ANNUAL REPORT

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(Unofficial Translation)

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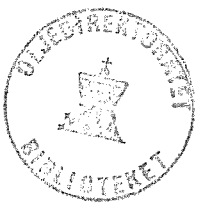

Norwegian Petroleum Directorate

1980

Translation from Norwegian

THE PETROLEUM DIRECTORATE

1979 ANNUAL REPORT

Table of contents:

PREFACE

The Board of Directors hereby presents the Petroleum Directorate's Annual Report of 1979.

The Board of Directors has noticed the question raised by the Storting's Industry Committee during the handling of the Petroleum Directorate's Annual Report for 1978 concerning the advantages of having this handled by the Storting in the Spring Session, so that this could be the basis for a somewhat broader oil discussion.

The Directorate's work on this year's report has been accelerated with a view to making this possible.

Stavanger, 31 January 1980

In the Petroleum Directorate's Board of Directors

Martin Buvik (sign.)
Martin Buvik

Andreas Lønning (sign.) Bjørg Simonsen (sign.) Liv Hatland (sign.)
Andreas Lønning Bjørg Simonsen Liv Hatland

Kåre D. Nielsen (sign.)	Ole Knapp (sign.)
Kåre D. Nielsen	Ole Knapp
Hallvard Tunheim (sign.)	Inge Døskeland (sign.)
Hallvard Tunheim	Inge Døskeland
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Fredrik Hagemann (sign.)	Bjørn Bratbak (sign.)

1. THE DIRECTORATE'S TASKS, BOARD OF DIRECTORS AND MANAGEMENT

1.1 INSTRUCTIONS FOR THE PETROLEUM DIRECTORATE

The object and tasks of the Petroleum Directorate are provided in special instructions. These were most recently changed by the Ministry of Petroleum and Energy's decision of 29 March 1979. § 1 concerning the object and §2 concerning the tasks in these instructions have this wording:

§ 1 - Object

The Petroleum Directorate is located in Stavanger and reports to the Royal Ministry of Petroleum and Energy. In matters concerning working environment, safety and emergency preparedness, it reports to the Royal Ministry of Local Government and Labour. The Petroleum Directorate is authorized to decide in matterns concerning exploration for and exploitation of petroleum resources in the seafloor and its subsoil, to the extent that the matters shall not be decided by the King, the relevant ministry or other public authorities. The Petroleum Directorate exercises this authority in inner Norwegian waters, the Norwegian sea territory and in the part of the Continental Shelf which is subject to Norwegian sovereignty, as well as in other areas where Norwegian jurisdiction follows from agreements with foreign countries or from International Law in general. In addition, the Petroleum Directorate shall

enforce safety regulations, etc. for exploration and drilling for petroleum resources and alike in the areas defined by Article 1 of the Svalbard Treaty of 9 February 1920 and § 1 of the Act concerning Svalbard of 17 July 1925, as well as in the territorial waters of these areas.

§ 2 - Tasks

The Petroleum Directorate have these tasks within its area of authority:

a) To look after the public administrative and economic control of the compliance with applicable legislation, regulations, decisions, concession terms, agreements, etc. in the exploration for and exploitation of petroleum, cf. § 1.

b) To control that the applicable safety regulations are complied with.

c) To control that the exploration for and exploitation of petroleum resources do not lead to unecessary damage or cause inconvenience to other activity.

d) To control that exploration for and exploitation of petroleum resources are carried on in accordance with the guidelines stipulated by the relevant ministry.

e) To collect and process geological, geophysical and technical material concerning subsea natural resources, including evaluation of this and the possibilities provided by this for assisting the formulation of the state oil policy and negotiation plans, as well as to plan and look after the execution of surveys concerning petroleum geology and geophysics.

f) To look after current economic control of the exploration for and exploitation of petroleum resources.

g) To issue exploration licences, as well as to assist the relevant ministry, upon request, in the handling of applications for other licences, the formulation of regulations, etc.

h) To keep in contact with scientific institutions and to ensure that the material is made available to interested companies, scientific institutions, etc. to the extent that this is possible in view of the rules which apply concerning confidential treatment of material submitted by the licensees and in general pursuant to the decision of the relevant ministry.

i) To keep the ministries informed about the activity as mentioned in § 1, as well as to present the matters which the Directorate learns about to the relevant ministry when they are not covered by § 2, litra a to h.

j) To prepare and present for decision by the relevant ministry matters of importance to vegetation and animal life or matters which may otherwise be of relevance to important preservation of nature interests in the areas mentioned in § 1, last sentence.

h) To present regulations and individual decisions concerning sound exploitation of petroleum resources (conservation) to the relevant ministry.

l) To be an advisory body to the Ministry in questions concerning exploration for and exploitation of subsea natural resources.

Even if a matter is subject to the authority of the Directorate pursuant to § 2, litra a-h, it shall be submitted to the relevant ministry if it is of special importance or of principal interest.

1.2 THE BOARD OF DIRECTORS AND THE MANAGEMENT

1.2.1 The Board of Directors

It was decided by Royal Decree of 5 September 1978 that the Board's term of office should be prolonged from 12 September 1978 to 1 April 1979. The background of this was the proposal under which the responsibility for safety and emergency preparedness matters should be transferred from the Ministry of Petroleum and Energy to the Ministry of Local Government and Labour on 1 January 1979 and that this Ministry should therefore be involved in the appointment of the new Board.

