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EXPLORATION AND EXPLOITATION OF OFFSHORE OIL AND GAS RESOURCES IN DEVELOPING COUNTRIES

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PROJECT

EXPLORATION AND EXPLOITATION
OF OFFSHORE OIL AND GAS RESOURCES
IN DEVELOPING COUNTRIES

IMPACTS ON ENERGY AND INDUSTRIAL DEVELOPMENTS

ELABORATED FOR

UNIDO

ELABORATED BY

a Team of Experts provided by

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FOPEWORD

This project has been elaborated with the target to inform about the global offshore business in a way which gives the possibility to identify opportunities and constraints for developing countries to participate in that business.

The field of offshore business and industry is very much diversified, is very diffused into other businesses, and has aspects of all shades. Thus the first objective of the writers has been to improve the reader's understanding of this field.

Since there is a variety of developing countries on the one hand to be set against this large field of offshore activities there is no way to find simple recipes as advice to these countries which fit all. Thus the second objective of the writers has been to point out differences and conformities, independencies and connections.

On the one side a study of this size cannot be expected to be read in one from everybody involved in the results. There is a need to present such content in a more encyclopaedical way without driving at either an educational manual or a dictionary. On the other side such studies require a relative completeness and a guiding structure. Thus the third objective of the writers has been to present a document which you can either read in one or which you can search in for specific information.

The writers hope that the readers find these objectives to be reached and to be helpful to them.

In addition, the study deals with a business and with markets which are constantly developing and changing. Therefore the writers were of the opinion that a "living" book should be created. The possibility to add, to change and to extend was guiding when the decision was made to produce the study as a loose sheets compilation. The paging was respectively designed to support this capacity.

Thus an exchange and addition service could be easily arranged.

The writers hope to have put forward valuable ideas for the readers and are prepared to discuss this rudiment to be utilized for further successful developments.

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I N T R O D U C T O R Y   R E M A R K S

Introductory Remarks

This study is subdivided into six main parts:

- Introductory Remarks
  which shall pilot the reader into the chapters

- Summary
  where by a brief synopsis the results of this study are presented to allow selective going into and detailed discussions of the different aspects

- Extended Synopsis and Assessment
  as PART A of the compilation
  where direct conclusions and recommendations can be found

- Elaborations and Materials
  as PART B of the compilation
  where certain subjects are dealt with in greater detail

- Prospect
  which gives very briefly the writers' views about the next steps to be done

- Appendices
  where you find detached materials which would have lengthened the chapters in case of incorporation too much

The Summary provides a brief synopsis by focussing on three aspects. First the overall offshore industry is described. The role of the main players is shown as well as the structure of this special market on a worldwide basis. Some particular offshore issues are depicted.

Then the whithin the study identified opportunities and constraints are highlighted. On the one hand the report is full of such advice and on the other hand there are no specific opportunities which are good for each developing country. Thus this part can only focus on examples in a selective way rather than summing up to generally valid statements.

Finally, proposals at the policy and operational level are described. Here also the same limitation of validity are to be recognized as they have been put out in the above.

The Extended Synopsis, Part A, follows the list of the five specific issues this study shall address. In the beginning the build-up of the background was not available thus resulting in the first chapters being little less concrete. However, additional answers and information are given throughout the whole study.

This begins with Chapter A-1, which is named "Linkages of offshore- and onshore activities and developments in particular in developing countries". After some rather general statements on economic and industrial impacts there is a little elaboration already here to demonstrate the importance of offshore activities in developing countries. Additional and more detailed information about the relative importance of offshore hydrocarbons and their distribution in the world as well as on the worldwide capital investments/expenditures for this energy development is presented in Part B, chapters 1 and 2.

Then the structures, procedures and phases of the offshore industry with all the onshore participation is described and the role of the developing countries depicted. But further aspects of linkages of offshore and onshore activities will be added continuously through the paper.

Chapter A-2 is focussing on the activities to be taken up be developing countries. These activities have been structured as follows since it is the principal way to handle such a problem:

STEP 1: Analysis of the country's own potential capacities and needs

This first step is necessary because it is the definition phase. The starting position of the countries is very individual, thus the activities to be taken up are that different from country to country that they have to be tailored for each one.

STEP 2: Selection of the principal way of development

The work to be done in this second step is to design the principal way of development on the basis of step one. Here we can find the basics of chapter A-1 (linkages offshore-onshore) to be discussed in continuation.

STEP 3: Decision on manner of international cooperation

Since there will always be an international cooperation this is a very important item. Even countries which have developed a selfsupporting offshore business in the past have recognized that the target to develop this area in an isolated way is misleading. Some countries as a matter of fact take corrective measures just now.

STEP 4: Creating the administrative pre-requisits

Many disappointments and set backs we have experienced in the past have demonstrated that just in this field too little was done. It starts that the administration people should know what type of questions will come up to them and should be prepared. As it is self-explaining for a business which is that much diversified, nearly all departments of the administration will be involved. There must be decisions on who is responsible and in charge, on who has the coordinating power to come up with complex solutions, and on how the procedures are to make decisions. The initiatives would not get stuck in the jungle of missing laws and rules, of power struggle in between the various departments of the administration and of lacking clear understanding among the actors in the administrative game.

STEP 5: Implementation of the selected way and building up the necessary industrial and social infrastructure
Even the best plan has to be launched and to be put into operation.

Chapter A-3 is then emphasizing on the strategics and policies to involve developing countries in the oil industry. Since the energy supply is a rather competitive market it is usually not sufficient to let the matters take care of themselves. One of the key points of state influence and control is the aspect of technology transfer, thus this is a dominant part of chapter A-3. A lot of background information in this respect is given e.g. in part B, chapters 3 and 4, also.

In Chapter A-4 a review of the aspect of training is presented. On the one hand the importance of training programs is obvious throughout the whole study. Examples give an idea of the content of training programs. However the type of training programs have to fit into the individual situation on the country, thus this more general work will become very specific for each individual case to be defined.

In Chapter A-5 the design of a marine technology information and documentation system is discussed.

The Elaborations and Materials, Part B, present in greater detail elaborations and materials on various aspects.

Chapter B-1 deals with the relative importance of offshore hydrocarbons and their distribution in the world. After a worldwide survey of reserves, the production, and drilling some future trends are drawn up.

In Chapter B-2 the capital investments and expenditures for energy development are investigated. The aspect of oil prices as well as actual statistical information about the real investment level are worked out. Special attention is paid to the situation of developing countries.

Rather detailed is the elaboration on legislation and financing in Chapter B-3. The understanding of this field is essential for all steps of activities and for all definitions in strategy etc. Some emphasis was put on definitions and descriptions of the basic roles of state and oil companies etc. Especially the various types of contracts in the area of state and oil company as well as the aspects of risk and risk sharing is touched in great detail.

The infrastructure of the offshore business and, of course, the procurement philosophies and methods are presented in Chapter B-4. Some examples demonstrate how international offshore projects are being managed. The time aspect is touched as well as the contractual one. The procurement procedures are in particular explained by two major examples.

In Chapter B-5 the aspect of contractual options for project phases is discussed in much more depth than in B-4.

Chapter B-6 presents a rough survey of the technological trends. This chapter is not designed to fully inform about the status of technical development, it is rather a technical background for reading the other part of the study.

Since offshore gas utilization wins more and more importance a special feature was put forward to highlight this field in Chapter B-7. Some eminent aspects are involved for developing countries.

In Chapter B-8 there are descriptions and informations of offshore projects in developing countries by examples. There are the examples of India and Indonesia in some more detail. A quick review of other areas is incorporated.

The parts Prospect and Appendices are sufficiently defined on page I, 2.

S U M M A R Y

1. Definition of the Offshore Industry

1.1 Key Players

The international offshore industry is a complex network of oil companies, consulting and engineering firms, suppliers and service companies.

The companies are either private, public or state owned. They are multinationally, regionally or nationally operating.

The overall offshore business is more or less state controlled. The degree of state and governmental influence varies very much.

Oil companies are the key players in the business. They decide in principle about exploration as well as about development and exploitation of oil and gas resources. They are the main investors and by that they define the budgets of the industry. However, they make their decisions in the framework of state control and governmental influence. This means that the decisions of the state authorities may effect or prevent the preparedness of the oil companies to invest or not.

Among developing countries the existence of state oil companies is the general rule where a petroleum sector, even a very young infant one exists. In some major producing countries where petroleum exploitation was nationalized they dominate the whole industry in the country concerned.

But the oil companies are not only investors, the most of them are also operators. Furthermore they are representing the bundled know-how of the overall oil and gas business. Of course, this does not apply to all oil companies

All other companies without regulatory bodies and authorities are contractors or subcontractors of a certain degree to the oil companies

1.2. Supply and Demand of Energy

The hydrocarbons oil and gas will continue to be a major resource for the prime energy demand in the world. Thus the exploration and production of hydrocarbons will remain a leading field of activity and business.

In spite of demand falling short behind expectations for certain periods the level of consumption of hydrocarbons is rather high compared with the range of variation.

The hydrocarbons provided from offshore resources have been constantly increasing and are today close to 25 % of total production.

A considerable proportion of the worldwide exploration effort takes place in developing countries with a few countries dominating. Also in the field development activities developing countries account for a considerable share of the expenditures.

1.3. Procedures and Practices

Offshore petroleum mineral rights within the Continental shelf of a country are vested in the government of that country. The definition of the term "Continental Shelf" is thus of great importance. In the essence the definition is adopted in the Continental Shelf Act of 1958.

The oil companies are generally concessionaires. When they form consortia for the ownership of one field one of them is the operating company. During the overall life of such cooperation the operatorship might change, e.g. when starting field development after exploration, or even during the production period.

The activities in the offshore field follow in general the scheme of phases:

- prospection
- exploration
- field development
- operation / production
- removal

Comprehensive organization and planning work is required to implement a large offshore project. As soon as a field is declared a "commercial" find, "project task forces" and/or "project management teams" are installed. Planning and construction require several years and several hundred companies participating in the project.

With few exceptions, the procurement procedures of the oil companies follow a definite pattern: suitable vendors are selected at various stages, followed finally by signing of the contracts.

Depending on the circumstances of the operator the contract philosophy must be decided upon at the beginning of even the feasibility phase at the outset of any proposed development. The initial choice of contract will affect the contract philosophy of the project phases.

2. Identification of Opportunities and Constraints

2.1 General situation

The worldwide energy situation of today is characterized by some particulars, e.g.:

- The growth in both energy and petroleum demand is generally forecasted.
- Offshore oil and gas are increasingly contributing to the prime energy supply worldwide.
- The developing countries are increasingly contributing to the offshore oil and gas supply worlwide.

2.2 General Opportunities

Hydrocarbon resources within the economic offshore zones of the coastal states are national property. Their exploration and exploitation may only be performed within concessions granted by the national governments or other authorities.

The owning state wants to make an optimum effect out of this property. This can be done in two ways, first to directly utilize the resources, the oil and gas, by own use or exportation, and second to utilize the activities by turning them to support the development of industries and human resources in the own country.

The concessionary national control contains also the possibility for the states to participate in the earning of taxes, license fees etc.

Additionally the state can define the rules of the business within their own area, i.e. for instance control the number of concessions, define the type of contracts with the oil companies, require certain national respectively local content of contracts, request certain technical and safety standards, determine conditions for environmental control etc.

Furthermore the state may instal rules for the protection of the home industry and for the ensuring of technology transfer taking place.

The states also have the chance to not only involve the own industry to a maximum extent but also to use the offshore activities for development of the home industry.

This might be envisaged via two directions. On the one hand backward linkages offer to be involved in the delivery of equipment, materials, and services for the exploration, field development and production.

On the other hand forward linkages offer to be involved in the delivery of equipment, materials, and services for downstream facilities and in the operation thereof, like refineries, petrochemical plants and fertilizer production etc.

Last not least it must be the target of developing countries to invite foreign financing power. Foreign investors can be challenged to invest in the developing country if they view the investment promising.

2.3 Utilization of Oil and Gas

Oil and gas resources represent a remarkable wealth for any country. The intention to make optimum use of it leads often to be carried away. This implements the danger of wrong developments.

Of course, the instant idea is to use the oil and gas directly either for own utilization or for exportation. In both cases the fiscal aspect is dominating, either to save money spent for buying prime energy or to earn money by selling.

But there are certain risks involved also for this alternative way:

- Direct utilization may disrupt use of other prime energy resources.
- Exportation means directly depending on world market conditions.

2.4 Utilization of Offshore Activities

The more strategic way, however, is to use the offshore activities for the development of the own industry. This is especially valuable since companies who are qualified to do the work in the offshore field are relatively highly qualified and by that enabled to be involved in other onshore areas.

The activities to develop qualified industries might be in the various directions which are linked directly to the offshore field.

There is the upstream involvement, which means to go into the highly specialized area of exploration and field development technology. The disadvantage is that there is no other market available to utilize the built up know-how than the worldwide one. And a newcomer cannot be competetive in that field.

In the downstream area large investments are necessary. This indicates a wider field of involvement. On the other hand there is no continous market, after the huge investments like refineries are done.

More interesting for developing countries is therefore the activating of the onshore peripherical industry. This industry should serve in the exploration and field development phase as much as possible. The integration into the projects can be enforced more easy than that in the more specialized areas. The involvement must be used to higher qualify the industry so that it can later compete in other areas of activities more easy.
This closer connection to not only offshore related industries and markets also can avoid impairment or even demolition of industrial and social structures in the country.

2.5 General constraints

The cases of unsuccessful involvement in the oil and gas and especially in the offshore field indicate that there are several constraints.

Definitely one of the most important is selfmade, it is the wishful thinking of an "unavoidable" wealth. This means disregarding that for other countries and companies it took decades to develop the know-how, the expertise, the experience, the skills etc. and that this is the basis for their business.

Another one is the dependence on these foreign countries and companies. The know-how, the expertise etc. of them is needed to develop the own resources. Thus the whole situation requires for international cooperation. Of course, this means business. The solution must be of mutual interest and benefit for both sides.

For the developing country the situation can be different:

- if there is no population and unemployment problem involved, the solution might be a pure financial one and by that rather uncomplicated

- if there is a population and unemployment problem involved, the solution requests an improvement in this field what makes such situation more complex since the qualification of the available resources play a dominant role.

In the latter case there is the missing qualification caused by

- the lack of educated, skilled and experienced people
- the lack of knowledge and information
- the lack of infrastructural pre-requisites.

The lack of infrastructural facilities could be solved by simply investing. Thus you can see in various developing countries most excellent facilities like shipyards. But the necessary people are not available to utilize fully these facilities and often the market is not available to sell the products of these facilities.

Usually the arguments advanced are the missing of knowledge and information. But there are many examples that the acquisition of such information and knowledge is not at all sufficient. You need the people who are able to work with this information and knowledge.

Thus the case boils down to the lack of educated, skilled- also in the sense of trained - and experienced people. There is no other field than education and experience which takes that long time.

So as a matter of fact it is also the lack of time which creates impatience. And impatience is the enemy of good solutions.

3. Proposals at the Policy and Operational Level

3.1 Analysis

Activities to be taken up by developing countries are quite different and individual from country to country. Therefore each one planning or continuing to develop the own offshore areas has to study and to analyse it's very own and individual situation:

- the existence of sufficient resources has to be ascertained
- the prime energy availability and demand in the own country has to be determined
- the trade balance situation has to be evaluated
- the principal potential industrial capacities have to be identified
- the potential impacts on the overall home economy have to be analysed to define the most appropriate activities.

The main factors of the economy to be discussed e.g. the absorptive capacity of the country are the infrastructure of the industry including ports, roads etc., the expertise and skills of the people, and the social structure where it has an impact on such new developments.

3.2 Strategic Planning

The developing country driving at offshore development will be to a large extent a host country. Thus it has as a host country to determine the optimal strategy of developing the offshore activities on the basis of the analysis, e.g.:

- The targets in the trade and energy balance have first to be defined and to be verified.
- The way of international cooperation must be determined.
- Targets for the development of the own supplying industry have to be set.

An overall basic scheme has to be laid out to guide the decision makers in details in the following steps. The basic scheme must be clear and convincing to allow the potential international partners in financing, know-how, operation etc. to trust in the development.

3.3 International Cooperation

Since the international cooperation is a necessity the respective developing country has to determine its policy in advance. The network of foreign policies in combination with the economic relations form the basic scanning for any international cooperation.

However, the cooperation must include countries and companies which have the necessary know-how and experience.

3.4 Management of Education and Information

As pointed out already the key issue for planning the development of the own industry in parallel to the offshore activities is the field of education and information. Without doubt this area needs management capacity.

There are the two examples China and India discussed in detail within this study. The certain disappointment of the developments in China has been shown and explained. Even if there is always the comment that there is never the case of one country alike that one of another country, everybody tries to find universally valid rules and recipes out of the successful as well the unsuccessful examples. In the case of China as well as India it is as a matter of fact finally a question of education:

- whereas China could not develop the necessary know-how, skills and experience in the time envisaged and by the way chosen
- India has a vast resource of highly educated people around the world .

This should be demonstrated by the following:

- The number of Indian people with an university degree is approximately equal to the total West German population.
- Nearly one third of the scientists of the NASA are of Indian origin.

3.5 Controlled Development of Own Industry

The envisaged development of the human and infrastructural resources of a developing country is a great undertaking. It can only be successful by good luck or by extraordinary planning and control.

The development of the own resources needs more care than the supervision of the multinational companies. In a well set environment investors will feel more a promising future and by that will be prepared to take a higher risk share than in more adversary looking set ups.

PART A

EXTENDED SYNOPSIS AND ASSESSMENT, CONCLUSIONS AND RECOMMENDATIONS

CHAPTERS

CHAPTER A-1

THE OFFSHORE INDUSTRY AN LINKAGES OF OFFSHORE- AND ONSHORE ACTIVITIES AND DEVELOPMENTS

SECTIONS

1. The Offshore Industry and Linkages of Offshore- and Onshore Activities and Developments

1.1 The Offshore Industry

1.1.1 Structure of the Offshore Industry

The international offshore industry is a complex network of oil companies, consulting and engineering firms, suppliers and service companies.

Oil companies are the key players in the business. They decide in principle about exploration as well as about development and exploitation of oil and gas resources - so moving the capital which the other parts of the offshore industry are depending on.

There are the multinational Oil Companies which have been the dominant factors of the oil and gas business in the past. In recent years national oil companies have emerged, which either are state owned or are at least to a certain extent state controlled. In several countries even the multinational oil companies have come heavily under governmental control of the host country as far as the local activities are concerned.

Usually the oil companies form consortia for exploration of new areas - two to about ten partners (in average 2 - 4 companies) to share the risk of exploration. One of the partners is acting as operator, playing a decisive role in that specific case. If exploration leads to an exploitable oil or gas field, the consortia principally remain together. The role of the other business partners differs from case to case.

1.1.2 Procedures and Phases in Offshore Field Development

The type of activities and business during the field development is depending on the succeeding steps from prospection over exploration, levelopment of a field, up to the production phase and eventually the removal of the offshore installations.

First Step - Prospection

First step of search for oil and gas is the prospection, performed by specialized service companies, using geophysical ships with seismic equipment. The special know-how and by that the business of these companies is rather the interpretation of the obtained data than the provision of the equipment.

Second Step - Exploration

Exploration consists of drilling boreholes in an area which - following the result of prospection - might contain oil or gas fields.

Offshore exploration drilling is performed usually by drilling companies which are contracting their services to the oil companies and which are the owners and/or operators of mobile drilling rigs, such as jack-ups, semi-submersibles and drill-ships.

These drilling companies are on the other hand customers of service companies, to mention

- operators of supply-ships (for transportation of mud, water, drill-pipes etc.)
- operators of crew boats or helicopters for transport of personnel
- geophysical companies for investigations and tests in the hole
- catering companies
- diving contractors.

All these companies are from their part orderers of the special equipment they use: e.g. drilling contractors are customers of shipyards for construction and repair of mobile drilling rigs, supply ship operators are customers for fabrication and repair of their special ships, diving contractors for construction of diving bells and diver support ships.

An important role in the exploration phase as well as in all following phases of the offshore business plays the onshore supply base - usually in a near port which has to be equipped with warehouses, repair facilities etc.

Third Step - Development of an Oil and Gas Field

When a sufficiently large oil or gas field is discovered and the reservoir assessment and the economical evaluation give positive results and a development plan has been elaborated, the decision for development of the field may be taken. The field development contains essentially

- design, construction and installation of one ore more platforms (substructure mostly of steel, sometimes of concrete) including the decks with various facilities like process plants, energy supply, drilling rigs, living quarters, safety equipment, interconnecting flowlines (pipeline) etc.

- possibly installation of subsea completion systems
- drilling of production wells from the platform after installation or from mobile drilling rigs through before installed subsea templates
- installation of transportation facilities e.g.
  - pipelines for oil or gas respectively
  - loading buoy or tower for oil-transfer to tanker
  - onshore terminals with unloading facilities, storage and treatment

In these stages namely the following type of industrial companies are involved:

Management Services

- consulting/engineering companies for the overall conception of the field development and the project management on behalf of or in an integrated way with the operating oil company
- engineering companies for the design of platforms, pipelines, terminals etc.

Construction

- construction yards for fabrication of substructures of platforms, of topside modules, of platform components as steel nodes etc.
- civil engineering companies e.g. for construction of onshore terminal, onshore pipelaying
- temporary assembly sites onshore, inshore or offshore

Installation

- operators of crane ships, work barges, tugs etc. for offshore installations
- pipelaying contractors
- diving contractors for subsea installation support

Equipment and Material Supplies

- steel companies for pipes, nodes, plates, ropes, wires etc.
- suppliers of mechanical, electrical and process equipment

Services

- drilling contractors
- supply ship operators, helicopter services etc.
- shore base services like warehouses, catering etc.

Fourth Step - Operation

The operation phase is handled in first line by the oil companies themselves. Special services are necessary for instance in the field of

- workover of production wells
- inspection, maintenance, repair for equipment on the platform, for the platform itselve above and under water, for subsea installations, for pipelines
- supply ship services for platforms
- helicopter or crew boat services for crew exchange.

Fifth Step - Removal

Increasingly the governmental bodies will ask to remove the offshore installations after the exploitation of the offshore oil or gas fields. They even require the design of the installations to be already made in a way that removal is preplanned. The companies involved for example will be

- diving contractors
- operators of crane ships and barges
- scrap yards

1.2 General Economic and Industrial Impacts

Oil- and Gas resources represent a remarkable wealth for any country. In principle no difference exists whether these resources are located onshore or offshore. Generally the onshore resources are to be exploited easier and at lower costs. But the economy of exploitation depends on a lot of parameters, to mention oilprice, location and depth of the resource, overall investment and operation costs.

There are two ways to turn to account oil and/or gas produced in a country. It may either be utilized in the country itself or may be exported to other countries. Both cases have positive impacts on the availability of foreign currency:

- in case of domestic utilization the oil or gas may replace energy which otherwise has to be imported from abroad, thus saving money which had to be payed to foreign suppliers

- in case of exportation of the produced oil or gas or their products respectively, foreign currency may be earned which can be utilized for importation of other necessary products and goods.

In the past the hydrocarbon resources of a developing country have been explored and exploited dominantly by foreign companies in the first phase. The oil was exported as crude oil, the products such as gasoline, lubrication oil etc. were reimported. Where possible the home industry had the chance to deliver goods and services during the field developments. In several cases the building-up of respective industries and know-how was reached.

Increasingly the developing countries are considering to build up their own refining and processing industries. Consequently the domestic market is supplied with products which have been processed in the country itself. All the more the exports take the form of final products as gasoline etc.

The step of building up own downstream facilities leads to large investments for refineries, pipelines, product distribution networks (as e.g. gasoline stations). These investments can contribute to the general onshore industrial development which needs to take place as well in the area of facilities as in the field of qualification of people.

All such developments have to be planned and controlled carefully to avoid

- impairment or even demolition of the industrial and social structures originated in that country, and

- impetuous booming, which will unbalance the economy, and the consequent collapse of the necessarily unsound situation.

1.3 Importance of Offshore Activities in Developing Countries

1.3.1 The Offshore Shares

Offshore oil and gas developments are making an increased contribution to the world`s oil and gas supplies. According to the source of statistics there are different production figures published. In this chapter we follow a recent report by Mackay Consultants of the United Kingdom. In chapter B2 we use the United States based Warlick Ass./Offshore Magazine as well as our own data base. In 1986 world oil production was according to Mackay estimated at 2,932.8 million tonnes. For that year offshore oil production has been estimated at 756.8 million tonnes or 25.8 % of the total (Appendix A-1-3). World natural gas production was estimated at 1,568 million tonnes of oil equivalent in 1986. Offshore gas contributed 311.3 million tonnes of oil equivalent or 19.8 % of the total. Both offshore oil and gas production are expected to increase over the next few years. Consultants estimate that oil production from offshore areas will reach 851 million tonnes in 1990 while natural gas production could attain a figure of 373 million tonnes equivalent.

A considerable share of the increased offshore production will emanate from developing countries. The estimates indicated that offshore oil production from the Middle East could increase from 139 million tonnes in 1986 to 178 million tonnes in 1990. In South America the projected increase is from 77.1 million tonnes in 1986 to 87.7 million tonnes in 1990. In Mexico they project an increase from 85 million tonnes in 1986 to 89.5 million tonnes in 1990.

In West and East Africa an increase from 92.5 to 99.8 million tonnes is expected over the same period. In the newly industrialized and developing countries of the Far East some consultants foresee offshore oil production increasing from 85 million tonnes in 1986 to 108 million tonnes in 1990.

Offshore production is thus making considerable contributions to domestic energy supplies. In 1986 offshore oil and gas production together produced the equivalent of 14 % of the world`s total commercial energy consumption and 24.3 % of the world`s consumption of oil and gas. Oil and gas contributed 73 % of the total energy consumption in Latin America in 1986. For the Middle East the figure was 97 %, for Africa 57 %, for South Asia 35.6 %, for South East Asia 69.9 %, for China 16.6 % and for the USSR 67.2 %.

1.3.2 Energy and Petroleum Demand

Growth in both energy and petroleum demand is generally forecasted. Most forecasters expect that total energy demand will increase faster than oil demand. For example, Chevron foresee world energy demand outside the centrally planned countries rising at an average annual growth rate of 1.9 % in the period 1986-2000. They expect oil consumption to grow at 0.8 % per year and natural gas demand to rise at 2.7 % per year.
Chevron`s forecast anticipates that oil demand will be rising faster than average in the Eastern Hemisphere outside Japan at 2 % per year. In Latin America the growth rate is expected to be 0.9 % per year. Chevron expect natural gas consumption in the world outside the centrally planned countries to grow on average at 2.7 % per year in

the period 1986-2000. In the Western Hemisphere outside the USA the expected average annual growth rate is 4.5 % in the period 1986-1990 and 3.9 % in the period 1990-2000. In the Eastern Hemisphere the expected growth rate is 7.5 % in the period 1986-90 and 4.7 % in the period 1990-2000. In the Middle East the expected growth rates for the two periods are 6.7 % and 5.8 % respectively. Thus gas consumption is likely to become relatively as well as absolutely more important in total energy consumption, especially in developing countries. Oil consumption is expected to grow at a lower pace than total energy demand. The rate of growth may well be higher in developing countries than in advanced ones, with consumption growing particularly quickly in those countries which are successfully industrialising.

1.3.3 Impact on Industrial and Onshore Development

The impact of offshore oil and gas developments on industrial development can take two main forms. These are through forward and backward linkages.

Forward linkages refer to the use of oil and gas as inputs into further processing and/or industrial activities. Obvious uses of crude oil include petroleum refining, petrochemicals and fertilisers. Natural gas can also be used as feedstock for fertilisers (particularly urea but also phosphates) and other petrochemicals such as ethylene. In many developing countries the existence of indigenous oil and gas has fostered the development of these petroleum-based industries. Agriculture constitutes the largest economic sector in most developing countries and fertiliser production is frequently given a high priority.

The backward linkages offered by petroleum production refer to the provision of all the equipment, materials and services required for exploration, development and production. These requirements are substantial, and are generally greater than those needed for exploitation onshore. The expenditures incurred indicate the size of the markets potentially available to suppliers and manufacturers from the host country.

The recent report by Mackay Consultants has provided estimates of the size of these markets. According to their calculations offshore exploration expenditures throughout the world were $ 8,102 million in 1986. On the basis of a constant real oil price of $ 18 per barrel they expect exploration expenditures to reach $ 10,447 million 1990 (Appendix A-1-3). For development expenditures total investments in 1986 are estimated at $ 27,442 million and for operating expenditures at $ 25,838 million. The estimates for 1990 are $ 33,635 million and $ 31,987 million (Appendix A-1-1 and A-1-4).

Total offshore investments (according to Mackay) amount to $ 61,4 billion. Other studies see a world market of $ 54 billion respectively $ 38 billion (details see chapter B-2.3).

1.4 The Role of the Developing Countries

1.4.1 Exploration Activities

A considerable proportion of this exploration effort takes place in developing countries with a few countries dominating. In South America total offshore exploration expenditure was $ 764 million in 1986 with Brazil accounting for $ 600 million, Chile accounted for $ 60 million and Venezuela $ 44 million. By 1990 expenditure could reach $ 1,433 million, with Brazil accounting for $ 850 million, Venezuela $ 165 million, Argentina $ 115 million and Chile $ 120 million.

Offshore exploration expenditure in Central America is dominated by Mexico where expenditure was $ 35 million in 1986. This could reach $ 60 million by 1990.

In the Far East the most important countries in 1986 for offshore exploration were India ($ 110 million), Malaysia ($ 85 million), Indonesia ($ 240 million), China ($ 280 million), Thailand ($ 30 million), Vietnam ($ 40 million) and Taiwan-Province of China ($ 40 million). Mackay Consultants forecast that in 1990 expenditure could reach $ 125 million in India, $ 75 million in Thailand, $ 150 million in Malaysia, $ 35 million in Brunei, $ 100 million in Vietnam, $ 230 million in China and $ 75 million in Japan.

In the Middle East offshore exploration totalled around $ 141 million in 1986 with the UAE accounting for $ 80 million and Saudi Arabia $ 35 million. By 1990 the total could be $ 385 million with the UAE accounting for $ 100 million, Oman $ 40 million, Saudi Arabia $ 85 million, Quatar $ 25 million and Iran $ 25 million.

In Africa offshore exploration totalled $ 751 million in 1986 with Ivory Coast accounting for $ 45 million, Nigeria $ 115 million, Cameroon $ 60 million, Gabon $ 120 million, Angola-Cabinda $ 130 million, South Africa $ 100 million and Egypt $ 110 million. By 1990 the total could be $ 1,264 million with Senegal providing $ 60 million, Ivory Coast $ 85 million, Nigeria $ 160 million, Cameroon $ 100 million, Gabon $ 135 million, Angola-Cabinda $ 180 million, South Africa $ 75 million and Egypt $ 200 million.

1.4.2 Field Development Activities

World offshore development expenditure has been estimated at $ 27,442 million in 1986 and will rise to $ 33,635 million by 1990 (Appendix A-1-3). Again developing countries account for a considerable share of this expenditure with a few countries dominating the picture. Thus in South America total expenditure was $ 5,664 million in 1986. Of this Venezuela accounted for $ 2,309 million and Brazil $ 3,245 million. By 1990 the total could be $ 6,350. Venezuela could account for $ 2,220 million, Trinidad and Tobago $ 205 million, Brazil $ 3,390 million, Argentina $ 200 million, Chile $ 240 million and Peru $ 60 million.

In Central America Mexico is by far the dominant country with development expenditure totalling $ 440 million in 1986. This could reach $ 780 million in 1990.

In the Far East total development expenditure was estimated at $ 4,470 million in 1986. Of this $ 640 million was in India, $ 520 million in Malaysia, $ 180 million in Brunei, $ 940 million in Indonesia, $ 240 million in Vietnam, $ 305 million in China und $ 90 million in Taiwan-Province of China. By 1990 according to Mackay Consultants total development expenditure could be $ 6,840 million, with $ 275 million in India, $ 160 million in Bangladesh, $ 400 million in Burma, $ 660 million in Thailand, $ 1,110 million in Malaysia, $ 200 million in Brunei, $ 1,480 million in Taiwan-Province of China, $ 60 million in Japan and $ 100 million in Papua New Guinea.

In the Middle East total offshore development costs totalled $ 2,028 million in 1986 and could reach $ 2,540 in 1990. In 1986 expenditure was $ 910 million in the UAE and $ 1,100 million in Saudi Arabia. In 1990 it could be $ 1,400 million in the UAE, $ 700 million in Qatar, $ 150 million in Saudi Arabia, $ 190 million in Iran and $ 60 million in Oman.

In Africa total offshore development expenditure was $ 1,105 million in 1986, it could reach $ 2,430 million by 1990. In 1986 the most important countries were Nigeria ($ 240 million), Cameroon ($ 180 million), Gabon ($ 165 million), Congo ($ 130 million), Angola-Cabinda $ 230 million) and Egypt ($ 220 million). In 1990 it could be $ 125 million in Ivory Coast, $ 570 million in Nigeria, $ 230 million in Cameroon, $ 160 million in Gabon, $ 140 million in the Congo, $ 160 million in Angola-Cabinda, $ 400 million in South Africa, $ 250 million in Tanzania and $ 305 million in Egypt.

1.4.3 Operating Expenditures

Offshore exploitation requires ongoing operating or production expenditures. For the whole world these totalled $ 25,838 million in 1986 and are estimated to reach $ 31,987 million in 1990 (Appendix A-1-4). In South America total expenditure were around $ 3 million in 1986 with Venezuela accounting for $ 1,420 million, Trinidad and Tobago $ 410 million and Brazil $ 1,050 million. By 1990 expenditure could be $ 100 million in Colombia, $ 1,580 in Venezuela, $ 540 million in Trinidad and Tobago, $ 1,370 in Brazil and $ 110 million in Ecuador.

In Central America Mexico dominates offshore petroleum exploitation. In 1986 operating expenditures were $ 1,900 million. These could reach $ 2 billion by 1990.

In the Far East total offshore operating expenses were $ 3,597 million in 1986. Of this $ 275 million occured in India, $ 185 million in Malaysia, $ 300 million in Brunei and $ 1,420 million in Indonesia. By 1990 the total would be $ 5,855 million, with $ 350 million taking place in India, $ 70 million in Thailand, $ 215 million in Malaysia, $ 340 million in Brunei, $ 1,850 million in Indonesia, $ 900 million in Vietnam and $ 140 million in China.

In the Middle East offshore operating expenses totalled $ 690 million in 1986 with $ 150 million taking place in the UAE, $ 275 million in Saudi Arabia and $ 220 million in Iran. By 1990 the total could be $ 1,175 million with $ 200 million in the UAE, $ 80 million in Qatar, $ 500 million in Saudi Arabia and $ 375 million in Iran.

In Africa offshore operating expenditures totalled $ 2,380 million in 1986. Of this $ 45 million took place in Ivory Coast, $ 120 million in Nigeria, $ 350 million in Cameroon, $ 240 million in Gabon, $ 215 million in the Congo, $ 315 million in Angola-Cabinda and $ 1,030 million in Egypt. By 1990 the total could be $ 2,767 million according to Mackay Consultants with $ 40 million in the Ivory Coast, $ 130 million in Nigeria, $ 400 million in Cameroon, $ 225 million in Gabon, $ 320 million in the Congo, $ 360 million in Angola-Cabinda and $ 1,200 million in Egypt.

CHAPTER A-2

ACTIVITIES TO BE TAKEN UP BY DEVELOPING COUNTRIES

2. Activities to Be Taken up by Developing Countries

2.1 Analysis of the Country's Own Potential Capacities and Needs

2.1.1 General Aspects

Hydrocarbon resources within the economic offshore zones of the coastal states are national property. Their exploration and exploitation may only be performed within concessions granted by the national governments. The concessionaires are the oil companies. They have to pay licence fees and taxes and have to comply with governmental requirements. The conditions imposed allow the government to secure its influence in all phases of the offshore business concerning economy, safety, local content of industry activities etc.

These conditions may concern

- economic requirements as performance of drilling work, volumina of investment, production rates, reservoir management, participation of national oil companies, participation of local supplier and service industry

- technical requirements as protection of the environment, safety conditions, R & D work.

It is quite apparent that the government of any country with offshore activities tries to secure as many advantages as possible in relation with the activities for offshore hydrocarbon resources in their economic zone. As far as the offshore supply industry is concerned, many conditions may be imposed in favour to the local industry, e.g. concerning transfer of technology, formation of joint ventures, financing R & D work and others. Such governmental measures may lead to higher costs for investments and operations in their sector. The governmental influence must aim to set the rules for fruitful cooperation between local industry and foreign partners which leaves the offshore business attractive for experienced foreign companies.

There is no doubt that each developing country will be able - after a certain period of training and gaining experience - to perform the majority of industrial activities required in the offshore business. There are developing countries with offshore resources which have already long experience in the offshore market and even provide an outstanding know-how in this field. Thus the following reflections concern mainly such developing countries where the offshore activities are just beginning or are being planned and expected.

The different phases of offshore activities and respective industries described in A-1 require quite different types and levels of know-how. Indead some of the mentioned industries exist already in developing countries, however with no experiences in the offshore fields, and can be included easily in the offshore business as "local content".

Activities to be taken up by developing countries are quite different and individual from country to country. Therefore each one planning or continuing to develop the offshore areas has to study and to analyse it's very own and individual situation.

* There is to ascertain the existence of sufficient resources of oil and/or gas in the offshore area. A clear indication of commerciality of the finds and resources as well as of an adequate amount of resources is a qualification for continued activities.

* There is to be determined the prime energy availability in the own country to establish the potential market for additional prime energy.

* There is to be evaluated the trade balance situation to examine the impact of additional oil and/or gas in all the various alternative ways.

* There are to be identified the principal potential industrial capacities, which have been developed already to a certain extent or which are lying dormant.

2.1.2 The Potential Impacts

The various expenditures discussed in A-1 indicate the general areas of industrial activity potentially open to host developing countries as a consequence of offshore petroleum exploration, development and production. This then raises the question of the most appropriate types of activity. The most appropriate for a host country will depend upon a number of factors including

- the size of the market which in turn depends upon the likely size of the recoverable reserves and thus the related size of the required investment, equipment, materials and labour force, and

- the absorptive capacity of the host economy, meaning its ability to absorb domestically the introduction of the technologies and activities at not unreasonable cost. These two aspects are now considered in detail.

The absorptive capacity of the economy in relation to offshore supply requirements depends upon a number of factors. These include principally the extent to which relevant infrastructure facilities and trained labour are available. Relevant infrastructure includes items such as appropriate sites for supply bases, construction yards, warehouses, shipbuilding and ship operating capabilities, and expertise in civil, mechanical and electronic engineering. Expertise in these areas includes not only the presence of physical assets, but the existence of a labour force with the relevant skills appropriate to the activities in question. This last element is at least as important as any of the others mentioned.

The extent to which the infrastructure as defined above and the necessary skills are available in developing countries varies enormously. Those countries which have developed significant shipbuilding, steel and engineering industries have simultaneously developed considerable labour and managerial skills. Examples of such countries are Taiwan province of China and South Korea. The ability of such countries to develop offshore technologies is very much greater than it is the case in the majority of African countries where such developments have not taken place on a significant scale.

In countries where the appropriate infrastructure and skills are generally lacking the cost of the introduction of the supply of the appropriate equipment and materials would be very much higher. In such cases there is to some extent a trade-off to be made by the host country between developing comparatively high cost supplying industries and taking the benefits of petroleum exploitation purely in the form of royalties and taxes. If very high cost local supplies are developed and used, the exploitation cost will be higher and the base for profits, taxes and royalties reduced.

2.1.3 Applicability of Industries by Example

Of course the applicability is a function as well of type of industry as of level of development in the respective country. The check of applicabilities is an important part of the analysis of the potential capacities for each country. However, in the following some basic statements are made for selected industries to give an idea of the necessary type and depth of such analysis. These statements do not claim to be complete or right in any case.

Oil companies require high levels of know-how and long experience. The possible way for long term implementation of the necessary experience is the formation of a national oil company which may be included in the offshore activities as consortium partner of foreign oil companies.

* To build up a national oil company which finally has the necessary power and competence needs long term strategic planning, consequent realization, and basically the chance to develop a sizeable body, which depends on the expected size of resource and business.

Prospecting companies (geophysical companies) require specially educated geophysists and some expertise based on long experience.

* Today the big oil companies rely on their own geophysical services and the other rely mainly on the services of some experienced geophysical companies worldwide. This is in principle not a field for developing countries to build up own capabilities.

Drilling companies may employ local workers in the crew. Supervisors and foremen will gain their know-how by specialized theoretical courses and practical experience in collaboration with their foreign colleagues on the rig and step for step inclusion in the responsibilities.

* This is an exellent field for developing countries to involve gradually local manpower, to build up own specialists by education, training and experience, and finally to provide complete drilling services by even national respectively local drilling companies. Of course, the latter can only be reached in acceptable terms by cooperation with experienced companies.

Diving operators are usually combined with work boat/work barge contractors. Divers need special education and training. The extent depends a lot on the necessary depth of diving. The safety of the divers is the key issue.

* Own involvement could start with the education of a team of divers in developed countries. Later a cooperation at home with the divers of the national navies of the developing countries is most common and recommendable.

<u>Supply shipping</u> may include local seamen in the first step, in a second step local officers, and in the third step the owning and operation of supply vessels.

The building of supply ships is a speciality. It has to be recognized that they are specially constructed ships. Thus they cannot be replaced by any other ships which are just available in a developing country.

A particular part of supply is the catering service. It involves land based facilities. Such facilities are also used in airline catering and in the field of touristic services.

* In many cases developing countries which are looking for offshore activities have own seagoing capabilities. This starts with owning and managing seagoing vessels. In several cases even a certain shipbuilding capacity is available.

  This field provides an exellent area of immidiate activities for the developing country to focus on offshore services activities. the pre-requisites are very much different and have to be studied in all detail before planning the involvement in a more strategic wav

Set up and operation of supply bases is a question on one hand of appropriate shoreline and on the other hand on management capabilities. Generally there is a special shore base for each producing field and it is operated by the operating oil company. But the individual services are widely hired in.

* Since the shore base usually will be situated near to the activities offshore, the location will be in the host country. This gives the respective developing country an outstanding chance to request a high degree of involvement in this activity. But e.g. the management skills have to be developed to become a partner.

Engineering and management services are supplied either to the oil company or to the contractors of them. In principle there are two reasons only to use such services. The one is the lack of simply capacity and the other is the lack of skilled personnel respectively of specialists for certain tasks, usually they are mixed. But even if e.g. an oil company cannot provide own people they will go for experienced companies and/or individuals who have proved to be qualified for the job.

* This field is most difficult to move in for developing countries. There is a chance to build up a certain capacity as a result of activities in one of the following areas.

