministry of Communications. Students who graduate from senior middle schools after passing the Annual National University Entrance Examination can enter into these maritime universities and institute.

These institutions have common maritime courses such as navigation and marine engineering. But each institution has some specialised courses relating to the shipping industry. Dalian Maritime University has specific courses of Radio Communications and Electronic Navigation. Shanghai Maritime University has the specific courses of Maritime Law, Shipping Management, Maritime Economy and Port Handling Machinery. All the courses at Jimei Navigation Institute are designed for the students who will work on board ships.

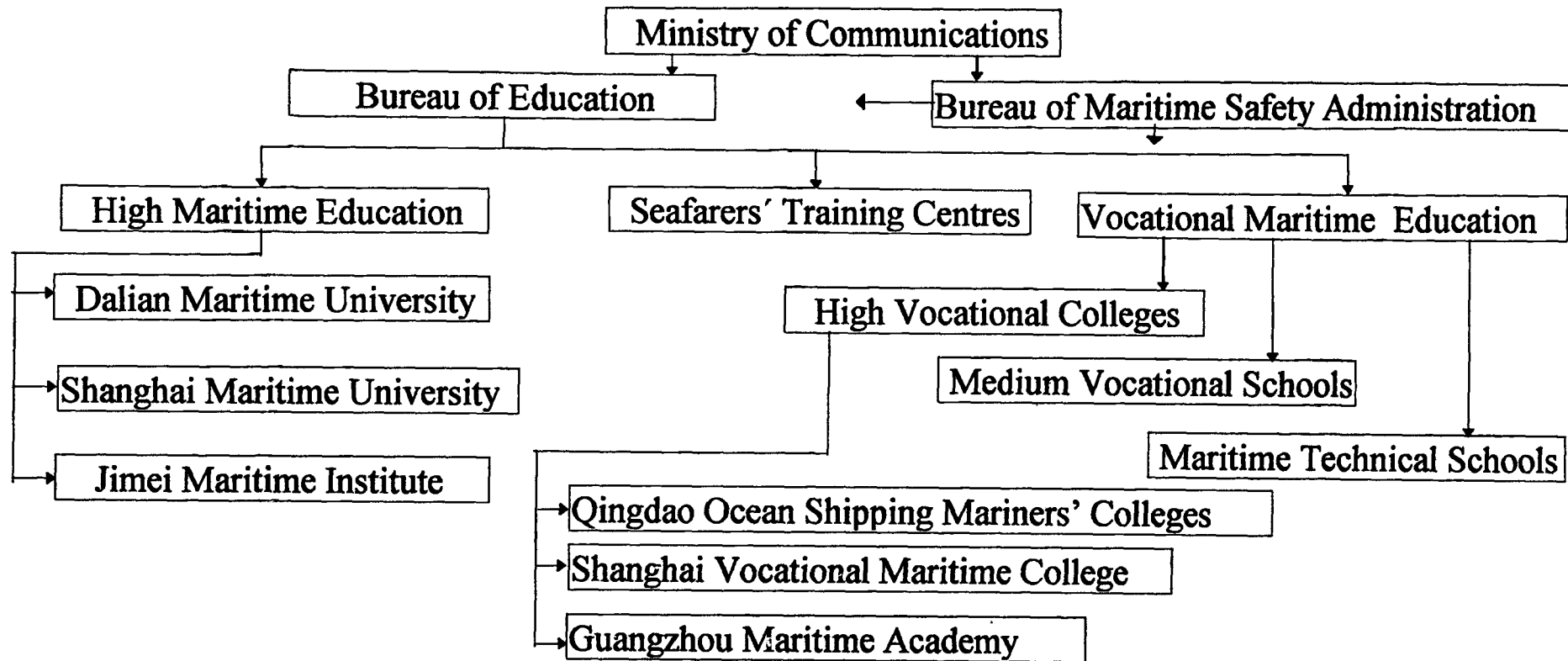


Figure 1-2 Maritime Education and Training in China

Generally, before students enter maritime institutions, they have never been on board ships as mariners. Students study in these institutions for four years. There are seven months' practice at sea within the period of four years. They will continue to train at sea for one year after graduation. If they complete the successful practical training at sea and pass the practice training report, the graduates in accordance with their individual learning specialities can be awarded a Second Officer Certificate or Third Engineer Certificate or Second Class Radio Officer Certificate on board ships.

1.3.1.2 Vocational Maritime Institutions

There are many vocational maritime institutions in China. Generally, these vocational maritime institutions are divided into three levels:

- higher vocational colleges,
- medium vocational schools,
- maritime technical schools.

Most vocational institutions offer enrolment to trainees with a certain experience of work at sea, and they study at these institutions for two or three years. The institutions are under the Ministry of Communications or local governments or shipping companies.

(1) Higher Vocational Colleges

There are two higher vocational colleges and one academy. They are :

- Qingdao Ocean Shipping Mariners' College,
- Shanghai Vocational Maritime College,
- Guangzhou Maritime Academy.

These higher vocational colleges are responsible for specialised MET. They are operated by different organisations. Guangzhou Maritime Academy is under the Ministry of Communications and the others are operated by Chinese shipping companies. Apart from Guangzhou Maritime Academy, whose students are directly from junior middle schools, the other two colleges offer enrolment to trainees with a sea experience of at least two years. During the study period of three years, students go on board ships for almost one year for practical training at sea. After academic

study, students have to pass the Examinations of National Certificates of Competence before they go on board ships to be senior officers. The Examinations of National Certificates of Competence are governed by the Bureau of Maritime Safety Administration every year.

(2) Medium Vocational Schools

Apart from Shanghai Maritime School and Dalian Maritime School which directly belong to the Ministry of Communications, more than ten medium maritime schools are operated by local governments or shipping companies. After two years' study, graduates are qualified to work on board ships as deck or engine-room ratings. They may obtain senior officers' certificates of competence if they pass the examinations of National Certificates of Competence and complete sea service over two years.

(3) Maritime Technical Schools

Maritime technical schools receive students who graduate from junior middle schools. Students study at schools for two years and are trained as deck or engine-room ratings.

1.3.1.3 Seafarers' Training Centres

Apart from Shanghai Seafarers' Training Centre, which is directly under the Ministry of Communications, there are many seafarers training centres in China for updating training in order to meet the new requirements of the international conventions and the national regulations, in particular in the field of maritime safety. Mariners have to go to these seafarers' training centres for training again before they join the national examinations of certificates of competency.

1.3.2 Courses and Curriculum

The main courses in Chinese maritime institutions are Maritime Navigation and Marine Engineering. This paper concentrates on the course of maritime navigation.

The present system of MET in China has existed since 1978. During this period of time, the instructional program of maritime navigation was revised several times in order to meet the new requirements of the international conventions and national

regulations. The example which is given is the course curriculum of maritime navigation of Shanghai Maritime University.

This main curriculum of the navigation course may be divided into four parts: common core, basic specialisation, specialisation and practical training.

(1) Common Core:

- Moral Education,
- English,
- Mathematics,
- Physics,
- Law.

(2) Basic Specialisation:

- Computer,
- General Electrotechnics,
- Engineering Mechanics,
- Marine Telecommunications,
- Ship Theory,
- Mathematics for Navigation,
- Chemistry for Navigation.

(3) Specialisation:

- Seamanship,
- Navigation,
- Marine Meteorology,
- Carriage of Goods by Ships,
- Shipboard Equipment,
- ARPA and GMDSS *,
- Ship Manoeuvring,
- Electronic Instrument for Navigation,
- Prevention of Collisions,
- Maritime Transport Security and Seamen's Duties,

- Ocean Shipping Business,
- Maritime Law.

(4) *Practical training:*

- Military Training,
- Practical skills at sea,
- Navigation training on board the training ship,
- Comprehensive Training on board the training ship,
- Field Work Before Graduation.

* Note --- The GMDSS subject has not been set for all navigational courses.

1.3.3 Academic Study, Certification and Sea Service

1. Highest Level of Maritime Education and Training

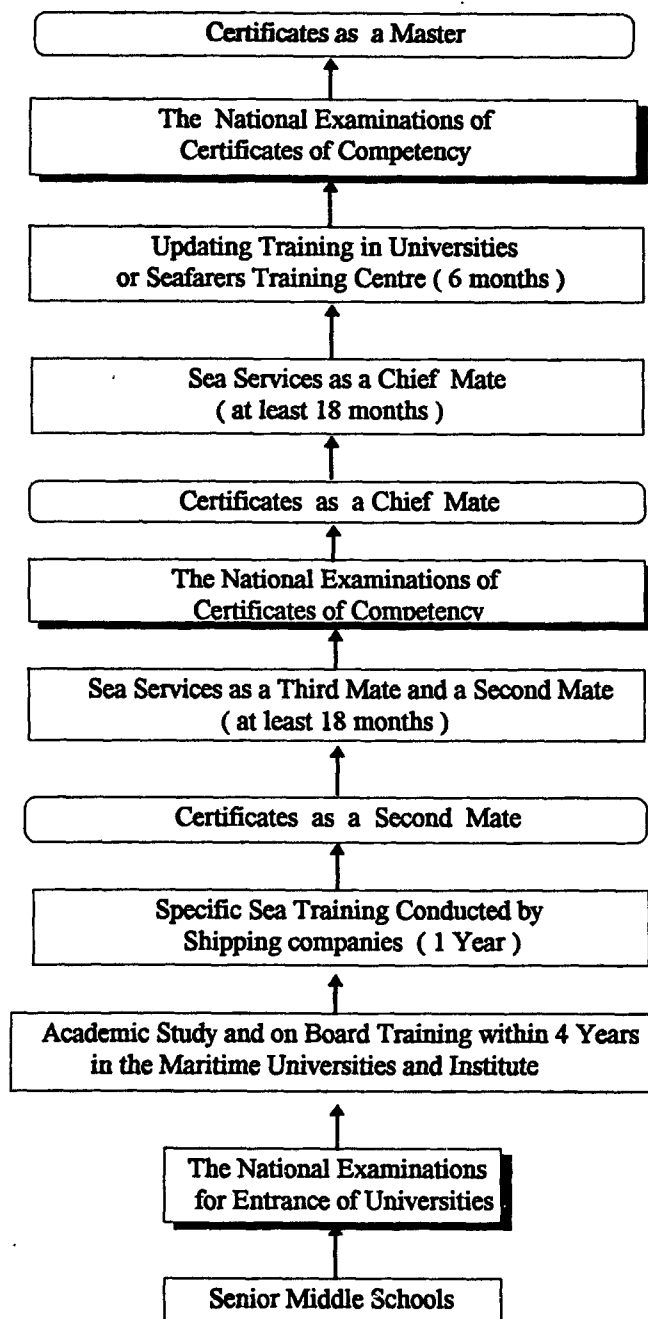


Figure 1-3 Highest Level of Maritime Education and Training in China

2. Vocational Maritime Education and Training

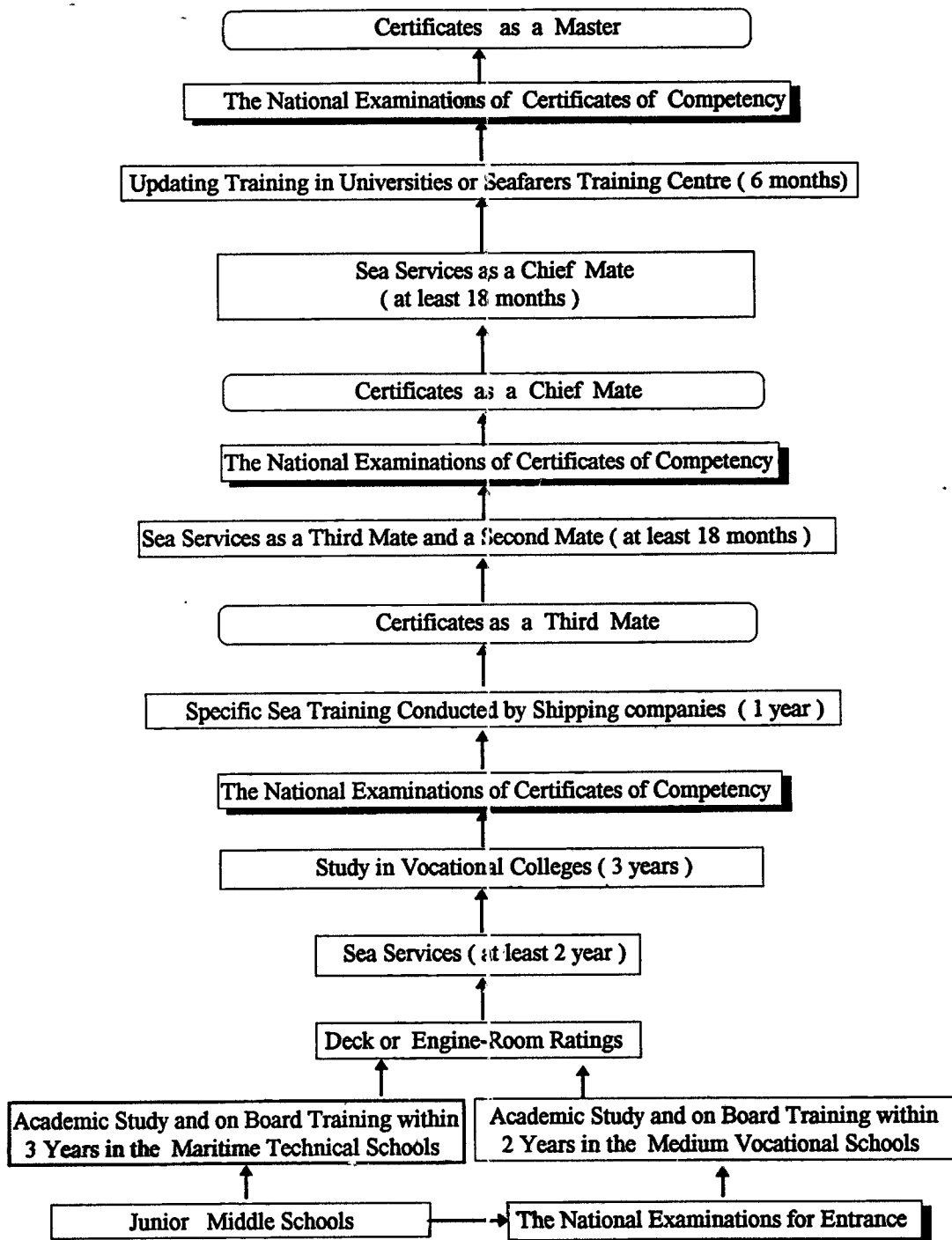


Figure 1-4 Vocational Maritime Education and Training in China

2. A Comparison of Chinese Maritime Education & Training with Other Countries' Institutions

A comparative study of MET for deck officers in some countries is introduced in this chapter. MET varies from country to country depending on the specific situations of geography, history, legislation, economy, politics, technology and society. By examining different kinds of MET, new ideas can be obtained and it is useful to update and improve the Chinese MET system. The main reason for choosing the particular countries is that their systems and course programs are successfully used in these maritime countries, and are dissimilar to that used in China.

The comparative study is based upon the following elements:

- kinds of maritime education and training system,
- main courses and their admission requirements,
- levels of certificate of competency,
- course programs.

2.1 Maritime Education & Training in Australia

The Australian MET system for the maritime industries has quickly developed since the 1970s, when there was the beginning of a period of rapid technological change in the shipping industry. Nowadays, the Australian Maritime College, which plays a significant role in the MET in Australia, provides educational programs and practical training for the shipping and fishing industries. The courses not only reflect the general trend in industry towards recruiting a greater proportion of graduates into executive positions, but also are flexibly structured and suitable both for school leavers and for experienced mariners wishing to upgrade their qualifications.

2.1.1 Courses for Deck Officers

There are two levels of ship operations' courses in the Australian Maritime College. They are called the Diploma of Applied Science (Nautical Science) and the Diploma of Applied Science (Ship master) both including an advanced Certificate in Marine Operations. The main difference between these two courses is that the former provides a course for Australian sponsored deck officer trainees only, the latter being provided for all other deck officer trainees both having a program which covers not only the academic requirements for deck officers to different levels, but also such professional qualifications for integrated marine operations.

2.1.2 Training System and Certification

Trainees, who are sponsored by shipping companies, can enrol on the course called the Diploma of Applied science (Nautical Science) with a program which covers the academic requirements for Australian Maritime Safety Authority Certificates of Competency as a Deck Watchkeeper, Chief Mate and Master Class 1. The admission requirement is that the student graduates from Australian secondary schools with satisfactory results in Mathematics, English and Physics, or the student has completed satisfactory service at sea.

