

OUR OCEANS AND OCEAN RESOURCES

A PRELIMINARY REPORT

OF

THE PANEL ON MARINE RESOURCES

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COMMITTEE ON SCIENCE AND TECHNOLOGY

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CHAPTER - I

INTRODUCTION

INTRODUCTION :

THE ocean and its inter-connecting seas form a continuous territory and cover about three-fourths of the earth's surface. Within these liquid expanses there are almost inexhaustible sources of food, minerals and energy. Even the continental shelf of the world's oceans, that is the area covered by 200 metres of water or less, is greater in area than that of the moon and it offers an almost virgin territory for those who would seek to explore it. Yet man has been able to touch only an infinitesimal part of these riches. The main deterrent has been his incomplete understanding of the ocean.

The exploration and exploitation of the ocean's resources require a tremendous amount of initial investment in money and skills. Yet, the very complexity of this effort offers, paradoxically, opportunities for significant break-throughs in our national economy. Development of marine resources such as fish, petroleum, sand and gravel, desalinated water, aquaculture,

phosphorite and manganese nodules, placer minerals, extracted chemicals, fish protein concentrates, etc is already possible with the available technology. Major countries of the world, recognising their potential economic importance, have already organised their efforts in this area. In India, however, consistent and co-ordinated efforts have not been made till now due to the absence of a formulated national policy, the unavailability of suitable technology and the lack of a project-oriented organisation charged with the specific responsibility of exploring and exploiting our marine resources.

A proper consideration of marine resources should begin with a summary of the characteristic features of the ocean. The physiographic features consist mainly of a continental shelf extending from the beach to a width as large as 1,300 kilometres with outer depths of 50 to 500 metres, a continental slope slanting rather abruptly downwards from the shelf to the ocean depths of 3 to 5 kilometres at a slope of about 5° , and deep abyssal plains consisting of flat lands beyond the slope. Isolated mountain peaks dot these plains, occasionally rising high enough to become oceanic islands. The

mid-oceans ridges, with a rift valley along its middle, roughly bisect the ocean basins (curiously, it also makes the longest continuous mountain range in the world).

The chemical features consist of a complex solution of dissolved chemicals with a surprisingly uniform content of approximately 40 chemicals constituting the common elements in the ocean's "salt", and a vastly more dilute and less understood solution of trace elements, and organic constituents that support and permit life to exist within the sea.

The biological features consist mainly of a variety of one-celled plants called phytoplanktons (over 10,000 known species) that support all marine life through photosynthesis, and an almost equally large variety of tiny animals called zooplankton that drift with the currents, an enormous variety (over 100,000 species have been identified) of invertebrates; fishes which range in size from a few centimetres in length to the large game fish weighing 1,000 kilograms and more, and mammals (e.g. whales, porpoises, seals, walrus, etc.) that form a curious classification that depends on the atmosphere for oxygen and includes some of the most intelligent animals in the whole sub-human kingdom.

The term 'resources', however, has an economic context that is, the ocean must not only have the physical capability of satisfying certain human needs, but it must also be possible for these benefits to be attained without using up more goods and services than are gained in the process. It has been estimated that the production of marine resource biological, chemical and geological amounted to Rs. 79 billion in 1964; in the same year, the land areas had yielded an estimated Rs. 2,500 billion worth of production. Of this, chemical resources accounted for a total of Rs. 3.75 billion, Rs. 2.25 billion coming from the ocean. Biological resources provided a total Rs. 1,995 billion with only Rs. 47 billion coming from the ocean, and of the geological resources estimated at Rs. 573 billion, only Rs. 28.5 billion came from the ocean. It must be noted that all of the marine chemical and geological resources and about 90 per cent of all biological resources have come from the continental shelf.

The major focus of marine activity today, however, tends to lie in mankind's search for food and energy. The total population of the world, which now numbers about three billion, is expected to double by the end

of the century and this has provoked an intense search for alternative sources of food. Of course, the sea can never satisfy the total food requirements of a very large sector of the human population. But it is an excellent source for a most critical element of the human diet, animal protein. Already some 15 per cent of the world's supply of animal proteins comes from the fisheries and it has been calculated that the potential yields, given the technology, is between 8 to 34 times the requirements. It has been estimated that ten grams of fish protein concentrate, a bacteriologically and biochemically safe and stable product of marine protein concentrate, could provide enough animal protein to meet the daily needs of a growing child at a cost of about Rs.15 per year (the commercial production cost will not exceed Rs. 4 per kilogram). A ton of hake when processed yields 146 kg of concentrate containing about 114 kg of protein. There the problem, however, will be to get the people to accept the product.

It is interesting that the harvest of marine food has increased since 1945 at a rate which considerably exceeds the rate of growth of human population. From

1955 to 1965, the commercial catch of fish increased at a compounded rate of more than 6 per cent per year. In part, this large increase resulted from exploiting fish stocks in highly productive areas of the oceans which had not been harvested before and also from the introduction of modern fishing methods such as factory ships and catchers. The Indian Ocean, however, produces only 2.4 million tons of fish which amounts to only 4 per cent of the total world production, though the potential fish catch from this area is estimated to be at least 3 to 6 times more. The major fishing areas in India today are confined to an offshore belt of 15 kilometres off the south-west coast, whereas the average shelf width is about 50 kilometres, and rich fishing grounds are available even further beyond the continental shelf. Waters which can sustain prawn and tuna have not been fully explored, and little attention has been paid to coastal aquaculture, i.e. the culture and raising of oysters, clams and mussels. On a rough average, the harvest from the ocean averages about 1.2 kg per hectare in general and about 24 kg per hectare on the continental shelf areas; but in fertilised fish ponds this productivity can be increased by as much as twenty times.

The success of oceanic fishing depends on our understanding of the location of the fish shoals and on the availability of sophisticated marine technology in the country. Location, tracking and identification of fish shoals involve two major steps: (1) search for the general area in which commercial concentrations are to be expected, and (2) the localisation and detection of the precise position of the fish. In most advanced countries, the long-range search involves large-scale mapping with heavy dependence on environmental information and receives much support from satellites and buoys with appropriate sensing equipment and computers. Localisation utilises sonars, odours emitted by fish, and even lasers and is critical with respect to groundfish. But each phase is dependent on basic data provided by biological research. Our fishing fleet consists of about 3,000 mechanised boats with the simplest of gear; compare this with the USA's over 76,000 powered crafts (ranging in price from Rs. 7,500 to as much as Rs. 13 million). It is thus clear that given an adequate programme and investment in appropriate hardware, a significant dent can be made on our food resources and nutritional standards by the exploitation of our seas.

A similar lack of urgency seems evident in our search for alternative energy resources. Take the case of oil. Approximately 20 per cent of world's reserve of oil have been established to lie offshore. India herself hopes to find about 115 million tonnes of oil offshore during the next 10 years and has set aside an outlay of Rs. 1,208 crores on the purchase of equipment and foreign consultancy services. Our potential oil provinces lie in the areas of Gulf of Cambay, Bombay High, Indo-Ceylonese Trough, Bay of Bengal and Andaman and Nicobar Islands, and the first offshore well at Aliabet has shown the existence of hydrocarbons in that area. Geophysical surveys, at a cost of about Rs. 7.5 million to demarcate the area for drilling, have been completed in the Bombay High region. The initial investments required for offshore drilling are 4 to 7 times higher than on land, primarily because of the cost of equipment (India has recently bought an offshore drilling unit at a cost of approximately Rs. 112 million), and also due to operations in dangerous and unknown ocean environment. It will take a few years before we can develop the expertise or the equipment necessary for our offshore

oil exploration programmes and this only if a planned, concerted research and development effort is mounted now. The fact that India imported crude oil worth Rs.102 crores in 1970-71 makes this all the more imperative. Moreover, although the existing programme seeks to go only up to 100-metre water depths on the outer shelf, it is becoming clearer that the continental rise and submarine-fan sediments lying at much greater depths may hold even a far larger wealth of petroleum resources.

The sea water itself is an excellent source of the soluble minerals like salt, potassium, magnesium and bromine. Every cubic kilometre of sea water contains about 40 million tons of dissolved solids which could have a value of more than Rs.75 billion when extracted. The exploitable mineral deposits are probably primarily the materials of the sediment and chemically-formed material at or near the surface, such as ferro-manganese nodules.

T A B L E - 1

MINERALS IN SEAWATER PER CAPITA FOR 6 BILLION PEOPLE

Mineral	Amount
Water	2×10^8 tons
Salt	6×10^6 tons
Magnesium	2×10^5 tons
Calcium	9×10^4 tons
Potassium	9×10^4 tons
Bromine	1×10^4 tons
Aluminium	200 tons
Manganese	2 tons
Copper	460 lbs
Silver	140 lbs
Gold	3 lbs

T A B L E - 2

SOME ELEMENTS IN FERRO-MANGANESE NODULES ON THE FLOOR OF THE PACIFIC OCEAN PER CAPITA FOR 6 BILLION PEOPLE.

Element	Amount
Manganese	60 tons
Iron	35 tons
Aluminium	7 tons
Nickel	2 tons

Copper 1 ton
Cobalt 1 ton

T A B L E - 3

VALUE OF PRODUCTION OF GEOLOGICAL RESOURCE FROM
THE OCEAN AND THE LAND (IN MILLION DOLLARS)

	Ocean	Land	Total
oil and gas	3,600	27,500	31,100
Sulphur	25	240	255
Sand and gravel	100	2,000	2,100
Titanium	33	37	70
Zircon	11	0	11
Tin	5	460	465
Diamonds	4	284	288
Monazite	1.5	0.3	1.8
Iron	0.7	5,300	5300.7
Gold	0	1,310	1,310
Phosphorites	0	375	375
Manganese	0	423	423

Productive operations for mining of submarine deposits of tin, diamonds, gold and iron in various parts of the world are well known. It is less widely known that the near-shore submarine deposits of sand and gravel are becoming increasingly important sources of construction

materials. It has been estimated that the minerals in seawater are present in large enough quantities to satisfy the potential demand for a number of decades if not centuries as shown in the tables 1 & 2.

It would be well, however, to point out that only a few of these minerals have any possibility of being economically mined with the present state of technology. In 1964, the total value of sea floor production of these minerals was about Rs. 285 million, while the value of the same minerals mined on land was Rs. 285 billion, only a bit more than half the Rs. 548 billion total production of all minerals on land.

In India, among other physical resources, heavy-mineral-rich beach sands containing monazite and ilmenite have been found on Kerala, Tamilnadu, Maharashtra, Andhra Pradesh and Orissa coasts. Ferromanganese nodules of 2.5 cm size and appreciable quantities of nickel and cobalt, besides 15 to 30 per cent manganese, have been sampled from various locations in the deeper parts of the Indian ridge and west of it, at 20° S, in the south-east Indian Ocean. Offshore occurrence of calcareous deposits suitable for chemical and cement industries have been

reported from bottom samples in Andaman and Nicobar and off Saurashtra, Kerala and Laccadive Islands. These deposits, which represent the remains of calcareous organisms such as corals, are expected to occur in many more areas all around the Indian Peninsula. Phosphate nodules and barium concentrations have also been recorded off the West Coast of India and Laccadive Islands while chromite has been found in the sea floor rifts in the Indian Ocean. The efforts to survey the extent of these resources have been few and far between and there has been no effort whatever to exploit these resources.

Further, development of large scale desalination of sea water using nuclear power is progressing rapidly in the world and the development of its technology may become important for the large urban centres near the sea. The Indian Atomic Energy Commission's plan for a similar effort is yet to get off the ground. The sea also has large potential sources of energy in the temperature-differential between surface and deeper water and at the surface between areas of upwelling and sinking. Theoretically this could provide 1,000 times the needed power, and one power plant to operate on this principle is under construction in

Abidjan in West Africa. Practical utilisation of this power source is not likely to be competitive with other sources at this stage, but this seems a fruitful area for engineering research.

The greatest potential resources for generation of energy are, however, the materials for atomic fission and fusion. It has been estimated that the thorium and uranium in the world's oceans could supply a power requirement for 6 billion people with a per capita requirement of .5 kwh per day for some 700,000 years and the deuterium and hydrogen could supply fusion power for times greater than the age of the solar system. The sea today, however, is used only as an excellent source of cooling water for absorbing waste heat. Till now little effort has been made to develop any extractive technology.

In India a large number of organisations have been working in the field of ocean sciences and engineering for a number of years. The Geological Survey of India is responsible for all investigations pertaining to geological sciences except for exploration and exploitation of oil and natural gas which is under the domain of the Oil and Natural Gas Commission. The

Atomic Energy Commission conducts studies on the deposition and replenishment of the minerals in the coastal regions as well as on the presence and behaviour of radio-active elements. The Tata Institute of Fundamental Research in Bombay has carried out research in chemical oceanography while the India Meteorological Department has done some work in marine meteorological studies. The National Institute of Oceanography, created in 1966, is responsible for carrying out research on the basic aspects of physical, chemical, geological and biological oceanography and also for handling oceanographical data. The Naval Hydrographic office conducts hydrographic studies while the Central Fisheries Research Institute and Central Institute for Fishery Technology are responsible for the work on fisheries development. There are, besides, a large number of institutions dealing with problems of research and exploitation of our living resources. Some consultancy and design engineering organisations have recently started to develop competence in offshore technology. There are also a number of Port Development Authorities as well as Beach Erosion & Protection Boards. Some state governments have their

own geological departments for carrying out geological surveys and some universities, like those in Andhra, Mysore, and Kerala are also involved in various coastal studies pertaining to marine geology, sciences and biology respectively. All these organisations and their research efforts are coordinated by the Indian National Committee on Oceanic Research (INCOR), established by the Government of India in 1960 for drawing up a programme for India's participation in the International Indian Ocean Expedition during 1962-65.

The multiplicity of organisations can be explained by the fact that the nation's marine interests are vast, complex and composed of many critical elements. Any worthwhile progress in this field would require a plan for national action and for orderly development of the uses of the sea. The plan must, in general, provide for a determined attack on immediate problems concurrently with initiation of a long-range programme to develop knowledge, technology and a framework of the laws and institutions that will lay the foundation for efficient and productive marine activities in the years ahead. It is clear that the creation of a strong central agency, which may be called the Commission

on Oceans and Ocean Resources (C.O.O.R.) would be necessary if our marine resources are to be effectively explored and exploited. A number of other countries have already started on such ventures.

The arguments for the creation of a Commission (C.O.O.R) in India are diverse. In the absence of an articulated national ocean policy or of specific national projects, the efforts of the many institutions in this area tend to be diffused and uncoordinated which leads to duplication of equipment on the one hand and the non-use of existing equipment on the other. Technology from abroad is imported without effective absorption or development on the basis of its import. Implications of this technology for peripheral areas are generally lost sight of. The scarcity of foreign exchange precludes import of new technology which in many cases would prove to be far more economical. The paucity of skilled personnel is paradoxically coupled with the non-use of the skills available, mainly because no flexible communications between the organisations exist. Hardware required for carrying out marine research exploration and development calls for substantial outlays. It is thus necessary to purchase equipments which could be utilised by a

number of these agencies and to develop an organisational structure which would give all users an access to these equipments. In some areas it is also necessary to start the development of indigenous technology and equipment. But this development is possible only if there is a coherent long term plan and an agency which is able to select the areas which would be of optimum use when coupled with the imported technology and equipment.

The research projects too cannot be carefully selected in the absence of a coordinating body. The educational programmes developed in the universities in the past have had very little to do with what is required in the field by the operating and consulting organisations. As this is an area of threshold technology, the challenges implied in working in this area should attract the best talent both within the country and from outside.

Another major lacuna in our system has been the absence of up-to-date information on various facets of marine technology around the world. Data collection regarding the physical environment needs to be centralised. Analyses of this data and presentation

for the benefit of the various user organisations are necessary. Much of the data can be collected by setting up various research projects under the different institutions while a central body could collect the information and make it available to all other organisations.

In view of these gaps in an area of threshold technology, the National Committee on Science & Technology set up a Panel on Marine Resources, with the specific objectives of :

Reviewing the known and contemplated needs for natural resources from the marine environment for the next 5-10 years.

Reviewing the surveys, applied research programmes and ocean engineering projects required to obtain the needed resources from the marine environment and assessing the current and planned ocean-oriented programmes for technical soundness, adequacy of scope, balance of content, appropriateness of organisation, funding and management.

Determining priorities and identifying existing programmes, including educational and technical,

training, which need to be supported and new programmes which need to be initiated.

