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EMERGING TECHNOLOGY SERIES

1/1996

Marine Industrial Technology

UNITED NATIONS
INDUSTRIAL DEVELOPMENT
ORGANIZATION

E M E R G I N G TECHNOLOGY SERIES:

MARINE INDUSTRIAL TECHNOLOGY - 1996/I

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UNIDO's Emerging Technology Series Marine Industrial Technology is established as a mechanism of current awareness to monitor developments in the marine industrial technology sector and to inform governments, industry and academia, primarily in developing countries.

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TO OUR READERS

Technology is now at the core of competitive strategies of successful industrial firms. The new and rapidly evolving generic technologies, such as biotechnology, new materials and information technologies, offer many opportunities and challenges for broad competitive strategies. They engender entirely new products, services, markets and businesses. Their impact is trans-sectoral, radically improving the competitiveness of products, processes and services of firms in a large number of traditional industrial sub-sectors. New materials improve product specifications and lower production costs in engineering and chemical industries; biotechnologies save energy and raw materials in chemicals, pharmaceuticals and food processing, while the pervasive applications of information technologies allow companies in all industrial sectors to re-engineer critical processes, improve overall efficiency and raise productivity across functional areas. Monitoring and access to information is now a key to competitiveness.

Experience in newly industrialized countries shows that access to reliable technical information can be instrumental in allowing manufacturers to leap whole periods of technological development and adopt state-of-the-art systems directly - without needing to undertake a painful and costly development phase. up-to-date economic information and analysis of global economic trends and the prevailing industrial situation in other countries is likewise indispensable - and the gateway to identifying industrial needs, opportunities, constraints and priorities of the country and region concerned.

Monitoring technological advances and economic analysis provide the basis for the formulation and effective implementation of appropriate industrial programmes and projects by both public and private entities. For developing countries, with their limited resources and often greater susceptibility to the negative aspects of technology-led change, such activities are doubly important. Yet many developing countries still lack the critical elements for technology monitoring of emerging technologies and their implications for national development strategies. If they are to maximise the benefits and minimize the negative effects of technology on social and economic development, developing countries must manage technology in an appropriate manner - and monitoring is an essential element of that management process.

One of the objectives of UNIDO is to carry out a set of coherent activities at the national, regional and international levels, to help developing countries at different stages of development to acquire, apply, develop and manage technologies against a global background of technological change. Investment and technology play a vital role in the industrial growth of developing countries, as well as their gradual integration into the international economy. Although most developing countries now have liberal regimes for investment and technology transfer, this is not a sufficient condition for industrial growth. There is a need for a wide-ranging investment and technology approach that will not only attract and retain the inflows of investment and technology, but also make the optimum use of them for the domestic economy. UNIDO's wealth of experience in industrialization, combined with its worldwide network of contacts makes the Organization an ideal partner to assist developing countries in building up their investment and technology partnerships. The Organization is a focal point of industrial technology; it is a global source of industrial information; and it is an honest broker for industrial cooperation.

Through this new series of publications on ***emerging technologies*** in developing countries, which supersedes the ***Industrial Technology Monitors*** and the ***Technology Trends Series***, UNIDO plans to sensitize industry and governments to the need for and requirements of technology monitoring and assessment in the areas of new and emerging technologies. These technologies play a catalytic role in the development process of the new global pattern of rapid and accelerating technological change, sweeping trade liberalization, far-reaching deregulation of markets - including the privatization of state-owned enterprises and commercialization of R&D - and the globalization of international business.

Anthony Bromley
Technical Editor

(iv), 43p.
illus.

EMERGING TECHNOLOGY SERIES

MARINE INDUSTRIAL TECHNOLOGY

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna, 1996

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A. SPECIAL ARTICLE

OTEC: A CLEAN ENERGY WHOSE TIME HAS COME

Dylan Tanner
Japan Energy and Environment

Introduction

In Madrid in November 1995, the Governments of more than 90 nations agreed that man-made global warming was already under way. Although sceptics (mainly groups and nations with a stake in the fossil fuel business) still claim the available evidence is inconclusive, the majority of the world's policy makers and scientific community now accept that increasing concentrations of carbon dioxide and other greenhouse gases in the atmosphere have resulted in an accelerated temperature rise of a degree not seen in more than 10,000 years. But like an alcoholic diagnosed with a terminal illness, the world's nations seem unable to mend their ways. This is perhaps even more true of the booming economies of developing Asia, (notably China and India), who are excluded from a plan by the developed economies to stabilize carbon emissions at 1990 levels by the year 2000. It would appear that now, more than any time in history, would be an appropriate time for renewable energies to be taken seriously as a major source of energy and for long-term investment. Of course the catch, as it has been in the past, is the lack of short term economic motives to invest on a large scale in appropriate renewable energy technology and applications. This is generally true throughout the world as the price of oil remains fairly stable with no significant price rises likely in the near future. An economic case can, however, be made for the development of renewable energy in certain countries where a combination of physical conditions and government policy make some forms economically feasible. Leading the field in the past have been solar, wind and biomass energy sources.

Although generally not familiar to the layman, OTEC (or Ocean Thermal Energy Conversion) has been hyped at various times as a source of limitless, cheap and clean energy. A NASA report published in 1972[1] predicted that by using OTEC to tap the thermal energy of the Gulf Stream, the electricity needs of the USA could be provided for. However, despite over one hundred years of research and development activity around the world, OTEC has not yet been commercialized. At first glance, the technology appears almost deceptively simple and of massive potential. Beneath this simplicity lies engineering and economic hurdles that need to be addressed before OTEC will be available as a viable energy source. This article looks at the state of the technology today, recent OTEC developments and the potential for OTEC in the future, notably in crucial energy markets of the developing nations of Asia: India, Indonesia and the Philippines.

A brief history and background to OTEC

The theoretical basis of OTEC as a source of energy lies in the thermal energy stored in the earth's water as a result of solar heating. About a fourth of the 1.7×10^{17} watts of solar energy reaching the Earth's surface is absorbed by the oceans and seas. This solar radiation does not distribute itself evenly within the water, but rather, is concentrated in the surface layer of about 100 metres. There is thus a temperature difference between the upper and sub-surface layers of the ocean, from which useful energy can theoretically be extracted using a simple heat pump. This is the basis upon which the French physicist and inventor of OTEC Arsene d'Arsonval began his research in the late nineteenth century. The first to attempt to put d'Arsonval's ideas into practice was by one of his students, George Claude, who conducted a series of experiments in the 1920s and 1930s. Claude constructed a 22 kW open cycle on-shore OTEC plant in Mantanzas Bay, Cuba in 1930. The plant did not succeed in generating net power and suffered from poor site selection and engineering difficulties. Subsequent to the widespread exploitation of crude oil in the Middle-east and other areas, world-wide interest and investment in OTEC (and other renewable energies) remained dormant. The next significant activity also originated in France, in 1956. The interest this time came from within the French Government, which produced a number of designs and a feasibility study for OTEC plants in various locations. Cold water pipe deployment tests were carried out in the Ivory Coast for the construction of a 3 MW plant, but a lack of financing meant the project did not get beyond the design stage. The next attempt to develop OTEC was made by Hilbert Anderson, an American engineer who formed a company (Sea Solar Power) specifically to promote OTEC, and began a series of design and feasibility studies. Most of Anderson's work centred around the construction of an off-shore closed cycle OTEC plant designed to produce 100 MW of power and utilizing a cold water pipe of a length of up to 1,200 metres.

In the early 1970s, two trends combined to greatly increase the level of interest in OTEC and other renewable energies. In 1973, the OPEC countries trebled the price of oil overnight, causing a sudden surge of interest in alternative energy sources. In addition, public and government awareness of the environment was beginning to emerge as a real issue. Interest in OTEC in the USA was coming from government departments, academic institutions and corporations such as Carnegie Mellon University and the Universities of Massachusetts, Texas and Hawaii. The USA Government first began to fund research into OTEC in 1972, when the National Science Foundation allocated $84,000 to various institutions. By 1977, this had been raised to the not insignificant sum of $36 million, provided by the Department of Energy's newly created Energy Research and Development Administration. Much of the money was given to large USA corporations (such as Lockheed, Westinghouse, Bechtel), who provided designs for plants and components for OTEC systems. The prevailing thinking in the early 1970s was that floating platform based plants would be the most feasible, and a great deal of time and money was spent trying to overcome the problem of the stability of the suspended cold water pipe of length up to 1,500 metres. Government-sponsored

and private research into the feasibility of OTEC resulted in the construction of two experimental OTEC plants, both in Hawaii. In 1980 the USA Government passed the Ocean Thermal Energy Conversion Act during the Carter Administration, which made both commercial and experimental OTEC plants eligible for government funding and simplified the patent procedures for OTEC applications. The Act also established goals of achieving a 100 MW OTEC plant by 1986 and a 10,000 MW plant by the year 2000. Following the change in administration, these goals were modified and set at constructing a 40 MW on a shore closed cycle plant in Hawaii. The design work was carried out but not implemented due to lack of funding. During the 1980s, the level of activity in the USA was reduced, reflecting the government policy of non-intervention in industry. Without this crucial support, OTEC became little more than an interesting "pipe dream" for the companies and individuals who had been active in the 1970s.

Activity and interest in OTEC in Asia has been restricted largely to Japan and Taiwan. In 1973, Japan relied on Middle-East oil for 90 per cent of its energy needs and was thus profoundly affected by the oil crisis. The Japanese Government responded by launching the Sunshine Project to promote and develop renewable energy. This project included OTEC, and was managed by the Ministry of Trade and Industry (MITI) as a highly cohesive and focused way of developing the technology. A MITI-backed group led by Tokyo Electric Power and Toshiba, established a 120 KW gross, 35 KW land-based plant on the South Pacific island of Nauru in 1981. The Japanese programme is now very much geared towards a complete OTEC system, whereby the cold water is used for a number of applications such as air conditioning, fresh water generation and seafood production as well as electricity generation. In its New Sunshine Project, announced in 1993, MITI has not prioritized OTEC, but an industrial consortium, OTECA, is currently trying to seek funds for a "multi purpose OTEC system" for a South Pacific island.

Various studies have been conducted and plans devised as to the future of OTEC in Taiwan, and for the past 10 years, it has continually been suggested that the Government was on the verge of investing up to US$ 300 million on a comprehensive OTEC programme. Most of the current research is conducted by the State-owned power company, Taipower, which would like to build a large (300 MW) plant, and the Government's Energy Research Laboratories who are promoting the more modest goal of starting with a smaller scale experimental unit. As yet, there has been no practical demonstration of OTEC in Taiwan.

State of the technology and latest developments

The means of thermal energy utilization that is thought to have the most potential, and is the most developed, is the utilization of the binary cycle heat pump to generate electricity. OTEC energy generation using such a heat pump can divided into two main types in terms of the development of the technology - open cycle and closed cycle OTEC. Variations involving combinations of both have also been suggested. Essentially, however, all OTEC systems require a method of bringing large amounts of cold sea water to the surface where it can interact with warm surface water in order to generate energy. In addition, the cold surface water has other useful applications (air-conditioning, breeding environment for aqua-culture and fresh water generation, if an open system OTEC is used).

OTEC power systems basically operate in the same way as conventional power stations. They use steam to drive a turbine and generate electricity. A major difference between OTEC and "conventional" thermal power stations is the temperature of the steam. In OTEC systems, the warm water at the surface of the ocean is at a maximum temperature of 25° C, well below the boiling point of water. In an open system OTEC, a low pressure environment is created and the water vaporizes at less than 100° C and drives a turbine. The vapour is then condensed by the cold water from the sea depths to complete the cycle (the condensing water is essentially distilled water and in some cases can be used as a valuable by-product). The closed cycle OTEC system employs a secondary fluid, such as ammonia or freon, with a lower boiling point than water, and involves the same simple binary heat engine cycle. Closed-cycle, 50 MW shore-based OTEC plants are within the reach of current engineering and designs have been completed. Such plants would use ammonia as a secondary fluid, and chlorination is needed to prevent bio-fouling of the aluminium heat exchangers. Without fresh water production, this plant would require the price of oil to be around US$ 40 a barrel in order to be competitive. The use of an open cycle in conjunction with this to produce fresh water would improve the economics.

The operating theory of both open and closed cycle OTEC systems is simple. The engineering realization, however, still presents some challenges. For example, an open cycle 100 MW OTEC plant would require about 450 m^3/s flow of water through the pipes. Pumping water at such a rate from up to 1,500 m below the surface of the ocean represents a leap in marine engineering technology. Both open and closed cycle OTEC have their merits. An open cycle, while inefficient, is easier to design and build than the closed cycle and does not have to withstand as high a pressure. In addition, there is the option of fresh water generation. A closed cycle is more efficient and enables the use of smaller turbines. Moreover, high pressure ammonia turbines have been developed for use in the refrigeration industry. On the downside, costly heat exchangers are necessary for the closed cycle, and there are problems with corrosion and bio-fouling. A hybrid system, combining both an open cycle and closed cycle has been suggested. This would use a closed cycle system to generate electricity, and then pass the water through an open cycle system to generate fresh water. There is also an ongoing debate as to whether OTEC will develop as a land-based system or is more feasible as a floating system. Numerous designs of floating-based OTEC systems have been proposed, many pre-empted in the early 1970s by the emergence of the off-shore oil industry in the United States. The advantages of off-shore based systems are two fold. Firstly, the design of such a system can be fairly generic, i.e. the sole specification is that there be a temperature difference in an appropriate depth of water. The thinking is that, in time, OTEC plants can be built from a standard design, as many conventional power stations are, and this economy of scale will make a crucial difference in OTEC's commercial viability. The second advantage in having an off-shore plant concerns the cold water pipe. Proponents of off-shore systems claim that it will be feasible to suspend a cold water pipe from a floating platform, thus eliminating the need for a costly shore-based pipe. However, no-one as yet has built an off-shore OTEC plant, and it seems unlikely that existing oil platforms can be used with ease as a base for OTEC

systems. Another problem with floating OTEC systems is the need to transport the products of the system to shore, but perhaps the key engineering problem is securing the cold water pipe. The concept of OTEC will function as long as there exists a temperature difference of 20° C or more. Under the systems so far described, this temperature difference exists between the surface ocean layer and the depths. However, this need not be a limiting factor. It is conceivable that the temperature difference is provided by hot waste water from a power station and cooler water from the ocean surface, thus eliminating the need for a long cold water pipe. Another system being proposed by GEC-Marconi in the UK, utilizes "solar ponds" to trap the sun's rays and thus increase the temperature of water in the ponds to up to 60° C. The planners claim that the use of solar ponds can double the efficiency of the OTEC system, thus reducing the cost per KWhr calculated over the plant's lifetime. The logistics and economics of creating solar ponds of sufficient size have yet to be worked out. The variety of engineering choices available illustrates the necessity by those developing OTEC, to keep an open mind with regard to the best way forward. There are numerous choices and the operating environment and market will determine which is feasible.

For most OTEC configurations the two engineering problems remain the cold water pipe and the heat exchangers. The most challenging of these is the cold water pipe. In open cycle OTEC applications, the diameter of the cold water pipe must be substantial (0.5-25 m), in order to achieve a reasonable flow of water. The world's only operational OTEC plant (an open cycle OTEC experimental plant in Hawaii) utilizes cold water pipes of a diameter 30 cm to 1 m). Whether the pipe is suspended from a floating OTEC platform or fixed to the seabed and running on-shore, the engineering, installation and operation present significant challenges in terms of cost-engineering. In the early 1980s, the US Department of Energy began a Cold Water Pipe R&D Programme specifically for OTEC to try to solve the engineering problems of bringing large quantities of water (2.5 $m^3/s/MW$) from the depths of the sea to the surface. The only sector which uses technology anywhere close to these requirements is the oil/gas industry, with the largest pipes in use today having a diameter of around 1 m (on-shore) and 50 cm under water. A pipeline currently being planned between Oman and India will span 1000 km and be on average 60 cm in diameter—this is considered to involve groundbreaking engineering and sub-sea construction skills. Almost all OTEC proponents accept that further development work will be necessary to perfect an economically and technically feasible cold water pipe to the necessary levels. Suggestions put forward for the construction of the pipe include a composite materials pipe and a flexible pipe held taut by water pressure inside. Don Lennard, a leading UK OTEC authority, regards the perfection of the cold water pipe as the key to commercial OTEC development. He is in favour of a composite pipe mounted on a floating OTEC platform, incorporating a technique to repair damaged pipe segments without removing the entire pipe. Most OTEC experts consider the most likely commercial configuration of OTEC will be on an off-shore platform. This will eliminate the need for a cold water pipe attached to the ocean floor and spanning perhaps 10-20 km, depending on the sea floor topography, and also allow the facilities to be mobile (the current plans by Sea Solar Power envisage towing a pre-constructed plant from the USA to India for the supply of electricity).

The other key engineering challenge for OTEC has been the construction of highly efficient heat exchangers at a low cost. Both open and closed cycle OTEC require heat exchangers with a large through-put of sea water. Due to the limited temperature difference of 25° C or so, a high efficiency is required to achieve any net power output at all. The conventional choice of material has been titanium. The drawback is the cost; titanium heat exchangers in OTEC units, swallowed up over half the cost of the entire facility. A breakthrough came in the mid 1980s with the development of a "mini-OTEC" experimental unit in Hawaii by a consortium including the University of Hawaii. Alupower (a subsidiary of Alcan Aluminium) and the UK power firm GEC-Marconi used the occasion to test their newly developed Roll Bonded aluminium heat exchangers. The key selling point was that the material used was resistant to corrosion in brackish water (the major difficulty with the use of most materials thus far). Heat exchanger cost was reduced by a factor of up to ten. The technology in general has advanced considerably in the last decade, driven in part by a drive to utilize excess or waste heat from conventional power stations. Additional development work is necessary on heat exchanger technology to reduce size and cost further.

An important point to realize about OTEC is that any pilot or initial commercial plant will be constructed from components using already proven technology. The key engineering challenge will be the detailed design and practical optimization of the assembly and a true analysis of the major hurdles will only come with practical experience. Dr. Luis Vega of the Pacific International Center for High Technology Research was responsible for the construction of the world's first operational open cycle experimental plant in Hawaii in 1993. He stated that the main problems encountered were in constructing an experimental facility using existing components, which were usually not designed for the specific application in question. Component manufacturers are often reluctant to custom build components for one-off facilities. The rigorous conditions under which the OTEC plant was operated (low pressure, corrosive environment, high water flow rate) meant that much trial and error was necessary before the plant could operate effectively.

The benefits of deep ocean water

There is another school of thought which views on-shore OTEC plants as preferable, chiefly because there is the added benefit of being able to easily access the large amounts of deep ocean water from the process. Cold water brought up from the ocean depths has two qualities that make it a valuable resource for the cultivation of marine organisms. Firstly, deep ocean water is rich in nutrients and is free from man-made pollutants and organisms that could be harmful to marine life. Thus it is a source of nourishment. Secondly, its temperature of about 4° C makes it possible to reproduce the environment of the sea floor and hence cultivate organisms such as lobsters, which flourish there. The fact that OTEC utilizes large quantities of such water has created an opportunity to cultivate useful marine life. Such activity is currently under way in Hawaii and in Japan. In Hawaii, the cold water is a by-product of an OTEC plant, and in Japan, in Shikoku, the cold water pipe was constructed for the sole purpose of marine farming. The potential of large scale marine farming can be illustrated by the fact that over 40 per cent of the world's fish catch is produced in regions where natural upwellings

of cold water occur, which represents only 0.1 per cent of the world's ocean area. An example is the extremely fertile fishing ground present off the coast of Peru, produced by the natural welling known as "El Niño". The cultivation of micro-organisms which thrive off the nutrient rich deep ocean water looks set to be a promising industry. Another important use of the deep ocean water generated from open cycle and hybrid OTEC configurations is fresh water production. This application of OTEC is often cited as being the most important, in parallel with energy generation, and indeed, in future scenarios may be the motivating factor behind the development of OTEC. The high throughput rate (450 m^3/s for a theoretical 100 MW open cycle plant), means that fresh water can be generated at rates comparable to municipal requirements. In areas where fresh water is at a premium, such as islands in the South Pacific, initial studies indicate that OTEC-generated fresh water is cheaper than water generated by other means, such as reverse osmosis, (a 50 MW hybrid plant could produce fresh water at US$ 0.80 per barrel, compared with about US$ 2 for reverse osmosis, in a situation where oil is about US$ 30 per barrel).[2]

Recent developments in OTEC

The United States

The bulk of the OTEC development activity undertaken in the last few years has originated in the United States of America and Japan. Both nations undertook large renewable energy programmes following the oil shocks of the 1970s (only Japan's was sustained into the 1990s). With funding provided by the Department of Energy (DOE) in the 1970s and 1980s, OTEC research and development in the USA emphasized large, closed cycle OTEC power plants that would float off-shore. In 1979, the DOE jointly sponsored with the State of Hawaii, a closed cycle 15 kW OTEC plant, and in 1981 conducted experiments at sea to evaluate certain components of closed cycle OTEC with the use of a vessel called OTEC-1. The purpose was to test the operation and effects of the heat exchangers, cold water pipe and power generation equipment at the MW level. As a result of this work, the DOE believes closed cycle OTEC to be sufficiently developed for industry to commercialize and is now concentrating its funding on open-cycle OTEC, with initial work aimed at shore based systems in the range 2-15 MW.

USA Government funding of OTEC declined steadily during the Reagan/Bush administrations and current activity is now centred on the Big Island of Hawaii. Two organizations play key roles: The Natural Energy Laboratory of Hawaii Authority (NELHA) and the Pacific International Centre for High Technology Research (PICHTR). PICHTR is part of the University of Hawaii and NELHA operates a combined R&D centre, the Natural Energy Laboratory of Hawaii and a business park, the Hawaiian Ocean Science and Technology Park (HOST). These facilities host a variety of R&D and commercial projects performed by Governments, universities and private groups. The attraction of the NELHA to OTEC research lies in the laboratory's location. The offshore slope is steep and provides relatively easy access to deep cold water, and the tropical climate provides the necessary temperature difference. Deep-sea water pipes have been constructed by NELHA to pump cold water from a depth of 600 m (the average temperature of the cold water is 5.5° C and the surface water varies from 24.5° C to 27.5° C over an annual cycle). In 1982, a 30 cm pipeline was constructed to provide 100 litres of cold water per second from a depth of 600 m. There are currently 11 deep water pipes supplying both cold and warm water from various depths, and ranging from 30 cm to 1 m in diameter. The first pipes were constructed from concrete while recent pipes were made from fibre-reinforced polypropylene. The pipes were originally constructed for OTEC related research, but the cold water is currently used, some of it on a commercial basis, for a range of applications such as air-conditioning and marine farming.[3] Using these facilities there are currently two major OTEC projects under way. In December 1992, PICHTR completed construction of the world's only operational OTEC plant and it is currently undergoing trials in preparation for a two year continuous operation period, which commenced in June 1993. The project is formally known as the Net Power Producing Experiment (NPPE), and was funded by the USA Department of Energy and the State of Hawaii at a cost of about $12 million. (It should be noted that this cost did not include the construction of a cold water pipe—NPPE utilized the NELHA's existing pipe). The pipe NPPE used, is a 1m diameter, 1,900 m long, high density polyethylene cold water pipe, which brings up 6° C water from 675 m at a rate of 0.4 m^3/s. A similarly constructed pipe of 71 cm diameter provides the warm water for the open cycle OTEC plant. The power equipment consists of a single 210 KW turbine placed at the top of a 8m diameter concrete vacuum chamber, with the generator placed above the turbine.