By Royal Decree of 30 March 1979, a new Board was appointed with a term of office from 1 April 1979 to 1 April 1981. By this appointment, the number of directors was increased from 5 to 8. The employer side and the employee side are currently represented by one representative each. The representation by the employees was increased from 1 to 2.

The new Board of Directors has this composition:

1. Governor Martin Buvik (Chairman)
2. Director Andreas Lønning
3. Mayor Bjørg Simonsen
4. Municipal Director Liv Hatland
5. Director Kåre D. Nielsen
6. Junior Executive Officer Ole Knapp
7. Senior Engineer Hallvard Tunheim
   (Elected by and from among the employees)
8. Senior Engineer Inge Døskeland
   (Elected by and from among the employees)

Deputies:
For 1-4:
Farmer Olav Marås
Consumer Advisor Ragna B. Jørgensen
Editor Marit Greve

For 5:
Director Odd Henrik Robberstad

For 6:
Attorney-at-law Bjørn Kolby

For 7-8:
Senior geologist Erik Talleraas
Senior Executive Officer Kåre A. Tjønneland

In accordance with instructions from the Ministry, the management has prepared draft regulations concerning the right of employees to take part in decisions in connection with matters handled by the Board of Directors. By negotiations with the organizations for the civil servants, and after a statement from the Ministry, agreement was reached in November about draft regulations. At the expiry of the report period, these have been submitted to the Ministry for evaluation and, in case, promulgation.

In the report period, the Board of Directors has met 11 times. In September, the Board made a visit to Northern Norway where the cities Harstad, Hammerfest and Tromsø were visited. Information meetings with representatives of the authorities and the commerce and industry were held.

1.2.2 The organization

In the spring of 1979, the Rationalization Directorate and Industrikonsulent completed its organizational study of the Petroleum Directorate. The Board considered the report from the study and submitted its recommendation to the Ministry of Petroleum and Energy in June, 1979. In the main, the Board supported the recommendations which the majority of the appointed management group had presented. The management group consisted of representatives of the Director General and representatives of the civil servant organizations in the Directorate.

In the main, the content of the proposals is that the present department structure should be retained, but that 2 and 3 sub-departments under the supervision of the Deputy Directors General should be established in the Planning Department and the Control Department, respectively. The number of sections proposed in the Planning Department was 5, while 11 sections were proposed in the Control Department. It was proposed that the names of these two departments should be changed to the Department of Resource Administration and the Department of Safety Control. It was proposed that the Measurement Technique Section should be transferred from the Control Department to the Legal-Economical Department. This last change was implemented on 15 August 1979 since no changes relating to positions were necessary. In the case of the Administrative Department, it was proposed that a separate section for economy and budjet matters should be established, and it was proposed that in the long range, separate sections should also be established for personnel administration and for administration.

The Board emphasized that the intentions of Storting Proposition No. 113 (1971-72) concerning a certain degree of flexibility in salary questions should be given greater interest.

The Board of Director's proposal concerning organizational changes was approved by the Ministry in principle, and in the budget proposition for 1980, the changes relating to positions following from this were proposed.

In Storting Proposition No. 1 (1979-80), the Ministry of Petroleum and Energy did not find that it could heed the Board of Director's proposal about changing contract positions into permanent positions.

The organizational changes proposed by the Ministry were approved by the Storting and will be implemented from the start of 1980.

1.2.3 Personnel

At the end of the report period, the Petroleum Directorate had authority for 210 permanent positions and 57 contract positions. There are 246 employees, 2 civil servants have not yet taken up their positions and 19 cases concerning employment is being dealt with.

In the budget proposal for 1979, the Petroleum Directorate asked for 38 new positions. By the final decision of the Storting in the autumn of 1978, it was decided that 20 new positions should be established. Most of these positions were classified in relatively low classes compared with the allocations of earlier years.

35 employees have resigned in 1979, cf. Table I. The number of resignations amounts to about 14 per cent of the total number of authorized positions as against an average of 8.2 per cent for the years 1972-1979. A further 11 employees have given notice for resignation in 1980.

There may be several reasons for the great number of resignations. The salary level is hardly competitive with the level in private companies within the oil industry, particularly in relation to personnel with professional education and experience.

The salary system is based on the State Schedule which is quite inflexible. The fact that the level of activities on the shelf has increased because of the 4th concession round has, without doubt, been important to the outside competition. At the same time, the trend in the private oil industry in the direction of increasing the share of Norwegian employees must be taken into account.

The circumstances mentioned above are also important to the recruitment. The file of applications for the different positions has shown variations in quality and number. It has only been possible to employ applicants with background in the oil industry in a very limited number of positions.

TABLE I

PERSONNEL WHO LEFT NPD IN 1979 WITH SPECIFICATION OF NEW PLACE OF WORK

Department	Oil industry	Other private	Other public	Sundry	Education	Total
Control Department	7		2	1		10
Planning Department	3	1		1		5
Legal/Economic Dept.	2	2				4
Administrative Dept.	2	1	7	5	1	16
Totals	14	4	9	7	1	35

In the main, important officer positions have been filled with applicants coming directly from an educational situation.