Identifying a few specific project areas like offshore oil and gas, marine metallic and non-metallic minerals, biological and biomedical resources for designation as National Projects and recommending a plan of government organisations best adapted to support the objectives of the national oceanographic policy and to indicate the expected costs.

To carry out this assignment, the NCST Panel on Marine Resources formulated nine Planning Groups in the following areas -

- | | | |
|---|----------|------------------------|
| - Offshore Oil, Gas and Minerals | Chairman | Dr. G. Ramaswamy |
| - Fish and Fisheries | " | Dr. N.K. Panikkar |
| - The Marine Environment | " | Dr. P. Koteswaram |
| - Coastal Zone | " | Brig. O.P. Nerula |
| - Sea Water | " | Dr. D.J. Mehta |
| - Survey Instruments | " | Miss A Mani |
| - Equipment | " | Col. G.N. Bajpai |
| - Education, Research and Manpower. | " | Prof. B.H. Karakaraddi |
| - Information Management and Data Collection. | " | Dr. P.K. Das |

In the formulation of the science and technology plan for this sector, an attempt was made to involve a large number of the nation's scientists and technologists over a wide spectrum. Table 4 indicates the number of individuals who participated directly in this work.

T A B L E - 4
COMPOSITION OF THE PLANNING GROUPS

Groups	Universities and Educa- tional institu- tions	R & D Institutions		Design & Engineer- ing Organizations		Government Departments		Total
		Govern- ment	Private	Public	Private	Defence	Non Defence	
1. Fish & Fisheries	4	7		1		3		15
2. Minerals, Oil & Gas	4	7	0	25	4	2	9	51
3. Environment	3	4	1	1		5	1	15
4. Sea Water	1	9	-	2	1	-	2	15
5. Coastal Zone	3	1	1	4	1	-	5	15
6. Survey Instruments	1	8	1	4	-	2	8	24
7. Equipment	6	2	1	3	2	1	4	19
8. Research & Education	6	2	-	2	-	-	-	10
9. Information Management & Data Collection	2	4	1	2	1	3	3	16
	<u>30</u>	<u>44</u>	<u>5</u>	<u>44</u>	<u>9</u>	<u>13</u>	<u>35</u>	<u>180</u>

This document is a preliminary report based on the reports prepared by the various planning groups and is being issued for discussion and debate. On the basis of these discussions, the detailed reports under preparation, and the interaction with the executive agencies concerned, a final plan will be submitted for inclusion in the National Science and Technology Plan.

It has been the conviction of all those who have participated in the preparation of this document and the various planning group reports that a time has come when our country must give serious and systematic attention to our marine environment and to the potential resources of the oceans. This will require a national commitment to take the necessary steps to stimulate marine exploration, science, technology and financial investments on a vastly augmented scale. (In view of the urgency of the problem and the critical nature of the applied technology required for any marine project, a detailed plan of action for development of offshore technology has been included as a part of this report).

Above all there is need for new institutional initiatives. The planning groups have been unanimous

in their recommendation for a new central agency -
Commission on Oceans and Ocean Resources (C.O.O.R.)
While institutional changes will not, by themselves,
lead to success in this endeavour, they would cer-
tainly enhance the possibility of significant
breakthroughs in our national development.

Dr. A.K. Malhotra
Member, National Committee on Science &
Technology
Chairman, Panel on Marine Resources.

CHAPTER - II

THE MARINE ENVIRONMENT

I. INTRODUCTION

The nation's interests in the sea, the floor beneath and the atmosphere above it, require that it attain the capability to observe, describe, understand and predict the various oceanic processes. A multitude of environmental information is required ranging from the description of the topography, geophysics and geological structure and composition of the sea floor to the understanding of ocean physics and chemistry, biology, thermal structure, dynamics and the prediction of the continually changing short and long-term ocean and atmospheric phenomena such as variations in daily and seasonal weather and sea state. It is essential to consider the marine environment in its entirety comprising the ocean, atmosphere and solid earth as interconnecting parts of a single geophysical continuum.

The national economy will be served in many ways by improved capability to forecast changes in the

oceans and the atmosphere as well as by comprehensive knowledge of the geology, geophysics, biology and chemistry i.e. the complete ecosystem of the surrounding oceanic areas. Marine fishing industry, for example, will be better served by the knowledge of ocean currents and temperature, circulation and mixing, the topography and nature of the sea floor, the distribution of biomass and primary production in the oceans as well as by forecast of hazardous sea-state and weather conditions. The petroleum gas and mineral industries will be served by a knowledge of the broad geological and geophysical characteristics of the seabed as well as by the realtime forecast of wind and wave conditions. Ocean transportation will be served by improved marine weather and sea state predictions and by improved techniques of routing the ships safely and efficiently. Improved forecasts of weather and climate will have tremendous implications for protection of life and property as well as for the land and air transportation. Agricultural interests will be served by better forecasts as monsoons rains are the biggest marine resource provided by nature to serve all the

population living in the Indian sub-continent and East Asia, and the ability to understand the aberrations due to the air-sea interaction and their impact on the monsoon will be of immense benefit to the economy. Better environmental data will also yield important dividends in the efficiency and reliability of the materials and structures used in the sea water and in the engineering of marine and atmospheric systems including the systems to observe the sea itself. Determining the feasibility of long-term possibilities such as generating power from the tides, creating upwelling for fish farming, using underwater currents to dissipitate pollutants, artificially changing the natural pattern of rains, making fish schools migrate, altering the intensity of cyclones, all require detailed knowledge of our marine environment. Also this marine environmental information is of strategic importance to the country's naval interests.

New technological developments like remote sensing from aircrafts and satellites, large anchored buoys and floating platforms, deep submersibles, highly capable research and survey vessels, high-speed

communications to aid quick data transmission to forecast centres, computerised data processing systems etc. also help in the development of a comprehensive national environmental monitoring and prediction system. However, it is important to realise that in view of the large dimensions of the oceans and limitations on our resources, effective exploration of the oceans can best be achieved through a balanced and integrated programme of research, survey and exploitation.

II. NATIONAL OBJECTIVES

The national objectives should be to develop and implement an intensive programme to explore the marine environment, monitor its motions and physical, biological and chemical characteristics, investigate the feasibility and consequences of environmental modifications and predict the changes of the sea, air and certain aspects of the earth beneath the oceans.

It is recommended that the following objectives be aimed for over the next 15-year period

- In 5 years, integrated exploration programmes

should be launched with special reference to these areas which may have direct impact on nation's security (defence), fishery development and oil & gas, on the continental shelf and slope.

- In 10 years, these integrated programmes should provide a comprehensive picture, based on empirical data collected, upto a depth of 500 metres all along our continental shelf and slope and the superadjacent water mass.
- In 15 years, the mapping and the collection of environmental data should cover the entire Indian continental shelf.

III. MAJOR PROGRAMMES

The major objective of the national programmes should be to develop an environmental monitoring and prediction system, the basic components of which must meet multiple needs such as scientific, economic, legal-political, etc. The basic system is composed of facilities for observation of oceano-meteorologic and seabed data and its collection, processing and dissemination. These

marine environmental monitoring and prediction services have to be organised at three levels -

- i) Collection, processing and dissemination of ocean measurements that are collected in connection with the essential meteorological services such as by the I.M.D.
- ii) Collection of meteorological and oceanographic data and its processing which are collected by our defence services.
- iii) Collection of specialised marine data and their processing by various institutions for their own exclusive use.

The most important products of the system, at this time, are weather analysis and forecast warning of severe storms and cyclones, tidal predictions and sea state reports. The development of this system however, must be made in an integrated manner so that the data and forecast to meet the common needs can be provided in a coordinated manner, and hence, the following specific programmes need to be taken up by the Commission on Oceans and Ocean Resources (C.O.O.R.) :

1. A GENERAL ENVIRONMENTAL MONITORING AND PREDICTION SYSTEM.

The system will consist of the following elements .

a) Programmes for Data Collection

The India Meteorological Deptt. has arrangements to collect meteorological observations made from ships belonging to the voluntary observing fleet (VOF) consisting of 45 selected, 102 voluntary and 7 auxiliary ships. It is however, estimated that for a given day, there are 7 ships at sea for each ship-observation received. Clearly more data could be received by increasing the number of ships in the VOF programme at low cost. It would also be advantageous to equip atleast 25% of these ships, especially the selected ones, with relatively inexpensive shipboard equipment to take oceanographic observations. For this purpose an observer trained in taking oceanographic observations could be made available on board for each voyage.

It is expected that a number of offshore installations would soon be coming up in our continental waters especially in coastal areas, Gulf of Kutch, Gulf of Cambay, Bombay High, etc.. A programme needs to be developed to ensure that

the permanent platforms such as lighthouses, offshore production platforms etc. are instrumented to provide environmental data for our major forecasting programmes.

India should also encourage participation in international programmes for the collection of oceanographic data along the pre-designated routes from time to time as was done during IIOE and is planned for MONEX.

An integrated programme for meteorological and oceanographic observations through stationary and free-floating buoy networks must be launched. Initially, these networks of buoys should be concentrated in areas which are of direct interest to the defence, fisheries, oil and gas and the prediction of cyclones.

Combined research programme with the proposed national remote sensing agency should be launched so that their aircrafts are fitted with remote sensors that can measure ocean parameters like sea surface temperature, state of the sea, migration of fish schools,

detection of ocean currents, upwelling etc. Activities of the Space Commission may also be coordinated to ensure that the capabilities of satellites to probe the environment through photographs of clouds, sea surveys, temperature etc. are kept in view during the development stages.

b) A programme for data analysis & dissemination

The data that is generated through these various observations at sea will need to be processed, filtered and analysed to ensure the accuracy of forecast and consistency of results. Development of suitable formats for data collection, of computer programmes for storage, retrieval and dissemination and of research programmes for more accurate environmental prediction models - calibrated with actual observations - are all tasks which will need to be coordinated by the C.O.O.R.

The need to standardise the storage and retrieval formats, error-flagging and consistency checks, efficient data carriers and 3rd-generation computer complex make it imperative

that a central data agency, which may be called National Marine Data Center, should be established. Initially, this center may begin in a coordinating capacity with different specialised data agencies.

2. DEVELOPMENT OF A NATIONAL CYCLONE WARNING AND RESEARCH CENTRE.

Improvements in our capability to forecast cyclones, development and motion of the storms, storm-surges are urgently required. The plans of the India Meteorological Deptt. for the detection and forecasting of cyclones through the setting up of cyclone warning radars and satellites monitoring stations need to be accelerated. It is also necessary to expand the coverage of cyclones by flight of suitable aircrafts. The cyclone warning and research centre for research in the area of formation, movement and decay of tropical cyclones and their morphology as well as on the storm surges need to be taken up.

3. ENVIRONMENTAL MODIFICATIONS

A comprehensive programme of research and development to explore the possibility of beneficial modifi-

cations of environmental conditions and the facets of the interference with natural environmental processes needs to be taken up. These research programmes for environmental modifications will vary from weather modifications through silver iodide seeding of clouds to the study of biological consequences of thermal additions, canal dredging, pollution, etc.

4. MARINE GEOLOGY & GEOPHYSICS

Systematic mapping of the country's land mineral resources has been limited, and almost no work has been done on locating and mapping of such resources off our coasts. It is recommended that a long-term programme be commenced for a general mapping, through geophysical and other means of the sea bed upto a depth of 200 m over the next 20-year period. The programme should focus in the first 5-year period on those areas where exploitable mineral resources are expected to occur. In view of mineral potential, technology and resources available, it would be necessary that marine geological and geophysical investigations are planned in the following phases :

(i) Geology and tectonics of the continental terrace

The program would include bathymetric, seismic, & magnetic continuous profiling coupled with shallow sediment sampling and key boreholes in coastal areas and islands. Possible occurrences of minerals in the seabed would also be investigated.

On the basis of preliminary geological mapping, detailed investigations in structure and stratigraphy of the shelf areas and in favourable mineral-bearing areas shall have to be taken.

Beyond the 5-year period, specific mineral exploration programmes for calcareous and phosphatic sediments, heavy-mineral placers and deep-sea manganese nodules, shall be defined.

ii) Structure and stratigraphy of the submarine fans:

Geological and geophysical studies of the fans off Indus and Ganges and shallow geology of the Indian Ocean floor, Mid-oceanic ridges and rift valleys would be investigated in continuity of the above programme. These surveys are intended for general information on ocean floor, sediments, and concretions and on the

composition of lavas and superadjacent waters in mid-oceanic mountain areas.

5. MARINE BIOLOGY

The oceans present a host of unsolved biological problems many of which are linked with the goal of increasing the productivity of food from the sea. The core emphasis of marine biological research must be placed on understanding the dynamics of marine eco-system. It is necessary to understand the flow of energy and matter and through them the utilisation of nutrients, the efficiency of conversion between various trophic levels and a host of related matters. A comprehensive understanding of eco-system dynamics would be a major advance towards prediction and ultimate control of biological events. This understanding is closely related to physical, chemical and meteorological investigations of the mechanisms of environmental change.

During the first 5-year period integrated research programmes need to be managed to collect the requisite oceanographic data in selected areas off the West and East Coasts of India, to prepare and publish charts and atlases showing the distri-

bution of planktonic organisms as well as description of environmental features.

During the next 15 years the research programmes should be aimed at intensifying its observational studies along all the coast-line of India.

The key to the study of oceans lies in the ability to deploy present technological capabilities effectively and to focus on a number of critical technological developments which will provide the capability to do in the future what cannot be done today. For carrying out the above objectives and programmes, the two major technological inputs that are needed today are :

a) Research & Survey Vessels

It is estimated that approximately 15 ships and boats varying from 13 m to 70 m overall size will be required during the next 5 years for an integrated environmental programme to investigate physical, biological, geophysical and geological parameters on the continental shelf and the slope. This would have to be supplemented by additional ships during the following years. The development of research and survey vessel fleet thus

should be one of the major priority items to be tackled by the Commission on Oceans and Ocean Resources (C.O.O.R.).

The objective should be to develop an adequate fleet for the work to be done which is outlined above and to create an adequate organisational structure for it, such as a National Ocean Surveys Agency. While the long term objective should be to ensure that each major institution involved in marine work in the country has a survey vessel of its own, built around its specific requirements, in the initial period, it would be advisable for a central national ocean surveys agency to own and operate a fleet of survey vessels on behalf of the various institutions, keeping in view the diverse requirements of the country, through an integrated survey programme.

b) Instruments

No national marine survey programme can progress unless sufficient importance is given to research and development in marine instrumentation.

Instruments for measurement and control are

required in almost all fields of marine activity and are implicit in the environmental projects defined above. The placement, maintenance and recovery of instruments and their effectiveness depends on the reliability, ability of sensors and capability to record, store and transmit information. The area of marine instrumentation also has some special characteristics, such as :

- the developments are in its infancy even in the developed countries
- the market for instruments of any one kind in India is usually small

Some instruments which need to be developed on a priority basis are :

(i) Sonar Instruments :

A variety of echo sounders, seismic profilers and seabed sonars are currently in use for fish detection and rapid geophysical surveys.

It would be essential to develop low-cost echo sounders which can be made available to the small operator, fisherman, for locating grounds and detecting fish shoals.

(ii) Current Meters :

A wide demand exists for self-recording telemetering type and direct-reading current meters, for both research and determination of ship's speed through water. It would be necessary to select and develop one or more types of the current meters, such as, those based on Savonius rotor, propeller, electromagnetic principle or acoustic transmission in two directions.

(iii) Ocean Data Buoys :

Designs are already available for the largest type of ocean buoys, while the smallest buoys are generally special purpose models for single users. However, there is a case for the Indian industry to examine the market for intermediate-size, permanently-moored buoys having applications in the ocean data field. Whilst there are design problems relating to the buoy and its moorings, major difficulties arise in providing satisfactory unattended instrumentation (e.g. for one year's operation). C.O.O.R. could coordinate requirements with a view

to preparing specifications and award a design feasibility study leading to a prototype buoy.

(iv) Underwater Instruments:

Instruments which can operate satisfactorily underwater, based on optical and sonar techniques deserve a high priority. These include underwater lighting and communication systems, cameras, television that may be operated either by remote control or by divers. Another equipment which needs immediate consideration is the 'side-scan sonar' utilised for hydrographic surveys, salvage and various defence operations.