NPPE represents the first operational open cycle OTEC plant and has experienced some technical problems. The NPPE was built on a fairly limited budget and utilized many components not specifically designed for the application. Pump and turbine equipment suffered sea water corrosion and incompatibility with other components. In general, PICHTR reports that its component suppliers were not willing to custom-build, or even properly service their components, due to the experimental nature of the project and the limited budget. Due to the inherent low efficiency of open cycle OTEC and the small scale of the project, the net power output is a relatively small 25 kW. Indeed, the Director of the project feels that the future of OTEC lies in large scale closed cycle plants. The USA Department of Energy was reluctant to fund a closed cycle plant as it deemed the technology to be developed, while open cycle OTEC technology was considered still in the research phase. The NPPE is significant in that it is the world's only operating OTEC plant, and as such provides a stimulus for continued investment and can be used for promotional purposes. The benefits in terms of technical knowledge remain uncertain, as it is unclear as to how far the operational behaviour of a 210 kW plant can be extrapolated. Previous studies into closed cycle OTEC by the Department of Energy showed that for many components, a prototype of up to 40 MW would be necessary to predict the behaviour of larger systems.

The second of the two OTEC projects under way at the NELHA in Hawaii has also been funded by the State of Hawaii, and involves a number of companies: the Hawaii Electric Company, GEC-Marconi, Alupower (a subsidiary of Alcan Aluminium) and Makai Ocean Engineering, a Hawaii based company specializing in marine engineering design. Construction on the project began in March 1993, and the plant began operations in 1994.[4] The plant will be a 100 kW closed cycle OTEC using, as with the PICHTR plant, the existing pipes of NELHA to obtain the cold sea water resource. The plant itself originates in experimental

work conducted by Alupower and GEC-Marconi at NELHA since 1986. At the core of this research is the testing of Alupower's new Roll Bond aluminium heat exchangers in a marine environment.[5] The two companies began testing various alloys with slightly chlorinated ocean water and produced a corrosion resistant material. Conventional industrial heat exchangers are of the so-called tube-and-shell type, and consist of a cylindrical shell encasing a number of tubes through which the heat exchanging fluids flow. The closed cycle OTEC currently being assembled by the group of companies is the first to utilize the new heat exchanger technology. The plant will use four heat exchanger modules with an input of 200 litre/s. The cold water will be distributed to other facilities in NELHA (air-conditioning, marine farming), after use in the OTEC plant. The turbine generator was previously used by the mini-OTEC offshore plant in 1979. By using existing components, and as a result of the low cost of the heat exchangers, the cost of the entire project has been kept down to $1 million, of which $725,000 has been provided by the State of Hawaii. The plant is scheduled for a one year operation. Both Alcan and GEC-Marconi are involved in the design of conventional power stations, and they hope the technology can be transferred. The Roll Bonded exchangers can be beneficially used within conventional power stations that use sea water as a coolant. GEC-Marconi has tested the heat exchangers in a Rankine cycle engine, which uses the hot water from the power station cooled by surface sea water to drive a turbine in a secondary fluid.[6] Both companies believe there is a large market for the new heat exchangers and intend to pursue non-OTEC applications.

Japan

The development of OTEC in Japan has followed the country's general pattern of development and market realization of technologies. A key characteristic of this pattern is long-term planning, funding and guidance by the Japanese Government. As such, alternative energy, and within this, OTEC, is viewed by the Japanese from three angles. Firstly, the Japanese economy is heavily dependent on imported resources for its energy needs and the Government is continually exploring ways of reducing this. Secondly, the Japanese Government realizes that the possibility of widespread commercialization of OTEC exists, and wants to ensure that Japanese companies will be ready to participate in this market. Lastly, Japan recognizes the environmental benefits of OTEC, both as part of its own energy efficiency programme and also as part of the recent push to internationalize Japan's environmental profile. Each of these driving forces has, and continues to play a part in OTEC activity in Japan. Within the Japanese Government, the Ministry of International Trade and Industry (MITI), has played a dominant role in the research and development of industry sectors. In the past MITI has targeted important sectors where it deemed success by Japanese companies was vital for the prosperity of the national economy. Examples of such sectors are the steel, machine tool, automotive and consumer electronics industries—and the results are self evident.

MITI's involvement with alternative energy began seriously after the oil shock of 1974, when it initiated its Sunshine Program. The aim of this programme was to co-ordinate the development of alternative energy in Japan, and a large part of this task involved researching the feasibility of various energy forms to determine which to prioritize—the aim being energy generation rather than environmental considerations. The energy forms prioritized by MITI were solar, thermal and geothermal electricity. However, MITI also noted the USA Government's interest in OTEC, and allocated a budget to OTEC research. Initially, MITI stated its desire to build an offshore, closed cycle OTEC plant of 10 to 40 MW. This was followed by 10 years of research by Japanese companies and MITI laboratories into closed cycle OTEC development. Plans switched to an on-shore based closed cycle OTEC system in 1980 due to difficulties with off-shore engineering. In 1983 a consortium of companies built and operated a 100 KW OTEC plant on the South Pacific island of Nauru.[7] The operational data from this pilot plant provided the companies involved (Tokyo Electric Power, Toshiba and others) and MITI with enough data to design a 2.5 MW plant, although this was never realized. As with groups in the USA involved in OTEC at the time, the Japanese OTEC group experienced problems associated with the high capital cost of the plant, especially the heat exchangers and the cold water pipe. To reduce these high costs, the Japanese began to research the feasibility of open cycle OTEC and, more seriously, the possibility of improving the economics by using the cold water for a variety of applications. This development represents the main thrust of Japan's current OTEC programme. In January 1993, MITI announced its New Sunshine Program which is designed to exploit the advances made through the Sunshine Project and realize renewable energy generation. The new program also incorporates an energy efficiency program (Moonlight Project) and the Global Environmental Technology Program of 1989 which promotes the idea of sustainable development with regards to energy generation. The priority energy technologies are solar, geothermal, fuel cell and coal conversion. The budget for OTEC has been reduced compared to the 1974 Sunshine Program, and this reflects several factors.

- Research and development has been conducted for 20 years, and it is not obvious that OTEC is close to realization. Many of the cost engineering difficulties, such as the cold water pipe remain unresolved.
- There are few regions in Japan where the marine environmental conditions would suit a large scale OTEC plant—there is a lack of an adequate temperature difference in most regions of Japan. One area where OTEC would be feasible is the southern Japanese island of Okinawa.
- One route the Japanese explored was to link the construction of an OTEC plant with its ODA (Overseas Development Aid) programme, which is largely limited to the Asia Pacific region. It has been trying to attract interest from developing island nations in the South Pacific as a site for an experimental OTEC plant, but has encountered difficulties.

Current research and development into OTEC in Japan is in a latent stage. Activity is being carried out by MITI, companies and universities at a low level, the aim being to maintain expertise should the technology suddenly become feasible due to, for example, a doubling of oil prices. OTEC activity in Japan is centred around a consortium of private companies, institutions and government departments know as OTECA (OTEC Association of Japan). Prominent members include Tokyo Electric Power, Toshiba, Kyushu Electric Power, Hitachi and MITI's Electrotechnical Laboratory. Another notable member is the Import Export Bank of Japan.[8] OTECA was established in 1988 to co-ordinate OTEC activities in the private sector, as government involvement was reduced. OTECA's aim is to

promote OTEC as a core technology for island nations, around which they can build up a number of industries, aside from power generation—desalination and marine farming are two examples. It is currently proposing to build a 1 MW closed cycle, land-based plant and has four working groups dedicated to what it deems are the most important issues and problems associated with OTEC.[9]

- One group is devoted to the cold water intake pipe construction and installation. The group has been simulating a pipe associated with a 1 MW plant by a 1/100 scale model. Initial results indicate that a feasible layout may be a "floating pipe", suspended above the ocean floor and anchored at both ends and at points in between. The group hopes to reduce installation costs and allow the 1.2 m diameter HDPE (high density polyethylene) pipe flexibility.
- Another group is concerned with aspects of the OTEC power plant. These include flow speeds of water, the fluid cycle and heat exchanger technology.
- In keeping with the theme of OTECA, one working group is concerned with finding new applications associated with an OTEC system. The group recently looked into the recovery of minerals from the deep sea water. It was found that vanadium is commonly found in trace quantities in invertebrates found in deep sea water. In 1992, the group found that fresh water recovery by condensing the saturated air above the sea surface could be feasible with the closed cycle system under consideration.
- OTECA is studying the feasibility of associating an oceanographic/environmental research centre with an OTEC plant. The research conducted at such a centre would be based around the cold water recovered by the OTEC system (similar to the NELHA in Hawaii, although the Japanese centre would not be commercially orientated).

Following the above research and a site survey exercise involving islands in the Pacific region, OTECA produced a basic plan to build a multi-purpose OTEC centre on the island of Viti Levu in Fiji. The system would contain a power generation unit (1 MW closed cycle OTEC), which would produce cold water for applications in marine farming and building cooling, as well as power generation. The plan calls for the location of an oceanographic research centre at the site. The initial business plan predicts the scheme will produce profits of over ¥600 million (£4 million) per year after 10 years, with the bulk coming from building cooling, and marine farming, (under this plan, power generation would continue to lose money after 10 years). The project would involve US$ 150 million of capital costs and OTECA admits these costs are not accounted for in the business plan. It hopes to receive funding from the Japanese Government to complete the project. These funds are unlikely to come from MITI in the foreseeable future, and OTECA is hoping to obtain funding as part of Japan's aid programme. ODA planners are increasingly sensitive to accusations of subsidizing Japanese industry abroad and are thus reluctant to spend large sums on environmentally-orientated projects unless specifically requested by the target country. Thus, a major task for OTECA is to convince nations, such as Fiji, of the benefits of a multi-purpose OTEC system, bearing in mind that such nations may forego other aid packages by accepting an OTEC system.

Taiwan

Taiwan is considered to be perhaps the most suitable location for large-scale OTEC development. A temperature difference of at least 20° C exists throughout the year on the east coast of the island, where the ocean floor drops off rapidly, facilitating cold water pipe construction for shore based plants. In addition to the physical environmental conditions, Taiwan has experienced substantial economic growth in the last 15 years and its power needs have increased sharply. The price of oil is controlled by a state monopoly at US$ 40/barrel, and the cost of electricity generation is roughly twice that of the USA. Taiwan's energy planners are unsure as to where the shortfall in the nation's energy supply will come from. Nuclear power was once thought to be the solution, but environmental pressure caused a delay in the planning of the nation's fourth nuclear power station. Taiwan's natural coal and oil reserves are minimal, and the country's power generation monopoly, Taiwan Power Company, is looking to mainland China's huge reserves of brown coal as a source of long-term power, although, again, there are environmental problems with this source.

Taiwan's OTEC programme began in 1981 and since then the Government has spent over US$ 3 million on research and feasibility studies. The key players in Taiwan's OTEC programme are the National Taiwan Ocean University, National Taiwan University and the Taiwanese Government (Energy Commission, National Science Council). The key industrial player involved is the State-owned Taiwanese Power Company (or Taipower). Like the Japanese programme, Taiwan's OTEC programme is influenced by activities in the USA. In 1989, the Taiwanese Government commissioned the Hawaii-based PICHTR to prepare a development plan for the construction of a 5 MW OTEC pilot plant. The scheme was known as Multiple Product OTEC Project in Taiwan and it outlined the steps necessary for the commercialization of OTEC in Taiwan.[10] The first recommended step was the building of the 5 MW plant and associated aqua-culture, fresh water generation and air-conditioning facilities. The development plan built on work conducted previously in Taiwan and elsewhere, and concluded that Taiwan's first OTEC plant should be of a closed cycle configuration due to the relatively advanced state of the technology. The cost of the recommended development plan was US$ 79 million over seven years, after which the plant would be handed over to Taipower. A commercial-size plant could follow, based on the pilot plant operational data, within a further nine years. Funding for this scheme has yet to be forthcoming.

A recent proposal, backed by Taipower, calls for a national scheme for Taiwan's OTEC development to be undertaken, rather than a limited one-project study. This would thus be similar to a national energy policy plan for nuclear or hydroelectric power, and has been dubbed Master OTEC Plan for ROC (MOPR).[11] It envisages the initial construction of a 200 MW demonstration unit followed by a number of 500 MW plants, with the "master plan" optimising the location and use of deep sea water resources on a national scale. Critics of this approach wonder how Taiwan can construct a full sized operational OTEC plant in one step, and certainly a lack of engineering expertise will be an issue. On the positive side, it is rumoured that the Government is contemplating investing up to US$ 300 million in OTEC related projects in the near future.

Future of OTEC in the developing world

It remains true that geographically, most of the sites which are suitable for OTEC plants, are in the developing world. To be economically viable, sites suitable for OTEC should have some or all of the following characteristics:

- Suitable geographic conditions: tropical/sub-tropical climate, proximity to sea, necessary marine depth;
- Economic conditions to suit OTEC-generated energy: lack of cheap indigenous energy source, consistent market for OTEC electricity and by-products.

The second criteria is a key one. Many OTEC projects have targeted small tropical island nations. Japan's initial OTEC scheme concentrated on looking for a suitable site in Fiji for its experimental OTEC facility. It failed to attract support and funding ultimately because the local economic conditions did not warrant a prototype new energy generation plant. The introduction of new, and perhaps untested technology, into such regions presents possible social and cultural impacts. In a largely rural and agrarian society, the environmental benefits of an OTEC plant to the local population may not be as obvious as they are to a scientist from Japan or the USA. Local populations may resent the intrusion of the infrastructure associated with a commercial, or even experimental, plant. In reality, technical and engineering labour would have to be imported, with the local population initially conducting manual labour. Thus the economic benefits of employment may not be immediate, and this could be a source of friction.

Most leading OTEC and renewable energy experts acknowledge that the regions most suitable for OTEC energy generation are the developing and growing economies of Asia. OTEC has been considered seriously by Taiwan and it looks likely that the country will develop a variation of OTEC in the near future. By the year 2010, expanding economies and living standards will see the region use 133 per cent of the energy it does at present, and 162 per cent more electricity (according to the Honolulu based East-West Center). Given that there are severe energy shortages throughout the region at present, it is difficult to see where the extra energy will come from. Even oil rich Indonesia is set to become a net importer of energy resources by the year 2003. It is thus clear that Asia's energy resources in their current form will not be able to keep pace with its growth and many are seriously looking at renewable energy options to supplement fossil fuel and nuclear options. The reasons for doing so are not always based on economic issues. Most of the developing nations of Asia have strong central Governments from which long term public sector planning is possible. Indeed, most infrastructure projects in developing Asia are initiated and financed by the public sector. There is a trend towards private sector investment in large energy and infrastructure projects; but these tend to be the exception at present. The motivation to develop renewable energy sources such as OTEC comes from a desire to diversify and to be as energy-self sufficient as possible. There are also emerging environmental movements throughout Asia, especially in the Philippines and Indonesia, although the effect this has on government energy policy is minimal at present. More crucial is the significant amount of international (notably from Japan) funding, in the form of soft loans and grants to developing Asia for environmentally benign projects. Japan alone provides over US$ 3 billion in what can be classified as environmental financial support to Asia each year. A key motivation is to reduce the levels of air pollution emissions from China, but it also has a significant CO_2 reduction assistance programme.

While various studies have been conducted which indicate that the price of oil will have to roughly double (to $40 per barrel) to make OTEC favourable to private investors in the free market, combinations of certain circumstances (such as those mentioned above) make OTEC feasible at present. The following outlines the potential and significance of OTEC and its related applications for some fast developing nations in Asia: Indonesia, the Philippines and India. Taiwan has been considered in detail previously and is considered also to be a leading candidate for OTEC commercialization.

Indonesia

Energy policy has been very much in the news recently in Indonesia. The country's energy needs are predicted to skyrocket in the next 10 years as it strives for industrialized nation status. Although Indonesia possesses significant reserves of oil, gas and coal, it also has the world's fourth largest population and a booming, energy-intensive manufacturing sector. Energy demand is expected to increase by an average 7.5 per cent per year to 2010 to around 1 billion barrel-oil equivalent. Presently the country relies heavily on its oil reserves for its domestic needs and it is also a major exporter; it will become a net importer by 2003, given production and consumption forecasts. The Government thus has a stated policy of encouraging non-oil energy sources. The country has 36 billion tons of coal reserves, (of which 60 per cent is of low quality) and coal is expected to account for 20 per cent of energy demand by 2015, up from 11 per cent in 1995. The use of natural gas is also being encouraged. The wild-card is nuclear power; there have been mixed signals recently as to whether Indonesia plans to go ahead with construction of its first nuclear power plant. There is strong lobbying against the nuclear option from influential environmental pressure group Walhi, and the Science and Technology Minister has labelled nuclear as the "last option" in the country's energy policy. Despite these somewhat confusing signals, Indonesia appears to have most of the right ingredients for a successful market for OTEC:

- Geography: Indonesia has the longest coastline in the world, all of which is in tropical waters; there are thus countless possible locations for an OTEC plant;
- Economic conditions: the country's demand for electricity is increasing at 10 per cent per year; the country will have to consider alternatives to its dependence on oil and coal;
- Indonesia is effectively an autocratic State, with political and economic power concentrated in the hands of the President. Under this regime it has been possible to develop and commercialize industries (such as aerospace and automotive), which may not have developed so quickly if left to market forces. Indonesia could do the same for its nuclear industry, or could decide to opt for developing a renewable energy industry. Whatever the choice, the mechanisms are in place for the Government to channel funds and nurture its policy choice to fruition.
- Indonesia's fledgling environmental movement is unlikely to have a serious impact on economic policy at present. However, of great importance is international funding, particularly from Japan. The Indonesian Government would find it fairly easy to raise international finance for a large scale renewable energy programme at present, given the concern over

the environmental impact of Asia's newly developing economies.

- Indonesia has a need for some of the other products and applications associated with OTEC: fresh water (shortages all over Asia); air conditioning and deep ocean water (whether this will be economical to use for aqua-culture at present is debatable).

Whether Indonesia will opt for a major renewable energy programme in the near future is unclear. The signs are not promising. In the past, the country has not taken many risks with regards to development of new technology, preferring instead to import proven technology and then develop its own expertise. There are many foreign industrial concerns who are pressuring Indonesia to develop nuclear power and can offer straightforward technology transfer. Indonesia has often opted to develop prestige sectors (such as aerospace, automotive) ahead of more practical, but perhaps less export-driven sectors. Government planners may feel that Indonesia needs a nuclear industry to maintain its place as one of Asia's leading powers. It is clear that the development of nuclear power would effectively shut out a major renewable energy programme, as much of the country's human and financial resources devoted to the energy sector would be allocated to this.

The Philippines

The Philippines has many of the same characteristics as Indonesia in terms of appropriate conditions for the development of OTEC. The Philippines especially lacks domestic sources of energy (unlike its neighbours Indonesia, Malaysia and Viet Nam, it is not blessed with reserves of oil and gas). Electricity shortages are common. Furthermore, the Philippines has the strongest environmental movement in South-East Asia, and perhaps the only one which actually affects government policy. In October 1995, plans to construct four coal-fired power stations in Quezon, to cater for critical shortages of electricity to the national grid, led to street demonstrations by a variety of environmental and special interest groups. Earlier in the month, the Department of Environmental Protection and Natural Resources rapped the country's leading power company (Hopewell Power) for unsound activities associated with its coal power stations. The fate of the nuclear industry in the Philippines appears to have been sealed when the USA firm Westinghouse Electric settled a 7-year dispute with the Philippines Government concerning safety for a never-operated reactor completed by the firm in 1985. National opposition to nuclear power in the Philippines means that the plant is unlikely to operate and any new plants will not be planned. The Philippines has an active renewable energy programme under way. The chief sources of energy considered are geothermal and hydropower. These are not without their problems however. The commissioning of a US$ 200 million geothermal project in Mt Apo in November 1995 was greeted with protests from indigenous groups and nature conservation activists. To tackle energy shortage, the country announced a 30 year Philippines Energy Plan this year. It will add 90,000 MW of power to the country's energy capacity, with 13,000 of this already planned. The country would like to maintain its self-sufficiency level at 40 per cent over the period; it has ruled out nuclear power in favour of renewable energy sources (hydro, geothermal, solar) and coal/natural gas. It is expected that renewables will play a major part in the realization of the country's energy needs. Private sector investment will form the major part of the 30 year plan.

Thus, it is believed the Philippines presents an ideal environment for OTEC. It has a need for self-sufficient, renewable energy due to a lack of resources and environmental pressure. Current priorities (geothermal and hydro) are likely to run into opposition from NGOs in certain parts of the country. A privately funded BOT style OTEC project (such as is being planned for India by Sea Solar Power) would be well received by authorities in the Philippines, and it is likely that such a project may attract subsidization from the various international organizations currently now focusing on the environmental issue in Asia.

India

India has actively encouraged its renewable energy industry in the recent past and has provided an investment-friendly environment for such projects. India relies on coal, nuclear and oil sources for much of its electricity but, over the last 15 years, has nurtured a renewable energy sector. This was done more out of economic necessity than for environmental considerations—in many rural areas, the installation of small scale wind, solar or biomass facilities was more feasible than connection to a national or regional grid. 800 MW of electricity is generated by renewables and India has the largest wind energy programme after the USA. A further 1,700 MW is generated from waste. As a result, India has developed one of the world's largest domestic renewable energy industries. A leading solar energy firm (Central Electronics Ltd.) was recently awarded a contract to set up a solar cell factory in Syria. The Government, now driven by environmental considerations and aware that international aid will be forthcoming, has initiated a 15 year Renewable Energy Plan. India expects to be the world's second largest generator of renewable energy in the near future and has elevated the theme to Ministry status with the formation of the Ministry for Non-Conventional Energy. The Renewable Energy Develoment Agency was set up to disburse US$ 195 million worth of World Bank funding specifically for this purpose. In November 1995, the state of Rajasthan commissioned a Sri Lanka-led consortium to begin construction of a 200 MW solar power facility costing US$ 500 million (one of the largest such projects ever).

