Analysis of the maritime engineering education in India

Netaideb Mukhopadhyay

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MALMO, SWEDEN.

AN ANALYSIS OF THE MARITIME ENGINEERING
EDUCATION IN INDIA.

by

Netaideb Mukhopadhyay.
India.

A paper submitted to the Faculty of the World Maritime University in partial satisfaction of the requirements for the award of a Master of Science degree in Marine Education & Training (Engineering).

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

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AN ANALYSIS OF MARITIME ENGINEERING EDUCATION IN INDIA.

The Marine Engineering Education and Training in India had its formal beginning in 1935 on board the training ship "Dufferin".

As soon as the country became independent in 1947, one of the major decisions of the new government was to form the Merchant Navy Training Committee to identify, among other things, the means for the creation of an efficient cadre of Merchant Navy Officers required in the future for manning India's National Mercantile Marine.

Accordingly, in 1949, Government of India, in lieu of the Dufferin course, introduced the new Marine Engineering Course under the aegis of the Directorate of Marine Engineering Training at Calcutta and Bombay.

Nearly four decades since then, the world has witnessed tremendous advances in Marine Technology. Simultaneously, the Indian maritime scene too has undergone phenomenal transformation. In this context, manpower planning for the shipping, ship building, port and allied sectors assumes special significance, more so, the planning of training and nurture of maritime technological personnel.
In this paper, an attempt has been made to examine in broad terms, the quality of the technological manpower requirements (at officer or supervisory levels) of the marine industry in the coming decade. Quantitative estimation of manpower requirements was not included since it is susceptible to change from time to time.
Preface.

The Directorate of Marine Engineering Training (D.M.E.T.), Calcutta and Bombay, are the premier institutions which have been engaged in imparting marine engineering education and training in India. Ever since their inception, D.M.E.T. have continued to play their pivotal role as the industry's core sector in meeting the demand for best of engineering personnel.

I was selected by D.M.E.T., as one of its lecturers at Bombay, to join the World Maritime University at Malmo, Sweden, for a two year course in Marine Education and Training (Engineering), commencing from March, 1986. After completion of the course in December, 1987, I shall return to my institution in India to resume my teaching assignment.

One of the requirements of the Maritime Education & Training (Engg.) course is to submit a paper to the WMU faculty prior to completion of the course. Accordingly, this paper has been written to fulfil this requirement.

The topic of this paper, namely, "An Analysis of Maritime Engineering Education in India", has been chosen because, by my profession, I have been intimately connected with maritime engineering education and training in India for the last fourteen years. Moreover, during my two year stay in the WMU, I had ample opportunity to scrutinise the maritime engineering education and training systems in a number of developed countries in the world during my field trips.
The present paper has been divided into eight chapters. Chapter one outlines the maritime background of India in order to justify a careful study of manpower needs. Chapter two elaborates the chronological development of the maritime education system up to its present status. Chapter three compares the present education with the minimum requirements prescribed in S.T.C.W. 78.

Development of some courses in the light of requirements under S.T.C.W. 78 has been described in the chapter four. Chapter five highlights maritime education systems in some of the developed countries in the world. Chapter six brings out justification for the changes that should be incorporated in our system of maritime education.

Training of trainers has been discussed in the chapter seven. Chapter eight finishes with conclusions and recommendations.

Finally, if this paper is accepted by the WMU faculty and further, if the Government of India considers the recommendations favourably, it would give me great satisfaction that my time and efforts put in at the World Maritime University, have been well spent.
Acknowledgements.

In the preparation of this paper, I owe my gratitude and sincere thanks to all those who provided me with the encouragement, guidance and information and made it possible for me to complete this paper.

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- My family, who have put up with the hardship of a prolonged separation and provided the support and encouragement to make it possible for me to pursue my studies at W.M.U.
Chapter I

MARITIME BACKGROUND OF INDIA.

1.1 : Location and History :

Geographically, India is set midway between the eastern and the western world and extends between 8°4' to 37°6' north and 68° 7' to 97° 25' east. The Republic of India, Asia's second largest country after China, fills the major part of the Indian subcontinent which it shares with Pakistan, Nepal, Bhutan and Bangladesh. This includes the Andaman and Nicobar Islands in the Bay of Bengal and Lakshadweep in the Arabian Sea.

According to provisional 1982 figures, the total area is 3,286,299 Sq.Km. and the total boundary length is 15,098 Km. She is bounded on the west by the Arabian Sea, on the south by the Indian Ocean and on the east by the Bay of Bengal. Thus she is bestowed with an extensive coast line of 5,700 Km. studded with numerous ports. (Ref. Fig. 1.)

Blessed with these natural advantages, India's maritime activities began as early as 3000 B.C. Historical evidence shows that even during the Buddhist period, i.e., over 2000 years ago, ship building in India had reached a high stage of development.

In the centuries that followed, India built ships in large numbers which enabled her to develop and
Fig. I  Map of India

Source: crldmark Encyclopedia of the Nations.
Vol. 4, p. 85.
maintain seaborne commercial and cultural contacts with far flung countries of the Red Sea and Egypt in the west and Indonesia, Malaya, Burma, Indo China and beyond in the east.

With the loss of the country's freedom, on the one side, and advent of steam and motor ships on the other, Indian shipping received a grievous setback and became almost extinct.

Early in the 20th. century, serious efforts were made by patriotic Indians like Mr. Narottam Morarjee, Mr. Walchand Hirachand, Mr. R. Pillay, etc. to revive the national shipping, but they were of little avail due to the fierce competition from foreign vested interests.

1.2 : Indian Ports:

India thus with her glorious past and a bright future as a maritime nation, has on her vast coastline numerous ports which play a vital role in the economic development of the nation. These ports serve as gateways for international trade of this maritime country.

Depending upon the national importance of various ports and the extent of facilities available, these ports have been classified as major, intermediate and minor ports. The overall control of ten major ports is vested in the central government by forming Port Trusts. The sixteen intermediate and seventy-nine minor ports are under the effective control of respective maritime state governments.
Major Ports: Bombay, Calcutta, Cochin, Kandla, Madras, Mormugao, New Mangalore, Paradip, New Tuticorin and Visakhapatnam.

Intermediate Ports: Bedi, Bhavnagar, Calicut, Kakinada, Karwar, Mandvi, Nagapattinam, Navelkhi, Okha, Porbander, Pondicherry, Ratnagiri, Salaya, Sikka, Tuticorin and Veraval.


The names of various major, intermediate and minor ports are given in Table 1, and their locations in Fig. 2.

All the major ports are provided with requisite infrastructure and various facilities for round-the-clock berthing, dry-docking, handling of container cargo and passenger traffic, oil discharging, bunkering, storage, dredging, adequate cargo handling equipment, etc. for quick turnaround of ships.

Under the Five Year National Development plans of the country, modernisation and improvements of various facilities in the ports in the perspective of the country's integrated sea transportation requirements have been going on.

On the basis of detailed traffic forecasts, made on the strength of extensive economic studies, articulated Master Plans for various ports are being finalised for the balanced development in the next fifty years with due regard to the needs of the new modes of marine transportation such as use of large bulk carriers, container vessels, LASH, etc.

Thus we observe a rapid quantitative as well as qualitative change in the development of Indian ports. In the post-independent era, during the late forties, there were five major ports with an annual traffic of the order of twenty million tonnes. But today we have ten major ports with a traffic of over one hundred million tonnes.
From a meagre permissible draft of 8.5 metres, the water depth available at present at many of the Indian ports enable giant tankers and ore-carriers to berth alongside.

From limited cargo handling capacity with berths fitted with 3 to 5 tonne wharf cranes, we are now provided with container-handling arrangements comparable with any overseas container terminal, general cargo berths capable of handling all kinds of cargoes, and highly sophisticated bulk loading-unloading facilities for crude oil, petroleum products, iron ore, rock phosphate, coal, fertilisers etc.

1.3 : Indian Shipping:

The Indian owned tonnage at the outbreak of the Second World War was only about 1,250,000 gross tonnes which became hardly 1,920,000 GRT on the eve of her independence. This was barely adequate to meet the requirements of a country of the size of India.

The government appointed in 1945 the Reconstruction Policy Sub-Committee on Shipping, which submitted its report in 1947. The main recommendations of this Committee were that the entire coastal trade, 75% of the nearer and adjacent trades and 50% of the distant trades should be secured for national shipping.

The government accepted these recommendations and endorsed the views of the Committee that India must adopt a dynamic shipping policy for quick
augmentation of her tonnage.

After the attainment of independence, the progress of Indian shipping has been appreciably fast. The development of Indian shipping became an accepted objective of the state policy. The government had since taken several steps to assist the growth of Indian shipping.

The most important of these steps included creation of the Directorate General of Shipping to provide a separate specialized setup of the government for quick and efficient handling of shipping problems; enhancement of limit of foreign participation in the Indian shipping industry from 25% to 40%, establishment of training institutions for the training of nautical and engineering officers; setting up of a 'Shipping Development Fund Committee' to provide loans to the Indian shipping companies for acquisition of tonnage at concessional rates of interest.

Ever since the promulgation of the Five Year Plans in 1951, shipping has been included in the plan provisions and its expansion is governed by the targets and financial allocations made therein.

Indian shipping thus made a remarkable progress from the tonnage of 3,723.780 GRT. with 94 ships dated 1st April 1951 to 6,270.000 GRT. having 427 ships till date, thus holding fifteenth position among principal merchant fleets of the world and carrying 1.4% cargo as relative percentage share of world merchant fleets.
An additional 0.94 million GRT, comprising of 59 ships are on firm order. The Indian fleet of the late forties had consisted in coal or fuel fired, reciprocating steam engine driven dry cargo ships, not exceeding 5000 GRT, in size. But the present fleet is almost entirely Diesel Engine driven and comprises vessels of different types and sizes as shown in Table 2.

It is hopefully expected that in near future other types of ships like fully containerized vessels, gas carriers, chemical tankers, Ro-Ro types are going to be added to the fleet. As per national estimation, the Indian fleet is expected to grow at an average rate of 200,000 GRT, per annum with allowance for writing off obsolete tonnage.

1.4 Ship Building in India:

The government have taken necessary steps to develop the ship building industry in the country. The ship building yard at Visakhapatnam established in 1941 became a public sector concern since 1952 and is named as Hindustan Shipyard Ltd. The first India-built cargo ship "Jala Usha" was completed and launched in 1948.

This shipyard can now build ships of size up to 30,000 DWT on any of the four berths of the yard, all "Panamax"/Bulk carrier type. The total building capacity is 3 General Cargo/Pioneer Type ships each of 21,500 DWT per year. The ships so far built cover a wide range from ocean going
### Table 2.

**Present Fleet of Indian Shipping.**

<table>
<thead>
<tr>
<th>Type</th>
<th>Nos.</th>
<th>Total GRT</th>
<th>Av. GRT Vessel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oa) Large Oil Tankers</td>
<td>32</td>
<td>1,389,451</td>
<td>43,420</td>
</tr>
<tr>
<td>Ob) OBOs</td>
<td>17</td>
<td>853,022</td>
<td>25,445</td>
</tr>
<tr>
<td>Ec) Bulk carriers</td>
<td>67</td>
<td>1,704,826</td>
<td>25,445</td>
</tr>
<tr>
<td>Rd) Tramps</td>
<td>56</td>
<td>585,537</td>
<td>10,456</td>
</tr>
<tr>
<td>Se) Liners</td>
<td>156</td>
<td>1,419,311</td>
<td>9,098</td>
</tr>
<tr>
<td>Ef) Cargo-Pass.Vessels</td>
<td>3</td>
<td>34,376</td>
<td>11,459</td>
</tr>
<tr>
<td>Ag) Container Vessels</td>
<td>3</td>
<td>8,874</td>
<td>2,958</td>
</tr>
<tr>
<td>Sh) Dry Cargo</td>
<td>41</td>
<td>104,390</td>
<td>2,522</td>
</tr>
<tr>
<td>Cj) Tankers</td>
<td>18</td>
<td>187,814</td>
<td>10,434</td>
</tr>
<tr>
<td>Ok) Pass- Cargo</td>
<td>13</td>
<td>35,974</td>
<td>2,767</td>
</tr>
<tr>
<td>Al) OPSSVs</td>
<td>24</td>
<td>26,910</td>
<td>1,121</td>
</tr>
</tbody>
</table>

cargo liners to all types of specialised crafts.

Another shipyard was set up by the government in 1976 at Cochin. The shipyard is capable of building about two ships a year of the size 85,000 DWT each "Panamax" type Bulk Carriers.

There are four other public sector shipyards namely Mazagon Dock Ltd. Bombay, Garden Reach Shipbuilders and Engineers Ltd. Calcutta, Goa Shipyard Ltd. Goa and Rajabagan Dockyard Ltd., Calcutta.

The Mazagon Dock, originally a British-owned repair farm in Bombay, is now a well-equipped modern shipyard, capable of building ships up to 27,000 DWT including passenger-cum-cargo ships, dredgers, off-shore supply vessels, trawlers, and destroyers, fregates, submarines, etc., mainly to cater to the needs of the Indian Navy.