Students study in College with a sandwich-type course over four years. There are five academic semesters (2.5 years) and three semesters at sea (1.5 years) including ratings training on board ships and seagoing training with the Industrial Experience Program (see figure 2-1).

Today, in Australia, any person who works on board ships as a mariner must first pass an Integrated Ratings Course. Therefore, in the first year, all students have to follow the Integrated Ratings (multi-skilling) Course which consists of 3 weeks Safety Training, 16 weeks Vocational Training and 20 weeks Sea Service.

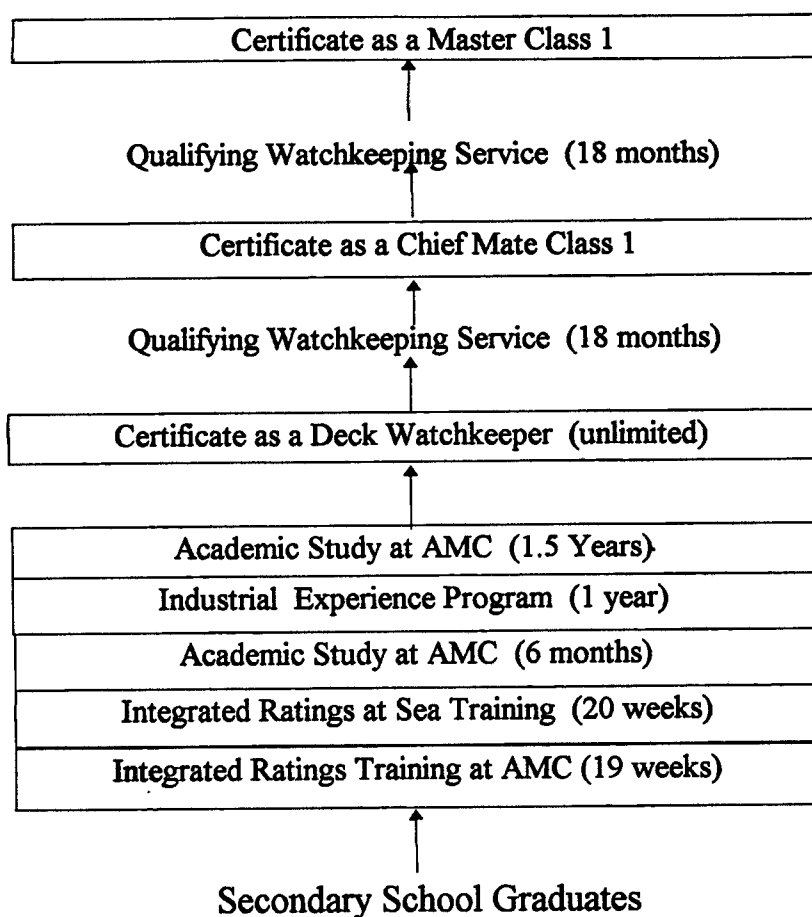


Figure 2-1 Australian Maritime Education and Training System

2.1.3 Curriculum

The detailed course subjects for the Diploma of Applied science (Nautical Science) are given in Appendix , 1.

In first year, the subjects of the integrated ratings course concentrate on shipboard safety and vocational practice both on deck and in the engine room. From second year to fourth year, the curriculum provides not only normal subjects such as the basic knowledge of ships, navigation, communications and cargo handling, but also a wide range of shipping aspects such as shipping business, maritime law and port marine operations. All the subjects are concerned with the safe and proper operations of

ships. In particular the subject of Safety & Emergency Procedures provides necessary and formal training in rendering first aid to the injured and in fire prevention and control, with particular emphasis on those situations which may arise on board a vessel.

A good arrangement is the practical training at sea for one year between the academic studies. After 475 hours of teaching the fundamental knowledge of ships, equipment and normal operations, students can go on board ships for the industrial experience program. It is very beneficial for students to obtain practical experience on how to operate a ship in a real situation.

2.2 Maritime Education & Training in U.S.A

There are seven merchant marine institutions in the United States to train deck officers. They are:

- The U.S. Merchant Marine Academy (Kings Point).
- State University of New York Maritime College.
- California Maritime Academy.
- Maine Maritime Academy.
- Texas Maritime College of the Texas A&M University at Galveston.
- Massachusetts Maritime Academy.
- The Great Lakes Maritime Academy.

Kings Point Merchant Marine Academy is run by the US Federal government, and the others are run by the state governments.

2.2.1 Courses and Entry Requirements for Deck Officers

The America maritime education and training is a system covers a broad range of studies including one year's training at sea in the middle period, along with attendant examinations. This system, which is different to the post-experience system, is a combination of the front-ended and sandwich training system (see figure 2-2).

Students enter maritime academies after graduation from high school being at least 17 years old. There are four years duration of study in the academic period with sea time almost 12 months. These institutions provide students with an academic background for a Bachelor of Science degree in addition to offering the necessary professional training for licences in the United States merchant marine, as well as becoming a commissioned officer in the naval reserve.

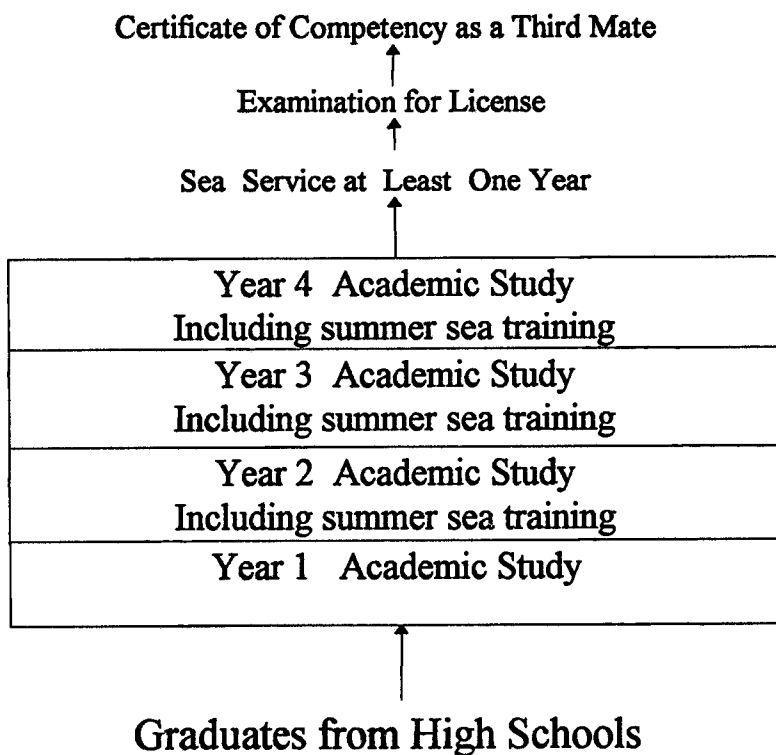


Figure 2-2 Maritime Education and Training in USA

2.2.2 Examinations and Certification

After passing the academic examinations with satisfactory results, the students can sit for the Third Mate licence examination which is conducted by the United States Coast Guard. It should be noted that the maritime academies do not award a degree to a student unless and until he passes the licence examination.

In the United States, there are two basic ways leading to the qualification of a third mate: a candidate must be a graduate of a merchant marine academy or he must be at least 19 years of age and have had three years' service at sea. After at least a year's sea service as third Mate or Second Mate, the Second Mate or Chief Mate certificate can be awarded. Similarly, there is at least one year's sea service as Chief Mate before the Master certificate is awarded.

2.2.3 Curriculum for Marine Transportation Course at State University of New York Maritime College

The detailed curriculum is given in Appendix, 2. This curriculum consists of four parts which are general knowledge, basic knowledge of ships, specialisation of ship's operations and practical training with 160 credits. Students may choose a numbers of elective subjects work up to 24 credits or about 15% of the total numbers of credits. The subjects within general knowledge, for example Principle of Economics, Humanities and English, are required studies for students who wish to enter a university or other high educational institutions in the first year.

The Marine Transportation Course provides the broader subjects of navigation, electronic equipment, ship's operation, cargo handling, safe operations, basic marine engineering, shipping business and financial management. There are three summer sea semesters for the practical training between academic years.

2.3 Maritime Education & Training in Japan

Highly-modernised vessels have been rapidly increasing in number as a result of the introduction of technological innovation in Japan since the 1960s. Since then the Japanese government has made the utmost effort to raise the standards of seamen and to improve their quality and qualifications by establishing more mercantile marine schools, providing the necessary training ships, and increasing their availability in order to meet the needs of the shipping industry. Today, there are five kinds of institutions for MET of seamen:

- Universities of Mercantile Marine,

- Mercantile Marine Colleges,
- Marine Technical Colleges,
- Marine Technical Schools,
- Institute for Sea Training.

These maritime institutions provide for different levels of qualification in the field of MET in accordance with the requirements of the international convention on the Standards of Training, Certification and Watchkeeping for Seafarers, 1978, (see figure 2-3).

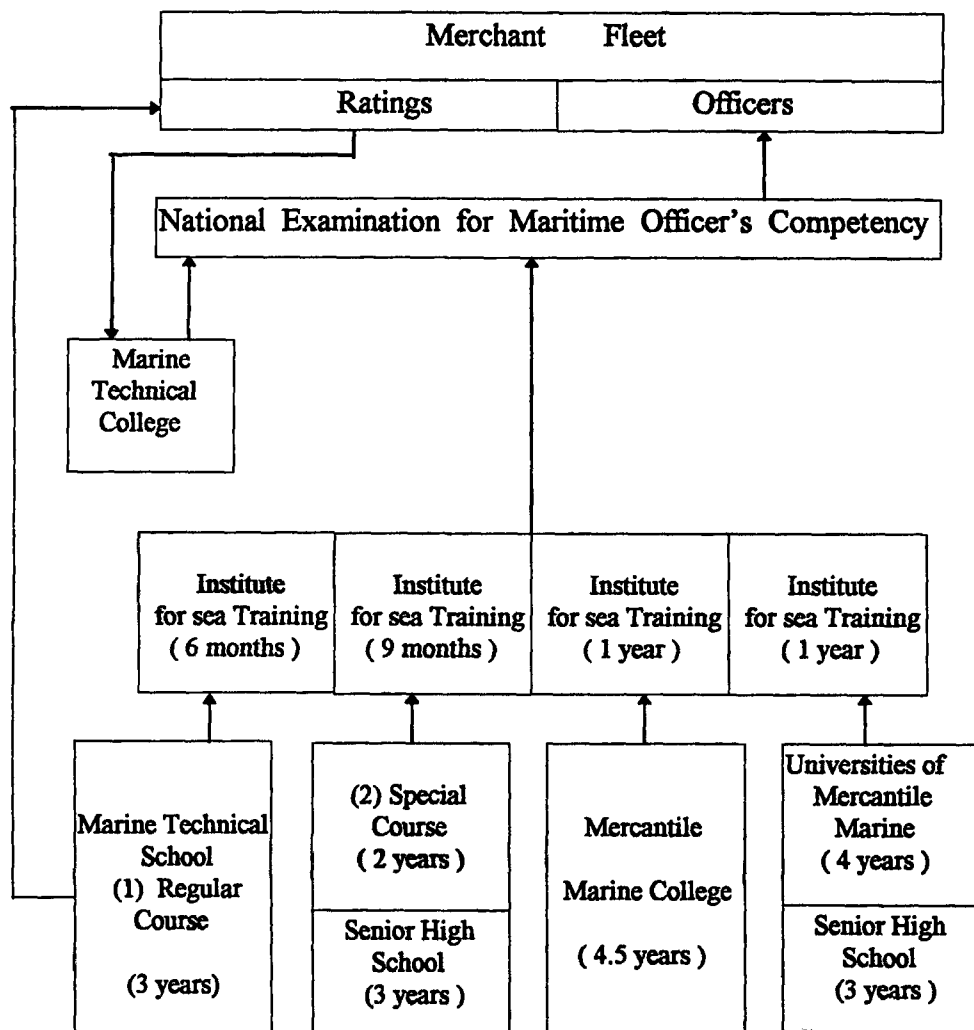


Figure 2-3 Maritime Education and Training in Japan

2.3.1 Universities of Mercantile Marine

Two universities of mercantile marine , which are the highest institutions for MET in Japan , are under the jurisdiction of the Ministry of Education . They are Tokyo University of Mercantile Marine and Kobe University of Mercantile Marine. These two universities provide students with fundamental knowledge for maritime officers, as well as making research in various fields of maritime science related to the operation of vessels and shipping business.

Candidates are required to be graduates of a senior high school or be of equivalent intellectual ability and pass the entrance examination.

These two universities provide students with the opportunity to study both academic and specialised subjects. Graduates are granted a bachelor's degree. If those students wish to gain a licence of maritime officer (second mate), they are required to study further for one year on the Sea Training Course on board the training ships of the Institute, and pass the National Examination for Maritime Officer's Competency.

2.3.2 Mercantile Marine Colleges

There are five mercantile marine colleges which are also under the jurisdiction of the Ministry of Education. These colleges provide an intensive MET course so as to develop the necessary ability to be a competent ship's officer in future.

Admission requires candidates to graduate from a junior high school and pass the entrance examination. The course for deck officer covers a period of 5.5 years. In addition, one-year practical training on board a training ship is included at the end of the schooling period. After graduation, the licence of the Third Grade Maritime Officer can be awarded if the National examination for Maritime Officer's Competence is passed.

2.3.3 Marine Technical Schools

Eight marine technical schools are under the jurisdiction of the Ministry of Transport. Trainees are required to be graduates of a junior high school and be

between the age of 15 and 19, or, of a senior high school be between the age of 18 and 20, as well as passing the entrance examinations.

These marine technical schools provide three courses which are called Regular Course, Special Course and Sea Training Course. A student who graduates from a junior high school must study the Regular Course with a schooling period of three years including three-month training aboard a training ship, and after that, the graduate can go on board a ship for ratings. If he wants to gain the licence of Fourth Maritime Officer, he is required to complete a two-year sea service aboard a ship and then go to Marine Technical College for further studies, as well as to pass the National Examination for Maritime Officer's Competency.

2.3.4 Institute for Sea Training

The Institute for Sea Training, which is operated by the Ministry of Transport, has six training ships. This institute is open to all maritime institutions in Japan and provides practical training on board ships at sea for ships' officers, such as watchkeeping, navigation, ship manoeuvring and cargo handling etc..

The training content and period of time depends on the Sea Training Course of the different maritime institutions.

2.3.5 Marine Technical College

The Marine Technical College, which is run by the Ministry of Transport, is a further educational institution. This college provides seafarers who have certain sea experience, with the necessary knowledge and skills for the operation of vessels so as to update with new knowledge and improve the qualifications.

There are three courses for candidates. The Maritime Officer Course is designed to give basic knowledge in accordance with the level of licence. The Training Course and Correspondence Course are designed to provide students with an in-depth education for maritime technical abilities and ship operation.

2.3.6 Course Length for Deck Officers

The regular course in marine technical schools consists of general subjects with 1365 studying hours and technical subjects with 1960 studying hours. The special course has a total of 2825 hours.

The Navigation Course in mercantile marine colleges or universities consists of general subjects and specialised subjects. For example, a Navigation Course in a university of mercantile marine has 1620 hours of general subjects and 2520 hours of specialised subjects. Detailed subjects are given in Appendix, 3.

2.4 Maritime Education & Training in Denmark

2.4.1 The system for maritime education and training of deck officers

Maritime education and training in Denmark is managed and controlled by the Danish Maritime Authority which is under the Ministry of Industry. The Maritime Education Council, whose members are representatives of shipowners' and seafarers' associations, lecturers' and students' organisations, the Royal Navy and the Danish Maritime Authority, is responsible for issues and important regulations on maritime education.

There are five ratings schools including three private schools and two sail training vessels. Three nautical schools and two motor training vessels provide training for potential deck officers. A board of examiners, whose members hold positions in the Danish Maritime Authority and are thus independent of the schools, sets up syllabi for the education at the nautical schools and conducts all examinations. A master's certificate and sea experience as deck officer are required for the teachers at the schools and an additional three-year theoretical education at a technical university is also required for lecturers at the nautical schools.

The main characteristic of MET of officers for merchant ships in Denmark is that the students must first complete sea-going service for 1.5 years including the necessary education and training for a ship's assistant or have sea experience of at least 3 years before they are admitted into nautical school. The candidates study at

nautical schools for 1 year normally and they will be awarded the certificates of Competency as a Watchkeeping Officer if they pass the examinations with satisfactory results. After study of two years at nautical schools, they are awarded the certificates of competency as a Mate Second Class. The certificate of competency as a Mate First Class requires sea service as a mate for at least 12 months, and the certificate of competency as a Master requires sea service as a mate for 24 months of which 12 months as a Chief Mate is required. In figure 2-4, the MET system in Denmark is given.