OTEC has played a relatively small part in India's renewable energy programme thus far. Perhaps one reason is that many of the areas where electricity is needed are inland regions, not easily serviced by an OTEC plant. India has dire fresh-water shortages and could well utilize deep ocean water for aqua-culture applications. The USA Electric Power Research Institute recently signed co-operation agreements with a number of influential Indian organizations on the theme of renewable energy, so there is a ready-made channel for the transfer of USA OTEC technology to India. Thus far about 20 joint ventures have been signed between USA and Indian firms in the field of renewable energy, and the Sea Solar Power venture looks set to be the first in a series of OTEC ventures for the country. The USA firm has been discussing OTEC projects with numerous tropical and sub-tropical countries over the last decade and has found India to be the most receptive so far. It signed a Memorandum of Understanding with the Tamil Nadu Energy Development Agency and the Tamil Nadu Electricity Board. Under the agreement, Sea Solar Power will construct and operate an offshore OTEC plant and sell the resultant electricity to local authorities. Although no commercial contract has been signed yet (as of January 1996), Sea Solar Power President Hilbert Anderson states that it is likely that India will sign a

20-year contract to purchase electricity. Anderson states that the resultant power will be comparable in price to other local sources and the OTEC unit will also generate fresh water and the nutrients brought from the sea depths will enhance the area's fishing industry. The 100 MW closed cycle OTEC plant was designed very much with economical operation in mind. The design calls for the construction of a 20,000 ton floating "tanker" plant. Aluminium heat exchangers will be employed along with a 7.7 metre diameter fibre-glass cold water pipe. The key challenge now for this OTEC project will lie in raising the necessary funds (US$ 250 million) for the project. Anderson predicts that the plant will be in operation within the next 3 years or so.

Conclusions

Ocean Thermal Energy Conversion (or OTEC) has, since its invention in the late 1800s, been one of a long list of technologies with huge potential but not yet commercialized. Like many renewable energy technologies, it looks destined to remain that way, either until a Government takes the lead or market conditions make it attractive to public and private sector investors. The former situation looks set to happen in India and perhaps other parts of Asia, particularly Taiwan, as the region begins to wake up to the fact that its economic boom cannot co-exist with environmental destruction. Investment from within the region, and also from the international community (Japanese aid, World Bank), is making it attractive for private sector investors to consider OTEC as a commercial proposition. The region's energy economics (energy shortages, lack of indigenous resources) and geographical conditions (tropical, sub-tropical, many island nations) point to the suitability of OTEC as one answer to the region's energy needs. By-products of OTEC can also be used for great benefit. As South-East Asia is likely to face severe shortages of economically obtainable fresh water; certain configurations of OTEC may provide both power and large quantities of fresh water.

There has been extensive experimentation and design work done on OTEC technology. Most OTEC experts agree that what is needed now is an operational prototype plant of 100 MW or so to "prove" the technology. It is understandable that few developing nations, with limited financial resources, want to be the first to commit to unproven technology. It is likely that the first plant will be built with foreign investment and technology. One USA company is already committed to undertaking such a venture in India. The successful demonstration of this plant will spur further investment and will be of great benefit to the local economics of the regions (a good precedent is India's booming solar power industry, which now exhibits 35 per cent annual growth to provide economic benefit as well as much needed power). The investment community in Asia is extremely receptive to viable energy projects at present and with many qualified subcontractors in the USA and elsewhere, OTEC looks set to take off in the early years of the next decade.

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B. INDUSTRY NEWS

Communications Network for Hyundai Merchant Marine

Hyundai Merchant Marine plans to invest approximately US$172 million by the year 2000 to equip the company with an advanced information network and technologies. This investment will be carried out gradually connecting the company headquarters in Seoul with four overseas subsidiaries (Los Angeles, Hamburg, Hong Kong and Tokyo), by 1998. They also plan to establish a satellite telecommunications system to cover the operations of its 36 offshore bases. (Source: *Korean Business Review*, September 1995)

FastShip Atlantic — More news

FastShip Atlantic, Inc. (Alexandria, VA, USA), has enlisted the assistance of the MIT's Department of Ocean Engineering and Centre for Transportation Studies to evaluate the vessel's design and to test the market for high-speed shipping.

The essence of this concept is speed—once built the vessel should cruise at 42 knots, cutting transatlantic crossing times from seven or eight days to three and a half. The key to this is the ship's "semi-planing hull". The stern is wide and shallow, with a hydrodynamic curve that lifts it part way out of the sea at high speeds. The hull design also calls for a deep, V-shaped bow that can plough through 50-foot waves at full steam.

FastShip is licensing the patent for this technology from Thornycroft, Giles and Co., whose design has been used in smaller naval and passenger vessels since the 1960s. The company plans to design freighters ranging from 560 to at least 860 feet in length. Six to eight gas turbines will drive five water jets, moving large volumes of water to propel the vessel. As with semi-planing hulls, jet propulsion has yet to be tried on large ships.

Another innovation is the rapid cargo handling. Containerized goods will glide on and off the ship on large metal pallets buoyed by a cushion of air, with a train of pallets being pulled by a single tractor. The company says that this will enable stevedores to load and unload cargoes in four to six hours instead of one to two days. They plan to shorten door-to-door delivery times for goods to five days, as opposed to the typical 14 to 35 days.

Some industries that have already been identified as possibly benefiting from this new technology include automobile makers. The Swedish Volvo company is assisting in setting up a service between Gotheburg, Sweden and Zeebrugge, Belgium. FastShip plans to have a 560-foot vessel built and operating on this route by the end of 1996. Other industries which could benefit from rapid shipping include clothing, pharmaceuticals, medical equipment, consumer electronics and perishable goods—in other words, any cargo of high value.

MIT is studying the vessel's hydrodynamic properties with a computer-simulation program called SWAN (ship wave analysis). This has been used successfully to design ships before. It is expected that small variations in the hull shape may materialize which could mean immense savings in fuel. Once this is completed, they plan to examine the ship's structure, to make it lightweight yet capable of withstanding the additional loads imposed by high speeds. This will be followed by a study of the propulsion system.

As a result of this cooperation, attempts are being made to establish a centre to study the concept of fast ships generally. (Source: *MIT Reporter*, 10 July 1995)

Dubai Creek contract awarded to Costain Dubai Company

Costain Dubai Company, part of Costain Middle East, has been awarded a contract by the Dubai Municipality to carry out improvements to the Dubai Creek which is the Municipality's principal waterway.

The contract includes dredging, excavation and the replacement of existing sheet pile quay walls with precast mass concrete block quay walls at five wharves along the Creek. It also includes the construction of a registration building, office accommodation and facilities for a number of government departments at the Reporting Wharf, one of the five new wharves. (Source: *The Dock & Harbour Authority, Vol.76, No. 862*, September/October 1995)

New Container Terminal at Colon, Panama

The Taiwanese company Evergreen Group has been awarded a contract by the Republic of Panama for the first phase of building a new container terminal at Colon, at the eastern end of the Panama Canal.

The new facility will be located at Coco Solo, 80 kilometres north of Panama City. Construction should start in March 1996 and is scheduled for completion by December 1997. Evergreen Group will manage the terminal on a common-user basis.

Once the first phase is completed, it is anticipated that the potential annual throughput will be approximately 300,000-400,000 containers. The quay length will be around 600 metres, allowing the berthing at any time of two Panamax containers. Initially the berths will be served by three Panamax gantry cranes, but an option exists to add more cranes later.

Evergreen Group anticipates that this terminal will become the hub of its operations in the region, serviced by their eastbound and westbound ships which provide weekly links with Asia, North America and North Europe. The company says they plan to expand further in this area to meet demand from customers for better services to and from Central and South American markets. (Source: *The Dock & Harbour Authority, Vol. 76, No. 862*, September/October 1995)

New Spanish heavy duty rotating beacons

La Maquinista, Valencia SA, have developed two new self-contained, heavy-duty rotating beacons for use as medium- to long-range landfall lights, as well as for marking headlands and entrances to estuaries and ports.

One of the models is particularly suited to marking hazardous reefs or rocky outfalls where access is extremely difficult and where economic and reliable solar power generation is essential. The BGC-300 is an efficient short-focus beacon providing nominal medium-range visibility to 19 nautical miles from an assembly of standard marine tungsten and halogen signal lamps. A larger version is able to achieve visibility ranges in excess of 23 nautical miles.

Both beacons utilize state-of-the-art microprocessor control of advanced technology with "smart" user-friendly software, and are specially designed for operation with

remote monitoring and control systems. Operational power supply is from 8-32V DC or AC 250V, AC50 Hz, or any other AC voltage. Accurate field, or factory selectable rotational speed is effected by fine electronic adjustment of 0.5-10 rev/min in continuous steps of 0.1 sec. Rotation power is supplied by a gearless, brushless stepping motor in either continuous operation of P/e cell operation. (Source: *The Dock & Harbour Authority, Vol. 76, No. 862*, September/October 1995)

Sea Beam survey system deployed in Gulf of Mexico

A Sea Beam multibeam system will be deployed in the Gulf of Mexico for oil exploration purposes under terms of joint venture/lease arrangements between Sea Beam Instruments Inc., (East Walpole, MA, USA) and John E. Change & Associates Inc., (Lafayette, LA, USA).

The Sea Beam 2136 survey system has been installed aboard a survey vessel. The system can generate precision survey data in water depths ranging from five to 1,500 metres. Swath coverage is 150 feet in shallow waters and 90 feet to maximum depths.

The Sea Beam 2100 series is the fourth generation of the company's multibeam bathymetric survey sonars. The company has sold eleven such systems to date. All series models are highly versatile and can be configured for multiple frequency operation and used to perform a variety of survey missions. Sea Beam Instruments has the largest installed base of swath mapping sonars in the world, according to the company, having delivered 42 systems and won all deep-water swath system competitions world-wide since September 1993. (Source: *Sea Technology*, October 1995)

Caris Hydrographic Object Manager sales

Hydrographic offices throughout the world are purchasing Universal Systems Ltd.'s (Fredericton, Canada) Caris Hydrographic Object Manager. This is a product used to manage hydrographic objects as defined by the International Hydrographic Office (IHO). During the past few months, many governmental agencies throughout the world have acquired the object manager to produce electronic chart data for electronic chart display and information systems (ECDIS). With the object manager, these offices are now able to transfer information as per the IHO special publication 57 and DX90 format. (Source: *Sea Technology*, October 1995)

Acoustic positioning system upgraded

Sonatech Inc., (Santa Barbara, CA), has produced an upgrade package for its Sun-based Sonatrack IV acoustic positioning system.

The Sonatrack IV system now supports a multiple concurrent direct interface to normal ship sensors, such as speed and heading, as well as attitude sensors. The ship sensor data is integrated with both the geodetic and acoustic position data to provide an integrated position solution. The upgraded package utilizes the pitch and roll sensor outputs to stabilize both the geodetic sensor, such as the global positioning system, as well as the acoustic transducer sensor outputs. These stabilized sensor outputs are then used in a data fusion Kalman filter to provide both an integrated position for ship and vehicle tracking and automated set and drift information. (Source: *Sea Technology*, October 1995)

Hyundai introduces PCTC

Hyundai Merchant Marine Company recently put its Pure Car and Truck Carrier (PCTC) into commercial operation for European trading. The new carrier can accommodate approximately 4,300 small-size vehicles. Unlike Pure Car Carriers, which only transport passenger cars, the PCTC can carry all kinds of vehicles ranging from passenger cars to buses, trucks and heavy equipment. Hyundai currently operates 35 PCCs. (Source: *Korean Business Review*, October 1995)

Korean shipbuilders continue growth

According to sources at the Korea Shipbuilder's Association, orders received for new vessels continued to register a double-digit growth rate. During the first eight months of 1995, orders for new vessels totalled 122 ships, with an approximate gross tonnage of 3,823,266, showing an increase of 36.3 per cent over 1994, in terms of gross tonnage. Of this number, 120 vessels were destined for export, an increase over the 77 vessels for the same period in 1994. (Source: *Korean Business Review*, October 1995)

EPIC offshore contract for Tiffany Field Rig

Agip (UK) and Tiffany Contractors have reached settlement on the EPIC (Engineer, Procure, Install and Commission) North Sea Tiffany contract—a joint venture between AMEC and Saipem. This is the largest single contract let in the North Sea and is the first EPIC contract on a major platform. The Tiffany field has estimated reserves of 200 million barrels of liquids, planned to be exploited through a 105,000 barrel a day platform.

The EPIC concept involves one organization undertaking all aspects of a project following the initial engineering design. AMEC hopes that the success of this project will pave the way for more EPIC contracts in the future. (Source: *Process Engineering*, October 1995)

First fast ferry to be built

Lindstøl Skips (Norway) and Abeking & Rasmussen (Germany) are joining forces to build two 27.5 metre catamarans recently ordered by Schiffahrtskontor Altes Land and Hapag for a commuter service on the River Elbe.

The 210-seat catamarans, planned for delivery by June 1996, are powered by 8V 396 diesels, giving a service speed of around 35 knots on the Hamburg-Stader route. To ensure safety, there will be a spare engine available for emergencies, or when overhauling is needed, thus ensuring that the ferries maintain the scheduled service at all times. The service is planned to start at 05:30 through 21:00 hours, and expects to carry 800 commuters daily, plus around 290,000 day-trippers per annum. (Source: *Fast Ferry International*, November 1995)

Holen delivers catamaran to Nigeria

Holen Mek Verksted has delivered the first of three MM 21 PC catamarans ordered by the Panama-based Scanfer International that are to be operated in Nigeria, transporting crew and light cargo to and from offshore oil fields, by InterOil Services on charter to Elf Petroleum.

Designed by Multi Maritime, the 21-metre catamaran has a single saloon equipped with 62 seats. The area behind the wheelhouse on the upper deck is fitted out as a crew mess.

As with other oil industry support operations, the catamaran will berth bow on and passengers will embark

and disembark over the foredeck. Luggage stowage areas are provided forward in the saloon and aft on the main deck. Cargo will be loaded over the stern by an electro-hydraulic crane on the starboard side which has a capacity of 500 kilograms, at a reach of 4.6 metres. The vessel is powered by a pair of diesels, rated at 806 kW at 2,300 rpm, giving a maximum service speed of 34 knots. So as to cope with the bad weather that can be experienced in this region, the catamarans were designed with lines and dimensions enabling them to operate at high speed in adverse conditions. They are constructed with curved frame, with a minium wetted surface. The positioning of the LCG/LCB allows a reduction of the stern area. The hulls are narrow, giving a tunnel breadth at the waterline of more than 2.5 metres. The company says that extensive use was made of specially produced extruded aluminium profiles so as to obtain the most advantageous weight/strength ratio. To permit direct contact between the catamarans and offshore installations, a new fendering system was also developed. (Source: *Fast Ferry International*, November 1995)

New shipbuilding facility in Vlissingen-Oost

A new shipbuilding facility for the Schelde Shipbuilding unit of Royal Dutch Schelde was officially opened in October 1995.

Located in Vlissingen-Oost, the yard is approximately 10 kilometres from the company's main Vlissingen shipyard, on the same site as the Royal Schelde's Scheldepoort repair yard. (Source: *Fast Ferry International*, November 1995)

New orders for Western Australian yards

SBF Shipbuilders has received an order from Development Consultants for a 28 m monohull to be delivered to India in March 1996. The Calcutta based company specializes in architectural engineering and consulting and has designed most of the power stations in India.

It has ordered a fast ferry for a route along the Hooghly river between Calcutta and Haldia, a distance of 56 miles that will take the monohull approximately 90 minutes to complete compared with 3-4 hours by road. The river is salt water, silted and has a tide of approximately 8 knots.

The 28 m twin deck vessel is to be equipped with 130 seats and a pair of MWM TBD 616 V16 diesels driving KaMeWa 50 SII waterjets to give a full load speed of up to 36 knots. The service is a new project for Development Consultants and could lead to orders for several more fast ferries.

Meanwhile, another of the yards based around Henderson, Oceanfast Ferries, has recently delivered two UT 928 surface effect ships. One, *Atlantica*, has entered service with Brudey Frères in the Caribbean on its routes from Guadeloupe.

The other, *Tamahine Moorea IIB*, should have now replaced an Incat Tasmania 37 m wavepiercer operated in French Polynesia by Ferry Transports between Papeete and Moorea. (Source: *FastFerry International*, November 1995)

BHC introduces larger hovercraft

The British Hovercraft Corporation has released preliminary details of a larger version of its AP.1-88/200 hovercraft. The new design is five metres longer and 1.9 metres wider than designs presently in use. The main difference, however, is in the disposable load and maximum operating weight. Figures released indicate increases of 9,200 kilograms and 33,700 kilograms respectively. Information about the engines so far released state that they will be four turbo-charged diesels. As with previous models, two will power 2.74 metre diameter ducted propellers to give a maximum calm water speed of over 50 knots. (Source: *Fast Ferry International*, November 1995)

Diving product recalled

All Viking Sport dry suit air hose assemblies which were purchased in North America between 1 January 1982 and 31 March 1988 have been recalled by the manufacturer, Trelleborg Viking Inc. (Portsmouth, NH). According to the company, a potentially hazardous problem may exist with the seating of the subject hose assembly to the air inlet valve, which may result in free flow of air into the dry dive suit. If this should occur during a dive, use of the subject hose assembly could result in serious injury, or even death of the diver. The company has said that it will replace all subject hose assemblies at no cost. (Source: *Sea Technology*, December 1995)

Special-purpose dredging ship

Mitsui Engineering & Shipbuilding Co., Ltd. (Tokyo, Japan), together with Ohmoto Gumi Co., Ltd., has developed a dredging ship for dredging soil containing sludge at high concentrations of 70 to 80 per cent from rivers and lakes.

Sludge pollution in shallow waters such as rivers and lakes has become a problem in recent years. The efficiency of sludge removal with conventional types of soil dredgers is not always good and the sludge content in the sucked-up soil is only about 10 per cent—the remainder consists of water.

This new special-purpose dredger is equipped with a unique sludge collecting system developed for the control of the suction pump on conformance with the incoming sludge amount to enable sludge to be sucked up in high concentration without increasing the turbidity of the water. Various types of sensors are used to detect information, such as the dredging depth and sludge content. The data are sent to a computer in the manipulation room to control the dredged sludge thickness and volume automatically. The dredger position is corrected appropriately with a global positioning system using radio waves received from an artificial satellite which is so accurate that dredging on predetermined courses is possible.

The sludge-collecting system is lowered to the river or lake bottom from the tip of an arm mounted on the bow and is designed to constantly face the direction of the sludge in conformance with the motions of the dredger that revolves by 180 degrees. The dredged sludge can be transported over a distance of 10 kilometres in pipes. The maximum dredging capacity is 150 m^3/hour. The dredger can be divided into several parts for land transportation from one river or lake to another.

More information is available from: Mitsui Engineering & Shipbuilding Co., Coastal Development Sales Dept., 5-6-4, Tsukiji, Chuo-ku, Tokyo 104, Japan. (Source: *JETRO*, December 1995)

New shipbuilding yard established

The Hong Kong Parkview Group and Aboitiz Transport System have established a new company to build fast ferries in the Philippines. A yard, including a dry dock and

repair facilities, is to be built on a 10 hectare site in Cebu, which is owned by Aboitiz Transport System.

The new company will be known as FBM Aboitiz Shipping. FBM is to provide the technical expertise and vessel designs. Two catamarans having a service speed of 40 knots are due to be completed during the first year of operation. It is planned that they will join the Aboitiz fleet of fast ferries now being introduced along the coast of the Philippines. (Source: *Fast Ferry International*, December 1995)

Fjellstrand catamarans for Republic of Korea and Brazil

South Korean operator Jindo Transportation has placed an order with Kværner Fjellstrand Singapore for two catamarans having service speeds of 35 knots. The first of the vessels, due for delivery late last year, is fitted out with saloons for 333 passengers, plus a cargo section with two refrigerated holds and a reinforced deck to take heavy loads. It has also been fitted with Kværner's MDS ride control system. It is to enter service on Jindo Transportation's route between Inchon and the island of Baek Reung.

Eagle Ridge, a Panama-based company, has ordered a catamaran from Kværner Fjellstrand's Omastrand yard, which has been charted to a Brazilian operator for 12 years. The catamaran is equipped for 449 passengers and is to enter service in the north-east of Brazil on a route between Salvador and the island of Itaparica. This order is a result of the privatization of transport systems currently taking place in Brazil. (Source: *Fast Ferry International*, December 1995)

Stena announces developments

The first sea trials of Stena Line's first HSS 1500 catamaran were carried out in Finland in November last year in coastal waters off Rauma, and in open water.

The company reports that the trials included adjustments to the drivelines and testing of the vessel's speed, manoeuvrability and course stability characteristics. Wind speed during the tests was approximately 20 metres per second and the average waveheight was 2 metres. Up to 43 knots was recorded during full speed runs carried out in open water in slightly calmer weather. The company has said that the results were better than expected. The vessel is planned to enter service on the Holyhead-Dun Laoghaire route in March 1996.

A new bridge linking the east and west sides of Holyhead harbour was formally opened in November 1995. The completion of the bridge marks the completion of one of the last phases of the harbour redevelopment scheme by Stena Ports. The final phases, work on a new deep water berth and the demolition of old buildings was scheduled for completion by the end of 1995. (Source: *Fast Ferry International*, December 1995)

STN ATLAS Elektronik VTS for Bombay Port

STN ATLAS Elektronik GmbH has been awarded a contract by the Port of Bombay Trust as the supervisory body for India's largest port, for the design and installation of a proprietary Atlas 9730 radar-based vessel traffic management system (VTS), which is expected to be commissioned early in 1997.

The system will provide extensive 24 hour monitoring and control of all cargo and oil terminal traffic within the main port area and channel approaches. The system comprises three strategically located Atlas X-band radar sites with dual transceivers and track processing facilities at Colaba, Jawahar Dweep and near the adjoining Jawaharlal Nehru Port Trust (JNPT) control centre on the eastern side of the port. The sites will be variously connected to two main control centres using a combination of microwave and fibre optic links.

A proposed new main control centre on the western side of the port, housing three operator workstations and five display terminals, is to be directly linked to a smaller centre with similar facilities at the JNPT on the opposite side of the harbour; an additional workstation and support facilities will also be maintained at the dock master's office at Jawahar Dweep.

Both control centres will additionally be equipped with multi-track recording and processing facilities for simultaneous taping and replay of raw radar video. High resolution console displays consist of overlays of raw radar data together with synthetically-generated information such as track data, symbols and electronic charts; a selective enlargement of given traffic situations will also be possible. (Source: *The Dock & Harbour Authority, Vol. 76, No. 864*, December 1995/January 1996)

New lanterns for Thames lighthouses

Tideland Signal's ML-300 lantern has been chosen by the Port of London Authority Marine Services to improve facilities at the Stoneness lighthouse near Gravesend, which is the only wind-powered beacon on the River Thames. Tideland will also supply mains-powered ML-300 lanterns for two nearby lighthouses at Broadness and Crayfordness. The lanterns in these lighthouses are being upgraded as part of an ongoing review of such equipment.

Tideland's ML-300 lantern features a 300 mm, one-piece acrylic Fresnel lens, designed to deliver maximum beamed light for the lowest possible power consumption. The Crayfordness and Stoneness lanterns will also include Tideland's TF-3B MicroPower Omnibus six place flasher/lamp-changer units, incorporating a timer circuit card to permit input voltages of up to 36V and giving up to 256 field-selectable flash codes.