The Garden Reach S.E.Ltd., another British-owned ship repair facility, in Calcutta, is now equipped for building ocean going vessels up to 28,000 DWT. in addition to its capacity for building several smaller sized vessels, dredgers, survey ships, drill ships and naval crafts for Indian Navy. They are also manufacturing several items of deck machinery.

The Goa Shipyard is engaged in ship building and ship repairs in addition to other general engineering works.

The Rajabagan Dockyard under Central Inland Water
Transport Corpn. Ltd., under Ministry of Transport has been engaged in Calcutta in building inland vessels and harbour crafts up to the capacity of 3000 gross tonnage.

There are also several small shipyards under private sector spread all over the country which are capable of constructing harbour crafts and inland vessels such as tugs, barges, dredgers, trawlers, etc.

Today our ship building output is of the order of 120,000 GRT. per annum and the technology employed is quite modern.

1.5 : Ship Repairing, Dry-docking & Ancillary Industries:

The growth of Indian shipping during recent years has brought to the light the need for expansion of ship repairing and dry-docking facilities in the country to ensure the efficient and economic maintenance of ships. Besides, the ship repair industry has potential capacity to directly earn and indirectly save foreign exchange.

Owing, however, to various factors such as lack of indigenous materials, stores and equipment and restrictions, etc., the existing repair facilities in the country are inadequate to meet the needs of India's fast growing Merchant Navy. As a result, Indian ships are often obliged to go to foreign ports for carrying out surveys and repairs involving huge foreign exchange expenditure.
The fast growth of Indian shipping during recent years has led to increased demand for dry-docking facilities at Indian ports. There are at present fifteen dry docks: 6 at Bombay, 6 at Calcutta, 2 at Visakhapatnam and 1 at Cochin, available in the country.

Apart from the major ship building yards in the public sector, as mentioned earlier, which also undertake ship repairing activities, there are over 80 other ship repairing yards scattered all over the country which are mostly in the private sector.

The development of ship building industry pre-supposes the production of necessary materials, stores and ancillary equipment. Government of India appointed in 1957 an Advisory Committee to advise on the steps to be taken to encourage indigenous manufacture of marine machinery, material, stores and equipment.

With a view to ensuring prompt action on the recommendations made by the Ship Ancillary Industries Committee and to accelerate the development of ship ancillary industries and ship repair industry in the country, the government set up an Implementation Committee in the Ministry of Shipping and Transport. A technical development cell comprising three major public sector shipyards was set up in order to codify, categorize and standardise various items of ship's machinery, stores and equipment, thus facilitating phased programme for
indigenous manufacture of such items.

As a result of the useful work done by the Technical Development Cell, the position regarding availability of several items including main propulsion engines, winches, windlasses, boat davits, fibre glass life boats, hatch covers, etc., from indigenous sources has considerably improved.

1.6 : Off-Shore Activities :

A major development of recent origin is the growing off-shore petroleum industry which requires sufficient maritime support in the form of storage and transportation tankers, drill ships, supply and support vessels, etc.

India’s crude oil production for the last twelve years or so by exploiting and exploiting ocean resources has been quite significant for the country’s economy.

With the highly fluctuating price level in a world of crude oil, India’s position is not very enviable though. India accounts for about 0.5% of the world’s proven resources of crude oil, about 0.8% of world imports, about 1% of production and about 1.3% of world consumption.

So we are in no position to influence world production, consumption or price. But for our economic development, energy is crucial, and our oil and its products account for 53% of our commercial energy consumption and thus play a major role in
our energy sources. (Coal and electricity are the other two sources.)

Our own production of oil increased significantly in the early eighties with the Bombay High off-shore discoveries, though we still import about 38% of our needs of petroleum products until the end of the seventh plan. It is estimated that our oil production will increase to 46.5 million tonnes by 1990, of which off-shore production will be 31.3 million tonnes and this would make the country largely self-reliant in oil.

1.7: Classification Society:

Like most of the principal maritime countries, India, having made considerable progress in shipping and other related fields like ship building, designing and marine hull insurance, etc., decided to initiate her own classification society. Accordingly, Indian Register of Shipping was registered on 25th March, 1975 at Bombay.

In view of the above position of India as a maritime country, it is imperative that the mobilisation and development of human resources which are to operate, maintain in efficiency, build, manage and co-ordinate our maritime activities, constitute a basic task which calls for careful study and constant review.
2.1: Introduction: It has been an established fact that no merchant navy can ever promote the best interests of the nation unless it is manned by the nationals of the country as executive officers, engineer officers and seamen. It is these very officers who, in the times of emergencies, have to assist in protecting the country.

Furthermore, there are a number of such officers and seamen who are required to render essential services to the shipping industries as ship surveyors, marine superintendents, technical advisors, pilots, harbour masters, dock masters, cargo surveyors, port officers, etc. Shipping thus provides vast opportunities for the trained sea personnel to find expression in highly technical and specialised fields of national activities and sea personnel become one of the most vital and precious assets of any maritime country.

One of the most important lessons which the First World War brought home to the maritime nations of the world was that it was their paramount duty to preserve and develop their sea power. It was generally recognised that the building up of an adequate and efficient sea personnel was as essential for the acquisition of sea power as the development of the merchant navy. The position of particularly all the third world countries, including
India, then was that they were maritime nations without any mercantile marine worth the name. Neither did they possess a merchant navy, nor any facilities for the training of officers and engineers who could man ships.

Even before the end of the First World War, a strong demand was made in the Indian legislature, urging upon the then government to recognise their responsibilities both for the development of national shipping and for the building up of national sea personnel. As a result, a committee called the Indian Mercantile Marine Committee was appointed in 1923.

The Committee submitted its report in 1924 and made categorical recommendation supporting the establishment of a training ship. It was recognised from the very start that the training ship was to become a special institution for enabling Indians to qualify for a career at sea. The able advocacy of the case won full support and the principle for the establishment of a training ship in Indian waters was unanimously accepted by the government.

2.2 : Training Ship, Pre-Sea Training of Officers:

A Training Ship, the "Dufferin", anchored in the bay off Bombay, was thus established on the 1st. December, 1927 and it started its first course with 30 cadets recruited from various parts of India. The emphasis then was mainly on establishing pre-sea training facilities for navigating officers leading to Indians eventually becoming
masters / captains of ships.

With the passage of time and as more and more experience was gained, those at the helm of affairs realised that it was not just enough to train navigating officers only, and that it was equally important to ensure that suitable training facilities were available for all categories of sea personnel.

The Marine Engineering Training in India eventually had its modest beginning, a little over fifty years ago, in January, 1935, when the first batch of 25 engineering cadets joined the training ship Dufferin.

It started as a six year training programme with half the time spent in the training ship and the remaining period spent in a marine workshop at Calcutta / Bombay. During apprenticeship the trainees had to attend technical classes in the Victoria Jubilee Technical Institute at Bombay and Calcutta Technical School at Calcutta. The entry qualification was secondary school level or matriculation and permissible age was about fourteen years.

2.3 : Merchant Navy Training Committee :

The annual requirement of trained cadets was, in the early years, comparatively small in view of the then Indian owned tonnage. With the gradual increase and increasing requirement of trained Indian Merchant Navy Officers, not only on board
ships, but also to fill the various technical posts ashore which were then being held by expatriates, it became obvious to the authorities that the limited facilities on the training ship Dufferin could not possibly meet the overall demand of the expanding shipping industry and the shore-based establishments.

Added to this was a lack of any post-sea training facilities for both deck and engineer officers. The authorities, therefore, decided to set up a Merchant Navy Training Committee with both the government and the ship owners being represented in it.

This committee was appointed in 1947 with its Secretary as Mr. C.P. Srivatsava, who was then in the Ministry of Commerce of the government of India, the Ministry which then looked after shipping. This committee was given broad terms of reference which included an examination of the availability of maritime personnel (navigating officers, engineer officers, deck and engine room crew) in the context of the Indian tonnage then available and a future projection, based on the planned expansion of Indian shipping. It can be emphatically stated that the seeds for the future training of maritime personnel in India were sown by this august committee.

2.4 : Recommendations of the committee:

The recommendations made by this committee included the following: 1. Formation of a Merchant
Navy Training Board.

2. Establishment of a Nautical & Engineering College to provide post-sea training facilities to both deck and engineer officers preparing for their professional examinations.

3. Introduction of direct apprenticeship scheme for both navigating and engineering branches and prescribing of minimum age and educational qualifications for direct apprentices.

4. Establishment of a shore based residential pre-sea training institution for marine engineers.

5. Reduction in the duration of total training period on the T.S. Dufferin from three to two years and an upward revision in the age limit and basic educational qualifications with emphasis on Mathematics and Physics.

6. Conduct of examination for issue of Certificates of Competency to sea-going officers.

7. Introduction of coaching facilities and examination for issue of Extra-Master and Extra-First Class Certificates to deck and engineer officers respectively.

8. Introduction of correspondence courses for apprentices serving their time at sea.

The recommendations made by this committee were accepted by the government and steps were taken to implement these in full measure.

2.5 Merchant Navy Training Board:

A Merchant Navy Training Board was set up in the year 1959 by the government of India. The board is reconstituted every two years.
All interests connected with the training of merchant navy personnel and the development of shipping are represented on it including members of Parliament, shipowners, merchant navy officers, seamen, Chambers of Commerce, port trusts, besides technical officers and the heads of maritime institutions. The Secretariate for the board is provided by the Directorate General of Shipping in Bombay.

The board is an advisory body and its function is to consider all matters pertaining to the training of merchant navy officers, ratings and other seagoing personnel; supervise the training imparted in the training institutions and recommend, from time to time, such measures as may be necessary for the building up of an adequate, efficient and devoted merchant navy personnel.

2.6: Nautical & Engineering College. Post-Sea Training:

Lal Bahadur Shastri Nautical & Engineering College was set up in Bombay in 1948 as per one of the recommendations made by the Merchant Navy Training Committee.

The college is the only one of its kind in India. The students trained here not only man the merchant ships of the country but are also in demand in many leading countries. A number of candidates from neighbouring countries also avail themselves of the facilities provided in the college.
A hostel attached to the college provides residential accommodation for about one hundred students. The college initially offered post-merit instruction both in navigation and engineering departments to candidates preparing for the various certificates of competency examinations conducted by the ministry dealing with shipping.

Table 3 shows the list of full time courses presently conducted in the navigation department. In the Engineering discipline, students used to be enrolled for the following courses:

1. Second Class Part A & Part B
2. First Class Part A & Part B
3. Endorsement Certificates

At present, courses for the engineering discipline have been discontinued. Regular classes are no longer held and faculty members in the engineering department are conspicuous by their absence. Thus the post-sea training facility for marine engineers in India is virtually non-existent at present.

2.7: Directorate of Marine Engineering Training:

Pre-sea officers training in Engineering:

One of the recommendations made by the Merchant Navy Training Committee was the establishment of a shore-based residential pre-sea training institution for marine engineers.

Following their decision to separate the engineering branch from Training Ship Dufferin in 1948,
Full-time courses: - \((\text{Nautical College, Bombay})\).

i. Master Foreign-going.
ii. First Mate Foreign-going.
iii. Second Mate Foreign-going.
iv. Master Home Trade.
v. Mate Home Trade.
vi. Skipper Fishing.
vii. Second hand Fishing.
viii. Radar Observer's course.
ix. Life Boat Training.

x. Specialised course on Tanker safety.

Additional courses:

a. Survival at Sea.
b. Proficiency in Survival Crafts.
c. Radar Simulator.
d. Electronic Navigational Aids.
e. Automatic Radar Plotting Aids.
f. Radio Telephony.
g. Radio Maintenance.
marine engineering training and expanded institution came into existence in early years of the post-independent India. The entire course of four years in this Institution was residential, and on successful completion of the course, the trainees were to take up careers as Engineer Officers in the merchant marine.

3. Other maritime training institutions in India

The first Indian Institute of Technology, was set up at Kharagpur in 1950 which offers a five-year degree course in Naval Architecture to start with.

The Indian Navy established Naval College of Engineering at I.N.S. Shivali in Lonavla near Bombay to train their own engineer officers in 1959.

Narottam Nararjee Institute of Shipping was set up in 1969 under the joint auspices of the government of India and the Indian shipping companies for training persons in Commercial Shipping and conducting professional examinations in various subjects in Commercial Shipping.

During the seventies a number of engineering institutes came into existence, namely, the Waltair Engineering College at Vishakapatnam, the University of Cochin and the Indian Institute of Technology at Madras. These institutes offered degree
The Shipping Corporation of India started a training department in 1973 which flourished into SCI Maritime Institute to offer specialised short courses to its own maritime personnel.

It may be pointed here that the main impetus on the part of government of India has been throughout the time to prepare marine engineers for the sea-going profession only.

9: Sources Of Engineers For Sea-Going Profession:

The Directorate of Marine Engineering Training (D.M.E.T., for short) remains the core sector in supplying the largest number of marine engineers to the national shipping. Apart from these, there exist two other parallel channels of entry to the marine engineering profession:

1. The general apprentices in various marine workshops, after completion of their five years apprenticeship and on passing the Part A of Second Class Certificate Examination, constitute the bulk of "traditional entry".