Shipyards and other heavy industies are heavily involved in the offshore business. They supply on the one hand all type of different seagoing vessels, e.g. from supply boat to semisubmersible drilling rigs, and on the other hand modules and components for plattforms. Of course, this does include repair services. Many shipyards are specialized for efficiency respectively surviving reasons since the worldwide competition especially in this branch is enormous.

* Existing local shipyards and heavy industries can be developed to take part in the offshore related fabrication. The development of new facilities however should be discussed and eventually planned carefully. Especially in the field of quality assurance and project managements capabilities have to be improved. Additionally the various skilled workers need higher qualification to deliver the work in the required quality. Even for the shipyards of countries like UK, West Germany, Schweden etc., which have the highest shipbuilding standard in the world, the step into the offshore area has been an eminent challenge.

Civil engineering is a discipline which is performed in each and every country. In the offshore area different standards are required. For instance is the construction of onshore terminals, bases etc. very similar to the construction of the general infrastructure in a country. The typical offshore structures and civil engineering works, however, require the highest standard and a certain specialization.

* This difference in standards and the different availability of such capabilities effect that either the statement that civil engineering activities might easily be performed by local contractors of the developing country or the statement that it is not recommendable for developing countries to go into the field of subsea reinforced concrete structures can be right.

Installation work offshore includes platforms, platform modules, pipelines etc. and requires a variety of different capacities. The erection work requires large specialized equipment like crane ships, work barges, pipelay vessels etc. All this equipment must be managed by experienced specialists. Thus such companies performing this work are also the engineers to define the work. The hook-up work needs the specialists in the various subsystems since they complete offshore what has been prepared onshore. But because of the expremely high expenses and time risks offshore they usually require higher skilled people than for the foregoing work onshore.

* For small platforms in shallow water the skills and the experiences as well as the equipment may be made available much easier than for deeper waters. Nevertheless this is not a preferred branch for developing countries to start offshore activities with.

Supply of equipment and materials requires the relatively high standards of the oil business. This area covers the full width of disciplines, like electrical, mechanical, hydraulical etc.

* It has to be investigated thoroughly whether already established fabricators and producers in the respective developing country are qualified to either deliver the required goods or to be able to develop the standard of fabrication etc. to later supply the wanted goods.

2.2 Selection of the Principal Way of Development

2.2.1 Basic Scheme

The basic scheme has to define the targets in the various aspects of an own development. The country of development will be to a large extent a host country, since there is a development of the offshore area which will be done with international cooperation in different fields.

The targets in the trade and energy balance have first to be defined and to be verified by respective studies. The realistic opportunities should be guiding rather than wishful thinking of an "unavoidable" wealth. An optimum utilization of the potential prime energy has to be found.

The host country has to determine the optimal strategy for the development of supply industries. The extent to which supply industries should be developed fundamentally depends upon an assessment of

- the likely size and duration of the petroleum exploitation activity, and
- the absorptive capacity of the economy as discussed above.

Thus, the larger the likely size of the petroleum exploitation sector and the higher the degree to which the relevant infrastructure and labour and managerial skills are developed, the greater the extent to which the supply industries can advantageously be developed. Similarly, the smaller the size of the petroleum sector and the less well developed the relevant infrastructure and labour skills, the less likely it is that the national economy will rap major benefits from developing the supply industries. The development of supply industries in these circumstances would mean that the costs would be much higher than those of imports, and the activity would not last long enough for these costs to be reduced and national benefits enjoyed.

2.2.2 The Supply Scene

Where the petroleum sector is larger or is likely to become large the host country has to determine the optimal manner by which to enter and develop the supply industries. The most sensible route of development is to commence with those activities where the disadvantages of lack of specialized knowledge and lack of skilled labour are minimized and where the locational advantages are maximized.

In practice this means that emphasis should initially be concentrated on provision of services to support the exploration effort (given that this is the inital activity). This in turn means the provision of logistical support facilities. Thus supply bases are required which contain warehouses and other facilities to supply the exploration effort. Local organizations can readily be involved here. Transport facilities are required to take materials to and from the supply bases. Sea transport is also required to take materials to the rigs. Local organizations can again be involved here. The provision of supply boats themselves is more specialized. If a shipbuilding industry exists new boats could be built, although such boats are somewhat specialized. Offshore catering is also an activity which readily be entered by local organizations through managerial skills are certainly required to satisfy the needs of the drilling cortractors.

2.2.3 Construction and Assembly of Larger Units

At the development phase production platforms are required and there is a locational advantage favouring construction in the host country, if a suitable site is available. The construction of a platform requires considerable specialized knowledge, however, and would have to be undertaken by an organization with relevant expertise. In most developing countries there would probably not be adequate expertise. If the petroleum sector is likely to become large it would certainly by appropriate for the host country to acquire the relevant expertise.

This should be achieved by the formation of joint ventures between local firms and the international contractor specialists in this area. Where local firms exist which have engaged in large construction projects the necessary expertise for the construction of comparatively simple platforms for use in shallow waters could be acquired as a result of being part of a joint venture with a specialist international contractor.

The more specialized and sophisticated the platform the greater the difficulty which local firms have in acquiring the expertise. If the offshore industry is going to become large i.e. with many field developments, it will generally be in the national interest of host countries to acquire expertise in this activity. This applies particularly to jackets where the locational advantage is greatest.

Supply boats can readily be constructed in countries where a shipbuilding industry exists. They are somewhat specialized and, while the low labour costs in newly industrialized and developing countries confer an advantage to local construction, their specialized nature requires the acquisition of the relevant knowledge. Safety vessels can readily be provided from host countries which have a significant shipbuilding industry. Where a fishing industry exists trawlers can be converted to function as safety vessels.

2.2.4 Materials, Components and Equipment

In the area of materials and intermediate products, which have a certain neighbourhood to the raw materials, e.g. steel, the availability of such supplies in the country itself depend very much on the resources available, like iron and/or coal for a steel industry.

The manufacturing of components for offshore petroleum exploitation is generally a specialized activity. Currently this activity is dominated by US companies which generally export the products in questions. The manufacture of components requires a high degree of engineering expertise. This activity is generally not suitable for developing countries where the size of the petroleum sector is small or moderate. Even where it is comparatively large it is by no means to be expected that this activity could economically be conducted in a developing country's setting.

2.3 Decision on Manner of International Cooperation

2.3.1 General Aspects

As pointed out already know-how and time of experience are in principle needed to drive at the offshore development of a country or at the continuation of the development in the offshore field. The less the industrialization is so far in a country the more international cooperation is required to start that type of business and to build-up an own industrial capacity in and around that field.

The manner of international cooperation is usually a result of various contributing but also even competing factors:

- the factor of philosophy of self understanding
- the factor of foreign affairs
- the factor of state economy
- the factor of social-political acceptance
- the factor of the most economic origin of know-how and goods
- the factor of own plans of industrial development.

2.3.2 The Rather Political Influence

Several developing countries have ties and alliances to other countries, and/or to political philosophies, which might be firm and steady. For such countries there is no way around than to build up a development strategy on the basis of such political believe and engagement.

Others are much more free to accept different ways of cooperation. But there is of course the greater difficulty to decide.

The political position and integration in blocks, groups, areas etc. have to be analysed carefully. The network of foreign policies in combination with the economic relations form the basic scanning for any international cooperation. Additionally this assessed fundamental conception has to have a social-political acceptance in the whole country. The domestic policy is finally that tool to support and to put through the international cooperation into the building-up of an own industry to be developed.

In the last analysis there must be a decision, must be a selection of partners, which fit into the political picture of the host country. But of course the partnership has to have an economic effectiveness.

2.3.3 The Factors of Economic Effectiveness

On the basis of the political background the detailed tasks look rather simple:

- the most economic origins of know-how and goods have to be investigated,
- the concurrence with the own plans of industrial developments detected, and
- the necessary purchase agreements negotiated and concluded.

Generally the funds are not just available to buy. International Cooperation means in the initial phase help. Since it is all a matter of give and take the helping countries or industries need at the end also a positive response for themselves, need finally business.

The period of potential cooperation is rather long since the development of a respective industry can be measured in decades only. Thus partnership in such cooperation require strategic planning.

2.4 Creating the Administrative Pre-Requisits

2.4.1 General Aspects

Typical difficulties and stumble blocks in establishing or improving offshore oil and gas activities are to be found in administrative unpreparedness. Thus the legal foundation is not yet laid, for instance, or the required organization and institutions, alike the national oil company, are not yet operationable.

Especially in the field of interdisciplinary responsibility, where e.g. ministries have to work together or different, usually not or little cooperating administrative bodies have to jointly act, the difficulties arise.

There might be regulations or decrees missing to define ways of controlling the activities of the various players in the game. For example, there might not be a regulation who has to have which education or passing of test certificates to do what type of qualified work. More precise, there must be a procedure to accept certificates and skills as being sufficient to work in the respective country in that field.

A clear definition of the governments is necessary to decide who really has to take responsibility and has the power of decision. At least there might be some kind of clearing committee to find solutions to open questions where clashes between involved parties arise.

There are developing countries which have the final decision maker named, it is here a man out of the ministries, there a specially designed body and in other cases an industry committee. But in many countries this has not been organized and the result is usually a power struggling still ongoing when the activities and the business start.

Among all the various possibilities of missing administrative pre-requisits there are three ones which shall be looked in particularly since in these fields the problems arise regularly and are annoying and sometimes even endangering the success of the activities

- the tax and custom problems around the importing of goods like equipment and material
- the problems around the employment of foreign workers and experts in the respective country and
- the problems of moving the money in form of foreign currency across the borders of organizations, institutions and countries.

2.4.2 Import of Goods

In the sphere of importing there are two different areas which are

- the temporary "import" of goods, equipment etc. to be used for a while in the work but which will be "exported" again after the respective service with this equipment has been finished
- the final "import" of goods, equipment etc. to be finally used as an integrated part of the installed systems.

On the one hand we have to discuss first the monetary side e.g. of taxes and custom fees. This is usually a part of the country's strategy also, which is discussed in chapter A-3 and in certain aspects in B-3. But here we should not touch the aspects of having the right strategy or not.

Much more the obstacles and barriers in the administrative cooperation have to be discussed. Often too many organizations are involved in the import of goods which all have the power to stop the import. And as a result thereof and additionally just in principle the time aspect leading to delays and protracting.

A lot of certificates are required to be delivered with the goods beforehand. Many hands and heads have to be passed to receive the respective endorsement for the import certificates.

Unfortunately not all the involved persons and institutions usually are aware of the importance of the imports and of the timely delivery of them. The subordination under the strategies of the respective country has to be required.

2.4.3 Foreign Workers and Experts

This study highlights from several points of view the aspect of international cooperation and technology transfer. There is no way around to proceed therewith without having foreign workers and experts locally involved.

Sometimes a kind of resistance against such cooperation can be recognized. This approach to the problem demonstrates a one-sided view of this item, usually it is the idea that foreigners are taking away jobs. This emotional approach is of course the more likely the higher the unemployment in a country is.

But it is an important task of the government and the administration of the respective country to convince their people that the foreigners are called in to help and to improve the situation. In addition they have to prepare the administrative ways to smoothen the procedures of bringing the foreigners in.

2.4.4 Transfer of Foreign Currency

If there is a hesitation with companies in developed countries for services of any kind or to go with local companies into a joint venture in developing countries, one of the most cited reasons is the lack of certainty that the payments involved clear all hurdles. On the one side it is a question of taxes and fees. But on the other side it is the organizational question.

Foreign currency is for several developing countries a precious good. Thus they take special care of it by issueing plenty of laws, orders and regulations. These generally acceptable measures turn out to be inconvenient and even obstructive to the target of, for instance, involving a team of experts from a foreign country.

Clear and simple and reliable procedures have to be established to regulate the payments and all flow of moneys involved in the business.

2.5 Implementation of the Selected Way and Building up the Necessary Industrial and Social Infrastructure

Even the best plan needs implementation. The phase of implementation is without doubt the most important one. Nevertheless there is no general way how to implement a plan. It is an individual case by case decision and measurement. But a basic objective is to use the existent industrial and social infrastructure in the country. Another aspect is to be consequent.

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CHAPTER A-3

STRATEGIES AND POLICIES TO INVOLVE DEVELOPING COUNTRIES IN THE OIL INDUSTRY

SECTIONS

3. Strategies and Policies to Involve Developing Countries in the Oil Industry

3.1 The Market Structures and Constraints

3.1.1 Oil Companies

The international petroleum industry is dominated by a comparatively small number of large oil companies. At the exploration, development and production stages of the business these companies contract out a large number of the necessary functions. Thus there are specialized drilling companies and others which provide specialized technical services and equipment. These companies are contractors and sometimes manufacturers. Contracting firms undertake functions relating to geology, geophysics, drilling, logging and engineering. Companies which supply equipment are frequently the manufacturers as well.

3.1.2 Exploration Technologies

The most important markets for exploration technologies are dominated by a comparatively small number of international companies. This is seen from the table below where it is seen that in some services and equipment the market is extremely concentrated. With regard to engineering services related to petroleum exploitation, while there are no direct statistics available, it is clear that a few very large companies also have a big share of the market.

Selected Major Oil Contractors and Oil Equipment Suppliers: Sales and Market Shares, 1976
(in millions of dollars and percentages)

Company	Equipment						Technical services					Total sales of companies[a] ($ millions)
	Drilling equip.			Well equipment			Logging		Prod.-related services			
	Bit	Drill pipes	Join-tures	Other drilling appliances	Packers	Security equipment	Open hole	Cased hole	Cementing	Acidification	Fracturing	
Baker International	12	6	31		56	15						553
Dresser Industries	17				12	31	12	16				2232
Halliburton					24	18	2	6	58	47	53	4866
Hughes Tools	38	3	58						10	6	4	383
Schlumberger				10			84	44	13	18	18	1815
Smith International	25	58		60								308
Others	8	33	11	30	8	36	2	34	19	29	25	
Total (industry)	100	100	100	100	100	100	100	100	100	100	100	10152

Sources: Bulletin de l'industrie pétrolière (Paris), 27 December 1977; Crédit industriel et commercial (CIC), "Note d'information économique et financière" (Paris), No. 8, November 1977. Reprinted in Petroleum Exploration Strategies in Developing Countries, UN Natural Resources and Energy Division (Graham & Trotman, 1982).

a Figures refer to the total sales of the companies, including sales not accounted for in the market share columns. All the companies except Schlumberger, which is Franco-American, are based in the United States of America.

3.1.3 Offshore Technologies

The high share of the market in offshore technologies held by a small number of international companies to some extent reflects barriers to entry which make it difficult for new companies to compete effectively. Contrary to what is sometimes believed, the ownership of proprietary technology is not a very important factor in determining the advantages of the established firms. It may be important in data processing for software and electrical logging.

In a very recent study of technologies employed in offshore exploration in China it was stated by oil companies representatives that proprietary technology accounted for only between 2 % and 5 % of the knowledge of the oil companies. Secret equipment design and complex knowledge are likely to be significant factors in technologies such as reservoir engineering, computerized interpretation for drilling control and mud logging.

A study of the barriers to entry in the supply industries in the North Sea found that ownership of patents probably played a role in restricting the entry of UK based firms into the business. This study and others also confirm the view that the established companies which supply their own equipment or have access to information not readily available to others have an advantage of potential or actual rivals. The North Sea study and others also stress the importance of the availability of skilled labour and managerial talents as being very important factors in giving cost advantages to the established, leading firms in the supply business.

In sum it is a combination of access to technologies and information, a highly skilled labour force, and well developed managerial talents which give the major companies a cost advantage and constitute a barrier to entry for new firms. It is difficult for new entrants to acquire this combination.

3.1.4 Economic Environment and International Market Constraints

The economic environment of the offshore industry is determined mainly by the following factors:

- oil price development
- oil companies
- market volumina and their changes
- influence of governments.

The oilprice influences decisively the budgets of the oil companies and, consequentely, the worldwide expenditures for drilling, installation, equipment and other services in the oil sector. The impact on the offshore activities depends on technical as well as on political/economical factors and may be different for each country. Certain downturns of the oilprice as 1984 have affected in first line new activities of the oil companies as exploration drilling or decisions for new field developments, while running field developments and fields on stream were advanced as before. On the other side activities in certain countries where not much affected by falling oilprices.

The sensibility of the oil companies to the oil price and consequentely to their budgets has a direct influence on the orders to the offshore related industry, e.g there is the potential change between high demand for equipment and services and low level of business.

3.2 Devices for direct Technology Transfer

3.2.1 General Aspects

Several devices exist whereby offshore petroleum technology can be transferred to host developing countries. They include principally

- provisions in the petroleum exploration concessions and contracts
- work contracts
- commercial technology transfer agreements, and
- official technical cooperation agreements.

All of these instruments are potentially useful in achieving technology transfers. How effective they are generally depends upon the specific provisions and the energy with which the objective is pursued by the parties involved.

With regard to petroleum exploration concessions and contracts the provisions regarding technology transfer are often in very general, even vague terms. An examination of 601 contracts signed in the 1970's classified the provisions relating to technology transfer under four headings, namely

- training and scholarships
- employment of nationals
- local procurement of equipment and technical services, and
- others.

Of the 601 contracts examined it was found that only 88 (or 15 %) contained one or more of these provisions. There was evidence, however, that in the second half of the decade more emphasis was placed upon achieving technology transfer.

3.2.2 The Case of China

The determination of host countries to obtain technology transfers through exploration contracts varies considerably from country to country reflecting different national priorities. China is a main example of a country which made a major effort to achieve technology transfer through their petroleum agreements. The sections of the agreements dealing with this subject formed a key element in the whole contracts from the Chinese viewpoint. The relevant clauses in the contracts are more detailed than in most exploration agreements. An informal translation of the introductory part of the relevant clause in the Chinese model contract reads as follows:

> "All the companies, including subsidiaries, which have worked in the process of oil operations and development will transfer their appropriate advanced technology and their management expertise, including proprietary technology, e.g. patented technology, know-how and other technologies and all their knowledge, data, materials, etc., for China to master them.
>
> The contractors will also train Chinese personnel-workers, technicians, businessmen, managers and petroleum lawyers in oder to enhance their technical and management capability".

Source G. Oldham, A. Warhurst, L.Y. Yi and Z. Xiaobin, Technology Transfer to the Chinese Offshore Oil Industry, University of Sussex, Science Policy Research Unit, SPRU Occasional Paper No. 27, November 1987.

The clause then proceeds to specify the scope of training and technology as follows:

"In accordance with the requirements for oil operation in the exploration, development and production the contractor must train personnel from the state oil company and must transfer technology and management expertise in the following specific areas (but not be limited to them):

1. Geological survey, oil geology, geochemistry, geophysical material, data collection, processing and interpretation (including special techniques in processing), measurements and estimation of oil and gas reserves.

2. Geological, engineering, reservoir development, engineering modelling of oil field development, physical modelling, seismic data collection, special processing and interpretation, feasibility study of oil field development and the formulation of oil development plans.

3. Research on environmental influences in platform development, engineering feasibility, project planning, designing, manufacture, production and assembly, pipeline laying technology, the

transmission and settlement of high density oil and gas, underwater monitoring and repair operations.

4. Operation and maintenance of production platforms. Automation of production processes. Remote sensing and control and secondary and tertiary oil recovery.

5. Directional drilling and optimized drilling, pressure measurement and blow out control.

6. Economic assessment, finance planning, purchasing, marketing, manpower development and contract management.

7. Law, safety, fire prevention, environmental protection, telecommunication, computer technology and supply base management and other areas which are related to contract implementation".

Source: G. Oldham, A. Warhurst, L.Y. Yi and Z. Xiaobin, Technology Transfer by the Chinese Offshore Oil Industry, University of Sussex, Science Policy Research Unit, SPRU Occasional Paper No. 27, November 1987.

The scope for technology transfer in China is thus very large indeed. This example shows that petroleum companies can agree to transfer highly advanced as well as more basic technologies. The areas covered by the clauses certainly cover reservoir engineering, drilling and production, structural engineering, underwater inspection and maintenance and repair. The incorporation of such comprehensive commitments to transfer technologies is at first sight rather surprising. It results from the high priority given to this subject by the host Government, and the high prospectivity of the Chinese Continental Shelf perceived at the time of the signing of the agreements. Very high reserve figures were widely foreseen in the Chinese offshore territories.

3.2.3 Evaluation of the Experiences in the Case of China

Despite this unusually comprehensive commitment the experience to date has not been satisfactory from the viewpoint of either host country or the oil industry. A detailed study on this particular agreement has concluded that "the experience of the first few years has been disappointing for CNOOC (the Chinese National Offshore Oil Corporation), and frustrating for the foreign companies".

It is instructive to consider why this state of affairs has emerged. The details of the study of the Chinese situation referred to above concluded that the difficulties were now due to the following factors:

(a) There was ambiguity in the contract terms. This led to the different understandings and expectations by the two sides.

(b) There was a lack of understanding by the Chinese National Offshore Oil Corporation of the unique characteristics of offshore petroleum technology and international practice.

(c) Constraining factors included differences in language, management styles, educational backgrounds, management and technology levels and changes in the interpretation of contract terms.

(d) There was an absence of a clear strategy by the Chinese National Offshore Oil Corporation to guide the role that the foreign companies should play in the development of China's technological and managerial capacity.

(e) There was a lack of appreciation of the practical conflict between the demands for training and technology transfer, and the requirement for operational efficiency in exploring for and producing petroleum.

(f) There was a lack of appreciation by the foreign companies of the extent and range of China's technology transfer requirements.

Source G. Oldham, A. Warhurst, L.Y. Yi and Z. Xiaobin, Technology Transfer to the Chinese Offshore Oil Industry, University of Sussex, Science Policy Research Unit, SPRU Occasional Paper No. 27, November 1987.

3.2.4 Conclusions for Technology Transfer Provisions

The findings of the above study indicate how provisions in contracts need to specify precisely the responsibilities of the parties to the agreement. If successful technology transfer is to be achieved it is not sufficient to specify the obligations of the parties in general terms. It is necessary to indicate how the obligations will be fulfilled as well. The Chinese example also highlights the importance of clarity or meaning. Major differences of interpretation about the meaning of the term "transfer of technology" have occured. Thus the Chinese apparently expected that the agreements would "lead to the transfer of advanced and proprietary technology in such a way that the Chinese companies would understand both the know-how and the know-why of these technologies". They believed that "technology transfer" involves transferring the whole process from "beginning to end".

- The oil companies did not always interpret the term "technology transfer" in this way. Some thought that "technology transfer was synonymous with training" while others thought that it incorporated "the transfer of an ability to perform a task". This could require "passing over a black box or instrumentation", but there were different views about whether this involved obligations to explain "how the box works".

The findings of this study of the Chinese contractual terms indicates clearly the importance of very clear definitions not only of terms but also of the responsibilities of the parties to the agreement. In the absence of such precision differences of opinion regarding responsibilities will emerge which can readily thwart the effective transfer of technologies.

3.3 Indirect Technology Transfer

3.3.1 Work Contracts

In some countries state oil companies have not employed the services of the international oil companies directly but have employed other devices to transfer technology. One takes the form of ad hoc work contracts. Specialized independent contractors are hired on a fixed fee basis. Their services could include project management and training. One example was a four year contract between the Indian National Oil Company (ONGC) and Total for the development of Bombay High and associated fields. This provided for the transfer of technology and technical services. The development of the field required advanced techniques of reservoir management.

Another example is a contract signed in 1981 between the Venezuelan state company PDVSA and Total. This was for long term scientific and technological cooperation. PDVSA was provided with help on various subjects including PLG projects, seismic work, and development of certain fields including secondary recovery.
It is not obvious that such work contracts effectively lead to the transfer of technology. Essentially they provide for the hiring of technical services. This need not lead to the transfer of the capability to conduct the activities in question by host country organizations. This would require other, complementary arrangement particularly the provision of training by the supplying organization. The work contracts may very well not include this facility. Thus this type of contract is not well designed to foster the transfer of technologies.

There appear to be two types of commercial technology transfer agreements. The first sets up subsidaries of the petroleum companies and the multinational supply companies for the supply of technical services. The second provides for technical cooperation agreements by national oil companies and foreign technology suppliers. The subsidiaries of the oil and oil related companies acquire the technology from their parent companies. They import operations and train indigenous people. In a sense their actions represent the fulfillment of the technology clauses in petroleum agreements. The success of the transfer agreements then depends upon the success of the training programs.

3.3.2 Technical Cooperation Agreements

In host countries where some expertise in the oil related sector exists it appears that technical cooperation agreements for the licensing of specific patents are in force. There are examples in Iraq, Venezuela, Mexico and India. There are cases of joint ventures between national oil companies and technical service suppliers. These have often been in areas where the difference between foreign and domestic technologies was large. A good example is in Algeria where the national oil company Sonatrack has concluded several joint venture agreements with oil service companies. They have provided for the supply of services relating to drilling, geological surveys, well-logging and engineering studies. These agreements have played a major role in obtaining technology transfers to that country. They appear to have been reasonably effective because the foreign companies were obligated to undertake training of local staff.

From the imperfect information available it appears that these technology agreements have had some success. This is probably because they were well-targeted on the objective in mind, and clearly specified in that both parties were well aware of their obligations. It is clear that host countries have generally been those with a very significant petroleum sector. They have a greater bargaining power with foreign companies. They are also likely to have a better capacity to absorb the technologies concerned than countries where the petroleum sector is very small.

3.3.3 Official Cooperation of Countries

Petrcleum technologies may also be transferred via official technical cooperation agreements. There are many examples. Iraq made several agreements with the USSR. There are many examples of agreements between the national oil companies from developing countries with highly developed petroleum sectors and host countries where the local industry was in a less developed phase. Examples include the ONGC of India and Iran, Iraq and Tanzania, Petrobas of Brazil and Colombia, Sonatrack of Algeria, Egypt and Libya, and Tanzania. The agreements were generally for exploration work.

There are also several examples of regional cooperation between groups of countries. Such agreements are normally quite loose and generally provide for collaboration and mutual assistance through joint endeavours. At the international level technical cooperation and assistance is provided in the field of petroleum by the UNDP, UNDTC, and the Third World Bank.

It is difficult to generalize regarding the effectiveness of official programs. Their objectives are rather varied and sometimes not very precisely specified. The effective transfer of technology does depend upon the arrangements clearly specifying exactly what is to be done by both parties and it is not always clear that this is the case with these agreements.

3.3.4 Special Aspects

It is clear that effective transfer of technologies in fields of reservoir engineering, drilling and production, structural engineering, underwater inspection, maintenance and repair and research and development require that they be clearly incorporated in agreements which also specify precisely how the transfer is to be achieved. Vague general statements which are frequently incorporated in exploration agreements and in official agreements are unlikely to produce the desired results. Specific commercial contracts are thus likely to achieve the desired result. Aid agreements which are absolutely specific can also achieve the desired result. Petroleum exploration agreements need to be specified at greater length and with more precision than they have been to date if they are to be more fully effective.

Reservoir engineering, drilling and production, structural engineering, underwater inspection and research and development all incorporate advanced technologies. It is only to host countries where the oil industry is destined to become large and long-lived that it will be practicable and economic to transfer these technologies.

CHAPTER A-4

T R A I N I N G

4. Training

4.1 General

Training of personnel is one of the most efficient ways to acquire know-how and to achieve tranfer of technology. A part of developing countries - especially such with offshore activities in their economic zone - have established meanwhile their own training facilities.

In case where training is needed the easiest way to implement suitable programs is in connection with the activities of foreign oil companies, engineering companies or service firms.

The forms of training will be different following the requirements to the respective types of work. In any case the training should be done as well by theoretical lessons as by training on the job. There exist a lot of training programs in the world which differ from company to company and from country to country. The following presentations should be seen as examples.

These examples include the following typical offshore related work:

- Exploration and Production Drilling
- Production on the platform
- Construction work for offshore structures
- Diving
- Engineering
- Project Management.

4.2 Exploration and Production Drilling

A drilling crew for exploration and production drilling consists essentially of the following people:

- drilling supervisor/toolpusher who has the overall responsibility of the rig
- driller or foreman
- derrick man
- drilling helpers also known as floormen or roughnecks
- motor man, mechanics and electricians for maintenance, inspection and repair
- in an offshore crew additionally a crane operator with some helpers, called roustabouts
- on offshore rigs radio operator
- on offshore rigs marine staff.

As demonstrated above drilling personnel has to be distinguished in

- personnel with special education for drilling as the drilling supervisor and the foreman
- personnel which are not specialized to drilling.

The training has to concentrate on the specialized personnel.

The trainees should have the following pre-qualifications:

- Supervisors:
    - school leaving certificate of primary school or equivalent
    - at least five years of practical experience

- Foremen:
  - school leaving certificate of primary school or equivalent
  - at least two years experience in operation of a drilling rig.

In both cases the knowledge of English language is necessary.

Initial items to be included in the theoretical training are summarized in Appendix A-4-1.

An example for theoretical courses, based on the schedule and experience of Deutsche Bohrmeister Schule, Celle, Republic of Germany are summarized in Appendix A-4-2.

Lessons should be held in the developing country. A part of the lessons should be given by specialists and teachers from the developing country as

- English
- Basic Sciences
- Public Regulations
- First Aid

Practical Training on the mobile drilling rig for foremen as well as for supervisors should be done by involvement in the drilling crew for at least 6 months. This may be done by doubling the functions of drilling supervisor and drilling foreman. Foremen/Supervisors with theoretical education and no practical experience may be attached to their experienced colleagues. After 6 months the trainees should take over the responsibility of the second shift on the drilling rig while the other shift will be under the responsibility of an experienced person.

4.3 Production on the platform

Production on the platforms involves instaliation, operation, maintenance, repair and replacement of production equipments. Further activities include well remedial work, well testing and routine servicing of wells. The following main personnel is requested:

- production supervisor
- production foreman
- maintenance personnel as mechanics and eletricians
- on offshore installations the crane operator with some roustabouts.

Furthermore from time to time specialists for workover of the production wells are needed.

As in drilling, also in production training shall concentrate on such personnel which need special knowledge as the production supervisor and the production foreman. Essential items to be dealt with in the theoretical course are summarized in Appendix A-4-3.

Pre-qualifications for the personnel to be trained:

- supervisors:
    - school leaving certificate of primary school or an equivalent
    - at least five years of practical experience

- foremen:
    - school leaving certificate of primary school or an equivalent

- at least two years experience in operation of oilfield equipment or processing plant.

As in drilling courses training for production will include theoretical and practical training.

Theoretical courses could be based on the schedule and experience of Deutsche Bohrmeister Schule, Celle, Republic of Germany. (Appendix A-4-4).

As in drilling lessons in the beginning a part of the courses should be given by teachers from the developing country as

- English
- Basic sciences
- Public Regulations
- First Aid.

Practical Training on the platform for foremen as well as for supervisors should be done by involvement in the production/processing crew for at least 6 months by doubling the functions of platform supervisor and production foreman. Foremen/Supervisors with theoretical education but no practical experience may be attached to their experienced colleague. After 6 months, these trainees should take over the responsibility of the second shift on the platform while the other shift will be under the responsibility of an experienced person.

Workover of the producing wells has to be done from time to time by a special workover rig crew. The special know-how is with the workover foreman, while the other personnel has to meet qualifications of drilling rig people. Workover requires a long time of experience and practice. Training for workover should be performed mainly in a practical way. Additionally theoretical courses may be foreseen which treat items given in Appendix A-4-5.

4.4 Construction

Construction work in yards for offshore structures and modules requires the following disciplines and skills:

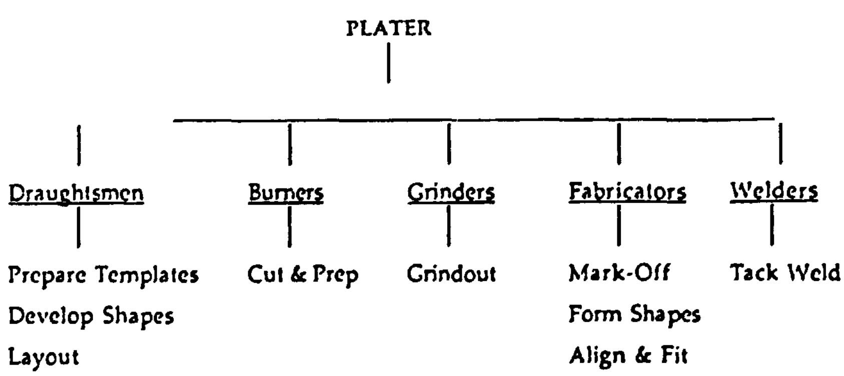
DISCIPLINE	TRADE SKILLS
Structural	- Burners - Grinders - Platers/Fabricators - Welders
Piping/Mechanical	- Pipe Fitters - Pipe Welders - Mechanical Fitters
Electrical/Instrumentation	- Electrical/Instr. Technician
Misc. Outfitting	- Outfitting Trades
Services	- Riggers/Scaffolding - Crane Operators - Plant Operators - Mechanics

In the developed countries, e.g. the United Kingdom, it has been the practice over the last 100 years that the training of craft skills took the form of an apprenticeship. The period of training being up to five years during this time all relevant skills and practices associated with the particular craft were mastered, e.g. a shipyard plater would be able to do the following:

- read a drawing,
- mark-off from drawings and templates,
- develop shapes,
- flame cut and prep,
- form shapes, and
- align and tack weld.

With the advent of the offshore construction industry it was necessary to establish construction yards on Green Field Sites located in remote areas of Scotland. Although these locations had an infrastructure that could support the new yards the local working population did not possess the required skills. To overcome this problem some yards set-up their own training schools with full-time instructors. Initially the type and content of training programs were completely different from the traditional apprenticeship methods in so much as they concentrated on individual elements within a traditional craft/trade and reduced the training period to approximately three months.

The traditional plater's scope of work and training would now be broken down into trade elements as follows:



By adopting this method of training the trainee can be trained very quickly to carry out specific tasks within the overall job function.

For typical examples of Training Programs see Appendix A-4-6.

4.5 Diving

For the diving standards for offshore divers the EDTC-European Diving Technology Committee has established recommendations. These standards concern the following types of divers and their assistance personnel:

- Offshore service orientated divers (air divers)

  This type of diver should be trained in all aspects of air diving up to 50 m waterdepth. He should be trained in the safe use of a range of hand tools and hand held power tools and equipment. He also should be given experience in compression chamber operations and surface decompression routines as well as wet bell techniques.

- Mixed gas diver

  This most highly operational diver must have considerably experience as an offshore service orientated diver. His training should include diving to a minimum depth of 100 m in open water with bell lockouts and saturation diving techniques.

- Life support technician

  The life support technician must not necessarily be a diver. He will be working especially on gas mixing, gas analysis, life support equipment, routine maintenance, recognition and monitoring of illnesses and sicknesses which may affect the diver.

Education of life supporting mission may begin with a theoretical training course. After working for a minimum of 200 days as an assistant life supporting technician he may be promoted to life supporting technician.

- <u>Life support supervisor</u>

The life support supervisor is a very experienced life support technician who has worked 200 days as life support technician and has a minimum experience of four years in the diving industry.

- <u>Diving supervisor</u>

The diving supervisor is a key person in any diving operation. He should be able to control the whole operation, ranging from simple underwater intervention tasks in very shallow water to highly sophisticated diving operations in very deep water.

4.6 Engineering

The offshore business requires essentially the following disciplines and engineering skills:

DISCIPLINE	ENGINEERING SKILLS
Structural	- Design Engineers
Piping	- Field Engineers
Electrical/Instrumentation	- Draughtsmen
H.V.A.C.	- Materials Engineers
Accomodation Outfitting	
Surface Protection	
Quality Assurance Control	- Dim. Control Engineers
	- Welding Engineers
	- Weight Control Engineers
	- QA/QC Inspectors
Misc. Services	- Heavy Lift Engineer
	- Load Out Engineer
	- Temporary Works Engineer
	- Material Control
Production Engineering	- Production Engineers
	- Schedule Planning
	- Methods Engineers
	- Systems Analysers
Information Technology	- Programmers
	- Hardware Engineers
	- Data Processing

The engineers to be trained from the developing country shall have in any case as prequalification a degree in petroleum engineering, mechanical, electrical or civil engineering from a technical university or a comparable institution. They also should have at least three years practical experience in their profession. Good knowledge in English language is indispensable.

Furthermore they should have in course of their studies some offshore-related lessons as

- Wave mechanics
- Wave forecasting
- Dynamic response of fixed and floating platforms
- Fatigue analysis
- Economic evaluation of offshore projects
- Risk analysis

The training on the job should be done in cooperation with experienced colleagues from a foreign country by involvement in a contracted project. This practical work should be accompanied by special lectures which should be given by university or company experts on problems which are important e.g.

- calculation methods for structures or decks
- production/process equipment selection and design
- welding procedures and techniques

4.7 Project Management

Project management is a special type of multidiscipline engineering which contains e.g. planning, estimating, project control, progress control, post control etc.

A very special example for a training program in project management is shown in Appendix A-4-7. It demonstrates, however, the variety of subjects and the great details which need to be covered by such a program.

Personnel for project management should be recruited from engineers trained as described in 4.3 who have yet some experience on the job. They should be included in the Project Management Organization and at first specialized in a specific project management activity as planning etc.

Training should be supplemented by employing outside consultants to give inhouse training seminars e.g. in computerized planning systems, cost engineering, contract management, project control and other project management functions.

CHAPTER A-5

DESIGN OF A MARINE TECHNOLOGY INFORMATION AND DOCUMENTATION SYSTEM

5. Design of a Marine Technology Information and Documentation System

5.1 The German Example

Twenty years ago, the field of information technology and electronic documentation was at a very early stage both in the Federal Republic of Germany and in other European countries, and technical possibilities such as on-line access to information services via low price terminals using dial-up links to international data networks appeared to lie in the distant future. At the same time, a rapid increase of industrial activity both in Germany and elsewhere in Europe in the field of marine technology was expected as a result of recent developments in connection with manganese nodules, mineral muds and offshore hydrocarbons. For this reason, a marine technology information system (MARINELINE) was initiated in Germany to decade or so ago with considerable help from several large industrial companies and with the support of research authorities. The purpose of the information system was:

- to facilitate the exchange of information and documentation in all areas of marine research and marine technology;

- to offer a computer-based information system;

- to cooperate both nationally and internationally with other information and documentation suppliers in related technical fields.

However, since this information system was first initiated, the development of both information technology and marine technology contradicted all expections: on the one hand, the field of information technology and electronic documentation developed extremely rapidly - during the seventies largely in the political sector but later in technical and commercial sectors - whereas the expansion of marine technology lay behind the predictions with the exception on the offshore field for oil and gas.

Accordingly, the German industry and scientific institutes working in the field of marine research lost interest in a computer-based information system. Information was obtained using traditional methods. In the meantime, various other highly effective information and data banks have become available in other countries to satisfy the information requirements of institutes active in the field of marine research. At the same time, interest in a national German system has receded.

In this situation, and following discussions with the official sponsors, the subject areas covered by the national system have been re-defined as follows:

- Offshore technology (Platforms and Pipelines),
- Recovery of marine raw materials,
- Marine research and development,
- Diving technology, and
- Selected themes concerning sea water desalination.

Since 1975, the national information system has been operated by the Bundesanstalt für Geowissenschaften und

Rohstoffe (BGR) (Federal Institute for Geosciences and Natural Resources), in Hannover and hosted at INKA in Karlsruhe; the system was transferred to FIZ Technik, Frankfurt in 1988.

Since operation of the system by the BGR, it was hoped to enlist international cooperation to integrate information in the field of marine technology into a common databank system. The most imporatant partners appear to be the operators of the databanks "ASFA" and "Ocenanic Abstracts". Two additional operators should be included to fill in other subject areas: GEOREF and NOROIL.

5.2 Databank Systems

5.2.1 General Aspects

Most of these databanks have been available for a number of years as on-line databanks on internationally accessible host computers.

The areas of information which are relevant to marine technology and should be covered by the national system are:

- technical methods of marine mining for recovering metals contained in manganes nodules, mineral muds and mineral deposits in coastal waters;

- components and systems for the production of oil and natural gas, in particular equipment designed for use in deep waters and under extreme environmental conditions, for example at locations north of the 62nd latitude;

- equipment to produce oil and gas reservoirs in marginal fields, i.e. fields which can only be produced economically using special techniques (advanced recovery etc.);
- floating and manufacturing plants, including automatic sub-sea completion and production facilities;

- new methods of shipbuilding aimed at highly reliable and high-value freight and other ships for specialized tasks.

The following lists the mosts important subject areas in the five above-mentioned databanks:

5.2.2 The Databank ASFA

Aquatic Sciences and Fisheries Abstracts.

Producer: FAO/IOC/UN.

File Size: = 76,000 records

Time span: 1978 to present day

Subject coverage:

* Aquaculture
* Aquatic Biology
* Biological Ocenaography
* Chemical Ocenaography
* Coastal Zone Management
* Commerce, Trade and Economics
* Ecology and Ecosystems
* Environmental Studies
* Fisheries (Harvesting, Processing and Marketing)
* Fish Products
* Geological Ocenaography
* Law of the Sea
* Limnology
* Man in the Sea - Diving
* Marine Biology
* Marine Policy
* Marine Pollution
* Marine Technology
* Marine Meteorology and Climatology
* Ocean Engineering
* Ocean Resources (Potable Water, Chemicals, Minerals, Oil, Gas, Energy)
* Offshore Structures
* Physical Oceanography
* Underwater Acoustics and Optics
* Vessels, Unterwater Vehicles and Buoys
* Water Pollution

ASFA citations contain bibliographic information, an abstract, descriptors and identifiers.

5.2.3 The Databank Oceanic Abstracts

Producer: Cambridge Scientific Abstracts, US.

File Size: 182,000 records

Time span: 1964 to present day

Subject coverage:

* Marine Biology and Biological Oceanography
* Physical and Chemical Ocenaography and Meteorology
* Geology, Geophysics and Geochemistry
* Marine Pollution
* Living and Non-living Marine Resources
* Ships and Shipping
* Engineering and Materials

Oceanic Abstracts citations contain bibliographic information, an abstract, descriptors and identifiers.

5.2.4 The Information System MARINELINE

Producer: Federal Institute of Geosciences and Natural Resources
Federal Republic of Germany.

File Size: 20,000 records

Time span: 1972 to present day

Subject coverage:

* Desalination
* Earth Sciences
* Exploitation Technology
* Measuring practices
* Navigation
* Platform construction
* Materials technology
* Environmental Protection
* Diving Technology
* Offshore Engineering

* Hydrology
* Marine Geology
* Mathematical Geology
* Mineralogy
* Mining Geology
* Palaeontology
* Petrology
* Seismology
* Stratigraphy
* Structural Geology
* Surficial Geology

5.2.5 Information System GEOREF

GEOREF citations contain bibliographic information and descriptors; abstracts are available in some cases.