It is likely that the recruiting problem will grow in the first years to come, also because the educational basis for oil related personnel in Norway has not been sufficiently developed in comparison to the increased extent of the oil activity.

One of the instruments in the recruitment policy is to facilitate the housing conditions for the employees. The need for houses has been large in 1979 and has to quite some extent been solved by the help of municipal authorities in the region. It must be expected that this help will be reduced in the years to come. For this reason, the Directorate works with alternative solutions, also through participation in private building projects and by passing on private housing offers.

It has not been possible, in this report period either, to arrive at an agreement about remuneration for inspectors for their activity on the Continental Shelf.

1.2.4 Training

The training activity has been extensive in 1979. In total, the Petroleum Directorate has used 2263 (1604) course days, whereof 1430 (1107) have been spent in Norway and 833 (497) abroad. The numbers in parenthesis are the corresponding numbers for 1978.

There was an average of 9 course days per employee in 1979.

Of the 1430 domestic course days, 100 course days were spent in Stavanger.

In 1979, the Petroleum Directorate had 37 course spaces at the Rogaland District University. During the year, 5 employees were granted leave of absence to enrol in part time/

semester courses at the District University. In these cases, the courses were related wo the participants day-to-day work.

In connection with the Ministry of Consumer Affairs and Government Administration's offers, the Petroleum Directorate made use of 7 course spaces in 1979. This amounts to 29 course days.

Through the concession agreements, the Petroleum Directorate has secured access to the companies' internal courses. In connection with the offers from the companies, the Petroleum Directorate used 167 course spaces in 1979. 150 of these have been used for participation in courses arranged by the companies in Stavanger.

The Petroleum Directorate has by itself, or in cooperation with oil companies, arranged a number of courses in professional subjects in 1979. To accomplish these courses, professional staff both from companies and consultants have been involved.

1.2.5 Information

Also in this report period, there has been substantial demand for information both from Norwegian and foreign public institutions, mass media, companies and private individuals. In the course of the year, the Petroleum Directorate has been visited by a number of official delegations from abroad. The Directorate's management and the other employees which have been represented at such events have looked at this information activity as an important task.

The Annual Report of the Petroleum Directorate has a central place in the Petroleum Directorate's information activity. The Annual Report for 1978 was available in May. In this connection, representatives from the press were invited to the Petroleum Directorate to meet the management of the Directorate, which made themselves available for supplementary comments to the Report. In the course of time, the Annual

Report has become a publication in great demand and 6000 copies are printed. When the Petroleum Directorate's Annual Report for 1978 was discussed, the Storting's Industry Committee stressed the Directorate's importance as a source of unbiased information about the oil activity.

Continental shelf maps, up to date to and including the 4th round allocation on 6 April 1979, were prepared and were available in final form at the same time as the Annual Report.

An information folder about the Petroleum Directorate was prepared. This was made in a Norwegian and in an English edition.

During the course of the year, a register was made of the Petroleum Directorate's stock of 16 mm film used for internal training, in connection with visits and made available for loan.

The number of press releases issued in 1979 shows a continued increase compared with previous years: At the turn of the year, 52 press releases had been issued. In 1978, the number was 48. The increase is first and foremost caused by increased drilling activity in 1979. Among the press releases, a monthly activity report, which is also issued in English, may be mentioned.

The information activity was discussed in particular by the Board of Directors in the course of the year. An orientation about the total information activity was prepared in this connection. Work will be done on a further rationalization of the information activity.

1.2.6 The Library

Applications for loans and copies have been doubled compared to 1978. The reason is a more conscious use of the library by the employees of the Directorate and an increase in the

knowledge about the library's services among outside users. The users outside the Petroleum Directorate include teachers and pupils from teaching institutions with education in petroleum subjects, and oil companies and other companies within the oil activity.

The interest for literature searching with the help of EDP from data bases has been increasing. In particular, American literature data bases have been used (Systems Development Corporation).

By utilizing EDP, a considerable rationalization gain in the indexation and registration of newly acquired literature has been effected. In close cooperation with Statoil's library and the Norwegian Center for Data Information, a petroleum Thesaurus has also been prepared for assistance in the indexation work.

1.2.7 The INFOIL Secretariat

The full editorial responsibility for the printed edition of the "Oil Index" has been assumed by the Directorate in 1979. The number of subscribers has increased by 50 per cent. Certain parts of the production have been subcontracted to a consultant. The Directorate has worked with the financing of the on-line edition of the "Oil Index" on the Nordic data network Scan-net.

The national Norwegian subscription to the literature service Petroleum Abstracts from the University of Tulsa has obtained several new Norwegian participants, and the use of the satellite hook-up to the data base in California has increased.

1.2.8 Measures for Greater Efficiency - EPD

The use of EDP-based routines has shown considerable increase in 1979. In addition to the administrative routines within accounting, the library, personnel administration, etc.,

greater projects have been developed and are being developed within the professional departments. This applies to areas such as geology/seismic, prognosticating, production accounting, safety, etc.

To satisfy the increased demand for EPD services, a new and advanced terminal system was installed in February 1979 with possibilities for local data processing concurrently with communication with greater data centrals. The terminal system has fulfilled the expectations. However, the use of local processing and storage of data has increased more than expected.