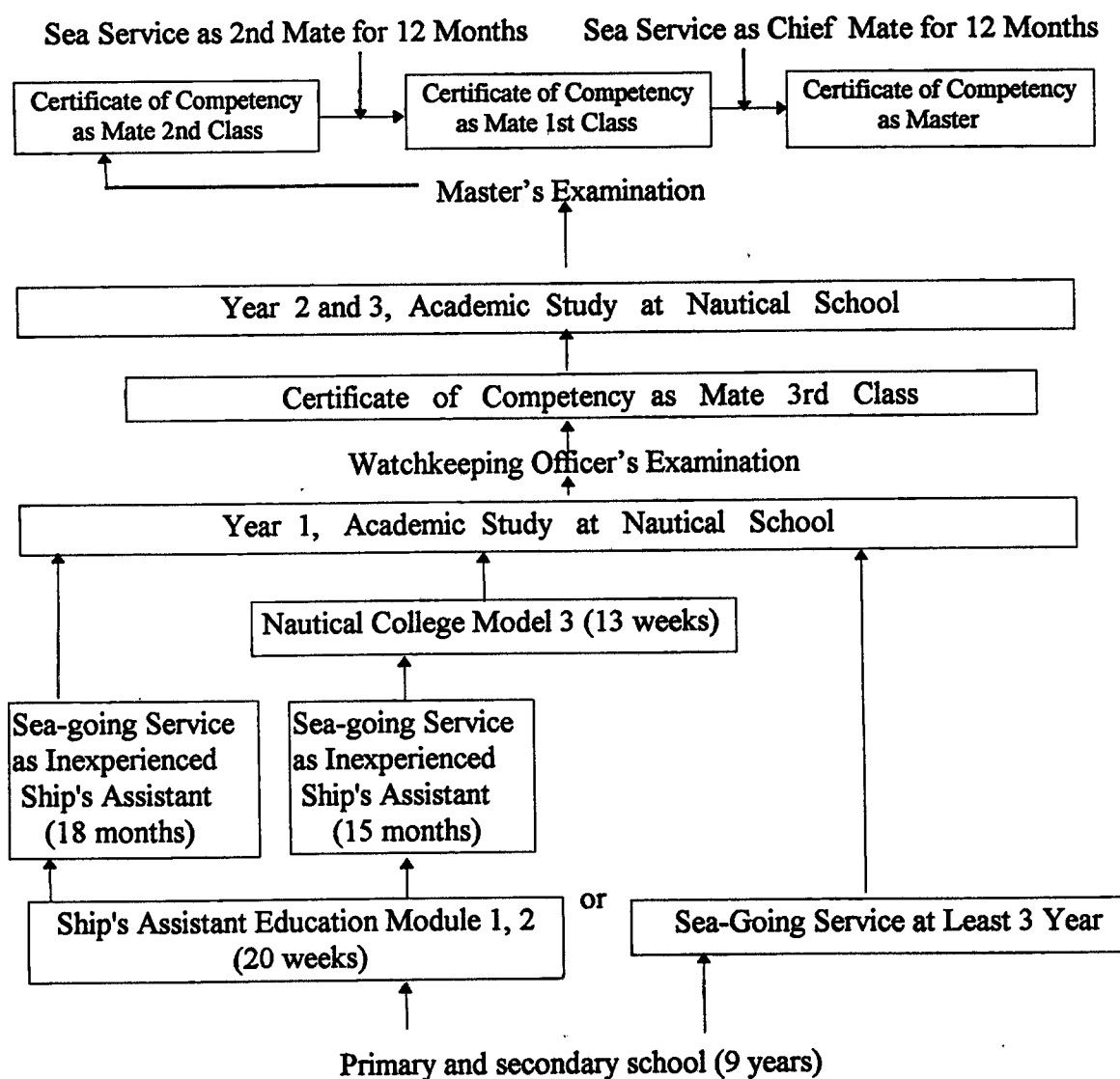


Figure 2-4 Maritime Education and Training in Denmark

2.4.2 Courses and Syllabi

There are three courses which are called Courses for Ship's Assistant, Watchkeeping Officer and Master.

2.4.2.1 The Ship's Assistant Course

A ship's assistant is a person who performs alternating service in the deck and engine room department of merchant ships. The ship's assistant course consists of three modules. Trainees can go directly from module I within 5 weeks to module II within 15 weeks. Module I and II may be taken at nautical colleges or on board sail training vessels, but Module III which has a duration of 13 weeks can only be taken at a nautical college.

A brief description about the subjects is given in Appendix, 4 (Table G).

2.4.2.2 Sea-Going Service Requirements

Normally, after completing module I and II, and before entering a nautical school to study on a deck officers course, the students must go on board merchant ships and undertake service in the deck department for 18 months. If students want to study the course of module III, the sea-going service requirement is reduced to 15 months.

2.4.2.3 The Watchkeeping Officer's Course

The course is designed to provide students with the certificate of competency as a Watchkeeping Officer. Normally the study will take one year. A student may build up his/her education which is longer so that he/she completes less subjects in each semester. All subjects must, however, be completed within a period of three years. The detailed subjects are given in Appendix, 4 (Table H).

2.4.2.4 The Master's Course

Students may be admitted to study for the certificate of competency as Masters with two years' duration after completing the Watchkeeping Officer Course. Students can extend the time taken to pass the course, all subjects must, however, be completed within a period of five years. Before the students get the certificate of

competency as Mate first Class and Master, they must go on board merchant ships for the required time as indicated in figure 2-4. The detailed subjects are given in Appendix, 4 (Table I).

2.5 Maritime Education & Training in France

A special integrated maritime education and training system is used in France. This is called the polyvalent training system in which the shipboard officer is trained both as master and as chief engineer of a ship. The polyvalent program was introduced in 1966. This polyvalent training system has been successfully used by the French maritime industry where shipping companies were interested in a uniform type of officer and a possible reduction of manning on board ships.

2.5.1 Training Scheme

There are four maritime academies which are located in Le Havre, Nantes, Marseilles and Saint Malo. Three levels of training scheme are conducted by these maritime academies except Saint Malo. The first and second levels of training scheme are polyvalent education and training, and trainees can be qualified as both deck officer and marine engineering. The difference in the two levels is that the former is open to all students and the latter is only open to professional applicants through further education. Students, who graduate from high schools, take nearly 12 years from entering the polyvalent system of MET to the award of the highest certificate of master and chief engineer. The third level scheme is still monovalent training and there have been few students entering this scheme recently.

2.5.2 The First Class Master Course

After passing competitive examinations, students can enter the training course for first class masters. Students study at the maritime academies over 4 academic years. There are seven-month training at sea and four-week training on simulators (deck and engine) during the academic study. After 3 years' academic study and 3 months sea training, students can obtain the Diploma of Merchant Navy Officer if they pass the examinations. Following 4 months at sea as cadets both on deck and in the engine

room, they can obtain the Certificate of Merchant Navy Officer. Then the students can go back to the maritime academies for a 4th year of study after completing at least 6 months at sea as officers both on deck and engine. Finally, they can obtain the First Class Master's Certificate after satisfying diploma examinations and completing at least 36 months at sea as officers both on deck and in the engine room(see figure 2-5).

The syllabus for the first level certificate provides a wide aspect of general knowledge, basic knowledge of the ship and its operation and maritime specialisation both for service in the deck department and engine-room department. There are a total of 2892 hours of academic study within the 4 years. Many subjects are a full combination of contents for both deck and engineering such as ship construction, safe operation of ships, electrotechnics and electronics, automation and ship's management.

2.6 Summary

There are many MET systems which cannot be totally compared. The above mentioned systems in some countries are different to each other and each system is of course suitable for its national situation. After a comparative study of MET systems, some ideas are highlighted in summarising this study.

(1) The "front ended" and "sandwich" type systems, which are different to a "step-by-step" system, are commonly used in most maritime countries around the world. These systems require students to study at school for a substantially continuous long period, along with attendant examinations. In these systems the higher level of certificates depend primarily on acquisition of subsequent sea-service at the different prescribed levels. The advantages of these systems are

- the trainees can systematically obtain maritime knowledge within a continuous period at school.

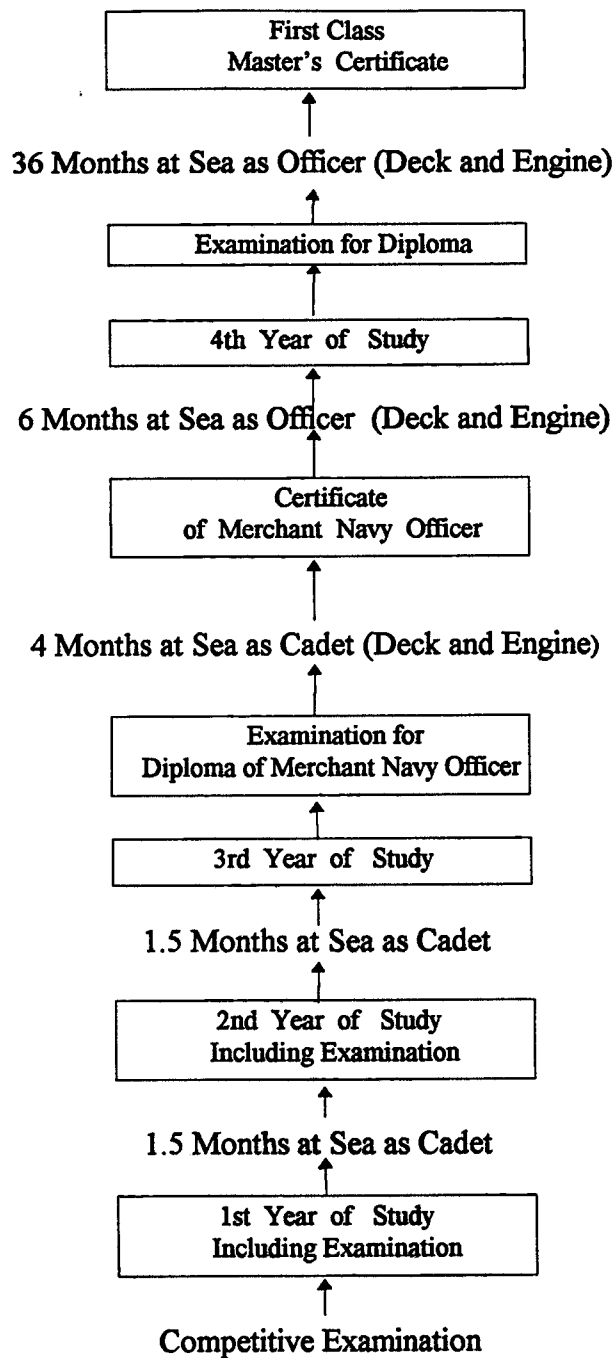


Figure 2-5 Maritime Education and Training in France

- the convenience of organising in a single course such as the course for Watchkeeping Officer or Master, as against different courses for different levels.

✓ the convenience for shipping companies of using mariners on board ships because it is difficult for the shipowner to organise for mariners to go to school for study for several times in the "step-by-step" system

But, on the other hand, the "front-ended" system does not easily overcome the problem of the ^{selection} divorce of theory from practice. Another problem is the students may not yet be ready to properly absorb the knowledge imparted for the higher levels, in particular the rapid development of maritime technology.

(2) There is a trend for the integrated training course to spread to many modern maritime countries. A polyvalent or dual-purpose officer can be efficiently employed both on the deck and engine-room departments of the traditional ship, or on modern ships which have full integrated manning.

(3) There are two kinds of admission requirements for the candidates who want to enter the maritime schools. In Denmark, students have to have a pre-sea service before they enter into a nautical school to study for deck officer. In Japan and the United States, graduates from high school can enter directly into maritime academies or colleges. These trainees will obtain the certificate of competency as deck officers after graduation from maritime institutions plus a required period of sea service. In the Australian Maritime College, the courses for deck officers are open both to graduates of high school and students who have pre-sea experience.

(4) In most countries, the time of the academic study at school is limited. But in Denmark the nautical schools provide courses with a normal duration, and a student is allowed to use more time, though all subjects must be completed within a set time limit. This time allowance is useful for a student wishing to organise his/her own study plan for a certain diploma.

(5) There is an obvious trend of paying great attention to the subjects of maritime safety and environmental protection in teaching, in particular the safe operations of ship and dangerous cargoes.

3. The Identification of Problems in the Chinese Maritime Education and Training System

In looking at the background to rapid development of the national MET recently, there were many problems which were a result of external influences and internal factors. The main influences are the development of the national and world economy and maritime transport, as well as the social and political situation.

3.1 Influence of the National Economic Development

The Chinese economy has continuously risen since ~~1989~~¹⁹⁷⁹. The growth of industrial output was 14% in 1991. After 1991, the Chinese economy boomed. The growth of industrial output went up to 20% in 1993 and 21% in 1994. The main reason for the rapid Chinese economic growth was the policy of opening up to the outside world, and internal economic innovation. Another important reason was large capital investment which was from outside China.

At the same time, the statistics of the customs show that China's total trade volume was US\$ 195.8 billion in 1993, nine times that of 1978 and a rise of 29 percent over the preceding year. *Chinese* China's maritime industry has forged strongly ahead in the past decade due to its fast-expanding foreign trade which results from rapid growth of the national economy. A significant maritime development was the development of containerisation in China. The first container line was set up between China and Australia in 1978. There were 47 container terminals and 3.755 million containers handled in 1993. Shipping officials of the Chinese government expected that China will double its 1993 container throughput when the southern and north-eastern ports

are completed by the year 2000. Nowadays, there are more than 70 shipping companies who are engaged in container transport at sea and on inland rivers. They own 1000 container ships and 18000 international standard container capacity.

As a result of many new shipping companies setting up and existing shipping companies quickly expanding their transport capacity for the development of trade, there has been a noticeable lack of marine officers which has posed a big problem for China. At present, maritime institutions provide more than 1000 graduates who will obtain the certificates of competency to be senior officers on board ships each year. This number of graduates however only meets 50% of the need which shipping companies want. The resulting problem is that shipping companies have to employ sub-standard or poor quality marine officers sometimes in order to maintain their shipping activities, particularly in coastal transport. The level of safety at sea is obviously compromised.

Maritime institutions in China are faced with the challenge of how MET must be geared to the needs of China's modernisation. at the same time maritime institutions are making continuous effort to improve the educational quality in order to meet the needs of opening up to the outside world and developing China's economy.

3.2 Influence of Global Economic and Maritime Development

Turning now to the future, there are many changes in the global economic and maritime development, and they will influence MET and manpower supply. Key issues facing the maritime industry are discussed below.

3.2.1 Impact of Global Economy and Trade

It is expected that the world economy and seaborne trade will increase slowly, but it will not be balanced from region to region. Based on this forecast, global needs for seafarers will also continue to increase slowly. The marine manpower market will continue to be subject to intense competitive pressure, specially, from country to country, where, because of differences in economic development and demographic

changes, a large number of seafarers move from developed countries to developing countries.

3.2.2 Development of New Technology

The development of new technology has led to many high-speed ships and modern new vessels being used at sea. New operational systems on board ships have also been introduced such as GMDSS, ECDIS and Integrated Bridge systems. These systems are recognised not only for high efficiency but also as improving safety at sea. Therefore, shipping companies should provide the most effective manpower arrangements needed to meet the challenges of technological change, new ships and new work systems. In this case, each shipping company assigning seafarers for service not only has to ensure that each seaman is properly certified, as appropriate in accordance with the regulations, but also that the new qualification meets the high standard for working effectively.

3.2.3 Global Standards of Qualifying Seafarers

The changes of the revised STCW Convention will affect everyone in the maritime industry. A new mandatory code is introduced with the technical details which define the standards required being added to the convention. Many new aspects, for example radar and ARPA simulator training, GMDSS certificates, functional certificates, requirements for teachers and examiners, are also added to the convention. The detailed discussion is in Chapter 4.

3.2.4 Increasing Emphasis on Safety and Environmental Factors

The growth rate of the chemical industry has been much greater than that of other industries. Recently, about fifty percent of the cargoes carried by sea pose hazards of varying degrees either from a maritime safety point of view or from an environmental point of view or in some cases both. It means that this development of world seaborne trade has greatly increased the problem of maritime safety and the danger to the marine environment.