There is today no coordinated research and development programme within the country for developing oceanographic instruments indigenously. A major effort is needed to develop specific instruments required for monitoring the environment by building up these capabilities within a number of organisations such as Central Water & Power Research Station, NGRI, IMD, etc. The primary objectives for the development of instruments should focus on those required for environmental monitoring in relation to our fisheries exploration and exploitation, for production of oil and gas from the sea and for defence purposes.

CHAPTER - III

RESOURCES FROM THE OCEANS

There is today no coordinated national policy decisions on the exploration and exploitation of marine resources. Policy decisions on marine resources require evaluation of long-term estimate of supply and demand, techniques of exploitation, access to foreign sources, technological capability development and the acquisition of data for long-term planning of resource management. Our attempt to explore and exploit marine resources off our 5000-km long coastline have been extremely meagre and it is necessary for the government to mount a sustained coordinated effort to explore and exploit both the living and non-living marine resources.

A. LIVING RESOURCES

I. Introduction

The ultimate potential for food from the sea remains unknown. The total annual world harvest from the oceans is estimated to be over 50 million metric tons, and fish provide about 3% of man's direct protein consumption. Whereas fish is also fed to land animals, fish is the basis of about 10% of all animal protein food production. The

marine fish production in India within the past one decade has gone up from 0.68 million metric tons in 1961 to 1.55 million metric tons in 1971. However, India's production was only about 40% of the total marine fish production in the Indian Ocean in 1970 and it is estimated that the annual potential catch from the Indian oceans is about 14 million tons. Our known coastal and offshore resources are thus estimated to be sufficient to support a fishing effort of 3 to 6 times the present level of exploitation. Expansion of the fishery production, however, is a matter of advancing on several fronts by way of improving the technical efficiency of harvesting known stocks, locating and defining new stocks, recasting the institutional setting for fisheries management, developing new end-product from presently unutilised or under-utilised species and opening up the new field of aquaculture.

II. National Objectives

Overall national objectives on marine fisheries must be to double the marine fish product in the

next 5 years. This accelerated programme for increasing the total production of fish and for exploiting our living resources can be planned along the following lines -

a) Coastal fishing

The objective should be to exploit, using the traditional means of country crafts and mechanised small boats, the marine resources upto and within the 20-fathom line.

b) Offshore and deep-sea fishing

Intensification of the effort by utilising larger fishing vessels for offshore fishing upto 40 fathoms and for deep-sea fishing upto 100 fathoms.

c) Distant water fishing

Initiation of an effort for fishing in distant areas by using self-contained large mother/factory ships.

The role of marine fishery management must be to develop an economically efficient and technically advanced fishing fleet with the minimum number of units required to take the catch

over a prolonged period of time. This would require a coordinated effort along well defined lines for -

- a) Surveys and exploratory fishing programme to establish potential or latent stocks.
- b) Basic biological studies to provide a basis for yield assessment.
- c) Development of more efficient methods for processing and handling fish products including quality control and increasingly diversified product utilisation.

III. Major Programmes

A few time-bound projects need to be undertaken with a view to achieving these objectives :

i) Pelagic Fishery Project (1971-76)

The project envisages exploration of the West Coast pelagic fishery resources using fully-equipped research and survey vessels and employing foreign experts and Indian counterpart scientists and technicians.

ii) East Coast Survey Project (1974-79)

The recent location of rich grounds of deep-sea lobster and prawns lends evidence to the

existence of potentially rich fishing grounds off the east coast. A full fledged survey of the East Coast is proposed to be undertaken through UNDP assisted programme of exploration.

iii) Survey Project on the North-West Coast of India (1975-80).

A detailed survey of the fishery resources of the North-West Coast of India, both demersal and pelagic, between 30 and 100 fathoms is proposed to be taken up with the assistance of Scandinavian Development Agency (SIDA).

Besides these a number of special projects need to be launched in the various institutions for improving our marine fishery exploration and exploitation programmes :

1. Increase in productivity in coastal fishing requires investments both on traditional fishing and on mechanised vessels :
 - a) Traditional Fishing
 - Improvements to shore seines, use of synthetic twine and shore-fixed power winches.

- Improvements to non-powered boats, by suitable designs, availability of material for construction, provision of improved sails, insulated boxes, etc.
- Provision for ice and cold storage facilities at each fishing centre. As small units are extremely uneconomical, the aim should be to instal sufficiently large plants at important distributing centres and to link the same with fishing villages, using insulated trailers which could serve as stationary units also.
- Provision of up-to-date fish curing yards equipped with artificial fish driers.

b) Mechanised Fleet

The following research projects need to be undertaken to ensure that return per unit investment for mechanised fishing is profitable :

- i) Determination of the most economic size and horse power of boats to be used under varying conditions. As larger boats are clearly not proportionately more efficient

in all circumstances, great care has to be taken to see that they are introduced only in areas where their introduction results in a proportionate benefit.

ii) Use of cheaper material for boat construction:

Limited experiments in introduction of ferrocement boats have indicated the scope for significant reduction in the cost of hulls. While studies on alternative material are intensified, a separate project is needed for pilot scale manufacture of ferro-cement boats.

iii) Reduction in the cost of engines through large scale manufacture of suitable designs.

2. Increase of productivity in offshore and deep-sea fishing :

The resources already located within a depth of 40 fathom can be effectively exploited by the 17.5m vessels, at present being constructed indigenously, by converting them for use as trawlers, long liners or seiners. The bulk of economic deep-sea fishing, even by technologically

developed countries is by using minimum sizes trawlers and it is recommended that concentration for the next 5 years should be on exploitation using these vessels. Two programmes need to be undertaken for these objectives -

i) Design & construction of future indigenous fishing vessels.

There is an urgent requirement for developing/locating suitable designs for fishing vessels to be built in India for various types of fishing. For this it is recommended that a Central Marine Design Orgn. be established to coordinate, select and evolve designs of fishing vessels together with accessories, supervise construction in accordance with the approved design and specifications, and to lay down standards for all types of fishing vessels. The design organisation would also have facilities to carry out intensive evaluation trials of different types of fishing vessels already imported to ensure development of indigenous designs.

It is also recommended that 2 shipyards should be designated/established on each coast who would specialise in construction of indigenous fishing vessels required in the foreseeable future.

ii) Development of fishery harbours

A concerted effort needs to be made to develop fishery harbours with adequate landing and berthing facilities for the estimated increase of mechanised fishing vessels.

3. Distant Water Fishing

Because the capital investment required for owning and operating large factory ships suitable for fishing in distant areas is very large, it is recommended that the government acquire one such vessel from abroad. It would be necessary that a separate commercial organisation be set up around this factory ship for the exploitation of the deep-sea fish. This vessel can be used for the harvesting of the tunas, bill fishes and variety of larger sharks, crustacean species from the

southern tip of the country as well as from the Laccadive & Andaman groups of islands.

4. Development of Processing Facilities

A coordinated approach needs to be evolved in respect of providing infrastructure and support facilities for optimum utilisation of available resources and marketing of the catch. The development of indigenous equipment for processing of fishing projects needs to be given higher priority. This would include the provision of cold storage facilities at the fisheries harbours and for long-distance transport by truck or by rail. This would also include research on problems of preventing spoilage of fish on non-mechanised and smaller mechanised fishing crafts.

5. Fisheries Research

The research projects being handled by the various organisations within the country need to be better focussed and problem-oriented. In the field of marine fisheries, research emphasis should be shifted from conventional fish policy studies to actual work on fisheries

which would include estimation of **stocks** of exploited, under exploited and new resources, location of potential fishing grounds, impact of fishing intensity on the abundance of stocks, preparation of area-wise fishery maps, incorporating resources data with environmental data, and a critical study of the various environmental factors which would enable forecasting the trends in fisheries. Research projects also need to be started on evolving suitable techniques for aquaculture and economically important marine organisms such as mussels, oysters, crabs, prawns, seaweeds, etc. Technological research covering craft and gear technology needs to be strengthened and support for it increased. On processing technology, the thrust should be to evolve better methods for processed fish for domestic markets alongwith the improved and diversified of fishery products and by-products for export trade. Some research projects also need to be started on the study of bacteriology of spoilage in storage and application of modern methods like irradiation and cryogenics in fish preservation. Developmental contracts need to

be given for the development of insulated rail vans, use of nitrogen as refrigerant, etc.

6. Extension

Extension work has been the weak link of marine fishery development. Basic organisational changes need to be made in these organisations. This would include the setting up of training courses for processing technicians, fleet operators, service mechanics, fishermen, better techniques for trade statistics and popularisation of fishery products and by-products etc. Adequate testing facilities, in view of their importance in commercialisation of operations, also need to become a part of extension organisations.

B. NON-LIVING RESOURCES

Oil, natural gas, and minerals in various forms _ dissolved, placer, nodule, and lode - and the water itself constitute the inventory of non-living resources in and under the sea. The energies of the oceans at some future time also may gain economic importance if commercial means to harness them are found. Although each of the industry engaged in the recovery of non-living marine resources presents unique problems, they share certain common technological needs such as environmental data, geophysical characteristics and geology of the ocean floor, bathymetry and installation of recovery equipment.

a) OIL & GAS

I. INTRODUCTION

India's requirement of crude oil and petroleum products is sharply increasing and is expected to be of the order of 26 million tons by 1973-74. In 1970 India imported 11.674 million tons of crude oil at a foreign exchange cost of Rs. 102.4 crores. In 1978-79 the total requirement is expected to be of the order of 42 million

tons and in 1983-84 about 85 million tons. Indigenous production of crude oil in 1973-74 is expected to be only about 8 million tons and the balance will have to be imported in the form of crude and products at a cost of approximately 280 crores of rupees. ONGC's 10-year profile (1969-79) for offshore oil exploration and production estimates approximately 8 million tons per annum offshore by 1978-79. An assessment has been made that the shortfall by 1978-79 taking into account both the onshore and the offshore production would be of the order of 20.6 million tons which would cost the country about Rs. 480 crores in foreign exchange per annum. It is expected that prospective offshore areas hold the best probability of success in the near future. A major break-through in the exploration of production in crude oil in the offshore areas over the next 10 to 15 years is needed. In view of the anticipated shortfalls and the necessity for intensifying exploration work on our continental shelf

the government have also recently announced a change in their policy by inviting foreign collaboration, on product-sharing basis, for exploring and producing in our offshore areas.

II. NATIONAL OBJECTIVES

It is necessary to ensure that adequate crude oil supplies are found within our country and to attain self-sufficiency in crude oil in the shortest time possible. A three-pronged strategy for meeting these objective is recommended :

- (a) Intensification of the indigenous effort for oil exploration and production,
- (b) Intensification of effort in indigenous waters, and
- (c) Intensification of effort for obtaining crude oil supplies outside the country preferably under Indian ownership.

III. MAJOR PROGRAMMES :

To carry out these programmes, a number of major projects need to be started for developing capability to carry out complete geophysical surveys and exploratory drilling over the continental shelf,

to design, fabricate and instal oil drilling and production facilities in 100-m deep waters in the next 5 years, and to lay submarine pipelines upto atleast 50-m water depth.

i) Development of Seismic Survey & Interpretation capability.

A detailed geophysical exploration programme needs to be drawn out to cover the entire continental shelf and slope areas in the shortest possible period. This includes the semi-enclosed water bodies such as the Gulf of Cambay and the Gulf of Kutch as well as union territories of Andaman and Nicobar Islands and their submarine continuation. This would require a combination of indigenous equipment, manpower & know-how, such as in the form of a seismic vessel and interpretation hardware and that which may be obtained from foreign sources. To date, the marine seismic exploration program has been almost completely dependent on foreign expertise and equipment in the absence of an adequate vessel and essential onboard indigenous expertise.

It would be essential to buy a seismic survey vessel immediately along with the necessary onboard equipment for seismic shooting, data gathering and processing. At the same time developmental contracts should be awarded for conventional as well as new seismic sources, hydrophone arrays and various data processing equipment. New research on how to reduce signal-to-noise ratio and proper reception of desired frequency ranges needs to be taken up in geophysical research institutes.

- ii) A suitable shallow-water mobile drilling platform for the Gulf of Cambay. Since the mouth of the Gulf of Cambay has various shifting sand banks, it is dangerous to take Sagar Samrat inside the Gulf. A large number of favourable structures have already been located in shallow waters of the Gulf of Cambay, and an intensified effort would thus become possible.
- iii) Development of capability for design, fabrication and installation of fixed production platforms.

Since the major cost of producing oil from, an

offshore field is in the cost of production platforms, it is important that the country develops capability for their design, fabrication and installation. This would require a combination of research and development projects for :

- a) Development of capability for design of production platforms subject to severe environmental forces during SW monsoon and tropical cyclones. Besides the design-environmental conditions along specific stretches of coastline based on existing data, theoretical designs of various types (e.g. jack-up, semisubs) of platforms, mooring facilities, etc. need to be performed. Inventories of material, expertise, equipment required for these platforms, their sources of supply etc. can be drawn up as well as the designs of supply and crew vessels, storage facilities etc.

- b) Development of Fabrication capability :
The existing workshops on the coastal areas are capable of developing their

facilities to cater for the large-size offshore production platforms, if given sufficient time. It is necessary to commence an exercise by which a selected number of fabrication organisations start developing their capability for fabricating and handling large size tubular platforms.

c) Development of Installation Capability:

The installation cost for offshore production platform in deep water constitutes about 50% of the total cost of the structure. It is, therefore, necessary that R&D projects are commenced to see if existing capabilities can be used for installing the production platforms by limiting the size of the various modules or by controlled flooding of members. This would also require the development of models for testing.

iv) Development of capability for Design Fabrication and Installation of Submarine Pipelines.

Submarine pipelines will be required for the transport of oil, petroleum products and iron-

ore-slurry from the shore installation to the large-size tankers. A development project needs to be commenced for -

- a) Developing design engineering and model testing capability for the submarine pipelines for the transport of various kinds of products.
- b) A field project needs to be initiated, in collaboration with the existing companies, for developing techniques for the installation of submarine pipeline in shallow water and in marshy areas. This project would also include evaluation of the available indigenous equipment and its possible utilisation for the various submarine pipeline jobs for the country.

v) Development of Marine Equipments

A major lacuna in our capability is the availability of equipment suitable for operations in the marine environment. A coordinated programme of development needs to be launched for the common marine equipment for various offshore operations

such as rotary coring rigs for soil investigations, pile-driving, pile hammers, suitably mounted for operations in deep waters, special mooring tugs and winches, stringers for pipe laying operations, etc.

vi) Marine Instrumentation

A number of research and development projects need to be commenced to develop capability and knowledge in those technological fields which are required for the country's offshore oil exploration programme in mid 1970s. These cover areas like deep-sea diving, underwater welding, explosives, under-water cutters, oil pollution control, marine corrosion, etc. Some of these would have to be developed through the mechanisms of developmental contracting to existing institutions while others would require the development of information through research project in the educational and research institutions.

The major inputs required for attaining the above objectives are:

a. Purchase of a seismic survey vessel

completely equipped for carrying out surveys in deep waters. With this vessel and the existing capabilities within the country for operating the seismic survey equipment and for interpreting the results, it should be possible to develop a competent self-contained organisation which could carry out surveys not only within the country but also outside on contracts.

- b. R & D Programme/developmental contracts-
Planning and funding.

It is necessary that a mechanism be developed for funding the research and development programmes and developmental contracts in anticipation of the marine environmental problems which will be encountered by the country's offshore oil exploration programmes. These programmes may be divided into basic research programmes to be taken up mainly by scientific institutions and the technology and equipment development

programmes taken up by the IITs, engineering research establishments and industries. These programmes can be coordinated by the Commission on Oceans and Ocean Resources (C.O.O.R.) so as to obtain maximum results at minimum costs in the short lead time that is now available.

Purchase of a Derrick-cum-Pipe-laying Barge.
It is estimated that for producing an offshore oil field of 10 million tons per year the total investment required would be of the order of Rs. 300 crores. A significant portion of the above investment cost is for the material, structures and installation cost. For example, a single platform in 200 ft. of water would cost approx. Rs. 5 crores and a submarine pipeline would cost about Rs. 50 lakh per km. Of these cost the installation equipment, mobilisation/demobilisation and rental costs would constitute approximately half of the total investment that is required. It is, therefore, recommended

that the country go in for the purchase of a multipurpose-derrick-cum-lay barge when production operations commence in the offshore areas. The hire of such an equipment from outside sources would necessitate a cost of the order of 500,000 dollars for mobilisation and \$40,000 per day for rental. Therefore, an advance action is much required to purchase/develop such a vessel. A specialist group under the Commission on Ocean and Ocean Resources (C.O.O.R.) can examine some of the existing vessels, and suggest the modifications required for providing the necessary multi-functional support to the various offshore activities.

d. Organisation of Design Engineering & Construction Operations.