5.2.6 Information System INFOIL

Producer: Cooperation between the Department of Energy, U.K. and the Norwegian Petroleum Directorate, Norway

File Size: = 2,500 records

Time Span: 1978 to present day

Subject coverage:

* Administration, Organization, Education
* Petroleum generally, Social impact, Politics, Conventional Industry
* Economy, Petroleum Economy
* Jurisdiction, Law, Regulations
* Petroleum Energy and other Energy Sources, Natural Resources
* Environmental Protection, Safety and Control/Inspection
* Theoretical Matter, Research, Mathematics
* Regional Geology
* Sedimentology
* Palaeontology
* Petroleum Geology and General Geology
* Geophysics, Marine Seismology
* Geotechnics

* Petroleum Recovery Technology, Drilling, Reservoir Techniques, Logging
* Exploitation, Production and Transportation of Oil and Gas
* Environmental Load, Marine Technology, Underwater Technology, Ships, Vessels, Diving
* Petroleum Plants and Facilities, Offshore/Onshore Plants
* Goods, Supply Services and Operations
* Petrochemical Industry, Refineries
* Auxiliary Technical Disciplines
* Work Environment

INFOIL citations contain bibliographic information and descriptors; abstracts are available in some cases.

A few other subject areas loosely related to marine technology, can be found in the databanks COMPENDEX, NTIS and DOMA etc.

5.3 Type of Information and Communication

5.3.1 General Aspects

All of the five databanks described in detail above are in the English language. The types of information sources are also identical for all five databanks. The main types are newspaper articles, books, government reports, technical reports, patents, theses, university papers, conference reports, reports of meetings, annual reports and, in part, reports from private companies.

Just as twenty years ago, it is still true today that if it is hoped to develop a new common information and documentation system in the field of marine technology, it is first necessary to get the cooperation of the above five main databank operators. Successful cooperation appears possible if the aimes of the new system are clearly defined from the start. The only realistic aim of a new marine technology databank appears to be the production of printed services or technical bibliographics which can then be made available to particular user groups in developing countries. Additionally, expert reports, which discuss or solve specific problems, could be prepared by specialists for specific technical themes. A cooperation with the sole aim of installing a new on-line databank would most likely be rejected for reasons of commerical competition.

A new on-line databank consisting of parts of the existing on-line databanks also appears to be unrealizable.

Cooperation can only be achieved if the already functioning systems remain unchanged. Changes to existing thesaurii, worksheets or indexing guidelines cannot be accepted.

5.3.2 How to integrate with INTIB

A working group should be formed to convert the data from the cooperation partners into the already defined INTIB data format. This would take place using a computer program and involve no changes in the information content. The cooperation partners would send their data on magnetic tape together with detailed data format descriptions on the conversion point. The copyright to the converted data remains the property of the original operator. An agreement is reached that data is solely used to produce printed services or literature reports, and will not be made available on-line to third parties.

This proposal does not imply a significant investment of money or time by the individual cooperation partners and is thus acceptable.

The working group should consist of specialists from the field of computing and may also include geologists, and experts in the fields of oil, natural gas and marine technology.

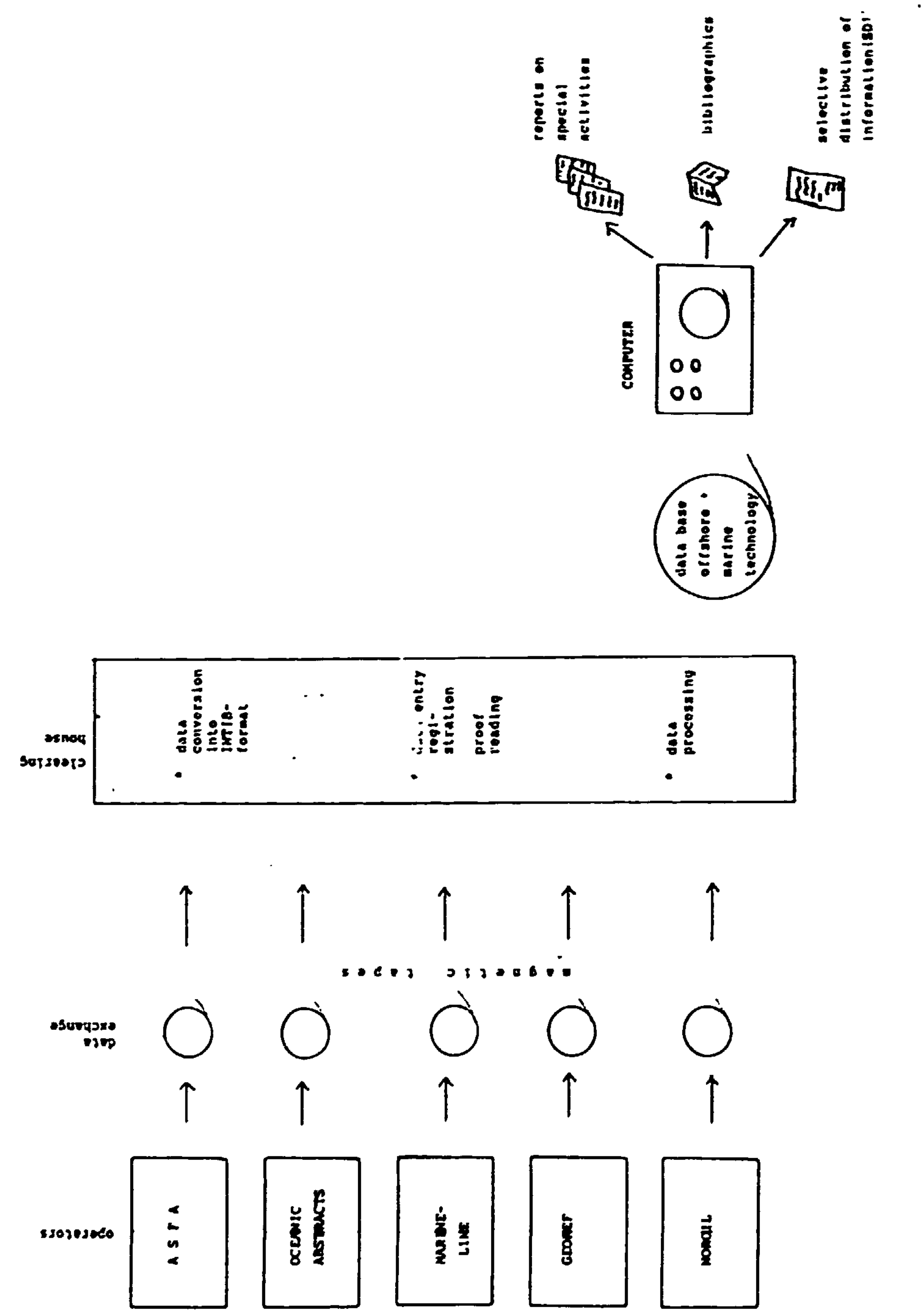
If such a cooperation cannot be achieved, the final possibility is that of downloading. Since the five databases are on-line systems which can be entered by anyone via databank gateway operators and international data networks, an expert group can manually offload publications on particular themes. Using personal computers or larger computers, the on-line data from various hosts can be re-combined into a new common machine-readable system. Listings on special themes, bibliography lists or the preparation of reports are then possible offline at a later date. This type of servie (electronic literature researching) is already offered by information brokers and other groups; as an example information broking in the field of marine technology is available from the BGR.

5.3.3 Addresses of the most important databank operators:

ASFA	Data and Statistics Service Food and Agricultural Organization (FAO), United Nations Via delle Terme di Caracella 00100 Rome Italy
Oceanic Abstracts	Database Services Cambridge Scientific Abstracts 5161 River Road Bethesda, MD 20816 USA
MARINELINE	Federal Institue for Geosciences and Natural Resources (BGR) POB 51 01 53 Stilleweg 2 3000 Hannover 51 Federal Republic of Germany
GEOREF	Georef American Geological Institute 4220 King Street Alexandria VA 22302 USA

NOROIL	Department of Engergy Petroleum Engineering Division Thames House South Millbank London SW1P 4QJ Great Britain or Norwegian Petroleum Directorate Lagardsveien 80 POB 600 4001 Stavanger Norway

Inhouse database on offshore and marine technology



PART B

ELABORATION AND MATERIALS

CHAPTERS

CHAPTER B-1

THE RELATIVE IMPORTANCE OF OFFSHORE HYDROCARBONS AND THEIR DISTRIBUTION IN THE WORLD

SECTIONS

1. The Relative Importance of Offshore Hydrocarbons and their Distribution in the World

1.1 Distribution of World Offshore Oil & Gas

Crude oil or natural gas will always be found in sedimentary source rocks which originally contained a significant abundance of plant or animal remains or organic material. The process of forming oil and gas, as most of us are aware, was complex. It is not reproducible in laboratories and took place since Cambrian time millions of years ago. Oil and gas accumulated in various regions around the world during different geologic eras and their formation was a result of environmental conditions.

In order to recover oil and gas on an economic basis they must be concentrated in porous sands, limestones or fractured rocks - all in reservoirs. This movement and entrapment of oil and gas in reservoirs enables us to discover, evaluate, drill and produce both on land and offshore areas. Importantly, there appears to be significant concentrations of oil and gas in many cases, in offshore areas where drilling and production can take place on an economic basis. A good example is U.S. Gulf of Mexico where there is a significant concentration of natural gas in relativeley shallow waters and an environment which is relatively calm.

By definition a hydrocarbon reservoir is an underground formation which must be porous, permeable and contain individual or separate accumulations of producible oil and/or gas. These reservoirs are most often classified as oil or gas reservoirs by some regulatory agency (like the United Kingdom's Department of Energy or Norway's Ministry

of Petroleum and Energy). The reservoirs are almost always confined by impermeable rock or water barriers and most often characterized by a single natural pressure system.
An oil or gas field may consist of one single reservoir or several reservoirs which are all grouped or related due to a common geological structural feature or staratigraphic conditions. There may be two or more reservoirs in the same field which may be separated by the intervention of impermeable strata (vertically) or they could be separate reservoirs on the basis of lateral separation due to geologic barriers.

New fields are defined as new areas of oil and gas concentration where production is controlled overall by separate conditions - geological features or stratigraphic conditions. Field extensions are usually new descoveries which extend a presently known field.

The principal hydrocarbons for which we search in the energy business are crude oil and natural gas. Crude oil exists in liquid phase in underground reservoirs and will remain liquid at atmospheric pressure. The basic volumetric measurement for crude oil is a barrel (or 42 standard U.S. gallons) respectively a cubic meter.

Natural gas is a mixture of hydrocarbon compounds which exist in the gaseous phase or in solution with oil in underground reservoirs. There are three classifications of natural gas:

* Associated Gas - Natural gas which is in contact with crude oil in the reservoir, sometimes known as gas-cap gas.
* Dissolved Gas - In solution with crude oil in the reservoir at reservoir conditions.

* Non-Associated Gas - Free natural gas which is not in contact with crude oil in a reservoir.

Reserves of hydrocarbons and the definition is important in the exploration, drilling and production process. A proper, scientific evaluation of reserves is important to the overall economics of field and reservoir development and the determination of operating companies to go forward in their search for hydrocarbons or further investment in a certain area.

Total reserves or reserves in place is the total quantity of hydrocarbons in a certain reservoir. Only a fraction of this can be recovered technically and/or economically.

Proven or recoverable reserves are the estimated quantities which engineering data and geological information indicate can be recoverable in future years with reasonable certainty from known reservoirs and under economic and operating conditions as we know them today. Crude oil and gas reservoirs are evaluated according to drilling or actual production tests and are delineated by seismic data, wireline logging data and drilling infomation as to the extent of such reservoirs.

Crude oil which can be produced through enhanced recovery on an economic basis, utilizing techniques such as waterflood or steamflood will be included in this "proved" classification upon completion of successful pilot project testing, operations of certain programs or evaluative proof by engineering or scientific means. Reported reserves for crude oil do not include natural gas liquids or any other oil whose production may be questioned or doubtful due to uncertainty of reservoir characteristics, geology or overall economics.

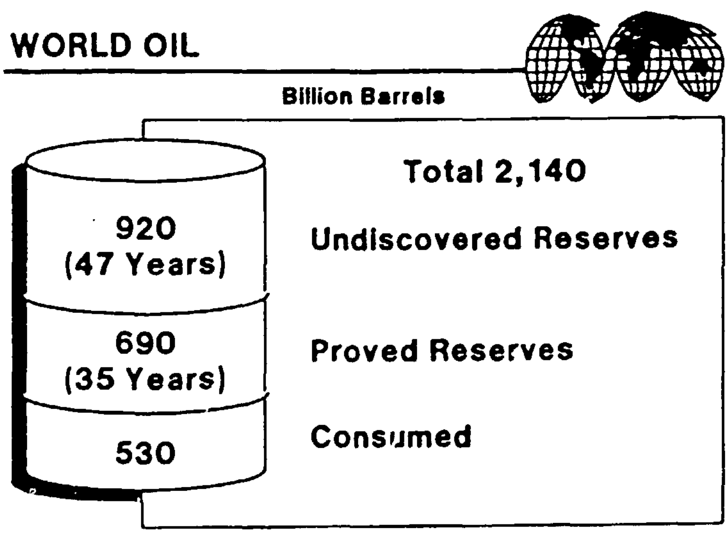
Natural gas reserve figures include the recoverable natural gas, non-associated gas and associated-dissolved gas. Not included in natural gas reserves are the gas-equivalents of natural gas liquids which are expected to be recovered from reservoir natural gas, any natural gas which is being held in underground storage or nonhydrocarbon gases such as CO_2.

1.2 Oil and Gas Reserves

1.2.1 Worldwide Reserves

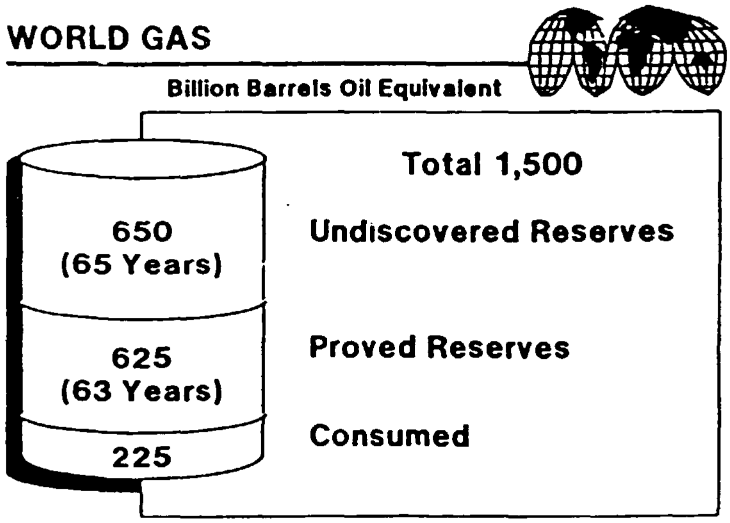
Information available from various international sources describing the extent of oil and gas reserves ranges widely in quality. For example, there is significant data available for the U.S. Gulf of Mexico, the U.K. and Norwegian North Sea areas. Conversely, one has difficulty in obtaining good data for Mexican offshore reserves or certain Southeast Asian countries. As a result the data for world offshore operation will vary widely in accuracy.

In a 1985 paper for an international energy seminar, the oil company CONOCO estimated the proven world reserves for oil to 690 billion barrels which would last for 35 years at the present rate of consumption:



Source: CONOCO

As far as gas is concerned, CONOCO believes in 625 billion barrel of oil equivalent, corresponding to 47 years at today's consumption rate.



Source: CONOCO

CONOCO is expecting another 1570 billion barrel of oil equivalent as "undiscovered reserves" assuming that the present relationship between price and development cost will be roughly maintained. All numbers for undiscovered reserves are, of course, highly speculative and should only be regarded as orders of magnitude for long term oil and gas activities.

TOTAL UNDISCOVERED RESERVES

Billion Barrels Oil Equivalent

Rank	Country	Oil & Gas Total	Rank	Country	Oil & Gas Total
1	U.S.S.R.	311	9	Indonesia	48
2	S. Arabia	182	10	Canada	46
3	U.S.A.	146	11	Venezuela	35
4	Iran	115	12	Algeria	30
5	Norway	90	13	U.K.	28
6	Mexico	62	14	Libya	28
7	China	62	15	Abu Dhabi	26
8	Iraq	56		Sub-total	1,265
				Others	305
				Total	1,570

Source: CONOCO

The information provided in a special report by Warlick & Ass. in 1987 is current and provides the best estimates of leading energy agencies, statistical databases, energy industry publisher, Gulf Publishing Co. and Warlick & Associates, Inc. In some instances one will review certain estimates which heretofore have been unavailable to the public.

WORLD RESERVES OIL & GAS
ON-/OFFSHORE per Jan. 1. 1987 (1)

Region	Cruide Oil		Natural Gas	
	Volume (Million BBL)	Percent of Total	Volume (Billion CF)	Percent of Total
North America	31,695	4,4%	289,686	3,4%
Latin America	119,470	16,7	223,751	6,5
Western Europe	18,923	2,6	205,103	5,9
Eastern Bloc	62,738	8,7	1.270,317	37,3
Middle East	387,076	54,2	992,239	29,1
Africa	56,982	7,9	206,767	6,0
Far East/Oceania	39,604	5,5	236,157	6,8
World Total	**716,489**	**100,0%**	**3.424,020**	**100,0%**

(1) Excludes natural gas liquids

Source: Gulf Publishing Company, U.S. Department of Energy, Warlick & Associates, Inc.

A special note: World oil and gas reserve estimates are in a state of change. The Oil & Gas Journal recently announced new reserve figures for world regions which are decidedly higher than those provided in this report. In summer 1988, World Oil will publish new reserve figures for the world which will reportedly be higher also.

1.2.2 Offshore Oil and Gas Reserves

Information sources for offshore oil and gas reserves differ in their definition and ulitimate evaluation of crude oil and gas reserve items. In summary though, the estimates shown in the following tables are relatively current and accurate according to selected sources contacted. The reserve estimates are current effective January 1, 1987 and as one will see, Latin America and the Middle East hold almost three-forth of the world's offshore oil reserves. In Latin America the principal offshore crude reserves are in Mexico and Venezuela. Arabian Gulf production from various countries account for a sizable share of crude oil. Western Europe has a remarkable 84% of its oil reserves in offshore waters.

OFFSHORE RESERVES CRUDE OIL

Region	Volume (Million BBL)	Percent of Total	Offshore Oil Share of Region Total Oil Reserves (%) (1)
North America	3,600	2,0	11,3
Latin America	60,930	33,8	51,0
Western Europe	15,896	8,8	84,0
Eastern Bloc	627	0,3	1,0
Middle East	73,544	40,7	19,0
Africa	15,955	8,8	28,0
Far East/Oceania	10,297	5,7	26,0
World Total	**180,849**	**100,0**	**25,2**

(1) Offshore oil reserves in each region as a percent of that region's total oil reserves (land and offshore).
Example: Western Europe's offshore oil reserves comprise 84.0% of that region's total oil reserves on land and offshore

Source: Gulf Publishing Company, Offshore Magazine, Warlick & Associates, Inc.

For an evaluation of natural gas reserves the picture changes somewhat by region since there are major producing natural gas reservoirs present in some regions and perhaps minimal natural gas in others. As the following table indicates, Western Europe and the Far East/Oceania regions account for half the world's natural gas reserves in offshore locations. There are significant gas fields in the southern U.K. and in Norwegian waters while Indonesia and Malaysia are sizable gas producers in the Far East/Oceania region.

OFFSHORE RESERVES NATURAL GAS

Region	Volume (Billion CF)	Percent of Total	Offshore Gas Share of Region Total Gas Reserves (%)
North America	38,000	8,1	13,1
Latin America	82,787	17,8	36,9
Western Europe	125,112	26,9	60,9
Eastern Bloc	12,703	2,7	0,9
Middle East	59,534	12,7	5,9
Africa	35,150	7,5	16,9
Far East/Oceania	113,355	24,3	47,9
World Total	**466,641**	**100,0%**	**13,6%**

Source: Gulf Publishing Co., U.S. Department of Energy, Offshore Magazine, Warlick & Associates, Inc.

Several comments about natural gas reserves: Again, Western Europe has almost 61% of its gas reserves in offshore locations (as opposed to approximately 40% of its reserves on land). Far East/Oceania has sizable gas reserves offshore, 47,9%. In North America the Gulf of Mexico is principally a gas-producing area. But there are sizable natural gas reserves on land in the U.S. and in Canada. Therefore offshore gas reserves make up only 13,1% of total North American gas reserves. The Pacific Coast offshore areas along the state of California up to Alaska are oil-bearing reservoirs.

If one combines the reserves of offshore oil and gas into equivalent barrels of oil it provides a summary of world offshore hydrocarbons and their distribution according to regions worldwide. The next table has coverted offshore gas reserves to equivalent barrels of oil providing the estimate that offshore reserves total 264 billion bbls of oil. (1.000 cu.ft. natural gas equals 0.1785 barrel of oil equivalent). According to definition, these hydrocarbons are recoverable via today's technology and economics.

Further, if one will rank order the regions according to size of offshore oil and gas reserves then the Middle East, Latin America and Western Europe are ranked as 1-2-3 and account for three-fourth of the world's offshore oil and gas reserves.

COMBINED RESERVES OF OFFSHORE OIL AND GAS

Region	Offshore Oil Reserves (Million BBL)	Offshore Gas Reserves (Billion CF)	Combined Oil and Gas: Volume (Million BBL Equivalent)	Combined Oil and Gas: Percent of Total
North America	3,600	38,000	10,383	3,9 %
Latin America	60,930	82,787	75,707	28,8
Western Europe	15,896	125,112	38,228	14,4
Eastern Bloc	627	12,703	2,894	1,0
Middle East	73,544	59,534	84,170	32,0
Africa	15,955	35,150	22,229	8,4
Far East/Oceania	10,297	113,355	30,530	11,5
World Total	180,849	466,641	264,141	100,0 %

Source: Gulf Publishing Co., U.S. Department of Energy, Offshore Magazine, Warlick & Associates, Inc.

1.3 Oil and Gas Production

1.3.1 Worldwide

The production of oil and gas from land and offshore locations around the world is shown, by region, in the next table providing the 1986 production, the most recent year where offshore-only data is presently available. One should note that 1987 annual crude oil production declined 2,6% while natural gas production declined only slightly.

The major volumes of crude oil production occur in the Middle East, Eastern Bloc nations and North America. For natural gas production, Eastern Bloc countries and the USSR plus North America combined for 70% of the world's natural gas produced from reservoirs on land and from offshore locations.

WORLD PRODUCTION OF OIL AND GAS
FOR LAND AND OFFSHORE
(Daily Averages, 1986, Includes Condensate)

Region	Crude Oil		Natural Gas	
	Volume (Thousand BBL/DA)	Percent of Total	Volume (Million CF/DA)	Percent of Total
North America	10,179	17,4	53,507	31,2
Latin America	6,348	10,9	7,671	4,5
Western Europe	3,766	6,5	18,274	10,6
Eastern Bloc	12,697	21,7	67,780	39,5
Middle East	14,186	24,3	7,123	4,2
Africa	5,241	9,0	5,151	3,0
Far East/Oceania	5,966	10,2	12,082	7,0
World Total	58,383	100,0	171,588	100,0

Source: Gulf Publishing Company, U.S. Department of Energy, Offshore Magazine, Warlick & Associates, Inc.

1.3.2 Offshore Oil and Gas Production

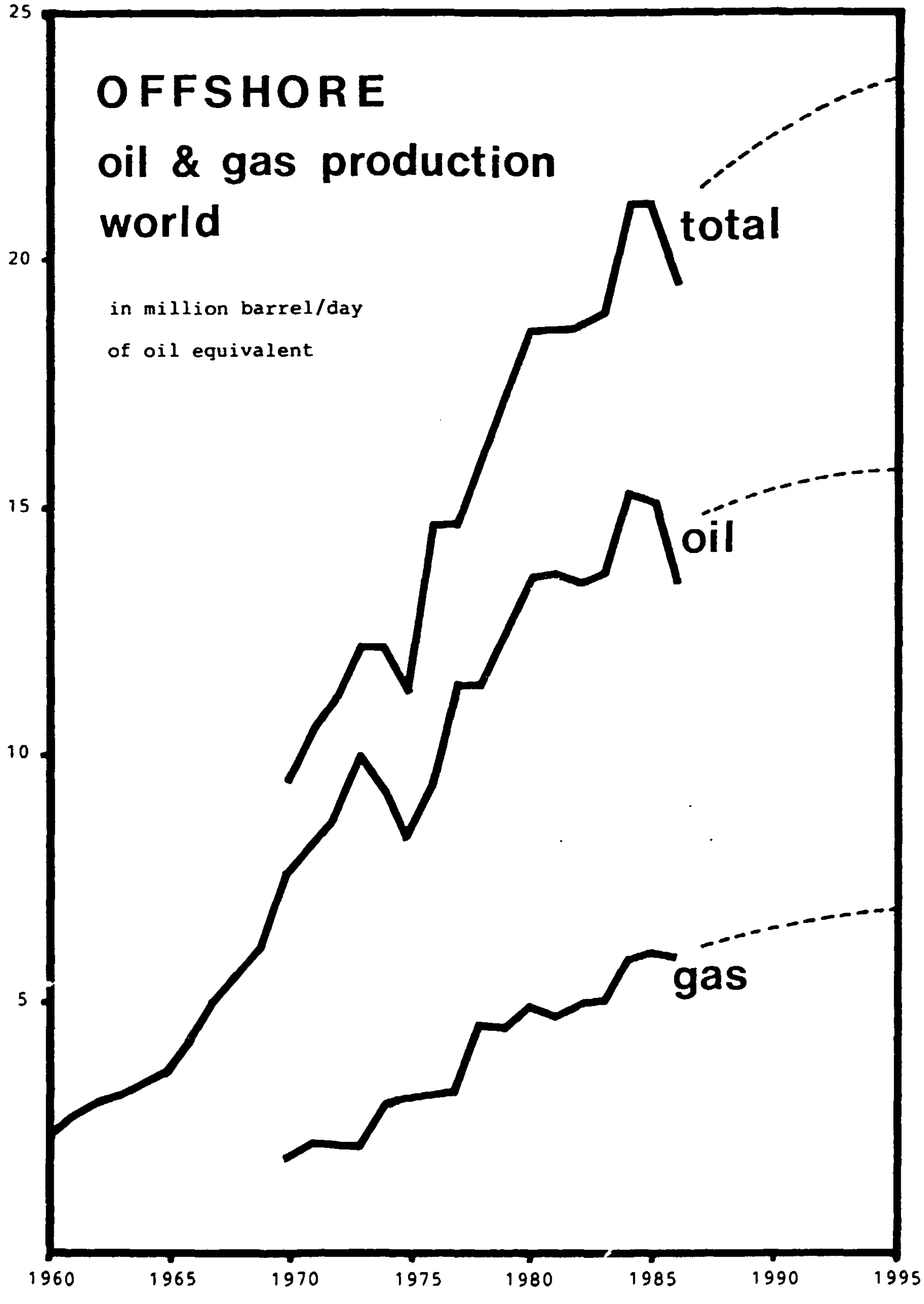
Production of oil and gas from offshore fields has increased considerably in the last 20 to 30 years. 1985 totalled to more than 15 million barrel per day of oil and 34 billion cubic feet per day of gas. Compared with 10 years ago this is an increase to close to 100%.

On the other hand, the offshore production was strongly effected by the first oil price crises in 1973/74 and the slump of oil prices in 1986. The 1986 offshore oil production dropped by some 10% from 1985, the gas production by approx. 1%.

The share of offshore oil & gas out of the total world production increased from 14,5% in 1970 to 25,3% in 1985 but dropped to 22,4% in 1986.

1987 figures are not yet available for offshore production of hydrocarbons.

The post development and a mathematical method for a forecast to 1995 is shown on the next two pages of this report:


OFFSHORE
oil & gas production
world
in million barrel/day
of oil equivalent
total
oil
gas
25
20
15
10
5
1960
1965
1970
1975
1980
1985
1990
1995

World/Offshore Oil and Gas Production

Year	Oil			Gas			Oil & Gas		
	World Total 1000 bpd	Offshore 1000 bpd	%	World Total Mio cuftd	Offshore Mio cuftd	%	World Total 1000 BOE/d	Offshore 1000 BOE/d	%
1960	22,010	2,200	10,0						
1961	23,430	2,700	11,5						
1962	25,380	2,950	11,6						
1963	27,200	3,100	11,4						
1964	29,410	3,300	11,2						
1965	31,380	3,600	11,5						
1966	34,340	4,200	12,2						
1967	35,660	5,000	14,0						
1968	40,080	5,500	13,7						
1969	43,290	6,195	14,3						
1970	46,840	7,604	16,2	105,070	10,689	10,2	65,589	9,511	14,5
1971	49,470	8,232	16,6	111,750	12,599	11,3	69,411	10,480	15,1
1972	49,698	8,859	17,8	118,034	12,564	10,6	70,760	11,101	15,7
1973	55,213	10,067	18,2	125,870	11,882	9,4	77,674	12,187	15,7
1974	56,772	9,269	16,3	128,770	16,395	12,7	79,700	12,195	15,3
1975	53,850	8,278	15,4	126,930	17,142	13,5	76,500	11,337	14,8
1976	57,210	9,432	16,5	131,680	29,733	22,6	80,708	14,738	18,3
1977	56,567	11,437	20,2	137,190	18,286	13,3	81,048	14,700	18,1
1978	60,337	11,481	19,0	141,450	26,052	18,4	85,578	16,130	18,8
1979	62,768	12,647	20,1	145,030	25,668	17,7	88,648	17,227	19,4
1980	59,812	13,687	22,9	145,100	27,838	19,2	85,704	18,654	21,8
1981	55,886	13,664	24,4	149,580	27,630	18,5	82,578	18,594	22,5
1982	53,191	13,541	25,4	150,560	28,292	18,8	80,058	18,590	23,2
1983	53,259	13,791	25,9	151,702	28,384	18,7	80,329	18,856	23,5
1984	54,090	15,312	28,3	163,306	33,325	20,3	83,331	21,259	25,5
1985	53,391	15,128	28,3	170,048	34,113	20,1	83,735	21,215	25,3
1986	55,801	13,479	24,2	174,758	33,832	19,4	86,986	19,516	22,4
Forecast									
1990		15,369			36,886			22,572	
1995		15,725			38,635			23,717	

Offshore gas production figures from 1960 to 1969 are not available

1 bpd (Barrel per day) = 49,3 tpy (metric tons per year)
1 cuftd (cubicfeet per day) = 10,34 cum/y (cubic meters per year)
1 BOE/d (Barrel oil equivalent per day) = 5,604 cuftd natural gas

Producing offshore wells are much more complex and involved than those on land. This is due primarily to the fact that wellheads and equipment associated with production are on platforms or in some cases oil or gas will be produced from subsea completions.

Fortunately in many offshore fields, reservoirs have sufficient downhole energy to produce themselves. That is, there may be no artificial lift systems required to produce oil or gas. Of course, produced liquids and gas must be pipelined to shore-base facilities, requiring pumps and compressors.

An additional consideration for offshore production is co-produced fluids and impurities which must be handled by surface treatment equipment. Water produced with oil and gas must also be treated in some way on the production platform, requiring treatment equipment. Additionally oil and gas must be separated from each other for ultimate disposition by pipeline. One additional point: Some reservoirs will need assistance in production which in most cases will mean waterflood. An additional technique utilized offshore gas-lift where produced gas is utilized to help to enhance the production of reservoir fluids.

Due to the tremendous costs to explore, drill , install production platforms and pipelines, production of oil and gas offshore is usually a continuous operation and is not interrupted for any reason. Typical offshore reservoirs may produce for twenty years, thirty years or even longer. Therefore it is unusual to shut-in an offshore platform except in extreme cases. Production may be cut back or slowed due to market conditions, maintenance reasons or otherwise but general operating environment for offshore production means a rather constant level of activity in offshore environments around the world.

Offshore Production by Regions

More specific data for offshore production by region is shown in the next tables.

In 1986 there were almost 13,5 million barrels of daily oil production from offshore locations. This accounts for 24% of the world's crude oil production from both land and offshore locations. We believe that offshore production has become a somewhat smaller share of total world production in 1986 (and probably in 1987) because significant fields on land in OPEC countries have been overproduced - at least during this period of time.

Further evaluation indicates that in each of two regions, Latin America and Western Europe, offshore oil production as a share of total oil production is approximately 24%, much higher than in other regions, except for the Middle East.

OFFSHORE PRODUCTION OF CRUDE OIL BY REGIONS (DAILY AVERAGES 1986)

Region	Production Volume (Million BBL (DA)	Percent of Total	Offshore Oil Share of Region Total Oil Production (%) (1)
North America	1,257	9,3	12,3
Latin America	3,232	24,0	50,9
Western Europe	3,171	23,6	84,2
Eastern Bloc	165	1,2	1,3
Middle East	2,651	19,7	18,7
Africa	1,445	10,7	27,6
Far East/Oceania	1,557	11,5	26,1
World Total	13,478	100,0	23,0

(1) Offshore oil production in each region as a percent of that regions's total oil production (land and offshore).
Example: Western Europe's offshore oil production comprises 84,2% of that regions's total oil production on land and offshore.

Natural gas production from offshore fields accounts for approximately one-fifth of the world's total gas production from land and offshore locations according to the next table. It is interesting to note that in Western Europe slightly more than 61% of the regions's total gas production will come from offshore fields while almost 37% of Latin America's gas production will be produced offshore. The Far East/Oceania region is provided almost half its gas production from offshore fields.

It is further indicated that North America and Western Europe together account for over three-forths of world offshore gas production. These important fields lie in the U.S. Gulf of Mexico, the southern North Sea off the U.K. and The Netherlands and Norwegian waters.

OFFSHORE PRODUCTION OF NATURAL GAS
(DAILY AVERAGES 1986)

Region	Production Volume (Million CF/ DA)	Percent of Total	Offshore gas Share of Region Total Gas Production (%)
North America	12,100	35,1	22,6
Latin America	2,802	8,1	36,5
Western Europe	11,226	32,6	61,4
Eastern Bloc	1,400	1,1	2,1
Middle East	400	1,1	5,6
Africa	864	2,4	16,7
Far East/Oceania	5,790	16,7	47,9
World Total	34,582	100,0	20,1

Source: Gulf Publishing Company, U.S. Department of Energy, Offshore Magazine, Warlick & Associates, Inc.

In the next table the offshore gas production has been converted to oil equivalent barrels in order to review how each region stands in world offshore hydrocarbon production. Surprisingly Western Europe produces slightly more than one-forth of the world's hydrocarbons from offshore locations being the largest offshore producer in the world and followed by Latin America and North America.

COMBINED PRODUCTION OF OFFSHORE OIL AND GAS
DAILY AVERAGES, 1986

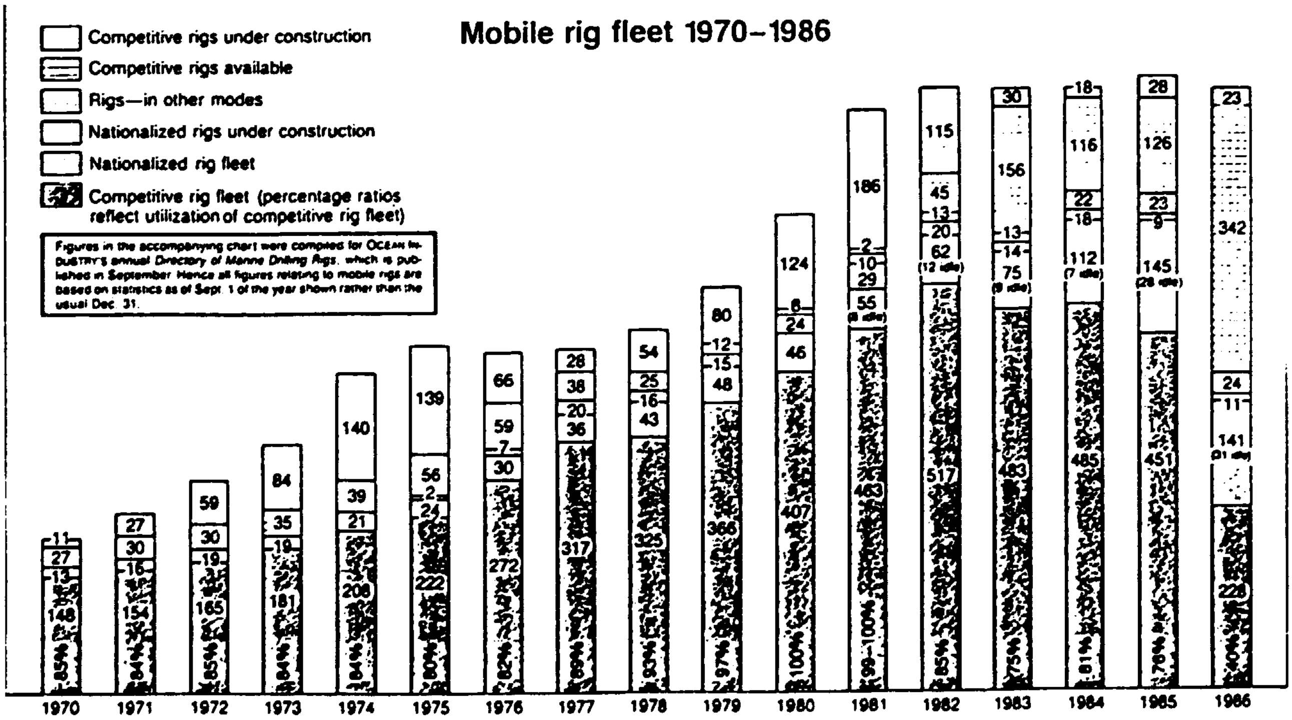
Region	Offshore Oil Production (Thousand BBL/DA)	Offshore Gas Production (Million CF/DA)	Combined Oil and Gas (1): Volume (Thousend BBL/DA) Oil Equivalent	Combined Oil and Gas (1): Percent of Total
North America	1,257	12,100	3,417	17,4
Latin America	3,232	2,802	3,732	19,0
Western Europe	3,717	11,226	5,175	26,4
Eastern Bloc	165	1,400	415	2,1
Middle East	2,651	400	2,722	13,9
Africa	1,445	864	1,599	8,1
Far East/Oceania	1,557	5,790	2,591	13,1
World Total	13,478	34,582	19,651	100,0

(1) Combined oil and gas Production. Basis: One thousand cubic feet of natural gas equals. 1785 barrels of oil.

1.4 Offshore Drilling / Drilling Rig Activity

In offshore waters drilling for oil and gas takes place in two phases - exploratory and development. The early phases or exploratory drilling is most often performed by floating drilling rigs such as drillships, semisubmersibles or even bottom-supported units such as a jackup rigs. Development drilling, or at least a major share of it, is handled by platform rigs after the platform has been placed in offshore waters. Also, cantilevered jackups can be utilized on small platforms for development drilling while floating drilling rigs may be used for development wells which will most often be subsea completions.

A good indicator of offshore trends will always be the number of active offshore mobile drilling rigs. Following a strong upward trend in 1982, the number of available (that meens idle) rigs grew damatically to the end of 1986.



OCEAN INDUSTRY, December 1986

This critical situation was followed in most areas by a steady improvement in fleet utilization since March, 1987. The rig utilization rate in the Gulf of Mexico e.g. touched in the fourth quarter 65% with over 150 rigs employed out of a total of 235.

The next table indicates that North American mobile offshore fleet activity is up almost 50% at this writing while Western Europe has increased 65% in the past year and Far East/Oceania increased 25%. Overall level of activity of the world's offshore drilling fleet is up 20.9% in January, 1988 compared to one year prior. We believe activity will continue to increase steadily in nearly all offshore regions around the world.

OFFSHORE MOBILE DRILLING FLEET
ACTIVE DRILLING RIGS

Region	January 1987	January 1988	Percent Change (%)
North America	98	146	48,9
Latin America	81	68	- 16,1
Western Europe	52	86	65,3
Eastern Bloc	30	34	13,3
Middle East	36	25	- 30,6
Africa	18	20	11,1
Far East/Oceania	52	65	25,0
Total	367	444	20,9

Source: Ocean Industry Magazine

As far as the number of offshore wells are concerned North America accounts with 878 for 38,1% of the world's offshore wells followed by the Western Europe and Latin America regions. In Western Europe, for example 375 = 52% of all wells drilled in that region in 1987 were offshore.

Looking ahead, a Gulf Publishing Company's forecast for offshore wells to be drilled in 1988 is shown below. As the table indicates there will be an almost 25% increase in drilling activity with major advances in North America (principally in Gulf of Mexico), Western Europe (led by the U.K.) and the West Coast of Africa.

OFFSHORE WELLS DRILLED
FORECAST - BY REGION

	Wells Drilled		
Region	**1987**	**1988**	**Percent Change (%)**
North America	878	1,270	44,6
Latin America	365	373	2,1
Western Europe	375	444	18,4
Eastern Bloc	NA	NA	----
Middle East	76	77	1,3
Africa	206	284	37,8
Far East/Oceania	392	413	5,3
Total	2,292	2,861	24,9

NA = Not Available

Source: Gulf Publishing Company

The driving factors behind offshore increases include:

* Expectations for less volatile crude pricing.
* Projects with long lead times.
* National goals which may include satisfying domestic demands.
* Perception that gas oversupply is diminishing rapidly in the U.S.

Besides gains in the Gulf of Mexico offshore drilling in the U.S. should increase significantly in offshore California waters and in offshore Alaska locations. Besides U.K. increases Denmark is projected to double last year's offshore drilling activity while Norway, The Netherlands and Italy will increase nicely. In the African region Nigeria should at least double with steady increases in Angola, Egypt and Gabon.

1.5 Future Trends for Reserves and Production

Trends for offshore oil and gas reserves, production and drilling in the short term and long term is often difficult to predict. This is espectially true in today's era cf fluctuating energy prices. After all, it is the management of international oil companies, state oil and gas operations and people in government who make the decisions to drill produce or add reserves to offshore holdings.

At this time, it appears that the world offshore energy business is more stable and predictable since the big downturn in activity and prices which occurred in early 1986. We consider 1987 as a year of consolidation, reorganizing and planning for the future in all sectors of the energy industry. In offshore operations and long term markets it is very important to have stability since we are dealing in a long-term business where projects get started and are difficult to stop once underway. Investments are made in offshhore lease concessions and seismic work. When exploratory drilling is completed the platforms and equipment are ordered. This is certainly a building process which counts on long-term stability and increasing prices for energy.

Specifically for reserves of oil and natural gas, we believe the overall trend around the world for the next five years is a slight increase. This will of course, vary by region. For example in the United States, oil reserves may continue their slight downtrend, then will steady and turn up at the end of this five year period. Conversely, gas reserves in U.S. waters should enjoy a significant increase due to ongoing and new exploration programs presently underway.

In Western Europe proven oil reserves fell in 1986 with gas reserves declining slightly. During 1987, although data is not yet available, we believe both oil and gas declined slightly but should begin to show some increases within the forecast period, perhaps sizable increases in gas reserves by 1992. In other regions of the world we believe the trend for oil and gas reserves will be slightly increasing.