These hazards associated with shipping casualties not only affect the seafarers and shipowners, but also have a serious impact on ports, harbours and coastlines thereby affecting the quality of life of their inhabitants. Accidents occurring to passenger ships also affect the citizens of many countries, and losses of human life such as the recent Estonia disaster highlight the dangers still. Therefore, the best efforts should be to maintain and improve maritime safety with a view to preventing shipping casualties and other accidents.

The most important factor affecting safe operations of a ship is the human element, though the continuous advance in technology has provided more and more sophisticated solutions to safety problems. It is often claimed that up to eighty percent of accidents at sea are caused by human error. According to analysis of many accidents, mistakes are usually made not because of faulty, deficient or inadequate regulations, but because the regulations and standards that existed have been ignored. There are enormous differences in the accident rates of one country compared to another, even though they have nearly all ratified the same major international conventions dealing with safety and pollution prevention. One main reason is a variable human factor where seafarers have a different level of qualification and skill according to the quality of MET in certain countries. It is an obvious objective for Chinese MET to strengthen the capability of high quality according to the international conventions and national regulations.

3.3 Problems Facing the MET System in Chinese Institutions

Regarding the background to development of the national economy and global seaborne trade, as well as developments in technology relating to the maritime industry, There are many problems facing MET in Chinese maritime institutions.

3.3.1 Problems Derived from External Influences

Like most developing countries, China has many basic problems in the field of MET which are not easily solved. In particular, certain factors limit the development of Chinese MET. These factors may derive from outside maritime institutions.

(1) The lack of updated maritime legislation is the most important problem, most legislation being out of date. Some regulations are not adequate for the development of the maritime industry or to meet the new requirements of the international conventions. These shortcomings not only hinder development of MET, but also affect quality assurance of education.

(2) The monitoring system of MET is imperfect. Recently, as there was a lack of seafarers applying, some institutions enrolled many students to train for marine officers. In fact, the trainees were not well prepared due to insufficient marine teachers and facilities. This raises the question how could these institutions or the government control the quality of education? It is necessary to establish an effective system to monitor and assess the MET so that the quality of education can be controlled.

(3) Most maritime institutions have difficulty with their financial situation. The governmental budgets are not enough to maintain the running of maritime institutions. In particular it is difficult to update training facilities and provide for more students to train for a sea career.

3.3.2 Problems in the Field of Teaching and Management at Maritime Institutions

Many problems exist in maritime institutions themselves. It is necessary to identify these basic problems and to take appropriate measures to overcome them.

(1) The syllabus for marine officers is out of date and it does not reflect changes in new maritime technology. Some new technical applications in ship operations such as Electronic Chart Display and Information Systems, Integrated Bridge System and computerisation of ship handling, have not been introduced into the navigational

course. Facing the revised STCW Convention, a new syllabus which meets the requirements should be prepared by maritime institutions.

(2) The training and examination systems are more concerned with teaching and testing knowledge. Maritime institutions only provide students with a few opportunities for practical training. For marine officers, it is the practical aspects and the application of basic theory which is important. The taking of measures to overcome this shortcoming is recognised as a very important and urgent matter.

(3) Aspects of maritime safety and environmental protection are not given sufficient attention in the teaching programs. It is a fact that safety consciousness does not feature in all staff in maritime institutions.

(4) There is a lack of self assessment and review of education to improve the quality of training. A good maritime academy has not only a good teaching program for marine officers, but also good educational management. Recently, some Chinese maritime institutions undertook to establish an appraisal system which can assess teaching in the class.

(5) There is also a lack of utilisation of new technology and methodology in teaching such as simulation and computer aided learning. Although training on Radar and Automatic Radar Plotting Aid (ARPA) simulators for deck officers is already used, there is no wide utilisation of simulators in the field of ship manoeuvring, cargo handling and comprehensive ship operations. There are few users of computer aided learning in most maritime institutions. The basic problem is that staff have either understanding or experience of computer aided learning. Therefore, many maritime educational software programs should be introduced accompanied by training programs for the teachers.

4. New Technology and Maritime Education & Training Practice

Against the background of world seaborne trade growing at an average of more than 4 percent over the past three years and rapid technical changes in maritime industry, there is not only a need for a supply of new graduates from which to recruit seamen on board ships, but also a need for high quality and experienced officers and ratings who meet the STCW Convention. Therefore, maritime institutions play a very important role in training students and providing MET on a high and international level. In particular for Chinese MET, the application of new technology and methodology should be considered in the context of the revised STCW Convention to improve educational quality and the development of marine courses to raise the training standards.

4.1 Impact of the Revised STCW Convention

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) was established by the International Conference on Training and Certification of Seafarers in 1978 and entered into force in 1984. Its aim was to establish basic international standards of training and competence for all seafarers including masters, officers and crews of ships on international voyages. The main objectives were covered by the 1978 STCW Convention:

- International minimum standards of competence of seafarers including masters, officers and key ratings;
- Global harmonisation of standards of training and examination of seafarers;
- Mandatory minimum requirements for the certification of seafarers;
- Safe and efficient manning of ships.

Since 1978 this Convention has however gradually become outdated due to the growing development of the maritime industry and rapid technical change. There is a basic need to revise, modernise and update the STCW Convention. There are several main problems with the 1978 STCW Convention.

(1) It has not been directed towards the assessment of skills. Practical skills are very important, in particular for marine officers who are interested in the application of theory.

(2) It contains provisions for competency, but it does not contain measurable standards which can ensure effective supervision, assessment and control for the issue of certificates of competency, and thus the subsequent improvement of MET. The need for quality assurance by using effective administration of MET is more important today than ever before in China, with an increasing demand for seafarers on the one hand, and different levels of quality of students graduating from the various Chinese maritime institutions on the other hand.

(3) The Convention is based upon the shipboard work organisation that is a traditional departmental division of deck, engineering and catering. It therefore limits the ability of the convention to meet rapid technical changes.

(4) The Convention does not provide the requirements or recommendations for qualification of instructors and examiners, and standards for governing maritime institutions on the approved international level.

The new revised Convention contains the broad principles, legal arrangements and a new Code that contains technical details in order to allow for a more convenient way of amending and updating detailed requirements. This code concentrates on

- the basic training for all seafarers,

- the new requirements for the standards of professional competence,
- the functional approach,
- use of simulators,
- quality assurance including requirements for practical skills, measurable standards for assessment and improvement in maritime education, and qualification of instructors and examiners.

These very important changes to the STCW Convention will have a powerful impact on the global maritime industry and MET in future. In China, this impact is also notable in particular in the field of ships' manning, standards of competence, quality of MET and management of maritime institutions.

4.1.1 Alternative Certification — Functional Approach

There are different ways of organising labour on board ships.

Traditional Approach

The traditional division of personnel on board was master and deck department, engine department and catering department. Similarly, maritime education, training and certification also mainly encompassed these separated divisions where trainees could easily go on board ships for the specific work in the different departments. This scheme which is called the traditional approach was appropriate and necessary for a long time because there was a need for many people to operate a ship, and the technology for operating a ship was at a low level.

Nowadays, developments in ship technology are growing at an accelerating rate and many modern work systems on board ships have been introduced. Technology allows a reduction in crew or the re-organisation of personnel on board a modern integrated ship because of the increasing extent of ship automation. The traditional roles of officers and ratings aboard ships have changed as technology assists the performance of some functions and new working methods move some tasks to other personnel on board the ship. For example, traditional departmental boundaries and

officer/rating distinctions have largely disappeared on smaller ships in European trades and this scene is extending to larger ships.

On the other hand, a seafarer who is trained in a traditional approach has narrow knowledge and skills only either a deck officer or a marine engineer. It is difficult for him/her to work on a modern ship which integrates the deck and engine departments. This problem is not only facing the Chinese situation, but also other developing countries.

Functional Approach

Another method which is called the alternative certification or the 'functional approach' is introduced by the revised STCW Convention (see Appendix 5, C). Its basic principle is to create a more flexible framework of modular qualification. This functional approach is a new methodology for maritime education, training and certification so that trainees can obtain knowledge and skills in several functions on board ships.

Normally, ships work may be divided into several basic functions:

- Navigation,
- Cargo handling and stowage,
- Controlling the operation of the ship and care for persons on board,
- Marine engineering,
- Electrical, electronic and control engineering,
- Maintenance and repair,
- Radio communications.

Each function has three levels of activity:

- Management--the overall responsibility for the proper performance of all functions or of certain specified functions on board ship,
- Operation--dealing with technical operations such as navigational or engineering watch,
- Support--dealing with basic maintenance of the ship and machinery other than responsibilities for management and operation.

Advantages of the Functional Approach

According to proponents of the functional approach, there are many advantages if the functional approach is used in maritime education, training, certification and manning on board ships.

(1) Seafarers can obtain fundamental conceptualised knowledge and ability for a multi-skilled, flexible and adaptable workforce. Institutions can provide different course models for both the present and future organisation on board ships.

(2) The functional approach is a competency-based or skill-based approach. It assesses the more obvious aspects of the cognitive domain relating to the recall or recognition of knowledge such as basic theory, technology of operating ships and technical skills. It also assesses the less obvious aspects of the affective and psychomotor domain relating to skills such as full application of knowledge and being competent in a changing situation.

(3) It focuses on outcomes rather than on the learning process. It means that it is easier to establish a universal standard of competency for seafarers.

(4) It is more flexible in allowing seafarers to update individual knowledge and skills on the basis of rapid technical changes relating to operation and management of ships. It is also more convenient for seafarers to develop their careers either in a horizontal or vertical direction or both.

Therefore, it is better for trainees to gain academic knowledge through a functional approach based on performing tasks. Obviously, there is a need to adopt the functional approach to improve Chinese MET.

4.1.2 Quality Assurance

The revised STCW Convention introduces the concept of quality assurance of maritime education, training and certification because there are many measures needed to implement convention standards world-wide. Seafarers obtain knowledge and skills under widely different maritime educational systems throughout the world. Certificates of competency have traditionally depended mostly on the demonstration

of knowledge in written examinations, rather than on the demonstration of necessary skills. The problem of implementation is that there is a lack of measurable training standards and in particular a lowering of general seamanship and watchkeeping standards. Another problem is that the traditional learning system cannot meet the new situation of increasingly sophisticated ship equipment and less opportunity for learning on-the-job. In earlier years, basic knowledge could be gained from teaching in the classroom or from more experienced colleagues on board ships. However, in the present situation, much training has to be done through the use of simulation or computer aided learning because there is a less opportunity for trainees to carry out the tasks under real conditions on board ships.

Therefore, it will become necessary to establish a good system of quality assurance in MET (see Appendix 5, A and B), and in doing so the following aspects should be considered:

4.1.2.1 Emphasis on Practical Skills

The revised STCW Convention aims not only to create the standards of basic knowledge for all seafarers, but also to establish that seafarers have the skills for the specific duties and responsibilities on board ships, and in particular the practical skills such as seamanship, navigation, ship operation, use of ARPA, Radar and GMDSS system and other necessary skills.

4.1.2.2 Effective Education and Training

Facing rapid development of the maritime industry, the traditional education and training system is becoming inadequate in the face of such change and cannot be expected to remain effective, particularly in developing countries. Therefore, many measures should be taken. Firstly, making new educational policies and changing old maritime education systems are the most important matters. Secondly, improving maritime education programmes in the institutions using a functional approach is also important. Some course programmes are obviously out of date and they need bringing up to date to meet the requirements of the revised STCW Convention.

Thirdly, new educational methodologies such as marine simulation and computer aided learning should be used.

4.1.2.3 Assessment

A good system of assessment is necessary for high quality MET in order to maintain the required standards for the issue of certificate of competency. The revised STCW Convention places emphasis on developing proper and effective methods of assessment so that the assessment can be closer to the actual job in future. But, it is not easy! Normally, the assessment lies much closer to shore-based training than to the real job because most training is away from the workplace. Another difficulty is that many training tasks cannot be assessed in a real world situation. For example, a trainee cannot demonstrate his ability to manoeuvre a VLCC ship in a real situation.

If the assessment for competency is away from the real job on board ship, it increases the gap between training for knowledge and training for onboard skills. So, how can the gap between theory and practice be narrowed? The traditional way is to undertake the practical training and practice on training vessels. This is a useful method and effective assessment can be gained, but it is not always available for all the training content. Modern methods of training are to use simulation and computer aided learning. These can also cover many aspects of assessment. The greatest advantage in using such modern methods of training students is to provide the opportunity to train and assess in a risk-free environment.

4.1.2.4 Qualification of Instructors and Examiners

The 1978 STCW Convention did not lay down standards for the qualification of instructors and examiners. The revised Convention includes provisions that the instructors and examiners of seafarers' training should be appropriately qualified and experienced.

In the writer's view, in order to control quality of MET, instructors should have a same level of certificate of competency with their students aspire to. They should also

keep updating their knowledge and experience in the subjects they teach. For examiners, these requirements are also needed, and in particular, examiners should have a higher level of experience at sea.

4.1.2.5 Standards of Maritime Institutions and Quality Control

The 1978 STCW Convention requires administrations to meet the required standards. But it is not spelt out how the standards should be met by Parties, nor how these standards can be achieved. The STCW Code in the revised Convention provides considerable guidance on the international standards relating to governing maritime institutions and quality monitoring. This Code also requires Parties to ensure that all training and certification activities are continuously monitored for their quality and that periodical external evaluations are made by appropriately qualified persons who are not involved in the activities being evaluated.

Though the above aspects do not cover all the content of the revised STCW Convention, the discussion emphasises the main impact on Chinese MET. Therefore, Chinese MET should not only meet the needs of China's modernisation, but also take a global view and take account of the future. It should make the greatest effort to use new technology and methodology in the field of maritime education and training.

4.2 Simulation in Maritime Education and Training

In modern shipping it is a fact that ships are growing larger and larger, ship operations are becoming much more complex, marine traffic are becoming increasingly heavy and crowded, especially in narrow straits. On the other hand, there are many marine accidents resulting from human error combined with the above factors. These marine accidents which result from human error are mainly caused by poor decisions rather than a lack of knowledge.

Most marine officers have a background of academic knowledge in the field of ship operations, but inexperience at sea and stress in the complex situation often face

them. In the case of traditional vessels, trainees can go on board ships for practical training in order to overcome the problems of inexperience and stress. Nowadays, there is however a less opportunity to train them in a real environment because the cost and risk relating to training on board ships are much higher. Therefore, reliable and cost-effective training must be provided by shore-based training establishments in order to obtain hands-on skills and experience other than by doing on board the real ship. In recent developments of maritime training technology, the use of simulation as a cost-effective method is almost universally recognised. Proper training on marine simulators can effectively overcome the problems of poor skills relating to many aspects of ship operations.

To promote safety of life and property at sea and to protect the marine environment, the revised International Convention on Standards of Training, Certification and Watchkeeping for Seafarers requires that radar and ARPA simulator training must be undertaken by all trainees seeking a deck watchkeeper or master certificate of competency (see Appendix 5, D). The convention also recommends the use of other simulation systems which can help in achieving the objectives of safe operations of ships and good training quality.

4.2.1 Advantages of Using Simulation for Training

Simulation is desired to provide a realistic environment which can be artificially controlled so that the training can be achieved off-the-job. The proposed definition of simulators is given by the government of the United Kingdom at the IMO 26th session of STW Sub-Committee about "Comprehensive Review of the 1978 STCW Convention and Preparation of Related Conference Resolutions--Simulator Training (STW 26/4/8)":

A simulator is a device, designed to satisfy specific objectives, which imitates part of a real situation in order to allow an operator to practice, and/or demonstrate competence in, an operation in a controlled and safe environment.

Marine simulators normally provide a realistic imitation of operations such as radar and ARPA operations, shiphandling, cargo handling, integrated bridge, engine room and full mission operations on board a ship. Nowadays, under the background of development of advanced technology, simulator-based training has many advantages, in particular for maritime education and training.

(a) Simulation Provides a Situation of Realistic Imitation for Training

In the early years, skills and experiences were traditionally obtained through the process of "learning by doing" on board ships such as practical operation with guidance from more experienced officers. In recent years, increase in ship size and complex operations means there is a less opportunity for trainees to train on board ships in many aspects of ship operations. Simulator-based training permits complex exercises such as ARPA and ship manoeuvring to be practised and the required skills obtained without real risk or serious damage.

For example, in the crude oil handling and washing operation, it is impossible for trainees to do training in the real situation because it may result an oil spill or serious damage from any mistake of operation. On the other hand, though trainees have knowledge of principles about tanker operations, there is no experience of the process of "learning by doing" and thus they cannot work on board tankers effectively. In the case of use of tanker simulators, it is an effective method of training providing "hands-on" training in a realistic imitation of the real world. This training process is safe and efficient.