2. Graduate Engineers in Mechanical or Electrical Engineering from universities / technological institutions, with certain period of apprenticeship in marine workshops, are eligible to join ships as marine engineers.

These two sources are tapped in different propor-
tions to get a cushioning effect in manpower requirement. In addition to the four year residential course at D.M.E.T., a one year special industry oriented course for graduate engineers in Mechanical/ Electrical Engineering was introduced in 1980 till 1984 as a temporary measure.

The entire bulk of the maritime personnel who take up engineering as a seagoing profession, come from the above three sources and they start their career from the same platform as junior engineers on board ships.

2.10: Shortcomings of Pre-Sea Training:

The biggest handicap for those marine engineers who do not come through D.M.E.T. is that there is no proper pre-sea training facility for them.

Particularly, for the marine engineers who come from the traditional entry channel, it is a long story of self-coaching and "trying of luck" for clearing the Part A of Second Class Examinations.

Even for the mechanical engineering graduates who get complete exemption in Part A of Second Class and Part A of First Class Certificate Examinations and electrical graduates, who have partial exemption, have no scope to get familiarised with certain aspects of basic maritime training dealing in life saving appliances, fire prevention and control, survival at sea, etc.

Like in many other countries, the rules relating
2.11: Progress of Marine Engineering Training Under D.M.E.T.: 

As D.M.E.T. began to function after its establishment in 1949 with a batch of engineering trainees shifted from Training Ship Dufferin, there have been many changes since then.

The first change was that the training period was reduced to four years from six years. The admission level was raised at par with entry into university engineering colleges (Intermediate in Science or equivalent). The course content in theoretical subjects was substantially upgraded.

It was still an apprenticeship training in engineering with evening and day classes in the college on two days in a week and Saturday. During the first three years of training, the trainees were attached to marine workshops for apprenticeship training. In the fourth year, they received full time training in the college in classroom instructions as well as practicals in college laboratories, workshop and power house.

Since it was generally agreed that a marine engineer has necessarily to be a highly practical hand to deal in any eventuality concerning repairs on the ship's hull or its machinery, the practical component in the training is that of theoretical
introducing a reoriented pattern of training from September, 1977.

The development of Indian shipping, which witnessed its heydays during late sixties with substantial progress in maritime technology, necessitated a change in the training programme. Besides, it was felt that there was a good deal of idle time which the trainees had to undergo during their training in marine workshops.

The reoriented pattern of training had the following changes:

1. During the first year, full time class room lectures along with laboratories and practicals are held in the college, in order to form an uniform base both in theoretical and practical aspects of the training.

2. During the second and third years, apprenticeship training in marine workshops are arranged along with theoretical classes in the college, alternating in equal spell of time like a sandwich pattern.

3. During the final year, full time class room lectures and laboratories in the college and practicals in the college workshop and powerhouse are held.
4. The course content was re-adjusted by introducing new subjects so that the theoretical instructions to practicals were in the proportion of 1:1.

D.M.E.T. till this time was offering only a passing out certificate to successful trainees on completion of training. This certificate was not nationally recognised and was valid only for Ministry of Transport Certificate Examination.

This had, naturally, created dissatisfaction among the trainees. Similar training courses in Great Britain and elsewhere were receiving exemptions in theoretical subjects in Statutory Certification Examinations. Finally the Administration granted recognition in way of exemption in Part A examinations of Second Class and First Class Certificates to D.M.E.T. Certificate from 1975.

The D.M.E.T. course continued to move more towards a theoretical bias to upgrade the training at par with an engineering degree standard. But a degree or diploma could not be awarded because of practical difficulties.

Ultimately D.M.E.T. approached the Ministry of Education in 1978 to recognise its 4 year course as equivalent to B.Tech. in Marine Engineering. Upon introduction of a revised curriculum based on the suggestion of an expert committee, appointed by the government, the recognition materialised from the session 1983.
D.M.E.T. certificate was also granted recognition by the Institute of Engineers, India, as an exempting qualification from their Part A and Part B Examination from 1982.

The subjects covered in D.M.E.T. four year training programme are listed in Table.4.
LIST OF SUBJECTS

Humanities & Social Sciences

HSS 101 English
HSS 102 German
HSS 103 French
HSS 304 Management Science
HSS 405 Economics & Commercial Geography
HSS 406 Civil Operation Management

Basic Sciences

BS 101 Mathematics I
BS 202 Mathematics II
BS 303 Numerical Analysis & Computer Programming
BS 104 Basic Thermodynamics
BS 205 Basic Electronics
BS 106 Basic Electricity
PS 107 Geometrical Drawing

Table: 4
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>ES 101</td>
<td>Applied Mechanics I</td>
</tr>
<tr>
<td>ES 202</td>
<td>Applied Mechanics II</td>
</tr>
<tr>
<td>ES 303</td>
<td>Mechanics of Machines I</td>
</tr>
<tr>
<td>ES 404</td>
<td>Mechanics of Machines II</td>
</tr>
<tr>
<td>ES 105</td>
<td>Strength of Materials I</td>
</tr>
<tr>
<td>ES 206</td>
<td>Strength of Materials II</td>
</tr>
<tr>
<td>ES 307</td>
<td>Strength of Materials III</td>
</tr>
<tr>
<td>ES 108</td>
<td>Material Science I</td>
</tr>
<tr>
<td>ES 209</td>
<td>Material Science II</td>
</tr>
<tr>
<td>ES 110</td>
<td>Workshop Technology</td>
</tr>
<tr>
<td>ES 211</td>
<td>Applied Electricity</td>
</tr>
<tr>
<td>ES 312</td>
<td>Electrical Machines I</td>
</tr>
<tr>
<td>ES 413</td>
<td>Electrical Machines II</td>
</tr>
<tr>
<td>ES 314</td>
<td>Electronics Circuits</td>
</tr>
<tr>
<td>ES 215</td>
<td>Applied Thermodynamics I</td>
</tr>
<tr>
<td>ES 316</td>
<td>Applied Thermodynamics II</td>
</tr>
<tr>
<td>ES 317</td>
<td>Mechanics of Fluids</td>
</tr>
<tr>
<td>ES 418</td>
<td>Dimension Analysis and Fluid Machines</td>
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<tr>
<td>ES 219</td>
<td>Engineering Drawing</td>
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Table: 4
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>MAR 201</td>
<td>Marine Auxiliary Machinery I</td>
</tr>
<tr>
<td>MAR 202</td>
<td>Marine Auxiliary Machinery II</td>
</tr>
<tr>
<td>MAR 203</td>
<td>Marine Auxiliary Machinery III</td>
</tr>
<tr>
<td>MAR 204</td>
<td>Marine Boilers</td>
</tr>
<tr>
<td>MAR 205</td>
<td>Marine Steam Engineering</td>
</tr>
<tr>
<td>MAR 206</td>
<td>Marine Internal Combustion Engineering I</td>
</tr>
<tr>
<td>MAR 207</td>
<td>Marine Internal Combustion Engineering II</td>
</tr>
<tr>
<td>MAR 209</td>
<td>Ship Life Saving Appliances</td>
</tr>
<tr>
<td>MAR 210</td>
<td>Ship Fire Prevention &amp; Control</td>
</tr>
<tr>
<td>MAR 211</td>
<td>Ship Construction I</td>
</tr>
<tr>
<td>MAR 212</td>
<td>Ship Construction II</td>
</tr>
<tr>
<td>MAR 313</td>
<td>Naval Architecture I</td>
</tr>
<tr>
<td>MAR 314</td>
<td>Naval Architecture II</td>
</tr>
<tr>
<td>MAR 315</td>
<td>Marine Engineering Drawing &amp; Design</td>
</tr>
<tr>
<td>MAR 316</td>
<td>Marine Machinery System Design</td>
</tr>
<tr>
<td>MAR 317</td>
<td>Marine Electrical Technology</td>
</tr>
<tr>
<td>MAR 318</td>
<td>Marine Control Engineering &amp; Automation</td>
</tr>
<tr>
<td>MAR 319</td>
<td>Marine Heat Engines &amp; Applied Thermodynamics</td>
</tr>
</tbody>
</table>

*included with 210

Table 4
Laboratories & Practicals

PR 101  Boiler Chemistry Lab.
PR 102  Electrical Lab.
PR 203  Electronics Lab. I
PR 404  Electrical Machines Lab.
PR 105  Applied Mechanics Lab.
PR 106  Applied Heat Lab.
PR 306  Electronics Lab. II
PR 409  Controls & Simulator Lab.
PR 210  Fire Fighting Practicals.
PR 111  Materials Lab.
PR 412  Marine Practicals & Power Plant Operation
PR 113  Workshop Diaries I
PR 214  Workshop Diaries II
PR 315  Workshop Diaries III
PR 116  Workshop Practicals I
PR 217  Marine Practicals I (Marine W/shops 2nd Year)
PR 318  Marine Practicals II (Marine W/shops 3rd Year)

Table: 4
Chapter III

ANALYSIS ON COMPLIANCE OF PRESENT EDUCATION WITH S.T.C.W.78.

3.1: Introduction:

The International Convention on Standards of Training, Certification and Watch-keeping for Seafarers, 1978 (S.T.C.W.78), which has already entered into force on 28th April, 1984, has been one of the major breakthroughs in the recent maritime history.

Investigations of a number of shipping casualties have revealed that human error has been the major factor in such occurrences despite the fact that these ships were fitted with highly developed navigation equipment. A definite correlation has been observed between safe manning of ships and quality of officers.

Every year about 380 ships grossing about one million and a half tonnes are lost through accidents at sea, and an even greater number of ships are severely damaged. While loss of life and property is the most serious result of maritime casualties, no less important are pollution hazards from oil, chemicals and other toxic materials.

With a view to minimising the factor of human error, education and training of maritime personnel play a pivotal role. Thus, recognising the cause and for-
mulating the minimum standards of education and training in the S.T.C.W.78, it would improve the overall standards of education and training of the seafarers on a global proportion. It is undoubtedly a very timely and praiseworthy achievement by the I.M.O. to account for their overall objective of "Safer Shipping and Cleaner Oceans" through higher standards of education and training of seafarers.

India has ratified this convention in February, 1985.

"The general obligations under the convention", to quote, "contained in Article I are:

1. "The parties undertake to give effect to the provisions of the Convention and the Annex thereto which shall constitute an integral part of the Convention. Every reference to the Convention constitutes at the same time a reference to the Annex.

2."The parties undertake to promulgate all laws, decrees, orders and regulations and to take all other steps which may be necessary to give the Convention full and complete effect, so as to ensure that, from the point of view of safety of life and property at sea and the protection of the marine environment, seafarers on Board ships are qualified and fit for their duties."

3.2: The Mandatory Requirements:

The mandatory minimum requirements, in order to comply with the Convention, are contained in the Annex Regulations. They are divided into six chapters, in which Chapter III: Engine Department (Regulations III/1 to III/5) is relevant to the
Since it is mentioned earlier, in section 2.6, that there is no provision for post-sea engineering training facility in India at present, and in section 2.10, that the Directorate of Marine Engineering Training (D.M.E.T. for short) is the only pre-sea training establishment, an analysis is made in Table 5, which summarises the compliance by training courses at D.M.E.T. with the mandatory minimum requirements of the Convention.

Table 5. Compliance by D.M.E.T. with the Mandatory Minimum Requirements of S.T.C.W.78:

<table>
<thead>
<tr>
<th>Annex Regulations</th>
<th>Engine Department</th>
<th>Compliance/Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>III/1. Basic principles to be observed in keeping an Engineering Watch.</td>
<td>The course is not covered considering it to be relevant to post-sea experience. Need to develop and introduce the course.</td>
<td></td>
</tr>
</tbody>
</table>

III/2. Mandatory Minimum Requirements for Certification of Chief Engr. Officers & Second Engineer Officers on ships powered by Main Propulsion machinery of 3000 K.W. propulsion power or
1. Every Chief and 2nd. Engr. Officers shall hold an appropriate Certificate.

2. Every candidate for Certification shall:

(a) satisfy the Administration as to medical fitness, including eyesight and hearing;

(b) meet the requirements for certification as an engineer officer in charge of a watch or as Second or Chief Engineer Officer.

(c) have attended an approved practical fire fighting course;

(d) have passed appropriate examination to the satisfaction of the Administration.

Such examination shall include the material set out in the Appendix to this Regulation.

3. Training to achieve the necessary theoretical knowledge & practical experience shall take into account relevant

For action by Administration.

For action by Administration.

For action by Administration.

Need to develop this course & to install necessary equipment.

For action by the Administration.

Not adequate. To be included, as proposed, in various subjects under relevance.
international regulations and recommendations.

4. The level of knowledge required under different paragraphs of Appendix may be varied according to whether the certificate is being issued at chief or second engineer officer level.