The Crayfordness lantern will be fitted with a clear lens and is set to flash every five seconds. Stoneness will show a green light flashing every 2.5 seconds, while the Broadness beacon has a red light with a flash occulting every five seconds. (Source: *The Dock & Harbour Authority, Vol. 76, No. 864*, December 1995/January 1996)

New electronic chart system

A new electronic chart system developed by Electronic Marine Systems (EMS) (USA) has one of the largest flat screen displays available. It will be available as a portable unit suitable for use by pilots.

The new system is called "The Navigator" and meets high professional standards and is the first of its type to incorporate a differential global positioning system to high position accuracy.

The display is a backlit 10-in. LCB with a blue background. The company produces its own vector electronic charts which are available in three different levels of detail covering ocean, coastal and harbour navigation. The chart information is carried on 3.5 inch floppy disks with up to 20 charts on each disk. Each chart comes complete with navigation aid descriptions and harbour information. Chart corrections can be added directly via the keypad. The integral differential global positioning system can operate through either AM or FM receivers built into the unit, depending on the differential systems in use. Position

accuracy available is 3 metres, and this allows accurate course and speed measurements. There are input ports for external transducers such as depth sounder and fuel meters. The display is waterproof and suitable for panel or trunnion mounting.

In addition to this general-purpose, high-specification electronic chart display and cartography, the company can also supply customized cartography for specialized applications. Whilst the standard unit has been designed for ship and workboat use, the portable version is being developed as a carry-on unit for pilots. This will give pilots direct access to accurate chart positions at a glance with up-to-date information, rather than having to rely on the ship's equipment. The portable unit will have its own self-contained batteries which will provide adequate power for a full day's use. (Source: *The Dock & Harbour Authority, Vol. 76, No. 864*, December 1995/January 1996)

New improved version of Capsat Gateway

The Danish Company Thrane and Thrane has launched a new, improved version of its Capsat Gateway for Windows software. Gateway for Windows offers quick and easy access between the company's Capsat mobile Inmarsat-C terminals and any PC network which runs Microsoft Mail electronic mail software. Addressing a message from a network PC to a mobile terminal becomes as easy as addressing another PC on the network, regardless of which Inmarsat ocean region the terminal is in. (Source: *Ocean Voice*, January 1996)

Bombay Institute of Nautical and Engineering Studies acquires Inmarsat satellite

The Bombay Institute has acquired an Inmarsat satellite epirb for training purposes. The epirb, an OHB ET-1600 unit, was supplied by a UK company, who says that it offers a number of advantages over epirbs operating with other satellite systems.

The company claims that the system is incredibly accurate—distress messages which are sent thousands of miles can be pinpointed to within 100 metres and they guarantee that it will keep pumping out the message for at least 48 hours, even under the most extreme weather conditions. The message is continually updated and can give a variety of information, including the vessel's name, nature of the emergency, the position, the course and the date and time of the distress. (Source: *Ocean Voice*, January 1996)

US Coastguard to use differential GPS

The US Coast Guard (USCG) has placed an order for 326 NT200CG global positioning system receivers with Trimble for use aboard its "aids to navigation" vessels. The units will be used to place and maintain more than 50,000 buoys, daymarks and lights in American waters. The company says that the NT200CG was custom-built for this contract and is the first to feature built-in differential capability. It will receive differential signals from the US Navy's own system of differential beacons which offer positional accuracy of 3 to 10 metres. (Source: *Ocean Voice*, January 1996)

Leica introduces new marine GPD navigator

Leica has introduced a new marine GPS navigator with a built-in receiver for differential signals, called the MX 400. This is a six-channel receiver embedded into which is an "auto tune" DGPS receiver, which automatically finds the strongest beacon transmitting DGPS error corrections and locks onto it in seconds.

The MX 400 has a large easy-to-read screen with a simple, menu-driven operation. It features dedicated keys for important functions, such as man-overboard position marking, and a "go to waypoint" facility which alters the planned course, entering new coordinates or range and bearing information. (Source: *Ocean Voice*, January 1996)

Personal distress alerting system

The French company Serpe IESM, has introduced a 406 Mhz satellite epirb which is so compact it fits comfortably into an oilskin pocket. The epirb, which operates in the Cospas Sarsat system, has been fully tested by French authorities and will be available for installation in survival suits and life-rafts. (Source: *Ocean Voice*, January 1996)

Daewoo wins Japanese order

Daewoo Heavy Industries Ltd., Shipbuilding Division, recently signed a contract with Mitsui O.S.K. Lines Ltd., Japan, to build and deliver a 177,000 dwt bulk carrier. The company has an option to build an additional ship for Mitsui. This would be the third bulk carrier Mitsui has ordered from Daewoo. The bulk carrier will measure 289 metres long, 47 metres wide and 24 metres deep, it will have a service speed of 15 knots. (Source: *Korean Business Review*, January 1996)

Spanish monitoring of fishing vessels

Declining fish stocks are a worldwide problem, but in Europe, where sophisticated national fleets compete more effectively for a dwindling resource, the problem is acute. The European Union Commission has been at the forefront of trials to establish a satisfactory way in which to monitor fishing vessel activity. The goal is to find a system which meets the fishery authorities' requirements for accurate and trustworthy information, the fisherman's requirement for security and everyone's demand for low cost. A number of trials are now coming to an end. The most successful have combined GPS for position determining, and Inmarsat-C for transmission. However, a project in Spain has included all these technologies in a manner which could prove to be a blueprint for future fishery monitoring schemes.

Rather than use data reporting and polling via Inmarsat-C to collect data regularly from vessels, the Spanish opted for an "event-driven" approach. Information is only sent when a change of status occurs. Typically, a vessel would be prompted to send a report on entering and leaving a country's fishery boundaries. The computer system in the fishery protection headquarters would have less data to process and overall transmission costs would be reduced.

The challenge lay in the requirement that much of the system's intelligence would be on board the vessels. The shipboard electronics would have to know when the trigger event had occurred if it were to send the appropriate report on time.

The Spanish company Sainsel provided the solution. On board the ships, a sealed, aluminium box containing a small computer linked to a Trimble Galaxy Inmarsat-C/GPS transceiver was installed. The box ensured that the whole system was tamper-proof and sensors detect any attempt to break in or interfere with the aerial or power feed.

The computer runs a version of the company's geographical information software containing charts of the areas in which the vessel operates. The software was programmed to recognize when the vessel crossed fishery

boundaries or particular depth contours, using GPS information from the Galaxy. These events triggered messages to be sent to the control centre, and simultaneously, to authorities in other countries, where appropriate. If controllers believed a violation of fishery law was taking place, they could poll the vessel for a fuller report of historical positions and other details.

The system has been fitted on more than 80 Spanish fishing vessels during 1994. The trial should end in the first quarter of 1996; results so far show that it is successful. Sainsel have already received a contract from the Argentinian fishery authorities to set up a similar system. (Source: *Ocean Voice*, January 1996)

SBF monohull in service in New Zealand

A New Zealand company, North by South Ferries has introduced an SBF Shipbuilders 31-metre monohull on a route across Cook Strait. The yard started building the vessel for stock, but it was launched in mid-1995 and was expected to enter service in Singapore, but the deal fell through. The monohull now operates from Porirua, North Island, about 30 kilometres from Wellington, to Picton on South Island. The trip lasts approximately 1 hour 45 minutes at a speed of 30 knots and misses the rough seas normally encountered here. The fit-out includes 146 seats in two main deck saloons. (Source: *Fast Ferry International* January/February 1996)

Kuwaiti-based United Arab Shipping Company

The company has awarded contracts to Business Information and Development Management and Marine Management Systems (both USA), to configure and install a new system that streamlines corporate communications and gives better control over items such as inventory and maintenance lists. Until now, the company relied on a centralized shore-based Vax mini-computer system. Each vessel took care of its own inventory and maintenance lists manually and communicated with the Kuwait office via fax or telex.

The new approach will be PC-based, with computers installed aboard all ships in the fleet. Both ships and the office will run MMS's Fleet Manager software, including the Fleetworks inventory and maintenance system, and Fleetwatch administrative and reporting system. Databases will be kept both ashore and on board the vessels and synchronized daily through routine file transfers. This approach will enable the company to adopt a coordinated fleet-wide maintenance, spares and overall management policy. (Source: *Ocean Voice*, January 1996)

Savings through using e-mail achieved

Shell UK Ltd., is reporting success for its Rapid Lubricants Analysis (RLA) service, which monitors machinery and oil aboard subscribing vessels to prevent mechanical failures and unnecessary maintenance. Shell claim that only its service offers an E-mail facility and that the resultant speed in delivering results to customers pays huge dividends.

Subscribers to the service send lubricant samples for analysis, testing and diagnosis. The results are returned to the shipping company's headquarters, or to the ship via e-mail, within 24 hours. One user of this service, Cable & Wireless Marine, estimates that it has saved US$ 385,000 by avoiding delays and minimising maintenance costs during a single cable-laying operation. Shell's analysis identified that the main engine's lubricating oil was diluted with fuel oil and enabled preventive action to be taken. Other Shell customers are reporting similar savings; Shell estimates that some 15 per cent of the world's fleets are now registered to use the service. (Source: *Ocean Voice*, January 1996)

New design from Incat Tasmania

International Catamarans Tasmania has confirmed that it is working on a design for a solar powered vessel. The new craft is six metres in length and is being developed for a six hour advanced technology boat race to be held on Canberra's Lake Burley Griffin in April 1996.

The company says that the vessel will be constructed from commercially available components and will be put through intense trials and testing. The company believes that it is possible to economically build a competitive vessel. A solar boat has great potential, not only for conventional boating, but also for commercial applications. Computer modelling predicts that the vessel will be able to operate at reasonable speeds, depending on the sun. Once the race is completed, details of the vessel will be released to parties interested in furthering the technology and design. (Source: *Fast Ferry International*, January/February 1996)

C. TECHNOLOGY UPDATE

The Perfect Sail?

Designers are using the latest CAD/CAM and FEA technology to concoct the perfect sail. One problem they face is that they design sails which are almost impossible or impractical to manufacture. Engineers at North Sails, Minden, Nevada (USA) have developed a method of building 3D sails that combines weaving and sailmaking in one process. The method allows the company to build unique sails, called 3DL sails (3D laminates), that more closely match what top boat designers are developing on their computers.

At the company's facilities, large moulds of aluminium panels match the size and shape of the sail being built. The moulds are precisely positioned according to settings generated from a computer model of the sail. A layer of Mylar is laid down on the mould, then a six-axis machine with a knitting head lays yarns onto it. The head, mounted on a six-axis gantry follows the shape of the computer model, so an accurate placement of the mould is crucial. The yarns, made from Kevlar, polyester, carbon fibre, or almost any other material, give the sail its strength. A light adhesive coating keeps the fibres in place on the Mylar. After the knitting head has positioned the yarns, a second layer of Mylar goes on top. A vacuum brings all the layers into close contact with each other. After curing under infrared lights, the sail is trimmed and receives attachments such as grommets.

The company says that this method allows them to vary the densities and directions of the fabric, thus obtaining a closer resemblance to the true loading specifications the designers want. The technique also allows the company to react quickly if a new material comes onto the market. All they need to do is to adjust the weaving head to use it and they do not need to wait for a company to make it into a fabric. (Source: *Machine Design*, 28 September 1995)

Corrosion problems in Santos Basin field

Petrobras, Brazil's national oil company, is planning to put on production a new offshore oil and gas field discovered in Santos Basin. Production from six oil wells and two gas wells will be routed to one floating production system, a semi-submersible platform. Production is expected to start during the third quarter of 1996. Studies indicate that a drastic reduction in investment could be achieved if unprocessed multiphase well-streams are transported from satellite wells on neighbouring fields to a central processing platform. Petrobras faces a challenge to avoid serious material loss caused by corrosion in carbon steel oil and gas lines, tubing and well-head equipment.

The two completed gas wells have extremely harsh operating conditions with high temperatures and pressures, and high concentrations of hydrogen sulphide and carbon dioxide. The oil wells also have harsh operating conditions with high temperatures and pressure, together with high concentrations of carbon dioxide and brine.

Such environments require special materials for downhole and surface equipment. The completion of sour, hot-gas producers is challenging because of the need for appropriate steel to withstand high pressure and temperature conditions. Based on studies carried out, it was decided to select corrosion-resistant alloys (CRA) tubing material and cladded wet Christmas trees. All pipelines were designed to transport unprocessed well fluid from subsea installations to an offshore production platform, using a carbon-manganese steel and a sour service carbon steel, both with continuous corrosion inhibitor injection for oil and gas respectively. The selection of CRA solved the technical problem, but considerably added to the cost. In any subsea project under development, the pipeline costs are a considerable part of the investment. Using pipelines made from carbon steel instead of CRA can result in savings.

The severe corrosive environment predicted in Santos Basin requires extensive and complex laboratory corrosion inhibitor screening programmes to determine the most efficient and cost-effective corrosion inhibitor programme (autoclave, jet impingement, pipe flow loop and RCE/RDE tests). For subsea pipelines, inhibitor selection should be based on simulated operating conditions including fluid velocity and flow regimes. Corrosion monitoring of offshore pipelines containing carbon dioxide and hydrogen sulphide is one of the more challenging problems facing industry today. The more limited the corrosion monitoring information, the more difficult corrosion control becomes. Typically, corrosion control and monitoring for offshore pipelines consists of injecting corrosion inhibitors, collecting iron count data, and monitoring corrosion coupons placed at the end of the pipeline. These monitoring programmes have so far been unable to provide information on the variables in corrosion behaviour throughout the pipeline. Successful subsea pipelines operation relies on effective corrosion control and corrosion monitoring.

One of Petrobras' goals is to improve the monitoring by using a model of the multi-phase fluid behaviour to determine the effectiveness of corrosion inhibitor distribution. In addition, the company has been studying electrochemical techniques to be used in the inhibitor laboratory studies and as a monitoring tool in the field. (Source: *Offshore*, September 1995)

Coordinated marine bridge system

Tokimec Co., Ltd., a leading manufacturer of marine equipment, has developed a coordinated marine bridge system that integrates a radar system, navigation information display system, electronic hydrographical chart, and other equipment normally mounted on ocean-going ships.

Shipbuilders are procuring bridge equipment independently for coordination into their own bridge systems, but the development of the new coordinated marine bridge system looks set to reduce the overall cost. The equipment is linked to a local area network (LAN) system, so they can be operated smoothly together.

The coordinated marine bridge system, called SEAVANS, integrates various marine navigation equipment such as the electronic hydrographical chart, radar system, navigation information display system that indicates the weather as well as the working conditions of the engines, the control system for automatic navigation, gyrocompass, and a system for receiving global positioning system signals. The new system was developed based on the emergence of the electronic hydrographical chart that increases the advantages of the coordinated bridge system. The layout of the system is based on human engineering,

by which all operations, including lookout, equipment manipulation and monitoring, are designed for convenience.

More information can be obtained from: Tokimec Co., Ltd., Public Relations Section, 2-16-46, Minamikamata, Ota-ku, Tokyo 144, Japan. (Source: *JETRO*, October 1995)

Wave power competes with wind and solar power offshore

The vision of developing a prodigious renewable power supply with low maintenance and high operating efficiency is a dream which has not yet been attained. The chloride environment and variable physical motion of the waves limits mean-time-between-failure for most mechanical systems, and others do not provide sufficient power consistently to warrant wider interest.

There are low-power requirements which are specific to offshore petroleum industry functions that can be filled by solar and wind power. Solar energy panels have powered data transmission and some control functions on unmanned production structure offshore and well-heads onshore. Presently, wind generators are being installed on several North Sea platforms to power electronics and data transmission functions.

Wave power has until now not been considered because of the high maintenance requirement of rotating equipment. Ocean Power Technologies of Princeton, New Jersey (USA), says its wave power unit features hydro-piezoelectric motion, and thus has no prime parts in motion. The company will install a 1kW generator on an undisclosed platform in the Gulf of Mexico early this year and expects to have a 1,000 kW unit operating by 1997.

The piezoelectric effect is the conversion of mechanical energy to electrical energy through the use of a material with piezoelectric properties. Ocean Power's system uses the differential between an anchored element and a moving element to generate the motion. A cam moves up and down past piezoelectric elements creating electricity. The units reach optimal output at 1 metre wave heights with a frequency of 0.15 Hz.

Other wave power designs have been tried in the past years. However, developers found that wave tank testing has not imposed the complete spectrum of offshore wave and seabed conditions, resulting in less-than-adequate performance or actual problems in trial. These designs include: seabed piston pump which involves a float at the surface connected to a piston pump and valved chamber on the seabed. Up-and-down wave forces on the float are transferred through a rope to the piston pump on the seabed, which pulls water through a turbine generator. Advantages of this type of system are that the wave energy is higher offshore than nearshore and the unit can be deployed in most shallow water regions.

A second design is the oscillating water column: this system operates best in a confined inlet along the shoreline, although platform-based models with an air chamber can be fabricated if the economics are justified. The principle is that wave oscillation in a confined space creates air oscillation, which in turn drives a bi-directional turbine positioned vertically or horizontally over the air chamber. A bypass helps smooth the flow regime. The turbine can operate with or without guide vanes. Greater efficiency can be created with linked upstream and downstream guide vanes.

A third design is the mid-water propeller: this system consists of an axial flow propeller mounted on an underwater monopile. The propeller is driven by mid-water current flows in coastal estuaries, between islands, or in strong offshore gyres. The propeller rotates about the pile to face current flow. The entire assembly can be lifted to the surface for repairs. A drawback to this system is the size of the propellers and possibility of blade impact with marine rubbish, mammals, or trawling gear. (Source: *Offshore*, October 1995)

Data-carrying pipelines

A data system being developed in the UK utilizes pipeline walls as a transmission medium. The system has been developed by Flight Refuelling of Wimborne (Dorset) in association with several large oil companies.

The unit couples a subsea electronics module to an acoustic transmitter at one end of the pipeline. An acoustic sensor, at distances of up to 35 kilometres away, picks up the transmitted signal. The system eliminates the use of umbilicals or water acoustics. Originally, water acoustics were the focus of considerable investigation for deep water operations, but thermoclines and salt saturation variances created major signal distortion. Immediate applications for pipeline signalling are subsea stepout well control and telemetry, monitoring of cathodic protection potential, integrity and thickness monitoring for pipelines and J-tubes, product transfer, anchor and mooring line monitoring. (Source: *Offshore*, October 1995)

Hurricane-damaged platform repaired by wet welding

In August 1992, a highly destructive hurricane crossed South Florida into the Gulf of Mexico, hitting the Louisiana coastline. Several offshore platforms in the Gulf of Mexico experienced storm damage. This damage ranged from localized cracks in members to structures completely toppled by the force of the storm.

Trunkline Gas Company's T-23 platform, located in the South Timbalier Block 52, was repaired by wet welding after sustaining structural damage. The successful replacement of two critical K-brace nodes by underwater wet welding provided significant cost savings, minimizing the offshore exposure time and returned the platform to its original structural integrity without shutting down the transmission of natural gas.

Three repair concepts were considered for the repair of the platform: mechanical clamps, dry hyperbaric welding and wet welding. All methods involved bisecting the members connecting to the damaged node at their mid length, for residual stress and spring back purposes, and reconnecting by the above methods. Due to the configuration and materials needs, wet welding provided the least expensive, easiest to implement and shortest offshore exposure time with an estimated cost saving of 40-60 per cent. A procedure was prepared to repair the two damaged nodes by fabricating similar replacement nodes, removing the damaged nodes and installing the new nodes by wet welding.

The whole project, including weather downtime, took 21 days; a total of 233 dives were recorded. Roughly 595 welding/diving man-hours were spent on the project, proving that underwater welding repair concepts are a feasible and cost-effective solution to offshore platform repair, at least in the Gulf of Mexico. (Source: *Offshore*, October 1995)

Advanced technology used for JAMSTEC's ROVs

The Japan Marine Science and Technology Centre (JAMSTEC) has developed manned submersibles and unmanned ROVs, and is presently operating these vehicles

for scientific research. One of the manned submersibles, Shinkai 6500, is the world's deepest submersible, capable of diving to 6,500 metres depth. At present, no other operational manned submersible can dive to this depth.

A full ocean-depth research ROV, Kaiko, has also been successfully developed by JAMSTEC. In March 1995, the vehicle touched the bottom of the Challenger Deep at the Mariana Trench. The Kaiko measured the depth at this point at 10,911.4 metres and also found marine life at this depth. (Source: *JAMSTEC*, Yokosuka, Kanagawa, Japan)

Acoustic tomography for oceanography

JAMSTEC has developed a new ocean observation system based on ocean acoustic tomography as a real-time, large-scale, three-dimensional ocean observation system. The core element of this system is a powerful, broadband, low-frequency source. JAMSTEC has successfully developed both a new 200 Hz source using a giant magnetostrictive material and a new receiver designed to discriminate between upward and downward travelling sound waves using beamforming. A 621 kilometre sound transmission experiment with the source and receiver has been conducted in the open sea. The source and receiver worked well and satisfied specifications. The data thus obtained were analysed using a standard tomography inverse method to reconstruct the sound speed and temperature profiles. The positive results enabled JAMSTEC to construct a 200 Hz acoustic tomography system, combined with a real-time data communication system using the Inmarsat-C Global Data Communication System. (Source: *JAMSTEC*, Yokosuka, Kanagawa, Japan)

Super high-speed cargo carrier

Tests have been started in Japan on a new type of large super high-speed cargo carrier, called the Techno Superliner. The prototype vessel apparently has excellent flexibility and the experiments are designed to assess the types of facilities necessary to achieve integrated door-to-door cargo transportation.

Seven leading Japanese shipbuilding companies are grouped together under the Technological Research Association of Techno Superliner, under the guidance of the Ministry of Transportation, to actively undertake research in this field. The basic idea is to establish new technology so as to raise the larger portion of the hull above water to minimize water resistance and to enable super high-speed cruising.

It is envisioned that the Techno Superliner will be a super high-speed cargo ship, with a cruising speed of 50 knots, a cargo capacity of 1,000 tons, a range exceeding 500 nautical miles and a seaworthiness enabling the ship to safely navigate even in high seas of sea state 6. The R&D effort at present focuses on the three forces that support the ship's weight: buoyancy, dynamic lift and air pressure, to derive two ship designs: a hydrofoil-type hybrid hull which combines buoyancy and dynamic lift; and an air-cushion type hybrid hull combining buoyancy with air pressure.

Two models have been built and have undergone sea tests to acquire data unobtainable through laboratory tests and to evaluate and verify the basic research findings. Obviously the test objectives of the two prototype ships differ due to their size and speed, but the performance of the models have been tested at a speed equivalent to 50 knots of an actual ship.

More information is available from Technological Research Association of Techno-Superliner, 1-3-8, Mejiro, Toshima-ku, Tokyo 171, Japan. (Source: *JETRO*, November 1995)

Radar-based oil spill system

A new oil spill detection system based on traditional ship radar (X-band) has been developed by Simrad Norge AS in cooperation with Elf Petroleum Norge.

The system detects oil spills on the sea and automatically provides information on the size, position and movement of the slick. A typical application will be the monitoring of unmanned offshore oil installations and coastal terminals to provide an early warning of oil leakage or spills. An advanced computer-based signal-processing system analyses and distinguishes radar echoes of oil slicks from those of an unpolluted sea surface. Information concerning the slick appears on the colour display of an operator's personal computer, both as graphical images and as numerical data.