World production of offshore oil increased until 1984, declined slightly in 1985 then fell in 1986. In 1986, offshore oil production declined by about 9% due to economic reasons. Conversely, gas production for the world experienced a steady upward climb. We believe that offshore oil and gas production last year held relatively steady and is set for slight increases during the next five years. Again, the picture will vary by country, but as the energy picture brightens and there is more stability in the industry we foresee steady, but slight uptrends in world markets.

Offshore drilling for oil and gas will experience a healthy increase in 1988. Given that world crude prices remain stable and increase slightly as experts predict, offshore drilling activity (as well as pipeline construction, fabrication of offshore structures and equipment sales to offshore projects) should increase over the next five years in total for the world. Keep in mind though, that each region (and individual country) is quite different in its planning and execution of offshore exploration and drilling programs. But we foresee a more steady and predictable market in which government planners and oil company management can operate with confidence. By 1992, we believe the offshore industry will have experienced five years of stability and growth.

CHAPTER B-2

CAPITAL INVESTMENTS/EXPENDITURES FOR ENERGY DEVELOPMENT

SECTIONS

2. Capital Investments/Expenditures for Energy Development

2.1 Basic Strategy and Pricing

Any capital investments or expenditures made in the world energy industry is affected by three important factors and is based upon the perceived future trends for each of these factors. They include:

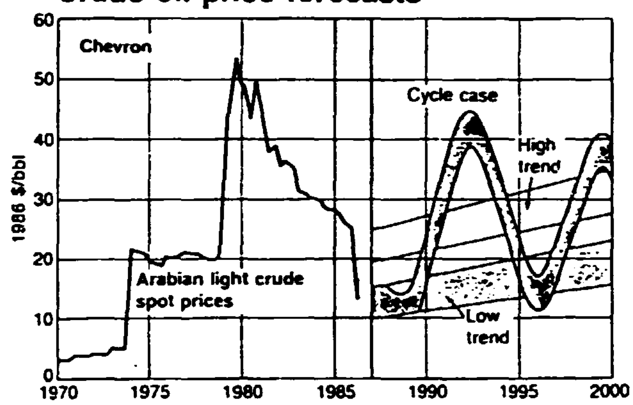
1. Anticipated actions of OPEC, which includes oil production and pricing.
2. World demand for oil and gas.
3. Economic and political situations within producing countries.

These factors apply for both land and offshore oil and gas development.

As discussed in this report, hydrocarbon development in offshore waters tends to have longer term trends and bases for activity. Projects involving in massive platforms, large fields and lengthy development typify the offshore industry. Land drilling and development can be both very short term and have long term orientation. The offshore industry will be impacted less by daily, weekly or even monthly changes in the three major factors just cited and will experience dampened up and down response within a cycle.

Nevertheless, offshore investments do depend upon the general price development of the procuced oil. The sudden price increase in 1973 and 1979 did push many exploration and production projects to be feasible and economical. With lower oil prices, the so-called 15 or 20$/Barrel-technology became of utmost importance. Other projects were suspended or cancelled. In this respect future investments have to be judged versus the development of prices. For this purpose there are several price scenarios which in most cases see a moderate increase from the current 18$/Barrel OPEC-price (Spot-price for Brent oil felt to $14,35 a Barrel in mid March 1988). From the following Chevron foreast the "Low Trend" - scenario has to be regarded as most likely.

Crude oil price forecasts



When one reviews just how companies and governments plan capital investments for the energy industry they must condider that most budgets are on calendar year bases and are planned for a January to December period. This is not always true for all companies, but the majority of world-level energy companies, state-run operations and other economic and financial entities plan their capital budgets on a calendar basis.

Going further into the process, to develop a calendar-year capital budget these entities typically begin the budgeting planning process about mid-year. They will revise continuously until year-end. Therefore events which occur during this six-month planning period which have effects on the three factors mentioned previously - OPEC actions, hydrocarbon demand, economic and political situations - will impact the planning process and have great effect on next-year increases or decreases for planned capital budgets and expenditures.

Also as we have seen repeatedly, the major international energy companies will control budgets very closely throughout the budget year with tight control in the first half of the year. An example: During 1987 U.S. and international energy companies were very frugal and careful during the first half of the year, not spending at expected levels. About mid-year they felt confident about OPEC pricing and production activity and demand, then opened the floodgates in some areas to begin spending their budgets as originally planned in the previous year. This was especially true for offshore development in the U.S. Gulf of Mexico and North Sea areas.

To summarize the planning and spending process for capital commitment in the energy industry: Man being what he is, will be affeceted by current events in his planning process and certainly during the budget period when significant money commitments must be handled very carefully. In other words, the budgeting and spending process may have many ups and downs within a year and will be much more susceptible to world events impacting energy prices and volumes. The good news for those who operate in offshore industries is that these fluctuations are dampened somewhat in the offshore business and have more long-term predictability than drilling, exploration and production on land.

2.2 Worldwide Investments and Expenditures

A number of reporting entities provide information covering certain area commitments and expenditures in energy. Very few cover the world in terms of total capital investments, expenditures and commitments by country, land vs offshore and certainly none provide specific details worldwide on the offshore industry.

Capital investments and certain expenditure data for the world has been provided periodically by Chase Manhattan Bank in the U.S. Their most recent report was issued in late 1985 and covers capital investments in the world energy industry through 1984. This report has utilized their information, provided estimates for 1987 and projected total capital investments for the world and selected regions for 1988.

The figures provide a summary of peak year investments which occurred in 1981, the most recent reported totals from Chase in 1984 and other estimates and projections for 1987 and 1988, respectively. The general definitions of Chase investment categories which will be used in this section of the report are as follows:

- Exploration and production expenses - Includes the costs for exploration, drilling, development and production of crude oil and natural gas and associated gas liquid plants.

- Geological and geophysical expenses - Covers the cost for seismic contracting services, aerial surveys, computers, instrumentation and equipment required to search for oil and gas and lease rentals.

- Pipelines - construction of crude oil, natural gas and petroleum product lines but does not include natural gas transmission pipelines.

- Refineries - Expenditures in equipment and services for refining facility construction, expansion or operations.

- Chemical plants - Covers petrochemical, plastics, fertilizers and all downstream chemical activities of oil and gas companies.

- Marketing - Includes infrastructure of terminals, trucks or transportation equipment as well as bulk plants and retail service stations required to provide support for and market petroleum products.

- Other - Administrative and miscellaneous transportation facilities, etc.

Not shown in the data nor included in the totals is capital invested in the worldwide tanker fleet, since ownership and operation of this worldwide fleet is spread among many non-oil company entities. In 1981 capital expenditures for tankers was almost $5 billion but dropped to about $2 billion in 1984. Reduced tonnage and lower prices were responsible fo. the large declines in this highly cyclical market. Although estimates and projections for 1987 and 1988 are not provided, we suspect that further declines have been experienced by the world fleet.

Today the worldwide energy industry is adapting to a new era of energy development and production. Most international companies who operate both on land and offshore have adjusted their operations and can be profitable, if only slightly so, at crude oil prices of $15/barrel. These worldwide companies adjusted significantly during 1985-86 and many have become extremely profitable as a result. The reasons: They conformed to a $15 barrel "benchmark" in their operations while world crude oil prices hovered around $18 to $20 barrel during 1987.

A good example of the effects on the international oil and gas business is shown below: production earnings are up significantly for selected international oil companies. As these figures indicate, major international oil companies improved significantly in their earnings for exploration and production-oriented activity. This is a result of lowered cost to operate (at the $15/barrel crude oil price) and stable, slightly higher oil and product prices (given the 1987 levels of crude oil pricing near $20/barrel).

NET EXPLORATION AND PRODUCTION EARNINGS FOR
GROUP OF
SELECTED INTERNATIONAL OIL COMPANIES
(Millions of Dollars)

Company	1986	1987	Year-to-Year Change (%)
Chevron			
U.S.	$ (34)	$ 304	NM
Foreign	398	433	9 %
Sub-Total	364	737	102
Exxon			
U.S.	724	1,268	75
Foreign	2,189	2,453	12
Sub-Total	$2,913	3,721	28
Mobil			
U.S.	76	363	378
Foreign	669	958	43
Sub-Total	745	1,321	77
Texaco			
U.S.	(7)	201	NM
Foreign	403	627	56
Sub-Total	396	828	109
Group Total	$4,418	$6,607	50%

NM=Not Measurable

Source: Salomon Brothers, Inc.

Now reviewing the next 4 tables where total capital investments and expenditures for the world for onshore and offshore operations and certain areas are summarized, we see that there has been a significant decline from the peak year in 1981. We should mention that total expenditures in 1982 were essentially equal to those in 1981. However the die had been cast and 1982 was the first year in a long decline we have experienced since the worlwide "energy boom" in 1981.
The drop experienced in world-level capital investments and expenditures from 1981 to 1984 was a reduction from $144 billion to $113 billion or an annualized decline of about 8% per year. The 1987 estimates for total worldwide capital investments and expenditures, is approximately $69 billion. There was a $44 billion decline from 1984 to 1987 or an annual decline of about 15% per year. Very few world industries have suffered this type of decline on a continuous basis. To experience a $15 billion per year decline in capital funding in an industry which requires ongoing activity could be defined as near-calamity by many. However the energy industry has adapted to these unusual conditions and did so by making significant cutbacks in people, facilities, plans for expansion, current levels of drilling and production.

The good news about worldwide capital investments and expenditures is that they will be increasing in 1988. The projection for total investments and expenditures will grow by $9 billion or 13% from 1987.

The figures for the world totals are followed by regional details which will be of interest for developing countries:

- Latin America
- Africa
- Far East/Oceania

CAPITAL INVESTMENTS AND EXPENDITURES
WORLD TOTALS (1)
(Millions of Dollars)

	1981	1984	1987E	1988P
Exploration & Production Expenses (2)	$ 93,375	$ 72,700	$ 39,900	$45,195
Geological & Geophysical Expenses (3)	10,600	8,375	4,685	5,615
Pipe Lines	7,075	4,850	3,425	3,785
Refineries	17,175	12,550	9,940	11,110
Chemical Plants	8,400	7,350	6,365	7,235
Marketing	5,200	5,175	3,710	4,100
Other	2,425	2,100	1,390	1,550
World Total	$ 144,250	$ 113,100	$ 69,415	$ 78,590

(1) Totals for all energy-related expenditures. Does not include Eastern Bloc nor People's Republic of China
(2) Includes drilling, completion and production equipment and services; costs of onshore and offshore lease acquisitions; natural gas liquids plants
(3) Includes lease rentals

NOTE: Does not include tankers
E = Estimate, P = Projected

Source: Chase Manhattan Bank-Global Energy Group, Warlick & Associates, Inc.

CAPITAL INVESTMENTS AND EXPENDITURES
LATIN AMERICA
(Millions of Dollars)

	1981	1984	1987E	1988P
Exploration & Production Experses (1)	$ 7,600	$ 6,525	$ 4,760	$ 5,370
Geological & Geophysical Expenses (2)	1,050	700	510	590
Pipe Lines	750	425	310	350
Refineries	1,775	825	600	690
Chemical Plants	1,200	925	675	785
Marketing	375	400	340	380
Other	275	350	300	340
Total	$ 13,025	$ 10,150	$ 7,495	$ 8,505

(1) Includes drilling, completion and production equipment and services; costs of onshore and offshore lease acquisitions; natural gas liquids plants
(2) Includes lease rentals

E = Estimate, P = Projected

Source: Chase Manhattan Bank-Global Energy Group, Warlick & Associates, Inc.

CAPITAL INVESTMENTS AND EXPENDITURES
AFRICA
(Millions of Dollars)

	1981	1984	1987E	1988P
Exploration & Production Expenses (1)	$ 4,650	$ 3,125	$ 2,060	$ 2,410
Geological & Geophysical Expenses (2)	800	450	300	355
Pipe Lines	1,250	1,175	775	885
Refineries	1,125	850	560	630
Chemical Plants	725	625	415	470
Marketing	275	375	250	260
Other	75	150	100	110
Total	$ 8,900	$ 6,750	$ 4,460	$ 5,120

(1) Includes drilling, completion and production equipment and services; costs of onshore and offshore lease acquisitions; natural gas liquids plants

(2) Includes lease rentals

E = Estimate, P = Projected

Source: Chase Manhattan Bank-Global Energy Group, Warlick & Associates, Inc.

CAPITAL INVESTMENTS AND EXPENDITURES
FAR EAST/OCEANIA
(Millions of Dollars)

	1981	1984	1987E	1988P
Exploration & Production Expenses (1)	$ 5,750	$ 6,350	$ 4,890	$ 5,475
Geological & Geophysical Expenses (2)	850	650	500	575
Pipe Lines	625	450	345	380
Refineries	2,850	2,175	1,675	1,875
Chemical Plants	750	650	500	570
Marketing	800	700	550	590
Other	350	250	190	200
Total	$ 11,975	$ 11,225	$ 8,650	$ 9,665

(1) Includes drilling, completion and production equipment and services; costs of onshore and offshore lease acquisitions; natural gas liquids plants
(2) Includes lease rentals

E = Estimate, P = Projected

Source: Chase Manhattan Bank-Global Energy Group, Warlick & Associates, Inc.

2.3 Expenditures for Offshore Energy Development

Only limited data has been consolidated for offshore expenditures by any world agency. The market figures published from Salomon Brothers and Chase Manhattan do not disclose the offshore portion of forecasted estimates.

The only three sources which have reviewed, at least in a general sense, world offshore expenditures are the

- Scottish Development Agency (SDA)
- the Norwegian NOROIL group and
- Mackay Consultants, Inverness, UK

in their assessment of offshore market opportunities. They provided estimates for equipment, services and total expenditures involved in offshore development for the year 1984, 1985 and 1986. To-date, these are the only definitive reviews of the offshore industry which provide any detail on expenditures whatsoever.

The Scottish Development Agency (SDA) estimated that $38 billion was spent in the upstream development of offshore fields in 1984. This includes expenditures for all equipment, services, structures, pipelines and any related expenses for finding, drilling, developing and producing oil and gas in offshore waters. This figure is approximately one-third of the total world capital investments and expenditures for energy in 1984 discussed in chapter 2.2.

The Norwegian NOROIL group published in April 1985 offshore expenditure figures which were some 40% higher than those from SDA amounting to $54 billion worldwide. Based on the optimism of those days and prior to the oil price slump this figure was expected to increase to arround $74 billion in 1988.

Worldwide Offshore Expenditure - $billion

	1985	1986	1987	1988
Development	23.24	26.18	29.94	34.44
Exploration & Drilling	20.04	21.01	22.54	23.56
Operating Costs	11.00	13.00	14.50	16.00
Total	54.28	60.19	66.98	74.00

Offshore Expenditure Outlook - $billion

		1985	1986	1987	1988
A	North America	13.08	14.57	15.99	17.72
B	Central & South America	4.75	5.24	5.68	6.41
C	Europe	16.56	18.24	21.06	22.55
D	Middle East	5.30	5.70	6.04	6.44
E	Far East	10.35	11.59	12.76	14.18
F	Africa	4.23	4.84	5.45	6.70
Total		54.28	60.19	66.98	74.00

Source: NOROIL 1985

Mackay Consultants have estimated the total offshore world investment for 1986 at $ 61,4 billion for exploration, development and operating.

OFFSHORE EXPENDITURE OUTLOOK - $ BILLION

	1986	Estimate 1990
Exploration	8.1	10.4
Development	27.5	33.6
Operating	25.8	32.0
Total	**61.4**	**75,0**

In Appendix A 1-2 to 1-4 investments are split by regions and selected countries also (this includes development countries in Africa and South East Asia), compared with SDA and NOROIL the forecast seems to be on the high side and may have to be reduced according to the respective knowledge.

Since 1984 and 1985 there have been obvious changes in the world energy marketplace. Those that affected offshore expenditures were the following:

- Offshore drilling activity declined from 1984 to 1987 on a steady basis, with the biggest decline occuring in 1986.

- Oil production from offshore declined only slightly from 1984 to 1985 but fell almost 9% in 1986. Warlick & Ass feel, production held relatively steady in 1987.

- Offshore natural gas production held relatively steady or increased.

Overall, the impact of perceived OPEC instability translated to less stable world prices for hydrocarbons. This made international oil and gas operators and state oil companies much more careful and conservative in the way they spent money for offshore development, as well as those developments on land.

In the next table we have provided offshore expenditure data by world offshore region. Based on the SDA survey, $38 billion was spent in 1984 to cover all expenditures related to offshore energy development. We estimate that total fell to approximately $24 billion last year, a 37% reduction in expenditures or a 14% annualized rate of decline. Most of the reduction occurred during 1986, with 1987 characterized as a year of stabilization and initial comeback for future years.

OFFSHORE EXPENDITURES[1]

(Millions of Dollars)

Region	1984	1987E
North America	$9,120	$6,850
Latin America	3,800	2,810
Western Europe	9,880	6,985
Eastern Bloc	N/A	-
Middle East	4,180	1,825
Africa	3,040	1,385
Far East/Oceania	7,980	4,215
TOTAL	**$38,000**	**$24,070**

(1) Includes all equipment and services for geophysical surveying, drilling and completion; offshore structures; marine pipelines; inspection, maintenance and repair; support services.

Source: Scottish Development Agency, Gulf Publishing Company, Offshore Magazine, Warlick & Associates, Inc.

North America and Western Europe account for a major share of offshore expenditures. In 1984 these two regions (principally the Gulf of Mexico and North Sea area) accounted for 50.0% of world offshore expenditures. Last year we estimate that these two regions increased their share of world offshore expenditures, rising to 57.5% of the total. The reasons: A longer term commitment by intervention as one would experience in developing countries and their offshore programs. Furthermore Western Europe and North America represent two very large markets which try to reach independence from imported oil & gas.

2.4 Future Trends

Money spendings for offshore exploration, development and production are initiated by drilling activity in offshore locations based on demand and oil prices. In turn, drilling activity is supported by oil and gas company commitment to expensive programs and their view of long-term market opportunities.

In the short term there might be a potential increase in total offshore expenditures to range from 15% to as much as 25% in 1988. Gulf Publishing Company's offshore drilling forecast details regional activity anticipated during 1988 and believes in a 25% increase in drilling activity for 1988. Other experts are a bit more conservative but all tend to agree on one point: We may be at the beginning of a multi-year drilling uptrend for offshore fields around the world.

Forecast of 1988 world offshore drilling *

Region or country	Wells forecast 1988	Estimated wells drilled 1987	% Diff.
United States	1,262	870	+ 45.1
Gulf of Mexico	1,132	812	+ 39.4
Off. California	91	35	+ 160.0
Off. Alaska	39	23	+ 69.6
Other North America	46	44	+ 4.5
Canada	8	8	...
Mexico	38	36	+ 5.6
South America	335	329	+ 1.8
Argentina	4	5	- 20.0
Brazil	168	158	+ 6.3
Chile	54	59	- 8.5
Ecuador	4	...	...
Peru	55	55	...
Trinidad	20	22	- 9.1
Venezuela	30	30	...
Western Europe	481	396	+ 21.5
Denmark	19	9	+ 111.1
Greece	3	...	...
Italy	77	56	+ 37.5
Netherlands	45	40	+ 12.5
Norway	89	80	+ 11.3
Spain	6	3	+ 200.0
UK	236	205	+ 15.1
Others	6	3	+ 200.0
Africa	284	206	+ 37.9
Angola	61	51	+ 19.6
Congo	38	34	+ 11.8
Egypt	59	48	+ 22.9
Gabon	34	24	+ 41.7
Libya	8	...	+ 41.7
Nigeria	33	15	+ 120.0
South Africa	15	14	+ 7.1
Tunisia	18	12	+ 50.0
Others	18	8	+ 125.0
Middle East	77	76	+ 1.3
Abu Dhabi	31	36	- 13.9
Dubai	18	20	- 10.0
Iran	2	...	...
Neutral Zone	2	2	...
N. Yemen	1	1	...
Oman	1	1	...
Qatar	3	2	+ 50.0
Saudi Arabia	12	13	- 7.8
Turkey	5	...	...
Others	2	1	+ 100.0
Far East	360	346	+ 4.0
Brunei	18	11	+ 63.6
China	25	26	- 3.8
India	95	95	...
Indonesia	63	67	- 6.0
Japan	2	1	+ 100.0
Malaysia	100	94	+ 6.4
Philippines	3	3	...
Taiwan	3	3	...
Thailand	44	39	+ 12.8
Others	7	7	...
Australia/Pacific	53	46	+ 15.2
Australia	44	37	+ 18.9
New Zealand	7	9	- 22.2
Others	2	...	...
Total	2,898	2,313	+ 25.3

* excluding USSR Source: Ocean Industry, Febr. 1988, page 18

Separately, a recent survey by Salomon Brothers Inc. among 157 North American and fifty leading international oil and gas companies is also supportive of a steady increase in offshore activity. Their figures show that international exploration and production spending planned for 1988 among this surveyed group will increase by 16.5%. Among U.S. operators, a majority are shifting emphasis to foreign exploration with a major share believing that the overall economics of international drilling and exploration are much improved over previous years. They foresee improved concessions from certain countries, larger field extent and reserves and larger development commitments.

International E&P expenditures, millions $ U.S.

	1988*	1987*
Exxon	$ 2.650	$ 2,175
Royal Dutch (Shell)	2,190	2,000
British Petroleum	1,500	1,300
DuPont (Conoco)	1,145	995
Total S.A	830	777
Mobil	700	650
Texaco	700	500
Norsk Hydro	665	665
Britoil	595	502
Amoco	560	450
Chevron	520	495
Atlantic Richfield	350	350
BHP	350	305
Unocal	300	145
Occidental Petroleum	265	225
Amerada Hess	200	185
Phillips Petroleum	200	150
USX (Marathon)	150	130
Maxus	105	75
Texas Eastern	100	60
30 other companies	738	586
Total	$ 14,813	$ 12,720

* Salomon estimates

Source: Salomon Brothers Inc.

Given that the oil producing countries and companies maintain some semblance of production discipline which should result in relative price stability over the next five years, one can foresee slow but steady price increases for hydrocarbons. This will support long-term offshore exploration and development programs and steady increases for offshore expenditures in most all offshore drilling and production regions.

2.5 Environment in Developing Countries

In the past, energy development has experienced significant highs and extreme difficulties in nearly all developing countries. In years prior to the runup in energy prices many countries offered attractive concessions and deals in order to draw international oil and gas companies into development in their specific country. As prices for oil and gas rose quickly these same countries became more demanding and took back many of the previously-offered concessions. They perceived a new leverage due to the shortage of hydrocarbons and high prices. Additionally, some non-OPEC countries emulated OPEC's stance and took advantage of the economic conditions at that time.

Some of the changes that could take place in a developing country involving international oil companies and impacts include:

- Changes in Government and Political Circumstances
- Expensive, High Cost Drilling and Production

However, in many cases these same countries have tremendous reserve potential and long-term opportunity. As a result many large international oil and gas companies continued attempts to work with developing countries in long-term energy development.

With oil prices now ranging between $16 and $20 (compared to prices in the $30's during the 1981-82 period) these same countries have experienced fiscal and economic difficulties and view the international oil and gas companies in a much different light than they did previously. Current conditions which are much more attractive to international drilling and exploration and developing countries can be summarized as according to the following points:

- Most developing countries are facing large national debt. Many are dependent upon agricultural commodity sales but world-level prices are low. As a result many desparately need to establish or increase hydrocarbon reserves and development.

- Reportedly there are many basins with good prospects which have had little or no exploration to date located in developing countries. A number contain hydrocarbon basins that may have larger prospects with even greater reserve potential than in many mature areas such as the United States.

- The cost to find and develop oil and gas reserves in developing countries are much lower than, say, in the United States. Currently the finding costs in North America are much higher.

- There is competition among developing countries to attract investment from international oil and gas companies.

- Many are offering terms and conditions to foreign oil and gas companies which are much more attractive than in previous years.

- These same countries are currently offering new areas for international bidding with improved fiscal terms.

- In the past these countries would change the deals and terms dealt to international oil companies. The risk of changes to these fiscal terms has decreased significantly and long-term contracts will now be more viable.

- International operators must act soon in order to initate exploration and development activity, since new production may require at least four years to come on stream after initial exploratory development.

In summary, dealing with developing countries is a much more attractive and predictable opportunity for the major international oil and gas companies. We foressee more activity taking place in these countries regarding offshore exploration, development and ultimate production. This bodes well for providers of offshore equipment, structures, vessels and services in future years.

2.6 Expenditures for Offshore Field Development

As noted in chapter 2.3 of this report the worldwide offshore industry spent according to the Scottish Development Agency $38 billion in 1984 on programs to explore for oil and gas, drill, develop and ultimately produce hydrocarbons. For the year 1987 approximately $24 billion on spendings were estimated and specified by region.

In this chapter this figure is broken down to equipment and service categories:

OFFSHORE EXPENDITURES BY CATEGORY
(in million US-$)

Category	1984	1987E
Exploration, Drilling and Completion	$14,900	$9,900
Offshore Structures	11,700	6,470
Pipelines	3,000	1,900
Inspection, Maintenance and Repair	2,900	2,200
Support Services	5,500	3,600
Total	$38,000	$24,070

Source: Scottish Development Agency, Ocean Industry Magazine, Warlick & Associates, Inc.

A more specific breakout of expenditures categories is shown in the following table. These descriptions of equipment and services is provided to clearly identify the types of business segments that make up the offshore expenditure categories.

OFFSHORE EXPENDITURE CATEGORIES
AND THEIR BUSINESS SEGMENTS FOR 1984

Category	Business Segments	Total Millions of Dollars 1984
Exploration, Drilling and Completion	- Seismic vessels, equipment, computers, electronic equipment.	$ 1,400
	- Contract drilling services, steel (flat, tubular), rig equipment, drilling tools, downhole tools.	11,800
	- Logging, cementing, stimulation, MWD services, monitoring, core testing, drilling mud.	1,700
Offshore Structures	- Jacket design, engineering, fabrication.	4,000
	- Top-side design, assembly, top-side equipment, subsea components.	5,300
	- Heavy lift barges, piling contractors inspection, installation and hookup.	2,400
Pipelines	- Pipeline engineering, installation, coating, inspection.	3,000
Inspection, Maintenance and Repair	- Diving services, equipment, support submersibles, repairs.	2,900
Support Services	- Supply vessels, helicopters, catering medical, shore-based services.	5,500
	Total	$ 36,000

Following an estimated category mix for 1987 estimate. Data indicates that this same distribution for these years apply, in general, to most geographic areas, but will have regional variance.

OFFSHORE EXPENDITURE
DISTRIBUTION BY CATEGORY
(Percent to Total)

Category	1984	1987E
Exploration, Drilling and Completion	39.2 %	41.0 %
Offshore Structures	30.8	27.0
Pipelines	7.9	8.0
Inspection, Maintenance and Repair	7.6	9.0
Support Services	14.5	15.0
Total	100.0 %	100.0 %

2.7 Comparison of Expenditures

2.7.1 Total View

The cost to drill and complete wells both on land and offshore has been reduced significantly since 1981. Land drilling and completion cost reduction per well has been most extreme with large declines in the cost of contract drilling and related services. The next table provides an index comparison of drilling and completion costs for all drilling in the U.S. for the 1979-86 period and exhibits the major changes in costs to drill and complete. As the table indicates, the average payments to drilling contractors for the average well drilled in the U.S. today is 73.5% of the cost in 1979. Likewise, direct expenditures by operators for all tubular goods, rigsite services and other expenditures required to complete the average well is 88.4% of the cost in 1979.

U.S. DRILLING AND COMPLETION COSTS
FOR LAND AND OFFSHORE DRILLING
(Index Basis: 1979=100.0)

	1979	1981	1983	1986
Payments to Drilling Contractors	100.0	140.8	95.0	73.5
Direct Expenditures by Operators[1]	100.0	135.6	108.3	88.4

(1) All costs of cementing, logging, drilling mud, tubulars, etc.

Source: Independent Petroleum Association of America

2.7.2 Finding Costs

The so-called "finding costs" for oil and gas companies are defined as those outlays for exploration and development onshore and offshore divided by reserve additions from extensions, discoveries, improved recovery and revisions. It is all translated down to dollars per barrel of oil equivalent (BOE) which is added to a company's reserves.

According to a recent study performed by Salomon Brothers Inc., 30 companies who operated in the U.S. (some in international locations) had a weighted-average finding cost for the period 1979-86 of $8.73 per BOE. This excluded property acquisitions. On a comparative basis, foreign finding costs outside the U.S. averaged only $5.96 per BOE.

In an April 1987 study from Behling, WPC, the author pointed out that until the last decade, U.S. finding costs were competitive with other areas of the world. The costs rose sharply in the 1876 to 85 years as more high-risk prospects were drilled in response to rising oil prices. Tax incentives also encouraged some reckless drilling. In the future finding and development costs will likely decrease as the industry adjusts to new price expectations.

United States Finding / Development Costs

	Average 1985 $/Barrel
1946 - 55	1,70
1956 - 65	2,20
1966 - 75	2,50
1976 - 85	6,75

Source: D.J. Behling, WPC, April 1987

To compare the finding costs in several regions of the world, North America is far and away the costliest area to find and to develop oil. The Middle East is the cheepest and even the capital intensive offshore development in Westerr. Europe requires only half the amountof money per barrel than North America.

FINDING AND DEVELOPMENT COST BY REGION
- AVERAGE 1966 TO 1985

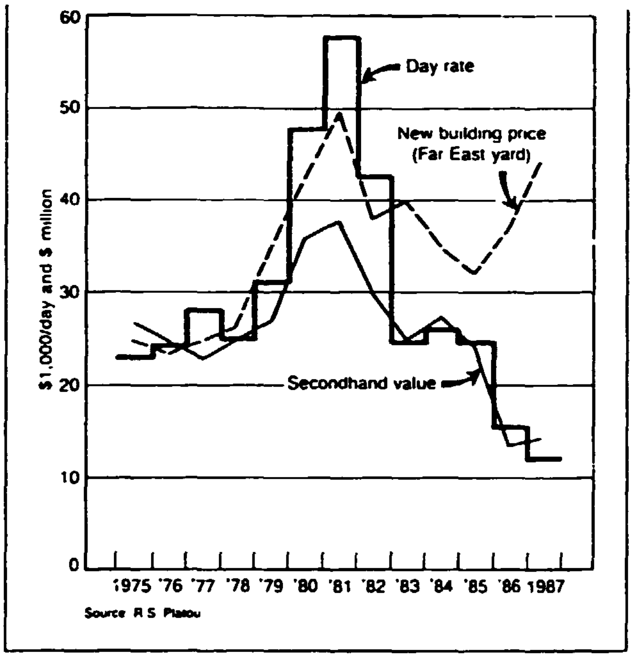
	1985 $/Barrel
United States	5,60
Canada	4,70
Western Europe	2,50
Latin America	1,60
Far East	1,50
Africa	0,75
Middle East	0,35

2.7.3 Typical Offshore Costs

The cost for offshore development has increased very much in the 70's to the early 80's. Actual costs did overrun the previous start estimates so great that only the Arab oil embargo and the ensuing price increases sored many operators from financial disaster.

The average Jack-Up Day Rates may serve as a general indicator for the cost development in the offshore industry even if we believe, that the total offshore development costs have been increased and reduced in a more moderate extent than the parly speculative exploration market.

Jack Up Day Rates



The figure shows a sharp increase in day rates and new building prices to 1981, and a sharp decrease in 1982 and 1983. Long term correlation between day rates, used rig values and new construction costs started to diverge in 1985 with rising yard costs and falling dollar values.

Most serious are high cost increases which have affected many projects. In a Cost Study Norwegian Contineta1 Shelf the so-called Moe-Committee evaluated costwise several Norwegian and British offshore projects. Norway, in the early 70's a newcomer on the offshore scene, was affected for 6 large projects which were started early 1970 by a cost increase of 178 %. Total investment was finally $7,3 billion. For another 4 projects from 1975 to 1980 and with growing experience the cost increase was only 29%.

There was a wide variation in cost increases from +1355% for hook-up, +469% for engineering and management to less than 100% for insurance, equipment and bulks:

DISTRIBUTION OF TOTAL COST AND COST INCREASES FOR 6 NORWEGIAN PROJECTS BEGAN EARLY 1970

	Cost		Start Estimate		Cost Increase		Increase Above Start Estimate
	mill. $	%	mill. $	%	mill. $	%	%
Total Cost	7.261	100	2.614	100	4.647	100	÷ 178
Hook-up	1.527	21	105	4	1.422	31	÷ 1.355
Engineering + Management	697	9	122	5	574	12	÷ 469
Transport ÷ Installation	1.948	27	729	28	1.219	26	÷ 167
Materials ÷ Construction	2.017	28	840	32	1.177	25	÷ 140
Insurance	131	2	66	2	64	2	÷ 96
Equipment + Bulks	562	8	333	13	229	5	÷ 69
Other Costs	377	5	416	16	- 39	- 1	- 10

The reasons for such cost increase in a new offshore country are quite interesting to know for developing countries in order to avoid the same problems:

- underestimation of problems and costs
- increased operator requirements
- weakness in project execution
- unforeseen inflation
- more stringent government requirements

Some more detailed information on exploration and development costs is compiled in the next 3 tables.

- Examples of offshore well costs
- Mobile Rig Rates
- North Sea / Gulf of Mexico platforms

Examples Of Offshore Well Costs

North Sea and Gulf of Mexico

Source: Ocean Industry, Oct. 1982/1983

	North Sea exploration well	North Sea development well	North Sea exploration well
Vertical depth	10,000 ft	10.000 ft	9.000 ft
Measured depth	10,000 ft	12.000 ft	9.000 ft
Water depth	350 ft	450 ft	100 ft
Days	45	60	45
Daily costs	**Semi-Submersible**	**Platform Rig**	**Jack-Up**
Drilling rig	$2,630,420	$ 973.950	$2,192.520
Day rate	* $ 60,000[1]	* $ 20.000[2]	* $ 50.000[1]
Fuel	$ 197,810	$ 209,890	$ 137,410
Other contracts	$ 401,660	$ 508,870	$ 264,250
Transport	$ 765,570	$ 289.920	$ 604,000
Supervision/overhead	$ 291,430	$ 451,490	$ 271.800
Total daily costs	$4,286,890	$2,434,120	$3,469,980
Footage costs			
Casing and wellhead	$ 853,150	$ 825,970	$ 768.590
Mud and cements	$ 496,790	$ 457,530	$ 646,280
Logging (surveys only)	$ 277.840	$ 203,850	$ 249,150
Other	$ 409.210	$ 356.360	$ 466,590
Total footage costs	$2,036,990	$1,843,710	$2,130,610
Other costs			
Site and rig move	$ 170,630	–	$ 170,630
Completion	–	$ 604,000	–
TOTAL WELL COST	$6,494,510	$4,881,830	$5,771.220

[1] Day rate assumes rig already under contract. Present market can result in costs varying from $20.000 day (recently contracted rig) to $100.000 day (rig contracted some time ago in light market) for semi-submersible and jack-up rigs.

[2] Platform rig rate can vary significantly depending on date of construction and contract arrangement (e.g., lease)

* Day rates are not included in the total well cost.

Examples Of Offshore Well Costs

North Sea and Gulf of Mexico

Source: Ocean Industry, Oct. 1982/1983

	Gulf of Mexico exploratory well	Gulf of Mexico development well	Gulf of Mexico exploratory well
Vertical depth	8,279 ft	8,252 ft	12,600 ft
Measured depth	8,279 ft	10,020 ft	13,560 ft
Water depth	266 ft	191 ft	40 ft
Intangibles	Semi-Submersible	Platform Rig	Jack-Up
	(Drill only)	(Drill and complete)	(Drill and complete)
Drilling rig (type)	$2,406,000	$1,088,000	$1,650,000
Day Rate	43,000	12,400	30,000
Bits	7,000	14,000	45,000
Supply vessels	391,000	364,000	464,000
Helicopters	43,000	78,000	100,000
Mud, chemicals and mud engineering	244,000	322,000	110,000
Cement and Services	153,000	139,000	60,000
Logging and perforation	209,000 (2)	213,000 (2)	145,000
Treating and testing	8,000 (3)	126,000 (3)	–
Directional drilling	–	60,000	60,000
Other downhole equipment	16,000	46,000	–
Surface equipment	–	–	–
Diving	19,000	–	–
Tool rentals	80,000 (4)	289,000 (4)	95,000
Field supervision and overhead	27,000	34,000	30,000
Fuel, power, water and lubricants	119,000	80,000	100,000
Core and sample analysis	–	–	5,000
Miscellaneous	312,000 (5)	377,000 (5)	533,000
Total Intangibles	$3,928,000	$3,230,000	$3,427,000
Tangibles			
Casing, tubing and accessories	$ 125,000	$ 641,000	$ 631,000
Wellhead	50,000	55,000	40,000
Total Tangibles	$ 175,000	$ 696,000	$ 671,000
TOTAL WELL COST	$4,209,000	$3,926,000	$4,098,000

(1) Includes cost of completion rig. Day rate cost represents drilling rig, surface equipment & catering
(2) Includes: mud logging.
(3) Includes: stimulation and gravel packs and completion fluids
(4) Includes: drill pipe and workstring rental.
(5) Includes: weather forecasting, location surveying and positioning, communications and pilot, contract labor, materials handling, etc
(6) Includes: catering

As the table show, an average well in the Gulf of Mexico costs (in 1982/83) $ 3.9 to 4.2 million and in the North Sea $4.9 to 6.5 million.

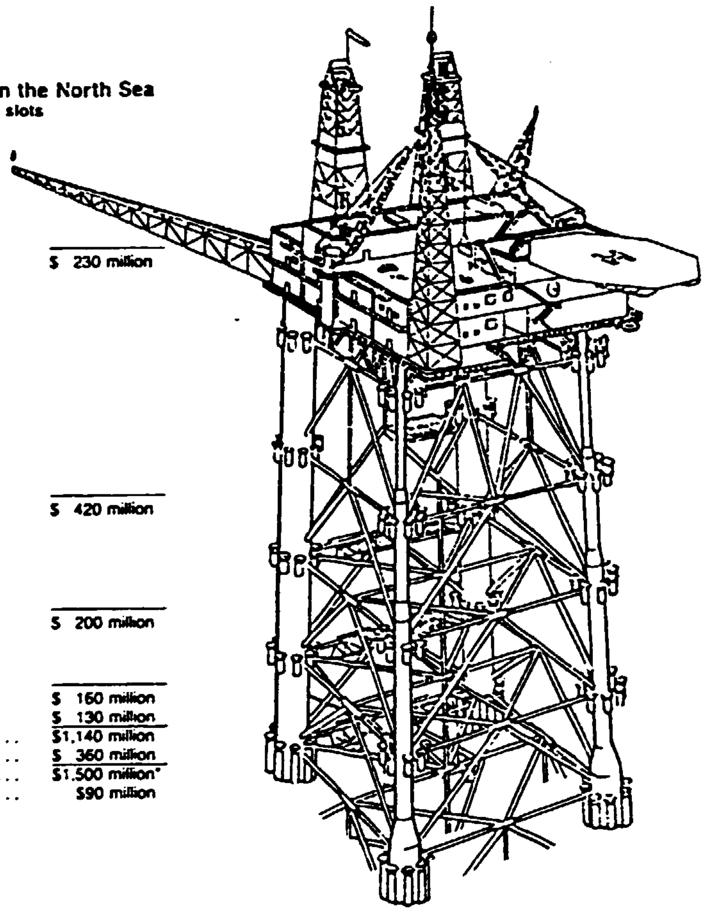
Development of mobile rig rates by type and area for 1983 to 1986 shows in general decreasing prices in 1985 and 1986 with a few exception (drill ships for South East Asia Mediterranean & West Africa).

MOBIL RIG DAY RATES (1000 US $)

	8/83	9/84	9/85	9/86
Jack-Ups (250-300 ft, new)				
Gulf of Mexico	8 - 14	12 - 18	10 - 15	6.5 - 9
North Sea	25 - 35	20 - 35	25 - 30	15 - 19
Southeast Asia	15 - 25	12 - 15	16 - 19	13 - 18
Mediterranean & West Africa	21.5 - 25	20	18 - 22	15 - 20
Semi-Submersibles (1970's generation)				
Gulf of Mexico	20 - 25	35 - 43	22 - 25	11 - 14
North Sea	25 - 35	20 - 35	25 - 35	15 - 18
South East Asia	20 - 30	18 - 20	20 - 23	N.A.
Mediterranean & West Africa	20 - 30	20 - 25	27 - 35	26 - 30
Drill Ships (conventional, 600 ft t)				
Gulf of Mexico	15 - 20	30 - 35	25 - 35	N.A.
North Sea	-	-		
South East Asia	15 - 20	15 - 18	20 - 28	20 - 22
Mediterranean & West Africa	15 - 20	15 - 22	18 - 24	18 - 24

Reliable data to compare the costs of production platforms are not published in recent years. Therefore following a 1981 example for a typical 36 slots North Sea Platform ($ 1,5 billion) and a typical 24 slot Gulf of Mexico platform ($ 40 million) published by Ocean Industry.

North Sea platform



Drilling/production platform in the North Sea
500-ft water depths/36 slots

Jacket Structure	
Materials-steel	
Piles/skirt piles	
Legs	
Buoyancy tanks	
Risers	
All other steel	
	$ 230 million
Topside Facilities	
Decks	
Accommodation modules	
Processing equipment	
Compression equipment	
Instrumentation	
Helideck	
Firefighting/lifesaving equipment	
Pumps	
Water systems	
Cathodic protection	
Heat exchangers, etc.	
	$ 420 million
Installation Costs	
Load-out	
Tow-out	
Placement	
Hook-up, etc.	
	$ 200 million
Oil Disposal Facilities	
SPM/Tanker or	
Tie-in pipe line	
	$ 160 million
Miscellaneous	$ 130 million
Total	$1,140 million
Development drilling	$ 360 million
Total project cost	$1,500 million*
Annual operating costs of this platform ..	$90 million

*Figured in 1981 dollars. Courtesy Wood McKenzie.

Gulf of Mexico platform

Estimated construction costs of a 24-slot drilling/production platform
300-400 ft waters in the Gulf of Mexico

Labor	$7,200,000.
Materials (steel)	$7,500,000.
Main Piles	
Buoyancy tanks	
Jacket legs	
Risers	
Main & cellar decks	
Etc.	
Installation	$6,000,000.
Drilling phase	
Drilling contractor provides quarters and heliport, drilling equipment and support services. Platform rig 1981 day rates are estimated at $18,600; tangible and intangible costs to the drilling contractor (est.) are $2,841,600; making the cost of each well around $3,957,600.	
Total cost for 22 wells	$87,067,200.