Appendix to Regulation III/2:

1. Regarding syllabus for examination of candidates for certification of chief or second engr. officers of ships having 3000 kw. propulsion power or more & testing candidate’s ability for safety operation of ship’s machinery.

2. Regarding discretion granted by the Administration for omission of knowledge for candidates on various types of propulsion machinery.

3. Every candidate shall possess theoretical knowledge in the following subjects:
   (a) thermo-dynamics and heat transmission.

Total compliance.
(b) mechanics and hydro-mechanics.
(c) operational principles of ship's power installation (diesel, steam and gas turbines) and refrigeration.
(d) physical & chemical properties of fuels and lubricants.
(e) technology of materials.
(f) chemistry & physics of fire & extinguishing agents.
(g) marine electro-technology, electronics & electrical equipment.
(h) fundamentals of automation, instrumentation & control systems.
(i) Naval Arch. & ship constrn. Damage control.

4. Every candidate shall possess adequate practical knowledge in at least the following subjects:
(a) operation & maintenance of:
(i) marine diesel engines

Not adequate. Since opportunities for trainees in marine workshops are limi-
(ii) marine steam propulsion plant.

(iii) marine gas turbines.

(b) operation & maintenance of aux. machinery, incl. pumping & piping systems, aux. boiler plant & steering gear systems.

(c) operations, testing & maintenance of electrical and control equipment.

(d) operation & maintenance of cargo handling equipment and deck machinery.

(e) detection of machinery malfunction, location of faults & action to prevent damage.

(f) organisation of safe maintenance & repair procedures.

(g) methods of, and

...ted at present, installation of modern slow speed / med. speed marine diesel engine fitted with equipments for conducting experiments is suggested.

Total compliance.

...Not available. Installation of gas turbine is suggested.

Not adequate. Auxiliary Boiler Plants (automatic packaged blr. & simultaneous/alternate fired blr.) require to be installed. Existing blr. attending staff to be trained / replaced.

Total compliance.

...Not available. Installation of deck machinery is required.

...Not adequate. Present simulator are out-dated. More modern unit of later design to be set up.

Need to introduce a course on Planned Maintenance which will be included in Ship Operation Management.

Not adequate. Installation of
aids for, fire prevension,detection & extinction.

(h) methods & aids to prevent pollution of environment by ships.

(i) regulations to be observed to prevent pollution of marine environment. Laboratory practicals.

(j) effects of marine pollution on the environment.

(k) first aid related to injuries.

(l) function & use of life saving appliances.

(m) methods of damage control

(n) safe working practices.

5. Every candidate shall possess a knowledge of international maritime law embodied in international agreements & conventions as they affect the specific

fire fighting complex is urgently needed.

Not available. All aspects of pollution, its effects and prevention, and the relevant regulations, need to be introduced setting up of equipment (oily bilge separator, coalescer, purifier etc.) is needed for laboratory practicals.

As above.

Total compliance.

Not adequate. Considerable amount of equipment is needed.

Need to develop a course and necessary equipment for practical work is to be set up. Total compliance.

Need to develop and introduce the course either as a new subject under Maritime Law or as a part of existing subject Ship Operation Management.
obligations & responsibilities of the engine dept. particularly those concerning safety & protection of marine environment. The extent of knowledge of national maritime legislation is left to the discretion of the Administration but shall include national arrangements for implementing international agreements and conventions.

6. Every candidate shall possess a knowledge of personnel management, organisation & training aboard ships.

III/3. Mandatory Minimum Requirements for certification of chief and 2nd. engineer officers of ships powered by main propulsion machinery between 750 kw. and 3000 kw. propulsion power.

Appendix to Reg. III/3:
Minimum knowledge required for certification of

More or less similar to Regulation III/2 which has just been covered.

More or less similar to Appendix to Reg. III/2
chief & second engr. officers of ships powered by main propulsion machinery of between 750 kw. and 3000 kw. propulsion power.

III/4. Mandatory minimum requirements for certification of engineer officers in charge of a watch in a traditionally manned engine room or designated Duty Engineer Officer in a periodically unmanned engine room. Need to develop this course. The present training complies with the required minimum age, duration of approved training relevant to the duties of a marine engineer, and theoretical and practical knowledge, with little modifications, of the operation & maintenance of marine machinery appropriate to the duties of an engineer officer. ( subpara 2 : (a) to (c) & (e) to (g) ; para 3 (g) and para 5. )

But it does not comply with requirements para 2 (d) for adequate period of sea-going service which may have been included within the total period of 3 years as stated in para 2 (c). It also does not comply with requirements as per para 3 : (a) to (f), regarding
watchkeeping routines, handling & assisting in the preparation of main & auxiliary machinery, pumping systems, generating plants, emergency and anti-pollution procedures.

This is because watchkeeping certification is viewed as post-sea experience. In the current practice, marine engineers start their profession as Junior Engineers while assisting the Senior watchkeeping engineers for about a year or so, depending upon vacancies, before they are promoted as watchkeeping engineers.

This is suitable for a labour-intensive marine industry in a developing country like India as it improves employment opportunities.

This is also economically acceptable to ship owners, as a junior engineer officer gets less wages than an independent watchkeeping engineer officer.
Requirements to ensure the continued proficiency and updating of knowledge for engineer officers.

V/1. Mandatory Minimum requirements for training & qualifications of masters, officers and ratings of oil tankers:

1(b). To attend an approved oil tanker familiarisation course which includes basic safety & pollution prevention precautions & procedures, layouts of different types of oil tankers, types of cargo, their hazards & their handling equipment, general operational sequence & oil tanker terminology.

The courses referred to in para 1 (b) (iii) which include changes in the relevant international regulations and recommendations concerning the safety of life at sea and the protection of marine environment, may be developed and introduced in D.M.E.T. as one of the short courses.

Need to develop and introduce the course; relevant training equipment (e.g. simulator) to be installed; training of lecturers is to be arranged.
logy.

2(b). To complete a specialised training program appropriate to the duties, incl. oil tanker safety, fire safety measures and systems, pollution prevention & control, operational practice & obligations under applicable laws and regulations.

V/2. Mandatory minimum requirements for the training & qualifications of master, officers & ratings of chemical tankers.

1(b). To complete an approved chemical tanker familiarisation course which includes basic safety and pollution prevention precautions & procedures, layouts of different types of chemical tankers.

2(b). To attend a special Need to develop and introduce the course; training of lecturers to be arranged.

Need to develop and introduce the course; training of lecturers to be arranged.
training program appropriate to the duties including chemical tanker safety, fire safety measures and systems, pollution prevention & control. operational practice & obligations under applicable laws & regulations.


1(b). To attend an approved liquified gas tanker familiarisation course which includes basic safety and pollution prevention precautions and procedures, layouts of different types of liquified gas tankers, types of cargo, their hazards and their handling equipment, general operational sequence & liquified gas tanker terminology.

2(b). To complete a specialised training program appropriate to the duties including liquified gas tanker safety, fire safety measures and systems, pollution prevention & control. training of lecturers is to be arranged.
tion & control, operational practice & obligations under applicable laws and regulations.

VI/1. Mandatory minimum requirements for the issue of certificates of proficiency in survival crafts.

Resolutions adopted by the Conference concerning Eng. department:

Resolution 2: operational guidance for engr. officer in charge of an engg. watch (a) during underway (b) at an unsheltered anchorage.

Resolution 4: principles & operational guidance for engr. officers in charge of an engg. watch in port.

Resolution 10: Training & qualification of officers & ratings of Oil Tankers.

Resolution 11: Training & qualification of officers & ratings of Chemical Tankers.

Not adequate. The course to be developed to give full coverage to requirement.

Need to develop and introduce the course. (See remarks for Reg.III/4.)

do.
Resolution 12: Training & qualification of officers & ratings of Gas Tankers.

Resolution 13: Training & qualification of officers & ratings of ships carrying dangerous & hazardous cargo other than in bulk. Need to develop the course & introduce in the curriculum.

Resolution 16: Technical assistance for training & qualification of masters & other responsible personnel of Oil /Chemical / Liquified gas Tankers. For action by the Administration.

Resolution 19: Training of seafarers in Personal Survival Techniques. Need to develop and introduce the course.

Resolution 21: Issue of International Certificate of Competency. For action by the Administration.


Resolution 23: Promotion of technical cooperation. For action by the Administration.
4. Introduction: After a detailed analysis of the course content for the education of marine engineers in India under the aegis of the Directorate of Marine Engineering Training in the previous chapter, we come to the conclusion that the following courses need to be developed and introduced in the academic curriculum for the education of the future marine engineers.


The above course should comprise of: (a) basic principles to be observed in keeping an engineering watch, (b) requirements for certification of engineer officers in charge of a watch, (c) operational guidance for engineer officers in charge of an engineering watch during underway and at an unsheltered anchorage and (d) principles & operational guidance for engineer officers in charge of an engineering watch in port.

This course should be taught in about eight lectures of sixty minutes duration and should be included in Marine Practicals & Power Plant Operation (PR 412) in the Practical Group.

Details of the course:
A. Factors deciding the safe watchkeeping system:
Type of ships, type and condition of the machinery, special mode of operation in conditions like bad weather, ice, contaminated or shallow water, emergency conditions, damage containment or pollution abatement, safety of life, ship, cargo and protection of the environment, observance of international, national and local regulations, maintaining the normal operations of the ship at all times, responsibilities of watchkeeping officers for inspection, operation and testing of all machinery and equipment affecting the safety of the ship.

B. Watch requirements:
Knowledge of
(i) the use of appropriate internal communication systems, (ii) escape routes from machinery spaces, (iii) engine room alarm systems and distinction between various alarms with special reference to the CO alarm, (iv) positions & use of fire extinguishing equipment in machinery spaces and (v) safe working practices for main propulsion & auxiliary machinery.

C. Watchkeeping routines:
Duties associated with
(I) taking over and accepting a watch, (II) routine duties undertaken during a watch, (III) maintenance of machinery space Log Book and the significance of readings taken, (IV) handing over a watch.

4.2 Practical Fire fighting Course.
This course should be supplemented in Fire fighting Practicals (PR 210) in the Practical Group. The theoretical approach to basic training in fire fighting is covered within the existing syllabus.
The idea of introducing this course is to supplement the practical aspect of fire fighting training.

It is recommended that the practical training, as far as possible, should be arranged in locations which resemble realistic working situations on board ships. For this purpose, simulated ship board conditions and dark compartments will have to be arranged.

The practical course should include: handling of various types of portable fire extinguishers and self-contained breathing apparatus; extinguishing various types of small fires (oil, electrical and propane); extinguishing extensive fires with water (jet and spray nozzles); extinguishing fires with foam, powder and halone gas; entering and passing through, with life-line and without breathing apparatus, a compartment into which high expansion foam has been employed; fighting fire in smoke filled enclosed spaces wearing self-contained breathing apparatus, extinguishing fire with water fog, or any other suitable fire fighting agent in an accommodation room or simulated engine room with fire and heavy smoke, extinguishing oil fire with fog applicator and spray nozzles, dry chemical powder or foam applicators, carrying out a rescue operation in a smoke filled space wearing a breathing apparatus.

4.3 : Shipboard Damage Control.
This course is to be supplemented to the syllabus for Naval Architecture and may be taught in about
ten lectures of ninety minutes duration each.

A. Principles of stability: basic structure of the ship, hull girder concept, hull stresses and forces on the hull, loss of a ship by flooding, fire damage by sea, stranding and collision.


C. Forces affecting stability: weight shifts, weight addition or removal, free surface effect, free communication.

D. Impaired stability: its effects as list, change in trim, loss of reserve buoyancy, various corrective measures as dewatering, counter-flooding, weight shifting, jettison of weight.

E. Onboard damage control system, equipment and its maintenance: structural features as watertight compartmentation with access closures and fittings like watertight doors, hatches, scuttles, bolted manhole covers etc.; hull piping systems such as the fire main system, main and secondary drainage systems, ballast / deballast piping etc.; damage control fittings such as sounding tube covers, voice tube caps, air test fittings, fire main cut out valve, vent ducting flame arrester, electrical cable stuffing tubes etc.; testing and maintenance of remote operation of doors, hatches, valves etc., importance of familiarisation with ship's layout and damage control plan. Leadership, duties and drill.

4.4: Maritime Law.

Various aspects of maritime law including marine
insurance, commercial shipping practices and national merchant shipping act are extensively covered in the subject Ship Operation Management (HSS 406). It is suggested that the following modules may be included in the course to give it a more balanced and comprehensive appearance.

**Module No. 1:**

**Module No. 2:**
United Nations Law of the Sea Convention. UNCLOS 82 Territorial sea & contiguous zones, straits, archipelagic states, EEZ and continental shelf, high seas, landlocked states, international seabed area, protection and prevention of marine environment, marine scientific research, transfer of marine technology, dispute resolution.

**Module No. 3:**
Maritime Commercial Law: Maritime liens and mortgages, collision, salvage, pollution, towage, arrest of vessels, limitation of liabilities of shipowners and others.

**Module No. 4:**
National arrangements for implementing international agreements & conventions.
4.5: Marine Pollution: its effects, regulations and control.