1.2.9 Premises

In the short range, the office space situation was improved in the course of 1979, in that the offices were centralized at two locations against 4 from before.

To have the Directorate divided on several locations is inefficient and does not lead to the best working conditions. efforts to get the institution into one building is therefore still continuing.

In the spring of 1979, the Rogaland County Assembly approved the allocation of a site for a new building to the Directorate in the Ullanhaug area.

The Directorate has presented a proposal to the Ministry concerning a new building, including a room program. In the course of January 1980, the Ministry and the State's Building and Property Directorate will evaluate whether the new building of the Petroleum Directorate will be included in the State's plans for new buildings in the next period.

1.2.10 The Cooperation Committee

In 1979, the Cooperation Committee has arranged 6 meetings

where matters like the annual report, budget proposals, program notes, questions concerning equal treatment of the sexes, housing problems have been considered.

In 1979, the Cooperation Committee has had this composition:

- Director General Fredrik Hagemann
  Chairman of the committee i 1979
- Assistant Director General Farouk Al-Kasim
- Assistant Director General Dag Meier-Hansen
- Head of Division Bjørn Bratbak

Deputies:

- Assistant Director General Nils Vogt
- Section Manager Egil Bergsager
- Section Manager Magne Ognedal
- Senior Executive Officer Nic. B. Askvik

Members appointed by the organizations:

- Senior Executive Officer Terje Kristoffersen (AK)
- Geologist Inger Flesland Strass (AF)
- Senior Engineer Hans Chr. Rønnevik (NOPEF)
- Junior Executive Officer Thomas Houge-Thiis (YS)

Deputies:

- Senior Engineer Einar Eik (AF)
- Executive Secretary Arne B. Wermundsen (NOPEF)
- Senior clerk Torunn Fraser (NOPEF)
- Coordinator of typing services Anne Margrethe Hansen (YS)

1.2.11 The Working Environment Committee

The Working Environment Committee consists of the members of the Cooperation Committee with the addition of the Main Safety Guard and an additional representative of the management.

The Main Safety Guard is:
Division Engineer Njål Corneliussen, who is also the safety guard for the Directorate's inspectors.

The Deputy Main Safety Guard is:
Executive Secretary Arne B. Wermundsen, who is also the safety guard for the other employees of the Directorate.

The management's additional representative in the Working Environment Committee:
Assistant Director General Nils Vogt.

Up to now, the chairman has been the same as in the Coordination Committee, Director General Fredrik Hagemann.

Four meetings have been held in the Working Environment Committee in 1979 for discussion of matters like safety/environmental training, the office situation, the health service, etc.

1.2.12 Budget/Finances

On the State Budget for 1979, Nkr. 127,065,000 was allocated to the various tasks of the Directorate.

Because of the activity on the shelf, there has been a marked increase in reimbursable control expenses, but for 1979, the control expenses were significantly reduced, since the use of outside consultants is somewhat changed by the introduction of greater responsibility on the licensees for controlling their own operations.

Of the total budget, Nkr. 45,000,000 was allocated to cover expenses in connection with the safety control. Because of the reduction mentioned above, the allocation was reduced by Nkr. 4,000,000 (cf. Storting Proposition No. 57).
The expenses are refunded by the licensees to the Directorate, cf. Section 9.4.

Of the allocations, Nkr. 32,200,000 is further used for geological and geophysical surveys etc. on the continental shelf.

To research within safety and preparedness, Nkr. 7,850,000 was allocated. To operate the Environmental Data Center at the Meteorological Institute, Nkr. 800,000 was allocated.

Revenues

In addition to the payment of production fees, area fees and exploration fees (cf. Sections 9.1, 9.2 and 9.3), the Directorate has received a total of Nkr. 79,624,611.51 in revenues.

Of this, the income from the sale of data packages amounts to Nkr. 30,684,000 (cf. Sections 2.2.3 and 3.2). Including this, the Directorate has sold data packages for a total of Nkr. 78,591,368.74 from 1976 until today.

Of the other income, Nkr. 47,358,235.34 represents reimbursement of control expenses (cf. Section 9.4), Nkr. 279,717.35 represents fee income from test material which has been released and Nkr. 291,375.47 represents sale of publications.

To ensure efficient cost control of the Directorate's expenses in connection with the safety control, the Contract Revision Office by the Defence's Joint Material Service was engaged to perform cost testing by two of the Directorate's consultants. A report was available by the end of the year.

2. THE ACTIVITY ON THE NORWEGIAN CONTINENTAL SHELF

2.1 SUPERVISION OF THE ACTIVITY

The Petroleum Directorate acts as the examining and supervising agency on several levels in the activity. In the most important cases, this work is performed in close cooperation with the Ministry of Petroleum and Energy and the Ministry of Local Government and Labour.

The work of the Petroleum Directorate in this area is summarized below with emphasis on the resource aspects before the activity within the various sections is described. In addition, reference is made to the special discussion of the safety and measurement control in Chapters 4 and 5.