Production equipment & services	
Permanent quarters & heliport	$ 150,000.
Cranes	$ 300,000.
Survival systems	$ 150,000.
Motor generator sets	$1,600,000.
Instrumentation & controls	$1,600,000.
	$4,000,000.
Other	
Compression equipment, pumps etc.	
Separators	
Heat exchangers	
Water systems for injection/drinking	
Corrosion control	
Firefighting systems etc.	$16,000,000.
Total Costs	$40,000,000.*
Annual operating costs for this type platform	$3,260,000

*All costs estimated in 1981 dollars

OCEAN INDUSTRY

Finally it has to be realized again that offshore equipment is long term investment and subsequently for short term price changes the so-called "Operating Costs" of a platform are ruling any price struggle with low cost competitors. For the North Sea the Financial Times published e.g. in 1985/86 operating costs which were surprisingly low. About 95 per cent of all North Sea produced oil was evaluated at $5 a barrel or less to operate. The rest costs between $5 and 11:

North Sea Operating Cost 1985

12% of North Sea oil for operating cost of US$	1,00
30% "	1,60 or less
60% "	2,00 "
80% "	4,00 "
95% "	5,00 "

2.7.4 Comparison of Onshore vs. Offshore Costs

Some figures provided from U.S. sources have to be used to compare typical offshore costs of drilling and equipping wells to that in offshore waters. Comparative costs around the world are not availabel in detail but the comparison in the U.S. will provide a vivid example of how expensive offshore operations can be when compared to onshore drilling and development. The next table indicates that deeper wells are obviously more expensive while the cost to drill and equip offshore wells is, on average at least fourteen times more costly than on land.

COMPARISON OF U.S. OFFSHORE VS. ONSHORE COSTS TO DRILL FOR AND EQUIP WELLS - 1985

Selected Depth Interval (ft.)	Cost Per Well (Thousands of Dollars)	
	Onshore	Offshore
5,000 to 7,500 ft.	$ 285	$ 1,876
10,000 to 12,500	$ 975	$ 4,157
15,000 to 17,500	$ 3,608	$ 7,976
Average for all wells drilled in 1985	$ 279	$ 4,073
Average for all wells drilled in 1986	$ 280	$ 4,005

Source: American Petroleum Institute, Independent Petroleum Association of America, Mid-Continent Oil & Gas Association

CHAPTER B-3

L E G I S L A T I O N AND F I N A N C I N G

SECTIONS

3. Legislation and Financing

3.1 Definition of Rights

3.1.1 Definition of Continental Shelf

Offshore petroleum mineral rights within the Continental Shelf of a country are vested in the Government of that country. The definition of the term "Continental Shelf" is thus of great importance. To the scientists it means that zone around a land mass which extends from the low-water line to a depth at which there is a marked increase of slope to greater depth. To the lawyer the continental shelf generally comprizes that zone around territory, extending from the outer limit of the territorial sea to a depth of 200 meters, or, beyond that point to a depth that is capable of exploitation.

This is in essence the definition adopted in the Continental Shelf Act of 1958. It thus means that the Continental Shelf begins further from land than the geological continental shelf. In the case of the UK it is 3 miles further from land. The legal definition means that it can also extend beyond the geological shelf edge. In the case of the UK areas have been designated for petroleum exploration 400 miles from the mainland and in water depths exceeding 100 metres.

In the view of the International Court of Justice the regime of the continental shelf is based on a number of interrelated factors. These are

- that the continental shelf was at one time part of the land territory of the state in question,
- that it is now a natural geographical and geological prolongation of the state's existing territory under the sea,
- thus this natural prolongation is seen in the gentleness of the gradient of the continental shelf, and
- that the continental shelf is proximate to the coast of the state.

The International Law Commission decided against adhering strictly to the geographical concept and envisaged a state exercising rights over an area of the sea bed which would not conform to the "normal" concept of a continental shelf.

Thus, Peru and Chile have no continental shelf in the geographic sense, but they have claimed rights over the mineral resources of the sea bed adjacent to its coast on the model of a claim to the continental shelf. Similarly Norway has not only claimed but exercized rights in the Noth Sea west of the Norwegian Trough.

3.1.2 Limits of State's Rights and Disputes about

Controversy exists regarding the definition of the outer limit of a state's rights in the sea bed proximate to its coast. The definition provided in the Continental Shelf Act of 1958 has been queried. One view is that the outer limitis a line which moves ever outwards with the development of the capacity to exploit the sea bed.

A second, more commonly held view is that the exploitability criterion is governed by the overall conception of the shelf as a geological feature and by the principle of adjacency. This means that the furthest that a state can claim beyond the 200 metres depth line by the use of the exploitability test is to the foot of the continental margin.

A vexed question is the rules for delineating the shelf between adjacent or opposite states. The Convention states (article 6) that in the absence of special circumstances the boundary between adjacent states is the medianline between their respective coasts. This has not always been accepted by countries and several disputes habe taken place. Where a party to a delineation dispute is not a party to the Convention, or where both states are not party to it, or where special circumstances justify departure from the median line principle (for example, if the coast of the state is concave and that of the other convex) the International Court of Justice has set out criteria which should be employed in reaching a settlement. Regard must be paid to broad, equitable principles, and among the factors to be taken into account are

- the median line principle,
- the configuration of the coasts of the states in question,
- the unity of the mineral deposits in the disputed territory, and
- the proportionality of the area and resources between the states.

Ownership of offshore mineral rights thus depends upon the definiton of continental shelf. There is no question that offshore rights within territorial waters belong to the state in question. Problems can arise in federal states, however.

In the USA mineral rights within the first three miles of waters from the shore are vested in the state in question.Beyond that point the continental shelf commences and all rights are vested in the Federal Government. Problems can arise. For example, in the Beaufort Sea there has been a long legal dispute over the Dinkum Sands. These are located more than three miles from the Alaska mainland. The Alaska Government claims that they constitute part of Alaska. The Federal Government claim that they are merely sands which appear above the surface of the water for only part of the year and cannot be considered part of Alaska territory.

3.2 The Role of National Oil Companies

3.2.1 With Nationalized Industry

Among developing countries the existence of state oil companies is the general rule where a petroleum sector, even a very young infant one exists. Their significance varies greatly from country to country. In some major producing countries where petroleum exploitation was nationalized they dominate the whole industry in the country concerned. Obvious examples are Iran, Saudi Arabia, Kuwait, Venezuela, Algeria and Mexico. In these countries the national oil company virtually runs the petroleum exploitation business.

There are significant differences within this group, however. In Iran, Iraq, Kuwait, Venezuela and Algeria the industry was nationalized in the 1970s, generally in an abrupt manner. The result was that the incumbent owners did not possess all the relevant technologies in sufficient quantity to continue exploration and development work. They sometimes concluded agreements with other companies to remedy this deficiency. Further new exploration work was slowed down because of lack of relevant expertise. In the case of Mexico Pemex has built up expertise over a long period of time and its technical skills are now highly developed.

3.2.2 Type of Contracts in not Nationalized Industry

In developing countries where the industry has not been nationalized but where the petroleum sector is substantial and long established national oil companies generally play a dominant role. Examples are Pertamina in Indonesia, Petrobras in Brazil, Petronas in Malaysia, NNPC in Nigeria and CNOOC in China. In these countries there is a spread of types of petroleum agreements but the roles of the national oil company is dominant within them all.

Thus in Indonesia and Malaysia and China there are production sharing contracts. The national oil companies are the licensees and partners in the exploitation process on that account. The national company is a partner in each of the fields being developed. In addition in Indonesia Pertamina has many subsidiaries involved as partners in the supply business.

Partnership under a production sharing scheme does not in itself mean equity participation. In Indonesia there is no participation in this sense, but in Malaysia and China equity participation at the rate of 50% does take place.

Being partner in a production sharing agreement does not automatically mean that a national oil company would play a dominant role in the industry. There are cases where national oil companies are licensees and partners under production sharing agreements but play a fairly passive role in the industry.

Mozambique is a case where the national company, ENH, does not play a dominant role. The extent to which the national company dominates the activity depends principally upon two factors, namely

- the degree to which active participation is allowed under the agreements, and

- the energy which the national company itself displays.

Where the petroleum industry has become large the national company has generally become more assertive and foreign investors have been prepared to let it have greater influence.

In Brazil risk sharing contracts constitute the main form of agreement. Under this type of arrangement an active national oil company is a sensible and possibly necessary vehicle to ensure that the risk service contracts operate efficiently. In Nigeria concession agreements exist but NNPC has equity participation in every field. It is on this basis that the national company plays a major role in the industry.

It is thus clear that under any type of contractual form the national company could play a major or minor role depending on

- the specific terms of the agreements and
- the energy with which the national company pursues its work.

Of course, where a large equity participation in every field is provided for, the national company is bound to play a major role. In such case the national company will be directly involved in the financing of field developments and questions of the funding of the company can loom large. This will especially be the case where there are considerable numbers of projects coming forward.

3.3 The General Role of Multinational Oil Companies

3.3.1 As a Concessionaire in Exploration

The first form of agreement between a host Government and multi-national oil companies was the concession. This has changed considerably in substance over the years with the regulations generally being tightened up to give the host country Government a much greater degree of control and involvement in decision making. Essentially the concession agreement gives mineral rights, originally vested in the state, to the investing oil company in return for certain obligations.

The rights which the licensee receives are equity rights. The investor will normally be given title to any oil discovered. Generally the company will be given a licence which allows him to explore for, develop and produce petroleum. Sometimes licences are divided between exploration licences and production licences. A company initially obtains an exploration licence. If a discovery is made a production licence is then obtained which enables the deposits to be developed and produced.

In modern concession agreements there are many obligations attached to the award of licences. There may be initial or signature bonuses to pay. In the USA and Canada licences are awarded by auction but this is generally not done in developing countries. Signature bonuses are common, however. The investor will have a work program to fulfil. This constitutes a main obligation required in return for the award of the licence.

At the exploration phase this will involve seismic and drilling obligations in particular. These will have to be conducted within a stipulated time period. By the end of the stipulated period (often five years for offshore situations) there will be a relinquishment obligation: a certain part of the acreage will have to be handed back to the authorities. There may be second and third exploration periods with further relinquishment terms attached to them.

3.3.2 In the Production Phase

In the event of a discovery there is frequently an appraisal period during which the investor has to appraise the prospect and determine whether it is commercial or not. If the find is commercial he will then have to prepare a development plan. Normally this will have to be approved by the appropriate Government ministry. Such approval will relate to principally

- the type of development plan (e.g. type of platform, whether there is a pipeline to shore or offshore loading, provision for environmental and safety problems), and
- the production profile for the field.

Often license provisions permit the authority to propose amendments.

License agreements will have many other provisions. Some of the principal ones are fiscal and others relate to training and the transfer of technology. These issues are considered below in some details. A concession can contain provisions for state company equity participation. This could be on a full risk-sharing joint-venture basis, or in a carried interest basis. This generally means that the investor pays for all the exploration costs. In the event of a discovery the national oil company would participate for a specified share. The details vary from one country to another. In some cases the state company pays all its share of the costs after a field has been declared commercial. In other cases it agrees to pay "its" share of sunk exploration costs. The importance of these differences is discussed further below in the section dealing with risks.

3.4 Production Sharing Agreements

3.4.1 The Foreign Oil Company as Contractor

The section main type of contract is the production sharing agreement. Under this scheme the foreign oil company is a contractor. The national oil company is generally the licensee. In some countries, however, there may be no national oil company even through there is a production sharing agreement. In that case a specified Government department looks after the state's share and interests. Nepal is an example of a country with production sharing agreements but no state company.

Under production sharing agreements the oil company as contractor does not have title to the petroleum. This generally remains with the State. The investor is given rights to dispose of the oil and retain some of the revenues. Generally the contractor will procure and pay for all the equipment necessary for exploration, development and production but title to the physical capital assets passes to the state oil company as well.

3.4.2 Obligations of the Foreign Oil Company

Under production sharing agreements the investor will have similar obligations as under a concession agreement. There may be signature bonus payments and sometimes production bonus payments as well. There will be an exploration period generally similar to that under a concession. The work program will be agreed at the negotiation stage of the contract. There will be relinquishment conditions as in a modern concession.

In the event of a discovery there will be an appraisal period during which the investor has to determine whether the project is commercial. In that event he has to prepare a field development plan as in a concession. This will have to be approved by the appropriate authority. Such approval includes the type of development proposed and the production profile. It will normally be the case that a field development and operating committee will exist which includes members from both the investing company and the national company. This will be the case even if the national company has no equity participation.

3.4.3 Share of Revenues

Under a production sharing agreement a certain proportion of the oil is initially employed for purposes of recovering the costs to date. This is termed "cost oil". The percentage figure is either stated in general regulations or subject to negotiation. There may also be regulations concerning the rate at which various categories of costs can be recovered. This again may be stated in general regulations to determine in negotiations.

The remainder of the oil is called "profit oil". This is split between the investor and the national oil company in predetermined shares. These shares may be fixed in general regulations or may be determined in negotiation. Frequently the percentage is not a flat one but varies with production: the Government's share generally increases as field production increases. The system is thus progressive in relation to field production.

In many production sharing agreements there is also provision for royalty payments and income tax payments. Conceptually these should not be included in production sharing agreements, but they have crept in during the 1970s on an increasing scale. Income tax is often included because it is often difficult for a host Government to exclude an industry from a general income tax. Fiscal aspects are discussed in detail below.

Equity participation by state oil companies is also possible within a production sharing agreement in a manner similar to that under a concession agreement. The variations noted with concessions are all possible with production sharing agreements. Examples include Malaysia and China. It is thus possible to have production sharing arrangements incorporating royalties, income tax and state equity participation. These are present in Malaysia and China.

From a legal viewpoint these are big differences between concessions and production sharing agreements. From an economic viewpoint they can be constructed to produce similar effects. An investor can generally operate within either framework. The effects of the agreements depend on the specifics of the provisions not the type or form of agreement.

3.5 Service Contracts

3.5.1 Risk Service Contracts

Another form of agreement is the service contract. There are two variants of this, namely

- the risk service contract and
- the non-risk service contract.

In service contracts the oil company is a contractor engaged to perform defined services. His reward may be in cash, but sometimes he will have access to crude oil under buy-back provisions in the agreement. In some contracts the oil company's fee can even be a percentage of the crude oil produced.

In some respects risk-service contracts are similar in their principles to production sharing contracts. The oil company generally undertakes the exploration and bears the exploration risk. In case of commercial discovery the oil company is reimbursed for its costs and investments and paid for its services. The oil company has no mineral rights. In fact in many agreements the national oil company takes over the operation of a field once it has been developed.

Brazil has played a main role in developing risk service agreements over the last 15 years. The features described above apply to the Brazilian agreements. The agreements provide for the reimbursement of funds employed for exploration purposes over a 5-year period without interest. Funds employed for field development are reimbursed with interest. The remuneration of the oil company is a certain percentage of the market value of the field's production. This is in effect a reserve royalty. The investor may also purchase a certain amount of the oil produced at world market prices.

Under risk service agreements the contractor is generally obliged to submit exploration programs for approval. Similarly field development plans have to be approved as in production sharing agreements. These are prominent features of the Ecuador risk-service agreements. In this country the cost recovery and the service fee are paid in kind out of the expected production. Income taxes are also payable by contractors under risk-service agreements.

3.5.2 Non-risk Service Contracts

Non-risk service agreements are not widely used. They have been employed by large producing countries such as Saudi Arabia and Venezuela. In Abu Dhabi the offshore Zakum field is operated by Total for a per-barrel fee coupled with the right to buy part of the production. No element of exploration risk is incorporated in these agreements.

3.6 The Risk Sharing Aspects

3.6.1 Illustration by an Example

The risk sharing under the different types of agreements is primarily a function of the specific elements in the contracts though the form does not have some influence. State company equity participation can have a significant effect on exploration risks and incentives in particular. This is best illustrated by an example. Suppose that the following information is available:

Cost of exploration program = E = $ 10 million
Net Present Value of Discovery = NPV = $ 100 million
Change of discovery = P = 1 in 5

The Expected Monetary Value (EMV) = P (NPV)-E = + $ 10 million

The effects of the following types of state participation can now be assessed. The rate of participation (GP) is taken to be 65 %.

State does not reimburse exploration costs:
EMV = P (NPV) (1-GP) - E = $ 3 million

State company pays its share of all exploration costs:
EMV = P (NPV) (1-GP) - E (1-GP) = + $ 3.5 million

State company reimburses exploration costs only where commercial discovery made:

EMV = P (NPV - E) (1-GP) - (1-P) E = - $ 1.7 million

The details of the participation arrangements are thus seen to be important in determining exploration incentives. The degree to which the state company shares in the exploration risks is the most important element but the extent of state participation is also important. Thus if the state's share were lower than 65 % the chances of disincentives being produced would be lessened.

3.6.2 Risk-Sharing with Different Contractual Forms

Some general statements may be made about the risk-sharing characteristics of the different contractual forms. With a pure non-risk service contract the contractor is paid a fee which is not dependent on the fruits of exploration nor on the behaviour of exploration and development costs nor on the behaviour of the oil prices. Thus no risks apart from the host country's ability or willingness to pay are incurred by the contractor. The other side of the coin is that no extra rewards accrue to the contractor if the project is very successful.

With risk service contracts the geological risk is placed on the contractor. With rewards to the contractor in the form of a fixed fee the development as well as exploration risks fall on the contractor. Part of the reservoir risk is also borne by the contractor. The oil price risk is not borne by the contractor. If the reward of the contractor is in the form of a royalty the contractor bears some of the reservoir risk and also a part of the oil price risk. Risk service agreements may not motivate contractors to seek reserves aggressively because they do not benefit to a major degree from such extra efforts. This effect is stronger with non-risk service agreements because the contractor has nothing to gain from "better" exploration and development strategies. Similarly under pure non-risk service contracts there are no incentives on contractors to keep costs as low as possible as their rewards are not linked to such achievements.

Under production sharing agreements this contractor initially bears all the exploration and cost risks but these are then shared with the Government through the revenues obtained from discoveries. There is a common interest in keeping costs as low as possible. Both parties gain from increases in reserves and so contractors have no incentive to explore agressively. Both parties share in the oil price and reservoir risks because both gain or loose as the size and value of reserves goes up or down.

Under concession agreements there is also a community of interest between licensee and host Government. The licensee bears the initial exploration risks (though these may be shared through the tax system) but both parties have an incentive for the exploration to be fruitful, and development costs to be kept as low as possible. Both parties share in the development risks (the Government through the income tax system) and both share in the oil price and reservoir risk (the Government again through the income tax system).

There are what may be described as contracting risks. These are here defined as unilaterial departures from the terms of the agreements by one party which jeopardizes the other party's position. In this context downside risks refer to cases where the contractor "walks away" from his obligations or where the Government defaults on payments to the other party (because it feels that the share going to that party is "too large"). Upside risks in this context refer to cases where the Government unilaterally reduces payments to contractors because they are thought to be "too large" in relation to the investment or risks undertaken.

In this context risk-service contracts could involve some downside risk on the part of a Government. Under production sharing agreements a flat production share (rather than one where the Government share rises with production) may produce upside risks if the reserves turn out to be very large or oil prices rise sharply.

3.7 Fiscal Aspects

3.7.1 Royalties

The fiscal aspects of petroleum exploration contracts are obviously important in determining the respective rewards to licensees/contractors and Governments but they also influence

- incentives to licenses or contracts,
- the likely stability of the contracts and
- the risk-sharing between Government and investors.

Royalties constitued the traditional reward to landlords from petroleum exploitation. Traditionally they were simple to calculate and brought revenues to Government as soon as production commenced. They do not involve much risk-taking on the part of Governments. The cost risks are kept firmly with the investors and the oil price risk in only borne by the Government to a very limited extent. When oil rices rose dramatically in the 1970's traditional royalties were perceived to be inadequate collectors of the greatly increased economic rents from petroleum exploitation. The convential rate (12 1/2 %) left too big a share of the rents with the investors. Higher rates of royalty were often introduced. These were sometimes on a sliding scale related to the size of field production. This reflected the idea that taxable capacity increased with field size.

Royalties, even of the sliding scale type, are a crude device because they are unrelated to profits. Thus when oil prices fell in 1986 large royalties could readily turn fields which were viable on a pre-tax basis into non-viable projects.

3.7.2 Profit-Related Taxes

Reflecting the high profits from petroleum exploitation in the 1970's special profit-related taxes were introduced within the scope of many concession agreements (though under separate legislation). These have purported to take into account the characteristics of petroleum exploitation offshore, particularly the fact that profitability varies considerable from one field to another. Such systems have an elaborate system of allowances. In general they are progressive in relation to profits (unlike royalties and production taxes which are regressive in relation to profits).

Being generally levied on a field-by-field basis such taxes share in the development costs to some extent although the investor has to wait until production from the field in question commences before the costs can be written off. Where exploration costs are allowed against income from other fields for purposes of the special tax, the Government shares to a high extent in the exploration risks.

Despite the profit-related nature of these special taxes they have generally not proved sufficiently flexible in response to major oil price changes and discretionary changes have been made in several countries. The schemes are not sufficiently closely related to economic rents (as opposed to profits in the normal sense) to prevent field development disincentives from being produced. The ring fence whereby the taxes are levied on a field-by-field basis contributes to the potential disincentives on field developments.

Under the production sharing schemes in many developing countries the share of profit oil accuring to Governments increases with field production. This means that the Government take is sensitive to changes in profits emanating from differences in field sizes. This is a factor producing stability in the agreements. On the other hand the Government take is not very sensitive to major changes in oil prices. Thus when oil prices fell dramatically the terms of production sharing agreements in several cases had to be changed to encourage new investments.

3.7.3 Company Income Tax

Company income tax is widely levied on petroleum exploitation. The terms of this tax can influence incentives. In particular the depreciation terms (how quickly costs are recovered against the tax) determine the extent to which post-tax rates of return are reduced below pre-tax rates of return. The slower the allowed rate of depreciation the greater the difference between post-tax and pre-tax rates of return. A further main issue concerns the presence or not of ring fence provisions. If they exist the investor will have to wait until production from a field commences before he can claim relief for the development costs of the field and possibly exploration costs as well. Such provisions put more of the risks on to the investor. If no ring fence exists the investor is able immediately to obtain relief for his exploration and development costs. The Government is then sharing in the risks to a greater extent.

3.7.4 Special Taxes

In some developing countries (e.g. Papua New Guinea and Tanzania) special resource rent taxes exist. These permit a specified rate of return to be achieved before taxation is levied. The tax is then levied on net cash flows. This tax is highly sensitive to changes in field size, development costs and oil prices. The scheme is thus likely to remain stable over a wide variety of operating conditions. This should encourage exploration and field development. The downside risk is shared to a very high degree by the host Government (unlike the case with a royalty or a standard company income tax).

3.8 Transfer of Technology Provisions

All types of contract contain provisions dealing with the transfer of technology including labour training and the purchase of local goods and services. No type of agreement is superior from the viewpoint of increasing local benefits by maximum economic use of local goods and services, labour training and transfer of technology. Effective results depend upon the specific details of the agreements and the vigour and energy with which the provisions are pursued by the parties to the agreement.

This subject was discussed in detail in Section A.3 above and the information and arguments presented there will not be repeated here. In general the lessons from actual experience over the last two decades are that insufficient effort has been given to this subject by both parties to obtain maximum economic transfer of technologies. In some cases the clauses have remained dormant.

Pakistan is an example where the regulations are very general and the Government has adopted a fairly passive attitude. To obtain more effective results in this area contracts need to have specific clauses dealing with the precise obligations of the parties to the agreements. Specific attention needs to be given to how the technologies are to be transferred. Similarly it would be helpful if specific financial commitments could be incorporated into the agreements. This can be done and is incorporated within the agreement in existence in Nepal.

Specific contracts for the transfer of technologies (separate from the petroleum exploration contracts) were discussed in Section A-3. Thus specific commercial contracts can certainly be effective in promoting technology transfer mainly because the obligations are clearly specified. Most general agreements whether with private organizations or with official organizations may effectively transfer technology but sufficient specific evidence is not available to make a general pronouncement on their effectiveness.

3.9 Financing

3.9.1 Standard Ways of Financing

Offshore oil and gas projects are essentially financed by

- retained earnings of the oil companies and
- borrowings from the banking system.

Exploration is generally financed by retained earnings. The exploration risks in the petroleum sector are such that banks are generally unwilling to lend for this purpose. As was discussed above the Governments of host countries may indirectly share to a considerable extent in the financing of exploration by permitting a fast rate of write-off of the exploration costs. Thus if the tax rate is 50 % and the rate of write-off for the exploration costs was 100 % (or immediate) the Government would in effect be financing 50 % of the exploration costs.

Field development costs are financed in part by retained earnings and partly by borrowings from the banking system. This ratios vary considerably from company to company depending on the financial position of the different companies. Thus the financially strong Shell company has financed most of its projects in the North Sea from retained earnings despite their huge cost. Bank finance was traditionally given in the form of loans where the other assets of the oil company were available as collateral. If necessary the bank had recourse to the borrower's other assets as collateral for the loan given.

3.9.2 Innovative Forms of Financing

In the 1970's because of the huge costs of some offshore projects innovative forms of lending were devised by the consortia of banks involved. Consortia were required because of the huge sums required. Production lending was developed in the first half of the 1970's. The project (or more specifically revenue from the field in question) is used to service the loan. It was not possible in the North Sea to offer the reserves themselves as collateral because the Companies did not have title. (Title is only transferred to the companies when the oil reaches the wellhead in the UK North Sea). It was not easy for operators in the North Sea to offer field production as the sole security, particularly before the oil had started to flow. Once production flows are established the stream of revenues can (and has) been employed as collateral for a new development. This has become known as piggy-backing.

Project finance has two criteria. The first is that the finance is raised from banks in the name of the project itself or collectively by the companies running the project. The second is that project finance offers little or no recourse to the companies involved and is off their balance sheets. There have been few collective financings in the North Sea because the financial standing of the participants often varies considerably within license groups. Examples of this type of financing are Ekofisk and Frigg. The Ekofisk pipeline was a suitable case because the financings could be based on throughput guarantees. Yet the security was eventually the borrowers'corporate balance sheets. Financing with limited or even zero recourse to the other assets of borrowers have been made in the North Sea, but they have generally been for individual participators rather than for projects in the sense of a whole field. "Off balance sheet" financing is supposed to invoice the borrower in paying a higher rate of interest to reflect the greater risk to the lending banks. The long term debt in the balance sheet of the borrower is kept down by the financing technique.

Under limited recourse loans the banks undertake some of the reservoir risks. Overall field recovery risks are also borne to some extent by banks under limited recourse loans. Project completion risks (whereby there is a risk that the date of first production may be delayed) will also to some extent be undertaken by banks under limited recourse loans. Oil price risks are also shared in part by the banks when undertaking limited recourse loans.

CHAPTER B-4

OFFSHORE INFRASTRUCTURE, PROCUREMENT AND PROJECT MANAGEMENT

SECTIONS

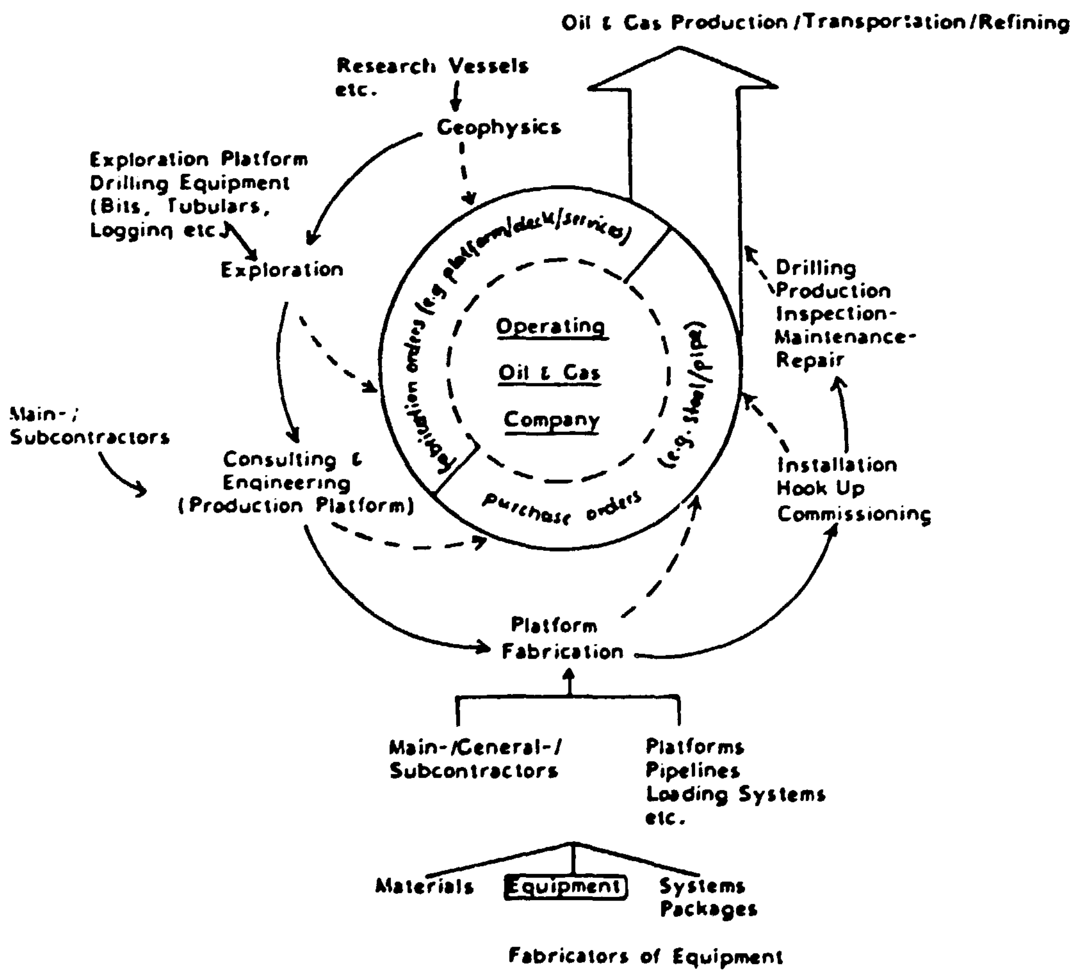
4. Offshore Infrastructure, Procurement and Project Management

4.1 International Offshore Projects

4.1.1 Network of Interdepe..dences

The international offshore industry can be characterized as a multi-level network of interdependences. Understanding this mechanism is essential for a successful sales policy.

Interdependences Offshore Industry



At the center of the industry is the operating oil & gas company. To support their activities there are thousands of consultants, engineering companies, contractors, fabricators, sub-contractors, etc. All efforts finally result in the production of oil & gas hydrocarbons. Organization structure and buying influences vary from company to company and from project to project.

The operating company may be an independent or integrated (drilling, production, pipelining, processing, marketing) oil or gas company. It may also represent a number of companies holding an offshore license in the form of a consortium.

In Developing Countries the operator often is a National Oil Company or it is a subsidiary of an International Oil Company. Personnel is seconded for a specific project or an oil company respectively a consulting company act as advisor for the developing country.

Comprehensive organization and planning work is required to implement a large offshore project. As soon as a field is declared a "commercial" find, "project task forces" and a "project management team" are installed.

4.1.2 Time Aspects of Project Realization

Planning and construction require several years and several hundred companies participating in the project. This can be demonstrated by three examples for oil and gas fields in the Norwegian North Sea:

1. **Statfjord B**
   Integrated drilling/production/quarters platform, 180,000 bpd. investment NKr 10.8 billion. Tenders requested 1975/76, on stream/installed August 1981. Main consultant was integrated in Mobil's project team. 3 main contractors. 300 companies with 40 000 people involved for 32 million man hours.

2. **Statpipe**
   Planning and Construction of 884 km subsea pipeline, 2 riser platforms and onshore terminal = 6 years, US-$ 3 billion

Schedule:	Sept. 1980	= Pre-feasibility study
	Febr. 1981	= STATPIPE group founded
	June 1981	= Approval by Norwegian Storting
	Dec. 1981	= Project services contract for Fluor Ocean Services
	1982-1983	= Contracts for steel/equipment
	1983	= Fabrication & installation riser platforms
	1983-1984	= Laying of pipeline
	1984-1985	= Construction of onshore-terminal
	1986	= Project completed

3. Oseberg A + B

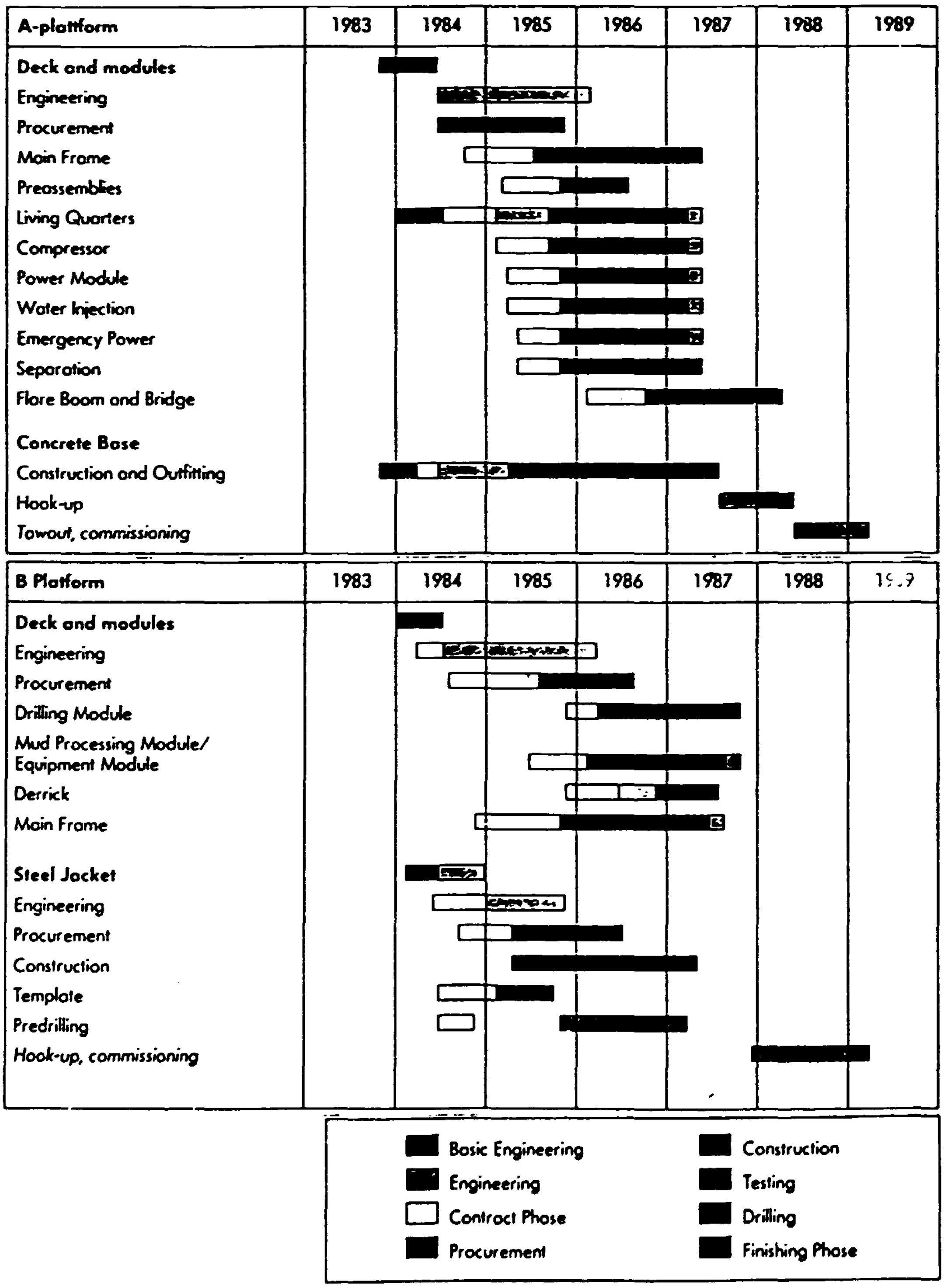
For a production start-up in 1989 the procurement started already in 1984, i.e. any possible vendor had to fill in questionnaires and establish a QA/QC system already years before delivery.

On the next page Norsk Hydro's Field Development Plan is illustrated:

U N I D O OFFSHORE STUDY
CNo 87/151 - PNo US/GLO/86/293

THE OSEBERG FIELD DEVELOPMENT PLAN

Source: Norsk Hydro



4.1.3 Main Development Schedule

The Project schedule will be developed following agreement over the development concept for a Project. The agreement being the result of detailed evaluations of the various proposed alternative concepts that were evaluated.

The first phase of the Project will be dedicated to Basic Engineering followed by the first part of Detail Engineering. These early phases will provide both technical and commercial details that will permit selections of Vendors and Contractors.

During the early phases a template will be fabricated and placed in the weather window, allowing the pre-drilling of wells to commence. The offshore phase will commence with installation in the weather window, and be completed to suit the program.

4.2 Execution of Project Development

4.2.1 Project Organization/Project Philosophy

To cope with billion-dollar projects, the oil companies have developed their own project philosophies and special procedures for awarding contracts. Based on Anglo-Saxon contract law, basic philosophies have been developed which, with some variations, are employed worldwide.

In the 1950s, contractors offered the oil companies a more or less precisely defined service for a firm price (possibly including an escalation clause). The reasons were: fastest possible field development and limited facilities of the oil company. Rapid technical advances followed, with different and higher demands being placed on offshore engineering. Improved management methods were required to cope better with specification alterations and cost increases for projects lasting several years. The contact between oil company and contractor became more and more important.

Interestingly enough, it was not the businessmen but the engineers in the offshore industry who opened up this new market. The engineering firms (that had until then only been active on the design and engineering side) increasingly offered comprehensive Project Management schemes with Procurement, Construction Supervision, Installation, Commissioning, Hook-Up and Finance Engineering. Nowadays, three types of management systems (with variations) have basically emerged:

1. General/Prime Contracts

The General Contractor takes an overall responsibility for Design/Engineering, Procurement and Construction, and possibly also Installation, Commissioning and Hook-Up.

This type of contract is preferred mainly by smaller oil companies (e.g. ONGC, Sanagol). Others split the tasks into several Prime Contracts, e.g.

British Petroleum Magnus Field:
Main Contractor "Structure": John Brown - Earl and Wright
Main Contractor "Deck": Matthew Hall
plus 160-man BP Project Team.

EPC-Contracts cover Engineering, Procurement and Construction as a turnkey service from the contractor to the oil company (often on a lump sum basis).

The fall of oil prices in the last years has caused a marked change in offshore project planning, with new contracts becoming once again subject to the idea of EPC-orders.

2. Oil companies with their own Management Team

Project Management and Procurement are carried out by the oil company, which then has greater control and influence but higher personnel costs.

This form of management is preferred particularly by the larger oil companies (e.g. Phillips), also for smaller projects. The oil company may possibly form a subsidiary for such purposes: Total CFP with Total Marine, BP with BPPG (for the Middle East), and Sohio USA.

3. <u>Service Contracts</u>

The Project Services Contractor and the oil company work together in a Combined Team. The Combined Team awards the orders for Design/Engineering, Fabrication, Installation, etc. The PSC strengthens the manpower capacity potential of the oil company. Numerous oil companies tend to choose this solution. The oil company and the PSC place the Engineering/fabrication order with the so-called Main Contractor who is, however, not given the responsibility of supervising his own work (conflict of interests!).

Which system the oil company will give preference to depends heavily on the answers to two questions:

A To what extent shall the oil company carry out Project Control work?

B How big or small is the oil company and therefore its manpower potential, and how big/small is the project?

Out of 23 oil companies covered in a recent study, only 4 still tend towards using a true outside General Contractor, 12 tend to use the Project Services Contractor (with hybrid forms), and 7 would prefer to set up their own Management Team.

An actual example for a large offshore project incorporating various types of contracts and more than 100 companies as contractors, subcontractors etc. are shown on the following page "Statpipe Project Orders".

STATPIPE PROJECT ORDERS

1. Sept. 1980

Pre-Feasibility Study
Statoil, Norsk Hydro,
Saga Petroleum, Dyno Ind.

27.2.81

Statpipe Consortium: Statoil 60 %, Elf 10 % Norsk Hydro 8 %,
Mobil 7 %, Esso 5 %, Norske Shell 5 %, Total 3 %, Saga 2 %

OPERATOR
Statpipe, Stavanger/London

100 Mill. $
Project Services Contractor
Fluor Ocean Services, London

884 km Pipelines

7 Mill. $
Pre-Engineering
Detail Design Work
Snamprogetti, Fano
50 Experts with Sub-Contr.
A/S Geoteam
A/S Geoconsult
Continental Shelf Institute
Huntings Survey

350 Mill. $
Fabrication Steel/Line Pipe
400 000 t 28", 30", 36"
1) Marubeni, Mitsui, Nippon Steel,
Nippon Kokan, Sumitomo,
Kawasaki, Mitsubishi
2) Mannesmann, Salzgitter,
Bergrohr

100 Mill. $
Pipe Coating
Bredero Price, Esbjerg
Norw. Contr., Andalsnes

260 Mill. $
Pipelaying
534 km deep section (150 Mio. $)
Mc Dermott (LB 200)
350 km shallow section
ETPM/ Bjorge Offshore
Shore approach
Ingeniør F. Selmer

100 - 120 Mill. $
Pipelaying Support
Pipe transport 40 - 50 Mio. $
various companies
Diving Support 11 Mio. $
Stolt Nielsen
Underwater work 60 - 70 Mio. $
Houlder
Comex mit Sub-Contr.
Stolt Nielsen u.a.

2 Riser Platforms

5 Mill. $
Engineering
John Brown Offshore, London
with Sub-Contr.
John Brown - Earl and Wright
Kvaerner Engineering
Phillips Petroleum

8 Mill. $
Engineering Communication, Control Systems etc.
Brown & Root

20 Mill. $
Fabrication Steel/Tubulars
Mitsui (Subcontr. Landruf,
Thyssen AG)
British Steel

75 Mill. $
Fabrication of Jackets
Aker, Trondelag
Highland Fabricators, Nigg

Fabrication Topside Fac.
Installation Jacket
Deck

Kaarstø-Terminal

3 Mill. $
Pre-Engineering
M.W. Kellog Co. London and
Sub-Contr. Ing. Strømme
Kvaerner Engineering
Moss Rosenberg

50 Mill. $
Engineering/Management Contr.
Linde, München

15 Mill. $
Site Preparation
Ingeniør F. Selmer
Høyer-Ellefsen
Construction Camp
Moelven
Water Supply
Hjellnes & Co. A/S

40 Mill. $
3 Tunnels total
Ingeniør F. Selmer
Hoyer-Ellefsen
Astrup & Auberg A/S
A/S Veidekke
A/S Stoltz Røthing & Co.
Ingeniør Thor Furoholmen

60 Mill. $
LPG-Plant (Fabric./Install.)
Noell Würzburg (Salzgitter)
50 % for Norweg. Sub-Contr.

approx. 600 Mill. $
Process Plant (Fabric./Install.)
Various Norwegian and
other companies

4.2.2 Responsibilities

The Project Organization, or Project Team, will be responsible for the planning and execution of the project until the complete, tested facilities are handed over to the Production Organization.