This course should comprise of three aspects of marine pollution: A. effects of marine pollution on environment; B. regulations to be observed to prevent pollution and C. methods and aids to prevent pollution by ships.

It may be introduced as an independent subject to the course curriculum, or else, be supplemented to Marine Auxiliary Machinery II / III (Mar 302 / 403) in the Marine Engg. Group. This course should take about fifteen lectures of sixty minutes duration each for classroom lecturing.

The syllabus:

A. Meaning of marine pollution: as the introduction by man, directly or indirectly, of substances or energy into the marine environment resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing, impairment of quality for use of sea water and reduction of amenities.

Sources of pollution: dumping of dredge spoils, industrial wastes, radioactive wastes, sewage sludge and solid wastes, oil from drilling platforms, tanker cleaning and deballasting, spills from shipping accidents, sewage and solid wastes from ships, river borne pollutants, precipitation from air borne pollutants, thermal pollutions from power plants anti fouling paints and natural sources; self cleansing ability of oceans.
Outcome of pollution: rivers as universal sewers and oceans as ultimate sink for wastes, permanent despoiling of most essential natural asset, hazards to humans from ingesting contaminated food, damage to fisheries, seaweed, birds, marine mammals, and other marine life, damage to beaches and other recreational areas, damage to marine ecosystem by eliminating or decreasing populations of certain species, modification of habitats, delaying or preventing recolonisation.

B. Regulations to be observed to prevent pollution:
public awareness, regulatory authorities, work program of IMO in the field of marine environment protection, oil pollution convention 54, and its amendments 62, 69 and 71, convention on intervention on high seas 69 and its protocol 73, convention on civil liabilities for oil pollution damage 69 and its protocol 76, convention on international compensation fund 71, convention on dumping 72 and its amendments on disputes 78, on incineration 78 and on list of substances 80, convention on marine pollution from ships 73 and its protocol 78 with annexes I to V, convention on tanker safety and pollution prevention 78.

C. Methods & aids to prevent pollution by ships:
operational pollution: discharge control (discharge criteria, designation of special area), reception facilities, construction & equipment (SBT, CBT COW, oil separator, oil monitor, record book)

accidental pollution: prevention (construction and equipment, navigation, cargo handling, crew train-
ing), limitation of oil spill (damage stability, protective location of SET).

Combatting pollution: regional arrangements, anti-pollution manual, right of intervention by coastal states, liability & compensation for oil spills.

4.6 : The Oil Tanker Familiarization Course:

A. Considerations: The oil tanker familiarization course is required to be as shown below:

- General Certification
- Shore based Fire Fighting Course
- Oil Tanker Familiarization course
- Appropriate Period of supervised shipboard service
- Service on oil tankers with special duties in connection with cargo & cargo equipment
- Relevant experience on oil tankers appropriate to duties.
- Special training program (Advanced oil tanker operation course)
- Service on oil tanker with immediate responsibility for cargo operation.

Training Scheme for Oil Tanker Staff.
B. Provisions: Teaching personnel: 4 persons: one marine engineer, one master mariner (both with oil tanker experience), one chemist and a physician.

The number of course participants should not exceed 15 to 20.

Duration: should be two weeks of ten working days with six lessons of sixty minutes per day.

C. Syllabus: 1. Knowledge of cargo properties and resultant hazards: chemical composition of crude oil components, flash point and flammability of oils, vapour pressure/temperature relationship lower and upper explosion limits of hydrocarbon gas/air mixtures, effects of inhalation of hydrocarbon gases and their T.L.V., effects of toxicity and skin contact, dangerous gases in the cargo tanks, pump room and adjacent spaces, electrostatic charge generation in oil tanker operations, effects of oil pollution to marine and shore environment, corrosion damage in cargo tanks, ballast tanks and piping and resultant hazards.

2. General sequence of operation according to typical layouts of oil tankers: hull division of a tanker on a general arrangement plan, typical full load condition, distribution of segregated ballast and the resultant stress situation, typical departure ballast distribution, typical arrival ballast distribution, cofferdams and slop tanks, flow of oil and ballast on the plan of piping and pumps of a tanker, necessary instrumentation in the cargo area of a tanker, measurement of cargo tank content during loading, discharging
tank washing and ballast distribution during ballast voyage, general loading and deballasting procedures, topping up last tank, safety considerations during loading, discharging and ballasting procedures, stripping procedures; crude oil washing, handling of dirty ballast, (COW, LOT), gas exchange procedure with IG system water washing in cargo tanks, slop tank operation in discharging port and at ballast voyage, tank inspection by port authority.


4. Ability to meet safety and pollution prevention requirements and supervise respective measures: ship-shore safety checklist, avoidance of sources of ignition, procedure for safe tank entry, safe working in cargo pump room, training for rescue from enclosed spaces, first aid after a gassing incident, precaution for hot work, lessons learnt from accidents on tankers.

5. Ability to calibrate and use portable safety equipment, monitoring of inert gas quantity, monitoring of tank atmosphere for COW, testing of tank content for safe entry, calibration of instruments, testing and fitting of breathing apparatus.

6. Ability to take an active part in ship's emergency procedures: handling of a manifold connection failure, measures after a major pump room leakage, measures after a major spill on deck, fighting a deck surface fire, fighting a vent stack fire, safety considerations after a colli-
4.7 Chemical tanker familiarization course:

A. The chemical tanker familiarization course is required as shown below:

- General Certification.
- Shore-based Fire Fighting Course.
- Chemical Tanker familiarization course.
- Appropriate period of supervised shipboard service.
  - Service on chemical tankers with specific duties in connection with cargo & equipment.
  - Relevant experience on chemical tankers appropriate to duties.
- Special Training Program.
  (Advanced Chemical Tanker Operation Course)
  - Service on chemical tanker with immediate responsibility for cargo operation.

Training Scheme for chemical Tanker Staff.

4.7: B. Course Provisions:

Essential Equipment: I. Overhead projector, Slide projector, appropriate transparencies and slides, charts, diagrams.
II. Gas detector sets, Explosimeter, Oxygen analyser, Protection suits (fire, chemical), Escape &
Resuscitation equipment, Fire fighting equipment, plain chemical experimental devices.


Desirable Equipment:
Film projector, Video tape recorder, appropriate films and tapes.

4.7 C. Syllabus:

1. Ship design and equipment: Codes and regulations concerning chemical tankers construction, equipment and classification; tank arrangements, tank coatings, pipe lines and pumping systems, tank cleaning and venting facilities; electrical equipment.

2. Cargo properties and reactions: physical properties, namely, specific gravity, vapour pressure, density, partial pressure, boiling temperature, diffusion, flash point, autoignition temperature, flammable limits, viscosity, electrostatic charge generation. Chemical properties and reactions, namely, chemical structure, symbols, nomenclature, reaction condition, interaction, catalysis, polymerisation, inhibitors, reactions with water and air. Toxicity of chemicals, toxicity limits (MAC, TLV, LD50).
3. Cargo handling systems: Types of cargo pumps, sealings and gaskets, gas detecting and monitoring instruments, cargo gauging systems, cargo heating and cooling devices, cargo sampling and control.

4. Operational procedure: National and International codes and regulations, port regulations & communication, cargo stowage, tank cleaning and gas freeing, safety check lists.

5. Emergency operations: emergency organisation plan, fire fighting on board chemical tankers, collision and grounding situations, tank leaks, first aid measures, rescue from enclosed spaces.

4.8: Fundamentals of automation, instrumentation and control system.

Recent advances in marine automation have made considerable impact on educational field of marine engineers. The application of this technology is proceeding at an astonishing pace and the day is approaching when a digital computer acting as a central data processor will carry out engine room watchkeeping and the other engineering functions like navigation, maneuvering, berthing, collision avoidance, materials handling and cargo control.

With the increased use of centralised instrumentation and the automatic control of ship's machinery, the future demand is going to arise for marine engineers having a broad knowledge of fundamental principles and an understanding of their
application to a wide variety of problems asso-
ciated with marine automation.

In the context of above, it is viewed that without extending the present period of one year of study of the subject Marine Control Engineer ing & Automation at D.M.E.T. to two years, it would be impracticable to give in-depth coverage to relevant topics in this important subject.

The syllabus, outlined here, is put forward as a suggestion for incorporation with the existing syllabus for a one year study program in the above subject. It is hoped that the enlarged syllabus would enable marine engineers to obtain a better grasp necessary for a clear understanding of instrumentation and control systems.

Syllabus : A. Instrumentation : Standards of measurement, accuracy of measurements, various methods for measurement of pressure, level, flow, temperature, vacuum, viscosity, gas analysis, electrical conductivity, p h value, humidity, vibration and noise.
B. Electrical and Electronic instrumentation : Negative feed back, effect on gain and distortion. Relays : electro magnetic, reed mercury wetted, electronic. Limitations and errors introduced, switching time, bounce, induced and thermal emf's leakage current and cutoff voltage, silicon controlled rectifiers, use as current control devices, heat control, applications and limitations of transducers, potentiometer, strain gauge, variable impedance and variable capacitance.
C. Automatic Control: Need for control, examination of physical quantities over which control may be exercised. Block diagrams, mathematical modelling, physical analogies. First order systems and concept of time constant, the idea of dynamic equivalence, second order systems, concept of damping ratio and undamped natural frequency, generalised second order transfer functions, the transfer function, representation of control system components by blocks having inputs and outputs, block diagram algebra, transient response analysis, stability analysis.

4.9: Handling, Stowage, and Transportation of dangerous, hazardous, and harmful substances.

This topic may be introduced as one of the short courses or may be included in the general curriculum of the 4-year study program. The course may be covered in ten lectures of ninety minutes duration.

Syllabus: A. Classification of dangerous substances, background of classification, International Conventions, Solas 74, I.M.D.G. Codes, different ways of assessment of hazards of substances, grouping of dangerous goods according to dangers for packing purposes.

B. Different classes of dangerous goods, class I to class IX, details of different classes of goods.
C. Decision charts: procedure for identification and classification of articles for harmful substances, procedure for using packing instructions and packing requirements, code of safe practice for solid bulk cargo, transport of dangerous substances by sea, IMO's involvement.

D. Recent and future development in the transport of dangerous goods by sea and in ports, dangerous cargo in containers, dangerous goods in packaged forms, stowage and segregation of dangerous goods.

E. Pollution threats and counter measures, contingency planning.
5.1: Objective: This chapter deals with the maritime education patterns adopted in some of the developed countries at present. The objective is to highlight how these countries have moulded their maritime education programs to suit their specific requirements in the context of the changing circumstances created by technological innovations, social outlook, economic needs and most importantly safety requirements.

5.2: Basic programs of training: All well-established maritime administrations recognize and approve one or both types of training programs for engine room personnel which might be described as "Hawse Pipe" education program and "Front End" education program.

In the former type, a trainee with suitable experience ashore is engaged as a crew member (engineer officer or engine room rating) and learns the particularities of his job by doing it under guidance and supervision. Such learning by direct experience is often supported by class-room instruction which includes some education in theoretical subjects.

In the later type of training, a trainee follows a carefully planned scheme of training covering all
aspects of his expected duties and carried out under controlled conditions mostly ashore in maritime training colleges or in other training establishments.

In considering the suitability of any form of training, the first consideration is the question of what the trainee is being trained to do. This leads to the concept of job description. When such a job description has been prepared, the suitability of an existing training scheme can be assessed. It may be observed that most of the developed countries have kept the maritime training in the general stream of education and laid considerable emphasis on front end education program to cope with the technological advances during the recent decades.

5.3 : Japan.

5.3.1 : Japanese maritime education system : Both the "hawse pipe" and the "front end" education programs are in use in Japan. The scale of maritime education in Japan is commensurate with the size of the shipping industry. There are two Mercantile Marine Universities at Kobe and Tokyo, five Mercantile Marine Technical colleges, ten Schools for Seamen's Training, five Institutes for training Radio Operators, all under the Ministry of Education and one Marine Technical College and the Institute for Sea Training under the Ministry of Transport. This is further supplemented by private institutions. In addition, the fishing industry and the Japanese Maritime Safety Agency (similar to the U.S. Coast Guard) have their own training and educational
establishments. Naval architects graduate and can go upto Ph.D. level from any of the six national universities at Osaka, Tokyo, Kuiysice, Hiroshima, Yokohama, and Osaka Prefectural.

All the institutions under the Ministry of Education include in addition to vocational training a general education component which gives graduates from these institutions educational qualifications that are recognised throughout the country. Opportunities for seagoing jobs can and do fluctuate. Training and education is provided for a wide spectrum of occupations in the shipping industry. At worst it is an opportunity to obtain a general education in a nautical environment.

The Institute for Sea Training (see figure 5.3:1) provides all the deep sea training on board its four large ocean going training ships (two diesel and two turbine) and two large four masted ocean going sailing ships. Period of prescribed training on these vessels are shown on diagram 5.3:1. In addition each maritime education establishment has its own small training ship. It is on the "Institute for Sea Training" ships that students from all the institutions under the Ministry of Education meet.