Surveying

A systematic surveying of the continental shelf is the first condition for sound exploitation of the resources present. In the report period, the Petroleum Directorate has contributed to practical surveying, also through the proposal of blocks for the 4th and 5th concession round. In the concessions which have been allocated, the Petroleum Directorate has participated in negotiations about the work programs which oblige the licensees to explore the concession area by drilling of the necessary number of exploration wells.

The knowledge about the geological conditions on the continental shelf has been considerably improved since the first concessions were allocated. At the same time, the profitability of the oil production has increased considerably, partly because of improved technology, but also through increased prices and the availability of free capacity in process and transportation facilities on the shelf. A result of this is that it is now interesting to go back and survey the older concession areas in a better way. The Petroleum Directorate has advocated that also some of the relinquished areas should be explored again and has prepared a proposal for areas

which should be announced for allocation.

The drilling in licensed areas will be followed particularly closely to control that the drilling may be accomplished in a sound manner from the point of view of safety. The geological information which comes to light is also registered. The fulfilment of the work program is controlled, and also that important information about the petroleum reservoirs is collected and integrated in the evaluation and decision work.

Evaluation of the development plans

In year 1979, significant new discoveries have been made as was assumed when the 4th round blocks were allocated. Furthermore, some discoveries that had previously been made have been further delineated.

In 1979, the Petroleum Directorate has endeavored to strenghten its ability to examine how new discoveries may be developed and how this may influence the level of activities, and what transportation and treatment requirements which may be expected for petroleum. This has been made possible, i.a. by the preparation of more discriminating perspective analyses than previously (cf. Chapter 2.9.3). On this point, the consequences of the development pattern or sequence in relation to investments, the quantity of work, the quantity of material, etc. have been appraised in addition to the consequences to the production and income side. This has been followed by the safety control which starts with the evaluation of facility concepts, after their functions have been clarified. Several licensees have worked with more detailed plans for the development of some individual fields. This applies in particular to Mobil with Statfjord, Phillips with water injection at Ekofisk, British Petroleum with the 7/12 field, Esso with the Odin field and Elf with the NE-Frigg field. Statoil has also been active in its evaluation of Sleipner, the 34/10 and the 1/9 fields. Other fields, as for instance Heimdal and the rest of Valhall and Hod may easily be considered for early deveopment. In the case of these fields, there has

not been any significant evaluation work in the report period.

The Petroleum Directorate has assigned priority to the close contact with the planning work of the licensees to ensure that the possibilities for sound exploitation is used from an early point of time. Where there has been no basis for a final decision by approval of the development plans, the Petroleum Directorate has stipulated the necessary reservations to maintain the flexibility required to take a position on the question when required by the situation. The work of approving development plans from the point of view of resources has been undertaken in close cooperation with the Ministry of Petroleum and Energy.

Follow-up and control of design and fabrication

An important part of the safety control is going on in this phase. Above all, the control is exercised by the stipulation by the Petroleum Directorate of functional requirements which the licensee must satisfy through his own control. This is followed up at certain predetermined phases in the work, where the licensee must obtain the approval of the Directorate before the fabrication may continue. The design of the platform is finally approved when of an operation licence is issued.

The design of the measurement arrangement for measurement of quantities produced is also decided in this phase in close cooperation with the Petroleum Directorate and the operator.

During the production drilling, the geological and reservoir conditions in the discovery is surveyed in detail. Through locating the wells and selection of depth intervals for production of petroleum and injection of displacement agents, the well productivity is also determined and largely also the opportunities for influencing the flow pattern of the reservoir.

Production drilling also represents a special safety risk because of the consequences that accidents may have

in relation to the drilling platforms.

To ensure that the reservoirs are utilized in a sound manner and in a manner which is satisfactory from a safety point of view, it is of the utmost importance that the results from the production drilling are registered and that appropriate steps are taken. The Petroleum Directorate controls this activity, but the capacity has limited the degree of control which has been unrelated to safety. In 1979, production wells have been drilled at Frigg, Statfjord and in the Ekofisk area. The activity has been highest in the Ekofisk area, where the geological conditions are most difficult and the potential for increased recovery is the highest. The control work has therefore been most comprehensive in this area. The experiences have shown that decisions must often be made during drilling when safety aspects and the considerations for high productivity and loss of reserves are balanced under strong time pressure. It has been necessary for the Petroleum Directorate to evaluate these and to give the operators the necessary directives.

Follow-up and control of exploitation of the reserves

Supervision of the reservoirs during production provides a better understanding of a number of circumstances of importance to the exploitation of the reservoirs. Decline in the reservoir pressure and distribution of pressure over the field after extraction of a certain quantity of petroleum reflect circumstances as reservoir size, water ingress and communication within the reservoir. In the same way, distribution or production of gas and water will provide information about how effectively petroleum is displaced, and thereby the degree of recovery which may be anticipated. Such information, together with the original registrations when the well was drilled, will provide a basis for evaluation of the degree in which the exploitation of the reserves may be improved. This may take place by drilling of additional wells, changes in the well depth at which the extraction is made, or changing/shutting-in extraction from wells. The registration of these circumstances is made under stringent safety requirements

because of the effects of accidents with production wells.

During the report period, the Petroleum Directorate has followed the development in the fields which are producing. A surveillance program has been stipulated upon application from the licensees, and possible changes in the production pattern have been examined and stipulated as part of the production licence issued by the Ministry of Petroleum and Energy at regular intervals.