The variety and depth of activities involved in the construction operations are indicated in Appendix I. While some of these should be carried out by suitable extension of the existing organisations in the

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public and the private sector, it may be necessary for the Commission on Ocean and Ocean Resources (C.O.O.R.) to coordinate the growth of these capabilities within these organisations in a phased manner.

The development of capabilities for carrying out offshore works at an early enough date is accentuated by the policy changes made by the government recently to permit foreign collaboration for offshore oil exploration and production on our continental shelf. It needs to be stressed that the government should take immediate action to set up a multi-disciplinary coordinated effort under the Commission on Ocean and Ocean Resources (C.O.O.R.) to develop the indigenous capabilities for offshore technology required so that if oil is found, even by the foreign companies, the amount of foreign exchange that would be payable to them for its production is decreased sharply by the utilisation of the indigenous capabilities and facilities. This development would also provide an impetus to the indigenous oil exploration

effort by providing them with a complete package of skills and services. It may also be noted that the development of skills would serve a variety of other projects in the future such as setting up of submarine pipeline and SPM systems for iron-ore export, sewage outfalls, design of super-ports and offshore terminals for oil import and commodity import-export, setting up of lighthouses and cyclone warning towers, for dredging of ports, etc.

A detailed note on the Development of Offshore Technology is given in Appendix I.

b) OTHER MINERALS

I. INTRODUCTION

The state of the marine mining industry in the world is still in its infancy. In 1967, nearly one billion dollar of offshore world mineral production was carried out and of that 20% came from the US waters. However, about 35% of the world's total was accounted for by coal recovered through tunnels from the shore and about 40% from chemicals extracted from the sea water.

Few types of hard mineral deposits extend from land offshore thus making the projections of favourable direct area much more difficult. Further the exploratory techniques are more expensive because the horizontal dimensions of most hard mineral deposits are smaller. The steps for discovery to production of hard minerals also involve considerably more effort and, except for near-shore operations, involve costly and complex technology.

In India, as far as offshore mineral deposits are concerned, the most important are the monazite and ilmenite-rich sands of the southwest coast. Dredging for lime sand is being carried out in the shallow areas off Jamnagar and the production in 1971 was 1,022,759 tons. Lime shells dredged from Vimbanad lake in Kerala were of the order of 94,000 tons in 1971. Small quantities of garnet-rich sands have also been recovered from the beaches of Tamilnadu.

II. NATIONAL OBJECTIVES

A beginning must be made for the geological mapping and analysis of the continental shelves and simultaneous

development of fundamental technology required for production of offshore minerals. Geological survey programmes should concentrate first in offshore areas having the highest potential for minerals, secondly in areas of scientific significance to enhance our understanding of the geological history of the continental shelves and slopes and thirdly in those coastal areas where the population is increasing rapidly and where planning and management will need sound basic information.

The goal should be that :

- (a) a preliminary geological map of the continental margin based on reconnaissance is prepared within the next 5 years.
- (b) a detailed survey of the known mineral occurrences and favourable areas should be completed within the next 15 years. These detailed surveys would provide an immediate assessment of the mineral resources in the offshore areas of the country.

III. MAJOR PROGRAMMES :

For carrying out the above objectives, a number

of projects need to be undertaken in a coordinated manner within the agencies, where the facilities exist :

i) Geological Mapping and Exploration

.. To obtain the basic knowledge of the geology of the continental margin and prepare a preliminary geological map of the continental margin, a survey and exploration programme needs to be carried out. This would include key bore holes in coastal areas and islands, stratigraphy, detailed investigations of heavy-mineral placers in offshore areas especially for the radio-active mineral deposits. The marine surveys be supplemented by air-borne magnetic surveys.

ii) Research Projects

A number of research projects relating to biogenous deposits, chemogenous deposits and terrigenous deposits need to be undertaken. This would include experimental studies for the formation of heavy mineral placer deposits, elementary geochemistry of marine sediments and studies on the sediments and hard rocks.

iii) Development of Fundamental Technology
in Offshore Minerals.

Besides the exploration stage in offshore mineral an applied technology needs to be developed within the country for the exploitation of offshore mineral resources. This would consist of projects for the development of high-strength and corrosion-resistant materials, hoist cables, laying flexible pipes, power packs to lift high loads of minerals, new sensors, and research on the simultaneous flow of solids, liquids, and gases through long pipes.

Development/^{at}contracts for producing the sophisticated equipment required for these activities such as dredging components, processing units, life support activities etc. would need to be placed.

For carrying out offshore works a number of equipment will have to be developed and some major items may need to be imported such as -

a) Dredgers for Submarine Pipelines

It is estimated that nearly 400 km of

submarine pipeline would be laid in the next 10 years off our continental shelf. Since dredging would be involved for cutting trenches to bury the pipelines it would be advisable to purchase equipment like grab, jet grabs etc.

b) Experimental Projects on Offshore Mineral Recovery

It is recommended that one dredger of special type suitable for mining upto 50-100 metre depths be acquired to carry out experimental work for offshore mineral exploitation. Other relevant research programmes such as, air-lift method, connected with recovery of minerals from offshore areas, also need to be undertaken.

c. SEA WATER

I. INTRODUCTION

Considerable work needs to be done to utilise the potential offered by sea water through desalination utilisation of marine algal resources and sea water irriculture. At present there are more than

100 large-size desalination plants over the world and 29 huge-capacity projects are under implementation. Sea weed farming has become an industry in a number of Asian countries. These are artificially cultivated on large scale in the coastal waters around Japan. Various raw materials are extracted from seaweeds, such as, agar, algin and carogeneen. The use of sea water for irrigation purpose on coastal dune sand is being attempted in several countries including Israel, Spain, Sweden, USA. The development of this technology in India would promote the exploitation of otherwise waste lands of the vast coastal tracts of the Indian shores.

II. NATIONAL OBJECTIVES

Although some work is being carried out in these areas within the country, there is a need to increase the investments on research and development work so that the benefits which are possible from the optimal use of sea water are available.

The following objectives are recommended :

a) Desalination of Sea Water

A balanced desalination programme should direct its attention to 3 key areas -

i) Techniques for meeting large-scale regional

water needs especially those of metropolitan coastal population.

ii) More reliable and efficient smaller plants for isolated shore sites and islands.

iii) Systems for industrial and municipal refuse of waste water.

b) Utilisation of Marine Algal Resources

Seaweeds form the basic raw material for important industries like agar agar, algin and carogeneen. An extensive survey needs to be carried out along the coastal areas including Andaman, Nicobar and Laccadive Islands to

locate spots of natural abundance of seaweeds.

c) Sea Water Irriculture

A new technology for sea water irriculture needs to be developed to promote growing crops and medicinal plants that can take the fluctuating salinity of sea water and their yield and quality need to be improved.

III. MAJOR PROGRAMMES

A number of research programmes need to be taken up -

i) Desalination of sea water

Research projects for desalination of sea

water need to be taken up in an intensified project -oriented manner for the following projects :

- a) Desalination of sea water by distillation techniques.
- b) Ship-borne desalination plants including treatment of waste water.
- c) Desalination by freezing including crystallization.

ii) Utilisation of Marine Algal Resources

The research and development programmes for the utilisation of marine algal resources should consist of :

- a) Survey of economically useful seaweeds.
- b) Large-scale cultivation of useful seaweeds for industrial purposes.
- c) Processing of seaweeds as cattle feed-supplement and protein.
- d) Recovery of chemicals like iodine from seaweeds.
- e) Pharmaceuticals from seaweeds.

Research projects need to be undertaken to help develop the science of growing plants

under sea water irrigation. This would include assessment of sea water tolerances on some of the food, fibre, cash crops and medicinal plants.

- Assessment of sea water tolerances.
- Field experiments with the evaluated crops and their improvement under sea water irrigation.
- Studies on the effects of accumulation of toxic elements.
- Stress physiology under sea-water irrigation.

CHAPTER - IV
THE COASTAL ZONE

1. INTRODUCTION

The global sea trade has increased from 550 million tonnes in 1950 to 2500 million tonnes in 1970. A major portion of this trade is bulk cargo, liquid and dry; oil alone accounting, for over 50% of the sea-borne trade. This increase in trade, especially with regard to bulk cargo, has vastly influenced the newer port developments. Transportation and port costs form a significant portion of total delivered costs of the cargoes, and, therefore, new techniques are constantly being developed to reduce the unit cost of transportation. These include large-sized vessels (VLCCs, OBO carriers, etc.), specialised ships, such as cellular vessels, liquified gas carriers, barge ships, unitisation of general cargo (pre-slinging, pallets, containers, RO/RO, barges) and speedier methods of cargo handling. Handling rates of 15 tonnes per hour for breakbulk, 200 tph for containers and 1400 tph for barges are common. Oil discharge rates have increased from 3,000 tph for 30,000 DWT to 15,000 tph

for VLCCs. Iron ore loading rates have also reached 15,000 tph; unloading is much slower but rates of 2,500 tph are normal. Higher rates of handling have been achieved by pumping iron ore in slurry form. Other dry bulk cargo rates are necessarily slower, but 3,000 to 4,000 tph are being increasingly adopted.

Due to the increase in size of VLCCs and ore carriers, the maintenance of inshore harbours, especially with regard to dredging, has become very expensive. Offshore terminals, such as fixed-tower platforms and floating and fixed single buoy moorings, have therefore been developed. With these unconventional structures new materials, equipment and techniques of construction, such as, high tensile steel, pipe laying barges, purpose built heavy duty equipment etc. have emerged.

With the increase in oil trade and offshore development of oil supply, the threat of major oil spills and its harmful effect on the coastal zone have also been recognised. Pollution control and abatement have great relevance in

the context of preservation of coastal water for human activities. Sea, along with the rivers and marshland has too long been considered a natural dumping ground for all waste matter, frequently untreated. Conflicting central, state & municipal laws and regulations govern this area adding to the problems of enacting effective laws. The UN conference on maritime pollution has recommended that maritime nations should prevent pollution by ships. Also USA, UK & Japan now require industries to use pollution control measures and to treat the effluents before discharging wastes into rivers and seas. Port authorities are also being increasingly compelled to provide for pollution control measures.

Although coastal areas are used for shipping, recreation, waste disposal and resources exploration, adequate knowledge is not yet available about coastal zone processes. The problems of coastal erosion and siltation still pose serious threats to our coastal installations. Methods adopted to save land and keep the

navigation channels open vary widely at different locations, and occasionally result in adverse affects on other areas. There are a number of organisations all over the world engaged in the study of coastal and nearshore processes. Some of the important aspects being studied are wave action, shore processes, tides and surges, river-sea interaction, environmental data collection, etc.

Port development work in India is controlled by the government. Traffic handled by major ports has increased from 19 million tonnes in 1950 to 56 million tonnes in 1970, with major increases being in dry and liquid bulk. Indian shipping has also increased with the addition of 85,000 DWT bulk carriers and tankers, and would continue so with the purchase orders having been placed for 126,000 DWT bulk carriers and 269,000 DWT tankers. However, Indian shipping accounts for only 20% of this trade; total tonnage for 1972 was 25 lakhs GRT and the target for end of the fourth plan is only 40 lakhs GRT. A number of ports have been developed to handle 50,000 DWT to 80,000 DWT, but there are no programmes to go beyond 100,000 DWT.

With the increase in trade, new cargo handling facilities have been adopted for speedier handling. Ore loading facilities upto 8,000 tph have been planned at a number of ports and oil handling rates of 3,000 tph can be attained. Unitisation in the form of preslinging and palletisation is being used at major ports, and container facilities are to be provided at Haldia, Nhava-Sheva and Cochin.

To examine working and development of major ports, a Commission was set up in 1968. This Commission made a number of important recommendations, such as, for improving general cargo handling, dredging, unitisation, minor port development, and no need for new major ports, etc. A committee has also been set up to examine development of minor ports. A National Harbour Board meets once a year and deals with broad policies relating to ports. Major ports, declared by Central Govt. statutes, are administered in accordance with Central Govt. Acts while minor and intermediate ports are under the jurisdiction of the respective state governments. The major source of funds for port developments

are government loans and funds with little self-financing. Also there are few centrally executed schemes for dredging and survey of minor ports, development of facilities for Andaman and Nicobar Islands and intensive development of selected intermediate ports. The major purposes of these funds are port maintenance, replacement of equipment and crafts, provision of additional berths and handling capacity, and facilities for fisheries activities. Acquisition of specialised equipment has been taken up, and an inventory of existing major equipment has been made.

The major ocean industries related to ports and shipping are ship-building and ship-repairing. There are today, five major ship yards, the largest being at Visakhapatnam, building vessels upto 20,000 DWT. A sixth yard is being developed at Cochin for construction of vessels upto 85,000 DWT. Though Indian shipping has increased from 59 vessels in 1947 to 256 vessels in 1972, mainly for overseas trade, there is a wide gap between indigenous shipping requirement and shipping production.

In addition to the major shipbuilding yards, there are 11 repairing yards, only 7 of which are available for merchant ships. The largest yard is at Visakhapatnam for vessels upto 70,000 DWT. These are inadequate for domestic shipping and substantial foreign exchange is incurred for repairing and docking Indian vessels abroad. At least six more docks are required but only one is planned, at Cochin for vessels upto 85,000 DWT. The ancillary ship repair industry are also not capable of major repairs and have little modern equipment.

Coastal zone management is generally poor, with only the major ports exercising limited control within their port limits. No regulations exist for pollution control and prevention, though the Government of India has brought forward a "Bill for prevention of Water Pollution (1969)". Another area of major concern is that of coastal erosion. Severe erosion occurs in Kerala, Orissa and West Bengal. Although a Beach Erosion Board was established in 1966, it was mainly concerned with the Kerala Coast. In 1971 a reconstituted

board was set up with representatives from other maritime states as well. A number of Indian organisations (CWPRS, GSI, NIO, etc.) are now engaged in coastal studies and problems of harbour siltation.

The main areas in which Indian development is lagging behind are

- (a) Lack of an independent authority for processing port development works;
- (b) Inefficient management and staffing;
- (c) Inadequate financial policies;
- (d) Lack of central control of coastal activities;
- (e) Lack of modern equipment & materials;
- (f) Inadequate ship-repair facilities;
- (g) Low share of cargo moved by Indian ships.

II. NATIONAL OBJECTIVES :

The national objectives should be to develop and implement programmes for speedier cargo handling, facilities for large-sized vessels, acquisition of specialised equipment for ports, such as tugs, dredgers, navigational aids, dry-dock machinery, training of personnel in shipping and marine works.

India's sea-borne traffic was about 56 million tonnes in 1970 at major ports only. The projections for 1974 indicate that this will rise to 66 million tonnes, bulk cargo, dry and liquid, accounting for 75% of the traffic. The projected traffic at the end of the Fifth Plan (1979) is about 107 million tonnes, iron ore export accounting for over 40% of this. Minor Port traffic is expected to nearly double from 1970 to 1979. Therefore, it is important to develop the necessary infrastructure, equipment and organisation, to tackle the large traffic. Also in the development of port facilities in the decade beyond 1979 new innovations and changes in port concept as well as shipping and transport are expected. High-capacity equipment and offshore structures are more likely facilities than building new ports.

The objective of carrying at least 50% of Indian seaborne trade by Indian shipping should be implemented. The targets set for acquiring shipping tonnage still fall considerably short of this objective. Due to the peculiar nature of

our coastal and shallow harbours, special designs will have to be evolved for low-draft vessels.

Technical and skilled manpower requirement for shipping and marine industry will need to be increased considerably. Establishment of industries, such as, deep-sea fishing, offshore structures, ship-repairs will further increase requirement of specialists and skilled personnel.

With the increased utilisation of the offshore areas, efficient management of coastal zone activities is required. Promotion of recreation and tourism should not conflict with tapping these areas for food and industrial development.

Development is required in mapping and study of coastal zone and coastal processes and reliable wave-forecasting methods. Indigenous consultancy capability should be improved in respect of port facilities, both inshore and offshore, and R&D programmes should be initiated for optimum and economic coastal structures.