The Marine Technical College under the Ministry of Transport at Ashiya near Kobe has several specialised functions:

(a). To provide training facilities to enable seamen to obtain certificates of competency as marine officers.
Fig 5. Maritime Training in Japan

- Compulsory Education: Primary School 6 yrs.
- Senior High School 3 yrs.
- Junior High School 3 yrs.
- School for Seamen Training 2 yrs.
- Namikata School for Seamen Training 1 yr.
- Mercantile Marine College 5.5 yrs.
- University of Mercantile Marine 4 yrs.
- License Aimed Course 0.5 yr.

- Institute for Sea Training
- National Examination for Merchant Marine Officers
- Marine Technical College Ashiya 0.5 - 2.0 yrs.
- Crew
- Officers
(b). To provide refresher and revalidation courses for existing officers to enable them to update their skills.
(c). To provide correspondence courses for seagoing mariners.
(d). To provide training for existing officers and ratings to enable them to obtain the dual qualification necessary to work as Watch Officers and Dual Purpose Crew on highly modernised ships in Japan.

5.3.2 : Integration of Deck and Engine departments:
This is being implemented in stages in a very cautious and methodical manner. Training to achieve this started in 1980 at the Marine Technical College, Ashiya. After a suitable period of training, the D.P.C. concept was implemented in its entirety in a number of selected experimental ships in which manning levels were gradually reduced to 15, and the new job classification of "Watch Officer" came into existence. In April 1983, the D.P.C. system was incorporated into Japanese manning regulations, and thus the government has indicated the principal requirement for future training.

5.3.3 : Marine Universities versus Marine Technical Colleges versus Seamen's Training Schools: The entry qualification for the marine universities is nine years of schooling (primary & secondary) plus three years of high school equals 12 years. Marine technical college take students after secondary education, i.e., nine years of schooling. Seamen's training schools admit students from seafarers with junior high school level.
Number of years of study in the universities is 3 1/2 years (academic plus laboratory practicals) plus 1 year on board training vessel equals 4 1/2 years. For the technical colleges the total period is 5 1/2 years including 1 year sea training. Seamen's training schools undertake basic training courses (induction course, home-trade officer course etc.) for about 6 weeks duration.

The emphasis at the universities is on research, and ample scope is provided for research work on Engineering and Nautical sciences including marine application of nuclear energy, economics, history and law. Only university degrees are granted and no seagoing certificate is issued, but the graduates are eligible to appear in the national examination for highest seagoing certificate.

Technical marine colleges have little scientific research work and the stress is on the ship operating skills. They have primarily two departments : Nautical and Engineering. After graduation, students from both departments are eligible to sit for national examination for highest seagoing certificate.

Thus, immediately after graduation, students from mercantile marine universities or technical colleges attain the theoretical knowledge stipulated for the post of chief engineer / master mariner. The certificate is kept pending till practical experience is acquired by the incumbent. The period of experience is about 7 to 10 years for chief engineer and master, 5 years for second engineer and
chief mate. The graduates are appointed as third engineer or second mate on board immediately after passing the theoretical examination.

5.3.4: Entry qualifications: Entry to any type of institutions is by means of a written examination. For the universities, entry is by means of the common university entrance examination. Students from technical colleges can change over to a university after a period of 3 years, i.e. after an equivalent level of high school education. Entrance to seamens school is also by means of a written examination (Japanese, English, and mathematics).

5.3.5: Latest trends in maritime education in Japan: Apart from the emphasis exerted on dual purpose training, there is a clear trend towards narrowing the gap between the qualifications of officers and crew on Japanese vessels. The other noteworthy event is diversification of courses offered by maritime institutions to cope with reduction in demand for marine officers.

5.4: United States of America.

5.4.1: Education Systems in the U.S.A.: Another country where both "hawse pipe" and "front end" education programs are in use is the U.S.A.

The "hawse pipe" education program is carried out through the following institutions:
(1) maritime schools managed by unions provide specialised courses and coach students for upgrading licences.
(2) academic programs below degree level but with a broad based foundation organised by City Colleges. (3) preparatory schools under private undertakings which coach students exclusively for U.S. Coast Guard examinations.

The "front end" education program is undertaken by both the federal government through the Merchant Marine Academy situated at King's Point, New York, and the state governments through the State Maritime Academies. At present there are six academies located at Texas, New York, Massachusetts, Maine, California and Michigan. All these academies are residential and coeducational type. Besides Michigan, these institutions offer a four year undergraduate program leading to a nationally recognised Bachelor of Science degree, a Coast Guard Licence to sail as officers in the American Merchant Marine as third mate or third assistant engineer, or both, and commission as ensign, U.S. Naval Reserve. The four year program includes two half year periods at sea aboard training ships or U.S.-flag merchant ships. In the academies, the four basic curricula offered are: Marine Transportation, Marine Engineering, Marine Engineering Systems and Dual Licence. State Academy of Michigan which is specially meant for Great Lakes and river licences, offers a three year program with an Associate of Arts degree.

The Federal Maritime Commission bears the entire financial expenditure of the Federal Maritime Academy at King's Point. All the cadets selected here are paid during their 4 years training period and
Figure 6. BLOCK DIAGRAM OF EDUCATION AND TRAINING PROGRAMME OF ENGINEERS IN U. S. A.

Examination for Chief Engineers Licence

12 months sea service

Examination for 1st Assist. Engineers Licence

12 months sea service

Examination for 2nd Assist. Engineers Licence

12 months sea service

Examination for 3rd Assist. Engineers Licence

Final 1 Year in Academy and Graduation

6 months in training ship

1 Year in Academy

6 months in training ship

2 Years in Academy
all their expenses are covered.

The federal government offers some assistance to the state programs by meeting part of the expenditure incurred by each cadet and by providing and maintaining training ships. Cadets have to support themselves individually by meeting the major part of their training expenses.

About 270 cadets graduate each year from King's Point Academy and about 500 more, excluding Michigan, from state academies depending upon the national requirement. These graduates have wide options either to sail on their licences or to take up suitable shore-based jobs under various organisations. Those graduates who do not sail, usually find employment in many respectable positions within and outside the marine industry. They become career Navy or Coast Guard officers, marine engineers, naval architects, shipping company executives, admiralty lawyers, oceanographers, marine underwriters, oil and mineral company executives etc.

The State University of New York, like the other state universities, provides the following courses for engineers:
Degree in Marine Engineering
Degree in Naval Architecture
Degree in Electrical Engineering
Degree in Nuclear Science & Engineering
Degree in Ocean Engineering

(Out of the four year course duration, the first two year course curriculum is common to all engineering concentrations and from the third year on, cadets)
take specialised courses relevant to the degree provided.

The cadets with nautical option, while preparing for third mate’s licence, can concurrently study for a degree in any one of the following subjects:

- Bachelor of Engineering (Electrical)
- Bachelor of Science (Computer)
- Bachelor of Science (Marine Transportation Economic)
- Bachelor of Science (Transportation Management)

All the courses are of four years duration. The bachelor of electrical engineering for navigating officers is specially designed taking into view the sophisticated electronic equipment being used on a modern ship.

The training program is the same as for marine engineers, i.e. the cadet completes one year of sea training during his four years of study in the academy.

In the U.S.A. there is another program of training for deck and engineer officer known as the Dual Licence program. The program gives common core of studies and training to both deck and engineering up to third mate/third assistant engineer’s level. The block diagram of education and training scheme is shown next to page 64.

5.5 : The United Kingdom.

5.5.1 : The training of engineer officers in the U.K. can be divided into three categories. These are:

A. Traditional training
B. Cadet training
C. Further training

5.5.2: Traditional training: For many years there has been a legal requirement for chief and second engineers on ocean-going ships registered in the U.K. to be duly certificated and the U.K. Administration has since 1863 held examination leading to the award of such certificates.

In the traditional scheme which was basically the "hawse pipe" education program, these trainees, selected by the shipping companies, passed through apprenticeship program for a period of four years in shipyards or marine workshops. After this, on completion of 18 months of sea service as uncertificated officers on their employers' ships, they qualified to appear in the second class engineers certificate of competency examination. They usually attended a private or public maritime college for about six months to prepare themselves for the examination.

A further qualifying sea service of 18 months, while holding a second class certificate, entitled them to appear in the first class examination, though they usually attended a private or public maritime college for a further six months before taking the examination.

The traditional training scheme continued uninterrupted till the early 1950's and then it was superseded by the cadet training scheme, which is in fact the "front end" education program, due to the
following reasons:
A. trainees coming up through traditional training program were not given broader studies of fundamental aspects of science or engineering,
B. increased diversity and sophistication of ships and machinery called for a more comprehensive, systematically planned and carefully controlled training program based upon a broader theoretical basis which will not only take care of safety but also of management aspects in a day to day ship operation,
C. necessity to organise education program of engineer officers so that they get a nationally recognised qualification which will give them a social standing and ample opportunity to get a shore job any time during their career.

5.5.3: Cadet training scheme: The cadet training scheme is provided at three levels depending upon the qualifications of the entry. They are:
A. O.N.D.scheme (ordinary national diploma)
B. H.N.D.scheme (higher national diploma)
C. Degree scheme

All the three schemes involve almost the same degree of practical training, but they differ from each other very much in theoretical content and standard. The schemes are flexible enough so that candidates with a diploma after study of a certain period can take a degree. All the courses are for a period of four years. In general, the ordinary national diploma covers the theoretical requirement of U.K. safety administration competency examination. The higher national diploma covers a syllabus
Fig. 7. BLOCK DIAGRAM OF MARINE ENGINEERING EDUCATION IN U.K.

O.N.D. SCHEME.

CLASS 1 ENGINEER (Chief Engineer Unlimited)
6 months course
21 months sea service

CLASS 2 ENGINEER
3 months course
18 months sea service

CLASS 4 CERTIFICATE
1 year in college
12 months sea training
2 years in college

5 years secondary education
Fig. 7. EDUCATION AND TRAINING OF ENGINEERS IN U.K.

H.N.D. SCHEME

CLASS 1 ENGINEER (Chief Engineer Unlimited)
- 3 months course in college
- 18 months sea service

CLASS 2 ENGINEER CERTIFICATE
- 3 months course in college
- 18 months sea service

H.N.D. & Class 4 Certificate
- 14 months in college and workshop
- 12 months sea service as cadet engineer
- 26 months in college and workshop

7 years of secondary education
which is more than the requirements of the U.K. safety administration. The theoretical content of the degree scheme is the same in standard and breadth as that of an engineering degree in U.K.

These courses also differ in other respects but, in general, the cadets, on leaving school and gaining employment with shipping companies as trainees, spend two years at a marine college, then one year at sea on board ships of their employers and, finally, one year at the marine college.

5.5.4 : Entry requirements : This varies, as shown below, according to the scheme followed by the candidates.

O.N.D. scheme : Candidates who have passed at least four subjects at "O" level which includes mathematics and a scientific subject or with a general certificate including mathematics, erecting machinery and technical drawing.

H.N.D. scheme : Candidates who passed five subjects of which mathematics and physics must have been studied at "A" level.

Degree scheme : Candidates must have "A" level with mathematics and physics. Candidates with H.N.D. can follow a further one year academic curriculum to get a degree.

Each of the courses includes regular monitoring of cadets progress, continual assessment of achievement and formal examinations which have been approved by U.K. safety administration, but the examina-
tions are conducted by the colleges.

5.5.5: Exemptions: Although these cadets are required to appear for their certificate of competency examinations, they are exempted from the theoretical subjects of the second class and first class engineers examination depending upon the scheme followed.

5.5.6: Further training: The following courses are mandatory and need to be taken by an engineer officer:

a) Approved fire fighting course
b) First aid at sea
c) Personnel survival at sea
d) Special course for oil tankers
e) Special course for chemical tankers and liquified gas carriers.

The last two courses are meant for officers serving on oil tankers, chemical or liquified gas carriers.

5.6: Netherlands.

5.6.1: Maritime education levels: There are three distinct levels in the Dutch maritime education system:

A. Higher vocational training (mono / dual discipline) for ocean going vessels.
B. Intermediate vocational training (mono / dual discipline) for coastal trade.
C. Lower vocational training for sea fishing.

5.6.2: Dutch education system: This system originally had the "hawse pipe" pattern of training.
Formally it was usual to take the various certificates in a consecutive sequence through the so called "sandwich system" and appearing for state examinations for engineer officers conducted by the Board of Examiners under Ministry of Transport. For this purpose, to undertake a regular course was not legally required, but prior to the examination a stipulated sea service was demanded.

5.6.3: **Present trend**: By the beginning of the present decade, attending a vocational training in maritime education had been accentuated more and more and the education system had assumed "front end" pattern of training.

The intention of this higher vocational training in maritime studies was to impart the subjects for tuition to the students in a 4-year training necessary to gain the highest maritime certificate, i.e. the first engineer's certificate C for foreign going trade together with a Bachelor of Science degree.

Apart from this, the higher vocational training also brought about production of hydrographic surveyors, general operational technologists, naval architects, maritime technologists, air craft engineers, etc. The first year of these higher vocational trainings are organised in such a way that the horizontal flow is possible, after promotion from the first to the second year.