(b) Simulator-Based Training Is Cost-Effective

Obviously, not only is training on board ships a high cost factor, but also it is very difficult and costly to put real maritime equipment into institutions ashore. In the case of Chinese MET, there are more than 2500 marine students studying at maritime institutions. The difficulties in providing support for every student to learn by doing on board training ship are obvious. Even though students can go on board ships for training, the training time is not enough. Therefore, the maritime institutions have to send students individually to shipping companies for training. However, how can the

training quality be controlled? Therefore, one necessary solution is the effective use of marine simulators to meet the needs of Chinese MET because establishing and maintaining simulators are a relatively low cost compared with building more training ships or installing different kinds of real marine equipment in institutions.

Because of the rapid development of PC based simulation, the costs of simulation itself and its maintenance can be significantly reduced. Available computer technology enables high quality of imitation and cost-effective utilisation. Although the PC based simulations do not meet all training tasks, it is expected that the utilisation of the PC based simulations will spread in many aspects of MET under the development of computer hardware and software.

Simulator-based training is also effective because training on simulators is close to shipboard practice in many cases. For example, a ship manoeuvring simulator can provide a situation of high fidelity regarding ship's motion, current, wind and other elements. The simulator can provide many possible scenarios for training while trainees will not easily experience on board training ships. Students can gain experience rapidly, using repeatable exercises for the purpose of safe real life and operational practices without risk.

(c) Simulations Help to Establish Uniform Systems of Training

Although the international training standards are adopted by most countries in the world, the quality of training varies from country to country. The use of simulators assists in the adoption of uniform international standards of training. It is relatively easy to establish universal standards and guidelines for simulator-based training in accordance with the standards of the STCW Convention.

(d) Simulators Are a Useful Tool to Assess Training and Competence

In traditional training, skills at sea are developed by repetition of doing and the accumulation of relevant experience. The assessment of skills in the workplace on board ships is limited. The problem is that a full assessment of skills may take a long time. In most cases, trainees have less opportunities to demonstrate their skills in a real situation. In the case of simulation, trainees can demonstrate their skills in many

situations by performing marine operations individually. Simulators can also provide an audio/visual process for instructors to assess students' skill and competence.

During the process of training, simulators can record each step and action which is done by the student. These records cannot only be played back to the students, but also assist in analysing the learning and training for meeting the specific objectives.

4.2.2 Utilisation of Simulators

Because simulators can produce many operational tasks and functions relating to training and assessment in a risk-free world, a series of simulators has been developed by manufactures for MET.

4.2.2.1 Types of Marine Simulator

Normally, there are three main types of simulator used for MET. They are bridge, engine room and cargo handling simulators. These types of simulator may be classified into four categories:

- Full mission ---- capable of simulating a total environment;
- Multi-task ---- capable of simulating a nearly total environment;
- Limited task ---- capable of simulating an environment for limited tasks;
- Special task ---- capable of simulating particular instruments, or limited operations.

In the real training practice, many simulators are combined by the different types and categories. The full mission shiphandling simulator and desktop computer-based engine room simulator are examples.

A. Bridge Simulators:

- 1) Radar and ARPA Simulators;
- 2) Ship Manoeuvring Simulators;
- 3) Navigational Equipment Simulators:

--electronic navigational aids (such as Loran-C, Decca, Omega, GPS Radio Direction Finding);

--NAVTEX;

- 4) Integrated Navigational Simulators;
- 5) Ship Communications and GMDSS Simulators;
- 6) Integrated Bridge Simulators.

B. Engine Room Simulators:

- 1) Engine-Room Operating Simulators;
- 2) Hydraulic and Pneumatic Simulators;
- 3) Electrical and Electronic Simulators;
- 4) Refrigeration/Air Condition Simulators;
- 5) Electrical Plant Generator Simulators;
- 6) Steering System Simulators.

C. Cargo Handling Simulators:

- 7) Cargo Stowage and Ship Stability Simulators;
- 8) Tanker Operating Simulator;
- 9) Product and Chemical Carriers Operating Simulators;
- 10) Liquefied Gas Carriers Operating Simulators;
- 11) COW and IGS Simulators.

4.2.2.2 Radar and ARPA Simulators

The revised STCW Convention produces a mandatory requirement of Radar and ARPA simulator training for all masters and deck officers. The main reason is that there is the greatest number of collisions between moving vessels at sea due to human errors such as mishandling and lack of knowledge. The requirement is that deck officers must have the knowledge of the fundamentals of Radar and ARPA and ability in the operation and use of Radar and ARPA including:

- (a) factors affecting performance and accuracy,
- (b) setting up and maintaining displays,
- (c) detection and misrepresentation of information, false echoes, sea return etc. ,
- (d) range and bearing,

- (e) identification of critical errors,
- (f) course and speed of other ships,
- (g) time and distance of closest approach of crossing, meeting or overtaking ships,
- (h) detecting course and speed changes of other ships,
- (i) effect of changes in own ship's course and speed or both,
- (j) application of the international Regulations for Preventing Collisions at Sea.

The above functions of training must at least be provided in the Radar and ARPA simulators so as to achieve the minimum standards of the STCW Convention for deck officers. Generally, the Radar and ARPA simulators provide standard control, as well as combining many additional training functions to improve the quality of skill. Recently, the trend is to put Radar and ARPA training functions into ship manoeuvring simulators or integrated bridge simulators. This combination provides a comprehensive environment to maximise student instruction.

4.2.2.3 Bridge Simulators

In the early years, the bridge simulator was designed for manoeuvring purpose only, such as ship handling using various ship models, manoeuvring in narrow channels and avoidance of collision. In the last decade, the available technology and innovative design of simulators has produced a high quality of realistic, efficient and comprehensive training functions. These simulators not only cover the training function of ship manoeuvring, but also the full range of navigation tasks.

The Norcontrol Bridge simulator is an example. The simulator uses real equipment and efficient man-machine interfaces together with advanced hydrodynamic models, realistic scenarios and environmental conditions. It is possible for trainees to experience the situation for navigation, collision avoidance and ship manoeuvring as if they were on board a real ship.

4.2.2.4 Cargo Handling Simulators

There are two major kinds of cargo handling simulators. One is the cargo stowage and handling simulator which is generally used for training in cargo operations in

general cargo ships, containers and bulkers. Another is the oil/liquefied gas handling simulator which is generally used for training in cargo operations in crude oil tankers, product oil tankers and liquefied gas carriers.

The cargo stowage and handling simulators are widely used to train deck officers in the skills of cargo stowage planning, loading, ballasting, unloading and to examine the ship's stability situation and strength.

Recently, as a result of the development of PC-based software programmes of cargo stowage and handling, many software programmes which are used on board ships can be directly applied for training in maritime institutions. Therefore, students have an opportunity to exercise on various types of operations covering cargo stowage and handling.

The oil/liquefied gas handling simulator becomes necessary for trainees who have no experience of tanker or liquefied gas carrier operations. Many accidents relating to oil or liquefied cargoes are caused by improper operations such as closing a valve too quickly, or making a mistake in COW procedures, etc.. The simulators ensure that students will be trained to a high level of skill, as well as having the fundamental knowledge in accordance with the IMO Standards so as to achieve safe and effective operation and to protect the environment.

4.2.2.5 Full Mission Simulators

Generally, maritime simulators have been used extensively for developing individual skills. The activities on these maritime simulators encourage repetitive drills of critical seamanship skills. This training however concentrates on the individual skills rather than the practice of co-operation, co-ordination and communication with each other on board ships.

A full mission simulator means an instrument or facility that is capable of operating in real time and producing typical behaviours of the real world. Trainees can obtain skills both in operations and management when they experience the actual shipboard management of the technical and social systems.

A Full Mission Bridge and Engine Room Simulator, for example, is located at the Maritime Training and Research Centre, Ohio, United States. This simulator consists of two parts: the controlling & monitoring part, and the training part. The controlling & monitoring part, which is called the Remote Monitoring Console, provides enough space for additional observers and staff to control or monitor the process of the "voyage". The training part includes the bridge and engine room. The bridge is typically equipped like a real ship's bridge including main facilities and navigational equipment. For example, the integrated bridge window has a simulated active and visible scene based on computer programmes. The engine room is also typically equipped as a real ships engine room. The vessel's condition and voyage environment can be controlled by the instructor. The vessel's motion and other necessary work can be done by trainees during the "voyage".

The training programme on the simulator requires a full complement of personnel in both the bridge and engine room. These trainees need to play helmsmen, deck and engine watchkeepers, and captain by performing the duties of those positions. There are many challenges, changes and decisions facing the trainees during the "voyage". The deck and engine room officers must co-ordinate their efforts, communicate their ideas and questions, develop alternative responses, find problems and errors, and then carry out the captain's decisions for a safe voyage.

The training on the simulator focuses on solving real problems in real time. Normal, abnormal and emergency conditions are included as part of the challenging situation. Everything which has been done by trainees is recorded during the training period. After the training process, the instructor can assess the performance of the "voyage" and as a result feedback is given to the trainees.

The full mission simulator provides trainees with a professional and complex environment composed of dynamic and interrelated technical and social systems. It not only trains students in individual skills at the technical level, but also trains students as managers on board ship on the social level.

4.3 Computer Aided Learning

Computer Aided Learning (CAL) is a way of education, and its use in the field of MET is growing rapidly.

4.3.1 Introduction of Computer Aided Learning

The advantages of using simulators in MET are well recognised. However, the investment and maintenance of a large simulator means a high cost. In China, the use of simulators and the training time available for each trainee are limited. It is very important and necessary to use multiple methods for MET so as to improve the level of quality assurance in education. Recently, developments in Personal Computer (PC) based simulators have clearly shown that computer aided learning is an effective means of training and assessing trainees. The main types of CAL can be summarised as demonstration programmes, man-machine interactive programmes and imitated & intelligent programmes.

4.3.1.1 Demonstration Programmes

Demonstration Programmes have a pre-determined sequence of frames, the student's response in the learning process not being taken into account. This type of programme provides students with fundamental knowledge and operating procedures. It is particularly useful for the introduction of new maritime technology and safe processes of ship operation. For example, the demonstration programme of Australian LNG Ship Operating Company (ALSOC) provides an introduction to LNG ship operations showing how this training programme can be used.

4.3.1.2 Man-Machine Interactive Programmes

Man-Machine Interactive Programmes are designed for interactive training during the process of the programme. There are many questions raised when the programme is running and each next step is determined by the student's answer. In some cases, the student is given several ready answers, and one of which must be chosen. In other cases, the student can pass to the next step after giving a corrected answer. For

example, in the International Code of Signals Training Programme, there are many questions about alphabet flags and number flags for a student to answer and self test. When a flag, which is a certain letter of the alphabet or number, appears on the screen, the computer waits for the student's answer. If the answer is wrong, the programme gives the corrected explanation and records the response. The student becomes familiar with the International Signal Code by repeating the exercise.

4.3.1.3 Intelligent Systems and Simulation Programmes

The intelligent systems are the best pedagogical type of CAL and have a high potential. The programmes give some situations for the student to make a decision on each step in the process. In some software training programmes, the teacher can set or justify some conditions and give different situations for the student's training on the computer. For example, "Mariner", which is a loading program for stability and strength designed by Baron and Dunworth, is very useful for the student to learn to understand and analyse the ship's stability and longitudinal strength for different conditions of stowage. Before a student starts this stowage planning, the teacher can give the particular condition. The student has to use basic principles and comprehensive knowledge to satisfy the exercise.

The three types of computer aided learning have different characteristics which relate to the level of learning. The apparent characteristic of the demonstration programmes is that there is no need to use the information from a student's answer. The programme gives an introduction which combines text and static pictures. There is a disadvantage in some cases because the student can also look at the introduction in other ways. The man-machine interactive programme asks the student to make decisions. It is useful for a student to consider and make a choice. This interactive function is better than a demonstration programme. But, there is no way of individually considering multiple or complex situations, and sometimes the student makes a choice for reaching a decision by luck and he still remains ignorant. The intelligent system simulation programmes are normally better than the above two

types of CAL and are more suitable for training and self-studying. The advantage is that not only do the programmes offer a specific situation, in which the student must join, just like entering into a role, but also the student must consider all necessary conditions and make a decision which is based on pre-knowledge.

In practice, a good learning programme, both for the purposes of training and assessing, should properly combine the above three kinds of characteristics. The software programmes called Officer Of the Watch (OOW), which is designed by PC Maritime Ltd, UK, is a good example. This programme provides a comprehensive situation of the ship's operation on sailing, which is simulated by computer. The sub-programme of the Expert System is a demonstrational and intelligent programme which provides a knowledge base for the International Regulations for the Prevention of Collisions at Sea. When a student is doing an exercise or meeting some problems, the Expert System gives guidance and interpretation of the Collision Regulation. The OOW has a question sub-programme which is a man-machine interactive programme, and it gives the instructors a powerful means of testing student watchkeeping knowledge in a broad range of situations from the simple to complex, including emergencies and equipment breakdowns. The OOW also provides a comprehensive watchkeeping situation for the student to analyse in order that the operation of the ship will be satisfied. In the simulation exercises, the student will know how to use radar information correctly, how to arrange watchkeeping, how to fix a position properly, and how to deal with emergency situations and sailing regulations. Therefore, OOW is a highly efficient example of computer programmed learning software.

4.3.2 Computer Aided Learning and Improved Training

Computer Aided Learning is a new innovation in maritime education because computer technology is developing very quickly. There are many advantages which are summarised as follows:

(1) **Effectiveness** The biggest advantage of computer aided learning is that it is more efficient than traditional learning in many cases, in which it saves time and increases the quality. In particular students can repeat some steps of the practical operation or review some important ideas through using programmed learning so that it can effectively improve the skills of mariners.

(2) **Low Cost Training** A PC based programme is relatively cheaper than that of a large system of simulation. It means more opportunities are provided to trainees for training at the same investment and they have enough time to do exercises individually. For example, Poseidon GMDSS/GOC (Global Maritime Distress and Safety System/General Operation Certificate) Simulator designed by Poseidon Simulation System AS, Norway, is a PC based simulator with up to 16 networked PCs which costs approximately US\$ 60,000. Normally, a large system of GMDSS simulator however costs more than US\$ 200,000.

(3) **Self-Learning** CAL can be done easily anywhere because the learning programme can be installed on any standardised PC. Many software programmes are suitable for the trainee's private study and for wherever the trainee has access to a PC at college, at home or at sea.

(4) **Consistent Training** There are many excellent PC based training programmes which meet the requirements of International Maritime regulations, codes and guidelines in the world. Trainees can undertake exercises in a consistent way which overcomes the problems of inconsistent training that often results from being taught by different instructors in the traditional training world.

(5) **Effective Assessment of Skills** Using computer aided learning means that it is easy to check out the result of the student's knowledge. Students can individually learn through personal computers. Every learning step or result of test will be automatically recorded on disk or printed out on papers. The teacher can check the result as required and he/she can also emphasise how to solve the problems which the student faces.

4.3.3 Limitations of Computer Aided Learning

Although computer aided learning has many advantages, it can in no way completely replace all traditional learning. For the maritime case, there are three basic types of study material with which a student deals. The first case is the theoretical and basic principles of knowledge related to navigation and ship control. In this learning, a student should have a very wide range of knowledge about mathematics, physics, radio techniques and applied sciences. Therefore, it is more suitable for traditional learning in most cases. The second case is to acquire knowledge of the ship's practical operation and to obtain the practical skills. The best way is to combine computer aided learning and traditional learning for this case. The third case is that the student should understand and fix the various rules, regulations and requirements for the ship's operation and cargo handling. Many software programmes are very satisfactory for this type of learning.

In general, most PC based software programmes play a role as limited task trainer or special task trainer. Another point is that there are many software programmes to be utilised for maritime matters in the field of ships stowage planning, ship manoeuvres, preventing collisions, dangerous cargo handling, navigation, route planning, bridge automation and ship repair. But, it should be taken in mind that some programmes may be designed for commercial operations, not as teaching tools and may only be partly suitable for use in the classroom. Some programmes may be designed for high level courses or senior officer level, and are of course unsuitable if there is a lack of shipboard experience or basic maritime knowledge.

In practice, the best way for MET is to combine computer aided learning with other methods of training such as traditional teaching, simulation training, videos and practice training.

Computer aided learning has great potential for modern education and training. It can be expected that the development of micro-processor techniques will make computer aided learning a suitable form of learning in maritime education and training.