Engineering

Basic Engineering and introductory detail engineering will be carried out by the Project Team. During these engineering phases design and documentation of equipment and structures will be performed as basis for bids for E.P.C. Contracts and Long lead delivery items. Detailed schedules for the remaining engineering and the construction phases as well as schedules for award of contracts and purchase orders will also be made.

Further detail engineering will be carried out by the E.P.C. Contractors and monitored by the Project Organization, who will establish Project site teams at all major fabrication sites.

Construction

The Project Organization is responsible for performance of the construction work according to the contract schedules. The execution of this work will be followed and controlled to satisfy requirements for quality, schedule and cost.

Installation and Completion

Prior to start up of installation activities, a detailed plan and specifications for execution of the work will be prepared.

Testing and Closeout

When the facilities are commissioned, tested and ready for production the Project Team will transfer project responsibility to the Production Organization. Prior to that time the Project Team will demonstrate and document that all requirements for the installations are met.

4.2.3 Project Execution

A Project Model will define the functions to be performed and how the results will be obtained. This will be specified in handbooks and manuals as follows:

- Project Activity Models
- Project Organsiation
- Project Manual
- Procurement Philosophy
- Bid Evaluation
- Project Procedures
- Project Tools
- Training of Personnel/Teambuilding
- Project Finance and Administration
- Quality Assurance
- Safety.

4.2.4 Project Organization and Project Control

In the various phases the detailed structure and size of the organization will be adjusted to match the individual phases of the development. The Project Organization will be an integrated task force consisting of personnel and consultants as required. The need for personnel will increase throughout the basic engineering period.

Project Control will be performed throughout the project development and compare achieved results to plans and procedures. The achieved results are to be compared with regard to:

- Quality requirements
- Time schedule
- Cost estimates.

The comparison is made to identify deviations in order to be able to make corrective actions at an early stage.

The total project will be split into manageable units according to the Project's Work Breakdown Structure (W.B.S). The W.B.S. will be the key tool to plan, organize and control the project. It will be presented as a visual picture of the total project, and will form the basis for all scheduling, budgeting, performance measurement and reporting.
The W.B.S. will be a logic physical breakdown of the project into controllable units such as:

- Total Project
- Sub-Project

- Main Areas
- Contracts
- Disciplines
- Work Packages.

The operator will develop the W.B.S. down to the contract level. A further breakdown into work packages will be done by the contractors.

4.2.5 Quality Assurance Strategies

An intensive effort should be made to execute all activities in a safe manner according to its well defined quality standards. Quality assurance programs are utilized to achieve these goals in all parts of the organization, and in coordination with all control systems in the project.

The objectives for a Quality Assurance System are:

- Ensuring that goals are reached in a formalized, systematic and effective manner

- Satisfy Authority requirements for internal control

  Fulfilling these objectives is primarily accomplished by:

- Decentralising establishment and maintenance of controlling documentation

- Responsibility for quality of own work is put on to each employee. Discipline leaders are responsible for work within each discipline.

- The Quality Assurance System will cover all technical and administrative systems necessary to organize, manage and execute quality assurance. The Quality Assurance System is established to control relevant functions in the permanent organization and all phases in planning, development and operation period for the total project. Vendors and contractors at all levels contributing to the project shall have acceptable quality assurance systems. Safety control is part of the Quality Assurance System.

The Quality Assurance System is documented in:

- Quality Assurance Program for the Oil and Gas Group
- Quality Assurance Manual for the Technology and Projects Division
- Quality Assurance manual for the Project (to be prepared)

A Quality Assurance Manual for the Project should be prepared to cover all phases of the Project.

4.2.6 Contract & Procurement Philosophy

Procurement of goods and services will be executed in accordance with the license documents, applicable offshore rules and regulations, and in accordance with established guidelines and principles.

Established procedures for pre-qualification which ensure that the selected contractors/suppliers are technically and commercially capable of performing required services and deliveries with regard to quality , delivery time, price and service.

Tenders received will be evaluated in accordance with established principles of evaluation. Clarification meetings will be held to the extent necessary to ensure that all aspects of the work to be performed have been fully understood.

Emphasis will be placed on business ethics, cost consciousness, good business practice, good communication and dialogue with the supply market. A fair and consistent treatment of contractors/suppliers should also be part of a contract and procurement philosophy.

A contract plan will be developed based on the above mentioned principles. Furthermore such a plan will reflect.

- Subdivision of the total Project's scope of work into clearly defined and manageable work packages
- Minimum hook up and commissioning offshore
- Use of EPC contracts where advantageous
- Use of lump sum/fixed price unit rate contracts where possible, with due consideration on the level of work definition
- Use of local supply and services whenever competitive on quality, delivery time, price and service
- Use of established model contracts based on laws familiar to the industry

- Project completion with acceptable technical quality on schedule and within budget.

The procurement strategy will be established during the concept and basic engineering phases. It will be further developed during the detail engineering phase to allow for necessary adjustments to the market situation and to incorporate required changes due to the development of technical solutions.

4.3 Procurement Procedures

4.3.1 General Remarks

With few exceptions, the procurement procedures of the oil companies follow a definite pattern: suitable vendors are selected at various stages, followed by signing of a contract. This several stage process can be characterized as follows:

Principle of Procurement Procedure

VENDORS LIST	
	Specifications
BIDDERS LIST	Invitation to Bid
	Bids Received
	Screening of Bids
SHORT LIST	
	Bid Evaluation
	Bargaining
	Vendor Choice
SIGNING OF CONTRACT/PURCHASE ORDER	
DELIVERY	
FOLLOW UP	

4.3.2 Example of STATOIL

Using the example of the Norwegian oil company STATOIL and their method for drilling and production platforms contract award and purchase procedures can be explained as follows.

First of all and behind all efforts is the idea of fair and equal competition to the benefit of the oil company.

All contracts for a certain project are split into:

A Fabrication Contracts

- large items of equipment or components (if the client wishes to have administrative control over fabrication)

- adjustments to original concept are possible in a controlled interface between client and fabricator

B Purchase Orders

- procurement of complete items for basic construction materials e.g. steel, pipe, fittings, electrical/mechanical equipment (use of suppliers or vendors)

For the awarding of fabrication contracts a 5-phase method is used:

phase 1: Pre-Qualification of Contractors

a) indexing of all contractors by questionnaires to obtain common basis for comparison and equal consideration (target: all contractors to have equal opportunity and consideration)

b) shortlisting of those contractors who are most suitable for the particular contract: analyzing the index and related information and questionnaires. To reduce the number of contractors a more detailed questionnaire may be issued (specificly related to the particular contract)

phase 2: Invitation to Tender

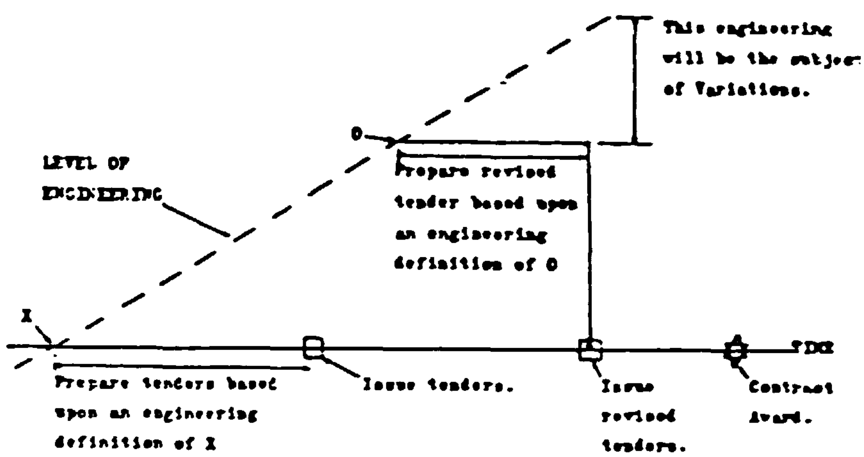
Tender documents are prepared/mailed from the client or his (general) contractor/consultant to the short listed contractors.
Tender contains comprehensive information on the project and necessary interface and control and schedule. Poss. preliminary tender information to short listed contractors for a presentation of their opinion on FEASIBILITY, RESOURCES & CAPABILITIES (e.g. construction & installation method).

phase 3: Submission of Tenders

The contractor presents his tender documents to the client. The presentation will influence the client opinion: complete and detailed but not too voluminous.
EXACTLY TO REQUIREMENTS.
Different proposals/offers with technical, alternatives only in addition to the one meeting the clients original requirements.
"Seal Bid" procedure is used for large contracts: the tenders have to be delivered at a certain time and to a special committee of the client and his partners. No communication between tenderer and client during clarification process. If necessary only through the route identified in the

Instructions to Tender (Never Subcontractor directly to client).

<u>"Two Stage Tendering"</u> may save time for large projects and is described as follows:



Final selection of contractor will be made upon results from both stages of tender.

phase 4: Evaluation of Tenders

Final process of contractor selection.

a) Screening of all tenders:
pricing technical features completeness etc. will lead to most attractive tenders.

b) Detailed analysis and evaluation of the most attractive tenders:
commercial considerations (qualifications, costs, pricing, financial background terms of payment); technical considerations (site

facilities, planning and scheduling, construction & layout methods, experience, management capabilities)

Conclusion for clarification meetings with specific contractors.

phase 5: Contract Award

a) "Clean" contract document is the newer method using Articles of Agreement based on the updated tender documentation (using word processing machines) signed

b) Form of Agreement reflecting the client's acceptance of the contractors offer based on the tender documents.

4.3.3 Example of BRITISH PETROLEUM

BRITISH PETROLEUM makes a distinction between two types of order:

1) "Purchase" (material/equipment) for materials and equipment; the responsible body is the central Purchasing Division

2) "Contracts" (work/service) for complete modules/systems and services; the responsible body is the Contracts Division.

A substantial portion of the procurement volume is handled by the "Main Contractors" and "Managing Contractors" on behalf of BP.

The Central Purchasing Division in Harlow has two technical departments, one non-technical, and one purchase preparation department. The technical departments are subdivided according to materials; the biggest single purchase amounted to US $ 100 million for 1 300 km 48" large-diamter pipes.

The large number and nature of the orders makes it necessary to follow certain methods and procedures. BP has a "List of Suppliers" containing those manufacturers who are capable of supplying certain materials or items of equipment in conformity with BP specifications, quality standards and general requirements. The list is compiled particularly for technically difficult/complex products, and in 1982 for example comprized about 40 product groups and over 700 suppliers. The list is updated on a continual basis and is regarded as an important tool in connection with the placement of purchase orders.

Every requirement received by BP is rewritten in the form of an enquiry and sent to a number of selected suppliers ("Vendors"). A "reasonable" period of time is given for submission of bids. The bids are opened at the end of that period. The purchasing officer checks that the bid agrees with the technical specification and purchasing conditions. The purchase order is placed following a decision passed by the "Contract Committee".

Maintenance of quality and delivery deadlines is assured by an "Inspection Division" which maintains close contact with the Vendors.

The Contracts Division in London works closely with the "Business Streams", "Projects" and "Engineering" departments. It is responsible for:

- Recommendations/implementation of contract strategy

- Updating and evaluation of documents concerning the supplies & services program of contractors and consultancy firms

- Comparison (screening) of various contractors for specific tasks

- Development of contract models for bid calls.

One of the first and most important decisions concerns the questions:

"Will BP use the services of a general contractor (Overall Managing Contractor) or set up an in-house Project Management Team?"

Other questions are:

- Because of the size of the project, should the services of several contractors be used?

- Should the contractors take over design, material procurement and construction in their particular sphere?

- What control and managerial authority will BP have?

The answers to these questions will have a major effect on the form of contract that is drawn up (e.g. firm prices, invoicing on an as-incurred basis, etc.). Lump-sum contracts are often signed for construction orders; the Managing Contractor can, however, charge materials and equipment to BP. In such cases, the Contractor agrees to engaging the services of sub-contractors must be approved by BP (Project/Contracts Division and the Contract Committee).

A special procedure has been developed for awarding contracts for major orders:

1) BP does not have any hard-and-fast list of so-called "approved contractors". Instead, BP constantly evaluates all information on their present and former business partners and bidders in order to compile a Tender List for a specific project. For this purpose, questionnaires are also sent out and visits arranged.

2) A final Tender List is drawn up in a final screening procedure and submitted to the Contract Committee for approval.

3) The Contract Engineer prepares the specification and the contract conditions, and makes up the Bid Package that is sent out to selected bidders.

4) Additional points and queries are raised, works visits arranged, etc. in the course of the Tendering Period.

5) The bids are opened by a set deadline, and are checked for technical, financial and commercial details. A proposal for awarding the purchase order is then worked out and submitted by the Project Manager to the Contract Committee.

6) The Contract Engineer is authorized to draw up a Letter of Intent.

As a member of the UK Operators' Association, BP also has to observe the "Memorandum of Understanding/Code of Practice" issued by the Britisch Energy Ministry. This gives British bidders "full and fair opportunity" (particularly in the case of more favourable bids submitted after the tender opening date = right of last refusal). Implementation is carried out by the Offshore Supplies Office.

Finally, BP gives some fundamental recommendations:

- DO read and understand the specification and other bid documents. If you are unable to comply with any fundamental point DO say so rather than waste your time and ours in submitting a bid. If you are unable to comply with some minor points DO give an explanation so that we know whether it is intentional or due to an oversight.

- DO understand that when we make a change in the specification or other requirements we do this for reasons of necessity, appreciating that some consequent disruption and increase in cost may be inevitable - but we expect everyone to minimize these.

- DON'T take on more work than you can perform, whether from the point of view of technology or capacity/workload. If we ask the impossible DO say that you can't meet our requirements and DO say what you can offer towards our objective. DON'T just hope that everything will turn out easier and quicker and cheaper than you honestly believe.

- If you are unable to bid due to workload DO say so immediately. We may then be able to ask another firm to bid. DON'T just put in a high bid or no bid at all.

- DON'T rely on our quality assurance and expediting rather than dealing with these functions as your own responsibilities.

- DON'T put in a low bid to get the job and hope (or expect) to make money on extras.

- DO deliver the goods in accordance with the specification and on time.

- DON'T expect to cut your teeth on BP. First establish a good track record on the type and quality of your work.

The bidder should never and on no account change the specification of his own accord. If he thinks that a different solution would be more advantageous, for example, he may only offer this as an alternative. If he does make modifications of his own accord, his bid will not even be admitted for screening.

4.4 Quality Assurance/Quality Control, Standards, Documentation

Quality Assurance/Quality Control (QA/QC) and Documentation became a very important factor where oil companies are looking upon.

The basic principle laid down is normally that demands on supplier's documentation are in accordance with the overall quality control/assurance philosophy prevailing. Documentation will be demanded to the extent required for the project planning and co-ordination carried out by the main contractor or the operator. This means that full documentation must be available from the supplier at any time should it be required.

For North Sea projects documentation is being categorized in classes, for one reprensentative project in 5 classes as such

Class I:

Documentation that the EMC (Engineering/Management/Co-ordination) contractor needs rapidly and on which project co-ordination main dimensions, space requirements and hoisting arrangements for dismantling and maintenance, information about weights and loads, definition of all external hook-up points. Class I documentation concerns product "interface" and is to be forwarded to EMC contractor during the project planning phase.

Class II:

Documentation concerning construction/details to verify that work is being performed in accordance with requirements specified. Since supplier is responsible for own design/fabrication, only essential documents will be called for during project planning.

Class III:

Documentation describing manufacturing process, testing and quality control/assurance. Normally this documentation will not be called for during project planning.

Class IV:

Fabrication reports, test reports, quality control reports, and certificates. EMC contractor will normally call for documentation for capacity tests and specially required testing.

Class V:

In it's final version this comprizes the total technical documentation and the basis fcr "Final as-built" documentation. This documentation is vital for the EMC contractor and will accompany the final "as-built" documentation.

Documentation

Demands on quality control will clearly be defined in vendors' request for tender. Invitation to tender will be accompanied by a form to be filled in by the tenderer together with this quality control documentation. Prior to any purchase order, the operator or his project management consultant will have received the contractor's (supplier's) quality control system and approved it. Approval of quality control systems will be co-ordinated in order to prevent repetition of review/approval procedures for additional contracts.

CHAPTER B-5

CONTRACTUAL OPTIONS FOR PROJECT PHASES

SECTIONS

5. Contractual Options for Project Phases

5.1 Types of Contract

5.1.1 Generally

Depending on the circumstances of the client, the Contract Philosophy must be decided upon at the beginning of the feasibility phase at the outset of any proposed development. The initial choice of Contract will affect the Contract Philosophy of the Project Phases, Project Phases can be summarized as:

* Feasibility
* Engineering
* Procurement and Construction
* Installation, Hook-up and Commissioning
* Operations

5.1.2 Turn-key or Traditional Contracts

The first decision to be made therefore is whether the client's circumstances dictate that a Turn-key Contract must be entered into or whether the more usual and traditional approach is to be adopted, where the client himself decides on the Contractual options and therefore retains some measure of control.

5.1.3 Turn-key Contract

Turn-key Contracts are those where the entire scope of work, including all Project Phases necessary to evaluate and develop an oil discovery, is entrusted to one Managing Contractor who provides all that is required to achieve the production and delivery of the specified end product - crude oil, and accepts the entire responsibility for the same with all attendant risks for an agreed lump sum all inclusive price.

The principal advantage of a Turn-key Contract is that it enables a Client with little or no experience or in house oil related administration or expertise to achieve the completion of complicated engineering projects where detailed knowledge and advanced engineering skills are required using expensive equipment.

The main disadvantage from a client's point of view is that he can have little or no control whatsoever over the running of the project insofar as all decisions relating to specifications, procurement of materials and supplies, labour requirements and the like will be made by the Contractor. For this reason very strict attention must be paid to any negotiations for a Turn-key Contract in order that the client's objectives can be achieved if possible.

5.1.4 Traditional Types of Contract

There are a number of different types of contract currently in use by oil companies when they let contracts for the construction of jackets, decks, modules, etc. The Conditions of Contract are often based on F.I.D.I.C. (Federation

International Des Ingenieurs-Conseils) standard conditions but are amended by the clients to suit the specific project and to match their own requirements in the light of experience on past contracts.

Contracts for construction contracts may be divided into three main categories:

a) Lump Sum,
b) Schedule of Rates, and
c) Cost Reimbursable.

The main difference in the types of contracts is (a) the information provided by the client, (b) the make-up of the tender figure and (c) the method of paying the Contractor. These may be shown:

Design	Method of valuing payments
Client	cost reiumbursable,
Client	bills of quantities (may be stated to be approximate) and lump sum tender schedule of rates, work to be measured as built and priced at rates
Client	lump sum tender from specification and drawings; changes valued by unit rate, cost reimbursement, daywork.

In traditional contracts the client has his own team of Engineers, Contract Specialists, etc., and therefore, provided the Conditions of Contract, Specifications, etc.

are properly prepared, can then exercise the required control over the respective contractual packages particularly with time constraints which can normally be respected with efficient planning.

In any event the drafting of any contract compensation appendix must ensure that the format adopted is consistent with the level of Engineering definition expected at the time of Tender Issue and Contract Award. Failure to recognize this will lead to contractual difficulty during the Contract Administration, with eventual claims from Contractors.

Lump Sum Contracts

a) Specification and Drawings

The Contractor offers to carry out the works for a fixed sum which is made up by the Contractor from the information given in the specification and drawings.

Each Contractor is responsible for material take-off for the whole of the works in all trades, for measuring welding content and for estimating manhours, plant, overheads and everything else required to prepare a tender. If an error is made, e.g. in measuring from the drawings, then the Contractor whill have to stand by his tender price, whether it be an over or undermeasurement.

The main difficulties arise in defining the scope of work and each Contractor may put a different interpretation on what is to be included in the price. If the drawings and specifications are not well advanced and if details are not produced then it is not likely that all Contractors will price for exactly the same work. There are difficulties for the client in evaluating the tenders because the Contractor with the lowest bid will not necessarily be the Contractor who will give the best value for money.

Contractors have a problem to decide on their tender figure because if they allow not only for what is specially shown on the drawings but also what they know from their own experience is likely to be needed and also for some contigencies then their price might be higher than another Contractor who has priced for the minimum amount of work. From the client's point of view, he might find it best to award the contract to the Contractor with the higher price, but how can this be justified at tender stage?

The contract may include for authorized changes to be priced on the basis of a schedule of rates, lump sum assessment or daywork.

Lump sum contracts therefore require a high degree of engineering definition at tender and contract award in order for the contractor to accurately estimate the quantity of work required. In order that the Company can understand the tender offered, the breakdown of such lump sums should identify the major elements of work. The selection of rates for valuing of variations should reflect those areas where changes are most likely to occur. Lump sum contracts do provide for simplification and administrative procedures assuming that there are limited changes. They also generate a simply basis for comparison during bid evaluation however they are difficult to evaluate and rates used to value changes are often limited and restrictive.

(b) Bills of Quantities

The Contractor offers to carry out the works for a fixed sum which is made up by the Contractors by pricing each item in the bills. The items are a description of work, labour and material combined with dimensions and total quantities stated; unit rates are applied to each item. The information in the bills is supplemented by specifications and drawings which are part of the tender documents.

The bills of quantities are prepared by the client and are at his risk should there by any errors; it is the client who has interpreted his own drawings and specifications and prepared the items upon which the tender sum is based. All Contractors price the project on the same basis and evaluation of tenders by the client is much easier and he is more likely to choose the Contractor whith the most advantageous price. The Contractor is relieved of the responsibility for material take-off, measurement of welding and the like.

Change orders can be priced using the unit rates if the work is of a similar character or on new unit rates based on the tender rates if the work is not exactly of similar character or not executed under similar conditions. If unit rates are not appropriate then reiumbursable or daywork methods may be used.

Schedule of Rates

This type of contract is often used when the drawings and details are not far enough advanced to prepare bills of quantities but the client wishes to invite tenders to allow a start to be made on construction as soon as possible.

A schedule is prepared which lists all the items which the client considers will be necessary to carry out construction. It has similar layout to bills of quantities but there will not be quantities against each item. However, approximate quantities are sometimes inserted in order to gain some idea of the total cost of the work and also to help in evaluating tenders.

The work is measured as it proceeds and valued at the rates in the schedule. Schedule of rates contracts can be used in work of repairs where they are repetitive or recurring.

Cost Reimbursable

This type of contract is used when the drawings and details are not far enough advanced to define the scope of work very clearly but the client wishes to start construction work. Works of alteration are very suitable for this type of contract.

(a) **Percentage Fee**

The Contractor is paid the cost of labour, materials and plant plus an agreed percentage to cover his overheads and profit. There should be a clear understanding as to what items are and are not included in the percentage.

(b) **Fixed Price**

Instead of a percentage a fixed fee is sometimes agreed, i.e. a sum of money is agreed and regardless of the value of the reimbursable parts of labour, material and plant, that sum does not change.

The fixed fee form is the more satisfactory than the percentage fee from the client's point of view since in the case of the cost plus percentage type it could be that the more inefficient the Contractor the greater his costs and therefore the greater his profit.

(c) **Target Cost**

An estimate of the work is agreed as the "target" price. A fee for management services is agreed.

The actual amount paid to the Contractor depends on the difference between the "target" price and the actual cost.

The fee is adjusted in an agreed manner according to whether the actual cost is greater or less than the "target".

If there is a saving, the fee is increased and provides a bonus to the Contractor.

If there is an extra, the fee is reduced and provides a penalty.

The real difficulty in this type of contract lies in the agreement of a relastic "target" and the adjustment of this target in the event of changes and variations. The scope of work has to be reasonably well defined if a realistic estimated cost is to be agreed between client and Contractor.

Composite Contracts

Sometimes contracts are let on the basis of a combination of two or more of these different types of contracts; or it may be agreed once a contract is underway to change from one type to another for the remainder of the contract.

5.2 Contractual Options for Project Phases

5.2.1 Feasibility

(a) **Reservoir Evaluation**

A study order is usually made to an International Expert Company for a lump sum price. The Company responsible for the study or survey may let sub-contracts for particular items of work.

(b) **Field Development Options**

An Engineering study is made by a recognized Company of Project Management Consultants on a target cost basis, i.e. a maximum number of manhours. The fee is then adjusted in the agreed manner according to whether the cost is greater or less than target.

A Client in-house analysis is conducted of study results achieved above or an independent audit may be performed.

(c) **Platform Selection**

Continous studies are prepared of differing options with cost estimates with recognized expert Company on the basis of either traget cost or lump sum basis.

Final authority is taken in house together with funding authority.

(d) **Pre-Engineering**

Pre-Engineering or Basic Engineering is done in the early stages to provide both technical and commercial details that will permit selection of vendors and contractors.

Pre-Engineering entails the production of document packages to suit ongoing detail engineering methods.

Basic Engineering Contracts should preferable be established on a cost reimbursable basis with a cost ceiling and milestone targets with corresponding "savings" and "penalties" conditions.

5.2.2 Engineering

(a) **Detail Engineering (Traditional Method)**

During this phase the design and documentation of equipment and structures will be performed as basis for bids for E.P.C. (Engineering/Procurement/Construction) Contractors. Detailed schedules for the remaining engineering and the Construction Phases as well as schedules for award of Contracts and purchase orders are also made. Further detail engineering will be carried out by the E.P.C. Contractors and monitored by the Project organization. The Project Organization is an integrated task force consisting of Client Personnel and Estimating Consultants.

Such detailed engineering of the facilities must be progressed to such an extent that the scope of work for each contract package is sufficiently defined and also to ensure total interface control between the packages.

This phase may be executed for an entire platform or more usually as individual major packages to relevent concerned consultants with proven track record if possible on previous client projects.

Contracts normally on a lump sum or reimbursable basis:

(b) **Engineer and Procure Contracts**

In certain cases and for specific items of specialized equipment it is sometimes necessary to request the engineering and the procurement in one package. This is handled in the same way as normal material procurement expect that the supplier is responsible for the engineering of the items in question. This would normally be done under a purchase order.

(c) **Specialist Component Engineering**

Usually lump sum or reimbursable basis.

(d) **Management Assistance Contracts**

Usually lump sum or reimbursable basis.

(e) **Long Lead Equipment Packages**

The client (or Operator) secures these items through direct purchase orders; these are usually critical items or where, for schedule or standarization reasons, are required to be Nominated Suppliers as, for example, where they need to be procured prior to award of EPC/fabrication contracts.

5.2.3 Construction

(a) EPC Contract Packages
(b) Onshore Construction Packages
(c) Bulk Material
(d) Equipment Packages
(e) Management Assistance
(f) Marine Operations
(g) Subsea & Pipeline Contracts
(h) Onshore Pre-commissioning & Commissioning
(i) Atshore Assembly/Instaliation

All of the above mentioned sections could be further split into a manageable units according to the projects work breakdown structure (W.B.S).

The W.B.S. is the key tool to plan, organize and control the project. It is presented as a visual picture of the total project and forms the basis for all scheduling, budgeting, performance measurement and reporting.

The W.B.S. is a logical physical breakdwon of the project into controlable units such as:

- Total Project
- Sub Project
- Main Areas
- Contracts
- Disciplines
- Work Packages

The client or operator develops the W.B.S. to the contract level. A further breakdown into work packages will be done by the contractors.

Most of the above mentioned Construction Contracts are let on a lump sum basis where the scope of work is defined. Alternatively, reimbursable contracts may be used in certain cases. Marine Operations are furthermore based on lump sums per defined tasks with differential dayrates for equipment working and on standby.

5.2.4 Installation, Hook-up & Commissioning

(a) Marine Operations
(b) Installation Contracts
(c) Pre-Drilling & Subsea Well Completions
(d) Construction/Accomodation Vessel Charters
(e) Hook-Up & Commissioning
(f) Export & Flow Line Installation & Tie-ins
(g) Platform Well Drilling

The activities listed in this section are normally the subject of individual Sub-Contracts, either on a lump sum basis or cost reimbursable if the scope of work cannot be defined.

5.2.5 Operations

(a) Logistics
(b) Maintenance
(c) Operations Support
(d) Shore Base Operation

The activities listed above are usually governed by lump sum contracts.

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CHAPTER B-6

TECHNOLOGICAL TRENDS

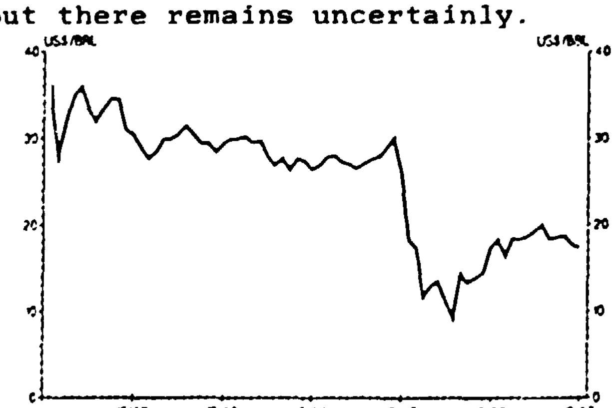
6. Technological Trends

6.1 General

In the years between 1970 and 1980 the rising oil prices and the expected shortage of oil and gas in the near future was a challenge to the oil companies to find new oil resources and - together with engineering companies and other oil related industries - to develop new technologies for exploration, production, loading, transport and even processing of oil and gas in the offshore areas. In these years most of the offshore technology was developed, which is always standard today. Trends in the seventies where essentially

- find and produce oil and gas at even any cost
- exploration and production in more and more deeper waters
- exploration and production in harsher environments as e.g. the northern North Sea or in ice covered areas.

Meanwhile the oilprice had a sharp downturn by end of 1984 to less than 10 US $/barrel in 1985. Actually there is a certain stabilization at 17 to 18 US $/barrel. Most of the experts expect a slow rising of the oilprice in the ninetieth but there remains uncertainly.



The oilprice development has affected the oil industry as well as the oil related supply and service industry. The consequences where cutting of exploration and field development budgets, dismissal of people in the oil industry as well as in service and supply companies, closing of construction yards and laying up or scrapping of mobile drilling rigs and supply ships.

The main technological aim rising from this economical trend was to develop and to use more cost effective systems as before. This aim does not cover only the so called "Marginal Fields". In the contrary: any cost effective system - be it for small fields or for deep water environment - will improve the economy of all exploration and production operations and contribute to the commerciality of oil or gas resources.

Low cost technical solutions are of special interest for developing countries with hydrocarbon resources which where up to now not developed due to their unfavourable geological conditions (small fields) or to their position far from the coast or in deep water.

In any way it should be mentioned that high technology developments which are in course or envisaged will not always be the best solution for a developing country. Cost saving is mostly achieved by saving manpower. This is mostly not in the interest of a developing country which in the contrary often has an abundance of people who have to be trained in the classic skills of offshore drilling and production technology. It has to be negotiated in any case of colaboration which technology shall be included in education and training.

6.2 Exploration

Drilling amounts to more than 35 % of an operators total yearly exploration and production expending charges. The average number of offshore wells drilled yearly is estimated to 3500.

Exploration drilling has reached a technical stand which enables the drilling contractors to offer drilling in waterdepths up to 3300 meters. The following examples give an impression of the capabilities of modern drilling rigs.

SEDCO 472, Drillship

Rig design:	Earl & Wright; dynamically positioning
Performance:	Water depth - 6.000';
	drilling depth - 25.000',
Quarters:	116 persons
Hull:	470'x 70'x 32'
Variable Load:	9.409 short/tons.
Heliport:	70'x 70'

DISCOVERER SEVEN SEAS, Drillship

Rig design:	Sonat Offshore Drilling;
	Discoverer class, turret-moored
Performance:	Water depth - 7.000',
	Drilling depth - 25.000',
Quarters:	152 (plus) persons
Hull:	534'x 80'x 32'
Variable load:	9.148 short tons.
Heliport:	83'x 83'

HENRY GOODRICH, Semisubmersible

Rig design: Sonat/Mitsui

Performance: Water depth - up to 10.000',
drilling depth - 30.000'

Quarters: 150 persons

Hull: 246' x 320' x 154'

Variable load: 5.500 short/tons.

Heliport: 90' diameter

The water depths of wells which effectively have been drilled has generally increased in the past years.

WELLS DRILLED ANNUALLY BY WATER DEPTH RANGE (FT)

Year	600-999	1.000-1.999	2.000-2.999	3.000 plus	Total
1987	23	32	9	10	74
1986	45	57	23	12	137
1985	62	67	20	5	154
1984	37	71	9	4	121
1983	65	33	0	5	103
1982	54	29	5	3	91

In fact the existing fleet of mobile drilling rigs consists of 741 units which are actively working, available for work or under construction (Ocean Industry, August 1987).

This figure contains

441 Jack-ups
187 Semisubmersibles
78 Drillships/Barges
35 Submersibles.

The drilling technology has got a lot of impulses in the past years wnich are mostly not directly related to offshore but concern as well onshore as offshore drilling rigs. The overall aim is also here cost diminuation.

In the past years one of the most promising projects which have been investigated in several countries was the automation of the drilling process including measuring of the drilling process while drilling, automation of pipe handling, handling the whole drilling operation including data from underground and the rig itself by utilization of data processing systems. automation of pipe handling.

Another promising way is the improvement of drilling bits by polycristalline diamond plates to extend the time of bit exchange intervall.

Another development is the replacement of the classic rotary table by a power swivel or top drive. This device enables to drill without kelly and so to extend the time of addition of new drill pipes to the drill string.

A fully automated drilling system is actually developed in cooperation of several European countries in the frame of EUREKA. This so called EUROFOR system is aimed at developing a lightweight, compact drilling rig. Work includes application of robotics, new materials and artificial intelligence. The four phase program is budgeted to cost a total of 26 Mill. European Currency Units (about 30 Mill. US $).

Eventually the German Deep Continental Program should be mentioned which aims to drill a hole up to 14.000 meters depth. Also this program will have a lot of positiv effects on drilling technology as well onshore as offshore.

6.3 Production Technology

6.3.1 General

The overall aim "Low Cost Technology" concentrates, as far as field development is concerned, on the question "Commerciality of Marginal Fields".

According to Gulf Publishing Company, there were almost 1.000 offshore fields discovered around the world before 1985 which have not been developed, due to economic considerations. These marginal opportunities were evaluated and found not to be economically justified in their ultimate development at the time of discovery. Europe, Africa and the Far East contain over 80% of these marginal fields. The North Sea accounts for 191 of the 263 discoveries in Europe:

UNDEVELOPED OIL OR GAS FIELD DISCOVERIES
AND THEIR DISTRIBUTION
(In Years Prior To 1985)

Area	Number of Discoveries	% to Total
Far East	293	31
Africa	264	27
Europe	263	27
South America	94	10
Middle East	48	5
Total	962	100

The distribution of the fields to waterdepth gives the following table

DISTRIBUTION OF UNDEVELOPED DISCOVERIES

Region	Water depth, ft 1-100	101-200	201-400	401-660	661-1.150	Over 1.150	Total
South America	26	23	29	9	5	2	94
Europe	41	55	97	46	13	11	263
Middle East	32	5	11	0	0	0	48
Africa	95	73	73	14	7	2	264
Far East	77	79	108	16	7	6	293
World Total*	271	235	318	85	32	21	962

* Except North America, USSR and Eastern Europe

Source: Ocean Industry

Indeed a field which may be commercial under the circumstances of high oil prices may become marginal under less favourable economical conditions. These conditions include besides the oil price financing methods, taxes, reserve potential, production rates, choice of development alternatives, physical field conditions (depth, saisonal sea states to infrastructure and land facilities) and a country's political environment.

Nevertheless the technical trends aim to realize technical solutions which lead to lower production costs.

These trends can in fact be valuable as well for small fields in shallow waters with large distances to the coast as well as for deep water fields and harsh environments.

Cost saving technologies may be summarized by the following keywords:

- floating productions systems
- subsea production systems including multiphases flow
- reusable platform structures
- and their combinations.

Additionally organizational measures may have costsaving effects e.g. pre-drilling before platform installation.

6.3.2 Floating Production Systems

Offshore operators consider floating production systems based on the following needs:

- Extended reservoir testing - Sometimes reservoir sizes cannot be determined according to acceptable confidence margins. Floating production systems can be used to produce and conduct reservoir tests concurrently.

- Early production - Important to generate early revenues in expensive projects. Floating production systems can be considered for these applications in order to justify overall economics of field development.

- Production in marginal fields - Floating production systems are appropriate for producing marginal fields and discoveries. Since costly platforms or infrastructure may not be necessary, temporary or mobile floating systems can allow operators to produce in fields with more limited economics.

There are operational factors involved in offshore applications which support the use of floating production systems. These factors include the following:

- Operators will have a reduced early capital investment for floating systems (compared to bottom-supported production platforms).

- There is usually a shortened lead time from initial discovery in a field to first oil or gas produced.

- Floating systems are usually appropriate for offshore areas with no existing pipelines nearby.

- There is relative insensitivity of initial cost to water depths. Floating systems can be suitable for both shallow or deep water applications.
- Floating production systems are mobile and can be used again in other areas. This is especially relevant for reservoirs that have high risk situations, early or temporary production required or in areas with political instabilities.

- **Basic Options and Technical Areas of Floating Production Systems**

Floating prodrction systems are composed out of some key components:

- the process plant
- the carrier system, the floater
- the storage facility (if integrated)
- the mooring system
- the crude riser system
- the unloading system (ship or pipeline)
- the subsea installation

The most obvious difference is the type of floater:

- Ships are well proven drilling rig carriers. They offer considerable storage capacity. Wind and wave directions are decisive for the motion characteristics. Large deck area is available for production facilities. Conversions are possible from available crude tankers.

- Semisubmersibles also are well proven drilling rig carriers. They are also adequate carriers for production facilities. Storage capacity is not available. The motion behaviour in wind and waves is the best of all floaters. They also are the most expensive ones.

- Barges, pontoons or other shapes of carriers are similar in conditions as the ships or they are purpose designed.

- **Tanker-Based or Shipshape Systems**

Typically suited for single well production, tanker-based systems can serve for special marginal or low cost applications in selected areas. Oil is produced from a subsea manifold through a riser system to the moored tanker. Production facilities are installed on the tanker for basic production process and the produced oil is stored on board. Shuttle tankers can be used to export from the production system. In some cases the same vessel may shuttle produced oil to nearby terminals.

Operators should also consider downtime due to weather is an important factor in such an installation. These vessels will heave and pitch with short period motions which can affect production handling on board. Overall, the tanker-based system is probably the least eypensive for most water depths.

British Petroleum has a tanker system called SWOPS (Single Well Offshore Production System) for their Cyrus Field. SWOPS disconnects and delivers the produced oil, then returns to resume production. Associated natural gas produced to SWOPS can be used to power the vessel's thrusters with excess gas being flared. Wells served by SWOPS must be naturally produced since there is no allowance on board for artificial lift equipment. If a marginal field does not have good natural water drive or high gas/oil ratio to maintain reservoir energy then SWOPS will not be applicable.

A similar vessel, the Petrojarl 1 has been utilized by Norsk Hydro. The vessel will be used as an early production or even permanent system in the Norwegian North Sea. Oil will be produced, treated and supplied for transfer by shuttle tanker to land-based terminals. Petrojarl 1 has been used in the Oseberg field by Norsk Hydro to produce and test production capabilities. Through its use, Norsk Hydro has developed more detailed analysis of production capabilities and reserves. Indeed, reserves in Oseberg have been increased from 1.088 billion bbls to 1.394 billion bbls.

- **Semisubmersible Production Systems**

The idea of a semisubmersible production system is not new. In the late 1970s the first such platform was installed by Hamilton Brothers in their Argyll field in the North Sea. The platform was formerly used as a drilling vessel and required minimal conversion. Today with a significant overcapacity in offshore drilling rigs the possibility of rig conversion to floating systems is attractive. For special-purpose applications when production rates or storage requirements are high or when offshore conditions dictate, specially designed semisubmersible vessels become necessary.

Semisubmersibles can be positioned dynamically via computer-controlled thrusters or will be moored by catenary wire rope or chain systems (which is most common). Combinations of dynamic positioning and mooring can also be used. Wells will be completed on the sea floor within a template or cluster or may be completed as single satellite wells. One advantage of the floating production system is its ability to accommodate production from distant wells in remote locations - ideal to handle single satellite completions in unusually-shaped reservoirs. Oil or gas production is gathered from satellites and processed through a single manifold and produced up through a bundled riser to the semisubmersible unit. Processed oil is sent back down the riser system to a pipeline or loading buoy. A converted semisubmersible is a quick, less expensive way to initiate production at this time. Typical semisubmersible drilling rigs are capable of processing up to 75.000 bbl/day but will have minimal storage on board.

There may be produced gas in the field which will be handled by platform production equipment. Also, some of the gas could be used as fuel gas on the semisubmersible. Separated gas may be injected into the reservoir to be utilized for gas drive which requires compressors on board. If that is the case gas injection equipment can be a significant requirement on the semisubmersible due to weight and space limitations.

Offshore operators must consider weather downtime for semisubmersible systems. Although moored, these units are floating and unlike a tension leg platform will roll, heave and pitch in short-period motions. Therefore the design of process facilities and the production riser bundle must be engineered to maintain operations with maximum vessel motion and minimize any downtime in difficult weather conditions.

- **Comparison of Floating Production Systems to other Producing Structures**

Floating production systems and their application for offshore production is appropriate to compare them to other types of producing structures.

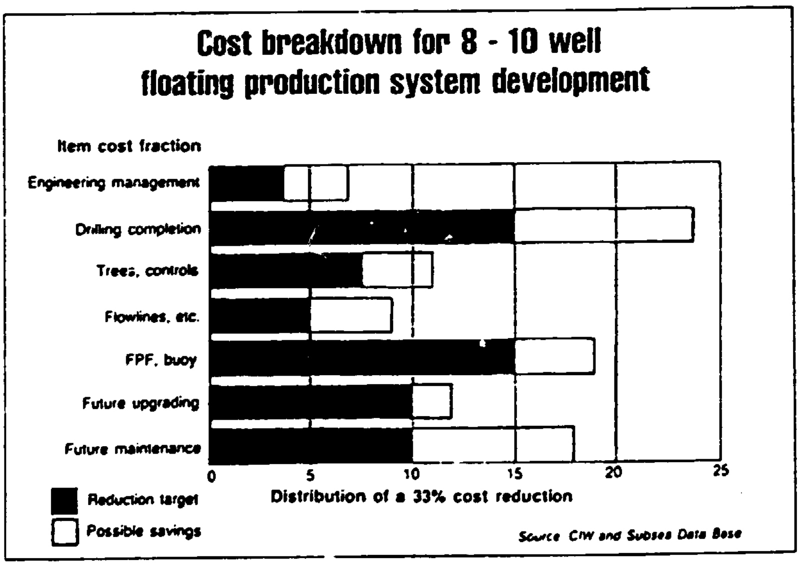
In the current economic conditions faced by the worldwide offshore industry, the oil and gas companies will ultimately require that the most economic production design be selected for the life of future projects. In a general sense it appears that the most economic and appropriate design for water up to 1,000 feet are the conventional steel platform. Guyed towers may be most suitable for waters extending to 1,500 feet. The most economic range for tension leg designs may be in waters deeper than 1,500 ft. Floating production systems are appropriate for deeper waters and, of course, in shallower waters where marginal economics are the rule.