One advantage of this system over other traditional methods of oil spill detection and monitoring is that it works just as well when darkness and fog reduce visibility, according to the company. (Source: *Sea Technology*, November 1995)

Sound travel study in Loch Ness

A project commissioned by the European Union and undertaken by the Ocean Systems Laboratory of Heriot-Watt University has been undertaken to acquire data from deep beneath the sea to examine how sound travels in depths to 200 metres. They aim to characterize the underwater acoustic channel using experimental data. This knowledge is considered essential for the design of future autonomous underwater vehicle (AUV) communication systems.

A number of experiments have been carried out in the Firth of Forth and Loch Ness in Scotland, as well as in the Mediterranean, to measure acoustic signals under differing conditions of temperature, salinity, bottom topography, swell and wind. The experiments have involved two ships several kilometres apart whereby one ship sends an underwater signal to the other, which receives it on hydrophones. The data received is logged by Racal Recorders' advanced Storeplex instrumentation records, which records all signals onto a time-coded tape. These signals are then compared with the signals which were transmitted and the effects of the various conditions calculated. The data can then be processed to give vital information on error rates underwater for various modulation formats.

These data, which are the first of their kind to be gathered under high-level software control, will be extensively used in the development of underwater communications and the verification of scientific and mathematical models. (Source: *Sea Technology*, November 1995)

Low-cost incremental seawater plant

Many localities throughout the world have installed reverse osmosis plants to provide potable water for their populations. A large number of these facilities operate at pressures of 900 to 1000 psig, with feedwater temperatures ranging from 18 to 32° C. Water sources are from beach wells for most small units, to open sea intakes for the larger-capacity ones. A number have been built with energy recovery modules designed to reuse 25 to 35 per cent of the electrical power. These reverse osmosis plants have

provided an excellent, reliable source of drinking water. However, today a number of these plants are faced with the need to expand their water supplies to meet a growing population and tourist demands. The world's economies, however, have placed severe restrictions on the availability of funds to finance the resolution of these needs. A new technical and commercial approach to an inexpensive capacity increase for existing plants is needed. This could be achieved where the two systems, which have been used for many years, are combined. This can be achieved when the brine effluent of an existing plant is pressure upgraded to 1200 psig in a Pump Engineering Hydraulic Turbo-Charger™ and then fed to a DuPont B-10 TWIN™ permeator. Additional permeate is extracted in this high-pressure membrane array, resulting in overall plant recoveries approaching 60 per cent. The brine from the high pressure stage energizes the TURBO,™ thus electrical consumption is zero, except for the instrumentation. No added pretreatment or raw water supply is normally required, thus leading to a significantly reduced energy consumption. (Source: *Desalination 102*, 1-3 October 1995)

Lightweight insulation material

In an answer to pressure on designers to reduce vessel weight, Blohm & Voss have developed a lightweight A60 standard insulation. The company claims a weight saving potential for the system that has an installed weight of approximately 4.5 kg/m^2. The system, called the E.P. System, has two notable features, the basic weight of the product and the carrying system.

The new system utilizes an insulating material Litaflex SM30, that is a high efficiency foam made up of mineral fibres and inorganic components having a density of between 28 and 32 kg/m^3. The carrying system, which has to be rigid and mechanically hard wearing in order to achieve low density, forfeits other basic properties, such as strength and rigidity. The company uses a thin AISI 301 stainless steel cassette, basically a shallow box filled with Litaflex, which sits on an aluminium understructure. The cassettes are held to the underframe by means of spiders, a fixing device designed for the system, and the underframe itself is pop-riveted to the ship's structure.

The idea behind the fitting system is to reduce the workload on the yard by supplying already prefabricated, ready to install components, thus speeding up the process of insulation. The company believes that prefabrication and ease of mounting are necessary for a good system and claims that the installation time can be as little as half that required for a conventional system. However, limitations are encountered, particularly when fitting the system to contours, or complicated edges and a space penalty can result as the system stands clear of bulkheads on its substructure. The company says the system can be easily repaired. Mechanical damage cannot be avoided completely—the movement of cars, cargo and passengers all taking their toll. However, individual panels can be quickly and easily replaced, leading to a repair time of about 15 minutes per square metre on small sections, and 10 minutes per square metre on larger areas. (Source: *Fast Ferry International*, November 1995)

Slice ATD swath details

Details have recently been released about the Slice Advanced Technology Demonstration which is being jointly developed by Pacific Marine, Lockheed and the US Navy's Office of Naval Research.

The details show that wave and total resistance of the vessel could be significantly reduced for speeds above 17 knots. The maximum speed is expected to be around 30 knots and unrestricted operation in sea state 5 conditions is anticipated.

The structural design of the ATD is based on six aluminium modules, the construction of which has been contracted to Nichols Brothers Boat Builders. Adaptations for ferry or naval payload modules can be made during trials according to requirements. The main engines, a pair of MTU 16 V 396 TB94 diesels, will be housed in the forward pods. Each will drive a 2.2 metre diameter controllable pitch propeller via a 6:1 reduction gearbox. (Source: *Fast Ferry International*, December 1995)

Collision resistance of double-hulled tankers

Tanker disasters occur on a large scale and make a deep negative impression on the public. In August 1990, the Oil Pollution Act of 1990 became law in the United States which required that all tanker vessels delivered after 1 January 1994 and operating in US waters must have double-hulled structures. The IMO agreed that an oil tanker must have a double-hulled structure, or an equivalent alternative, in March 1992. A double-hulled tanker proves its merits in avoiding oil spills. Studies have shown that a double hull provides 4-5 times the protection of a single hull in a collision. The depth of the double hull contributes significantly to the energy absorption capacity of the ship's side structure before leaking oil. (Source: *Offshore*, November 1995)

Taut leg mooring provides deepwater solution

Few questions remain on the use of polyester ropes for the taut mooring of semisubmersible production vessels in deep water. These are: durability, aging effects, shark-bite phenomena, the possibility of heat buildup during high cycling periods, and suitable end terminations.

Deepstar, a multi-operator research consortium, has installed a taut polyester line in the Gulf of Mexico for test purposes. Petrobras is conducting similar tests. These tests should resolve the remaining questions. It appears that, unless the tests provide negative results, the taut system using polyester ropes will become the system of choice for deepwater mooring. The taut-rope system has important benefits for mooring deepwater production vessels, and as an alternative for dynamic positioning during drilling operations.

Floating production systems are becoming increasingly popular because of the growing environmental requirements, residual liability and costs surrounding the removal of fixed structures, especially larger units in deep water. Taut line mooring further reduces the costs of floating production deployment.

However, taut-line mooring is not always a trouble-free choice. Natural frequencies in the axial direction must be accounted for, unlike catenary mooring systems. Piles are required for taut-line mooring, which have a higher vertical component in the tension regime than catenary mooring. Catenary mooring makes use of embedment anchors to reduce costs. Norsk Hydro is considering a less expensive alternative to piles as they are a costly component in taut mooring. (Source: *Offshore*, November 1995)

Jackup workover platform in Europe

A new generation of self-elevating operations support vessel (OSV) has begun operation in Liverpool Bay, United

Kingdom. This will be the first OSV to service production facilities in the UK. Although the use of such platforms is relatively common elsewhere, this is the first time that they have been used in Europe, where conditions are slightly different to those encountered elsewhere in the world.

Halliburton Energy Services and BHP Petroleum have evolved already proven technology and adapted it for use in Liverpool Bay. Effectively, standard lift boat technology has been combined with jackup drilling rig design in a purpose-built OSV providing cost-efficient infield services while ensuring that all safety and environmental requirements are met.

Applications include platform planned maintenance, accommodation, platform breakdown repair, heavy lifting, structural inspection, diving/ROV support, pipeline inspection and maintenance, well data acquisition, well workover, well interventions and well testing. (Source: *Offshore*, December 1995)

Wet welding improvements

A research project to reduce the drydocking of a large number of US Navy ships has developed a new underwater welding electrode that overcomes most of the problems associated with wet welding. The new electrode requires no mechanical shielding.

The electrode has been developed by Ohio State University, under a programme sponsored by the US Navy/ National Sea Grant. A two-year test found that weld appearance was excellent and micro-cracking was eliminated. Two additional benefits from the new electrode are that it provides good metal deposition in virtually any position and the electrodes are less expensive than conventional electrodes. (Source: *Offshore*, December 1995)

Trinidad well reworked

A well off Trinidad that sanded up after acid stimulation was successfully recovered after being cleaned out, recompleted and gravel packed through the tubing string with a coiled tubing unit and no rig. The well is among a few wells that have been recovered after significant sanding with minimal surface equipment required.

Originally the well had been gravel packed around slimpak screens. Well flow was down to 140 bbl/d with 10 per cent water before acid stimulation and sanding up. Flow after completion and gravel packing was 308 bbl/d with 13 per cent water. The cost of the operation was US$ 200,000, as compared with US$ 800,000 for a conventional sand cleanout and gravel packing. (Source: *Offshore*, December 1995)

Induced earthquakes boosting output in North Sea wells

Small earthquakes, induced accidentally in producing zones in the northern and eastern North Sea are triggering increases in production through the re-pressurization of reservoirs. In other cases, field production has partially collapsed, shutting off production entirely.

Researchers are studying the process in order to develop ideal producing zones for earthquake induction with the objective of increasing production. As fields mature in the North Sea, seawater injection is being used to enhance the remaining productive life of the reservoir. In some cases, results have far outweighed the expectations. A computer simulation program has been developed that can spot reservoirs which are ideal for earthquake induced production enhancement. (Source: *Offshore*, December 1995)

MHI develops CFC-free freezer

Mitsubishi Heavy Industries (Japan) has developed a freezer for ocean-going vessels which uses a new coolant developed by DuPont (R404A). The new system will be available early in 1996, when a total phase-out of CFC production is implemented in Japan. (Source: *Asia Environmental Review*, Japan Energy and Environment Ltd., 55 Exhibition Road, London SW7 2PG, UK)

Digital breakthrough for chart updating

The eventual replacement of paper charts with electronic data has been brought significantly closer with a number of commercial initiatives that took place towards the end of 1995.

The Dutch Ministry of Transport has successfully completed trials of a system for updating electronic charts that uses e-mail transfer over the Inmarsat satellite network. Although the feasibility of sending digitized chart corrections via Inmarsat is long established, the trials concentrated on the question of verifying the transmission and confirming the validity of the information received. At the same time, the establishment of a logical path for the generation, storage and eventual transmission of the corrections was required. These are crucial elements for any digitized chart-updating system, given the essential nature of the information being sent.

The trial was carried out in conjunction with the electronic chart display (ecdis) manufacturer van Rietschoten en Houwens and the communication software specialist Nayville. The trial was based on Nayville's Route 400 e-mail software which allows messages to be addressed using the international X.400 standards and delivered via Inmarsat. It envisages a service provider being the distributor of official chart updates generated by national hydrographic services.

The service provider would establish an e-mail network with a mail box for each ship subscribing to its service. The hydrographic office would supply the service provider with all chart updates. Then the service provider would allocate the appropriate updates to each subscribing vessel's mailbox. Before feeding the updates into the ecdis system, the software was able to check them and generate warnings if any data had been received incorrectly, was unavailable or had already been collected in an earlier transmission. As all actions taken were automatically logged, a report could be generated to verify what information had been collected by the ship, and when, in the case of a dispute or even litigation.

The development of electronic charts and the associated technology for displaying them has been quicker than that of the regulatory framework that will eventually control them. A number of chart providers and communication specialists have introduced schemes to offer a more effective means of updating the traditional paper chart. (Source: *Ocean Voice*, January 1996)

INMARSAT data for 1995

Following the commercial launch of Inmarsat-B, 1995 was a year of transition. The number of fittings for Inmarsat-B SES has been steadily growing. By the end of 1995, more than 600 Inmarsat-B SESs were installed.

The transition from Inmarsat-A to -B is crucial for Inmarsat's strategy of maintaining customer satisfaction. The principal feature of the new system is the opportunity for cost-saving that it offers. Tariffs are around 30 per cent lower than Inmarsat-A. The increased use of data communication by many vessels around the world is another

feature which led to the launch of Inmarsat-B, which is expected to become the mainstay of maritime communication with merchant trading vessels expected to be the largest beneficiary.

As a consequence of the Global Maritime Distress and Safety System (GMDSS), the number of Inmarsat-C fittings has increased steadily. The regulations of the GMDSS will be phased in fully by 1999 and shipowners must progressively implement the technology on board all vessels over 300gt.

The continuing depletion of fishing stocks in waters around Europe has been causing great concern. In 1995, the European Union Pilot Project fitted a number of fishing vessels to test the effectiveness of Inmarsat-C for fleet tracking. Through equipping fishing vessels with Inmarsat-C and an integrated Global Positioning System, vessel movements can be monitored and controlled. Results from this project are expected some time in 1996. (Source: *Ocean Voice*, January 1996)

Foam pigs remove paraffin

Petrobras, the Brazilian national oil company, is experiencing success in pushing foam pigs through pipes, manifolds, gas-lift valves, and Christmas trees not designed for pigging and removing large amounts of paraffins from deepwater production lines.

Conventionally, thermal and chemical methods are used to dislodge paraffin buildup on production piping and equipment. Pigging is an alternative, but the presence of valves, tree blocks, various pipeline and manifold tubing diameters, and sharp turns discourages pigging operations.

However, these methods can be very expensive, especially if the well was not designed for such methods. Usually, initial production tests will indicate whether paraffin deposition will prove to be a problem over the range of temperature and pressure variations experienced during production routing. A paraffin treatment programme can normally be built into the system. When the problem appears later, there is little one can do other than to stop production and deploy cutting tools, or attach heat tracing equipment, usually at great expense.

Petrobras has used these methods before with moderate success, but the process required the mobilization of a completion rig. Research therefore started on ways to mechanically clean the lines with pigs.

The challenge faced was how to get the pigs through the minimum diameter gas lift lines through manifolding valves, and Christmas trees intact to conduct a reasonable paraffin removal operation. The solution found was sequences of low-density compressible spherical and cylindrical foam pigs that could be pushed through small diameter pipes and orifices without shredding.

A Deepstar research committee on hydrates and paraffins developed a scenario of thermal, chemical and mechanical means to attach paraffin production. Less attention was paid to mechanical methods at the outset because of the presumed difficulty and cost associated with setting up pigging loops and the lack of research on foam pigs. Following the Petrobras research and collaboration, the situation has now changed. (Source: *Offshore*, January 1996)

Sulphur-based breakdown of oil

A bacterium discovered on the sea floor in an oxygen free environment can break down crude oil, a task which was previously considered improbable. The bacterium uses sulphur, or sulphates, as its conversion medium instead of oxygen. The discovery was made by a team from the Woods Hole Oceanographic Institute at a depth of 6,000 feet. They believe that the bacterium can also sour reservoir oils. (Source: *Offshore*, January 1996)

Liquefaction of seabed soils

As producers plan more oil and gas developments in earthquake zones around the world, the earthquake design of fixed platforms and floaters (peak surge and sway) will be taken into consideration. However, one element of earthquake design for fixed structures, liquefaction of sand and soils, may not always be considered.

Sand and silt lose their strength during liquefaction because of the materials' tendency to compact during severe shaking, shifts stresses from grain-to-grain contacts to the pore space liquids. The resistance to shearing or deformation is reduced as pore water pressure increases. During maximum events such as earthquakes, sands and silts turn to water. All support for surface or imbedded structures is removed.

Although fixed offshore structures are deeply piled into the seabed, extreme seismic events could liquefy the soils along the top portion of the pile depth, allowing the structure to sink far enough so as to become unusable. Even though this has not yet occurred, increasing developments in earthquake zones make this a possibility. In general, the presence of consolidated clays along the piling path, which can make pile driving difficult to start with, reduces liquefaction response.

Hurricanes and typhoons can create the same seabed conditions. Wave tank tests and seabed evidence in the wake of such events show that high variations in water pressure and subsequently, seabed liquefaction, begin when the magnitude of surface waves occupies a certain percentage of the water column. Low air pressure at the surface may have something to do with it.

The exact role of seabed liquefaction during such events is difficult to determine. There exists reasonable suspicion that soil liquefaction plays a greater role in releasing the hold of anchors, embedded gravity structures, angled piles, as well as deep vertical piles during extreme wave events, thus maximizing the impact of loads at the surface. Another disturbing phenomena is particularly applicable to earthquake prone areas of the world: once sand has been moderately liquefied in the recent past, it becomes more responsive to the forces that cause liquefaction for some time afterward. (Source: *Offshore*, January 1996)

Australian designers target short routes

With high-speed vehicle ferries finding increasing acceptance throughout the world, two Sydney-based design companies, International Catamaran Designs and Advanced Multi-Hull Designs, have recently released details of catamarans aimed at a new market sector—relatively short and partially sheltered water routes that require vessels having only a limited car-carrying capacity.

Incat Designs has produced two versions of a "Jillaroo" class, a Z-bow catamaran that has passenger saloons forward port and starboard either side of a vehicle deck, an open full width vehicle deck aft, and ramps fore and aft.

The vessel is intended for routes serving small island communities. The company says that the layout can be adapted to also carry light buses and trucks, or containers that can be loaded by crane or forklift truck.

The hulls, deck and superstructure of both vessels would normally be constructed from 5083 aluminium alloy plate and 6082TF extrusions, although the hulls and superstructure could also be produced in a combination of aluminium and composite if specified. A pair of diesel engines and waterjets give the catamarans speeds of up to 35 knots.

The passenger saloons and vehicle deck are on the same level, with the wheelhouse located above the main deck on a bridging structure. External seating can also be provided. Cars parked forward would be protected from sea spray by the ramp which would close off the whole bow area of the vessel when stowed.

Advanced Multi-Hull Designs' AMD 700 is a 59 m catamaran, designed to carry 350 passengers and up to 42 cars weighing an average of 1.25 tons, featuring a superstructure forward and an open air vehicle deck aft. The vessel is powered by a pair of Caterpillar 3616 diesel engines, anticipating a service speed of 39 knots when carrying 30 cars and half loads of fuel and fresh water.

All cars would be carried on a single vehicle deck while passengers would be accommodated in two saloons located amidships. These saloons would be reached via a midships casing around the centreline of the vehicle deck. (Source: *Fast Ferry International*, January-February 1996)

D. OCEAN RESEARCH

Porto Santo solar seawater desalination

A solar seawater desalination plant that has been in operation for more than 10 years on the Portuguese island of Porto Santo is proving its worth. It is the only solar-powered seawater desalination plant in Europe today.

Originally set up as part of a joint research project between the Technical University of Berlin, the Portuguese Regional Civil Engineering Institute LREC and the Deutsche Gesellschaft für Technische Zusammenarbeit, it consists of four 15 m^2 basins. Each basin was constructed to 50 per cent along the lines of the normal greenhouse procedure and 50 per cent according to a procedure developed at the Technical University of Berlin. The goal of the project was to compare the costs and performance of this newly developed plant with those of traditional desalination plants.

The central idea of the University of Berlin's procedure is to achieve a high productivity per square metre of solar insulation by repeatedly using the condensation heat, based on traditional greenhouse procedures. The moist warm heat which forms over the seawater basins does not generate condensation on the transparent covers (double glazing), but is cooled with seawater via a heat exchanger. The heated seawater is then stored. The heat store has the task of absorbing the incoming solar energy during the daytime and returning it to the condensation basin as warm seawater during the night. Warm moist air again forms over the basin and condensation can form a second time.

At the Porto Santo location, the local mean solar insulation allowed an average productivity of 1.8 litres/m^2/day. The mean productivity of the plant over a one-year period was 2.0 litres/m^2/day. It was able to achieve 15-20 per cent higher productivity after some modifications were made.

Since completion of the research work, all basins have continued to operate along the greenhouse procedure. The plant has continuously supplied drinking water and operational water to an office and workshop building. The building does not have any other source of water and no supply bottlenecks occurred. Maintenance has been carried out by a member of the Institute who has no technical background.

The materials used have withstood all weather conditions, applying both to the aluminium and the glass fibre reinforced plastic profile of the various roof constructions.

Work on solar seawater desalination has shown that the greenhouse constructions only require low maintenance and servicing inputs. Solar desalination technology is receding world-wide as other desalination procedures are available, even for small plants, such as reverse osmosis. (Source: *Gate*, 3/95)

Environmental impact of aquaculture

The need is arising for aquaculture facilities to manage the environmental impact of their operations. Aquaculture facilities discharge nutrients and organic matter that can affect water quality. Continued growth of the industry thus requires that greater attention be given both to the efficiency of feed utilization and to the fate of the substances in the effluent. (Source: *Sea Technology*, October 1995)

Toxic algae in Monterey Bay

Following the apparently intoxicated gathering of pelicans and cormorants in shallow water near Santa Cruz, CA in 1991, researchers discovered an algae living in Monterey Bay. It would appear that the poison can spread throughout the food chain—from mussels and clams to fish and seabirds, and potentially to humans.

The poison, known as domoic acid, is produced by a marine phytoplankton species *Pseudo-nitzschia australis*. In strong doses it can cause severe stomach distress, brain damage and even death. Domoic acid is relatively common and spreads quickly. The algae forms the base of the food chain and each animal in the chain can pass the poison to the next. As yet unknown is the amount of poison each animal retains and the possible health hazards of eating low levels of domoic acid over long periods of time. (Source: *Sea Technology*, October 1995)

Oil company aids university research

Shell Offshore Inc. has donated a deep-sea survey system to allow university researchers to attempt the first detailed seabottom survey of the Alaminos Canyon: a slash across the floor of the Gulf of Mexico in which water reaches depths of almost two miles. The equipment was donated to the Texas A&M Research Foundation for use by the Offshore Technology Research Centre. It will allow researchers to chart seabed and sub-seabed geological features more than a mile under water. The equipment is highlighted by a 17-foot tow fish with side scan sonar and a high-resolution sub-bottom profiler. This equipment is one of perhaps only two such systems known to exist world-wide and will establish the Centre as a leader in technology for deep-water geotechnical surveys. (Source: *Sea Technology*, October 1995)

Crack in one of the Earth's great crustal plates

Scientists at Columbia University's Lamont-Doherty Earth Observatory have reported evidence that one of the Earth's crustal plates is cracking. They claim that the Indo-Australian Plate has broken apart just south of the Equator beneath the Indian Ocean. The two continents are now moving independently of one another in slightly different directions. (Source: *Sea Technology*, October 1995)

Natural gas from the ocean floor

Through the steady industry of countless bacteria digesting the ocean's organic debris, a surprising stash of methane gas has been deposited beneath the sea—trapped in icelike crystals in floor sediments.

This quarry is now the object of a geological quest as some scientists believe that the microscopic methane molecules locked inside could eventually provide a salvation for energy-hungry societies around the world. It is possible that these methane deposits may hold twice as much carbon as all other fossil fuels on Earth-coal, oil and existing sources of natural gas-combined.