Control of the production facilities

The production facilities are subject to comprehensive safety control in the operating phase. To govern the exploitation of resources, it is necessary to have a certain surveillance of the production facilities. In the report period, the Petroleum Directorate has controlled the flaring of gas particularly closely.

In the report period, operations have been started at the Teesside facility. Following this, the Petroleum Directorate has controlled the production of NGL components and the circumstances which control the recovery of these components in Teesside.

Because of changes in the method for exploiting the resources, it will frequently be necessary to make changes on the platforms. It has also been considered if this is possible and also what costs will be associated with this.

2.2. REGIONAL SURVEYS

2.2.1 Geophysical surveys directed by the Petroleum Directorate

The State geophysical surveys effected under the direction of the Petroleum Directorate amounted to 10,550 km in 1979.

The field surveys were wholly performed by the Norwegian

company Geco A/S. Two collection vessels were used at the same time, and this made a flexible and effective execution of the work possible.

Concurrent with the deep seismic surveys, analog sparker data and gravimetric data were obtained. These data were obtained to the same extent as deep seismic data.

The main quantity of exploration in 1979 went on in the Barents Sea (Figure 2 A). A smaller part was collected in the Helgeland area (Figure 2 B).

As a follow up of the air magnetic measurements made by the Petroleum Directorate in 1976, a geophycial cruise was made to the Jan Mayen area in the summer of 1979. The exploration was carried out on the Jan Mayen Ridge. This ridge has a North-South direction and stretches from the island itself and south to about 68°N. Earlier surveys have discovered relatively large sediment thicknesses in this ridge. A long energy source (super long air gun array) was used in the collection to have the best data possible, and 600 km of seismic was obtained on the very ridge (Figure 2 C).

To have the best possible use of this cruise, the Jan Mayen survey was combined with two long lines, one line from Helgeland to Jan Mayen and one line from Jan Mayen to the Troms area. A total of 1.700 km was obtained from the passage to and from Jan Mayen (Figure 2 D).

The data has been processed, and it seems that the quality is good.

The surveys in 1979 are divided on the various areas as follows:

- Helgeland, deep seismic, sparker, gravimetric	680 km
- Barents Sea, " " " "	7.570 km
- Jan Mayen, " " " "	600 km
- Norskehavet " " " "	1.700 km
Sum	10.550 km

Figure 2 E shows the surveys of the year combined with the earlier surveys.

During the years 1969-1979, a total of about 77,500 km of refraction seismic has been shot north of 62^{o}N.

2.2.2 Interpretation

Relinquished areas

Relinquishment of parts of the concessions in the North Sea is going on more or less continuously. As per today, 50 blocks have been relinquished and 35 partly relinquished.

In these wells which are mainly located south of 62^{o}N, a number of wells have been drilled. There are nevertheless some blocks on which no wells have been drilled.

In the proposition about the 4th concession round it is suggested that it is also an aim to allocate some of the relinquished blocks in the southern part of the North Sea. In the summer of 1979, the Ministry of Petroleum and Energy made the intention of announcing some blocks on the relinquished areas early in 1980 known. Revelant oil companies were asked to contact the Ministry of Petroleum and Energy to indicate what blocks they were interested in.

Thus, during the autumn, meetings with 16 companies have been held, and the companies evaluation of and interest in these areas have been presented.

The level of interest is high for some of the relinquished areas. There is also considerable diversification as concerns prospect types and blocks.

Concurrant with the contact with the companies, the Petroleum Directorate has undertaken its own evaluation of selected blocks. This work will continue in 1980.

There seems to be 5 main types of prospects of particular interest. These are:

- Jura sandstones of the same type as in Ula in the SW part.
- Cretaceous prospect in the SW part.
- Rotliegende sandstone in the SE part.
- Jura sandstone around the Egersund basin (Bream-Brisling area).
- Middle Tertiary sandstone in the area around Myrphy's gas discovery in 2/3.

On this background, the Petroleum Directorate has recommended, in December 1979, the blocks which should be announced for new allocation among the relinquished blocks.

The Halten bank

The evaluation of the six blocks on the Halten Bank was completed in the Spring of 1979. The data basis was mainly the detailed seismic net which was obtained by Statoil in the 1977 and 1978 season. The data provided a basis for a detailed interpretation of blocks as well as the individual prospect therein. Reserve calculations were made for the individual structures at the relevant levels, and this was the basis for a ranking of the individual blocks. The result of the geophysical exploration confirms that the area is interesting in the petroleum context.

Troms

New data have not come to light which changes the evaluation of the geology in Troms. The interpretation of all data which were obtained by Statoil in 1977 was completed in 1979. Maps were made for the most important horizons in the area.

On the basis of these data, the estimated reserves for all defines structures in the area have been calculated. Afterwards, the reserves have been assessed according to risk, and the blocks have been ranked in accordance with the reserves and risks within each area.

In 1979, Saga performed i.a. seismic exploration in the western part of Troms I. The data for this area have not been of sufficient quality from before, but Saga's surveys show an improvement in data quality which is encouraging.