The figure on the following page summarizes major considerations for offshore structures.

COMPARISON OF OFFSHORE PRODUCTION FACILITIES

	Conventional Fixed Steel Platform	Guyed Tower	Tension Leg	Condeep	Floating Tanker-Based	Floating Semisubmersible
Capital Expenditures	High	High	High	High	Low-Medium	Low-High
Well Completion	Surface	Surface	Surface	Surface	Subsea	Subsea
Oil Storage	Yes	No	No	Yes	Yes	Possible
Processing Equipment	Standard	Modified	Standard	Standard	Slight Modification	Standard
Demobilization and Re-Use	Difficult	Difficult	Somewhat Difficult	Extremely Difficult	Easy	Easy

Following Philip Burguieres, Chairman of Cameroon Ironworks in his presentation at Offshore Technology Conference 1987 ("Offshore" July 1987) future subsea production systems will often be 40 to 50 % less expensive than those of 1981 and more realible of higher quality when full project cost is taken into account. "Offshore" published the following cost break down for 8 - 10 well floating production systems and their possible cost savings:



Source: Offshore, July 1987

6.3.3 Reusable Production Units

Another method for enhanced profitability is the multiciple use of production structures for several fields.

In this respect is to consider that a fixed or floatable structure cannot be installed in any other field without modifications. Waterdepth, environmental conditions, soil conditions, production rates of the fields have to be in the same size.

The following solutions for multiple use of structures are feasible:

- floating structures as ships or semisubmersibles
- fixed structures.

For floating structures the problems are relatively easy to be solved. Attention has to be given especially to the mooring system as well as to the production riser.

As fixed structures are to be mentioned in first line jack-ups which can be converted from mobile drilling units to drilling/production platforms. Jack-ups may be used in waterdepths up to 130 meters.

But also for concrete structures reuse is possible. The prime condition is that the structure is constructed and founded yet from the first location to be removed to a second field.

6.3.4 Adaption of Structure to Lower Cost Requirements

For cost saving at production structures a lot of engineering measures is meanwhile developed and applied. The following measures can be mentioned as examples:

- Reducing the number of deck-modules on the supporting structure. This means in the same time a rise of the module weights. Modules are units which are pre-fabricated on shipyards e.g. for energy supply, drilling, living quarters, processing or helicopter deck. Such modules were pre-fabricated in the past years in the weight of some thousands tons, the weight being limited by the capacity of the available crane ships. 1986 and 1987 two large lift ships - Mc Dermott's DB 102 with 12.000 tons and Micoperi 7.000 with 14,000 tons lift capacity came in operation.

- In the same time deckloads are reduced by using high strength steels for the deck constructions.

- Structure weights are reduced by using underwater hammers for piling, and so far avoiding the pile conduction sleeves.

6.3.5 Production Drilling

It is in the interest of the oil companies to start up oil production as early as possible to get the investment paid back in an early phase of the project. One essential solution is drilling of the production wells before the installation of the production structure. This may be done through a pre-installed template by a mobile drilling unit e.g. a jack-up or a semisubmersible. This solution offers furthermore the advantage that the deckload of the production platform must not be constructed for supporting a heavy production well drilling unit but only to carry a much lighter workover unit. In so far the whole deckload capacity may be lighter.

Another essential technology step is a possibility of extended reach drilling from the platform. CONOCO is planning to drill an extended reach well in 1989 with a length to about 9 km from the rig and reach a depth of between 2.740 and 3.650 meters at an angle of 72 to 75^{0}. This technology enables the company to develop a much greater part of the field from one platform before.

Equally the technology of horizontal drilling has been developed. This allows the drilling company to follow the oil carriing layer for a great length, thus having a very much larger contact in the producing well and to get higher production rates.

In total all these developemts will have a remarkable cost saving fact on field development and oil production.

6.4 Subsea Production

Without improved technology for subsea installations the floating production system concept would not be economically viable nor even practical.

Not a new technology, subsea completions and production began in the late 1950s. The offshore industry determined that the costs associated with constructing conventional platforms for deeper waters or in Arctic or harsh environments dictated that a new way be developed for completing oil and gas wells. The earliest efforts came from Shell and Union Oil in some U.S. developments. The early stages of subsea completions required that the oil companies who were supporting the new technology utilize equipment that had originally been designed for land use.

The adaption of this type of equipment for undersea applications required special engineering and technological skills. Later, vendors for specialized subsea and submarine equipment became prominent in the development of technology and new equipment, providing the oil and gas companies the type of service and equipment which would be required for new, deeper applications.

- **Application of Subsea Production Technology**

Subsea production systems are applicable in several instances:

- To accelerate production early in order to generate cash flow for expensive offshore operations.

- Allow oil and gas companies to drill step-out wells to fully develop a field with wide spatial extent and to utilize existing platforms.

- Develop marginal fields where economics could not justify extensive platform installation.

- Allow operators to develop unusually-shaped fields.

With regard to the acceleration of production from an offshore field, present economic conditions require operators to carefully cost-justify significant projects. Operations on offshore drilling/production platforms can require hundreds of millions of dollars over a period of several years to drill, complete and produce into a structure and bring up the facility's production to the planned peak levels. The oil companies can drill and produce from wells away from the platform via subsea completion technology and begin initial production to generate revenue more quickly.

As mentioned in chapter 6.3.5 operators will complete directional wells, sometimes with targets several miles from the platform. When the extent is too significant or targets too distant, subsea completions may be the answer.

Satellite or subsea completions away from the platform (which may be in excess of ten miles distant) are possible with submarine pipelines connecting back to process equipment atop the offshore platform.

This type of completion will place the primary well control equipment on the sea floor (christmas tree, associated valves, manifolds, etc.). This will alleviate weight and space problems on existing production platforms. However, subsea systems must be connected in some form to a surface facility which will support control and production functions (as well as delivery to sales lines and pipeline transportation). A relatively high degree of functional integration results.

Production from subsea installations can connect with and be supported by almost any type of offshore platforms or producing systems fixed structures as well as floating systems.

- **Types of Subsea Systems**

There are basically three subsea production systems which are typed according to installation and long term maintenance requirements after production has been initiated:

- Standard or wet tree installation - wellhead and associated equipment is installed in the sea floor, exposed to undersea environment.
- One atmosphere or "dry tree" installation - typically, a vessel which allows manned entry into a one atmosphere environment encapsulating equipment, controls, electronics, etc.
- Combination systems - allows for either of the previous types in combination.

The predominant system today ist the satellite wet tree where single wells are served by one installation. A one atmosphere production system is quite expensive and will be designed and installed only on very special applications where manned intervention is warranted. The primary advantage for dry installations is that all equipment (controls, valves, etc.) are easily accessed for maintenance and inspection by technically qualified personnel. Electrical connections in this type of a controlled environment allow more sophistication in subsea control systems.

There may be several satellite installations producing to the surface production facility and there may be varying types (dry vs wet) which are connected to the same installations. A multi-well or template application is a cluster of wells with production co-mingled and handled through one manifold system. In the North Sea multi-well template installations are becoming popular as technology has allowed oil and gas companies much familiarity with this type of system. When oil or gas is produced through the subsea installations it is brought to the surface through a production riser to the surface production facility. If treatment or separation is required it will be handled aboard that surface facility.

- **Remote control of subsea production**

A decesive step in the use of subsea production systems is the possibility of remote control of the subsea installation. Two milestones have to be mentioned in this connection:

- the UMC - Underwater Manifold Center at Shell/Esso's Cormorant Field which is now about 6 years in operation. The conclusion after some years was given at ONS-Conference in Stavanger/Norway: "A computer-operated multiplex system is the only acceptable means of safely and economically operating a large subsea development".

- Skuld is a program which has been conducted by Elf Aquitaine with a full scale experimental station in 100 meter water depth near Bergen/Norway. In course of the test 20 years of operation where simulated. The test resulted in the decision to apply Skuld for exploitation of a small gas field 11 miles east of the main Frigg field.

- **Multiphase Flow**

A next important technological step aimed at by offshore companies is the subsea production with transportation of the crude oil over some hundred miles to the coast. This technology means saving of a production platform - be it fixed or floating - which operates the remote control units and serves normally as carrier for the processing facilities for the crude oil. The processing necessary for degassing, desalting and dewatering of the oil before it is transported by pipeline to the shore. If pipeline transport of crude oil over long distances shall be feasible, a technology has to be developed which allows pipeline transport and pumping of a mixture of oil, water and associated gas. This technology is very difficult to control as the different components of the crude tend to separate from each other. The problems are investigated by a group of Norwegian, French and British Companies as well as by German Companies. A complete multiphase production and transportation unit will not be in operation before the beginning of the ninetieth.

6.5 Subsea Technology

Subsea technology may be divided in

- diving technology
- underwater working technology
- mobile underwater working systems (manned and unmanned)

Some overlapping items concern

- underwater energy supply
- underwater handling systems
- measuring, transmission and processing of data
- underwater health and savety.

Essential technical trends are actually aiming at the following problems:

- **Diving technology and safety**
  The performance of divers is limited by physical conditions to a waterdepth which may be in long term between 400 to 600 m. Tests and simulations have been up to now in more than 600 meters simulated waterdepth. In greater waterdepth divers will be replaced by manned submersibles or remotely operated vehicles (ROVs).

- **Cost saving systems for inspection, maintenance and repair /IMR) of existing offshore structures**
  One of the most time consuming activities is in connection with underwater inspection the cleaning of the structure to be inspected.

The working tools of the diver or a ROV have to be adapted to IMR of the structures from the beginning of design.

Otherwise the construction of offshore and subsea installatins are now designed for easy IMR, for example by constructing such systems, which have to be replaced and repaired as modular systems and which can be exchanged in a whole.

- **Surface independent energy supply**
  These developments may consist in diesel engines with closed cycles for manned submersibles or underwater production systems.

- **Automated underwater working systems**
  These systems have to cover mostly tasks as IMR. A very promising approach seems to be the coorperation of remotely operated and widely automated systems with a diver, the ROV doing the routine work while the diver observes and steers the system and does such work where human intelligence and the agility of the human hand is needed.

  In connection with automated systems the trend is going to handling systems which are supported by computers even up to "artificial intelligence". Experiences with robotics in onshore industrial applications shall be transformed to underwater tasks.

- **Manned submersibles with multiple application**
  Manned submersibles are in development which are able to perform a wide range of underwater tasks, for

example installation and replacement of heavy parts of subsea installations, diver lockout, remotely operating of unmanned tools. The great adventage of the manned submersibles is their independence of the weather conditions on the surfac which enabled them to work undisturbed from harsh environmental conditions at the surface.

- **Technologies for removal of offshore installations**
  Offshore installations will have to be removed after exploitation of an offshore oil or gas field. Actually a draft is discussed in the International Maritime Organization (IMO) which after elaboration will give recommendationes to the adhearing countries.

  Special technologies which cover the requirements of removal not only of steel structures but also of concrete structures and subsea installations will have a wide application.

CHAPTER B-7

SPECIFIC REQUIREMENTS OF OFFSHORE GAS UTILIZATION INCLUDING PIPELINE TRANSPORT, LIQUEFACTION, MANUFACTUING OF FERTILIZERS AND OTHER CHEMICAL PRODUCTS

SECTIONS

7. Specific Requirements of Offshore Gas Utilization including Pipeline Transport, Liquefaction, Manufacturing of Fertilizers and other Chemical Products

7.1 Offshore Gas Production

The production of natural gas is today an approved technology up to waterdepths of 150 tO 200 meters. In Norwegian waters engineering is presently carried out for the Troll-gasfield with a waterdepth of 300 to 350 meters.

Supporting structure for offshore gas production is generally a bottom supported structure of steel or concrete. The processing of the natural gas on the structure depends widely on the gas composition - be it a dry gas (mainly consisting of methane-CH_4) or a wet gas with higher contents of hydrocarbons as ethane, propane, butane, pentane etc. Additionally natural gas can contain higher parts of nitrogen, carbon dioxide and hydrogen sulfide.

The table below shows some examples of gas compositions for various types of gasfields in production:

	North Sea Leman Bank	Netherlands (Groningen)	Brunei	Libya	Algeria	Nigeria (Ughelli)
Methane	94,8	81,7	88,0	71,4	86,5	88,1
Ethane	3,0	2,7	5,1	16,0	9,4	6,3
Propane	0,6	0,4	4,8	7,9	2,6	2,1
Butanes	0,2	0,1	1,8	3,4	1,1	0,3
Pentanes	0,2	1,1	0,2	1,3	0,1	1,1
Nitrogen	1,2	14,0	0,1	-	0,3	-
Carbon Dioxide	-	-	-	-	-	2,1

The different stages of gas processing have to take in account the following factors:

- high pressure of the gas at the wellhead
- the moving of solids (particles of reservoir sand)
- removing of water
- removing of condensate
- removing of hydrogen sulfide and carbon dioxide
- future gas compression (for transport in the pipeline and further processing)
- gas- and condensate metering

The following table gives an impression of the equipment on a gas platform with a production rate of 50 Million scf/d.

Equipment of a Gas Platform in the North Sea
(production 50 mill. scf/d)

	Total topside weight
Wellhead module	280 t
Production module	410 t
Gas compression	680 t
Utilities module	530 t
Power generation and switchgear	210 t
Living Quarters	150 t
Ductwork and miscellaneous	140 t
Module support frame	730 t
Flare boom	220 t
Helideck	180 t
Total	3.530 t

7.2 Gas Transport to Shore

The gas treatment may be performed on the platform or - in case of short distances to the coast - in a gas treatment and processing plant onshore. In both cases tranport by a subsea-pipeline is necessary.

Laying of subsea pipelines is a proven technology. Large gas pipelines have diameters up to 48", the actually planned waterdepths are in the range of 350 m in case of the Norwegian Trollfield.

Before laying a subsea pipeline a careful route survey is necessary (using special ships, divers, remotely operating vehicles and/or submersibles). The laying is performed by a pipelaying barge or - for greater waterdepth - by a special pipelaying ship. After laying the pipeline often it is necessary to protect it against damage from anchoring ships or fishing gear. The pipeline in operation has to be inspected regularly, especially for its position on the seabed (danger of unsupported spans) as well as for possible leaks or damages. Modern inspection techniques trend to use specially equiped pigs inside the pipeline.

7.3 Gas Utilization

The utilization of produced gas is essentially an economic question. The influencing parameters are mainly

- waterdepth at location
- distance to shore
- magnitude of proven reserves
- gas composition
- market opportunities

The following screen gives an overview of different possibilities for gas utilization - be it on the home market as well as for export markets.

O F F S H O R E G A S

Natural Gas Products

Product	Captive Markets	Home	Export
LPGs	Heating & Lighting	x	x
Propane	Vehicle Fuel	x	x
Butane	Petchem Feedstock	x	x
Ethane	Petchem Feedstock	x	x
	Gasoline Blending	x	x
Ammonia/ Urea	Fertilizer Plants	x	x
Methanol	Gasoline Blending		x
Gasoline	Vehicle Fuel	x	x
Middle Distillates	Heating Fuel	x	x

Pipeline Gas

Home Market	Export
Fuel for - End Users - Power Generation - Refiniery - Steel & Aluminium - Vehicles (CNG)	Same Application as Home Market

LNG

Home Market	Export
Peak Shaving Regasification & Pipeline Supply	Same Application as Home Market

One of the first investigations should be the evaluation of opportunities

- to penetrate the domestic market and to substitute such energies which are easy to be transported and thus to be exported, i.e. coal and oil, or

- to convert natural gas into exportable products adding at the same time higher values to it compared with the primary fuel, i.e.
  - methanol,
  - ammonia or
  - LPG as examples.

The gas composition remains now as the last but decisive parameter which has to be considered. In any case, the gas produced from the wellhead has to be sent to a treatment plant in order to extract those components which can be separately marketed and/or those which have to be extracted to arrive at a "pipeline quality gas" for utilization in boilers of all kind.

7.3.1 Pipeline Gas to the Home Market

The development of pipeline gas deliveries to the home market necessitates an investigation of the market potential in the generally adapted division of three market segments:

- Domestic Heat Market
- Commercial Customers
- Heavy Industry and Power Generation

Besides the opportunities to substitute fuels in existing boiler plants, the potential for gas deliveries in new housing or industrial developments has to be assessed together with the structure of existing and additional demand for energy:

- Continuous demand over the day, week, month and year
- Discontinuous demand with hourly or daily peaks
- Interruptable demand in case of dual fuel boiler facilities

These parameters decide upon the technical design of the transmission and distribution pipeline system and eventually necessary intermediary storage facilities.

The economics are determined by the investment, maintenance and operating cost for the pipeline grid and the value for the natural gas payable by the customers in comparison to alternative fuels.

To secure the economic viability, long-term contracts have to be concluded with customers.

Apart from regulations regarding the technical delivery of gas, i.e. volume per year and peak quantity per hour, a proper price revision clause and tariff system has to be established.

The **sales tariff** should comprize

- **The Standing Charge**
  to cover all fixed cost related to investment, maintenance and operation expressed in domestic

currency per month or per contracted volume per hour/day

- **The Variable Charge**
  to pay for the actual gas consumption expressed in domestic currency per MMBTU

The **Price Revision Clause** should cover all elements of the sales tariff which are not constant during the life time of the contract such as

- Interest rates on capital investment
- Prices for spare parts and labour for maintenance and operation
- Value of the gas in relation to other fuels on energy equivalent basis

The formulation of such contracts and the calculation of tariffs and revision clauses requires good care and diligence.

Last but not least it is necessary to develop parallel to the gas delivery system the necessary **Administration Facilities** for metering, invoicing and payments and also the **Logistic Facilities** for the operation of the gas flow between production and customers.

7.3.2 Pipeline Gas to the Export Market

As for the home market the first step to be taken is the identification of potential export markets.

Offshore reservoirs in the North Sea are today connected with the European transmission system via subsea pipelines, e. g. the gas fields Troll and Sleipner have planned to transport the gas by a subsea pipeline to Zeebrügge/Belgien at a distance of more than 1300 km.

Deliveries to Export Markets should not take the same consideration into account as those for the Home Market:

- The annual contract volume should be delivered on a continuous basis over the year to optimize the operation of all installed production, treatment and transport (pipeline and compressor) facilities.

- The sales price should also be split into a standing and variable charge, the latter however has to be calculated on the energy equivalent values prevailing on the export market.

The formulation of long-term contracts for natural gas exports with tariffs and price revision clauses requires even more care and dilingence compared to the home market because of the multiple interests of buyers and sellers.

In addition to securing a coverage of all fixed cost and to generate a fair revenue for the gas sales, the currency risk has to be eliminated to avoid marging erosion.

There are a number of examples where contracts broke up because of inadequate formulation in respect of the above mentioned elements.

7.3.3 Gas Liquefaction

Gas Liquefaction is a well established technology with more than a dozen large LNG complexes - some consisting of several plants - operating in seven different countries throughout the world.

The gas liquefaction plant is an essential link of the total LNG chain consisting of

- Gas field/gas production platform
- Pipeline to LNG plant
- LNG plant
- LNG storage
- LNG tanker
- LNG gas terminal
- Regasification plant.

For the utilization of offshore gas fields by gas liquefaction a whole range of concepts have emerged:

1. Prefabrication of the LNG plant on a steel or reinforced concrete barge that is either moored, bottom-supported or beached in the immediate vicinity of the coast.

2. Installation of the LNG plant directly above the offshore gas deposit on a floating or fixed structure.

Prefabrication on a barge or a floating or jack-up structure offers the following benefits:

- Construction, assembly and testing are carried out at the manufacturer's fabrication yard.

- Construction and assembly times would be shorter, even taking into account the time involved to towing the plant to its final location. This means that LNG production and cash flow begin earlier than in a conventionally erected plant, thus affecting positively the economy of the whole project.

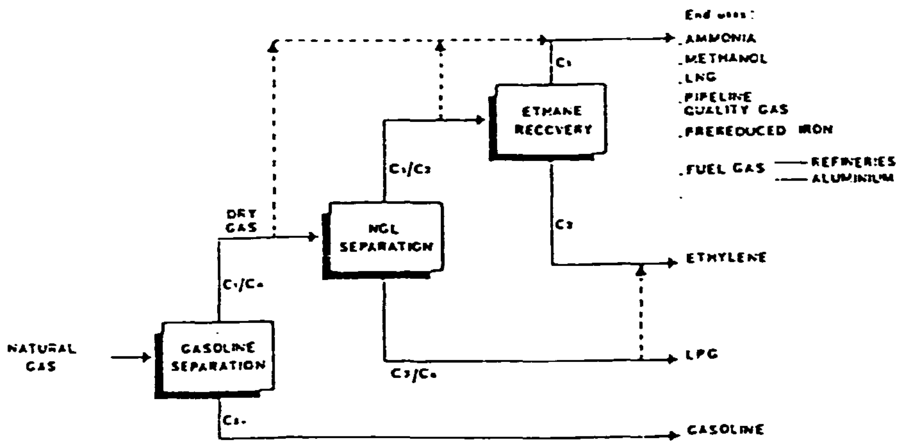
In principal barge-mounted plants use known technologies. Barge mounted concepts which have been studied have capacities in the range of $2.4 - 8 \times 10^9$ Nm^3/a.

Genuine offshore platform versions with installation of the liquefaction plant in the offshore field require new technical developments in operating and in particular in the offshore-loading of LNG tankers. Such offshore LNG plants must be characterized as "first of its kind" with all negative consequences regarding safe and reliable operation, financing, insurance etc.

7.3.4 Conversions into Exportable Products

The disadvantage of natural gas over oil and coal in respect of transport over long distance was already mentioned in the beginning of this chapter. Besides the described alternatives in 7.3.1 to 7.3.3 above, the conversion of natural gas into exportable products with higher added value is another opportunity to overcome the transport problem.

Assuming the gas has a certain mix of methane and ethane, the following options could be considered and are shown in principle on the diagram below:



Principle Options Gas Conversion

Natural Gas Liquids (NGL)

The term "Natural Gas Liquids" (NGL) refers to those hydrocarbons present in a "wet" natural gas which can be separated out by field surface facilities either offshore or onshore. They consist of mixtures of hydrocarbons (ethane, propane, butanes and pentanes), which can be extracted by compression and cooling of the separated gases.

A minimal removal of NGL is generally necessary to prevent two-phase pipeline flow, but otherwise the decision to separate NGL from a "wet" gas stream is an economic one determined by the appreciation of the prices that the separated liquids will command as compared with the price obtainable for the higher calorific value gas that will

remain if the liquids are not separated.
After the extraction of NGL, the resultant fluid will have too low a boiling-point to make it suitable for blending with normal gasoline; it therefore must be "stabilized" or "rectified" by distillation under pressure in a processing plant, so that the ethane, propane and some butanes pass from the top of the fractionating column for subsequent further stabilization and separation into **Ethane** and **Liquefied Petroleum Gas** (LPG fractions; while the liquid emerging from the bottom of the column (some butanes, with pentanes, hexanes and heptanes) is then blended with other gasoline fractions to make the so-called "natural gasoline".

Ethane is chiefly used as a feedstock for petrochemical plants manufacturing ethylene, as well as to some extent directly as a fuel. **Normal butane** is also used as a petrochemical feedstock as well as for gasoline blending, while iso-butane is a source of propylene oxide and is also used in the production of high-octane gasoline by alkylation. **Propane** may be "cracked" under controlled conditions to produce ethylene and propylene.

Both, ethane and the Natural Gasoline are products for which demand in several markets also in the Asiatic part of the world is growing.

Liquefied Petroleum Gas (LPG)

The mixture of C_3 and C_4 hydrocarbons which are extracted from "wet" natural gases (and also obtained from crude oil refining operations) are mainly composed of **propane** (C_3H_8) with some propylene (C_3H_6); and **butane** (C_4H_{10}) with some butylene (C_4H_8). Small proportions of ethane, ethylene, iso-butane and iso-pentane may also occur in the mixture, and an odorant is usually added for safety reasons. The term "LPG" is a rather unsatisfactory general description of a variable product, whose overall properties, however, are usually determined by appropriate national standards specifications.

- Commercial liquefied "Propane" is commonly used for special applications - e.g. the production of protective atmospheres in metal treatment operations, or in the glass industry. Propane-air plants are used to supplement natural gas supplies at times of high demand or during conversion operations.

- Commercial liquefied "Butane" is usually distributed for large-scale applications (e.g. factory heating and direct-firing industrial operations) in the form of a vaporized butane/air mixture, the composition of the mixture being selected so as to depress the dewpoint to an acceptable level. Suitable mixtures have frequently been used (paticularly where LNG is not yet available) in "peak-shaving" operations, to provide additional gaseous fuel at peak periods where the local supply of natural gas is inadequate to meet demand, or as a gas source in rural areas.

The properties of commercial LPG mixtures vary according to the proportions of the different components present. LPG in cylinders forms a convenient and highly portable source of heat and light for domestic and commercial applications, particularly where supplies of piped gas are not available. LPG is also widely used in industry wherever a consistent, sulphur-free, non-toxic fuel gas is of special value, as in food manufacturing and poultry breeding.

Its use as an automobile engine fuel has developed more recently, particularly for heavy lorries, public vehicles and urban bus and taxi services in the USA, Netherlands, Italy, Japan and Korea.

Since the other source to produce LPG, the oil refining process is decreasing due to the lower demand for oil products, world demand for LPG's is expected to rise considerably during the years until 2000.

Chemical Products

A variety of chemical products can be derived from natural gas feedstocks, depending on the composition of the gases and prevailing economic and technical factors.

Important amounts of **sulphur** are obtained by the treatment of high H_2S gases in France, in Canada, in the United States, and in the Middle East. **Carbon black**, a pigment of colloidal dimensions, is made by burning the gas with only a limited supply of air and depositing the product on a cool surface.

Ammonia is manufactured by a catalytic process; more than half the world's ammonia output comes from natural gas feedstocks. Ammonia can be used directly as a plant food when injected into clayey soils, or as a secondary feedstock from which a variety of other chemical products can be produced - notable hydrogen cyanide, nitric acid, urea and a range of fertilizers.

Acetylene can be produced by a process similar to ammonia synthesis, and hydrogen can be made by reacting natural gas with steam at elevated temperatures over various catalysts. Ethylene and propylene are made by the thermal dehydrogenation of the propane-ethane NGL fractions of suitable gases.

A wide range of other chemical products can be made from natural gas, by controlled oxidation processes. These include methanol, propanol, formaldehyde, acetone, etc., many of which can be used as basic materials for a variety of further syntheses. Aromatic compounds such as benzene, toluene and the xylenes may also be produced from suitable gases by catalytic reforming processes. Eventually the production of urea, methanol, gasoline and middle destillates should be mentioned.

7.3.5 Offshore Power Generation

Offshore power stations for generation of electric current have been developed with two aims:

1. Mobile power stations in areas with not sufficiently developed infrastructure.

2. Utilization of marginal gas fields offshore.

The power generation from natural gas is normally based on gas turbines as gas turbines/generators on one platform or barge power stations of 500 MW or more can be realized. The capacity is limited by the gas production rate of the field as well as by the requirements of the energy consumers onshore. A 300 MW station using the normal gas turbine process would require a gas flow of about 700 million cbm a year.

Offshore power generation on a platform on the field itself would require transmission of the electric power by high voltage direct current; this is normally only economic when the gas has a very low heating value.

7.3.6 Other Uses

Apart from the alternatives described in detail above, there are some other opportunities to utilize natural gas in direct or converted application.

- Refinery Fuel

  This is the simplest way of utilizing gas and to arrive at exportable products, namely all oil products from a refinery which at the same time substitute oil and thus reduce the need for imports.

  As an indication from a case study, a 9 million ton per year refinery would utilize around 250 million cbm per year of natural gas.

- Steel and Aluminium Industry

  Two further examples shall be mentioned where indigenous gas availabilities can be utilized in the export orientated industry:

  Steel Production could be based on sponge iron instead of scrap iron via chemically reducing iron or to sponge iron with a reducing product such as synthesis gas obtainable from natural gas. For a steel plant with a capacity of 600,000 tons per year, the gas consumption would be 250 million cbm.

Aluminium Production through electrolysis is a high electric-power consuming process and the production cost depend upon the cost to produce electric energy. Countries with sufficient supplies of cheap hydro electricity are therefore found in the lead of aluminium production. Where this advantage is not given, gas based power generation could be the alternative and the consumption related to the production of 150.000 annual tons of aluminium is in the order of 700 million cbm per year.

- Compressed Natural Gas (CNG)

  Apart from LPG as an alternative fuel for road vehicles, natural gas is utilized in compressed form.

  Successful trials have been made in Canada with car fleets like taxis, food delivery vans and buses.

CHAPTER B-8

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES

SECTIONS

8. Offshore Projects in Developing Countries

8.1 General Comments to the Following Examples

The question is raised and has to be answered how a developing country with certain offshore resources can adopt the experience and expertise from industrial nations in exploiting their own Outer Continental Shelf oil and gas fields.

There are several examples available. In the following are picked

- the example of India, as a country special
- a review of some projects in Africa, South East Asia and Latin America, to point out the big number of projects already being realized in developing countries, and
- some examples for marginal field development in developing countries, as a technically related aspect.

The example of China has been discussed in detail in the course of the study.

8.2 Example India

The example of India may serve as a pattern for other developing countries as well. With industrial branches like space- and nuclear power technology this country is no longer a developing country in the original sense. Nevertheless India may be regarded as an experience how a country is able to generate own technical and project management know-how in less than one decade.

The first Indian Offshore field "Bombay High" was discovered in 80 m water-depth in Febr. 1974 by the national Indian oil company ONGC and went on commercial production already in May 1976.

This fast progress was only possible due to a close cooperation between ONGC and the French oil company CFP Total generating the subsequent know how transfer necessary for field development.

In 1982 already some 30 drilling and platforms were installed and with the production of more than 8 million t/y the "Bombay High" field amounted to 70% of the total Indian oil production.

In an ambitious plan another 40 platforms for an oil production of 19 million t/y were planned for the year 1984/85.

The Indian Government tried to set parameters to enable the Indian oil companies to realize this target:

A **Operators**

Following the nationalization of the Indian Oil Industry in 1976 all activities were concentrated on two national companies:
ONGC (Oil and Natural Gas Commission) and
OIL (Oil India Ltd.)
In the mid-eighties production sharing agreements were offered to foreign oil companies, e.g. to Chevron Comp., California.

B **Engineering and Consulting**

In engineering and consulting Indian companies gained significant benefits from the cooperation with foreign counterparts:

- ONGC in 1977 signed an agreement with the French CFP-Total for assistance in interpreting oilfield data, studying reservoir engineering and preparing the "Bombay High Development Plan"

- Mazagon Dock entered a cooperation agreement with the French contractor ETPM.

- Davy Mc Kee (Oil and Chemicals) became adviser for the "Bombay High Waterflood-Programme."

- Fluor Ocean Services and Davy Mc Kee are back-up consultants for EIL, Engineers India, Ltd.

- The Italian Snamprogetti was active in pipeline engineering.

Based on these various cooperations and know-how transfers, Indian companies now are in the position to make preliminary design, detail engineering, bid preparation and project execution supervision. This is in particular the case with EIL Engineers India Ltd.

C Contractors and Fabricators

The Indian Oil company ONGC as newcomer on the offshore scene tends to place Turnkey jobs to Prime Contractors.

For that reason - particularly in the early phase of "Bombay High" - large foreign companies won several big contracts as Prime Contractors.

- ETPM Sharjah: four platforms, including French and Japanese financing for about 100 million US-$; subcontractors: Kawasaki and Hitachi, Japan.
- McDermott-Oceanic Contractors, Dubai: large production platform (90 million US-$) and eight drilling platforms.
- Nippon Steel: one production and three drilling platforms.
- Nippon Kokan: large production platform (190 million US-$) and four production platforms.

Based on the own growing knowledge the state-owned Indian Mazagon Dock ltd., Bombay, started to produce first simple wellhead platforms and later water injection platforms followed by drilling & production units.

In addition, Hindustan Shipyards in Visathapatnam on the Indian eastcoast won a first contract for "Bombay High South".

Also DODSAL, a private Indian Contractor in the onshore pipeline business was discussing an offshore yard in Kandla (Gujarat) together with Mannesmann and Micoperi.

In 1987 a total of another 51 platforms were under construction or planned for the following six fields or prospects:

- South Bassein
- Panna
- Heera
- Bombay High South, North, East
- Canvery Basin and
- Godavari Basin Razole

Due to cost effective fabrication in South Korea at least 9 platforms of the total 51 are scheduled for fabrication or fabrication sharing in South Korea through Hyundai, Samsung and others. More details on current and future offshore projects and the companies involved are illustrated in the following tables on page B - 8.2 - 6 to 10.

Summary

As a result of all these efforts the Indian offshore oil production did meet the previous targets and in fact 1986 reached 621000 barrels/day, equal to 30.6 million t/y, thus putting the country into the position to save foreign currency on one hand and to reach independency from imported oil on the other.

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES - INDIA
under Construction / Planned / Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
Indien				
- South Bassein	ONGC	78 m	2 Drilling under construction Design: Jacket, piles: Mc Dermott Fabr.: Jacket, piles, deck: McDermott	1 Gaspipeline 32", 186.0 miles, designed 4 others planned 1 single, 18 trees, bidding
"			1 Drilling/production, bidding 1 Drilling/production, completed Design: Jacket/Piles/Deck/ Topsides: Hyundai Fabr.: Hyundai (Ulsan, South Korea) Inst.: Jacket/Deck: Nippon Steel	
"			1 Quarters, bidding 1 Quarters, completed Design: Jacket/Piles/Deck/ Topsides: Hyundai Fabr.: Hyundai (Ulsan, South Korea) Inst.: Jacket/Deck: Nippon Steel	
"			2 other, bidding 1 other, under construction Design: Jacket/Piles/Deck/ Topsides, Snamprogetti Fabr.: Jacket/Piles/Deck: Mc Dermott Topsides: AG & P	
			2 other: completed Design: Hyundai Fabr.: Jacket/Piles/Deck/ Topsides: Hyundai Inst.: Jacket/Deck: Nippon Steel	

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES - INDIA

under Construction / Planned / Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
- Panna	ONGC	45 m	3 Drilling, bidding 4 Drilling/Production, 2 bidding + 2 planned 2 other, planned 1 Quarters, planned	2 pipeline, 1 (oil) planned + 1 bidding 1 subsea satellite wells with associated gas-pipelines 90 km, 6-18" planned 800-900 km subsea pipelines, 26", 30" + 36" to be tendered (oil & gas)
- Heera	ONGC	59 m	5 Drilling/production/bidding	1 Pipeline, 12", 4.1 miles, completed 1 Pipeline 3", 12 miles, completed Installation: Nippon Steel 1 Oil-Trunkline, 100 km, 18" 1 Gas-Trunkline, 100 km, 20" 1 Mooring-Terminal, bidding
22 additional platforms may be needed to fully exploit reserves in Panna + Heera field				
- Bombay -- High North	ONGC	75 m	4 Drilling/Production, under construction Design: Jacket/Piles/Deck: Engineers India Fabr.: Jakcet/Piles/Deck: Mazagon Dock (Bombay, India) Inst.: Jacket/Deck: Mazagon Dock	1 Pipeline, 42.0 miles, bidding 1 Subsea System, 6 lines planned 1 Subsea System, 6 lines completed 1 Mooring Terminal, bidding
-- High East	ONGC	75 m	1 Drilling/Mobile, design Design: Jacket/Piles/Deck/ Topsides: Mc Dermott	

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES - INDIA
under Construction / Planned / Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
-- High South	ONGC	75 m	1 Drilling, completed Design: Jacket/Piles/Deck:/ Engineers India Topsides: Gilley Fabr.: Jacket/Piles/Deck/Topsides: Mazagon Dock (Bombay, India) Inst.: Jacket/Deck: Mazagon Dock	Vetco, Singapore has awarded $ 11.1 m Contract for design, engineering and fabrication and installation of template, wellheads + x-mas tree + control system + control umbilitals
"	ONGC	75 m	2 Drilling, under construction Design: Jacket/Piles/Deck: Snamprogetti Fabr.: Jacket/Piles/Deck/ Hyundai (Ulsan, South Korea)	Connection pipelines, 170 km 3 - 20" to be laid by Sumitomo, Japan
"	ONGC	75 m	1 Drilling/Mobile, under construction Design: Jacket/Piles/Deck: Mc Dermott Fabr.: Jacket/Piles/Deck: Mc Dermott (Batam Isl., Indonesia) Topsides: KHIC	
"	ONGC	75 m	1 Drilling/mobile, under construction Design: Jacket/Piles/Deck/Topsides: Engineers India Fabr.: Jacket/Piles/Deck: Hindustan Shipyard (India)	
"	ONGC	75 m	2 Drilling/mobile, under construction Design: Jacket/Piles/Deck/Topsides: Snamprogetti Fabr.: Jacket/Piles/Deck: Huyundai (Ulsan, South Korea)	

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES - INDIA
under Construction / Planned / Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
-- High South	ONGC	75 m	1 Drilling/Production, under construction Design: Jacket/Piles/Deck/Topsides: Samsung Fabr.: Jacket/Piles/Deck: Samsung (Kyungnam, South Korea) Inst.: Jacket/Deck: Mc Dermott	
"	ONGC	75 m	2 Drilling/Production mobile, under construction Design: Jacket/Piles/Deck/Topsides: Samsung Fabr.: Jacket/Piles/Deck/Topsides: Samsung (Kyungnam, South Korea)	
"	ONGC	75 m	1 Production, design Design: Engineers India	
"	ONGC	75 m	2 other, under construction Design: Jacket/Piles: John Brown, Hyundai Fabr.: Jacket/Piles/Deck: Hyundai (Ulsan, South Korea) Inst.: Jacket/Deck: Hyundai	
"	ONGC	75 m	2 other, under construction Design: Jacket/Piles/Deck: Mc Dermott Topsides: KHIC Fabr.: Jacket/Piles: MC Dermott, Batam Isl., Indonesia) Deck/Topsides: KHIC (Changnon, South Korea) Inst.: Jacket/Deck: Mc Dermott	

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES - INDIA
under Construction / Planned / Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
-- High South	ONGC	75 m	3 other, 2 planned, 1 bidding	
- Cauvery Basin	-	9 m	1 platform, under study	
- Godavari Basin Razole	-	-	1 platform, under study	

8.3 Africa, South East Asia, Latin America

The following tables for offshore projects in

- Africa, comprising Angola, Benin, Congo, Egypt, Gabon, Ghana, Equatorial Guinea, Ivory Coast, Libya, Mozambique, Nigeria, Senegal, Zaire.

- South East Asia, comprising Burma, Indonesia, Malaysia, Philippines, Thailand, Vietnam

- Latin America comprising Colombia, Peru, Trinidad

show basic data, companies involved and possibilities for an offshore policy in those countries.

These information could be evaluated with regard to the final aim to define suitable strategies for a future oil policy in selected developing countries.

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES
Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
A F R I C A				
Angola				
- Blk 2 - Tubarao	Texaco	38 m	1 Well Protector/Mobile, under construction Design: Texaco/Mc Dermott Fabr.: Jacket/Piles: Petromar (Ambriz, Angola) Fabr.: Deck/Topsides: Hyundai (Ulsan, South Korea) Inst.: Mc Dermott (DB 21)	Pipeline planned Install. Mc Dermott
- Blk 2 - Lombo East	Texaco	38 m	1 Production, under construction Design: Texaco/Mc Dermott Fabr.: Jacket/Piles/Deck: Hyundai (Ulsan, South Korea) Fabr.: Topsides: Nuova/Pignone/ Hyundai, Powell Electric Inst.: Mc Dermott (DB 21)	Pipeline under construction Inst.: Mc Dermott
"		37 m	1 Well Protector/Mobile + 1 other, under construction Design: Texaco/Mc Dermott Fabr.: Jacket/Piles: Petromar (Ambriz, Angola) Fabr.: Deck/Topsides: Hyundai (Ulsan, South Korea) Inst.: Mc Dermott	
- Blk 2 - Suele West	Texaco	32 m	1 Drill/Production/Mobile, under construction Design: Texaco Fabr.: Jacket/Piles/Deck: Petromar (Ambriz, Angola) Topsides: Petrofac Inst.: Mc Dermott (DB 21)	Pipeline planned , 74 km Inst.: Mc Dermott

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES

Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
- Nunbi	Chevron/ Gulf	44 m	1 Drilling/Production, under construction Fabr.: Jacket/Piles/Deck: Bouygues (Ambriz, Angola) Inst.: Bouygues	Pipeline system with 5 lines planned Inst.: Brown & Root
"	Chevron/ Gulf	44 m	1 Production, under construction Design: Jacket/Piles: Chevron Fabr.: Jacket/Piles/Deck: Brown & Root (Belle Chasse, LA) Inst.: Jacket/Deck: Brown & Root	
"	Chevron/ Gulf	44 m	1 Production, under construction Fabr.: Jacket/Piles/Deck: Bouygues (Ambriz, Angola) Inst.: Jacket/Deck: Bouygues	
- Cabinda Takula	Chevron/ Gulf	63 m	1 Drilling, planned Design: Jacket/Piles: Chevron 1 gaslift and water injection system planned for 87/89	
"	Chevron/	60 m	1 Production, planned Design: Jacket/Piles: Crest Fabr.: Topsides: Solar	
- Cabinda Wamba	Chevron/ Gulf	66 m	1 Well protector/mobile + 1 other planned Design: Jacket/Piles: Chevron	
"	Chevron/ Gulf	81 m	1 Drilling/Production, planned Design: Jacket/Piles/Deck: Chevron/Gulf	

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES
Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
- Bufalo	Elf	84 m	1 Drilling/Production, planned	associated pipelines under study
- Palarca	Elf	-	1 Drilling/Production, completed Fabr.: Brasoil	
- Other structures earmarked for development are Punja, Impala, Veado, Pacassa				
Benin				
- Seme	Semefield Development & Co	30 m	1 Production, status unknown	
Congo				
- Zatchi	Agip	57 m	1 Drilling + 1 Production, under construction Design: Jacket/Piles/Deck: Tecnomare Fabr.: Jacket: Boscongo Yard (owner Bouygues, France)	
- Tchibouela	Elf	83 m	3 Drilling/Production + 1 other, under construction Design: Technip Fabr.: Jackets: Bouygues, France	
- Emeraude	Elf	65 m	Heavy crude oil find. Might require offshore steam injection and many injector platforms. Complicated and innovative Charters Financing Scheme under evaluation comprising the operator, the contractor and the oil customer. Formerly design for pilot platforms at C.G. Doris, fabrication at Bouygues Offshore and UIE (jacket).	