The so-called methane hydrates form when the methane gas, which is excreted by sea bacteria that primarily consume phytoplankton as well as the flesh of assorted dead organisms, dissolves and forms into crystals in the icy cold waters and tremendous pressures at the

bottom of the sea. This process, over millions of years, has left huge deposits of the natural gas.

A research team is planning to look into the molecular structure and look for clues as to how the methane gas can be harvested. One approach is to melt the deposits so that the gas can be vented to the surface. Using traditional gas or oil drilling techniques, concentric pipes could be placed on the ocean bottom. Then, warm water could circulate down through one pipe to melt the crystals, while the released gas could travel through the other pipe to the surface. Obviously such an approach needs a lot of refinement. A risk also exists that the melting crystals could destabilize a region of the ocean floor turning it into a slurry of mud that could damage the pipe rigging. Economic factors play an important role—many millions of dollars would be needed to manufacture such special drilling equipment. At present, sufficient untapped deposits of methane are available on land. (Source: *Technology Review*, 18 October 1995)

Polar sea ice decreasing

A team of scientists from the Nasen Environmental and Remote Sensing Centre in Bergen, Norway have reported that the sea ice in the Arctic and Antarctic has decreased since 1978. Although this change matches the pattern expected from greenhouse warming, it is as yet too early to pinpoint the cause.

The research team has based its findings on two sets of satellite measurements. The first was taken by NASA from 1978 to 1987; the second was collected by a different satellite sensor between 1987 and 1994. As the data from the sensors overlapped by six weeks, the data sets could be matched by the scientists. The rate of ice reduction in the Arctic was found to have accelerated from 2.5 to 4.3 per cent per decade. The drop in the Antarctic sea ice amounted to a relatively constant 1.4 per cent per decade over the 16 year period. (Source: *Sea Technology*, November 1995)

Cause of fish deaths studied

A single-cell, microscopic algae releases a toxin that has caused multi-million dollar fish kills world-wide. Washington Sea Grant researchers are developing a test to detect the presence of this toxic alga, *Hetero-sigma carterage,* before it reaches a density high enough to injure fish. With advance warning, salmon farmers may be able to take precautions to protect their crops.

Such toxic algae are a danger when their numbers increase dramatically. These population explosions are called "blooms". The researchers are also studying the threats posed by this algae on other marine organisms, including sea urchins and shellfish. (Source: *Sea Technology*, November 1995)

Altimetry study of the earth

Through the TOPEX/POSEIDON programme, some answers may emerge as to how deep the oceans really are. Via satellite, the precision altimetry mission can measure the elevation of the Earth's surface to an accuracy of less than six centimetres. This technique makes it possible to observe ocean-surface wind speeds, wave heights, and deformations in the lithosphere. The programme is a joint effort of NASA, the French Space Agency and the international scientific community. (Source: *Industry Week*, 4 December 1995)

Alternative diving method with nitrox

Underwater Breathing Systems Inc. (Lake Fort Worth, Florida) has introduced a product that offers an alternative method of diving with nitrox. The permeable membrane system produces NOAA nitrox-I and -II air using a method of denitrogenation, as opposed to the current standard for enriching air with oxygen. The system is apparently rendering traditional mix gas procedures obsolete. (Source: *Sea Technology*, December 1995)

New seafloor map

Using satellite sensor data recently made available by the US Navy, in combination with data from the European Space Agency, the National Oceanic & Atmospheric Administration, together with the Scripps Institution of Oceanography, has generated a computer model of the seafloor in unprecedented detail.

The new map infers seafloor features from changes in the strength of gravity, providing the first detailed view of ocean floor structures in many remote areas of the world.

The data used to generate the map were gathered between March 1985 and October 1986 through a satellite orbiting the Earth. A radar altimeter on board returned readings of the distance from the satellite to the ocean surface, accurate to about 2 centimetres. Radar waves were reflected by the ocean surface and did not penetrate it, unlike the sound waves of an echosounder, so that the satellite data yielded highly accurate measurements of the shape of the ocean surface, not the ocean floor itself. The researchers involved have found a method to explore the ocean floor using the data available. They first use the satellite data to find tiny changes in the pull of the Earth's gravity field and then use those gravity anomalies to infer the topography of the ocean floor.

Marine geologists have been mapping the ocean floors for some time, but have been hampered by the limited quality and coverage of the available data, mostly using guesswork. Until now, the most common method of mapping has been acoustic echosounder readings taken by ships; thus only a small fraction of the seafloor has been charted. (Source: *Sea Technology*, December 1995)

New system for screening submerged soils

Boskalis Offshore BV has developed an underwater system for the screening and bulk sampling of submerged soils. The system can be used for standard civil dredging works, clean sediments down to the bed rock, excavate bridge footings and other structures. It is claimed to be well suited to selective dredging tasks, such as the recovery of aggregates, the sampling of polluted soils in estuaries and the excavation of materials beneath jetties, without disturbing other ground sediments.

The system is said to be a complete self-contained workstation with two booms with which it gathers the sediments and a built-in screening plant. It is remotely operated from the surface and designed to enable the civil/offshore engineer to work relatively unhindered by adverse weather or deep waters. (Source: *The Dock & Harbour Authority, Vol. 76, No. 864*, December 1995/ January 1996)

Deep ocean mining technology developments

Once its potential is fully realized, the deep seabed promises to make an enormous contribution to the world's resource base. Manganese nodules and cobalt-rich crust are

resources of current interest for exploration and are deposited over and beneath the ocean floor at depths ranging from 800 to 6,000 metres.

With the entry into force of the Law of the Sea Treaty, each premier investor has the obligation to prepare legal, environmental and technological backgrounds for future mining operations. Manganese nodule mining usually involves the coordination, or integration of five distinct systems of operation: (1) an exploration survey, (2) a nodule collection from the seafloor, (3) hoisting to the mining ship, (4) transportation to land, and (5) processing onshore or in the ocean.

The Japanese Ministry of International Trade and Industry (MITI) has promoted the research and development of a nodule mining system. Geological studies have been carried out together with fundamental engineering research. An R&D programme for nodule processing technology and the environmental impact of ocean mining was started in 1989.

India has already undertaken extensive survey cruises in the central Indian Ocean for the exploration of manganese nodules. India projects a semi-industrialized mining phase by 1997, aiming at commercial mining by the year 2010.

Indonesia has been producing tin from offshore and is currently developing a plan for ocean-resource development. The Ocean Engineering Research Centre is undertaking research for new mineral production from water deeper than 100 metres. The Centre has already initiated automation research of tin dredge operations aiming at lowering the cost involved. (Source: *Offshore*, January 1996)

E. ENVIRONMENT

Environmental law on small islands

With its population of 140,000, Curaçao is the largest island of the Netherlands Antilles. As a result of growing appreciation of the need for environmental protection and increasing public environmental awareness, the island's Government has passed a new anti-pollution law. This aims to manage and minimize air and water pollution from island industries, as well as governing industrial waste management.

The main economic sectors on the island are tourism, international banking, trade and oil refining. The single oil refinery is the island's largest single industrial site and at the same time the largest source of pollution.

The new Nuisance Ordinance aims to correct many deficiencies of the old anti-pollution act. It covers all businesses and agencies whose activities have an impact on environmental quality. The law defines levels of air and water quality to protect public health which were based on a review of European and American standards. Regulations govern air quality, wastewater and waste management. Prevention as well as control are goals of the wastewater regulation. (Source: *UNEP Industry and Environment*, April-September 1995)

Refined environmental monitoring in the Orkneys

One of the four largest oil handling terminals in the United Kingdom is using an Epic 1030 pressurized pipe sampler from Montec International to monitor treated effluent water.

The Flotta Terminal on the island of Flotta, handles crude oil and gas products. Treated effluents are discharged through a 3.5 mile pipeline into the Pentland Firth. To ensure that the oil content of the water discharged into the Firth complies with regulations, the company installed the Epic 1030 pressurized pipe sample. This system is programmed to extract samples on a continuous basis which are then collected for daily analysis. In addition, a manual spot sample is taken for operational purposes.

Epic was chosen due to its easy and safe installation, its pneumatic collection head and its operating record in Zone 2 hazardous areas. It has no sensors or level detectors to break down and the two valves which pass the effluent are purged between samples to prevent any pipe blockages. (Source: *Process Engineering*, October 1995)

Water around UK Isles to be monitored

To improve monitoring and forecasting capabilities for waters around the British Isles, the Defence Research Agency (DRA), Proudman Oceanographic Laboratory and the UK Meteorological Office are collaborating to produce a new computer-based operation forecasting model. It is planned that the model will make routine predictions of extreme currents, sea levels, and wave conditions over the whole of the north-west European shelf. One of the first products of this project will be a new 3-D digital atlas of tidal currents. In the future, the project aims to integrate other data: space-based radar data to identify and locate oil slicks, ocean model data to enable identification of threatened coastline and ship surveillance radar data to identify the ship responsible for generating an oil slick. (Source: *Sea Technology*, November 1995)

Oceanor environmental analysis in Indonesia

As part of wide-ranging environmental agreements signed between Norway and Indonesia, Oceanor is to provide its Seawatch system to monitor Indonesia's marine environment. The company will also provide a training programme for Indonesian staff.

The task is immense—Indonesia occupies an area measuring 4,500 kilometres from east to west and 1,500 kilometres from north to south and consists of some 17,000 islands. The company will tackle the most important areas first, the Malacca Strait and the Java Sea.

The company expects a number of benefits to result from implementing the Seawatch system. These include improved weather forecasting, improved forecasting of the spread and drift of oil slicks and of the appearance of algae blooms, while for the offshore industry there will be numerous marine environmental data.

Oceanor claim that the Seawatch is the world's first complete integrated marine environmental monitoring and forecasting system. It brings together data collection and analysis within a framework of environmental modelling and forecasting. The data is communicated to controllers via satellite. The front end of the system is the Seawatch automatic buoy, which is equipped with an array of sensors to measure wave heights, wind speed and direction, air temperature and pressure, currents, water temperature and salinity, and the presence of algae, nutrients, oxygen and radioactivity. The buoy is apparently able to operate for several months without maintenance. (Source: *Offshore*, November 1995)

UK River Authority calls for pesticide action

The National Rivers Authority in the United Kingdom has called for more concerted action to prevent pesticides from entering the aquatic environment. The move follows the most comprehensive assessment of water pollution from pesticides in England and Wales to date.

The Authority would like the water industry to adopt measures that include the designation of special water protection zones inside which pesticide use would be banned, or tightly controlled. They believe that this method would be cheaper than relying on water treatment works to ensure that drinking water meets European Union standards. (Source: *National Rivers Authority*, December 1995)

Link in marine food chain at risk

The population of zooplankton near the coast of Southern California has decreased by 50 per cent since 1950. This decline could cause a significant threat to other marine life according to scientists at the Scripps Marine Life Research Group.

Zooplankton are the primary source of food for hundreds of species of fish and seabirds, including sardines, anchovies, hake, and jack mackerels. While researchers agree that the declining zooplankton population is linked to a warming of the top 600 feet of the ocean in the region, they disagree as to what has caused the ocean surface temperature to rise. A lack of evidence has prevented scientists from speculating as to whether the population of zooplankton will continue to decrease in the future. (Source: *Sea Technology*, December 1995)

Oil spill agent developed

Researchers at Zhongshan University have developed a simple agent to soak up pollution caused by oil spills. The so-called Forming Oil Agent utilizes sawdust, sugar-cane residue and an organic compound. It has been tested in an actual spill situation when it was used to absorb 320 tons of crude oil spilled by a tanker in Xingang Port. The Guangzhou Haichang Oil Transportation Co., who managed the clean-up, verified the effectiveness of the new agent. The developers claim it is 25 per cent cheaper than comparable products, and up to 60 per cent of the retrieved oil can be recycled. (Source: *Asia Environmental Review*, December 1995/January 1996)

F. COUNTRY NEWS

Africa

Eritrea

Eritrea has awarded the Zula Block in its Red Sea aquatory to Anadarko. The 6.7 million acre concession is a subsalt play in water ranging from 75 to 200 feet in depth. Only two wells have so far ever been drilled on the block, with eight in the aquatory. The company plans magnetic-gravity surveying together with 3-D seismic; drilling is more than a year off, using technology similar to that used in the Gulf of Mexico.

The frontier province of Eritrea is also being explored. IPC has acquired a 15 per cent interest in the large Danakil Block, with the Jurassic prospect, Big Edd, believed to be holding between 1.7 and 6.8 billion bbl recoverable reserves. A well is planned before the end of the year. (Source: *Offshore*, October/November 1995)

Damen Shipyards (Gorinchem, Netherlands), has recently completed a 45 metre tug for the Eritrean Port of Massawa. The tug is propelled by Aquamaster type US 901 azimuthing stern drives fitted with 1,600 mm diameter fixed propellers running in nozzles with stainless steel inner rings. Propulsion power is given by a pair of 12 cylinder Cummins KTA 38-M diesels.

The tug was built to a standard Damen design and is intended to be an optional harbour tug. The hull shape and the swivelling thrusters give excellent manoeuvrability and the layout is such as to enable a crew of three to safely operate the vessel. It can, however, accommodate a crew of 10. The round bilge hull is of a very heavy construction, being plated in 12 mm steel, with sheerstrake of 20 mm. Heavy Hercules rubber fendering is fitted at the bow and stern.

Equipment includes an electrical capstan on the foredeck, a Ridderinkhof 50 t towing winch on the aft deck, a towing bitt aft, an Effer 10.000 2S hydraulic knucklebook crane just aft of the cabin, and an Ajax de Boer fire-fighting monitor on the top deck. A diving compressor is also provided. (Source: *The Dock & Harbour Authority, Vol. 76, No. 862*, September/October 1995)

Equatorial Guinea and Nigeria

The Qua Iboe Channel in Equatorial Guinea and Nigeria is being surveyed by Mobil via a 1,100 km^2 3-D seismic study following the success of the company's Zafiro Field discovery whose reserves are in the Qua Iboe. (Source: *Offshore*, November 1995)

Gabon

Marathon has made a major discovery in Gabon's Kowe offshore permit. The Tchatamba Marine #1 wildcat in 151 feet of water 18 miles offshore has been tested at a rate of 4,545 bbl./day oil from 180 ft of net pay. Further seismic activity is planned to delineate the discovery. (Source: *Offshore*, December 1995)

Gambia

The Ministry of Works and Communications of the Government of Gambia recently signed a contract with IHC Holland for the construction of three ships.

These comprise a grab dredger cum buoy tender with a hopper capacity of 250 m^3, a 25 t bollard pull harbour tug of about 1,750 hp and a mooring launch of 120 hp. The ships are destined for the Gambia Ports Authority and will be used to upgrade the infrastructure of the Port of Banjul. With plans for Banjul to become a free port in the near future, a substantial increase in throughput is anticipated. (Source: *The Dock & Harbour Authority Vol. 76, No. 864*, December 1995/January 1996)

Nigeria

Activities in Nigeria's offshore fields continue to make news. The Ejulebe Field which is operated by the Nigerian oil company Atlas Petroleum has tested 6,000 bbl/day of oil. It lies close to Chevron's Mefa Field and will probably be produced through the Chevron facility. Shell's deepwater Bonga-1, which drills in almost 4,000 feet depth, is Nigeria's second deepwater well. Other companies are preparing their own deepwater locations.

The Amenam and Kpono Fields are likely to be joined. They are located in the south-east sector of the Niger Delta Basin where they actually form one structure which straddles the leases of Elf and Mobil. The Amenam discovery is one of offshore Nigeria's major discoveries, flowing at 9,000 bbl./day of oil.

Following recent political pressure, the Nigerian authorities are considering diversifying its concession holders. New exploration and production awards may well go to several Asian companies. (Source: *Offshore*, October, November, December 1995)

Seychelles and Sudan

After an absence of a number of years, drilling has been renewed in the Seychelles following the spudding of Enterprise's Constant Bank 1 wildcat well. The well was drilled in 51 metres depth and is 200 km south-southeast of Mahe.

The Delta Tokar Block in Sudan's Red Sea aquatory is due to see the drilling of a second wildcat, the Suakin 2. The Suakin structure contains approximately 325 million bbl condensate and 2.7 tcf natural gas and was last drilled nearby by Chevron in 1976. If it is successful, the operating company International Petroleum Corp., plans a fast track subsea development. (Source: *Offshore*, October 1995)

Arab Region

Dubai

The Dubai Port Authority has experienced an increase in the throughput of tonnage in 1995, amounting to 2 million TEU. Total tonnage handled was up by 12 per cent. The Port Authority believes that in order to succeed in the future, new developments will have to be made to offer more than just vessel loading and discharging services. They want to streamline the flow of cargo through efficient handling, to introduce improved information technology and communication systems, and in general to work together with other government departments, port users and their customers.

In less than 25 years Dubai Ports have developed from serving only local interests to being the hub port of the

region and being recognised as an important link in international transport chains. By the year 2000 an automation programme will be developed so that many terminal operations will be either operated automatically or monitored by surveillance systems. Through this system they plan to be better able to physically move containers through the terminals accurately and efficiently. An extensive and sophisticated computer system has so far been installed primarily enabling the Port Authorities to manage terminal operations and to track containers. An Electronic Data Interchange will be a major innovation in the port industry whereby manifests, discharge plans and loading plans will be instantly dispatched between ports and their customers without any paper. (Source: *The Dock & Harbour Authority, Vol. 76, No. 864*, December 1995/ January 1996)

Iran

According to recent reports, Iran has probably the largest gas potential in the Middle East, with 15 per cent of the world's total supply. Iran's gas needs are growing, but so are its offshore gas fields, mostly in the southern Gulf and Strait of Hormuz. The South Pars and Sirri Fields are the first to be developed; funds are needed for other major gas fields.

Iran has been offered participation in the exploration and development of the Shakh Deniz Field in Azerbaijan's southern Caspian aquatory. This field has been the subject of talks with numerous international oil companies. (Source: *Offshore*, December 1995)

If talks prove successful, the gas production from the Sirri A and E Fields in the Persian Gulf, operated by Total, will be piped to nearby Dubai. (Source: *Offshore*, October 1995)

Oman

Despite rumours to the contrary, the Oman-to-India gas pipeline project appears to be on track. The 1,135 km double gas pipelines are planned to carry 1 bcf/d gas across the Arabian Sea from Oman to western India by mid-1999 and to be completed by 2001. Several problems still remain to be solved, the most difficult being the pipe itself, as it will be laid at a depth of 3,500 metres. (Source: *Offshore*, October 1995)

Qatar

Qatar's Al-Khaleej Field has been handed over to Elf and Agip for development by the Qatar General Petroleum Corp., in a move aimed at boosting oil production. The field is expected to produce some 300,000 bbl/day by 1997. (Source: *Offshore*, October 1995)

Asia

Bangladesh

Bangladesh has spudded its first wildcat in over 15 years. In Block 16 in the offshore part of the Bengal Basin, Cairn spudded wildcat Sangu #1. It is located roughly 35 kilometres south-west of Chittagong in the northern part of the block and has a PTD of 3,000 metres, probably to test Pliocene sandstones. Strong currents, a soft seabed and the possibility of overpressure make this a potentially difficult drilling operation. (Source: *Offshore*, January 1996)

Brunei

In Block A in the Baram Delta Basin, Fletcher Challenger Petroleum Borneo has spudded its first well in Brunei. It is designed as a deviated well to test Lower Pliocene sandstones at a PTD of 3,255 metres. (Source: *Offshore*, October 1995)

People's Republic of China

A major new fast ferry yard covering 50,000 m^2 was recently completed in the Panyu economic zone of the People's Republic of China. The facility was commissioned by A. Fai High Performance Ships who state that this yard is the only one of its kind in China with a capability to build high-speed aluminium vessels. The company has been building small aluminium vessels at the yard for some time, but with the main production facility now available, it can construct larger fast vehicle ferries of up to 100 metres in length.

The yard is wholly foreign owned and managed by A. Fai and will utilize a mixture of modern management styles suited for Chinese design technologies. The company has taken particular care to ensure high quality and consistency in its workmanship. The Panyu yard is 90 minutes from Hong Kong by catamaran. (Source: *Fast Ferry International*, November 1995)

China's National Offshore Oil Corporation recently described the current state of offshore exploration, development and production in the country. They believe that the future holds tremendous promise. Offshore at present only represents 8-10 per cent of China's current oil production, but they are optimistic that in roughly 15 years, this figure will have increased to around 50 per cent. Field development has been increasing so as to step up production and eliminate oil imports.

Much of the economic development of the southern provinces of China depends on the development of the South China Sea reserves, particularly the apparently abundant gas reserves. This discovery and development is considered as very important.

The Bohai Gulf has some giant oil fields, where production is progressing well and a second phase is being planned. Seismic analysis is needed as are geological studies to develop the fields economically. The complexities of this require considerable expertise and technology, which are supplied by foreign oil companies.

Exploration of the East China Sea has been undertaken in two phases. The first phase was mainly self-funded; the second is both cooperative and self-financed. At the beginning, activity was limited due to a lack of funds and technology, but served as a preparatory stage for the current activities. This second phase has just started and involves considerable funds and technology from abroad. It is anticipated that by the end of the century, major production activities will be coming from the East China Sea. (Source: *Offshore*, November 1995)

Hong Kong

A new typhoon shelter is to be built in Hong Kong. TBV Consult Asia has been appointed to supply the site staff to supervise the construction of the shelter at Hei Ling Chau, a small outlying island off the east coast of Hong Kong.

The project involves the construction of three breakwaters, 15 mooring dolphins and associated security faci-

lities. The project is due for completion in October 1997. In Hong Kong, as in most other tropical countries, storms regularly occur in the summer months. Smaller sea-going vessels have to take shelter from these storms in typhoon shelters—harbours with protected entrances and strong sea defences. (Source: *The Dock & Harbour Authority, Vol.76, No. 864*, December 1995/January 1996)

India

Scientists at the National Institute of Oceanography, Goa, India have been studying the upper layer seasonal thermal structure and the inferred zonal flow path along the Bombay-Mauritius XBT trackline. They have utilized data collected during a TOGA-XBT program during 1992-1994. The flow pattern has revealed the presence of undercurrents which are seasonally dependent. The intense surface layer cooling which was observed is primarily due to the upwelled cold waters off the south-western coast of India and partly due to the influence of equatorial divergence.

Investigations on flora and associated biota around the area under the National Marine Park, Gulf of Kuchchh, Gujarat, indicated that it consisted of about 50 species of seaweeds and seagrasses and 22 species of mangroves, mainly restricted to reef slope and reef flats. The Gulf of Kuchchh region, is probably the richest in marine diversity along the west coast of India and needs protection, as well as further evaluation.