III. MAJOR PROGRAMMES

The basic aim should be to develop coordinated and integrated policies for the development of the Coastal Zone and suitable organisations for implementation of these policies. Integrated development calls for proper planning of the ports and port-based industries, sea resorts, fishing complexes, coast-based industrial complexes, offshore exploration, etc. Existing gaps have to be bridged by means of collection of data, R&D programmes, optimum utilisation of existing facilities, mechanisation and better management.

1. Development of Ports:

Large-scale developments of Indian ports have already started. Economic development of port regions should, however, receive greater attention by Central and State Govts. Improved cargo handling facilities are required, especially with respect to bulk handling, both wet and dry. Development of major as well as minor ports should be based on techno-economic considerations and should

be centrally coordinated. A central dredging pool has been set up, but additional dredgers are required. It may be advisable to set up a National Dredging and Salvage Corporation to acquire, operate and maintain dredgers required for capital & maintenance dredging. This could be split up for East & West Coasts. Incentives need to be offered for intensive utilisation of berths and facilities. The development plan of port industries, such as, ship-yards, is inadequate to meet the demands of Indian shipping. High priority is to be given to develop additional yards and procurement of vessels from overseas. Productivity and capacities of existing yards should also be increased. The smaller yards could be programmed to design and develop small vessels which can operate economically in coastal waters, and thereby increase the sea transport, in coordination with the land transport. Adequate repair yards

are also required to reduce foreign exchange expenditure and also increase foreign exchange earnings.

2. Coastal Pollution Control:

With development of ports and port-based industries, threat of coastal pollution will increase. A detailed study of this problem needs to be undertaken for few selected stretches of the coastline. The provisions of "Preservation of Water Pollution Bill 1969" are comprehensive to take care of the problems of water and coastal pollution, and a specified limit of the sea from the shore, harbours, etc. would need to be brought under the provisions of the Bill. Research laboratories could be utilised for collection of basic data. For dealing with minor spills appropriate organisation and equipment needs to be developed. Large spills should be treated as a major disaster, and an organisation should be formed for dealing with anti-pollution operations. Until then, the

Indian Navy, Port Trusts, etc. could be made responsible for dealing with oil pollution. Training of personnel to deal with pollution, and R&D programmes for manufacture of indigenous equipment need to be taken up.

3. R&D Programmes:

The following research programmes need to be taken up:-

- (i) Collection of data for coastal areas, such as aerial photography, direction and volume of coastal drift, siltation, erosion, river sediment discharge and dispersal, meteorology, tides.
- (ii) New materials for harbour construction, such as fibreglass, plastics, anti-corrosive coatings, high-strength metals, etc. Development of items such as marine fenders, floating breakwaters, offshore platforms, dredging equipment. Study of ship behaviour in channels and at berths and propulsion of marine craft. Development of electronic

instruments for navigation, evaluation and dissemination of oceanographic data.

- (iii) Oceanographic study for offshore structures and determining the influence of natural agents in cleaning the coastal waters.
- (iv) Evaluation of marine forces on structures, and design of inexpensive shore protection and offshore facilities.

In conclusion, there is a need to set up a central coastal commission, similar to CW & PC. The Commission will coordinate an integrated policy for development of the coastal zone and implement these policies. Its objectives would also be to initiate R&D programmes, enforce water pollution act, and administer all coastal zone activities. To get suitably qualified personnel for the proposed Commission existing facilities should be used for training of graduate engineers.

CHAPTER - V

DEVELOPING TECHNOLOGICAL CAPABILITIES

I. INTRODUCTION

For carrying out the major programmes in the marine areas, it is necessary to develop technological capability within the country. The development of national capability in the marine area must be built upon an expanding base of knowledge and practical skills. Some of the basic components of this capability are an adequate system for the education and training of the necessary technicians, scientists and engineers, an organisation for information and data services, both for scientific research and actual operations, and the provision of support services necessary for operation at sea, such as, navigation, mapping, rescue and safety etc.

Understanding the sea is the task of marine sciences and the improvement of operational skills, equipment and method, the total capability to utilise the ocean is the responsibility of marine technology. The development of basic science and technology both fundamental and applied, requires, however, a

proper institutional framework, establishment of programmes, creation of facilities, man power, strong communication channels among the many segments of the scientific and engineering community and adequate funds. Operations in the sea also require certain indispensable technical and operating services. To move from one place in the oceans to another requires nautical charts and aids to navigation. Safe operation on, under and over the ocean calls for rescue facilities as well as adequate law enforcement. It is, therefore, necessary to organise an integrated national programme to build capability in marine science and technology as well as in the necessary support services.

II. NATIONAL OBJECTIVES

It should be the endeavour to provide, in a phased manner, the necessary capabilities within the country to satisfy all the needs for the various programmes mentioned in the earlier chapters including adequate facilities for education and training. These specialised tasks can only be accomplished, through a close integration and development of the nation's scientific and technological services.

III. MAJOR PROGRAMMES

a) Education

Education in marine science and technology within the country is provided by many different institutions with very little coordination between them. While a number of institutions provide training in limited marine areas there are no centres explicitly geared to the training of engineers and technologists. For effective training in these rather highly specialised, multi-disciplinary fields, the basic requirement is generally a degree in fundamental science with broad background of the physical and natural sciences. The total body of oceanic knowledge is really advanced by the pursuit of fundamental understanding of the biological, physical, geological and chemical characteristics of the planetary ocean without regard to immediate application. As far as technology is concerned it is necessary to simultaneously develop capabilities in fundamental technology and in instruments and facilities to undertake the scientific tasks which may be necessary

for the effective use of the sea. It is important to draw a distinction between fundamental and applied technology and to stress that both these need to be developed. An example of this would be the materials necessary for activities in the sea. Salt water is an inhospitable medium and yet all marine activities today depend greatly on material developed initially for use on land and in the air. Fundamental work in improving material technology would not only result in lower costs for construction, operation and maintenance of structures and equipment but also provide greater reliability, efficiency and safety. Entirely new engineering methods presently not feasible due to the inadequacy or unsuitability of materials would become feasible. Therefore a wide spectrum of marine activities would be advanced through progress in the fundamental technology of materials.

In India facilities for educational training in the area of marine living resources are provided in a number of institutes and

and universities (a list of the institutions providing courses is given in Appendix II).

There is however no university or Institute in India which offers fullfledged courses in ocean sciences, such as, at the post-graduate level in marine geology, geophysics and geochemistry. To improve and prepare better qualified marine scientists and technologists, the following programmes need to be undertaken:

1) Training Facilities

One of the primary lacuna pointed out by the Planning Groups is the absence of practical training due to lack of sufficient specialised facilities, such as, vessels, etc. Because there is also a paucity of marine scientific instrumentation, little practical training can be imparted to the students for work at sea. A programme needs to be drawn up through which the students in the area of marine sciences are able to use research vessels and instrumentation for a prescribed minimum period of time during their

education. This may be done through the central coordinating body that has been recommended i.e. NOSA, which could utilise the existing facilities available with the various agencies in the field such as GSI, ONGC NIO for educational training purposes as well.

ii) Special funds for development of Marine Sciences

For expanding the activities in applied research, training and education, it is necessary that demonstration and extension services for sea based industries are provided. A fund for specific projects related to marine resources development needs to be set up by COOR. This special fund could make awards to institutions of higher education dealing with the marine sciences for building their infrastructure and capabilities. It could also be responsible for providing funds towards the specific projects related to the development of marine resources.

iii) Extension Courses

The existing institutions would also need to be provided funds and facilities to carry out regular extension courses for the benefit of personnel already working in the field. This would ensure that the latest research and the new technology are transferred at the earliest to the operators in the field. Special attention should be given to methods for updating mid-careers skills and for aiding transfer across disciplines. The transfer of scientists, engineers and technicians from land to marine activities will follow the opening of new opportunities in the sea. But in some specialities the transfer requires re-education, reorientation and special courses need to be organised in these areas.

b) Man Power

Attempts to determine the number of trained and educated people available for marine operations or to forecast future requirements

inevitably encounter serious difficulties. The principle problem in this is one of definition and of correlating the supply of trained people with the jobs that are available. Although degrees are granted in oceanography by a few universities, and their holders may work as oceanographer attached to the Port Trusts, most marine scientists obtain their degrees in the basic scientific disciplines. The 2-year courses that are given to convert basic scientists into oceanographers needs to be made more rigorous so that oceanography, for example, is recognised as profession to be followed thereafter. The same is true of ocean engineering which is just now emerging as an accepted term. An ocean engineer practices specially in the marine environment or in activities related to the sea and basically has a marine orientation. To a degree the same problem exists in the various technical specialities as well. Although, it is possible to identify some exclusive specialities, such as, fisheries technician, oceanography aide or

divers, others such as laboratory technician or biological, library technician are skilled in both land and marine activities. Presently, many technicians whose work relates entirely to marine matters never go to sea. The basic point is that many of these scientists, technicians and engineers who are trained in the fundamental subjects can be, after a brief period of intensive training, made available for work in the marine related works. While universities are turning out considerable number of graduates in the marine sciences, many of them are not able to find adequate number of jobs primarily because there is a mismatch between the supply and demand and the quality expected of these products. One of the fields, however, in which there is a critical shortage of personnel is that of deep sea fishing. Some assessment has been made about these operations during the 5th Plan period and is given in table below and it is estimated that similar trend would follow during the 6th Plan period ;

<u>Category of Personnel</u>	<u>Number required during fifth plan period,</u>
1. Skippers	400
2. Fishing second hands	1400
3. Sea-going Engine Drivers	400
4. Engine Drivers - Class I	1400
5. Shore Mechanics	1500
6. Boat building Foremen	120
7. Gear Technicians	150
8. Radio Telephone Operators	400
9. Trained Teachers	120

One of the prime reasons why there is a paucity of personnel in this area is that the facilities required for them to get the necessary "sea time" under the Mercantile Marine Department regulations are not available.

Since the existing institutions, like CIFO are not yet fully equipped to give sea time to all trainees, there is bound to be a shortage.

In order to meet these shortages, it is necessary to provide two large vessels, with 40-50 trainee berths, and to equip these

vessels for effective fishing. These trainee vessels would be adequate to provide the necessary sea time to the various personnel required for the expanding programme of off-shore and deep sea fishing during the 5th and 6th Five Year Plans.

Also there is today no single agency with the overall responsibility for marine man-power matters, although several agencies, operating with nominal coordination, are supporting, initiating or planning marine educational and man power programmes. It is recommended that COOR should be assigned the responsibility to obtain, organise and maintain marine man power statistics, to analyse trends in man power requirements in all marine fields, to project future requirements, to coordinate marine education and training activities and to maintain an inventory of marine educational facilities including ships and shore installations.

c) Information & Data Services

One of the key element in effective working

at sea is the availability of accurate and adequate data, in time. Oceanographic data are generally collected at great expense and that too with great difficulty by a number of different agencies. It is, however, necessary to establish and maintain appropriate data centres for the storage, retrieval and dissemination of such data, including measurements of the physical and chemical studies of the ocean atmosphere as well as geological, chemical and biological samples readily amenable to numerical storage in computer systems.

There are many gaps in the collection of data and their dissemination in our country. The most important gap in the field of marine data is the limited number of ships' observations in general, and paucity of observations from areas of low traffic density in particular. There are also much time gaps in the retrieval of data due to faulty archiving, lack of computers and inventory equipment. Time gaps also exist between the making of observation in the field, their arrival at the collecting

centres and their dissemination to the actual users. There is no coordinated system of data centres for storing and retrieving oceanographic data. As a result large amounts of useable data are not available to the potential users. For example, physical, biological and geological investigations carried on by mission-oriented agencies like ONGC, GSI, universities and oceanographic institutions, frequently result in collection of large and diverse samples. In many instances, only a small portion of the collection is studied and the remaining portion of the samples, which constitute more than 90% of the collection and are valuable for future reference, are not retained in the absence of suitable storage facilities. It would seem rational to insist that adequate storage facilities and appropriate curatorial responsibility be assigned to these agencies to ensure that these valuable materials are not lost. Since the cost of maintenance are relatively small compared to the cost of obtaining the collection, they should be considered as part of the operating expenses of the national oceanographic data collection programme.

The information that is collected from various sources in the marine field are utilised by various ocean industries such as -

i) Cement Industry

The industry needs information on depletion and movement of sand and hence requires a detailed study of the processes of sedimentation.

ii) Weather routing of ships

The technique of weather routing is yet to be utilised in India although it could save considerable expenses both in the transit time of vessels and safety. This, however, requires an ability to produce reliable forecasts of the surface winds and waves, 48 to 72 hours ahead and to predict the environmental conditions in the area so as to recommend an optimum route depending on the characteristics and loading of each ship.

iii) Offshore drilling operations

The erection, installation and operation of exploration and production systems for oil offshore require the prediction of

environmental conditions both for design and for operations.

iv) Fishing Industry

Meteorological services for fishing crafts already exist but they need to be suitably augmented.

v) Defence

Oceanographic data of almost all categories, particularly of underwater conditions, is of great significance to defence.

In the field of data collection, storage and retrieval the most important requirement is the setting up of an organisation to be called the National Marine Data Centre to coordinate the existing data collecting agencies and to serve as a nucleus for a Central Data Bank. In the country today there is no centralised data collecting agency, and the departments like the IMD, NHO, CWERS NPOL, NIO and D.G. Shipping have collected and stored data piece-meal to meet the needs of their particular field of work. Further a large volume of marine data are likely to be generated by the expanded research programmes and the increased use of continuous

remote sensing and recording devices, on research and survey vessels, buoys, submersibles and satellites. It is thus necessary that a central coordinate agency be set up under the COOR to provide an effective contribution in the field of data collection, archiving, retrieval and coordination. The main functions of this National Marine Data Centre could be the following -

- to improve coordination between user agencies.
- to standardise formats.
- to prepare bibliographics, maintain a reference library and issue publications.
- to devise measures for effective quality control and error flagging procedures.
- to collect data from other data centres, store and process them and retrieve them as and when necessary for users.

To meet the computer requirements of this National Marine Data Centre, a computer complex system would be needed which should have the following characteristics :-

- Large memory
- Push down (stack type) memory for information retrieval and other non-numeric problems.

- Multi-programming facilities to accomodate at least two to three simultaneous programs with hardware protect features.
- Multi-channel facilities with few remote control channels.
- Magnetic tape units
- Disk drives
- Printers
- Card Reader punch
- Plotter.

Besides this there would also be a need for the training of data scientists for the proposed centre.

d) Support Services

To carry out the work in the marine areas, it is necessary that a number of support services be developed in a phased and integrated manner such as mapping and charting of the oceans, providing testing facilities and an organisation to ensure safety at sea.

Mapping and charting provide graphic description of the marine environment in terms of various properties with paramount interest to users.

A map is a graphical representation of certain

features of properties while a chart is a specialised map intended primarily for navigational use. Nautical charts provide information about bottom depth, shoreline configuration, location of dangers, man made features and navigational aids. Marine maps provides information about such features as bathymetric, magnetic, gravity and sediment type and thickness.

Mapping the bathymetry and the geophysical characteristic of the continental shelves and slopes is a top priority task. This task is being done at the moment primarily by the Naval Hydrographic Office. They have drawn up a long-term programme, including purchase of properly equipped and supported ships, for the collection, processing and map compilation of our continental shelves.

With the increase in offshore activities there would also come, progressively, a need for an organisation to enforce the laws for fisheries and as well as to provide safety and salvaging services. It would be necessary for them to provide for a fleet of vessels which would perform

a number of jobs as indicated above and would also have the powers of inspection and enforcement. This may be done by expanding the existing organisation such as the Customs or, the Deptt. of Lighthouses & Lightships or by the creation of entirely new organisation similar to the U.S. Coast Guards.

Another major areas where there is a tremendous technological gap in the country is that of instrumentation. The development of instruments suitable for use in marine areas has been stressed in a previous chapter but one major supporting service that is required to complement the production programme is the presence of an instrument testing and calibration facility. The data that is generated through the various surveys must inspire confidence and provide a measure of compatibility with the data obtained from other sources. What is really needed at this stage is a facility to define, in a common language, the desirable characteristics of an oceanographic instrument, to test it

and calibrate it, so that the operational measurements could be certified within acceptable tolerances. In addition, it is necessary to define standards against which instrument may be callibrated, the definition of performance and test criteria and the development of field and laboratory facilities and techniques to test instruments against these standards.

CHAPTER - VI

ORGANISING THE NATIONAL EFFORT

I. THE INSTITUTIONAL IMPERATIVES :

The previous chapters have pointed out the need for developing national capabilities for exploration and exploitation of marine resources, for monitoring and predicting the ocean environment and for administering the coastal zone. There has been a general consensus in the various planning groups that in order to meet the overall interest of the country, a central agency for overall planning and coordination of marine resources and management was necessary.