5. Quality Assurance in Maritime Education and Training

Although there are many factors which have an influence on MET, quality assurance is one of the most important factors needed to establish a good quality of education in order to achieve international maritime training standards. To implement the requirements for quality assurance in the revised STCW Convention in China, there is a need to incorporate a quality control system within the maritime education structure.

5.1 Implementation in Relation to the Requirements of the International Conventions

In order to implement the requirements of the International STCW Convention in China, There are a number of key elements to be dealt with:

(1) All the present rules, regulations and guidelines relating to MET should be updated in accordance with the revised STCW Convention.

(2) It is necessary to establish a Chinese Maritime Education Council. This Council will comprise members who are representatives of the seafarers' union, shipowners, lecturers, education authorities and maritime authority. The Council will play a role in formalising co-operation between all parties concerned and in supervising the MET. The council will develop new MET policies and issue advice to all parties.

(3) Uniform standards of MET for the different levels of institutions must be developed. All the course programs in the different maritime institutions should be approved by the Bureau of Education.

(4) New integrated ratings and master courses must be developed. All the existing course plans and curriculum must be revised and updated. Particularly, attention

should be paid to the aspects of safe operation, environmental protection and utilisation of new technology on board ships.

(5) The training programs should consider how to minimise the problem of the gap between fundamental knowledge and skill acquisition.

(6) A quality assurance system must be developed for both internal and external quality control. The detailed discussion will be in section 4 of this chapter.

(7) The policies made by the government have significant influence on the national MET such as investment in training, requirements of sea service, examinations and certification etc. Nowadays, the most important policy is to pressure the national shipping industry to contribute to maritime education because there is a lack of adequate investment in most institutions, particularly in the acquisition of new simulators.

5.2 Construction of a New Maritime Education System

As discussed in Chapter 3, because the existing Chinese maritime education system cannot meet the needs of the maritime industry, the change in new technology and international requirements, There is a need to develop a new Chinese maritime education system.

5.2.1 The Purpose of Developing a New Maritime Education System

- implementing the international conventions, in particular the revised STCW Convention;
- achieving high standards of MET to meet the needs of the maritime industry;
- meeting the changes of modern technology;
- Overcoming the present problems in MET.

5.2.2 The Framework of the New Maritime Education System

In developing a new maritime education system the specific national situation should be considered. Although there are a few shipping companies who have some modern ships, many traditional ships still exist in most shipping companies and it is

expected that these traditional ships will remain for more than a decade into the future. Therefore, two stages may be considered.

The first stage is to develop a combined system making use of the "front-ended" and "sandwich" types. Each student must pass the integrated ratings course if he is to enter this system. Two levels of training courses are provided for the watchkeeping officers and masters. To meet the needs of the present traditional manning and future modern manning, the course for watchkeeping officers is still divided into deck and engine sections within an academic period of 4 years including 1.5 years' training at sea. The graduates can obtain the qualification of master or chief engineer in the traditional approach.

However, in order to enable the student to prepare himself for the integrated-manned ships of the future, it is necessary to offer nautical students certain additional engineering modules and vice-versa for the engineering students. These modules are optional.

If the student satisfactorily completes the nautical or engineering watchkeeping course, he/she can obtain the diploma of bachelor degree, as well as the certificate of 2nd Officer. After that, if the student wishes to get a higher qualification and satisfy the additional modules in the previous courses, he/she can enter the master course which is an integrated training program with both a deck and engine responsibility with a duration of one year's study (see figure 5-1).

After the year 2000, the second stage is to establish a fully integrated training system. Graduates can obtain the certificate of ship operator and master so as to meet the needs of integrated manning on modern ships (see figure 5-2).

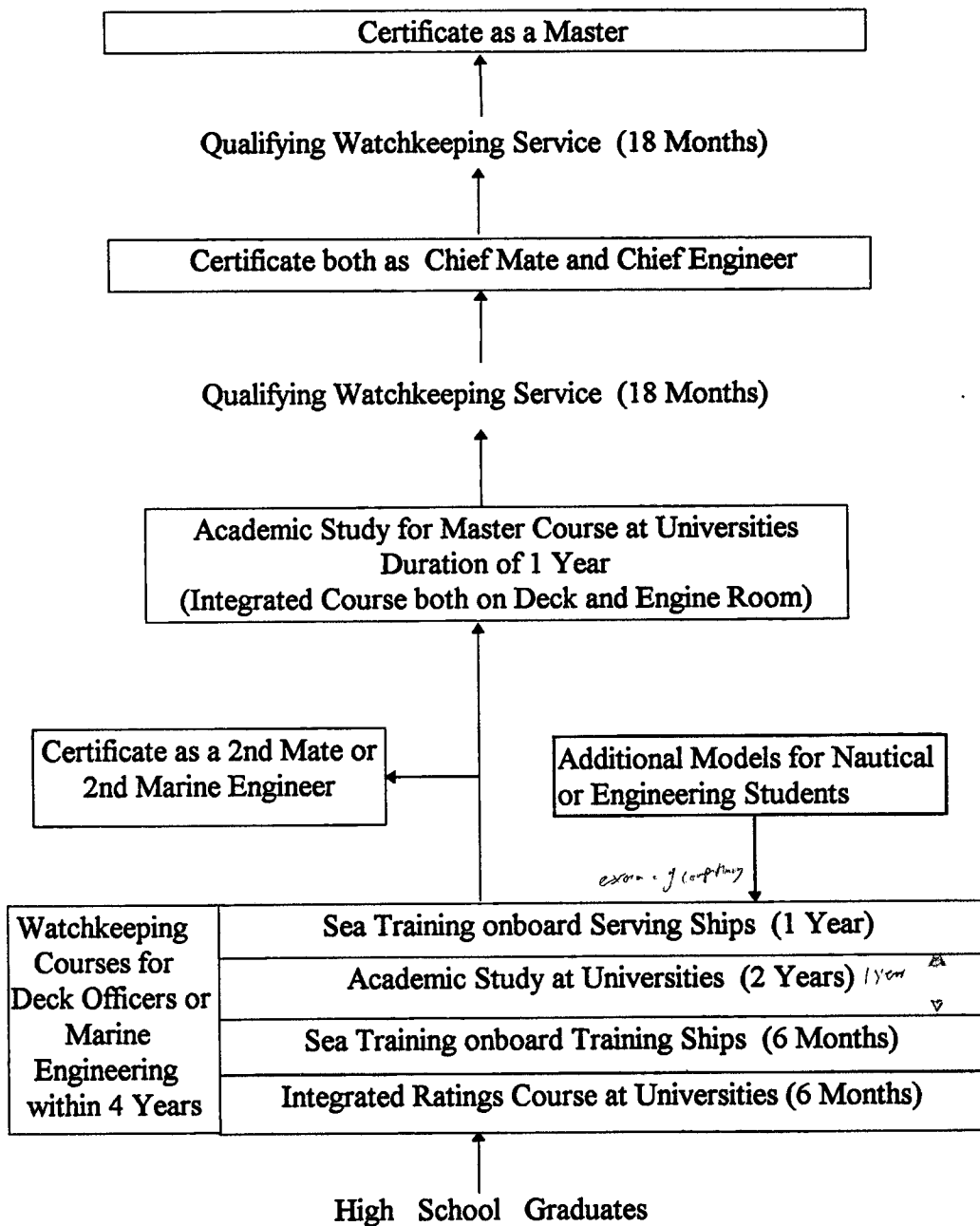


Figure 5-1 The New MET System on the First Stage

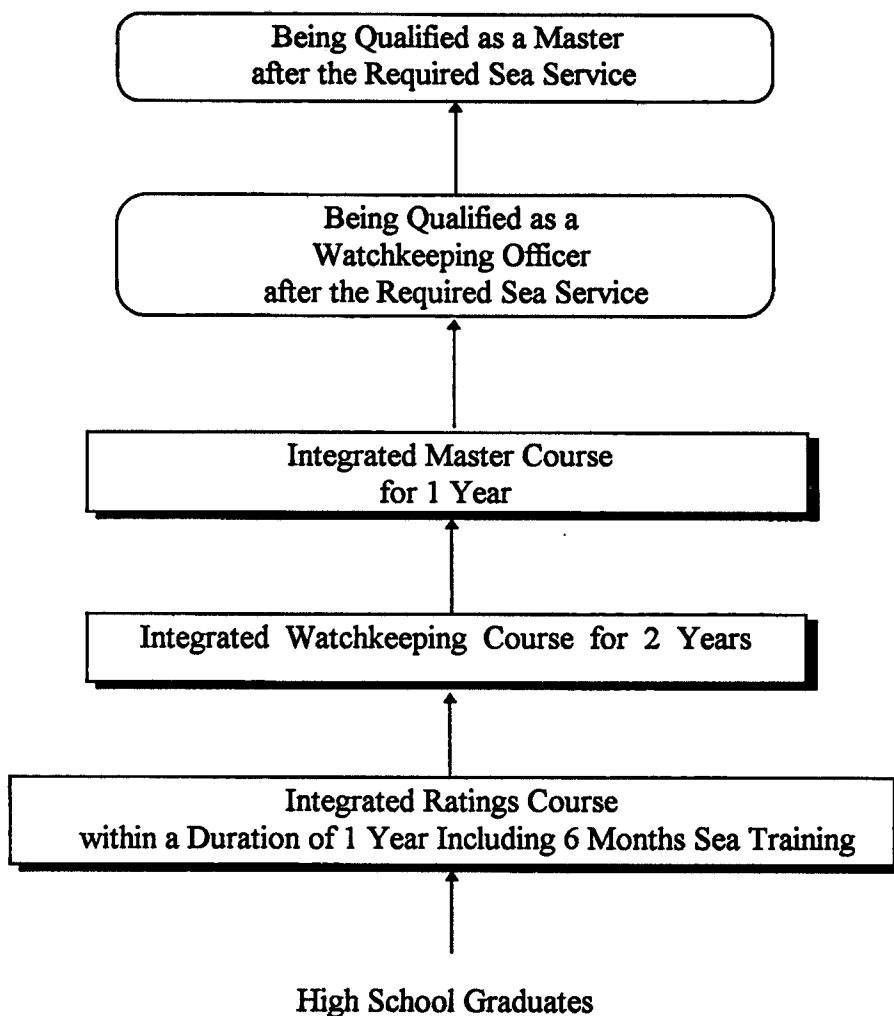


Figure 5-2 The New MET System on the Second Stage

Ref

5.3 Course Development

Successful MET depends heavily on a sound and effective course curriculum. The course curriculum determines the course structure, required staff, admission requirements of students, syllabus and detailed lesson plans. The course development may be divided into two aspects:

- improving the existing course so as to meet the changes in requirements for national regulations and international conventions.
- establishing a new course so as to meet the needs of new manning requirements on board ships and the technical changes in the maritime industry.

Facing the Chinese situation and the revised STCW Convention, there are needs of not only improving existing courses for marine officers, but also establishing new courses.

5.3.1 The New Course for the Masters Certificate

Currently, there are two levels of course for mariners on deck. One is a higher level of navigation course for watchkeeping officer (third officers or second officers) at maritime college and universities, and another is a lower level of the seamen course for ratings at middle maritime schools. There is not the highest level of the course for masters who systematically study at maritime universities.

It is necessary to establish a new course which has an integrated content for both deck and engine departments for trainees who want to obtain the certificates of ship master. This ship master course is intended to provide trainees with, not only the necessary fundamental knowledge and skills, but also, the updating knowledge relating to the changes of rapid technical development, and in particular in the field of navigational safety, protection of the marine environment, modern communications, operations in the integrated bridge system, safety and emergency procedures, shipping business and personnel management.

5.3.2 Revising the Present Course Curriculum for Watchkeeping Officers

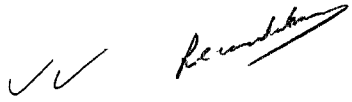
Maritime education and training is the systematic development of attitudes, knowledge and skills required by an individual in order to perform adequately a given task or job. After the course plan is confirmed, the course curriculum has a significant role in the training environment for achieving the objectives of the course.

The present course curriculum contains many weaknesses. The major weakness is that it is out of date. Nowadays, new technical developments are rapidly applied on board ships. Many advanced vessels with effective and sophisticated equipment need officers who have high qualifications, updated knowledge and skills.

5.3.2.1 ^x The Required Training Content

Concerning the new technology, maritime safety, protection of marine environment and other factors relating to ship operations, the main content of MET should emphasise knowledge, skills and attitude as illustrated below:

- Basic knowledge and skills of ship operation and maritime transport,
- Knowledge of both traditional and modern maritime techniques,
- Knowledge of potential weaknesses of modern technologies applied aboard,
- Knowledge and skills of concerned maritime safety and protection of marine environment,
- Knowledge and attitude of cultural, economical, social and political particularities relating to maritime industry,
- Knowledge and skills of general computer operations,
- Ability of using national and English language,
- Ability and skills to become familiar and find fault with complex systems in a quick, effective and reliable way,
- Disciplined approach to work and a willingness to be part of a team effort.



5.3.2.2 The Key Elements of Concerning the Course Curriculum in Chinese Maritime Education System

In the development of the course curriculum, some important elements should be considered:

(a) IMO Model Courses provide important guidance on designing or revising course curriculum. IMO Model Courses are periodically revised to take into account the changes which have taken place in relevant international conventions, resolutions and other matters affecting each course. These Model Courses provide a detailed syllabus, curriculum and expert guidance on many aspects of delivering training necessary to meet the convention requirements, in particular in the field of ship safety and pollution prevention.

(b) It should pay much attention to ship safety and protection of the marine environment. For example, the subject of major international conventions, safety & emergency procedures should be added to the syllabus. Instructors should instil a safety and environmental awareness in the students throughout their teaching activities.

(c) It is necessary to increase the content of practical skills. Many trainees come direct from high schools and they have no sea experience. The better way is to provide an opportunity for trainees to go on board ships for a long period of training and making them familiar with operations of radar, ARPA, the integrated bridge system and other navigational equipment.

(d) There is an obvious weakness for Chinese marine officers in the use the English language. Many maritime accidents have been caused by language problems in China. In the present case, instructors have much more concern in how trainees can read English material and use grammar correctly. They overlook listening and speaking skills. The listening and speaking skills are however much more important than reading and writing skills for Chinese marine officers, therefore, it is not good to stress one aspect to the neglect of another.

5.3.3 Approach to an Alternative Certification Structure

Facing the rapid development of maritime technology and modern organisation of manning on board ships, obviously, application of the functional approach is more flexible to meet the needs of the maritime industry.

Considering the factors relating to the functional approach under alternative certification in the revised STCW Convention, the revised course curriculum should reflect the three levels of responsibility and nine basic functional works which have been discussed in Chapter 4.

At maritime universities, there is a need to provide several functional models of subjects for trainees according to the basic functional work on board ships. The obvious advantage of setting up the functional model of training is a clear link to the alternative certification in future. It also provides an opportunity for trainees to choose certain models for their specific purposes and for the flexible arrangement of learning time.

The course for deck watchkeeping officers may be divided into basic and additional models. These models are

(1) The basic models

- General knowledge on the level of high education
- Basic knowledge of ships
- Seaman ship practical skills
- Ship navigation and operations (1)
- Cargo operations
- Maritime safety and protection of the marine environment
- Communications (1)
- Shipping business (1)
- Sea training on board ships

(2) The additional models

- Marine technology and automation
- Marine diesel engine and auxiliary machinery

- Shipborne electrical equipment
- Marine engine repairing and manufacturing
- Marine engineering management (1)

The basic functional models must be studied by students who want to complete the course for deck watchkeeping officers and the additional models can be chosen by students who want to enter the integrated course for masters. After studying basic functional models and passing the examinations, as well as satisfying the sea service, the trainees may obtain the watchkeeping certificate of competency or the functional certificates of competency.

The models of the integrated course for masters provide trainees who have already passed the course for watchkeeping officers both on the basic and additional models.

- Ship navigation and operations (2)
- Advanced integrated bridge procedures
- Communications (2)
- Shipping business (2)
- Ship management
- Marine electrical systems
- Marine engineering technology
- Marine engineering management (2)
- Maritime safety and emergency procedures

5.3.4 Short Courses

Apart from systematic and academic study for students in maritime institutions, it is useful to provide a range of short courses for maritime industry personnel who wish to update their knowledge and skill or to study for a special purpose. In particular, in the case of functional certification, many mariners who wish to obtain certain functional certificates can study for specific needs for a short period of time. These short courses, for example, are radar and ARPA, GMDSS, survival at sea, fire

fighting, tanker safety, operation of chemical and gas carried on board ships, integrated bridge systems, specific cargo handling, personnel management etc.