Fluvially derived fine-grained sediments (clay minerals and amorphous materials) are mostly deposited in the near shore and continental margins, with the rest being transported to the deep sea. The distribution and dispersal of fine-grained sediments on margins depends on the hydrodynamic conditions and the depositional processes. A knowledge on the fate of these sediments is of scientific interest and useful in understanding the pathways of pollutants. Studies undertaken by the National Institute of Oceanography have indicated three characteristic clay mineral assemblages reflecting three principal sources of sediments. These source sediments are distinct all along the inner shelf, but mix on the outer shelf and slope of the western continental margin of India. (Source: *CSIR News*, 30 July 1995)

Indonesia

FB Marine International, a recently formed subsidiary of the Hong Kong Parkview Group, has formed a joint venture company to operate fast ferries in Indonesia. The establishment of this joint venture has followed extensive research into ferry operations in the country. It is anticipated that the first service will commence early in 1996 on the route Merak-Bakeheuni. The company intends to operate fast, reliable and safe services providing a high degree of comfort and service on board. (Source: *Fast Ferry International*, January/February 1996)

Indonesia's important Wiriagar Deep #2 wildcat is now testing after reaching a depth of 2,979 metres. The well is located in 48 metres of water and is some 15 kilometres southeast of the Wiriagar Deep #1 location. Results are still awaited. (Source: *Offshore*, December 1995)

Republic of Korea

According to a report from the Republic of Korea Development Bank, the shipbuilding industry in that country could well rank first in the world in terms of output by the year 2005, with a world market share of 28.5 per cent. The backlog in Korean shipyards is sufficient to keep the dockyards working at full capacity for a full two years.

The Korean Shipbuilding Association has said that in order to maintain the present momentum, the shipbuilding industry needs to raise its technological level and to develop its own high technologies through an increased investment in research and development activities. The local production of core ship machinery and equipment should be accelerated due to the fierce competitiveness in this field. A belief that shipyards should also diversify their activities is also proposed; cooperation between domestic shipbuilders should also be considered. One way of achieving this could be joint R&D efforts and order receipts through consortia among Korean shipbuilders. (Source: *Korea News Review*, 2 December 1995)

Malaysia

Agreement appears to have been reached over gas supplies to the Malaysian LNG Tiga project. Following the entry into the project of Shell, with its solid LNG operating expertise, along with other shareholders, activities look set to progress further to strengthen Malaysia's LNG supply profile. (Source: *Offshore*, November 1995)

Elsewhere, mixed results appear following recent drilling in Malaysia. Occidental's Asam Kandis #1 wildcat was plugged and abandoned after reaching a depth of 1,670 metres in Middle Miocene Cycle III/IV sediments. Other wells have been plugged and abandoned as the results were not promising. (Source: *Offshore*, January 1996)

Myanmar

The Ministry of Energy of Myanmar has announced the opening of the Ninth Bidding Round for a total of 20 blocks, including five offshore blocks. The offshore blocks are all located on the Arakan coast and have not been held under licence since the 1970s. No blocks in the Martaban Basin were offered. (Source: *Offshore*, October 1995)

New Zealand

New Zealand has granted Occidental Petroleum its first frontier five-year permit to explore off the Southland-Otago coast in a deepwater block covering 26,000 km^2 of the Great South Basin. It is believed to be highly prospective. The company have 18 months in which to decide whether or not to commit to a drilling programme. (Source: *Offshore*, November 1995)

Papua New Guinea

Papua New Guinea has awarded Block PPL 179 to Oil Search (as operator) and its equal-interest partner Ampolex, located in the western Gulf of Papua. The award is for a six-year, three-phase exploration period. The first phase will involve reprocessing of old seismic data and the acquisition of aeromagnetic data, with 1,000 km of new seismic data and a wildcat stipulated in the second phase. Should the final phase be started, an additional 500 km of new seismic data are required, as well as a second wildcat. (Source: *Offshore*, October 1995)

Taiwan, Province of China

As part of a plan to develop ocean resources, Taiwan, Province of China through its National Science Council, plans to establish a fleet of three ocean research vessels.

The Council also plans to construct a large research vessel and deep sea submersible devices. According to information released by the Council, Taiwan's land-based resources are already developed to the greatest possible extent. Therefore the need for the development of ocean resources is being viewed as a core technology. (Source: *Sea Technology*, October 1995)

A new container terminal for Uniglory Marine Corporation has recently been opened at the Port of Taichung, on the west coast of Taiwan.

The terminal has two berths with a combined length of 320 metres, and the back-up area for container handling and storage extends 500 metres inland from the quay face. To start with, two ship-to-shore cranes have been installed which are capable of handling Panamax-dimensioned container ships. The container stacking area is served by four rail-mounted gantry cranes.

The new terminal has been built because the port of Taichung has a substantial cargo catchment area. By increasing direct calls, the costs associated with transporting containers from Taichung to and from Keelung and Kaohsiung will be reduced. In addition, there was a need to alleviate some of the pressure felt by the terminal at Kaohsiung. (Source: *The Dock & Harbour Authority, Vol. 76, No. 864*, December 1995/January 1996)

Thailand

Thailand has signed an accord for Tantawan gas deliveries with the Pogo Producing Company from the field in the Gulf of Thailand. The contract involves pumping 100 MMcf/d gas from the field which is located approximately 150 kilometres off the southern province of Surat Thani for a period of 30 years starting in 1997. The annual value of the gas sales is estimated at 1.85 million baht, with estimated proven reserves of 0.3 thousand cubic feet in the structure. (Source: *Offshore*, December 1995)

The Thai-Malay Joint Development Area Block A-18 has produced a major discovery for Carigali-Triton, the jointly owned operator, the Cakerawala 1A, which tested at 58 million cf/d gas and 945 bbl./day oil and condensate. It is the first of five wells to be drilled in the block. (Source: *Offshore*, November 1995)

Viet Nam

Viet Nam's Dai Hung disappointment is growing. The operator, BHP, is considering abandoning the project and is having discussions with PetroVietnam as to what to do now. The field was at first thought to hold 800 million bbl. of oil, now estimates predict it to have less than 100 million bbl.; BHP say that the operating costs will exceed the field's income. (Source: *Offshore*, November 1995)

A seismic data processing centre has been established in Ho Chi Minh City. The Petro Vietnam Golden Processing Centre was established by the Vietnam Petroleum Institute and Fairfield Industries (Houston, Texas, USA). Previously unavailable services will be provided, including seismic, gravimetric, magnetic and VSP processing. (Source: *Sea Technology*, November 1995)

Asian economies

According to a report from the US National Science Foundation, several Asian economies appear to be heading toward greater prominence as developers of technology. This achievement will enable them to become more viable challengers to world high-tech markets, which are currently dominated by the industrialized countries.

Japan was used as a benchmark to compare the technological capabilities of countries such as Hong Kong, Singapore, Republic of Korea, Taiwan, People's Republic of China, India, Indonesia and Malaysia. Among the criteria used were an analysis of patents and patenting trends, US/Asia trade in American high-tech products and technological know-how, acquisition of companies and the acceptance of foreign investment.

The report showed that the economies of Hong Kong, Singapore, Republic of Korea and Taiwan are relatively close behind Japan; with Taiwan and Republic of Korea predicted to make the greatest impact in technology-related fields and high-tech product markets. (Source: *Sea Technology*, November 1995)

Latin America

Argentina

The Inter-American Development Bank has approved a loan to the Argentinean Terminales Portuarias Argentinas SA (TPA), to support the rehabilitation and modernization of Terminal 3 of Puerto Nuevo in Buenos Aires. TPA recently won a 25-year concession to upgrade and operate the port. The total project cost is in the region of US$ 50.3 million. The upgrade involves the installation of cranes and cargo handling equipment and the improvement of warehouses and automobile storage facilities. (Source: *Project Finance International Issue 82*, 11 October 1995)

Falkland Islands

Waters close to the Falkland Islands are basically undrilled, apart from one alleged Texaco well to the south. In 1974 three boreholes were drilled by the Deep Sea Drilling Programme on the Maurice Ewing Bank which confirmed the existence of potential oil source rocks in the area.

Seventeen wells are known to have been drilled in the adjoining Argentine part of the offshore Malvinas Basin. Although none has as yet yielded commercial hydrocarbons, resultant oil and gas shows are encouraging. Seismic data is plentiful; the first commercial surveys were made in the late 1970s which were partially reprocessed in 1991.

The main interest in the current licensing round derives from two surveys made in the south and north of the islands in 1993 which confirmed the existence of a number of interesting areas. Findings suggest that much of the South Falkland Basin is underlain by Devono-Carboniferous and Permo-Triassic rocks similar to those which form the landmass of the Falkland Islands. These rocks may have the potential to form deep reservoir sequences. The North Falkland Basin is said to be geologically similar to the San Jorge Basin to the north-west which is an established petroleum-producing basin.

No further independent seismic surveys are planned for the waters around the Falkland Islands. Future activity will come from tranche licence holders under their phase-1 exploration commitment programme. (Source: *Offshore*, November 1995)

Brazil

Petrobras, the Brazilian national oil company has now drilled the world's deepest offshore horizontal well. At

2,985 ft, it is part of the company's ongoing US$ 50 million horizontal drilling programme. (Source: *Offshore*, September 1995)

Cuba

The Ministry of Industry of Cuba has confirmed that the island's oil production is edging towards 30,000 bbl/d, thanks to a well workover programme of foreign contractors. This is still below Cuba's annual needs.

To encourage further exploration, more blocks have been offered around northern and southern Cuba, along with new geophysical data and attractive tax terms. It is planned to have individual production-sharing contracts, with a maximum duration of 2.5 years, including an initial four-year period for exploration. Most aspects are negotiable.

The State oil company, Cupet, has updated a 1992 report on the island's petroleum geology and hydrocarbon pespectivity, based on the analysis of datasets acquired since that time. Packages are available for each of the seven blocks on offer that comprise composite, wireline, and simplified statigraphic well logs; shot point maps; and seismic, velocity, test, core analysis and geochemical data.

Although most hope is pinned on fresh oilfields being discovered, Cupet is keen to discover gas for possible use in power stations. (Source: *Offshore*, January 1996)

Venezuela

Studies are under way to try to cut some of the enormous cost of Venezuela's Cristobal Colon. Plans to find ways to improve the gas project's projected profitability are also included. (Source: *Offshore*, September 1995)

Europe

Azerbaijan

The consortium of oil companies committed to the offshore oil development in the Caspian Sea has reached an agreement to split the export of early production between pipelines through Russia and Georgia.

The steering committee of the Azerbaijan International Oil Company, comprising leading international oil companies, approved the twin route for approximately 80,000 barrels per day from late 1996. The Russian route is almost in place, while the Georgian one requires the construction of roughly 140 kilometres of new pipelines. It is anticipated that the new Georgian section will be able to accommodate most of the development's anticipated peak production of around 700,000 barrels a day which is expected early in the first decade of the next century. (Source: *Project Finance International Issue 82*, 11 October 1995)

Caspian Sea

The first of several big pipeline engineering contracts intended to open up the hydrocarbon reserves of the Caspian Sea to the world energy markets has been signed.

A joint venture of Willbros/Saipem won a contract from the Caspian Pipeline Consortium for Phase One in the construction of the 155 mile link to carry crude oil from Azerbaijan and Kazakstan, as well as from Russia, to a new Black Sea oil terminal north of Novorossiysk. The contract covers detailed engineering procurement and construction planned to last throughout 1996.

This is a companion project linked to a much bigger scheme which calls for a 1,616 mile pipeline connecting the Tengiz field in Kazakstan and Chiraq in Azerbaijan with the Mediterranean port of Ceyhan in Turkey.

The US oil company Unocal, with Delta Oil of Saudi Arabia, have signed a contract for the construction of a 812 mile natural gas pipeline from the Caspian production fields of Turkmenistan to Pakistan via Afghanistan. Another pipeline to the Indian Ocean via Afghanistan is under active consideration by Unocal and Delta.

All these plans will create business opportunities for international shipping, construction and engineering companies. The landlocked Caspian region is estimated to hold oil reserves in excess of 50 billion barrels, as well as huge natural gas reserves. The Caspian region has reserves second only to those of the Persian Gulf and is expected to be able to export up to 2 million barrels of oil a day to the Western European markets by the end of this century. (Source: *The Middle East*, January 1996)

Norway

A small Norwegian offshore engineering firm, Super Nor Group (Kristianstad), is suggesting that offshore platforms planned for dismantling and/or ocean dumping should be donated to developing countries instead of being dumped. The company is not pushing for platforms to be transported around the world to be used as housing, but rather that usable parts of dismantled platforms should be provided to developing countries where they could be put to good use. The company claims that, for instance, the accommodation modules on platforms could be used as clinics and medical centres. The pumps on platforms could be used to provide water for villages, with the flare booms being used as bridges. An interesting proposal—the company has applied for State funding to develop the idea further. (Source: *Offshore*, November 1995)

Norway looks set to be able to arrest an anticipated drop in its oil production after the year 2000 with new discoveries having been made in the North Sea. Five wells are to be drilled through the Fullfaks C platform, increasing reserves by 35 million barrels, according to Statoil. (Source: *Offshore*, November 1995)

Halliburton has proposed a methanol production ship to Statoil as a means of exploiting the Mid-Norwegian Norne Field's gas reserves. The field is currently being readied to produce oil as of 1997. However, the northerly location, which is remote from any infrastructure, means that there are no plans for the estimated 15.6 bcf of gas in place, other than reinjection into the reservoir.

The ship would be able to convert gas from the seabed injection manifold into methanol, offloading supplies to a shuttle tanker. Evaluation of this concept, called the Total Energy Preservation System, is shortly anticipated. (Source: *Offshore*, October 1995)

Northern Ireland

The Belfast, Northern Ireland based shipbuilder Harland & Wolff is moving away from the general shipbuilding market after suffering losses. It plans to move into the specialized domain of offshore production vessels for the oil industry.

The yard has recently designed a new vessel suitable for oil production in very deep turbulent waters. Experience gained on the Schiehallion field, which is 150 kilometres west of the Shetland Islands and lies in some 375 metres of stormy waters has been put to good use. The vessel

(floating, production, storage and offloading) will draw in the oil from seabed wells. It will be able to process up to 170,000 barrels of oil a day and to store up to 850,000 barrels of oil. (Source: *Technology Ireland*, October 1995)

United Kingdom

According to the Department of Transport's statistics, the volume of waterborne freight carried in the United Kingdom rose in 1994, the first rise since 1989.

The statistics showed that waterborne freight rose by 4 per cent over 1993; waterborne freight accounted for 24 per cent of all domestic freight moved; the Thames was the busiest of the major inland waterways; and the UK flag share of vessels employed in coastwise and one-port oil traffic was 41 per cent of goods lifted and 43 per cent of goods moved. (Source: *The Dock & Harbour Authority, Vol. 76, No. 864*, December 1995/January 1996)

The Southampton Oceanography Centre finally opened at Empress Dock in Southampton (United Kingdom) in 1995. The marine science centre will provide space for 450 research scientists, lecturers and support staff. The Centre is considered crucial to the United Kingdom's activities in ocean sciences and was established following a need for greater collaboration between research institutes and universities in the country. (Source: *Sea Technology*, December 1995)

Subsea developments are dominating the latest round of developments in the UK North Sea. Mobil has released information about Nevis, a 21-year old discovery. Reserves are estimated at 50 million barrels of crude oil and 175 bcf of gas.

This will be a multi-stage development, the first of which will be Nevis South aiming at producing 13,500 barrels of oil per annum. Future stages will depend on the reservoir's performance. (Source: *Offshore*, October 1995)

Mobil's SAGE terminal in St. Fergus, north of Aberdeen, has been selected to handle gas from the Chevron/Conoco Britannia development. New facilities will be built, including a bypass train. Construction will take two years and should be finished by late 1998, in time for the first production from Britannia.

Another contract relating to the Britannia development has been awarded to supply and connect bundled flowlines from the platform to the subsea production centre. These bundles will be joined on the seabed to form a 15 km single length, which is possibly the longest yet installed using this technique. (Source: *Offshore*, September 1995)

The European Union Commission

The European Union Commission has proposed a three-year pilot programme aimed at improving the management of the Union's coastline. It concludes that existing rules to protect coastal zones are sufficient in theory, but poorly enforced and coordinated in practice.

The main tasks of the programme will be to identify the cause of environmental damage, to study the effects of current and planned preventive measures and to work out how well local, national and European Union policies interact. (Source: *European Union Commission*, November 1995)

G. INTERNATIONAL NEWS

IMO SOLAS amendments enter into force

Several major changes to the International Convention for the Safety of Life at Sea (SOLAS), adopted in May 1994, entered into force on 1 January 1996. These amendments include the addition of two new chapters.

Chapter X makes mandatory the International Code of Safety of High-Speed Craft (HSC Code). Many new types of HSC are now being constructed and the new chapter intends to provide international regulations dealing with the special needs of this type of vessel.

The HSC Code will apply to high-speed craft engaged on international voyages and will include passenger craft which do not proceed for more than four hours at operational speed from a place of refuge when fully laden and cargo craft of 500 gross tonnage and above which do not go more than eight hours from a port of refuge. It requires that all passengers are provided with a seat and that no enclosed sleeping berths are provided for passengers.

The craft covered by the Code include, among others, air-cushion vehicles (such as hovercraft) and hydrofoil boats. The Code is intended to be a complete set of comprehensive requirements for high-speed craft, including equipment and conditions for operation and maintenance. A basic aim is to provide levels of safety which are equivalent to those contained in SOLAS and the International Convention on Load Lines, 1966.

The second new chapter is Chapter XI which includes Special Measures to Enhance Maritime Safety, containing four regulations.

Regulation 1 states that organizations entrusted by Administrations with the responsibility for carrying out surveys and inspections shall comply with the guidelines adopted by the IMO Assembly by resolution A.739(18) in November 1993. The guidelines are intended to ensure that organizations employed in this capacity comply with standards listed in an appendix.

Regulation 2 requires that bulk carriers and oil tankers shall be subject to the enhanced programme of inspections in accordance with the guidelines adopted in 1993 by Assembly resolution A.744(18). The enhanced surveys should be carried out during the periodical, intermediate and annual surveys prescribed by the SOLAS Convention.

The guidelines on the enhanced programme of inspections were developed as a result of casualties in recent years and of increasing concern about the ageing of the world merchant shipping fleet. They also pay special attention to corrosion. Coatings and tank corrosion prevention systems must be thoroughly checked and measurements carried out to check the thickness of plates.

Regulation 3 provides that all passenger ships of 100 gross tonnage and above, and all cargo ships of 300 gross tonnage and above shall be provided with an identification number conforming to the IMO ship identification number scheme, as adopted by resolution A.600(15) in 1987.

Regulation 4 makes it possible for port State control officers inspecting foreign ships to check operational requirements "where there are clear grounds for believing that the master or crew are not familiar with essential shipboard procedures relating to the safety of ships". (Source: *IMO Briefing*, 28 December 1995)

Amendments to the 1978 STCW Convention

Amendments to the 1978 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) adopted in May 1994 also entered into force on 1 January 1996.

The amendments replace the existing Chapter V which deals with special training requirements for personnel on tankers. Four new appendices to regulation V/1 dealing with a tanker familiarization course and subjects to be covered by specialized training programmes appropriate for oil tankers, chemical tankers and liquified gas tankers. (Source: *IMO Briefing*, 28 December 1995)

Ro-Ro Ferry Safety Conference at IMO

A conference to consider measures to improve the safety of roll on/roll off passenger ships was held at IMO Headquarters in London in November 1995.

The conference discussed a number of amendments to SOLAS 1974 prepared in response to the *Estonia* disaster in September 1994 and based on proposals put forward by a panel of experts set up by IMO.

The most important and probably most controversial of the proposed changes are concerned with the stability of ro-ro passenger ships and the effect of water accumulating on the vehicle deck.

In October 1988 IMO adopted amendments which have applied to all passenger ships built since 1990. These amendments, sometimes referred to as the SOLAS 90 standard, are intended to improve the stability of passenger ships in the event of damage. SOLAS 90 was extended to existing ships in a slightly modified form and is being phased in under a programme which started in October 1994.

The panel of experts proposed that the regulations be changed so that the SOLAS 90 standard could be met even with 50 centimetres of water on the vehicle deck. It also proposed that this standard should not only be applied to new ships, but should be applied to existing ferries over a number of years. It was recognized that this could result in extensive modifications having to be made to some existing ships and that the costs could be so high that some ships might have to be scrapped.

The conference also considered proposed amendments to other regulations in chapter II-1, in chapter II-2 (which deals with fire safety) and chapter III, which is concerned with life-saving appliances and arrangements. The proposed changes to chapter III include the addition of a new section requiring ro-ro passenger ships to be fitted with public address systems, a new regulation providing improved requirements for life-saving appliances and arrangements, and a requirement for all passenger ships to have full information on passengers, including names.

Other amendments to SOLAS 1974 which were agreed at the conference included new restrictions on one-compartment passenger ships; improvements in evacuation arrangements; requirements that life-rafts should be easy to board, should float free from the ferry and remain upright. These amendments will come into force in February 1997. (Source: *IMO Briefing*, November 1995)

The impact of ozone-layer depletion on the oceans

Ozone-layer depletion seems likely to disrupt ocean life and seriously affect the marine food web. Of major concern is the impact that increasing amounts of ultraviolet radiation will have on plankton and other tiny marine organisms at the base of the marine food web.

These creatures, which provide the original food source for every other living thing in the oceans, are highly sensitive to current UV-B radiation because they lack the protective UV-B-absorbing outer layers of higher forms of plants and animals. As ozone levels diminish, growth and survival of the primary producers are likely to be threatened by the resulting increases in UV-B, with wide-ranging consequences.

Phytoplankton are the plant varieties of plankton. Each year, they produce more than one-half of the Earth's biomass. Even slightly increased doses of UV-B radiation reduce the amount of food phytoplankton created through photosynthesis, and that even a small loss in production would dramatically affect the intricate marine ecosystem with serious knock-on effects for global food supply.

Zooplankton, which feed off phytoplankton, are also affected by increased UV-B radiation. If ozone-layer depletion reached 15 per cent over temperate waters, it would take less than five days in summer for half the zooplankton in the top metre of these waters to die from the increased radiation.

UV-B also damages juvenile fish, shrimp and crab larvae and other small animals in the oceans. These damaging effects closely parallel the effects on zooplankton. The ability of food fish larvae to reproduce, grow and survive diminishes as ultraviolet radiation increases.

If, as seems likely, plankton numbers and production drop, and smaller amounts of fish, shrimp and crabs survive to adulthood, less food will be available for adult fish and other forms of marine life, and thus for human consumption.

More than 30 per cent of the world's animal protein for human consumption comes from the sea, and in many developing countries this percentage is significantly higher. Enhanced UV-B radiation could also dramatically change species composition among the oceans' plant communities. This could further disrupt the marine food web by removing yet another source of food for marine creatures. (Source: *The Impact of Ozone-Layer Depletion, United Nations Environment Programme*, 1992)

New port State control regulations

The Marine Safety Agency (MSA) of the United Kingdom has announced new regulations implementing the European Commission's Directive on the inspection of visiting foreign ships. These regulations came into force on 1 January 1996.