The Barents Sea

In 1978/79, the Petroleum Directorate has interpreted data obtained from the transition zone between the relatively shallow Barents Sea and the Norskehavet consisting of vulcanic rocks formed in the last 60 million years, while the basis for sediments in the Barents Sea is older than 400 million years. In large parts of the period after 60 million years, the Barents Sea was dry land. Rivers deposited thick layers of sediments in the transition zone between the two sea areas. The sediments deposited in the last 30 million years have not been disturbed, while the sediments deposited in the period from 30-60 million years has been tectonicly disturbed in the same way as corresponding sediments on Svalbard.

2.2.3 Sale of data

The Halten bank

The six blocks on the western flank of the Halten Bank was announced on 10 June 1979 in connection with the 5th concession round (Chapter 2.2.6). Before the time limit for applications on 1 August 1979, 27 companies had purchased data from the Halten Bank. These companies were: Union, Elf, Esso, Phillips, Arco, Total, Agip, Shell, Conoco, BP, Deminex, Hydro, Saga, Amoco, Gulf, Cities SErvice, Fina, Mobil, Superior, Getty, Hispanoil, Texaco, Petroswede, Texas Eastern, Chevron, Murphy and Petro-Canada.

This sale has provided an income of about Nkr. 22 million to the State through the Petroleum Directorate, and about Nkr. 46 million to Statoil.

The Træna Bank

As part of the preparations for start of drilling on the Træna Bank, a letter was submitted on 1 October 1979 to 38 oil companies with an offer to purchase geophysical data from the area. The data package consists of 4,365 km of seismic and the price has been stipulated at Nkr. 1.744 million. In the main, the data is concentrated on the 12 blocks on the Træna Bank, but in addition, some lines go so far south that they may be correlated to the Halten Bank. As per 10 December 1979, 15 companies had purchased the data package. These are: Conoco, Shell, Statoil, Esso, Elf Acquitaine, Deminex, BP, Saga, Agip, Union, Mobil, Fina, Total, Hydro and Amoco.

As of the same date, the sale had resulted in income of about Nkr. 26 million to the State by the Petroleum Directorate.

As concerns geophysical exploration in this area, there hasn't been any on the Træna Bank itself in 1979, but the Directorate has obtained about 700 km of seismic just north of the Træna Bank to have a good correlation to the data from the Vestfjorden which has been obtained previously.

Troms I

In addition to the purchasers mentioned in the Annual Reports for 1977 and 1978, the following companies have purchased the main package in Troms: Superior, Chevron and Getty.

Sale of seismic data in Troms has resulted in State revenues of Nkr. 10 million. In addition, the sale has contributed to the income of Statoil, Norsk Hydro and Saga.

2.2.4 Surveys directed by the companies

In 1979, about 14,750 km seismic was shot in the Norwegian part of the North Sea under contracts from the various oil companies.

Under the direction of Statoil, 1180 km of seismic data were obtained in the Halten Bank area in 1979. In addition, the company directed a survey of 1210 km of seismic in the Troms II area.

In Troms, the acitivity of the companies has been coordinated since 1977 through the body "Operators Committee North" (OKN) where Statoil, Norsk Hydro and Statoil are members at this time. OKN has three sub-committees: The Committee for Geology/ Geophysics, the Emergency Preparedness Committee and the Operations Committee. It is expected that the OKN's area of authority will be expanded to include also the areas opened offshore Mid-Norway. The Ministry of Petroleum and Energy and the Petroleum Directorate have an opportunity to meet as observers in the OKN and the sub-committees.

The OKN, the Committee for Geology/Geophysics, directed the collecting of 1560 km of seismic data in the Troms I area in 1979. The collection of this data had been scheduled for 1978, but was delayed until 1979.

In total, the oil companies have obtained about 18,700 km of seismic on the Norwegian Continental Shelf in 1979.

Since 1962, the companies have shot a total of about 270,000 km of seismic on the shelf. The Petroleum Directorate's own surveys should be added. Figure 2 F shows the total extent of the companies' surveys on the Norwegian Continental Shelf.

2.2.5 Geological and geochemical survey's in the North

The Petroleum Directorate did not arrange any test taking expedition in 1979 by itself. Instead, the work in 1979 was wholly concentrated on continued analyses of the material obtained in 1976 and 1978, as well as comparing this with the results of the analyses for the whole Barents Sea.

In 1979, the Petroleum Directorate participated in an expedition north of Svalbard arranged by the Earthquake

Station, University in Bergen. This was a combined geophysical/ geological expedition. The Petroleum Directorate was responsible for the technical part of the test taking. A total of 26 tests were collected from previously un-explored areas. Because of favorable ice conditions north of Svalbard, the work was concentrated on obtaining reflection and refraction seismic data. The most notherly position was 81°44'N, which is probably the most northerly seismic survey in the world.

Analyses of the tests will be performed, partly by university institutions and partly by the Petroleum Directorate.

2.2.6 The 5th concession round

The Petroleum Directorate has performed a comprehensive assessment of the 6 blocks offshore Trøndelag and 20 blocks offshore Troms announced in the 5th concession round. Applications for production licences were divided between 18 of the 26 blocks announced, and the applications have been thoroughly evaluated by the Petroleum Directorate. On the basis of these evaluations, the aim is mainly to make these recommendations:

1. The blocks which should be allocated from a geological and strategic point of view, and the sequence in which they should be allocated.