Rec **5.4 Construction of the Evaluation System for Quality Assurance in MET**

Quality assurance is very important in MET. It should be conducted throughout all educational processes because a good education depends on the quality of students, quality of teachers, quality of course design and teaching system, as well as quality of assessment. These elements are applied, whether the education is taking place in the classroom and on board ships, or by computer-aided learning and distance learning or other techniques. The internal and external quality assessment of education and training at maritime institutions are basic means for quality assurance.

Rec **5.4.1 The Purpose of Quality Evaluation**

Maritime education and training is conducted by different institutions which may be under different organisations. Each institution has different conditions of instruction, teaching systems, course plans and training facilities. There is a need for internal quality assessment and an external quality audit in accordance with international and national quality standards so as to:

- find out and overcome shortcomings in course programs, curriculum and teaching activities;
- evaluate the level of quality about students' knowledge and skill;
- examine the quality of staff with qualification and experience;
- evaluate the feedback of educational quality from the maritime industry;
- improve teaching methods and techniques for high quality;
- ensure the capability of maritime institutions to meet quality requirements in accordance with international and national standards.

✓ 5.4.2 The Requirements of Quality Assurance

The revised STCW Convention provides not only quality standards for seafarers, but also requirements and guidelines for instructors, examiners and institutions, as well as the quality control. New provisions require that those engaged in the instruction of seafarers are appropriately qualified and experienced. These instructors who assess skills and competency should hold a level of qualification at least equivalent to the qualification for which the assessment is being conducted. They should also have at least one year of service in a capacity corresponding to the level of qualification concerned and be trained in assessment techniques and evaluation processes.

The new provisions require the Parties to ensure that the quality assurance is conducted in all training and certification activities which are in relation to:

- the determination and implementation of the quality policy;
- a quality system with an organisational structure, responsibility, procedures and resources;
- the necessary activity for effective quality control;
- the planned and systematic quality assurance reviews;
- the periodical external quality audit.

✓ 5.4.3 Internal Quality Assessment

The internal quality assessment is to examine the education quality, quality management and quality control at all levels of the institutions' teaching activities by using the self-assessment model. This assessment can be done within a periodical time depending on the working plan at the specific maritime institution, and one year's period would be normally chosen.

✓ 5.4.3.1 Internal Quality Assessment Process

The internal quality assessment is done periodically and there are five main stages for the process.

(1) Preparation

The internal quality assessment involves a comprehensive effort and there is a need for ample time to prepare all the institutional matters to be covered as follows:

- a self-assessment committee including a working group, which is responsible for the internal quality assessment, should be established. The members of this committee must be representative of the various quarters within the maritime institution. If necessary, external experts or visiting professors can be invited as consultants;
- all the necessary information about teaching, management and quality control should be collected and documented;
- various forms and tables recording teaching programs, lecture evaluations and data concerned should be drawn up;
- a plan of the internal quality assessment is approved by the institution's head;
- the quality standards within the frameworks of the specific maritime institution are adopted by the recognised academic accreditation body. In China, this body is the Bureau of Education, Ministry of Communications.

(2) Self Study

A self study is the most important stage for the internal quality assessment. The working group under the self-assessment committee will make a comprehensive effort to sort out, investigate, analyse and evaluate all materials and information concerned so as to provide sufficient and necessary information for assessment. In this stage, the investigation and analysis is not easy work. It should take into account that all the materials or information must be a "dry weight" which truly reflects the activities of teaching and quality management in the institution.

(3) Self Assessment

The self assessment is conducted by the self-assessment committee so as to measure achievement of the stated policies, aims and objectives through application of

the quality management and operational control functions at all levels in accordance with the self assessment model. The detailed discussion of the self assessment model is in 5.2.3.2. This assessment should emphasise the outcomes of the education and training processes. The members of committee examine the necessary assessment materials and discuss them within committee meetings. Each member gives scores on all items of assessment under individual judgement. The self-assessment committee provides the final score of the internal quality assessment including a comprehensive report which describes the main comments about education quality and quality control.

(4) Report Review

The report from the assessment must be explained to the staff in the maritime institution. The achievement will encourage staff to make greater progress in future. It is also very important to analyse what shortcomings exist and where the problems are from. This review provides a measure of the qualitative level of the institutional education.

(5) Recommendations for Improving Quality Assurance

The self-assessment committee provides recommendations to the head of the institution for reference when a new plan to improve institutional quality assurance is implemented. These recommendations should emphasise the measures by which the problems can be overcome.

The recommendations are also provided to the government and other concerned organisations so that these bodies may consider some common problems in the MET system. In particular, the government may make a new policy or put pressure on all maritime institutions to improve quality assurance.

5.4.3.2 Self-Assessment Model

The self-assessment model is given in table 5-1.

(1) The structure of the self-assessment model

The structure of the self-assessment model may be divided into three levels of items. The first level (A) consists of education quality and quality management &

control. The second level (B) consists of the main functions relating to the quality assessment. The third level (C) consists of the supported items which are described in detail. Each item on the third level covers a specific area which is reflected the education quality and activities of quality assurance in the maritime institutions.

The assessment can be done by means of this model. Each item has its own weighting (w) relating to the higher level. Therefore, the result of the assessment may be given by the formula below:

$$\begin{aligned} R &= A_1 W_1 + A_2 W_2 \\ &= A_1 (\sum B_i W_i, \sum C_j W_j) W_1 + A_2 (\sum B_i W_i, \sum C_j W_j) W_2 \end{aligned}$$

where :

- R = result of assessment
- A₁ = education quality at the first level
- A₂ = quality management & control at the first level
- W₁, W₂ = the specific weighting relating to A₁ and A₂
- B_i or C_j = items at a second level or third level
- W_i, W_j = the specific weightings relating to B_i, C_j

(2) Weighting Items

An item's weighting concerns the priority of comparing the values of two items or more on the same level relating to their higher level. The weight of an item not only represents a position in all the related items, but also reflects the relationship with other items. Therefore, the proper and correct weighting of items directly influences the reality and quality of the assessment.

The AHP method, which is the Analytic Hierarchy Process provided by T.L. Saaty, USA(1980), is normally used for the development of weighting in an assessment system. The principle is to establish a judgement matrix depending upon the

hierarchical structure of the self-assessment model. Each item must be compared with any other item on the same level and which item is important between two items relating to the higher level. Therefore, every item in the hierarchy of the self-assessment model can be weighted on a certain intensity of importance. During the comparison, the scale of the intensity of importance may be used in accordance with the AHP method (see table 5-2)

Items at First Level	Items at Second Level	Items at Third Level
Education quality (A1)	Knowledge and understanding (B1)	Fundamental knowledge (C11)
		Specialisation (C12)
	Skills (B2)	Basic skills (C21)
		Sea experience (C22)
	Disciplines (B3)	
Physical requirements (B4)		
	Feedback from maritime industry (B5)	
Quality management & control (A2)	Management integrity (B6)	The expressed quality policy (C61)
		Quality system coverage including structures, responsibilities, procedures, process and resources (C62)
		Educational regulations (C63)
		Teaching documentation (C64)
		Financial support (C65)
	Course development (B7)	Course plan (C71)
		Admission requirements (C72)
		Curriculum design (C73)
		Assessments and examinations (C74)
	Teaching activities (B8)	Teaching preparation (C81)
		Teaching techniques (C82)
		Teaching quality (C83)
		Teaching evaluation (C84)
	Training facilities (B9)	General training equipment and instruments (C91)
		Simulators (C92)
		Special training facilities (C93)
	Application of new technology and methodology (B10)	Developing new training courses (C101)
new teaching methodology (C102)		

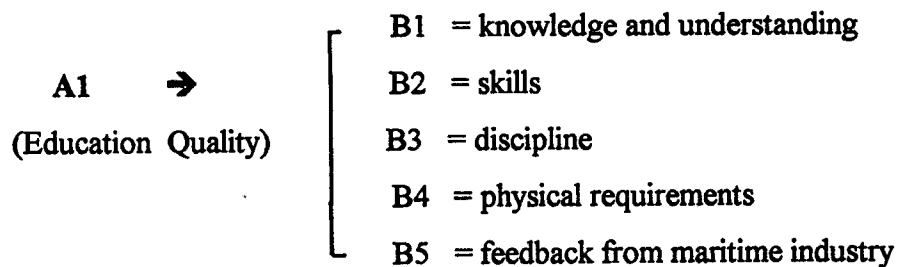
Table 5-1 Self -Assessment Model in Chinese Maritime Institutions

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance over another	Experience and judgement slightly favour one activity over another
5	Essential or strong importance	Experience and judgement strongly favour one activity over another
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
9	Absolute importance	The evidence favouring one activity over another is of the highest possible order or affirmation
2, 4, 6, 8	Intermediate values between adjacent scale values	When compromise is needed

Source: The analytic hierarchy process.

Table 5-2 9 Level of Intensity of Importance

After structuring the hierarchy in the self-assessment model, all the items may be compared by means of the AHP method. For example, the item of education quality (first level) has five sub-items (second level).



Then the judgement matrix (M) can be established by comparing all items and the intensity of importance of each item relating to the A1 (first level) can be developed.

$$\begin{array}{l}
 \mathbf{M} = \\
 \text{Education Quality}
 \end{array}
 \begin{bmatrix}
 B_{11} & B_{12} & \dots & B_{15} \\
 B_{21} & B_{22} & \dots & B_{25} \\
 \dots & \dots & & \\
 B_{51} & B_{52} & \dots & B_{55}
 \end{bmatrix}
 \rightarrow
 \begin{bmatrix}
 1 & 1 & 5 & 5 & 5 \\
 1 & 1 & 5 & 5 & 5 \\
 1/3 & 1/3 & 1 & 1 & 3 \\
 1/3 & 1/3 & 1 & 1 & 3 \\
 1/3 & 1/3 & 1/2 & 1/2 & 1
 \end{bmatrix}$$

This judgement matrix is a square matrix which has an equal number of rows and columns. It also meets the following conditions:

$$B_{ij} = \frac{1}{B_{ji}}, \quad i \neq j, \quad i, j = 1, 2, \dots, n, \quad B_{ii} = 1$$

In this case, a set of weightings for item A1 may be obtained by two steps:

(a) Summing (S) the elements in each row:

$$S_i = \sum_{j=1}^5 B_{ij}$$

(b) Normalising by dividing each by the total of all the sums:

$$W_i = \frac{S_i}{\sum_{i=1}^5 S_i}$$

Therefore, S_i and $\sum S_i$ can be found from the judgement matrix (M). These are:

$$S_1 = 17, \quad S_2 = 17, \quad S_3 = 5.7, \quad S_4 = 5.7, \quad S_5 = 2.7,$$

$$\sum S_i = 48.01.$$

Then, a set of weightings for item A1 can be given:

$$\begin{array}{l}
 \mathbf{W}' = \\
 \text{(matrix result)}
 \end{array}
 \begin{bmatrix}
 0.3541 \\
 0.3541 \\
 0.1187 \\
 0.1187 \\
 0.0562
 \end{bmatrix}
 \rightarrow
 \begin{array}{l}
 \mathbf{W} = \\
 \text{(Normalising result)}
 \end{array}
 \begin{bmatrix}
 0.35 \\
 0.35 \\
 0.12 \\
 0.12 \\
 0.06
 \end{bmatrix}$$

Concerning the deviation between the matrix result and the normalising result, the consistency of the judgement matrix for the weightings must be checked by means of the AHP method. A consistency ratio (C.R) of 0.10 or less is considered acceptable and the formula is given by:

$$\text{C.R.} = \frac{\text{C.I.}}{\text{R.I.}} = \frac{\lambda_{\text{max}} - n / n-1}{\text{R.I.}} < 0.10$$

- Where: C.R. = Consistency ratio.
 C.I. = Consistency index of a randomly generated reciprocal matrix from the scale 1 to 9.
 λ_{Max} = The maximum eigenvalue in the matrix.
 n = The number of items.
 R.I. = An average random index provided by Saaty (sample size =500).

Here the relationship between “n” and “R.I.” is given:

n	=	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.I.	=	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.58

It can be identified that the C.R. is 0.0625 for this case. Therefore, the consistency ratio for these particular weightings is considered acceptable.

In practice, the important comparison on each level should be done by the expert team. All the judgement matrixes can be counted and the statistical result of weighting of each item on all levels can be obtained. The suggested distribution of weighting is given in table 5-3.

(3) Assessment Criteria

The design of the self-assessment model depends on the requirements of the national regulations and international conventions, in particular the revised STCW Convention. The extent of items which can be assessed depends on the nature of the specific item. Some items can be directly assessed in number. However, in this model, most items cannot be directly assessed in number. Several levels may be used to describe the extent of items in the model. Each level represents a fixed number and

Level 1		Level 2		Level 3	
<i>Items</i>	<i>weightings</i>	<i>Items</i>	<i>weightings</i>	<i>Items</i>	<i>weightings</i>
A1	0.60	B1	0.35	C11	0.60
				C12	0.40
		B2	0.35	C21	0.60
				C22	0.40
		B3	0.12		
		B4	0.12		
B5	0.06				
A2	0.40	B6	0.12	C61	0.18
				C62	0.38
				C63	0.10
				C64	0.14
				C65	0.20
		B7	0.35	C71	0.35
				C72	0.10
				C73	0.32
				C74	0.23
		B8	0.35	C81	0.15
				C82	0.22
				C83	0.45
				C84	0.18
		B9	0.12	C91	0.35
				C92	0.45
				C93	0.20
B10	0.06	C101	0.40		
		C102	0.60		

Table 5-3 Distribution of Weightings in the Self-Assessment Model

then the extent of items can be easily converted in numbers. Five levels are normally used for assessing every item (see table 5-4).

Excellent	Very good	Good	Pass	Fail
5	4	3	2	1

Table 5-4 The Extent of Items in Levels for Assessment

In practice, the detailed description of the extent of items in the levels should be given as a criteria of the assessment.

5.4.4 External Quality Audit

A good and integrative quality assurance not only has an internal quality control system, but also provides an external quality audit. All the training and examination activities in maritime institutions should be continuously monitored by the periodical external quality audit so as to achieve the quality standards in accordance with the STCW Convention.

(1) Organisational Responsibility and External Audit Team

The organisation responsible for external quality audit should be a recognised academic accreditation or quality standards body or government agency. An expert committee, whose members are representative of different maritime institutions, and other organisations may be established as an alternative way. The external audit team must consist of appropriately qualified persons who are not involved in the training and examination activities at the institution being audited.

(2) The Process of the External Quality Audit

The process of the external quality audit is essentially one of peer review including reading, visiting, listening, investigating, discussing and analysing. The audit team should be provided with sufficient advance information to give an overview of the tasks in hand and normally stay at the institutions for several days so as to examine the main aspects of education and training relating to the quality assurance in depth.

Prior to the visit the audit team may receive and read the briefing material and comprehensive report of the internal quality assessment supplied by the institution. These briefing materials must cover the following:

- an overview of the institution and its aims, objectives, mission, policies and purpose;
- a description of the institution's management and quality control system;
- a description of course plans, teaching programs, and training facilities including their performance standards;
- copies of management and teaching documents concerned;
- a description of admissions, students' learning activities and progress;
- new developments in teaching and learning innovation.

When the audit team enters the institution, their workplaces emphasis on the quality assurance practices in the teaching and learning activities. They try to find the strengths and weaknesses to be encountered within the system. In some areas, they may investigate the specific aspect in depth. They review the report of internal quality assessment and compare it with their finding. In most cases, there would be some difference between the internal assessment and external audit, and this difference is helpful to find shortcomings in the institution.

Finally, the audit team should draw up an audit report which mainly covers:

- The audit procedure used;
- A briefing of all observation about education, training, management as well as the quality assurance;
- A summary of the education quality;
- Conclusion and recommendations.

6. Conclusions and Recommendations

6.1 Conclusions

Since it has been generally accepted that the major cause of marine accidents is human error, it is also a natural tendency to automatically attribute such failure to crew in competence. The root cause of crew incompetence is attributed to the poor quality of training. Therefore, a good quality of maritime education and training greatly contributes to safe and efficient ship operation, as well as protection of the marine environment.

The investigation has identified many present weaknesses in the Chinese MET system by examining national maritime development and comparing to that of other countries. The major problem is a lack of qualified seafarers in the maritime industry because of rapid development of the national economy. The high demand leads to maritime institutions providing many more graduates. However, the resulting problem is that it is not possible to maintain a high quality of education and training. Therefore, there is a basic need to improve Chinese MET in many aspects.