The Directive provides a legal framework for the current port State control system which is operated by European Union member States. The Directive 95/21/EC concerns the enforcement, in respect of shipping using community ports and sailing in waters under the jurisdiction of member States, of international standards for ship safety, pollution prevention and shipboard living and working conditions and was adopted in June 1995. (Source: *The Dock & Harbour Authority Vol. 76, No. 864*, December 1995/January 1996)

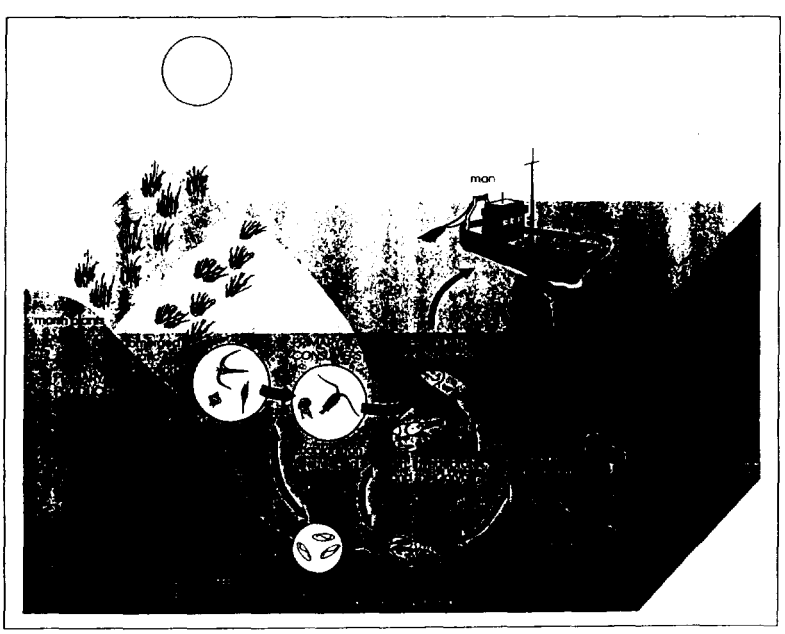
News from ECOR

ECOR is planning to produce a technical journal entitled: *Oceanic Engineering International.* This journal is published jointly by ECOR and the Ocean Engineering Research Centre of the Memorial University of Newfoundland, Canada. Manuscripts are invited in the following categories: full journal papers; technical notes or short papers.

The scope of the journal covers the broad interdisciplinary area of oceanic engineering. The main subject areas of interest are: arctic engineering; coastal, ports and aqua-engineering; engineering aspects of oceanography; environmental aspects; fishing technology; hydrodynamics; ocean acoustics; ocean geotechnical engineering; ocean use of new materials; offshore oil and gas; marine mining; marine propulsion; recreational vehicles; seakeeping and manoeuvring; shipbuilding; shipping; structures, codes and standards; subsea and wind.

Readers interested in submitting papers should contact either the Executive Secretary of ECOR or the Editorial Office at the Ocean Engineering Research Centre at the Memorial University of Newfoundland. (Source: *ECOR*, March 1996)

In Volume 3, Number 1, 1995 of the Marine Industrial Technology Monitor, page 28, we unfortunately gave the address of the Engineering Committee on Oceanic Resources (ECOR) as being in London, UK. This is incorrect and the address is as follows: Mr. Neil Bose, ECOR Executive Secretary, c/o Ocean Engineering Research Centre, Faculty of Engineering & Applied Science, Memorial University, St. John's, Newfoundland, Canada. Tel.:+(709) 737 3284; Fax: + (709) 737 2116. Our apologies for any inconvenience caused.



H. SOFTWARE

New workstation for ocean surveillance

Following cooperative research using ERS-1 SAR data to assess the potential of RADARSAT data for a variety of ocean applications, the Canadian Centre for Remote Sensing (CCRS), the Department of Fisheries and Oceans and the Canadian Space Agency have supported the development of an ocean workstation.

The workstation will operate in unattended mode and will be capable of determining the possible products to generate on the basis of the RADARSAT imaging mode, image resolution and image statistics. Products will include wave mode data for assimilation into forecast models, vessel location/point target information and ocean feature information such as currents, fronts, slicks and eddies.

More information is available from Ms. C. Bjerkelund, Applications Division, CCRS, Fax: + (613) 947 1385. e-mail cathryn.bjerkelund@ccrs.nrcan.gc.ca (Source: *Backscatter*, 1995)

Silent vessel traffic system

A silent vessel traffic system (VTS) has been developed by Hughes Naval & Maritime Systems (Fullerton, CA).

The silent VTS system uses advanced technology to broadcast waterway traffic information to ships and boats without relying on overcrowded voice radio channels. The system provides ship captains and pilots with a greatly improved display of vessel traffic instead of a limited radar picture. It displays independent traffic information for each vessel, including its name, course, speed and other data. The information is displayed on a computerized electronic chart that includes all ships that are tracked and reported from the radars located ashore.

Designated ships are equipped with an automated dependent surveillance system: a transponder that broadcasts each ship's global positioning system location. The VTS collects track information from radars, correlates the tracks and merges them with the ship's broadcasted ADS position. Each ship is identified to the system and to all other ships within the system without using voice radio circuits. (Source: *Sea Technology*, December 1995)

ARPA Information Technology project

ABS Marine Services, an affiliate of the American Bureau of Shipping, will participate in an Advanced Research Projects Agency (ARPA) project to develop an integrated shipboard information technology (ISIT) platform. The platform will provide a shipboard technology and communication base that will integrate the various islands of information that exist on board commercial ships.

Although significant amounts of information management data exist in the navigation, cargo and machinery control systems, these data have not been available from a single shipboard source and therefore are largely unavailable to shore-based management. (Source: *Sea Technology*, November 1995)

Advanced enclosed Mast/Sensor System

The advanced enclosed mast/sensor (AEM/S) program is scheduled for shipboard installation and will demonstrate the ability to reduce mast signatures and improve sensor performance by enclosing or embedding radars, communication antennas, and equipment in an advanced hybrid composite mast. The objective is to develop an affordable mast with enhanced capabilities by fully integrating sensor technology, electromagnetics, signature reduction, advanced materials, structures and manufacturing technologies.

This is considered as a necessary step for the next generation of radar and communication systems. (Source: *Sea Technology*, November 1995)

New messaging technology

The exchange of files between shipboard PCs and office networks ashore is set to be transformed following the development of a new wireless interface. It will link wireless communication networks with electronic mail products from the world's leading producer of software for personal computers.

The Inmarsat Wireless Messaging Technology (IWMT), which has been developed by Inmarsat in conjunction with Paragon Software (UK) and Telesis North (Canada) provides a simple and effective interface between Microsoft Exchange and a number of wireless networks. It has been fully endorsed by Microsoft.

Inmarsat says that the new interface has been designed to solve a number of problems inherent in sending data over wireless networks. These include loss of connection due to obstructions in signal path or atmospheric conditions; variable time delays, often caused by network loading; low bandwidth, limiting the data transfer rates; and relatively high user charges as compared with the switched fixed-wire networks.

In essence, IWMT is a set of tools for software developers. It will allow their products to incorporate seamless communication between mobile Microsoft Exchange users and the local area network Microsoft Exchange mail servers in their offices. Communication can take place across a variety of mobile data networks, including the global Inmarsat-C service, cellular radio and packet radio.

Software developers have the advantage that allows them to build a communication facility into their products that overcomes the problems inherent in wireless networks without having to acquire a specialized knowledge of these networks. For end-users, IWMT can result in the ability to exchange files and messages easily between remote PCs and office LANs, using the same simple procedure for each wireless network, regardless of its particular characteristics. (Source: *Ocean Voice*, January 1996)

Data boost for the Pacific Ocean region

Comsat has announced a range of enhancements to its C-Link Inmarsat-C satellite communication service in the Pacific Ocean region.

The company says that the enhanced service will make it easier for Comsat customers to prepare, edit and send messages to mobile Inmarsat-C terminals. All Comsat Inmarsat-C land-earth stations now use a common, single address code, obviating the need for multiple log-in procedures.

Mobile users now have a single, world-wide e-mail address on the Internet from which they can send and receive messages. Further, Comsat's Inmarsat-C polling and

data reporting service has been simplified, making it easier and faster for customers to track and monitor their fleets automatically. The enhanced service also offers simplified billing and cost accounting procedures. The enhancements are coming on-line automatically and are available to most users without requiring equipment modifications. (Source: *Ocean Voice*, January 1996)

Inmarsat dropping formal distress testing

Inmarsat has announced that, for some new terminals, it will shortly drop its requirement for the distress capability to be tested before the terminal can be formally commissioned into the system.

The organization says that following modifications to the Inmarsat-C LESs scheduled for 1997, no performance verification test will be required for Inmarsat-C terminals. This means that the terminal's distress-alerting capability will not be tested unless the operator initiates it himself.

Commissioning processes for both Inmarsat-B and -M terminals have also been streamlined and the distress calling capability of new terminals will not be tested unless the operator initiates it.

In future it will be the responsibility of the shipowner to test distress calling capabilities, which will be free of charge. Inmarsat-A terminals will however continue to be commissioned by a technician when formal distress alerttesting will be carried out. (Source: *Ocean Voice*, January 1996)

Latest Catia designs plants and ships

Catia/Cadam Solutions Version 4 Release 1.5 enhances applications for manufacturing industries and adds two new product lines, for plant and shipbuilding. It is an object-oriented plant-modelling system with knowledge-based engineering capabilities that can streamline plant-design processes. Unlike CAD systems where data is attached to graphics, the object-oriented plant model stores plant components as intelligent objects which contain information about their industrial characteristics.

Shipbuilding Solutions include Catia Ship Steelwork Design and Production products, which cover the whole process of steel part modelling and preparation for production. The Design package provides an application for creating hull structures of all kinds. With a user interface dedicated to shipbuilding, 3D solid parametric parts, such as decks, bulkheads, brackets, stiffeners and girders are created according to customized shipyard rules. (Source: *Machine Design*, 25 January 1996)

I. PUBLICATIONS

Island technology: technology for development in the South Pacific

This book contains 34 essays on aspects of technology and technological development in the 13 island nation members of the South Pacific Forum. A theme running through the book is that the islands' isolation and relatively low level of economic developments means that imports of technology have significant social, cultural, economic and environmental impacts, which are often negative. The adaptation of foreign technologies is discussed together with adaptation of island life to new technological realities and ways in which indigenous technologies can be supported.

Author: Tony Marjoram, ed. (1994) Intermediate Technology Publications Ltd., 103-105 Southampton Row, London WC1B 4HH, United Kingdom. ISBN: 1-85339-223-5.

Fish as biocontrol agents in rice

Worldwide there is an increasing need for sutainable crop production making efficient use of scarce natural resources.The integration of fish culture in rice-based farming systems has a long tradition in parts of Asia.After a period of heavy pesticide use, rice-fish culture is regaining importance in the region.This book deals with the contribution of two common and widespread fish species to integrated pest management, particularly the biological control of pests in rice.

Author: Matthias Halwart, Margraf Verlag, P.O. Box 105, Weikersheim, Germany. ISBN: 3-8236-1241-7

Worldwide directory of petroleum ministries and national oil companies

A newly compiled directory for 1995-1996 in alphabetical order covering more than 80 countries and 125 office locations.It provides a brief résumé of oil and gas activity by country, plus telephone and fax numbers.

Contact: Ms. D. Green, Offshore Magazine, P.O. Box 1941, Houston, Texas 77251, USA

Drilling & completion fluids directory

This directory lists environmental drilling and completion fluids by product name and description. It contains over 1,100 products from 50 companies, including their addresses.

Contact: Ms. D. Green, Offshore Magazine, P.O. Box 1941, Houston, Texas 77251, USA

The world ferry market: prospects to 2005

This is a new study of the prospects for ferry activity worldwide and indicates considerable market development, including growth in certain areas, traffic decline in specific markets and the continued replacement of conventional tonnage by high-speed vessels in many ferry markets.

The international ferry industry has changed significantly in recent years and is currently undergoing the most dramatic and far-reaching period of change ever witnessed in this sector.Significant advances in technology and the opening-up of several key markets have seen the development of new vessel designs, the economics of which favour the replacement of old ferries with new units and the promotion of keen competition between ferries and alternative transport systems.

Contact: Study Sales Department, Ocean Shipping Consultants Ltd., Ocean House 60 Guildford Street, Chertsey, Surrey KT16 9BE, United Kingdom.

Clean ships, clean ports, clean oceans

This was written by the Marine Board's Committee on Shipborne Wastes of the US National Research Council. It assessed US activities and the implementation of the International Convention for the Prevention of Pollution from Ships and the 1978 Protocol (MARPOL 73/78) annex V. It concludes that a coordinated effort is needed to keep US beaches and coastal waters from being polluted by ship's rubbish.Those who operate boats and ships can do a lot to reduce pollution by meeting the specific clean-up objectives spelled out in the report.

Contact: National Academy Press, USA

Renewable energy from the ocean: A guide to OTEC

This book explores the history, technology and viability of ocean thermal energy conversion (OTEC) as an alternative to polluting fossil fuels as a power source. It highlights some signs of a resurgent interest in the technology, especially in Taiwan and Japan.

Author: Dr. Chih Wu. Contact: Oxford University Press

World shipping statistics 1995

This book includes extensive graphs on the world's shipping fleets, derived from data on more than 39,000 vessels. The graphs include comparative presentations of the world fleets, by type, size, flag, ownership, builder, classification society, and age, as well as an analysis of new building, repair and scrapping activities.

Contact: Fairplay Publications Ltd.

Port Technology international

This publication contains a review of advanced technologies for ports and terminals world-wide. Published twice a year. ISSN: 1358-1759

Contact: I.C.G. Publishing Ltd.; Russel House, 28 Little Russell Street, London WC1A 2HN, UK.

Or: I.C.G. Publishing Ltd., c/o Shiny International Ltd., A1, 3/F Fortune Factory Building; 40 Lee Chung Street. Chai Wan; Hong Kong.

J. CALENDAR OF EVENTS

Baltic Sea Policy Conference

This was the fifth in a series of regional conferences, held in Nykoping, Sweden, that addressed environmental and sustainable development issues in the Baltic Sea region. The intention was to contribute a scientific analysis of current issues in key sectors as an aid in formulating regional policies. The topics covered were: prospects for energy co-operation and integration in the Baltic Sea region; a scientific basis for Baltic environmental policy; industrial transformation in the region: the economic and environmental challenges; Baltic Sea institutions and decision-making.

Further information from: Centre for Research on Natural Resources and the Environment, Stockholm University, S-106 91 Stockholm, Sweden

Deeptec '96 - 3rd Annual Deepwater Technology Forum

Held in Aberdeen, Scotland from 29 to 31 January 1996. Information from: IIR, 6th Floor, 29 Bressenden Place, London, United Kingdom

12th Fast Ferry International Conference

This conference was held in Copenhagen, Denmark from 20 to 22 February 1996. Papers presented included plans and designs of fast ferries for the future.

More information from: Fast Ferry International Conference, Milroy House, Sayers Lane, Tenterden, Kent United Kingdom

International ROV Forum '96

Held in Aberdeen, Scotland from 14 to 15 February 1996. Information from: The Conference Partnership, Eastlands 2, London Road, Basingstoke, Hampshire, United Kingdom

Worldwide Deep Water Technologies Conference

Held in London from 26 to 27 February 1996. Information from: IBC Technical Services, Gilmoor House, 57-61 Mortimer Street, London W1N 8JX, United Kingdom

Seventh Middle East Corrosion Conference

Held in Manama, Bahrain from 26 to 28 February 1996. Information from: Bahrain Society of Engineers, P.O.Box 835, Manama, Bahrain

Explorisk 96 - Exhibition on Explosion Safety and Risk Control

Held in Gent from 5 to 7 March 1996. Information from: EuropEx, Heiveldekens 8, B-2550 Kontich, Belgium

Oceanology International 96

Held in Brighton, United Kingdom, from 5 to 8 March 1996. Further information from: Spearhead Exhibitions Ltd., Ocean House, 50 Kingston Road, New Malden, Surrey, United Kingdom

International Programme for Port Planning & Management

Held from 18 to 29 March 1996 in New Orleans, USA. Further information from: Director, IPPM, University of New Orleans, Louisiana 70148, USA

9th Underwater Technology Conference

Held from 20 to 22 March 1996, in Bergen, Norway. Information from: Norwegian Petroleum Society, P.O. Box 95, N-5049 Sandsli, Norway

26th International Symposium on Remote Sensing of the Environment

Held from 25 to 29 March 1996 in Vancouver, British Columbia, Canada. Information from: The GLOBE Foundation, Suite 504, World Trade Centre, 999 Canada Place, Vancouver, British Columbia, Canada V6C 3E1

Thalassa '96—4th International Shipping Conference & Exhibition on Roro Ferries and Bulk Carriers

Held from 28 to 30 March 1996 in Greece. Further information from: Thalassa Secretariat, 6 Skouze Str., Piraeus 185 36, Greece

8th International Symposium on Vessel Traffic Services—VTS '96

To be held from 15 to 20 April 1996 in Rotterdam, Netherlands. Further information from: VTS Congress Bureau, Coolsingel 67, 3012 AC Rotterdam, Netherlands

Irish Water & Environment '96

To be held from 24 to 25 April 1996 in Dublin, Ireland. More information from: Mr. B. White, Faversham House Group Ltd., Faversham House, 232a Adddington Road, South Croydon, Surrey, United Kingdom

32nd International Seminar on Port Management

To be held at the International Institute for Infrastructural, Hydraulic and Environmental Engineering (IHE), Delft, Netherlands from 7 May to 14 June 1996. More information from: IHE, P.O.Box 3015, 2601 DA Delft, Netherlands

11th International Harbour Congress and 8th International Harbour Exhibition

Organized by the Royal Flemish Society of Engineers, to be held in Antwerp, Belgium from 17 to 21 June 1996. More information from: Rita Peys, c/o Ingenieurshuis, Desguinlei 214, B-2018 Antwerp, Belgium

Baltexpo '96—8th International Maritime Exhibition

Organized by Agpol Promotion Ltd., to be held in Gdansk, Poland from 3 to 6 September 1996. Details can be obtained from: Agpol Promotion Ltd., 00-654 Warsaw, ul. Sniadeckich 17, Poland

MARSIM '96 - International Conference on Marine Simulation and Ship Manoeuvrability

Organized by the Danish Maritime Institute, to be held from 8 to 13 September 1996 in Copenhagen, Denmark. Information from: Danish Maritime Institute, Hjortekaersvej 99, DK-2800 Lyngby, Denmark

International Conference on Preventing Collision at Sea

Organized by the IMO, Dalian Maritime University and the University of Southampton, United Kingdom. To

be held in Dalian, People's Republic of China from 20 to 23 September 1996. Information can be obtained from: Department of Ship Science, University of Southampton, Highfield, Southampton, Hampshire SO17 1BJ, United Kingdom.

Sea96—11th Offshore South East Asia Conference and Exhibition

To be held from 24 to 27 September 1996 in World Trade Centre, Singapore. Information available from either: Singapore Exhibition Services Pte. Ltd., 2 Handy Road, #15-09 Cathay Building, Singapore 229233; or: Overseas Exhibition Services Ltd., 11 Manchester Square, London W1M 5AB, United Kingdom

Deep Foundations Institute Annual Conference & Meeting

Organized by the Deep Foundations Institute, the technical programme covers designing and constructing deep foundations for extreme events. To take place from 2 to 4 October 1996 in San Francisco, California, USA. Information can be obtained from: Mr. R. Short, c/o Harza Consulting Engineers & Scientists, 425 Roland Way, Oakland, California 94621, USA

INFOFISH-AQUATECH '96

The third in a series of international conferences on aquaculture will focus on the latest developments in world aquaculture and its technical and economic outlook for the future. A panel of speakers will speak on a wide range of topics, including recent developments in research and technology, disease control, and trade and market aspects for commercially important species.

It will be held in Kuala Lumpur, Malaysia from 25-28 September 1996.

Aquaculture Asia '96

This exhibition will feature the latest equipment, technology, feeds and services for the booming aquaculture business.

It will be held parallel to INFOFISH-AQUATECH '96. More information can be obtained from: INFOFISH, P.O. Box 10899, 50728 Kuala Lumpur, Malaysia. FAX: 603 291 4466. E-mail: infish@pc.jaring.my

UNIDO NEWS

Establishment of the Mediterranean Centre for Marine Industries in Greece

In spite of the considerable efforts taking place in industrializing countries in scientific research and technology development, the industrial gap between the North and the South continues to widen. The marine sector has significant potential for the South. However, the development of this industry lags behind in terms of access to competitive technology and investment capital. The marine industry and its related technology services is an important economic factor for the Mediterranean region.

Facing this challenge, the United Nations Industrial Development Organization (UNIDO), in cooperation with the Government of Greece (General Secretariat of Research and Technology, Ministry of Industry, Energy and Technology), is now promoting the establishment of a **Mediterranean Centre for Marine Industries** located in Greece aiming at stimulating the advancement of the marine industries sector in the Mediterranean region, with particular emphasis on North-South cooperation.

MISSION STATEMENT

The mission of the Mediterranean Centre for Marine Industries is to primarily promote strategic partnerships among Mediterranean countries in marine technology development and commercialization leading to enterprise cooperation between developing and developed countries in the region.

OBJECTIVES AND FUNCTIONS

The Centre will undertake activities related to the identification, evaluation and promotion of business development projects. It will assist in the initial phases of joint projects through provision of such services as technology and market assessment, strategy development and project management.

Aiming at increasing industrial activities in the marine sector, the Centre will provide a variety of benefits to its participants, including:

- Acting as a bridge for the transfer of marine technology, encouraging international cooperation and eliminating duplication of efforts;
- Providing information relating to national priorities and business environments, technology and market opportunities, potential partners, funding mechanisms, etc.;
- Improving access to new markets and technologies through promotion of strategic alliances and joint projects between enterprises;
- Promoting the pooling of technology development resources, resulting in an enhanced technology base, shared risks and reduced technology developments costs;
- Provision of a linkage to regional or sub-regional R&D programmes with implications for the marine industry.

WORK PROGRAMME

The Centre will be responsible for developing a work programme in accordance with its objectives and the priorities of the participating countries. The core activities of the programme are anticipated to cover:

- Establishment and management of an industrial North-South network, providing a clearing-house function for the creation of joint enterprises;
- Identification, screening and promotion of commercially oriented projects in selected priority areas;
- Project management and technical services supporting the initial phase of joint project operations;
- Centre and programme administration.

It is considered essential that the programme places priority on projects having regional importance and for market opportunities in the marine industrial sector. The initial priority areas will be established following consultations, these will include: solar desalination; marine environmental measurements and aquaculture at the present time.

FURTHER INFORMATION

Further information on the proposed Mediterranean Centre for Marine Industries can be obtained from:

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Programme Coordinator
Technology Services
Investment and Technology Promotion Division
P.O.Box 300, A-1400 Vienna, Austria
TEL: (+43) 1 21131 5158
FAX: (+43) 1 21131 6809

GREECE:
P. Stolakis
Martedec S.A.
16, 2nd Merarchias str.
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FAX: (+301) 453 5588

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	TRENDS IN PARALLEL PROCESSING
	ENVIRONMENTALLY SOUND MANAGEMENT OF BIOTECHNOLOGY (The Task Managers' Report on Chapter 16 of Agenda 21)

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V.96-84639—July 1996—700

Printed in Austria