A large number of research institutions/organisations in India are involved in marine resources and oceanography and a summary of the fields of their study is given in Appendix III. Each of these institutions/organisations generally has a special interest in some specific field. It is necessary that some of them should maintain their identities and be strengthened further so that they would be contributory to

the national marine effort. Others should be combined with weaker elements to provide a new central focus. Because the work till now has been spread over a large number of organisations, the optimum level of critical requirements necessary to mount an effective effort to explore and exploit our marine resources has not been possible. Many of the sectoral marine programmes are, for example, too small to have any impact. Equally important is their isolation from each other which even coordinating mechanisms like INCOR are never able to overcome, and which has caused an inevitable degree of insularity and competition. Perhaps, most significantly, their very isolation has made it very difficult to launch a comprehensive and integrated programme to remove the obstacles that stand in the way of full utilisation of our oceans and their resources.

An analysis of the requirements and programmes submitted by the various planning groups shows that a number of general purpose activities like environmental monitoring, production technology,

marine instrumentation etc. serve common needs of many government and private users. Many of these activities are strongly inter-related, are based on common technology and are best conducted in an integrated manner. Their effective implementation requires overall systems management which can be achieved only if they are brought together under a single head. Also, existing marine programmes do not cover the full spectrum of functions necessary to meet the nation's needs. New programmes must be created and it is important that there is, in the Central Government, a single agency, of sufficiently broad mandate and capabilities, to provide for their enunciation and for their development.

In getting a major effort under way, the case for creating a new and independent organisation is compelling. An independent agency can bring an ambitiousness and urgency in outlook and freedom of action, which are difficult to attain within an existing department. Its greater public visibility would draw stronger public interest and support, and the head of the independent agency would be

better able to organise the agency's activities to achieve the multiple purpose of a national ocean programme.

It is therefore our conviction that the objectives of the marine resources and management programmes recommended by the various planning groups can be achieved only by creating a strong civil agency within the central government with adequate authority and adequate resources. No such agency now exists and no existing single central agency provides an adequate base on which to build such an organisation.

The agency that is created to implement the national ocean programme must be of a size and scope commensurate with the magnitude, importance and complexity of the problems it seeks to solve, the services it seeks to render and to its potential for contribution to the well being of the society.

A broad mandate is required to advance the more effective use of the sea and our understanding of the total sea, air environment, with a flexibility of organisation to meet new needs as and when they arise. Bringing together functions now distributed among several different departments would create a

national capability to attack oceanic and marine resources problems which will be far more effective than can be achieved through today's individualistic, often half-hearted, efforts. A strong operating commission with a broad and coherent mission in marine resources, oceanographic work and the related technology would also contribute to the better achievement by other agencies, such as, ONGC, GSI, etc. in their central missions by obviating the need for them to develop marine activities oriented to their specific interests. It is clear that a system relying upon coordination of organisationally disbursed activities, no matter how well administered, is not a substitute for a single operating organisation having authority and capability commensurate with the scope and urgency of the national marine resources and management programme.

II. THE COMMISSION ON OCEANS AND OCEAN RESOURCES (C.O.O.R.)

The primary function of the Commission would be to ensure the full and wise use of the marine resources and the environment in the best interest of the country. The Commission would be entrusted with the

following functions :-

- a) To plan, guide, direct and execute through the existing organisations, where they exist, a unified approach to the problems of the ocean and the atmosphere and the marine resources.
- b) To finance, set up or operate facilities for the exploration, exploitation and conservation of marine resources including those of the sea bed.
- c) To consolidate efforts towards acquiring a greater knowledge of oceans; ocean-atmosphere and coastal phenomena.
- d) To prepare and execute a long-term marine resources and ocean development plan.
- e) To coordinate the work of the various government departments, universities etc. in the field of oceanography, and to ensure that the resources of these agencies are pooled together and used economically to the maximum advantage in accordance with the national priorities laid down by the Commission.
- f) To act as the sole advisor at the national level on the seeking and dissemination of oceanographic

data, available with the different departments, to international bodies, world data centre etc. taking due measures in respect of the national security and defence. The Commission may advise on the manner by which national data storage and retrieving centre is created and controlled.

- g) To maintain scientific and technical liaison in the field of oceanography and marine resources with other countries at both governmental and non-governmental levels.
- h) To advise the Central Government on all matters regarding oceans and ocean resource development.
- i) To design, promote and implement policies for the provision and development of appropriate marine technology and instruments for marine operations.
- j) To manage a coordinated programme of research and development for developing the national capabilities to use the marine environments.
- k) To launch a number of national projects recommended by the NCST Planning Groups.

- l) To help assure the availability of educated and trained manpower adequate for the National Marine Resources and Development Programmes.
- m) To provide essential services to all users of the marine environment including navigation maps, charts, data, instruments, standards and testing services etc.
- n) To advise the government on the measures, legislation and finance needed to execute the programmes drawn up by the planning groups for ocean resources and management.

The Members of the Commission should be mainly scientists and technologists in specialised areas. Administrative and Naval representative in the concerned subject could also be members of the Commission while the Ministry of Defence could be represented at an appropriate level to look after the security and defence aspects. Whereas the Commission will be embarking on an unchartered task its strength and financial support would increase gradually depending on the nature and scale of activities the Commission decides to undertake.

III. CONCLUSION

In this preliminary report, the NCST panel on Marine Resources has refrained deliberately from framing precise financial commitments required of the Nation. A part of the reason certainly is the difficulty involved in deriving costs of projects in uncharted territories, but the main constraint has been our view that a basic reorganisation of the national effort is needed to make effective use of any financial resources deployed for work in the oceans. In the absence of this institutional imperative, funds are likely to remain at subcritical levels with only marginal returns to the economy. It is only through the creation of a major marine agency that a national effort can be launched. Even if fiscal constraints require that this effort be begun on a modest scale, action on the necessary reorganisation is a prerequisite for any future expansion. Reorganisation cannot be a substitute for new programmes, but neither can programmes be launched with maximum effectiveness through our existing machinery of Government. And if our oceans and ocean resources are to be effectively utilised, it is necessary that the organisations are created, with adequate resources and formal authority.

APPENDIX - I

OFFSHORE TECHNOLOGY AND INDIA'S OFFSHORE

PROGRAMMES

OFFSHORE TECHNOLOGY AND INDIA'S OFFSHORE PROGRAMMES.

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OFFSHORE TECHNOLOGY AND INDIA'S OFFSHORE PROGRAMMES.

1. DEVELOPMENT OF OFFSHORE TECHNOLOGY ABROAD

The world energy consumption is expected to double from the present rate of 87 million barrels per day to 160 million barrels per day at the end of the next year. As the demand is increasing at the rate of about 10% per annum, there has been a tremendous increase in activity for oil exploration and production offshore. Offshore oil exploration production commenced in the late 1940s and today about 20% of the world's crude oil production outside USSR comes from the continental shelf and the offshore activities are increasing at the rate of about 16% per annum. Today more than 400 mobile offshore rigs are drilling on the continental shelf of atleast 70 countries. Oil and gas offshore has been discovered in 37 countries and 25 of these are now in commercial production.

The increased activities offshore have been made possible by the development of technology in a number of areas such as the development of technology for design, fabrication and installation of fixed offshore platforms for production of oil offshore, for laying submarine pipeline and offshore oil terminals, for single point mooring systems, submarine storage tank etc. These systems and activities have in turn led to the development of related offshore services and equipment such as pile driving hammers of over 40,000 ft. pound energy, underwater technology, under water cutting and welding techniques navigation etc. In the world today technology and equipment are available for the exploration of oil and gas from offshore areas in water depths

of upto 400 metres though so far all commercial quantities of oil have been produced in water depths of 100 metres or less. For exploration of oil and gas offshore, the following different types of platforms/vessels are in use :

1. Fixed drilling platforms in 6 m to 35 m water depths.
2. Mobile platforms
 - a) Jack-up type for 25 m to 100 m water depths.
 - b) Semi-submersible for 30 m to 125 m of water depths.
 - c) Submersible (posted barge) for 10 to 15 m water depths.
3. Floating vessels for 30 m to 60 m of water depth (Catamaran Barge or single hull ship/barge).
4. Drill ship with dynamic positioning for water depth of 30 m and beyond.

For erection of fixed platforms and for supply of material and equipment etc. the following types of vessels are available :

1. Derrick Barges of 800 tons capacity.
2. High speed towing-cum-supply boats.
3. Barges upto 1000 tons capacity and above.

In advanced countries, drilling technology has been developed for drilling directional wells with angle of inclination as high as 80°. This technique is being used for drilling a group of development wells from fixed platforms. It has also been found that this technique is useful and economical for drilling exploratory wells from fixed platforms as it results in the reduction of requirement of fixed platforms for exploratory drilling in a particular area. Advanced technology for sub-sea well completion is available besides the technology for above water completions. Necessary know-how is

also available for the following :-

- i) Production platforms for deep waters.
- ii) Subsea storage techniques.
- iii) Deep sea diving techniques.

2. NEED FOR DEVELOPING OFFSHORE TECHNOLOGY IN INDIA

Offshore technology is an area of threshold technology requiring a multi-disciplinary approach and having a large amount of fall out effects in related areas. Not only can it be used for offshore oil exploration and production, this technology, when developed, could also be utilised by the country for its offshore oil terminals for receiving very large crude carriers, for submarine pipeline for export of iron ore slurry, offshore lighthouses, ports and harbour development works and for various naval works. The development of offshore technology, which would imply adequate planned investment in areas varying from underwater welding to oil pollution control, from offshore drilling technology to laying of submarine pipelines using indigenous equipment needs to be taken up on emergency basis for a variety of reasons.

According to the projections of the Ministry of Petroleum & Chemicals and the Planning Commission, it has been estimated that in 1978-79 our annual crude oil requirements would be of the order of 42 million tons while the total production, due to a fairly ambitious onshore programme and a rudimentary offshore programme, with an outlay of Rs. 624 crores (of which Rs.166 crores will be in foreign exchange), would be 11.4 million tons. This would require an import of 30.6 million tons of crude oil at an annual cost of Rs. 480 crores in foreign exchange in 1978-79. And this foreign exchange outflow will increase

progressively if no indigenous crude oil is discovered in our onshore and offshore areas. In view of these anticipated shortages as well as the magnitude of the capital required for exploring and exploiting crude oil reserves in the offshore areas, where according to the Ministry, existence of large reserves of oil is most probable, the government has recently enunciated a policy for foreign collaboration in the offshore areas. There would therefore be an intensified effort in the next decade for exploration for oil in our offshore areas not only by our Oil and Natural Gas Commission but also by various foreign companies operating under the new guidelines published by the Ministry.

In this it is necessary to point out that the major portion of investment in offshore oil exploration occurs in the commercial production phase rather than in the exploration stage, and the investment relevant to commercial production are heavily dependent on the cost of installation, development drilling, submarine pipeline, transportation, production platforms, offshore oil storage etc. Another area of heavy investment is that of the construction equipment which would be required for the installation work in the offshore areas. By a planned investment, however, it should be possible to obviate the need for renting heavy construction equipment from foreign sources at the cost of 40 to 50,000 dollars per day and also for developing capabilities for design, installation and operation for offshore oil fields within the next 3 to 5 years. Since it would take at least 2 years from now for commercial reserves to be proved, if a parallel action is initiated on both exploration and production, a substantial portion of the hardware and software required for production could be

could be made available from indigenous sources by the time commercial reserves are proven either by our own offshore unit or by the foreign companies operating in our waters. This would greatly reduce the need for large investments to be made by foreign companies for the production operations and consequently reduce the foreign exchange outflow or the need for selling our crude oil to pay for their services.

Further in view of the anticipated short falls in crude oil, it would be necessary for India to import large quantities of crude oil from oil producing countries. It is anticipated that the refinery capacity by 1978-79 would be of the order of 36 million tons requiring the import of substantial crude oil. Since the cost of transportation of crude oil forms an important part of the total cost paid by the country for import of crude, it would be desirable to explore ways and means of reducing transportation costs. Table I (enclosed) indicated relationship of transportation cost to that of the size of tankers and shows that substantial economies are possible if larger tankers are used. It is important to note, however, that the very large crude carriers require the development of offshore terminals since the existing port handling capacity within the country and even those planned for the next 10 years do not permit the use of very large crude carriers. In Table II (enclosed) a rough estimate has been made of the freight savings possible by using very large crude carriers (that is VLCC class of tankers 160,000 tons and above) as compared to the present MR or LR class tankers. Some other advantages of providing suitable offshore oil terminals for VLCC type tankers for import of crude oil or export

TABLE - I

Distance in miles for round trip.	Cost in US \$ per ton for the tanker size in 1000 tons.								
	20	30	40	50	60	70	80	90	100
3000	1.8	1.4	1.2	1.0	0.9	0.05	0.85	0.8	0.8
5000	2.7	2.2	1.8	1.6	1.4	1.35	1.25	1.2	1.12
8000	4.0	3.3	2.8	2.4	2.2	2.00	1.09	1.8	1.7
10000	5.4	3.8	3.2	2.8	2.6	2.04	2.02	2.1	2.0
16000	-	5.8	4.8	4.2	3.7	3.05	3.02	3.1	2.9

TABLE - II

(Freight savings per year in rupees/crores)

<u>Name of the Port</u>	<u>1976</u>	<u>1978</u>	<u>1980</u>
Bombay	2.2	2.9	2.9
Goa	2.0	3.1	3.1
Cochin	3.2	3.2	3.2
Madras	1.6	1.6	3.2
Vizag	2.0	2.0	2.5
Haldia	5.7	8.8	6.5
Salaya	3.1	6.3	9.9
TOTAL -	<u>19.8</u>	<u>27.9</u>	<u>31.3</u>

of iron ore slurry are that as oil traffic represents about 1/3rd of the total traffic dealt with by our ports, substantial capacity would be released for other traffic. Also the magnitude of investment required for creating conventional type berths and other facilities at the ports and normal dredging for dealing with the increased volume of oil traffic would probably be 5 to 10 times more than what would be required for putting up offshore terminals. The technology that is developed for offshore oil production and operation can also be utilised for the design, fabrication and installation of offshore terminals. Further since offshore terminals require considerable maintenance it would be necessary for the country to develop adequate supporting services such as under water welding, cutting, precision-navigation, submarine pipeline, oil pollution control systems etc. Offshore technology would also prove to be of considerable use in the Ministry of Defence's naval projects. Various ports and harbours in their expansion programme would require the development of new offshore equipment and techniques. Further, the Deptt. of Lighthouse and Lightships has drawn up a 10 year programme which includes design, fabrication and installation of fixed type lighthouse platforms for navigation of large crude carriers. A number of related projects such as installation of an early warning weather systems in the sea, oil pollution control measures, fisheries development projects etc. would all require the early development of offshore technology indigenously.

3. OFFSHORE TECHNOLOGY: AREAS FOR DEVELOPMENT

For the development of offshore technology, a selective and integrated phased programme in various areas needs to be organised. The following are some of the major areas which need to be developed;

- i) Marine investigations capabilities.
- ii) Offshore structures.
- iii) Production technology.
- iv) Transport of crude/slurry through submarine pipeline.
- v) Storage at sea.
- vi) Specialised support services.
 - a) Underwater technology
 - b) Navigation aids
 - c) Pollution
 - d) Safety

i) Marine Investigation Capability

The marine investigations which need to be carried before any offshore structure can be installed consist of -

- a) Oceanography
- b) Hydrographic surveys and
- c) Marine soil investigations

These investigations require hardware like current meters, wave recorders, soil and seismic equipment, piston gravity corers deep rotary coring rigs, remote control - soil testing equipment etc. and software such as computer programmes for prediction of oceanographic conditions, assessment and design parameters for environmental conditions determined from field investigations and from historical data collection and analysis.

Some sea bed investigations have been carried out by CGG of France for the ONGC in the Bombay High area towards the month of November-December 1972 in collaboration with EIL. Historical data collection and analysis of environmental conditions for a number of areas have also been carried out by EIL for ONGC, M&DC and the IOC. Some relatively unsophisticated hardware such as wave recorders, piston gravity corers are available with organisations like CWPRS, GSI and EIL. EIL has also recently purchased a shallow seismic profiling system which is the only unit at the moment in the country.

ii) Offshore Structures

Offshore structures are required for oil production at sea, lighthouses, single point mooring systems, instrumentation platforms etc. and involve the design, fabrication and installation of fixed tubular steel structures in shallow and deep waters. The hardware required for carrying out this work consists of equipment for fabrication of large size tubular structures, floating construction equipment, like derrick barges, for the installation work at sea and pile driving hammers for pinning the fixed structures to the sea bed. The software necessary requires development of capability for the design and planning of these structures including computer programmes to simulate environmental conditions and analysis of response during the fabrication, installation and life time use.