Since 1985 the existing higher vocational training for deck officer and marine engineer were converted
into a training for dual purpose merchant officer.

Besides this, there are intermediate vocational trainings which train for the A certificate for a marine engineer either for overseas or coastal or fishing trade. If desired, higher certificates can again be acquired through following the courses and passing the State examinations. In the intermediate vocational trainings, a training for dual purpose merchant officer has also been started.

The lower vocational training is provided to cater to the sea fishing trade. This has four levels stretched over four years of training leading to school examination conducted under the ministry of education for the award of certificate meant for skipper-engineer on fishing vessels of various length and power. The certificate of competency is obtained after 18 months of sea service from the ministry of transport.

5.6.4 : Various means to get a maritime certificate :
Thus to sum up, any one wishing to obtain a maritime certificate may act as follows:
 a) to undergo a State examination which is undertaken by the ministry of transport, or,
 b) to attend vocational maritime education, ending in a school examination.

5.6.5 : State Examination : This examination is undergone before one of the following Boards of Examiners for seafaring certificates:
 Board of Examiners for deck officers,
 Board of Examiners for engineer officers,
Board of Examiners for fishing trade.

The Boards of Examiners under the State Examination Committee are appointed by the ministry of transport & public works. The only condition to be admitted to the examination is that the candidates must have had a certain sea service. They can even sit for their examination without having the necessary sea service provided they have successfully attended a course.

When passing they obtain a certificate of knowledge, which, after getting the required sea service, can be exchanged for a certificate of competency. If so desired, these examinations can be undergone in parts. Courses providing training for the different examinations are given by various maritime academies and private training institutes. The courses are not obligatory. On account of examinations already passed, the candidates can get certain exemptions when sitting for the State examination.

The institute of the Board of Examiners functions as an objective institute, which is independent of trade and industry as well as of official bodies. The examinations are held five times a year.

5.6.6: School examination: The second possibility to acquire certain maritime diplomas is by attending a vocational training at one of the maritime academies, followed by school examination. These school examinations fall within the scope of the ministry of education and sciences. Delegates of
Fig 8. DUAL PURPOSE TRAINING IN NEDERLAND.
the ministry exercise supervision of the school examination. To acquire the competency a sea service must be completed and the students must give evidence in writing of their practical experiences, which will be judged by experts of the ministry of transport. These experts are the delegates of the Board of Examiners.

At present there are about 25 State -aided maritime schools which are imparting vocational courses at different levels in the Netherlands.
Chapter VI.

CHANGES NECESSARY FOR THE EDUCATION AND TRAINING SYSTEM.

6.1: Introduction: Most of the developing countries have inherited their maritime systems from one or other of the major advanced nations generally because of colonial / historical reasons. Although these bilateral arrangements have undoubtedly accelerated the establishment of maritime infrastructures in the developing countries, their appropriateness to local conditions is open to questions.

This is particularly so in the case of maritime education and training, because of its social implications. Maritime education and training not only concerns people but also involves the education system of the developing country, which is likely to be quite different from that of most advanced nations.

One of the common criticisms levelled at maritime education and training establishments in the developing countries is that their curricula have not kept abreast of the significant technological changes experienced by the shipping industry in recent years. There is no doubt that an element of conservation exists in the education establishment, but there are also other factors such as the education/training dichotomy, and the long "lead-times" involved, all of which emphasise the importance of
identifying the basic objectives before making substantial alterations to existing system of training.

The purpose of writing this chapter is to emphasise the importance of first identifying objectives and then suggesting corrective measures that are relevant.

6.2: The shipping industry: In the reappraisal of a maritime training facility, a primary consideration is whether the trainees are being prepared for the shipping industry only or for a wider field of employment. That is, whether other maritime industries such as shipbuilding, ship repairing, offshore engineering, commercial management of ports, etc., are included.

Maritime education establishments which are publicly funded have, of course, a responsibility to the individual and to the country in general. Although this should not necessarily be in conflict with the provision of a service for the country, there is a particular need to recognize the long-term implications. In the case of new entrants to the industry, for example, it is important to remember that they will have a working lifetime of some forty years ahead of them, during which vast changes in technology will be experienced. The importance of inculcating a sound knowledge of fundamentals upon which basis the changes can more readily be absorbed by short updating courses etc., might not always be appreciated by the government. Nevertheless, the education and training programs must be relevant to
the needs of the industry, and the importance of close liaison and involvement with the industry cannot be overemphasised.

5.3 Today's maritime technology: The engineering aspect of maritime technology includes sciences which relate to two basically different but complementary professions. They are: naval architects and marine engineers. Naval architecture concerns the design of ships and other mobile floating structures and their construction. Marine engineering pertains to the design, manufacture, installation, operation and maintenance of ship-board machinery and equipment. The naval architect is totally shore-based. Marine engineering can be either a seagoing or shore-based profession as it depends on whether the job to be carried out concerns running and upkeep of ship-board machinery at sea or design, manufacture, installation or repair of such machinery ashore. In case of marine engineers, senior personnel with long sea experience are required ashore for managerial functions.

Today's maritime technology has changed significantly from what it was thirty years ago. There have been great variations in size and sophistication of ships in different trades and operations. Function-built ships have become the order of the day. Hull forms which would ensure maximum efficiency are being introduced. Computer-aided designs for ships are being increasingly utilised in the industry.

Gone are the days for uneconomic steam reciproca-
ting engine in the field of marine propulsion. Even
steam turbine propulsion has almost disappeared
from the shipping scenario, but for a few high
power ratings. The diesel engine, in its multiple
forms, has been largely accepted for ship's propul-
sion machinery. Utilisation of gas turbine and nu-
clear energy for ship propulsion have become estab-
lished facts.

The entire machinery and equipment on board a typi-
cal ship is a combination of intricate mechanical,
hydraulic, electrical and electronic devices comp-
lete with self-regulating automatic controls and
monitoring devices, all centralised in computer-ai-
ded controls. Marine technology has reached a stage
where it is technically possible to operate a
modern ship with only minimal crew strength of 15
to 20 as against the conventional 50 to 60. All
this calls for a fresh approach and a critical look
at the training of the future marine engineers.

6.4: Total professional activities: There is a very
large area of professional activity concerning
marine engineering in the successful operation of
the maritime industry. This primarily includes run-
ing and maintenance of marine machinery; designing
building and repairing of ships; designing and
manufacturing of propulsion system, auxiliary
machinery and other equipment; fleet operation,
maintenance and management; ocean engineering; tea-
ching of subjects in marine engineering; research
and development related to marine engineering; ins-
pection and survey of ships and their machinery
during construction and while in service; statutory
administration concerning maritime industry; maritime economics; management of shipping companies, shipyards and port complexes; etc.

It is very evident that considerable professional experience backed by a strong technological knowledge is necessary to discharge these various activities. In addition, post-basic education is also required to supplement the roles in some of the fields.

6.5: Training facilities at present: The responsibility for planning, training and certification of seagoing marine engineers has been assumed by the government of India through the ministry of shipping from the very beginning. But, quite unfortunately, the responsibility for assessment of requirements of naval architects and marine engineers to fulfil roles other than ship operation has been simply overlooked. Institutions like I.I.T., universities, etc., are undertaking training and certification only. The ultimate effect is that the main consideration has been on personnel planning for the seagoing profession only and very little importance has been laid in respect to requirements for the needs of other areas in the maritime field.

The present setup of maritime engineering education in India, which has been described in detail in Chapter II, is characterized by the following major shortcomings:

1. There is no coordinated assessment and action relating to the personnel needs in various fields
of the entire maritime industry consisting of shipping, shipbuilding, ship repairing, shipboard equipment manufacture and port sectors.

2. The certification of seagoing personnel leaves much to be desired in regard to advanced education. The passing out (graduation) certificate of D.M.E.T. practically constitutes a passport for entry into seagoing careers. The statutory certificates of competency, issued by the government of India, do not have national recognition as professional qualifications, and any recognition of it is restricted to limited purposes of employment where the possession of such a certificate is a "must". In the days when the limits of technology are advancing ceaselessly and when new ideas can be innovated only through postgraduate learning and research in almost every field of professional activity, it is an unfortunate turn of event for the Indian seagoing marine engineer to find that he cannot seek admission to any course of a postgraduate status in any university on the strength of his statutory certificate of competency.

3. The training and education of marine engineers is not continuous with their post-experience period. A strange situation prevails in India today unlike in any other maritime countries in the world. Here the pre-sea and the post-sea trainings are treated separately as if the one is segregated from the other. This has undoubtedly restricted the growth of professionalism in teaching and training institutions meant for the purpose. None of the educational institutions which have been set up in the
developing countries in the recent past under the guidance of I.M.O. follows such practice. This incurs duplicating of costly facilities involving faculty and equipment. A number of developed countries, in fact, have successfully introduced a single training scheme for seafarers belonging to different streams (dual purpose training for officers and ratings). So these two parts of training should be grouped together to form one institution, while nautical and communication streams may be grouped together to form another institution.

4. It is already mentioned in Chapter II that the training of marine engineers in India after they join the ship is conspicuous by its absence. The same story goes for the bulk of marine engineers who form the "traditional entry" scheme (from general apprenticeship in marine workshops). The saddening fact remains that there is virtually no education or training in vital aspects of marine machinery and ship construction, operating principles and practice relating to safety and efficiency, environmental pollution and damage control. This has been going on for ages without anybody bothering to think whether such a practice should continue. Thus the statutory examination has been accepted as a substitute for a course oriented education and training. The I.M.O., on the contrary, has repeatedly emphasised the need for more education and training and also the usefulness of conducted courses between periods of sea-service. Government of India's attitude in this respect should have been in the direction, as pointed out by the Shipping Corporation of India, of conducting a
number of training courses for their own personnel.

6.6 : Updating of training facilities : It is a matter of great importance that the future marine engineers should have a satisfactory minimum standard of basic technical education. Our National Education System, which has the requisite expertise, may be approached in this connection.

It is very desirable to enforce a minimum basic fundamental education at the entry point to marine engineering. The graduate engineers and D.M.E.T. candidates, however, satisfy this part of the requirements. For the traditional entry candidates, Part A examination of the Institution of Engineers (India) would provide a satisfactory coverage and would ensure a minimum educational standard.

On joining there should be a period of three months on-plant practical training on board ships of national shipping companies. Candidates may approach various shipping companies through government agency for the ship-board training. The government, on the other hand, may have to arrange for some subsidies to the shipping companies for the purpose of conducting practical training scheme on board ships.

The practical training should be followed by a two and a half year course of instruction in a shore-based institution (D.M.E.T., Calcutta/Bombay, L.B S. Nautical & Engg. College) in subjects like operation and maintenance of marine diesel engines, marine auxiliaries, safe working practices, fire-
fighting and safety appliances, watch-keeping routines, survival at sea, first aid, anti-pollution and emergency procedures, etc.

The theoretical course should be followed by another three months of ship-board practical training on vessels of the national shipping companies in order to qualify the candidates for the first certification (watch-keeping engineer) as per S.T.C.W. 1978, Reg. III / 4, sub para 2 (c) and (d).

Structural changes should be brought in certification system making it obligatory for all candidates to attend a course prior to the joining of their sea career.

All candidates, before their second class certificate of competency, should compulsorily undergo a properly laid out course of about twelve months in a shore-based institution (D.M.E.T. Calcutta/Bombay, L.B.S. Nautical & Engg. College) in line with Reg. III / 2 of S.T.C.W. 78, with practicals in electronics, automation, computer and simulator.

Examinations for all grades should be held by the institutions and only teachers, internal and/or external, would be eligible to test the knowledge in fundamental engineering subjects. Certification by the statutory board should cover only the safety aspects. Thus the training, education and examination should be left to the institutions. The economic absurdity of duplicating the existing machinery for the purpose of assessment -- within the education system -- at public expense -- within the mari-
time authority has to be recognised.

As per Regulations III / 2 and III / 3 of S.T.C.W., 78, the requirement of theoretical and practical knowledge for the chief engineer officer and the second engineer officer is the same. The only difference has been in approved sea experience, for example, a period of 12 months for the second engineer officer and 24 / 36 months (depending on propulsion power) for the chief engineer officer. So the candidates for the first class certificate of competency having requisite sea service need not take any further theoretical or practical training course or examination. They will undertake short updating course of about three months duration in a shore-based institution (D.M.E.T. Calcutta / Bombay, L.B.S.N.E. College) relating to changes in the relevant international regulations and recommendations concerning the safety of life at sea and the protection of marine environment, in line with Regulation III / 5 of S.T.C.W.78 convention. Certification, once again, will be by the statutory board covering the safety aspects.