Looking at the new STCW Convention, some important changes will have a powerful impact on national maritime development and MET in future. The new standards together with the technical details provide the basic requirements for seafarers. Technical innovations such as the use of new practical training methods and of simulators, have been recognised and will improve maritime education and training. A new concept of quality control in the revised convention will require all parties to ensure that the training, certification and other procedures are continuously monitored and controlled by means of a quality assurance system.

The aim of this study has not only been to examine the development of MET and identifying the weaknesses, but also to try to find an approach and solutions for the future improvement of maritime education in China.

The paper identifies that the present MET system does not meet the needs of the maritime industry. A new MET system should therefore be developed, including revision of the course programmes and establishment of an integrated course for masters.

The use of maritime simulation has become universally recognised because the simulator-based training is reliable, cost-effective and non-risk. Recent developments in PC technology has led to a significant reduction in training costs. Many powerful and effective PC-based software programs are widely used for training seafarers to overcome the problems of poor skills relating to many aspects of ship operations. This technology should help to improve the low quality situation at an affordable cost.

The importance concerning the quality of maritime education has been recognised by the revised STCW Convention. Quality assurance should be conducted through all the MET activities. This includes not only teaching policies, educational management and learning activities under the effective quality control, but also includes a need for continuous monitoring by means of internal assessment and external evaluation. The proposed internal quality assessment process by using the self-assessment model is an attempt to provide an available measurement system for maritime institutions and achieve improvement of the Chinese MET system.

6.2 Recommendations

Considering the above study in this dissertation, it is the author's point of view that the following recommendations highlight the important points for achievement of high quality in Chinese MET in future. It is recommended that:

(1) Facing the new STCW Convention, a comprehensive review of the Chinese MET should be made and organised by the government. Some important aspects should be examined such as policy, legislation, present regulations, MET system,

management of maritime institutions, new course and curriculum, quality assurance system, certification, practical training and instructor qualification.

(2) The Chinese government should establish a policy to encourage maritime institutions to use modern technology and teaching methodologies in MET. Although the use of radar and ARPA simulator are already mandatory in China, there is a need to use various simulators for improvement in effective training such as ship handling, cargo handling, tanker operation, integrated bridge operations and other forms of simulation.

(3) It is a need to establish a fund of setting up and updating training equipment and facilities so that the maritime institutions can maintain a high quality of training by using these facilities.

(4) New regulations for a quality assurance system for MET with technical details should be developed as soon as possible. According to the new STCW Convention and ISM Code, maritime institutions should comprehensively consider quality control and make a great effort to introduce quality assurance of education relating to quality policy, management, documentation, organisation, course programmes, instructor qualification, self evaluation and external audit.

Appendix

1. Course outline for the Diploma of Applied Science (N.Sc.) at the Australian Maritime College

The detailed course subjects for the Diploma of Applied Science (Nautical Science) are given (table A, table B, table C and table D):

Table A Integrated Ratings Course (one year)

Year 1, Semester 1	Study Hours
Survival at Sea	43
Shipboard Safety & the Shipping Industry	56
Fitting and Machining	132
Welding and Thermal Cutting	67
Maintenance	30
Marine Operations	132
Marine Machinery Systems	120
Rigging Technology	38
Communication	20
Total hours:	638
<hr/>	
Year 1, Semester 2	Study Hours
Task and Guided Study (training at sea)	160
Total hours:	160

Table B Academic Study (a half of year)

Year 2, Semester 1	Study Hours
Off-shore Navigation 1	60
Coastal Navigation	40
Electronic Navigation Systems	90
Bridge Equipment	15
Navigation Safety	15
Communication 2	15
Ship Operations	60
Computing 1	30
Marine Climatology	30
Safety and Emergency Procedures	160
Training Vessel 2	60
Total hours:	475

Table C Seagoing Training (one year)

Year 2 , Semester 2	Study Hours
Industrial Experience Program	465
Total hours:	465
Year 3 , Semester 1	Study Hours
Industrial Experience Program	475
Total hours:	475

Table D Academic Study (one year and half)

Year 3 , Semester 2	Study Hours
Computing 2	30
Communications 3	45
Ship Stability	60
Off-shore Navigation 2	15
Ship Structures	30
Marine Machinery System 2	30
Cargo Systems & Safety	60
Marine Climatology 2	45
Nautical Knowledge 1	30
Safety and Emergency Procedures 2	30
Training Vessel 3	60
Total hours:	435

Year 4 , Semester 1	Study Hours
Command Navigation 1	60
Cargo Handling & Stowage	60
Business & Management in Shipping	60
Maritime Law & Industrial Relations	60
Compass Compensation	45
Safety and Emergency Procedures 3	60
Project 1	30
Total hours:	375
Year 4 , Semester 2	Study Hours
Training Vessel 4	60
Terminal Operations	60
Command Navigation 2	60
Marine Surveying	60
Nautical Knowledge 2	30
Project 2	60
Port Marine Operations	60
Orals Preparation	30
Total hours:	420

2. Course Outline for the Marine Transportation Course at the State University of New York Maritime College, USA.

Subjects	Credits (year1)	Credits (year2)	Credits (year3)	Credits (year4)
Principles of Economics	6			
English	6			
American Civilization	6			
Elements of Calculus	7			
Operations	3	3	3	
MMRCO	1			
Physical Education	2	2	1	
Business Computing	3			
Terrestrial Navigation	3			
Humanities		6		
Technical Writing		3		
Applied Macroecon. Policy		3		
Business Statistics		3		
College Physics		8		
Meteorology for Mariners		3		
Managerial Economics		3		
NACN		3		
Ship Construction and Stability		3		
Organizational Management			3	
Organizational Behavior & Development			3	
Financial Accounting			3	
Cargo Operations			6	
Basic Marine Engineering			3	
Marine Electronic Systems			3	
Collision Avoidance			2	
Elective			9	15
Analysis of the Marketing Process				3
Financial Management				3
License Seminar				2
Advanced Navigation				2
MMO				4
Seminar in SMBP or				3
Seminar in ETB				3
Operation Research				3
TOTAL	37	40	36	35

Note:

MMRCO = Merchant Marine Reserve Commissioning Orientation

NACN = Nautical Astronomy and Celestial Navigation

MMO = Naval Science for the Merchant Marine Officer

SMBP = Strategic Management/Business Policy

ETB = Economics of Transportation Business

Table E Course Outline for the Marine Transportation Course in USA

3. Course Outline in Japanese Maritime Education and Training at an University Level

Types	Subjects	Credits		
		Compulsory	Elective	Remark
Humanities	Philosophy		4	10 Credits are to be taken
	Ethics		4	
	Psychology		4	
	History		6	
	History of technology		4	
	Problems of science		4	
	Literature		4	
	Sentence-expression		4	
Social science	Economics	4	6	10 Credits are to be taken
	Jurisprudence	4	6	
	International law		2	
	Political science		2	
	Sociology		4	
	Geography		4	
Natural science	Mathematics		15	18 Credits are to be taken
	Physics		11	
	Chemistry		7	
	Astronomy		4	
Foreign languages	English	3	13	12 Credits are to be taken
	German	2	8	
	French	2	8	
Physical education		4		4 Credits
Fundamental	Applied mathematics		6	12 Credits are to be taken
	Statistics		2	
	Strength of materials		2	
	Fluid mechanics		2	
	Dynamics of ship motion	2		
	Basic electronics & engineering	2	2	
	Control theory		4	
	Applied chemistry		2	
	Information processing		2	
	Computer and computing	2		
Industrial psychology		2		
Professional	Celestial navigation	2	2	75 Credits are to be taken
	Costing and ship's routs	2		
	Navigation planning and routing		2	
	Sailing's in navigation	2		
	Electric navigation	2	2	
	Navigational aids	2	6	
	Electromagnetic wave engineering		2	
	Meteorology	2	2	

Professional	Ship maintenance	2	2	
	Ship handling	2	4	
	Calculation for ship stability	2		
	Cargo handling	2	2	
	Naval architecture	2	2	
	Marine casualties		2	
	Rules of the road	2	2	
	Marine public law	2		
	Law for seafarers	2		
	Marine sanitation		2	
	Marine engineering	2	8	
	General marine electric apparatus		2	
	Nuclear ship engineering		2	
	Oceanography		2	
	Ports and harbours planning		2	
	Shipping economics	4		
	Shipping management		2	
	Marine insurance		2	
	Maritime commercial law		2	
	Maritime labour		2	
	Maritime international law		2	
	International logistics		2	
	Marine traffic engineering		2	
	Physical distribution management		2	
	Business English		2	
	Science of fleet operation		2	
	Laboratory in navigation	2		
Exercise in seamanship	4			
Ship manoeuvring practice	1			
Sea training	10			
Graduation thesis	4			
Total credits		80	216	141
To be taken for graduation				141

Table F Course Outline in Japanese MET at an University Level

4. Course Outline of Maritime Education and Training in Denmark

Table G The Ship's Assistant Course

	Subjects	study hours
Module I 5 weeks	general subjects	10
	safety at sea	80
	safety at work	30
	watchkeeping duties	20
	seamanship	20
	marine technology	10
	first aid	10
	ship's cleaning	10
		Total: 190 hours
Module II 15 weeks	general subjects	15
	safety at sea	75
	safety at work	15
	fire fighting	15
	ship's machinery	45
	reading of drawing	30
	workshop practice	105
	ship's maintenance	120
	navigation, collision regulations	30
	seamanship	60
	marine technology	30
first aid	15	
		Total: 555 hours
	Subjects	study hours
Module III 13 weeks	safety at sea	65
	safety at work	26
	fire fighting	26
	ship's machinery	52
	workshop practice	104
	ship's maintenance	65
	navigation, Collision Regulations and radiotelephony	52
	seamanship	65
	first aid	26
	concluding tests	19
		Total: 500 hours
Total Module I, II and III: 1245 hours		

Table H The Watchkeeping Officer's Course

Subjects	study hours
navigation I, II	385
training vessel	26 (3 weeks)
radar simulator	24
ARPA simulator	24
seamanship	193
visual signalling	36
general operator's certificate (GMDSS)	102
meteorology	68
computers	42
English	108
mathematics	90
maritime law	12
fire fighting	18
safety at sea	15
watchkeeping duties I, II	141
hygiene	102
Total: 1486 hours	

Table I The Master's Course

Subjects	Study hours
navigation	112
training vessel	42 (1 week)
cargo handling and stowage	68
ship's stability I, II	165
manoeuvring of ship's	16
meteorology	85
advanced computer	42
ship's business I, II	148
personnel management	68
ship's machinery	68
Danish I, II	136
English I, II, III, IV	335
mathematics I, II	187
physics and chemistry I, II	170
electricity	51
electricity and digital techniques	166
maritime law I, II	148
fire fighting (leadership and instruction)	14
economics	85
watchkeeping duties	32
Total: 2138 hours	

5. Extracts from 1995 STCW Convention

A. Instructor qualification and experience

Section A-I/6 (STCW Code, Chapter I)

Training and assessment

1. Each Party shall ensure that all training and assessment of seafarers for certification under the Convention is:

.1 structured in accordance with written programmes, including such methods and media of delivery, procedures, and course material as are necessary to achieve the prescribed standard of competence; and

.2 conducted, monitored, evaluated and supported by persons qualified in accordance with paragraph 4, 5 and 6.

2. Persons conducting in-service training or assessment on board ship shall only do so when such training or assessment will not adversely affect the normal operation of the ship and they can dedicate their time and attention to training or assessment.

Qualifications of instructors, supervisors and assessors

3. Each Party shall ensure that instructors, supervisors and assessors are appropriately qualified for the particular types and levels of training or assessment of competence of seafarers either on board or ashore, as required under the Convention, in accordance with the provisions of this section.

In-service training and assessment

4. Any person conducting in-service training of a seafarer, either on board or ashore, which is intended to be used in qualifying for certification under the Convention, shall:

.1 have an appreciation of the training programme and an understanding of the specific training objectives for the particular type of training being conducted;

.2 be qualified in the task for which training is being conducted; and

.3 if conducting training using a simulator:

.3.1 have received appropriate guidance in instructional techniques involving the use of simulators, and

.3.2 have gained practical operational experience on the particular type of simulator being used.

5. Any person responsible for the supervision of in-service training of a seafarer intended to be used in qualifying for certification under the Convention shall have a full understanding of the training programme and the specific training objectives for each type of training being conducted.

6. Any person conducting in-service assessment of competence of a seafarer, either on board or ashore, which is intended to be used in qualifying for certification under the Convention, shall:

- .1 have an appropriate level of knowledge and understanding of the competence to be assessed;
- .2 be qualified in the task for which the assessment is being made;
- .3 have received appropriate guidance in assessment methods and practice;
- .4 have gained practical assessment experience; and
- .5 if conducting assessment involving the use of simulators, have gained practical assessment experience on the particular type of simulator under the supervision and to the satisfaction of an experienced assessor.

Training and assessment within an institution

7. Each Party which recognises a course of training, a training institution, or a qualification granted by a training institution, as part of its requirements for the issue of a certificate required under the Convention, shall ensure that the qualifications and experience of instructors and assessors are covered in the application of the quality standard provisions of section A-I/8. Such qualification, experience and application of quality standards shall incorporate appropriate training in instructional techniques, and training and assessment methods and practice, and comply with all applicable requirements of paragraphs 4 to 6.

B. Quality standards

Regulation I/8 (STCW Convention, Annex, Chapter I)

Quality standards

1. Each Party shall ensure that:

.1 in accordance with the provisions of section A-I/8 of the STCW Code, all training, assessment of competence, certification, endorsement and revalidation activities carried out by non-governmental agencies or entities under its authority are continuously monitored through a quality standards system to ensure achievement of defined objectives, including those concerning the qualifications and experience of instructors and assessors; and

.2 where governmental agencies or entities perform such activities, there shall be a quality standards system.

2. Each Party shall also ensure that an evaluation is periodically undertaken in accordance with provisions of section A-I/8 of the STCW Code by qualified persons who are not themselves involved in the activities concerned.

3. Information relating to the evaluation required by paragraph 2 shall be communicated to the Secretary-General.

Section A-I/8 (STCW Code A, Chapter I)

National objectives and quality standards

3. Each Party shall ensure that an independent evaluation of the knowledge, understanding, skills and competence acquisition and assessment activities, and of the administration of the certification system, are conducted at intervals of not more than five years in order to verify that:

.1 all internal management control and monitoring measures and follow-up actions comply with planned arrangements and documented procedures and are effective in ensuring achievement of the defined objectives;

.2 the results of each independent evaluation are documented and brought to the attention of those responsible for the area evaluated; and

.3 timely action is taken to correct deficiencies.

C. Standards regarding alternative certification

Section A-VII/1 (STCW Code A, Chapter VII)

Issue of alternative certificates

1. Every candidate for certification at the operational level under the provisions of chapter VII of the Annex to the Convention shall be required to complete relevant education and training and meet the standard of competence for all the functions prescribed in either tables A-II/1 or A-III/1 (Specification of minimum standard of competence for officers in charge of a navigational watch on ships of 500 gross tonnage or more; Specification of minimum standard of competence for officers in charge of an engineering watch in a manned engine-room or designated duty engineers in a periodically unmanned engine-room). Functions specified in tables A-II/1 or A-III/1 may be added provided the candidate completes, as appropriate, additional relevant education and training and meets the standards of competence prescribed in those tables for the functions concerned.

2. Every candidate for certification at the management level as the person having command of a ship of 500 gross tonnage or more, or the person upon whom the command of such a ship will fall in the event of the incapacity of the person in command, shall be required in addition to compliance with the standards of competence specified in table A-II/1 to complete relevant education and training and meet the standards of competence for all of the functions prescribed in table A-II/2 (Specification of minimum standard of competence for masters and chief mates on ships of 500 gross tonnage or more). Further functions specified in the tables of chapter III of this part may be added provided the candidate completes, as appropriate, additional relevant education and training and meets the standards of competence prescribed in those tables for the functions concerned.

4. Every candidate for certification at the support level in navigation or marine engineering shall comply with the standard of competence prescribed in table A-II/4 or A-III/4 of this part, as appropriate.

D. Use of simulators

Regulation I/12 (STCW Convention, Annex, Chapter I)

1. The performance standards and other provisions set forth in section A-I/12 and such other requirements as are prescribed in part A of the STCW Code for any certificate concerned shall be complied with in respect of:

- .1 all mandatory simulator-based training;
- .2 any assessment of competency required by part A of the STCW Code which is carried out by means of a simulator; and
- .3 any demonstration, by means of a simulator, of continued proficiency required by part A of the STCW Code.

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