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES
Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
Egypt				
- North American	ENPPI	-	2 Production, planned, bidding	
- Abu Qir	Wepco	35 m	1 Production, mobile, completed Design: Jacket/Piles: Bechtel Fabr.: Mc Dermott (Aik Shouhna, Egypt) Inst.: Mc Dermott	Pipelines, designed Design: Bechtel
- Nile Delta Abu Modi	Petrobel	39 m	1 Production planned	
- North Sinai	Total	150 m	1 Platform under study	
- Al-Amal	Total	-	1 Platform under study	
Gabon				
- Obando	Tenneco	49 m	1 Drilling/Production under construction Design: Jacket/Piles/Deck: CBS Topsides: Gilley Fabr.: Jacket/Piles/Deck: Mc Dermott (Morgan City, LA) Topsides: CE/Natco/Universal/Fab/Seeco Inst.: Jacket/Deck: ETPM	Pipeline planned
- Octopus Marin	Tenneco	49 m	1 Drilling/Production under construction similar to Obando field	

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES
Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
- Pelican	Tenneco	34 m	1 Well Protector + 1 other, under construction similar to Obando field	Pipeline planned
- Grodin	Elf	-		Subsea satellite wells planned
Ghana				
- South Tano	Ghana Nat'l Pet. Co.	-	1 Platform, under study	
Equatorial Guinea				
- Blk B-13 Alba	GEPSA	-	1 possible platform, development under study	
Ivory Coast				
- B 1 Foxtrott	Phillips	75 m	1 Drilling, cancelled (?)	
Libya				
- Blk NC 41 B Bouri	Agip	158 m	1 Drilling/Production, under construction Design: Jacket/Piles: Tecnomare Deck/Topsides: Snamprogetti Fabr.: Jacket/Piles/Deck: Belleli (Taranto, Italy) Topsides: Daewoo/Hyundai Inst.: Jacket/Deck: Micoperi	Pipeline-System with 2 - 16" and 1 - 12" lines planned Design: Snamprogetti Inst.: Saipem Mooring terminals & tanker "Agip Sardegna" under construction Design: EMH/Bluewater Fabr.: Dragados y Construccion Spain

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES
Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
Mozambique				
- Xai-Xai	BP	> 200 m	Exploration period	
Nigeria				
- Agbara	Agip	59 m	1 Production planned Design: Tecnomare	43 km pipeline
- Isan	Chevron	18 m	1 Compression planned Design: Chevron	
- Okan	Chevron	8 m	1 Compression planned similar to Isan	
- Pitangueira	Agip	-	1 possible platform, under study	
- Otuo	Elf	6 m	1 possible platform, under study	
- Oso	Mobil	17 m	3 Drilling + 1 production, under study	
- Akam - Adanga	SBM		1 Production mobile, completed Design: SBM Fabr.: SBM	1 Subsea pipeline, 22 miles, 8" - 10", 12", completed Pressure gas system for future gas lifting under construction
- Ebughi			to be tied in 1 Production + 1 Quarters + 1 Well Protector + 1 Support, delayed	1 Subsea pipeline, 36 miles 12", delayed
- Warri to Lagos Gas-Pipeline				Gas-Pipeline, 380 km, 16", 300 m S, Contractors Snamprogetti/Saipem

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES
Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
Senegal				
- Dome Flore	Senegal/ Venezuela Joint Vent.	117 m	1 possible platform, under study	
Zaire				
- Muanda	Zaire Govt.	-	2 platforms, under study	1 Pipeline to shore) under 1 Mooring terminal) study
A S I A				
Burma				
- Gulf of Martaban	MOC	-	Exploration program in the Gulf of Martaban suspended	
Indonesia				
- Ardjuna	Arco	39 m	1 Production, under construction Design: Jacket/Piles/Deck: PT Tri Patra Fabr.: Jacket/Piles/Deck: PT Adiguna (Jakarta, Indonesia) Topsides: PT Dock/PT Adiguna Inst.: Jacket/Deck: IOC (Pribumi)	
"	Arco	42 m	1 Production, under construction Design: Jacket/Piles/Deck: PT Adiguna Fabr.: Jacket/Piles: PT Adiguna (Batam, Indonesia) Deck: Guna Nusa (Grenyang, Indonesia)	

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES

Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
- Ardjuna	Arco	27 m	5 Well protector/mobile, under construction, 3 under study Design: Jacket/Piles/Deck: PT Tri Patra Fabr.: Jacket/Piles: PT Adiguna (Batam, Indonesia) Deck: Mc Dermott (Batam, Indonesia)	
"	Arco	28 m	2 Well protector/mobile, planned Design: Jacket/Piles/Deck: PT Tri Patra	
	Arco postponed installation of well protector platforms			
- Bima	Arco	37 m	1 Production, mobile, under construction Design: Jacket/Piles/Deck/Topsides: PT Tri Patra Fabr.: Jacket/Piles: Mc Dermott (Batam, Indonesia) Deck/Topsides: PT Guna Nusa (Grenyang, Indonesia) Inst.: Jacket: Mc Dermott Deck: IOC (Pribumi) Topsides: PT (Essarindo)	
"	Arco	32 m	1 Quarters, under construction Design: Jacket/Piles/Deck/Topsides: PT Tri Patra Fabr.: Jacket/Piles/Deck: PT Arlau (Batam, Indonesia) Topsides: PT Arlau/AG&P Inst.: Jacket/Deck/Topsides: Mc Dermott	

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES
Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
- Bima	Arco	27 m	4 Well Protector/mobile, 3 planned and 1 designed Design: PT Tri Patra	
"	Arco	27 m	1 Processing platform, under study	
- Kakap Blk KF	Marathon	86 m	2 Drilling/Production, planned Design: Jacket/Piles/Deck: Fluor Topsides: Fluor/Omega	1 Oil pipeline, 10", 9 miles planned
- Notuna Sea Blk A Anoa 1	Chevron Conoco	81 m	Drilling/Production, planned	1 Mooring terminal planned 1 Diver-assisted wet, single Non-TFL planned
- Mengkapa	Hudbay	-	5 Well protectors	3 pipelines, 2- 10", 1 - 8" completed, Inst.: Mc Dermott
- Sisi-1				
- Ikan Pari				1 Oil/Gas/condensate pipeline planned 1 Subsea planned
- Pagerungan	Arco	54 m	1 Platform, under study	1 Mooring terminal, bidding with associated pipelines
- Rawa	Asamera			1 Pipeline, under study
- Belanak	Conoco	90 m		1 FPSOW/CALM or turret mooring under study
- Forel	Conoco	-		1 Subsea completions, under study

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES
Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
- Wiriagar	Conoco			2 Pipelines under study
- Camar	Texas Eastern	62 m	1 fixed platform, under study	
- Gita	Iiapco	30 m	1 Drilling/Production, under study	
- Rama	Iiapco	36 m	1 Drilling/Production, postponed	
- Zelda	Iiapco	14 m	1 Drilling/Production, delayed	
- East Java	Nodeco	27-39 m		8 wet non-TRL diver assisted subsea trees, under study
- North Sumatra	Mobil	90 m	2 Drilling) under 1 Production) study	1 Gastrunkline, planned
Malaysia				
- St. Joseph	Shell Sarawak	-	Other, under construction Fabr.: Jacket/Piles/Deck: Promet (Singapore)	
- Temana	Shell Saramak	-	1 Drilling, under construction Fabr.: Jacket/Piles/Deck: Promet (Singapore)	
- J 4	Shell Saramak	54 m	1 Production + 1 Drilling/ Production, completed Design: Jacket/Piles: Protech Fabr.: Jacket/Piles: Sembawang (Singapore)	
- Dulang	Petronas	71 m	4 Drilling/Production, 3 designed, 1 bidding Design: Jacket/Piles/Topsides: MMC	1 SPM tanker storage, bidding

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES
Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
- Seligi	Petronas	26 m	2 Drilling/Production, under construction, 1 planned Fabr.: Mc Dermott Yard + Sime Sambawang Yard	
- Barton	Shell Sarmak	60 m	2 Drilling/Production, 1 under construction, 1 planned Fabr.: Jacket/Piles/Deck: Promet (Singapore)	
- Tabu	Esso	75 m	2 Drilling, planned Design: Jacket/Piles/Deck: EPRCO	
- Guntong	Esso	62 m	5 Drilling, 2 under construction, 3 planned Design: Jacket/Piles/Deck: EPRCO Fabr.: Jacket/Piles: Sembawang (Singapore) Topsides: Malaysian Shipyard	
- Palas	Esso	-	1 Drilling, planned	
- Sabah Tambungo	Shell Sabah	83 m		Pipelines planned
- Bekok	Esso	70 m	1 Production, under study	
- Tapis	Esso	66 m	1 Drilling/Production, under study	
- Tembungo	Esso	83 m	1 Drilling/Production, under study	
- Trengganu	Esso	62 m	34 Production, most under study 2 under construction	100-200 km extensive pipeline system, under study
- Bokor	Shell Sarawak	-	1 Drilling/Production, under construction	

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES
Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
- Samarang	Shell Sarawak	-	1 Gas compression structure, under construction	
Betty	Shell Sarawak	72 m	2 platforms, under study	
- K-8	Shell Sarawak	60 m	4 platforms, under study	
- F-13	Shell Sarawak	68 m	4 platforms, under study	
- Tukau	Shell Sarawak	42 m	2 platforms, under study	
- West Luntong	Shell Sarawak	45 m	1 platform, under study	
Philipines				
- Palawan Island Tara	PNOC + Petrocan	-	2 platforms, under study	Pipelines planned
Thailand				
- Gulf of Thailand	Union	60 m	1 Production, under study 1 Quarters, under study	3 Gaslines (90, 130, 180 miles) under study
"	Petroleum Authority Thailand	60 m	1 Production, under study 1 Other, under study	1 Gasline 18", under study 1 Gasline 32", under study
- Dara	Union	63-72 m	1 Platform, under study	

OFFSHORE PROJECTS IN DEVELOPING COUNTRIES
Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
- Funan	Union	63-72 m	1 Platform, under study	
- Jakrawan	Union	63-72 m	1 Platform, under study	
- Pakarang	Union	63-72 m	1 Platform, under study	
- Nang Nuan	Shell	30 m	1 Well completed. Shell is applying for a production license which, if granted, would allow the Company to produce from a converted jack-up to a converted tanker FPSO	
Vietnam				
- Dragon	Vietsorpet	42 m	1 Drilling/Production, planned Design: Jacket/Piles/Deck/Topsides: USSR Fabr.: Jacket/Piles/Deck: Nicolaersk (Amur, USSR)	
"	Vietsorpet	-	1 Platform, under study	
- White Tiger "	Vietsorpet Vietsorpet	42 m 31 m	2 Drilling/Production, planned Design: Jacket/Piles/Deck/Topsides: USSR Fabr.: Jacket/Piles/Deck: Nicolaersk (Amur, USSR).	1 Pipeline planned
- "	Vietsorpet	49 m	3 Drilling/Production, under construction Fabr.: Jacket/Piles/Deck: Vung Tan Shipyard (Vietnam)	

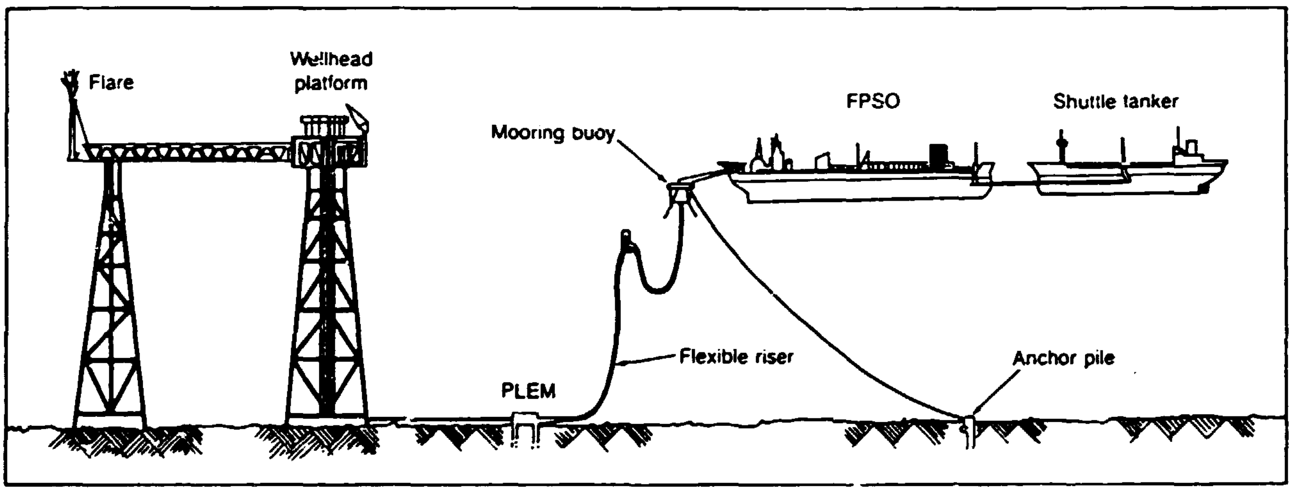
OFFSHORE PROJECTS IN DEVELOPING COUNTRIES
Under Construction/Planned/Under Study

Country/Field	Operator	Water Depth	Platforms	Pipeline - Subsea Projects Mooring Terminals
L A T I N A M E R I C A				
Colombia				
- La Guajira	Ecopetrol	-		1 Gas pipeline, under study
Peru				
- Piedro Redonda Blk Z 1A	Petromar	90 m	1 Drilling, under study	
Trinidad				
- Pelican	Tritoc	71 m	1 - 12 Slot drilling, planned Design: Sante Fe / Braun	1 - 16" gas pipeline, planned 1 8" condensate pipeline, planned
		77 m		1 - 16" gas condensate pipeline planned

8.4 Examples for Marginal Field Development in Developing Countries

Indonesia: KAKAP KH Field *)

KAKAP field is situated 775 miles north of Jakarta in Natuna Sea. The field came onstream March 1986. Operator is Marathon (37,5%), other participants are Aminoil Indonesia (KAKAP) Inc., BP Petroleum Development (KAKAP) Ltd., London and Scottish Marine Oil KAKAP Ltd, Hudbay Oil (KAKAP) Ltd. and Pertamina. Waterdepth is about 90 m.



OVERVIEW of Kakap KH field production system.

*) Source: Ocean Industry, Nov. 1986

The field production system choosen by the field partners is a small wellhead platform with a steel substructure, combined with a flare, the processing facilities supported by a floating production storage and offloading system (FPSO).

The wellhead platform is a conventional four leg steel wellhead platform, accommodating 15 production wells. Its weight is about 1.100 tons. The topside facilities include production deck, accommodation and helicopter deck.

The wellhead platform is connected with a steel tubular flarebridge to a three leg steel flare tripod and - by two subsea pipelines - to the FPSO. The whole system is designed for a peak production of 25,000/barrel per day. The FPSO has been built on the base of a converted tanker. It accommodates the whole process system for the oil and the necessary storage. Distance between the wellhead platform and the FPSO is 1,2 miles. Other parts of the system are the pipeline end manifold (PLEM) and a mooring buoy.

Offloading is performed to a shuttle tanker which is moored in tandem with the FPSO. The offloading rate is 19.000 barrel per hour.

UMM Al-DALKH Field and SATAH Field (Abu Dhabi)[1]

The UMM Al-DALKH and SATAH fields are operated by UMM Al-DALKH Development Company, which is jointly owned by Abu Dhabi National Oil Company and Japanese Oil Development Company.

The UMM Al-DALKH field lies in the Arabian Gulf about 30 km north west of Abu Dhabi. It is developed with in total ten remote, unmanned production wellhead platforms and six water injection platforms. Additionally the field contains a central production platform complex consisting of three platforms with central production, living quarters and flare. All cruide oil is processed by a two stage separation before being exported to the large ZAKUM Complex. Additionally to the oil production a water fluid program is operated using the unmanned injection wellplatforms.
Associated gas is used for fuel on the central platform, the rest of the gas is flared offshore. The total field production is designed for 25.000 barrel per day.

The SATAH Field

The Satah field is situated about 55 km Zirku Island about 145 km north west of Abu Dhabi. The field consists of five wellhead platforms for oil production, three water injection/observation platforms and one gas production and reinjection platform.

[1] Source: Offshore Technology Conference 1987

The process facilities for Satah are located onshore on Zirku Island. The process design is for 32.000 barrels oil per day. The processing units contain two stages of separation and a stabilizer to reduce the h2s concentration in the oil. The production rate of Satah was at the beginning 15.000 barrel oil per day.

The relatively low production with the large number of wellheads required new technical approaches to remain in an economical cost marge.

The following solutions are to be mentioned:

- distributive control systems
- telemetry monitoring of wellhead platforms
- power generation by solar panels and thermo electric generators
- control and handling of a high pressure crude oil with high hydrogen sulphide (H_2S) content
- removal of H_2S from produced gas

Distributive Control System

Distributive Control System processes 400 analog and status signals produced on 15 graphics, and 72 parameters are recorded in the historical trend panel.

Telemetry Monitoring of Wellhead Platforms

The wellhead control systems which are installed on each wellhead contain alarm indicators which are part of a communication system.

Power Generation on Wellhead Platform

Power is required for navigational aids (lights and foghorns), fire and gas panel, poiline radio and corrosion inhibitor pump. Power requirements on the platforms vary from 150 Watt on the waterinjection platforms to 600 Watts on the production wellhead platforms.

The choosen system for power generation on water injection platforms are soloar panels. The production wellhead platforms are equipped with thermo-electric generators, using fuel gas.

Crude processing

To avoid corrosion and provide safe operation the designers incorporated the following features:

- selected materials
- vessels with protective coating
- corrosion inhibitor injection
- installation of corrosion monitoring points
- use of intelligent corrosion monitoring pigs in the pipelines
- extensive application of h2s detectors and alarms.

Gas processing

Highly sophisticated gas treatment unit was installed onshore to absorb H_2S at high concentations and low pressure.

Pipeline design in shallow water

Special attention was given by the designers to the pipeline stabilization in shallow water (UMM Al-DALKH 12 - 21 m, SATAH 9 - 20 m). The soil conditions are characterized by geographical irregularities and hardliers such as rock outcrops. Equally the danger of score on pipelines at the sea bottom existed. Following computer studies and investigations the pipelines were coated with concrete, partly mechnically anchored and trenched in the sea bottom.

P R O S P E C T

PROSPECT

The principal relations in the offshore oil and gas business, and the position and the chances of the developing countries have been elaborated throughout this study.

However, for a deeper analysis the concrete situations have been missing resulting in less specific statements. Also the examples in B-8 cannot explain the relations. The less specific the situations are known the less pointful and in various cases even wrong the resulting advice must be.

The authors recommend to continue and to complete this study by elaboration of concrete conceptions for one or more selected countries.

The U N I D O Expert Group Meeting on the Offshore Oil and Gas Industries in Developing Countries, which will take place in September 1988 in Hamburg, West Germany, gives the first chance to discuss such proposals. The leader of the team of experts who have been the authors will contribute by presenting this main discussion paper.

At least for one selected country the method of establishing a status and developing a strategy should be exercised. The team of experts should investigate in the country, elaborate the status and prepare a strategy.

During a workshop with the responsible persons of the respective country the results of such work should be discussed in great detail.

APPENDICES

FOR CHAPTERS

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		APPENDIX A-1-3
		APPENDIX A-1-4
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		APPENDIX A-4-2
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		APPENDIX A-4-5
		APPENDIX A-4-6
		APPENDIX A-4-7

APPENDIX A-1-1

SUMMARY DETAILS OF OFFSHORE DEVELOPMENT EXPENDITURES BY REGIONS AND MAIN COUNTRIES

		Offshore Development Expenditures (US $ Million, Constant 1986 Prices)	
		1986	1990
SOUTH AMERICA		5,664	6,350
of which :	Venezuela	2,309	2,220
	Brazil	3,245	3,390
CENTRAL AMERICA		440	780
of which :	Mexico	440	780
FAR EAST		3,000	5,550
of which :	India	640	275
	Thailand	70	660
	Malaysia	520	1,110
	Brunei	180	200
	Indonesia	940	1,480
	Vietnam	240	320
	China	305	675
MIDDLE EAST		2,028	2,540
of which :	UAE	910	1,400
	Qatar	3	700
	Saudi Arabia	1,100	150
	Iran	15	190
AFRICA		1,105	2,430
of which :	Ivory Coast	10	125
	Nigeria	240	570
	Cameroon	80	230
	Gabon	165	160
	Congo	130	140
	Angola-Cabinda	230	160
	South Africa	10	400
	Tanzania	5	250
	Egypt	205	305
TOTAL WORLD		27,442	33,635

Source G.A. Mackay, G. Rosie, Suzie Nickalls and Juliet McKee, World Offshore Oil and Gas Industry 1986 - 90, Report by Mackay Consultants, Inverness.

APPENDIX A-1-2

ESTIMATES OF OFFSHORE OIL AND GAS PRODUCTION BY REGIONS AND MAIN COUNTRIES

		OIL (million tonnes)		GAS (billion cubic metres)	
		1986	1990	1986	1990
SOUTH AMERICA		77.1	87.7	38.4	49.0
of which :	Venezuela	44.8	49.8	6.5	6.9
	Trinidad & Tobago	6.6	6.2	3.8	5.9
	Brazil	19.5	25.7	24.9	24.9
CENTRAL AMERICA		85.0	89.5	10.5	12.5
of which :	Mexico	85.0	89.5	10.5	12.5
FAR EAST		85.4	108.1	38.48	50.85
of which :	India	28.1	32.7	3.85	7.25
	Malaysia	23.5	25.5	14.10	17.30
	Brunei	6.0	6.2	8.35	9.40
	Indonesia	26.2	27.0	7.90	9.70
	Vietnam	0	12.5	-	-
MIDDLE EAST		139.0	177.7	13.7	46.0
of which :	UAE	30.1	32.5	7.2	12.0
	Qatar	9.7	10.2	1.0	4.5
	Saudi Arabia	75.0	90.0	5.5	15.5
	Iran	24.2	45.0	0	8.0
AFRICA		92.5	99.8	2.57	4.77
of which :	Nigeria	19.0	20.5	1.00	1.60
	Cameroon	10.0	11.2	-	-
	Angola-Cabinda	13.0	14.5	0.35	0.45
	Egypt	36.3	37.0	1.20	2.70
TOTAL WORLD		756.8	853.5	345.90	414.33

Source G.A. Mackay, G. Rosie, Suzie Nickalls and Juliet McKee, World Offshore Oil and Gas Industry 1986 - 90, Report by Mackay Consultants, Inverness.

APPENDIX A-1-3

SUMMARY DETAILS OF OFFSHORE EXPLORATION EXPENDITURES BY REGIONS AND MAIN COUNTRIES

	Offshore Exploration Expenditures (US $ Million, Constant 1986 Prices)	
	1986	1990
SOUTH AMERICA	764	1,433
of which : Venezuela	44	165
Brazil	600	850
Argentina	25	115
Chile	60	120
CENTRAL AMERICA	35	85
of which : Mexico	35	60
FAR EAST	916	1,365
of which : India	110	125
Thailand	30	75
Malaysia	85	150
Indonesia	240	345
Vietnam	40	110
China	260	230
Japan	50	75
MIDDLE EAST	141	385
of which : Oman	10	40
UAE	80	160
Saudi Arabia	35	85
AFRICA	751	1,265
of which : Ivory Coast	45	85
Nigeria	135	160
Cameroon	60	100
Gabon	120	135
Angola-Cabinda	130	180
South Africa	100	75
Egypt	110	200
TOTAL WORLD	8,102	10,447

<u>Source</u> G.A. Mackay, G. Rosie, Suzie Nickalls and Juliet McKee, <u>World Offshore Oil and Gas Industry 1986 - 90</u>, Report by Mackay Consultants, Inverness.

APPENDIX A-1-4

SUMMARY DETAILS OF OFFSHORE OPERATING EXPENDITURES BY REGIONS AND MAIN COUNTRIES

		Offshore Operating Expenditures (US $ Million, Constant 1986 Prices)	
		1986	1990
SOUTH AMERICA		3,030	3,815
of which :	Venezuela	1,420	1,580
	Trinidad & Tobago	410	540
	Brazil	1,050	1,370
CENTRAL AMERICA		1,900	2,000
of which :	Mexico	1,900	2,000
FAR EAST		2,307	4,005
of which :	India	275	350
	Malaysia	185	215
	Brunei	300	340
	Indonesia	1,420	1,850
	Vietnam	0	900
MIDDLE EAST		690	1,175
of which :	UAE	150	200
	Saudi Arabia	275	500
	Iran	220	375
AFRICA		2,380	2,767
of which .	Nigeria	120	130
	Cameroon	350	400
	Gabon	240	225
	Congo	215	320
	Angola-Cabinda	315	360
	Egypt	1,030	1,200
TOTAL WORLD		25,838	31,987

Source G.A. Mackay, G. Rosie, Suzie Nickalls and Juliet McKee, World Offshore Oil and Gas Industry 1986 - 90, Report by Mackay Consultants, Inverness.

APPENDIX A-4-1

The Drill Site
- Finding Oil and Gas
- Selecting the Drill Site
- Preparing the Site
- Moving Equipment to the Site
- Rigging Up

Rig Components
- Power System
- Hoisting System
- Rotating Equipment
- Circulation System

Drilling Operations
- Drilling the Surface Hole
- Tripping Out
- Running Surface Casing
- Cementing
- Tripping In
- Running and Cementing Intermediate Casing
- Drilling to Final Depth
- Evaluating Formations
- Completing the Well
- Special Drilling Operations

Well Planning

Bit Selection
- Bit Design
- Bit Classification
- Dull Bit Evaluation
- Drilling Performance Records

Weight On Bit and Rotary Speed
- Special Considerations
- Rate of Penetration Control

Drilling Fluid Properties
- Mud Characteristics That Affect ROP
- Air Drilling

Bit Hydraulics
- Bit Hydraulic Horsepower
- Hydraulics Calculation

Formation Properties

New Technology

APPENDIX A-4-2

Theoretical lessons for drilling foremen and supervisors (Deutsche Bohrmeisterschule, Celle)

Theoretical courses for foremen (drilling) will take 7 months with 40 lessons weekly!

	lessons total
English	80
Basic sciences	
mathematics	120
physics and chemistry	160
technical drawing	60
geology	40
Application of technology	
public regulations	60
industrial safety	60
drilling engineering	200
well production technology	40
mechanical technology	80
drilling equipment	80
first aid	20
	1.000

Theoretical courses for drilling supervisors will take 18 months fulltime training with 40 lessons weekly as follows:

English	160
mathematics	300
physics	120
Chemistry and material technology	80
mechanics	160
technical drawing	80
geology	120
mechanical technology	140
computer and data processing	40

Application of technology

public regulations	70
industrial safety	70
industrial economy	80
drilling technology	400
well production technology	80
prime movers	120
measuring/control technology	80
drilling equipment	120
first aid	20
	2.240

APPENDIX A-4-3

Essential items for a Training Course in Oil and Gas Production.

- Origin and Accumulation of Oil and Gas
- The Well
- Well Treatment
- The Wellhead
- Artificial Lift
- Well Testing
- Separation, Treatment and Storage
- Gaging and Metering Production
- Offshore Production and Structures
- Special Problems
- Enhanced Recovery
- Production People
- Tools and Equipment
- Pipe, Valves and Fittings
- Reports and Records
- State and Federal Oil and Gas Regulations
- Economic Considerations
- Future Trends

APPENDIX A-4-4

Theoretical lessons for production foremen and supervisors (Deutsche Bohrmeisterschule, Celle)

Theoretical courses for foremen will take 7 months with 40 lessons weekly as follows:

	lessons total
English	80
Basic sciences	
mathematics	120
physics and chemistry	160
technical drawing	60
geology	40
Application of technology	
public regulations	60
industrial safety	60
drilling engineering	200
well production technology	40
mechanical technology	80
drilling equipment	80
first aid	20
	1.000

Theoretical courses for supervisors will take 18 months fulltime training with 40 lessons weekly as follows:

English	160
mathematics	300
physics	120
Chemistry and material technology	80
mechanics	160
technical drawing	80
geology	120
mechanical technology	140
computer and data processing	40

Application of technology

public regulations	70
industrial safety	70
industrial economy	80
drilling technology	400
well production technology	80
prime movers	120
measuring/control technology	80
drilling equipment	120
first aid	20
	2.240

APPENDIX A-4-5

Essential items for a Training Course in Oil Well Service and Workover.

Introduction
- Petroleum Reservoirs
- Drilling Rigs and Servicing Equipment
- Casing and Tubing
- Logging
- Coordinating the Work

Well Completion
- Perforating
- Potential Test
- Swabbing
- Gas Wells
- Injection Wells

Service and Workover Rig Equipment
- Truck-mounted Units
- Carrier Units
- Auxiliary Equipment
- Marine Equipment

Remedial Well Work
- Sucker Rod Pumps
- Sucker Rods
- Production Tubing
- Packers
- Wellhead Repairs
- Blowout Prevention

Well Cleanout and Workover
- Completion and Workover Fluids
- Sand Cleanout
- Sand Control Measures
- Plugb-Back
- Casing Repair
- Sidetrack Drilling
- Drilling Deeper

Well Stimulation
- Explosives
- Acid Stimulation
- Hydraulic Fracturing

Fishing Tools and Accessoires
- Taps and Die Collars
- Spears and Overshots
- Internal and External Cutters
- Milling Tools
- Washover Pipe
- Junk Retrievers
- Fishing Accessoires

Analysis, Planning and Economics
- Problem Wells
- Problem-Well Analysis
- Workover Planning
- Economic Justification

APPENDIX A-4-6

SUGGESTED HEADING FOR TRAINING PROGRAMS OF CRAFTSMEN IN CONSTRUCTION YARDS

FABRICATOR - SAFETY
INTRODUCTION TO EQUIPMENT
OPERATION OF EQUIPMENT
FREEHAND CUTTING
MACHINE CUTTING
INTRODUCTION TO DRAWING
METHODS OF MEASURING
TEMPLATE MAKING
USE OF LEVELS
PLATES - BEST USE
STRUCTURAL STEEL - LAYOUT AND BEST USE
PIPES AND TUBES

EXTENSION COURSE

MASTER TEMPLATES - ADVANCED
CALCULATIONS - TRIGONOMETRY
RECORDS
DIMENSIONAL CHECKS
THEODOLITE
SETTING OUT

WELDER - INTRODUCTION TO EQUIPMENT
INTRODUCTION TO ELECTRODES
JOINTS AND WELD SYMBOLS
JOB INSTRUCTION AND RECORDS
LIMITING DISTROTION
WORKHOLDING METHODS
SAFE WORKING PRACTICES
BASIC MANUAL METAL ARC WELDING
POSITIONAL WELDING ON PLATE SURFACES
WELDING FILLET JOINTS
WELDING SINGLE VEE BUTT JOINTS
PIPE WELDING - SINGLE VEE JOINTS
FAULT DIAGNOSES AND TESTING

BURNER - SAFETY
INTRODUCTION TO EQUIPMENT
INTRODUCTION TO THEORY
OPERATION OF EQUIPMENT

FREE HAND CUTTING
MACHINE CUTTING
SQUARE AND BEVEL CUTTING
CUTS TO A MEASURED DISTANCE
INTRODUCTION TO GOUGING EQUIPMENT

<u>GOUGER</u> - SAFETY
INTRODUCTION TO EQUIPMENT
INTRODUCTION TO THEORY
OPERATION OF EQUIPMENT
FREE HAND CUTTING
MACHINE CUTTING
SQUARE AND BEVEL CUTTING
CUTS TO MEASURED DISTANCE
INTRODUCTION TO GOUGING EQUIPMENT

<u>SCAFFOLDER</u> - SAFETY
TYPES AND USES OF SCAFFOLD FITTINGS, TUBES AND BOARDS
ERECT AND DISMANTLE-INDEPENDENT SCAFFOLD
MOBILE TOWER
LADDERS AND GIN WHEELS
PUTLOG SCAFFOLD
BIRDCAGE SCAFFOLD
BUILDING CONSTRUCTION REGULATIONS (SCAFFOLD)
STATUORY REGULATIONS (SCAFFOLD)
INSPECTION AND STORAGE
MATERIAL ASSESSMENT

<u>RIGGER</u> - SAFETY
INTRODUCTION TO LIFTING APPLIANCES
RIGGING AND LIFTING
WIRE ROPES
USING LIFTING GEAR
ERECTING HEAVY COMPONENTS

<u>HELPER</u> - SAFETY
INTRODUCTION TO HEATING TORCH
INTRODUCTION TO GRINDERS
OPERATION OF HEATING TORCH
OPERATION OF GRINDERS
ABRASIVE WHEELS REGULATIONS AND TEST

APPENDIX A-4-7

TRAINING

CONTENTS

ARTEMIS

An important aspect to consider when using any sophisticated computer software is the training that is available.

PACE can offer a range of courses from the basic discipline courses, through the fundamentals of using ARTEMIS, to the advanced processing techniques.

The courses are categorised into training levels, each level indicating the experience level of the trainee on the ARTEMIS system, making it possible to identify the level of expertise within an organisation, department or discipline and how that expertise can be upgraded.

The courses available are detailed following this overview and consist of ;

Training Level 1 (TL1)	Basic Planning Basic Costing
Training Level 2 (TL2)	Introduction to ARTEMIS
Training Level 3 (TL3)	Project Management Overview
Training Level 4 (TL4)	ARTEMIS Scheduling Database ARTEMIS Relational Database
Training Level 5 (TL5)	Network Modeling Cost Application Modeling

PRODUCT COURSES

ARTEMIS 2000	-	Introduction Course
ARTEMIS 2000	-	User's Course
ARTEMIS 2000	-	Planning & Scheduling Course

INTRODUCTION

SERVICES OFFERED

BY

PACE

We consider that an integral part of offering solutions to clients problems is, the ability to be able to educate and train different disciplines in the main areas of Project Control.

Over the years PACE has developed several courses that are tailor made to perform these tasks and has recently developed specific courses to help with the use and understanding of computer systems.

Details of all these courses are included in this section

- Artemis Courses
- Course for the "TISEST" Estimating System
- Cost Course for Construction Yards

BASIC PLANNING
AN INTRODUCTION TO THE DISCIPLINE OF PLANNING

COURSE CODE	BPL
OVERVIEW	This course introduces the basic techniques of planning. It gives hands-on experience of manually computing network data.
WHO SHOULD ATTEND	This course is for those who have a planning responsibility but have had little formal training in the discipline, or for those who will be responsible for an ARTEMIS system and wish to gain basic understanding of networking.
PRE-REQUISITE KNOWLEDGE	None
DURATION	2 Days
OBJECTIVES	Upon completion of the course the trainee should be able to : • Specify a calendar • Draw a precedence network • Perform Time Analysis of the network • Identify critical activities • Calculate activity start and finish dates • Schedule and aggregate resource quantities • Identify resource overloads and underloads • Produce reports in the form of Barcharts • Histograms, 'S' curves and Pie Charts

BASIC PLANNING
AN INTRODUCTION TO THE DISCIPLINE OF COSTING

COURSE CODE	BCS
OVERVIEW	This course introduces the basic techniques of costing. It will enable participants to understand how costing practices can be applied in their own work situations.
WHO SHOULD ATTEND	This course is for those who have a costing responsibility but have had little formal training in the discipline, or for those who will be responsible for an ARTEMIS system and wish to gain a basic understanding of costing.
PRE-REQUISITE KNOWLEDGE	None
DURATION	2 Days
OBJECTIVES	Upon completion of the course the trainee should be able to : • Understand the functions of Costing • Identify the range of information and procedures used • Know how and when to secure information • Identify contractual obligations • Know how costing relates to other disciplines • Know how to analyse the data and prepare reports for management

INTRODUCTION TO ARTEMIS

COURSE CODE	IA1
OVERVIEW	This course introduces the major concepts of ARTEMIS. It gives an overview of the product, describes how ARTEMIS operates and what it consists of.
WHO SHOULD ATTEND	This course is a pre-requisite for those who will be using ARTEMIS. It is also a useful course for people who want an overview of ARTEMIS.
PRE-REQUISITE KNOWLEDGE	None
DURATION	1 Day
OBJECTIVES	Upon completion of the course the trainee will understand • The design of ARTEMIS • The operating environment • The ARTEMIS environment • The Database Contents • The Scheduling Database • The Documentation

PROJECT MANAGEMENT OVERVIEW

COURSE CODE	PMO
OVERVIEW	This course introduces the concepts and techniques of Project Management. It explains the project hierarchy, the interdependency of disciplines, reviews breakdown structures, the project cycle and the reporting structure.
WHO SHOULD ATTEND	This course is for those who are involved in Project Management and who require a basic understanding of the discipline of Project Management.
PRE-REQUISITE KNOWLEDGE	None
DURATION	3 Days
OBJECTIVES	Upon completion of the course the trainee should understand : • How to define a Projects Parameters • Project Hierarchical Structures • Breakdown Structures • Project Organisation • The major project disciplines • Change Control • Resourcing • Project Reporting Structure

ARTEMIS SCHEDULING DATABASE

COURSE CODE	ASD
OVERVIEW	This course covers the use of ARTEMIS for creating and using precedence networks. It is an introduction for planning with an advanced Project Management Information System.
WHO SHOULD ATTEND	This course is for those who understand the principles of planning and will be using ARTEMIS to create and compute precedence networks.
PRE-REQUISITE KNOWLEDGE	Familiarity with precedence networks or the Basic Planning Course. Introduction to ARTEMIS. It is also recommended to have attended the Project Management Overview course.
DURATION	2 Days
OBJECTIVES	Upon completion of this course trainees should be able to : • Specify a Calendar • Create a Network • Perform Time Analysis • Enter and interrogate Resourcing Information • Schedule networks • Produce Graphical reports • Produce Tabular Reports

ARTEMIS RELATIONAL DATABASE

COURSE CODE	ARD
OVERVIEW	This course introduces users to the ARTEMIS Relational Database Management System and describes the setting up of database through to reporting.
WHO SHOULD ATTEND	This course is intended for ARTEMIS users who will be responsible for creating and maintaining databases and producing graphical and tabular reports.
PRE-REQUISITE KNOWLEDGE	Introduction to ARTEMIS. It is also recommended to have attended the project Management Overview course.
DURATION	2 Days
OBJECTIVES	Upon completion of the course the trainee will be able to : • Create an ARTEMIS database • Understand the methods of data security • Perform calculations on the database • Understand application development • Produce Graphical Reports • Product Tabular Reports

NETWORK MODELLING

COURSE CODE	NWM
OVERVIEW	This course covers the advanced techniques of planning using an ARTEMIS Project Management Information System.
WHO SHOULD ATTEND	This course is for personnel who have a responsibility for planning in a project and wish to investigate the advanced planning techniques that are available using an ARTEMIS System.
PRE-REQUISITE KNOWLEDGE	ARTEMIS Scheduling Database Course. At least 3 months experience using the ARTEMIS Scheduling Database System.
DURATION	5 Days
OBJECTIVES	On completion of this course the trainee will have reviewed advanced techniques and worked examples using WBS and OBS in • Networks • Scheduling Techniques • Aggregations • Progress in a Project Hierarchical Structure • Planning and Scheduling Graphics • Interface Design • Output

COST APPLICATION MODELLING

COURSE CODE	CAM
OVERVIEW	This course covers the advanced techniques of application design and programming using an ARTEMIS Project Management System.
WHO SHOULD ATTEND	This course is for personnel who have a responsibility for costing in a project and wish to investigate the advanced application writing techniques using an ARTEMIS Relational Database System.
PRE-REQUISITE KNOWLEDGE	ARTEMIS Relational Database Course. At least 3 months experience using the ARTEMIS Relational Database System.
DURATION	5 Days
OBJECTIVES	On completion of this course the trainee will have reviewed advanced techniques and worked examples using WBS, OBS and CBS for a costing application paying particular attention to : • System Design Techniques • Applications Writing Techniques • Data Processing Techniques • Data Input and Amendment • Interface Design • Output

"TISEST" THE BASIC SOFTWARE PACKAGE

TRAINING

TRAINING

INTRODUCTION TO "TISEST"

COURSE CODE

IT1

OVERVIEW

This course introduces the major concepts of 'TISEST'. It gives an overview of the product, describes how 'TISEST' operates and what it consists of.

WHO SHOULD ATTEND

This course is a pre-requisite for those who will be using 'TISEST'. It is also a useful course for people who want an overview of 'TISEST'.

PRE-REQUISITE KNOWLEDGE

None

DURATION

1 Day

OBJECTIVES

Upon completion of the course the trainee will understand

- The design of 'TISEST'
- The 'TISEST' environment
- The Database Contents
- The Report Formats
- The Documentation

TISEST ESTIMATING SYSTEM

COURSE CODE

TES

OVERVIEW

This course covers the use of "TISEST" for developing estimates. It is an introduction for estimating within an advanced Project Management Information System.

WHO SHOULD ATTEND

This couse is for those who understand the principles of estimating and project control and will be using 'TISEST' to create and compute a project estimate.

PRE-REQUISITE KNOWLEDGE

Familiarity with the principles of manhour estimating, production method, project control and the preparation of construction tenders.

DURATION

2 Days

OBJECTIVES

Upon completion of this course trainees should be able to :

- Create a new contract
- Copy Data Bank to new contract
- Create an estimate
- Perform changes and updates
- Enter and interrogate estimating information
- Create norms
- Factor norms
- Apply the "what if" situation
- Produce tabular reports

PROFESSIONAL ADVISERS COST ENGINEERING LIMITED

PROJECT COST ENGINEERING 2 DAY COURSE

Cost Course

DAY 1

08.30	Course Introduction
09.00	Project Life Cycle
09.30	Discussion 1 - Who should carry out the Cost Engineering Function ?
10.00	Feedback From Discussion 1
10.30	Role of Cost Engineer in Clients Organisation
11.00	Role of Cost Engineer in Contractor's Organisation
11.30	Total Management Approach to Project Execution
12.00	Defining The Scope Of Work
12.30	Break
01.15	Defining The Scope of Work (continued)
02.00	Types of Contract
02.45	Discussion 2 - Advantage and Disadvantages of Various Types of Contract to Client and Contractor
03.15	Role of the Cost Engineer in Each Type of Contract and Feedback From Discussion 1
04.00	Outline the Theory of "Unit Rating" and its Application To Offshore Fabrication and Construction
05.00	General Discussion

Cost Course

DAY2

08.30	Take Off Quantities (Task 1)
09.30	Preparation of Bills of Quantities (Task 2)
10.00	Build up Manhour Content per Unit of Work and Further Explanation of Concept of Unit Rates with Various Examples.
10.45	Calculate The unit Rate Values (Tasks 3 & 4)
11.30	Explanation of Items Shown in Unit Rate Calculation and The Concepts for Apportionment of Overheads and Profit
12.30	Break
01.15	Other Cost Elements and Subcontracts
02.00	Cost Control and Reporting
02.30	Example of Cost Reporting System in operation in Norway
03.00	Impact and Control of Changes to the Scope of Work
03.30	Worked Example of an actual Change Order
05.00	Daywork and its Implications
05.30	Productivity and its cost to Harland & Wolffe
06.00	Course Summary and Review (possible continuation on Thursday morning)