In India one fixed platform in shallow water was installed at Aliabet by the ONGC in 1969-70 based on the designs provided by the USSR.

The fabrication and erection of this platform was done by ONGC using indigenous equipment. Studies which have been carried out for the design, fabrication and installation of offshore platforms reveal that limited indigenous capabilities at the present are developed only for working in the shallow waters. While software has been developed in EIL for design of offshore structures in deep waters, the necessary fabrication capability and equipment for work in deep water is not available within the country.

iii) Oil Production Technology

Oil production technology needs to be developed in areas such as drilling directional wells, cementation, drilling fluids chemicals etc. This production technology requires the development of suitable tools, instruments and equipment.

Since Oil & Natural Gas Commission and Oil India Ltd. have been working on land for a number of years, there is not only considerable hardware available but also the capability exists for evolving the necessary production technology for operation in the offshore areas with marginal inputs.

iv) Transport of Crude Oil/Slurry Through Submarine Pipeline.

Transport of crude oil/slurry from the source to the shore or vice versa is normally done through a net work of submarine pipelines. The submarine pipeline diameter ranges from 6 to 42 inches depending upon the quantity of flow, and the techniques involved are those of welding, weight coating, cathodic protection, pumping and laying of submarine pipelines in shallow and deep waters. For laying submarine pipeline close to the shore a technique which uses barge

mounted winches can be utilised while for deep waters a derrick lay barge would need to be obtained. In all cases it would be necessary to set up plants for weight coating of pipelines and for their welding which requires special techniques and equipment. So far in this country there is only one submarine pipeline which was laid in 1953 from Bombay to Bucher Island. While very limited indigenous capabilities exist in the country for the design of submarine pipelines and the laying of small pipelines from the shore, it would be necessary to organise these capabilities with suitable inputs from experienced agencies abroad, including purchase of equipments like lay barges, winches, coating plants etc.

v) Storage

In case of an oil discovery at some distance from the shore, it would be necessary to store crude in the field either in submerged storage tanks or in storage tankers moored nearby. This may also utilise a single buoy mooring system for loading and unloading of crude. The technology required for the design, fabrication and installation of suitable storage systems is similar to that required for the design and installation of offshore structures, although these may, sometime, require the carrying out of suitable model experiments.

There are no offshore storage facilities in the country nor have any SFM systems been installed. Detailed studies are, however, being carried out for the design, fabrication and installation of offshore terminals which could be utilised for loading and unloading of crude oil tankers for iron ore slurry tankers of over 100,000 dwt.

vi) Specialised Support Services

To carry out any work in the offshore areas, a large number of specialised support services need to be developed:

a) Under water technology

Under water technology consists of deep diving, under water maintenance, repairs, under water cutting welding etc.

b) Navigation Aids

With the advent of giant tankers and bulk carriers, the demands of accurate positioning will become necessary and several electronic instruments are now available. Accurate positioning fixing is also required for oil drilling production platforms, well location, excavation, submarine pipeling laying SPM system etc. Besides the normal aids such as offshore lighthouses, a number of electronic aids such as radars, radio beacons, low range decca, shoran, hi-fix, micro wave survey system, toran etc. have been developed.

India has a network of 3 major decca chains and a limited number of decca hi-fix chain are available with a few agencies such as Deptt. of Lightships & Lighthouses, Naval Hydrographic Office, etc. Some of the port authorities also maintain limited navigational chains for their own dredging purposes. There is, however, no indigenous development of navigational aids to match the requirements in quantity or sophistication of the extended offshore programme now being envisaged in the country.

c) Pollution

With the increase in activities offshore through the production and transportation of crude oil through tankers and terminal, there are increased chances for oil spillage and pollution. The technology required for removal and disposal of oil require suitable development of chemicals, mechanical equipment and organisation.

There are no capabilities within the country for tackling major pollution of oil spillage at sea. Very crude techniques are being utilised at present for removing oil spillage at sea by use of soaking straw. Minor spillage within the ports, however, can be tackled by use of suitable equipment. A detailed project report has been prepared by EIL for the Madras Port Trust for a suitable oil recovery and containment system.

d) Safety

With the increased activities anticipated offshore a technology needs to be developed to handle accidents such as 'blow out', collision of vessels and salvaging of structure and vessels. This requires equipment and organisation for handling major fires offshore and for rescue and speedy rescue operations in case of collision of vessels.

Limited capability exists within the country for salvaging small crafts and diving capabilities are limited to less than 100 ft. of water.

4. A BRIEF ASSESSMENT OF INDIA'S REQUIREMENTS FOR THE NEXT 10 YEARS

A brief assessment is made based on the programmes drawn up by various agencies in the country for works to be carried out in our offshore areas over the next decade :

A) Offshore Oil Exploration & Production

Based on the assumption of a minimum of offshore crude oil production of 10 million tons per year in the next 10 years through programmes to be undertaken by ONGC and other foreign companies in Indian water under the revised government policies, an assessment has been made for the hardware requirements for the shallow and deep water production and development. The requirement would be -

- | | |
|--|----------|
| i) Fixed offshore shallow water structures | 6 Nos. |
| ii) Fixed offshore deep water structures | 25 Nos. |
| iii) SPM Systems | 2 Nos. |
| iv) Submarine pipeline | 380 KMs. |

In Appendix I, ONGC's offshore programme for 4 million tonnes per year is given.

B) Transport of Crude Oil/Iron Ore Slurry Through Submarine Pipelines.

IOC has planned to install an SBM system and to lay about 10 KM submarine pipeline for its offshore oil terminal required for transporting crude oil to the shore for its North West Refinery. The total financial implications of this offshore terminal and submarine pipeline is Rs. 7.4 crores of which Rs. 2 crores is for the SBM system and Rs. 5.4 crores for the 10 KM of submarine pipeline.

NMDC is contemplating installation of an SEM system and the laying of about 16 KM of submarine pipeline for the export of iron ore slurry from the Kudremukh Iron Ore Project. The total financial implications for the offshore terminal are approximately Rs. 10.6 crores with Rs. 2 crores being for the SEM system and Rs. 8.6 crores for the submarine pipeline.

C) Other Offshore Projects

The Deptt. of Lighthouse & Lightships proposed to build 5 offshore lighthouses in the Gulf of Kutch and Gulf of Cambay during the 5th Five Year Plan and is also contemplating putting up 5 additional offshore lighthouses in the succeeding 5 years. The total financial cost for the design, fabrication and installation of these 10 offshore lighthouses works out to approx. Rs. 15 crores.

There would also be an additional requirement for installation of offshore/structures such as single buoy mooring, instrument platforms, submarine pipeline etc. for the import of crude oil. A detailed assessment of the additional offshore oil terminals that would be required has not been made, but as has been indicated above considerable savings in foreign exchange are possible if offshore terminals suitable for handling very large crude carriers of over 160,000 dwt are installed by 1978-79.

It can thus be seen that the total cost for the design, fabrication and installation of various kinds of offshore structures over the next 10 year period estimated by the various agencies in the country would be of the order of Rs. 340 crores with a

foreign exchange component of Rs. 270 crores. (These figures are based on an oil production of only 10 million tonnes per year). If the additional offshore oil terminals necessary for import of crude oil are also installed the total cost would rise to a figure of approximately Rs. 400 crores with a foreign exchange component of approximately Rs. 330 crores. In addition to these costs for structures if production technology for offshore oil drilling has been developed considerable more savings in foreign exchange would be possible.

Based on the known programmes of the existing agencies, a brief estimate is made of the requirements for the steel and equipment.

- i) The steel required for the fabrication of the above offshore structures would be of the order of 1,75,000 tons and of this 1,55,000 tons would be in the form of pipes made from strips and sheets and the rest in the form of structural conforming to IS 226 and IS 2062. Of this 1,55,000 tons of steel, 90,000 tons shall conform to API Std. 5 L-X 52 and the rest to API Std. 5 L grade B. Since offshore structures are generally tubular in nature with the diameter ranging between 6 to 42 inches and thickness between .375 to 1.5 inches, it would also be necessary to set up adequate fabrication facilities. A detailed break down of the requirement of steel pipes for a 10 million tons per year programmes for offshore areas is given in Appendix II.

ii) The equipment required for the fabrication and installation of these structures are given in Table III. It has been estimated that if the above equipment are hired from abroad rather than purchased out-right at the commencement of the oil production programme, the hire charges would be of the order of Rs. 28 crores, in foreign exchange, as given in Table IV.

It is expected that the total cost for the design, fabrication and installation of these major production structures would be of the order of Rs. 340 as given in Table V.

5. A PROGRAMME OF DEVELOPMENT OF OFFSHORE TECHNOLOGY

In view of the economies that are possible consequent upon the development of offshore technology indigenously, it is necessary to develop a plan for operations over the next 10 years. As has been pointed out if offshore technology is not generated indigenously in a phased and integrated manner, the country would have to pay a considerable amount of money in foreign exchange over the next 10 year period. For example, for a programme based on 10 million tons per year oil exploration and production target, the development of offshore technology indigenously can save the country to the order of Rs. 270 crores in foreign exchange. If offshore terminals are developed and provided additional savings of the order of Rs.20 crores per annum could be generated by use of very large crude carriers which can be unloaded by deep water offshore oil terminals. Further, if the estimated shortfall of 30 million tonnes is to be met from offshore oil exploration and production, the savings

TABLE - III

EQUIPMENT TO BE IMPORTED & BREAKDOWN OF COST

Sl.No.	Item	Nos. required.	Approximate amount in crores of Rs.
1.	Ocean going derrick cum pipe laying barge.	1	10.0
2.	Ocean going flat deck cargo barges		
	Approx. sizes 120 M x 30 M	1	2.0
	105 M x 25 M	1	1.5
	75 M x 25 M	1)	2.0
	60 M x 20 M	1)	
3.	High power tug cum anchor shifting vessel 4000 HP.	2	2.0
4.	Crawler cranes - capacity 150 t.	8	1.5
5.	Offshore pile hammers		
	60,000 ft. lbs. capacity	2)	0.3
	120,000 ft. lbs. capacity	1)	
	200,000 ft. lbs. capacity	1	
6.	Concrete coating plant	1	0.5
7.	Underwater cutting & welding tools	-	0.4
8.	Deep diving complex	-	0.5
9.	Navigational aids like shoran, toran etc.	-	1.0
10.	Shaped charged explosive cutters	-	0.4
11.	Heavy anchors & winches	-	0.4
12.	Stringers	-	0.5
13.	Habitat	-	0.5
14.	Misc.	-	3.3

Approximate total (in foreign exchange) 27.0

T. FILE - IV

HIGHER CHARGES OF EQUIPMENT WITH SERVICES

S.No.	Description	Mob. days d ₁	Demob. days d ₂	Working days d ₃	Per trip days d ₄ =d ₁ +d ₂ +d ₃	Nos. of trips n	Total days d ₄ x n	Rate in lakhs Rs. / day	Total in lakhs Rs.
1.	Ocean going derrick cum pipe laying barge - 1 No.	15	15	50	80	10	800)	
2.	High Tower Tugs - 2 Nos.	15	15	50	80	10	800)	
3.	Offshore pile hammers 2 Nos.	15	15	50	80	10	800) 3.00	2400
4.	Stringer - 1 Nos.	15	15	50	80	10	800)	
5.	Heavy anchors & winches.	15	15	50	80	10	800)	
6.	Deep diving complex.	15	15	30	60	10	600)	
7.	Habitats	15	15	30	60	10	600) 0.10	60
8.	Crawler crane - 1 No.	15	15	100	130	10	1300	0.05	65
9.	Ocean going flat cargo barges with tugs - 2 Nos. 120 ^m x 30 ^m	15	15	50	80	10	800	0.20	160
10.	Navigation aids eg shoran etc.	5	5	30	40	10	400	0.10	40
11.	Misc. equipment (e.g) under water cutting & welding tools, explosives, cutters, etc.	-	-	-	-	-	-		75
								TOTAL -	<u>2800</u> lakhs.
								(Rs. 28 crores in)	
								(foreign exchange)	

TABLE - V

TOTAL FINANCIAL IMPLICATIONS FOR DEVELOPMENT
OF OFFSHORE TECHNOLOGY - NEXT 10 YEAR PROGRAMME.

.....000.....

S.No.	Description	Nos.	Unit cost in crores/Rs.	Total cost in crores/Rs
1.	Fixed platforms in shallow water for crude production.	6	1.5	9.0
2.	Fixed platforms in deep water for crude production.	25	5.0	125.0
3.	Single Buoy Mooring System for crude production.	2	2.0	4.0
4.	Submarine Pipelines for crude production.	380 KM	-	131.0
5.	Fixed platforms in shallow water for lighthouses.	10	1.5	15.0
6.	Single Buoy Mooring System for crude unloading.	1	2.0	2.0
7.	Submarine Pipeline for crude unloading.	10 KM	0.54/KM	5.4
8.	Single Buoy Mooring system for Ore Transportation	1	2.0	2.0
9.	Submarine Pipeline for ore transportation.	1.6 KM	0.54/KM	8.6
10.	Imported equipment for fabrication & erection of above jobs.	-	-	27.0
11.	Indigenous equipment for fabrication and erection of above jobs.	-	-	2.0
12.	R & D Project.			3.1
13.	Miscellaneous.			5.9

340.00

With foreign exchange component of - Rs 270.0 crores.

would be three times as much as indicated above i.e. about Rs 900 crores, besides providing a substantial employment potential.

It is thus necessary to commence an integrated and comprehensive programme for development of offshore technology in the country. The major components of this programme would be -

i) Framing of Policies

- To define important marine projects as "National Projects" and responsibilities for achieving the goals to be fixed on various operating agencies.
- To evolve policies for collaboration and working with foreign contractors, agencies and importing offshore equipment, so as to utilise maximum amount of indigenous equipment and expertise.

ii) Creation of Separate Agency/Agencies for Exploration, Development & Production of Hydrocarbons Offshore.

A separate autonomous agency needs to be created to handle exploration, development and production of oil and gas offshore.

iii) Engineering Services

Separate agency/agencies need to be set up or commissioned for developing offshore engineering and construction capabilities for :

- Marine Investigations
- Engineering
- Fabrication
- Offshore Construction & Erection
- Laying of Submarine Pipelines
- Survey & Navigational Equipment.
- Underwater Technology - Support Services Development

iv) R & D Programmes

It is essential to have our own research and development programmes in the field of offshore technology to suit our needs and marine environments. As such a special fund - to be called Development of Offshore Technology Fund of Rs. 3.5 crores over the next decade, needs to be set apart to train considerable numbers of our Engineers/Technicians and to initiate research and developmental projects on contract. Some of the research problems concerning offshore requiring study are :

- Basic Study of Hydro dynamic forces
- Study of Sea & bottom sediments
- Offshore Piling
- Performance of Offshore Platforms
- Welding Techniques
- Launching of Structures by Flooding Technique
- Corrosion and its Prevention
- Pollution
- Marine Instrumentation
- Deep Diving

(Refer Appendix III for R & D Projects)

v) Education & Man Power

Some universities and technical institution need to be asked to arrange for comprehensive courses and training facilities in the diversified field of ocean engineering and offshore technology in their curriculum.

A few national institutions to be identified as major centres for specialisations in the various fields connected with offshore.