It is very desirable that the professional qualification of a marine engineer is disconnected from the statutory certificates of competency, and should be linked with university accreditation. Whatever may have been the merits of the system of statutory certification in the past, in the present context it is outdated. It may sound unbelievable that the use of simple calculators in the examination is not yet permitted under the statutory rules. The government agencies, concerned entirely with
the administration of the Indian Merchant Shipping Act, attribute to themselves the role of a university examiner. To the extent of statutory requirements, the government agencies should limit their scrutiny and examination of sea-going engineers to ensuring that their knowledge relating to safe operation of the ship and its machinery is sufficient for the responsibility to be certified. Besides, the Part A examinations do not adequately cover the subjects necessary to impart a satisfactory minimum standard of basic technical education. The certification examinations have remained in a state of stagnancy. Hence the system has failed to generate enthusiasm amongst the candidates. It contains a lot of unworthy materials according to present day standard. It concerns more of obsolescence rather than what is relevant. The examination pattern must deviate from the "set system" and introduce an open type of examination with intelligent and searching questions set afresh for every examination.

In the case of the marine engineering course conducted by the D.M.E.T., the changeover from the initial pattern to the re-orientation scheme (three years apprenticeship in selected marine workshops followed by one year at the Marine Engineering College to one year at the Marine Engineering College workshop interspersed with theoretical classes, two years at the selected marine workshops with theoretical classes at the Marine Engineering College in a sandwich pattern and the final year at the Marine Engineering College) is a definite step in the right direction, but it does not go far enough. The pattern of practical training needs a complete
change. The long period of apprenticeship in shipbuilding / ship-repairing yards, which does not justify good training any longer, must be replaced with on-plant practical training on board a training ship / vessels of national shipping companies. The theoretical content of the education of the future marine engineer, whether he is to take up a seagoing career, or he is to take up a career in shipyards, port trusts, dredging organisations or machinery manufacturing units, has to be reasonably higher than what is possible to provide in the present course.

It is, therefore, suggested that the present system be partially modified to provide a four year degree course with eight semesters of which the fifth and seventh semesters will be set apart for sea training, exposure to design and production techniques, at major shipbuilding yards (H.S.L., C.S.L., M.D.L. G.R.S.E.) and machinery manufacturing units (G.R.S.E.-Ranchi Unit, Kirloskar-Cummins, H.E.C., B.H.E.L.). The remaining six semesters should be devoted to a balanced course of instruction in class-room studies, engineering drawing, laboratory work and workshop practice.

Apart from the requirements of engineers to man ships, marine engineers are also required ashore for assignments in shipyards, marine equipment manufacturing facilities, ports, ship-repair organisations, dredgers, etc. This justifies creation of a second stream of first degree course in marine engineering to cater to the needs of maritime industry ashore. The best course of action will be
to provide for the two options in a single marine engineering course so that, from the fifth semester onwards, specialisation towards each option is provided for. A major advantage of two streams will be that the periodic depressions in international shipping will not adversely affect the employment opportunities of the new graduates.

6.7 : Scope for postgraduate education : It has been a well-accepted fact that technical education cannot be looked upon as an one-time effort and only practical experience will never create expert knowledge, skill and managerial qualities in the various spheres of maritime technology. Postgraduate studies and research are some of the most important aspects of any organised structure training facilities. Today's marine technology is progressing stupendously all over the world. Thus it is of paramount importance that marine engineers have adequate scope for postgraduate education and research so that the fruits of achievements acquired in some other parts of the world may be utilised for our national needs.
7.1: Objective: In the years preceding the 1960's, a maritime lecturer had a vast amount of professional knowledge in the field of the subjects in which he was lecturing and in fact he had only to keep up to date with very slow changes in the professional field.

After the 1960's, however, there were fast and radical changes in the fields of marine engineering, maritime communication, ship handling and navigation which were caused by innovations in technology such as computers, micro-electronics, application of automated systems and satellites. The fact that modern types of ships were built with so far unknown properties related to strength, stability and cargo handling also had its influence on maritime education and promoted the need for updating of maritime lecturers.

Consequently, any maritime teachers' training programme has not only the obligation to educate future maritime lecturers but also has to keep track of innovations in the maritime field. Such a programme must take care of the post-academic training of maritime lecturers.

7.2: Limitations of maritime lecturers: These lecturers are normally recruited as practical marine engineers with chief engineer's certificate / navigators with
master mariner's certificate. It may be argued that this procedure to promote technically skilled personnel with maritime background to maritime lecturers is not sufficient to provide for good education. It needs to be accepted that teaching capabilities are quite independent of technical proficiency in any particular field.

Apart from this, the technical personnel recruited as maritime lecturers who completed their studies five to ten years ago may be blissfully ignorant about the rapid changes in the maritime field. They will be, naturally, failing in their vital task to be able to teach the latest techniques and methods developed in the concerned field to the students.

A very practical drawback of teaching in an undergraduate class in an education system which is self-centred without having any link with the industry and is not placed in the main stream of general education, is that it induces the lecturers to follow the path of least resistance in the matter of teaching. The lecturers usually, perhaps with few exceptions, lose initiative, with the passage of time, to improve their teaching techniques and the quality of teaching material delivered by them. They tend to circle around the localised small eddies around them. This situation will, naturally, worsen in the event, as is the case in India, if the maritime lecturers have the added complacency of being public servants by the nature of their duty.

Thus the updating of maritime lecturers, which can hardly be over emphasised, must be an important part of the activities of any academy which is willing to
provide for sound maritime education.

7.3 : Licence / Certificate for Teaching : A system may be introduced by the competent authority that all lecturers will have licence for teaching which they will have to renew once in every five years from a board appointed by the government. The board may be constituted of university professors, leading educationists, noted maritime technologists, etc. Lecturers will have to convince this board that they have kept their knowledge abreast with the development of technology in their concerned field of teaching.

This system, in fact, will not be a very novel idea in itself. It is very much in line with one of the recommendations of the STCW 78 that demands that navigators and marine engineers, coming back to work at sea after an interruption ashore, must go for renewal of certificate in case the break exceeds five years.

Renewal of teaching licence is also an established practice in some of the developed countries, notably U.S.S.R.

7.4 : Teachers Training Institute : Such an institute may be set up for updating maritime lecturers in India at any one of the principal cities like Bombay, Madras or Calcutta. Classes may be held here once or twice a week in the afternoons / evenings. Regular courses may be offered for first degree (university level) diplomas and for second degree diplomas.

The duration of the first degree courses should be five years, of which the last year may be used to make a
thesis on a maritime subject. During the first four years about 1800 hours of lecturing should be delivered and examinations on all subjects may be held. The duration of the second degree diploma may be two years, during which about 500 lecturing hours should be arranged and examinations on all subjects may be held.

The admission requirements may be identical for both the diploma courses. Various courses which may be offered under these two diplomas may be:

I. Diploma in Marine Engineering: concerning motors, steam plants aux. systems, engine room automation, mathematics, applied mechanics.

II. Diploma in Marine Communication: covering electronics, tele-communication, automation, mathematics.

III. Diploma in Navigation: concerning navigation, navigation instruments and systems, automation, maritime meteorology, mathematics.

IV. Diploma in Seamanship: concerning seamanship, law of the sea, ship dynamics, ship building, marine meteorology, mathematics, applied mechanics.

Besides the lectures in the qualification subjects, there should also be lectures on supporting subjects such as digital techniques, computers, physics, chemical technology, statistics, etc.

Lecturers should be encouraged to take up these courses for the benefit of everybody. There should also be some form of incentive for the lecturers who would success-
fully complete the course.

7.5 : Short courses in universities / other institutions : Even if updating of maritime lecturers may be an important national issue and nobody would like to agree to undermine this, it may be equally true to think of how difficult it is to convince the government to set up a proposed teachers’ training institute because of its attended financial implications. Besides, the prolonged situation of subsidised over-capacity and instability in world shipping market has been a major setback for the long-term planning in the maritime sector in many developing countries.

Under such a state of affairs, it may be just possible to arrange for short courses on relevant maritime topic in various universities / outside institutions, where professors / competent technologists can deliver lectures to the attending lecturers for the stipulated number of hours. Thereby, the cost involved in building a separate establishment, to have the necessary infrastructure and the administrative formalities can be avoided.

7.6 : Research facilities : Another very useful way to upgrade the lecturers in an institution is to have its own research program. Lecturers should be scrupulously encouraged to undertake research activities in their concerned fields and to produce text books. This opportunity will breed a number of advantages which will be useful in many areas of activity of the institution. Not only the lecturers will extend their horizon of knowledge in their respective spheres while pursuing the research work, but it is bound to tell upon their
quality of teaching, for which the students will be benefitted to a great extent. Research contributions of the institution can help to solve some of the most urgent problems of the marine industry. The institution thus, in lieu of its research programs, can earn from the industry a handsome dividend which may be utilised for some development work of the institution. This will open up an avenue for a close and congenial relation between the academy and the industry, which is an absolute necessity for the academy. It will help the academy in two ways: (1) it will keep the academy aware of the practical needs of the industry for which the academy is meant, (2) it will help the academy to be one step in advance of the industry.

7.7: Short sailing trips: Lecturers should always be encouraged to undertake short voyages on board ships of the national shipping companies after every three or four years. This would give them an opportunity to be conversant with the latest design and layout of the shipboard machinery and the operational and maintenance aspects concerning them. Thus the students, by turn, will get to know the modern version of the ever-changing marine machinery which they are expected to come across when they start their career at sea.

7.8: Regular contacts with universities / other institutions: It is very necessary to establish and maintain a regular and cordial communication with universities and other educational institutions within the country as well as abroad. This would facilitate some academic programs like exchange of scholars among different institutions, advanced studies and training of lecturers from the developing countries to the institutions in
General, I.M.O., and the Chancellor, W.M.U., "provides a critical element now missing but necessary for a coherent and comprehensive system of training and education - an international centre for advanced study for high level specialised personnel in developing countries including maritime teachers, surveyors, inspectors, technical managers and maritime administrators.

"The World Maritime University provides a pivotal link in the international system for training in the maritime sector. It complements, supplements and strengthens the training activities now being carried out in the developing countries. It is a unique institution which offers an advanced level of training in a number of different maritime fields at a single institution, which is presently not available elsewhere."

The World Maritime University has introduced since 1983 the Maritime Education and Training Courses for lecturers in maritime education and training institutes. The courses are divided into two fields, namely, nautical and engineering. Each course consists of the best obtainable balance of classroom work and practical training / experience. There are over one hundred and fifty distinguished visiting professors attached to the university from all over the world. The field training includes as wide a practical experience as can be gained from visits to maritime training institutions and visits to and training at centres of advanced maritime technology in a number of countries which provide the facilities for such training.

Based on the foregoing, it may be observed that a very suitable institution available for providing advanced
education and training in the maritime field for the development of lecturers from any developing country would be the World Maritime University.

After a lecturer is recruited and subsequently found suitable to continue in his assignment at the institute he ought to be developed into an effective teacher being provided with higher education and training by the institute.
CONCLUSIONS AND RECOMMENDATIONS.

1. India's maritime development since independence is a series of achievements which include a merchant fleet of 6.27 millions of G.R.T., 10 major ports with a total traffic of over 100 million tonnes, 4 major shipyards, a modest dredging fleet, a fast-expanding off-shore oil industry and a national classification society.

2. The marine engineering course first started along with navigation in 1935 before independence on board Training Ship Dufferin.

3. The government of India introduced a new marine engineering course in 1949 under the aegis of the D.M.E.T. with admission level at par with entry into university engineering colleges, and in the long run, the course has now been recognised as equivalent to first degree level.

4. The present course needs upgrading of its training facilities and syllabi, and inclusion of a number of subjects in the curriculum as per the minimum requirements of S.T.C.W. 78.
5. The leading maritime countries have increasingly adopted a "front end" type of maritime education within the general stream of national education program leading to first degrees with university recognition; their maritime education is provided with arrangement for ship-board training, a lot of diversifications for employment ashore and opportunity to reach the highest level of university education.

6. Marine technology has undergone phenomenal transformation in the four decades since the end of World War II.

7. Multifarious activities in the maritime field involve professional personnel with expertise and experience.

8. The present training facilities primarily centre around ship-manning and do not take into account other needs of the maritime industry.

9. Updating of training facilities calls for a fresh assessment of the present system and justifies a modified program with two streams of training of marine engineers. In both cases, the education and training must lead to the award of first degrees of university recognition.

10. The present system of D.M.E.T. training of marine engineers be reformed as set out in chapter 6.6 with provision for practical training in leading shipyards, engine manufacturers and on shipboard in lieu of prolonged apprenticeship in marine
11. Pre-sea and post-sea training programs should be grouped together in a single institution.
12. Regular course-oriented programs for pre-sea training of "traditional entry" candidates and post-sea training for second class certification examination should be started without any further delay. Attending such courses should be mandatory.

13. Statutory certification of sea-going competency at different levels be restricted to verification of capability of safe operation of the ship and its machinery.

14. The present system of statutory certificates of competency and examination is outmoded and calls for a comprehensive re-examination.

15. Examination in fundamental knowledge should be held in the institutions by teachers. Certification by statutory board should cover only the safety aspects of safe manning and operation of ships.

16. Facilities for post-graduate education and research are "must" in the background of the accelerating progress of maritime technology.

17. Teachers' training program should be included, as set out in chapter VII, in the regular activities of the institutions.
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