6. ADVANCE ACTION TO BE TAKEN FOR THE 5TH FIVE YEAR PLAN

In order to ensure that adequate advance action is taken for the development of offshore technology, the following immediate steps need to be taken and adequate funds set aside :

a) R & D Projects

A sum of Rs. 0.50 crores with foreign exchange component of Rs. 1,00,000 needs to be set aside for the specific R & D programmes for the development of offshore technology. Work needs to be commenced on a priority basis on the following projects :-

- i) Marine Investigations Capability.
- ii) Design of Offshore Structures.
- iii) Laying of Submarine Pipelines.
- iv) Production Drilling Technology.
- v) Offshore Oil Terminals.

b) Purchase of Equipment

A sum of Rs. 3.5 crores, with a foreign exchange component of Rs. 3 crores needs to be sanctioned for the purchase of the equipment required for operations in the offshore areas :

- i) Offshore vessels suitable for sea bed investigations and other services.
- ii) Navigational aids.
- iii) Offshore pile hammers.
- iv) Underwater cutting & welding tools.
- v) Oceanographic instruments such as wave recorders, current meters etc.
- vi) Pipe coating plant.

c) Organisation

Steps need to be taken to set up a nodal organisation to oversee the development of offshore technology in India. It is recommended that a total amount of Rs. 4.00 crores with a foreign exchange component of Rs.3.10 crores be allocated to the Special Projects Division of the Department of Science and Technology. The Special Projects Division of the Deptt. of Science & Technology would be responsible for the coordination of these programmes till such time as a separate Commission on Oceanography or a Marine Resources Management Commission is set up.


O.N.G.C'S 4 MILLION TONNES PER YEAR PRODUCTION PROGRAMME IN NEXT FIVE (5) YEARS
 DEEP WATER OFFSHORE DEVELOPMENT DRILLING & PRODUCTION DEVELOPMENT PROGRAMME

YEAR	DRILLING-CAPITAL AND OPERATIONAL					PRODUCTION CAPITAL AND OPERATIONAL					TOTAL FINANCIAL OUTLAY OFFSHORE DEEP WATER DEVELOPMENT IN CRORES OF RS.	PRODUCTION	
	COST OF DRILLING PLATFORMS IN CRORES OF RS.		NUMBER OF WELLS TO BE DRILLED	COST OF DRILLING IN CRORES OF RS.	TOTAL FINANCIAL OUT LAY IN CRORES OF RS.	PRODUCTION INSTALLATION IN CRORES OF RS.	PIPE LINES TRUNK FEEDER IN CRORES OF RS.	OVER HEAD ESTABLISHMENT IN CRORES OF RS.	OPERATIONAL EXPENDITURE IN CRORES OF RS.	TOTAL FINANCIAL OUTLAY IN CRORES OF RS.		NUMBER OF WELLS	MILLION TONNES PRODUCTION PER YEAR @ 100 TONNES PER WELL/DAY.
	NUMBER	COST											
1974-75	3	8.70	36	14.48	23.18	5.00	15.00	0.42	-	23.42	46.60	30	-
1975-76	3	8.90	36	14.84	23.74	0.30	0.03	0.44	3.96	5.73	29.47	30	1
1976-77	3	9.04	36	15.21	24.25	0.62	1.03	1.11	8.12	10.90	35.15	30	2
1977-78	2	6.24	36	15.59	21.53	0.95	1.06	1.14	12.90	15.67	37.50	30	2
1978-79	-	-	36	15.99	15.98	1.30	1.11	1.17	17.08	20.66	36.64	30	4
TOTAL	11	32.82	180	76.10	103.98	8.17	22.27	4.29	41.66	76.38	185.36	150	-

BASIS FOR CALCULATION

1. PRODUCTION RATE PER WELL PER DAY = 100 TONNES.

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 ENGINEERS INDIA LIMITED NEW DELHI	DWG. NO.	REF. DRAWING	NO.	DATE	REVISION	BY/CH	APPD.	O.N.G.C'S 4-MILLION TONNES PER YEAR PRODUCTION PROGRAMME	JOB No	DRG. No.	REV.	
				24-4-78	ISSUED FOR INFORMATION					2003	SK-1	0
								EIL-505	B-279 X 432	DISTRIBUTION CODE		

PIPE REQUIREMENT FOR OFFSHORE

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YEARS	DIAMETER & THICKNESS OF PIPE IN INCHES & WEIGHT IN TONNES																														TOTAL	REMARKS					
	42"		40"		36"		34"		30"				28"	26"		24"		20"				18"		16"		14"		12 3/4"		10 3/4"			8 5/8"				
	0-5	1-5	1-0	0-625	1-25	1-0	0-75	0-625	1-0	0-5	1-5	1-25	1-0	0-75	0-625	0-5	0-438	1-0	0-75	0-5	0-625	0-5	0-438	0-375	0-5	0-375	0-625	0-5	0-375	0-5			0-375	0-375	0-375	0-375	
1973-74	-	-	-	-	-	-	-	-	30	60	60	20	120	200	75	300	-	500	75	10	10	30	20	10	100	65	30	60	240	15	35	40	45	85	35	2270	2 LH + 1 SW PLATFORMS
1974-75	-	-	-	<u>1000</u>	-	-	-	-	60	120	120	40	200	400	115	600	-	750	115	20	20	60	40	20	200	130	45	120	360	30	70	60	90	155	60	15,000	3 LH+2 SW PLATFORMS KUDREMUKH PIPE LINE
1975-76	<u>3000</u>	160	80	150	50	125	450	750	60	120	120	40	120	400	-	700	<u>2000</u>	-	-	40	40	120	90	50	300	195	-	180	-	45	105	-	135	165	45	10,035	2 SW+1 DW PLATFORMS + CRUDE PIPE LINE + SUBMARINE PIPE LINE
1976-77	-	430	240	450	100	250	900	1500	50	100	100	30	75	275	-	600	-	-	-	90	60	180	150	90	300	260	-	240	-	60	140	-	180	220	60	7,780	1 SW+3 DW PLATFORMS + SUBMARINE PIPE LINE
1977-78	-	750	480	900	200	500	1800	3000	-	-	-	-	-	-	-	200	-	-	-	180	120	360	300	180	600	390	-	360	-	90	210	-	270	330	90	12,720	6 DW PLATFORMS + SUBMARINE PIPE LINE
1979-83	<u>5800</u>	2400	1200	2250	800	1250	4500	7500	-	-	-	-	350	-	375	500	<u>14000</u>	2500	375	450	300	900	750	450	1500	975	225	900	1800	225	525	300	675	1050	375	112,100	15 LH+15 DW PLATFORMS + SUBMARINE PIPE LINE
TOTAL IN TONNES	61000	4000	2000	14750	850	2125	7650	12750	200	400	400	130	865	1275	565	2900	16000	3750	565	790	550	1650	1350	800	3000	2015	300	1860	2400	465	1085	400	1395	900	665	159,905	
TOTAL WITH 10%	67100	4400	2200	16200	900	2400	8500	14300	220	440	440	150	960	1400	620	3200	17600	4100	620	870	600	1800	1500	880	3300	2220	330	2050	2650	520	1200	440	1550	990	740	1,77,000	


SAY 1,80,000 TONNES

NOTES :-

- 1 PIPE MATERIAL SHALL BE API-5L GRADE-B.
- 2 PIPE MATERIAL FOR UNDERLINED FIGURES SHALL BE API-5L X GRADE X 52

LEGEND :-

1. LH = LIGHTHOUSE
2. SW = SHALLOW WATER
3. DW = DEEP WATER

 ENGINEERS INDIA LIMITED NEW DELHI	DWG. NO.	REF. DRAWING	SMALLER DIA. & SUBMARINE PIPE LINE FOR OIL EXPL. PROGRAMME INCLUDED				10 YEARS REQUIREMENT OF PIPES FOR OFFSHORE	JOB NO.	DWG NO.	REV.	
				NO.	DATE	REVISION		BY	CH	APPD.	1153

APPENDIX - II

Educational Institutions in the Marine Sciences

Area of Research and Training

1. Andhra University Special paper at M.Sc. level in Geology, Meteorology, and research on shallow ocean oriented problems, Marine geology, Physical Oceanography, Marine Biology, Marine Engineering.
2. Annamalai University Paper on Marine Geology at M.Sc. level.
3. University of Kerala Trivandrum. Research in Aquatic Biology and Fisheries.
4. Osmania University, Hyderabad. M.Sc. (Tech.) Course in Geophysics.
5. The Indian Institute of Technology, Kharagpur. M.Sc. Courses in applied geology and Exploration Geophysics. Research facilities in Marine geology, Marine geochemistry and application of computational methods in Marine Sciences.
6. The Indian Institute of Technology, Bombay Post-graduate diploma in Dock and Harbour Engineering.
7. The Karnataka Regional Engineering College, Surathkal. M.Tech. Course in Marine Structures and Coastal Engineering. Basic and Applied research in various aspects of Coastal Engineering.
8. The Indian Institute of Technology, Madras. Elective paper on Coastal Engineering at the Tech. level.
9. Jawaharlal Nehru University, New Delhi. Coastal geomorphology; Marine-Resources. School of Environmental Sciences Plans to proceed with marine meteorology and marine earth sciences.

Area of Research and Training

School of Environmental Sciences Marine-geophysics, marine geochemistry and air-sea interaction studies are proposed to be taken.

10. Tata Institute of Fundamental Research
Bombay.

Marine Geochemistry.

11. Cochin University,
Kerala.

Marine Geology, Physical Oceanography of inshore waters, currents in estuaries.

12. L.B.S. Nautical & Engg. College, Bombay.

Navigation and Marine Engineering - M.O.T. Certificate Courses.

13. College of Engineering, Andhra University.

B.E. Course with Mechanical Engg., with specialisation in Marine Engineering, M.E. Course in Marine Engineering.

APPENDIX - III

Institutions in India involved in Oceanographic

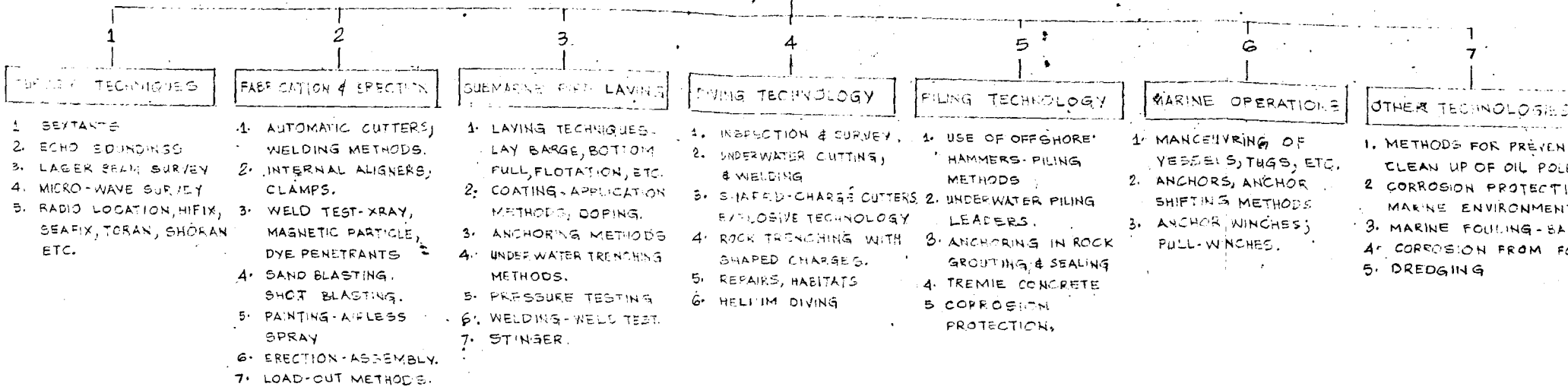
Work

1. National Institute of Oceanography (NIO) (OSIR) Physical, Dynamical, Chemical, Geological, Biological Oceanography, Data and documentation, and instrumentation.
2. Naval Physical & Oceanographic Laboratory (NPOL) (Ministry of Defence) Underwater acoustics, physical oceanography, instrumentation, seismic surveys.
3. Naval Chemical & Metallurgical Laboratory (NCML) (Ministry of Defence) Chemical Oceanography, Marine Biology.
4. Naval Science & Technological Laboratory (NSTL) (Ministry of Defence) Marine Biology, Ocean-Floor studies and development of technology in this area.
5. Naval Hydrographic Department (Ministry of Defence) Hydrographic surveys and preparation of navigational charts of bathymetry, observations on tides, gravity and magnetic surveys.
6. Central Marine Fisheries Research Instt. (CMFRI), Central Institute of Fisheries Technology (CIFT) (ICAR) Marine Biology, Temperature, Salinity collections.
7. India Meteorological Department, Ministry of Tourism & Civil Aviation. Temperature and salinity, wave and swell data in support of meteorological activity, air-sea interaction studies.

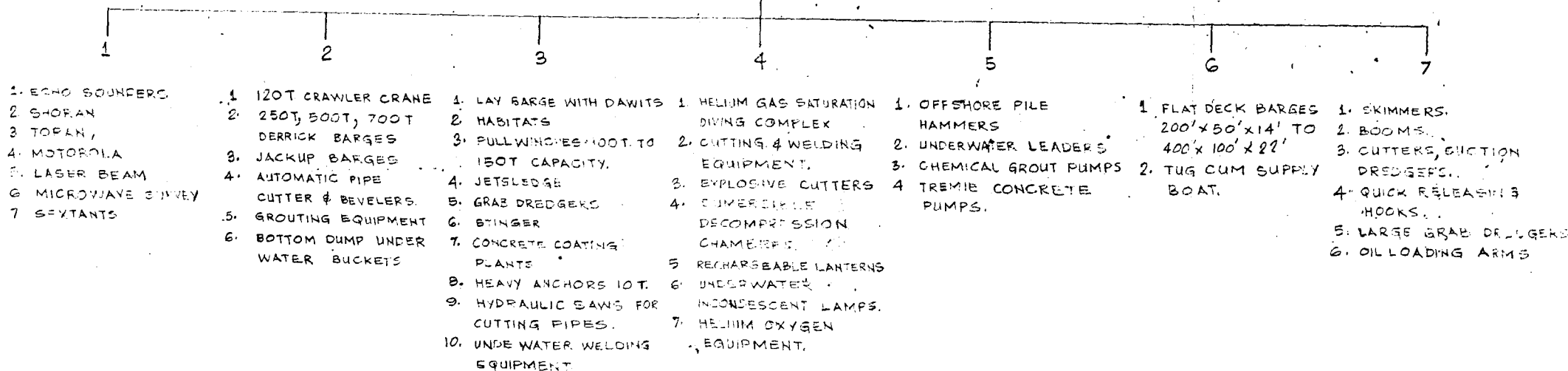
- | | | |
|-----|---|---|
| 8. | Geological Survey of India (Ministry of Mines & Metals) | Collection of bottom sediment samples and bottom topography for exploration of mineral deposits. |
| 9. | Survey of India (Geodetic & Research Branch), Ministry of Science & Technology. | Tidal observations, geomagnetic measurements. |
| 10. | Oil & Natural Gas Commission (Ministry of Petroleum & Chemicals) | Geophysical exploration, & bottom topographic surveys, sea bottom sediments. |
| 11. | Zoological Survey of India. | Survey of marine fauna and ecological conditions. |
| 12. | Department of Atomic Energy (Minerals Division) | Tracer studies for siltation in harbours, sea pollution, offshore exploration of atomic minerals. |
| 13. | Engineers India Limited (EIL) (Ministry of Petroleum and Chemicals) | Ocean engineering including marine surveys, design, engineering, fabrication, installation of offshore structures, submarine pipelines, terminals etc. Ports and Harbour development consultancy. |

OFFSHORE CONSTRUCTION ACTIVITIES

APPENDIX IV



EQUIPMENT



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OFFSHORE CONSTRUCTION
ACTIVITIES & EQUIPMENT

JOB No	2009	DRG NO	EK-2	REV.	
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A P P E N D I X - III

<u>Sl.No.</u>	<u>Description</u>
1.	Development of single buoy mooring system for oil transportation.
2.	Design & development of offshore containers for storing oil (a) in shallow water, (b) in deep water.
3.	Pipelines transportation of heavy crude oil.
4.	Basic study of hydro-dynamic forces acting on offshore fixed platforms and study for structural stresses.
5.	Design fabrication and construction of fixed drilling and production platforms in water depths upto 100 metres.
6.	Laboratory studies for launching and erection of fixed platforms by using buoyancy tanks.
7.	Anchoring & piling of offshore structures.
8.	Development of oil and gas collecting and metering equipment for offshore platforms.
9.	Submarine pipelines, wrapping, coating and burying techniques.
10.	Deep sea diving techniques.
11.	Advance welding techniques and equipment required for offshore industry and development of underwater welding/cutting techniques in deep waters.
12.	Construction of derrick barges, supply boats, pipe laying barges, oil tankers, shallow draft self propelled vessels etc
13.	Development of anti-corrosion and anti fouling methods for equipment used in offshore exploitation of minerals, oil and gas.
14.	Development of technology for designing of offshore oil-gas separation, treatment and storage facilities.