2. The work duties which are necessary for the individual block.

3. The companies which may be relevant for the various blocks from a geological and technical point of view.

The first two points are based on the Petroleum Directorate's interpretations and evaluations through a number of years as well as on the applications received. Figure 2 G shows the numbering of the blocks west of the Halten bank.

Block priorities

On the basis of the geology, the blocks announced have been

divided into 7 geological areas which must be assessed independently from each others. By independent we mean that the negative results from one of the areas will not lead to writing off the other areas as uninteresting. On this basis, we are of the opinion that at least one block should be allocated from each of these 7 areas before a further evaluation can be made of the potential reserves within the 26 bocks which have been announced. The areas may facilitate the evaluation of relatively large areas offshore Mid-Norway and Northern Norway.

The work program

In 1979, the Petroleum Directorate performed an evaluation of the blocks in the 5th round. On the background of this evaluation or the structural mapping, it was evaluated how many wells would be necessary to obtain sufficient exploration of each individual block (the work program). An effort is made to plan the work program in such a way that all opportunities which are interesting from an economic point of view in the concession area will be tested. An effort is made to secure that sufficient geological information is obtained from each individual well by assigning certain duties as concerns the location of the wells and minimum drilling depth. By comparing the evaluations of the Petroleum Directorate with the work programs offered by the companies in the applications, a draft work program for each individual well is arrived at.

Company priorities

The Petroleum Directorate has also performed an assessment of the companies which from professional and technical criteria may be accepted as technical assistants or operators. There was much wider distribution as concerns the block priorities in the 5th round than in the 4th round. The result has been than blocks which have been very closely examined by some companies have hardly been mentioned by others. The quality of the geological work which the applications have been based on is also quite varied.

This made it possible for the Petroleum Directorate to make a list for each individual block which is considered for allocation, containing the companies which may be accepted as technical assistants or operators, and a list of the companies which are desirable from the Petroleum Directorate's point of view. This was done in the autumn of 1979 and was the basis for further negotiations and the work which followed in the Ministry of Petroleum and Energy. The allocation may take place in the spring of 1980.

2.2.7 Exploration licences

A total of 80 commercial licences have been issued.

The following licences were issued in 1979:

Licence No.	072	Conoco Norway Inc.
"	073	Saga Petroleum A/S & Co.
"	074	Western Geophysical Company of America
"	075	Geophysical Company of Norway A/S
"	076	Superior Oil Norge A/S
"	077	Norwegian Gulf Exploration Company A/S
"	078	BP Petroleum Development of Norway
"	079	Den norske stats Oljeselskap a.s
"	080	Esso Exploration Norway Inc.

New licence forms have been introduced. The most important difference by comparison to the earlier forms is a tightening up of the information and duty of care in relation to fishing vessels.

2.3 DRILLING

2.3.1 Exploration and appraisal wells

At the turn of the year 1978/79, 3 exploration wells (30/4-1, 2/7-12 and 30/7-7) and one delineation well (15/9-3) were being drilled. These 4 wells have all been completed in 1979.

Two wells, 15/5-2 and 34/10-2, had been temporarily abandoned at the turn of the year after having been drilled to total depth. The remaining work, consisting in testing reservoir rocks containing hydrocarbons, has been finished in 1979.

28 new wells have been started in 1979. Of these, 17 are exploration wells while 11 are delineation wells on structures where hydrocarbons have previously been discovered.

At the end of the year, a total of 236 wells had been started on the Norwegian Conctinental Shelf. These are divided on 172 exploration wells and 64 delineation wells. Table II shows a summarly of the exploration wells and delineation wells which had been started or completed in 1979.

At the turn of the year, different forms of work was going on on five of the exploration wells and six of the delineation wells. This relates to Statoil's 15/9-5 (D), 30/6-3 (D), 34/10-5 (D) and 34/10-6 (D), Amoco's 34/2-1 (E), Elf's 18/10-1 (E), Phillips's 2/7-14 (D) and 17/12-3 (D), Norsk Hydro's 31/4-3 (E) and BP's 2/1-3 (E) and 30/4-2 (E).

The drilling activity in 1979 has been shown on Figure 2 I. It is considerably higher than the prognosis (18-21 wells) which the Petroleum Directorate gave in the Annual Report for 1978. The reason is, above all, that the activity in the 4th round concessions has been considerably higher than expected. At the last turn of the year, it was still uncertain when the allocation of the 4th round concessions could take place.

The reason for the high level of activity in the 4th round blocks is a combination of a duty concerning early drilling of selected blocks and encouraging results. The highest number of wells per year from before was 26, and that figure was reached in 1975.

Figure " J shows the 1979 wells located in relation to the

structural main features.

As it appears from this figure, the main part of the exploration activity has taken place north of 60°N in blocks allocated in the 4th concession round. The level of activity has been particularly high in Statoil's blocks 30/6 and 34/10.

Otherwise, the activity has been large in the Sleipner and Ekofisk areas, as in 1978.

For 1980, the Petroleum Directorate expects an increase in the level of activities in comparison with 1979.

In addition to a continued high level of activities in the 4th round blocks, drilling will take place on the 5th round blocks (North of 62°N). The announced allocation of relinquished areas on the southern part of the shelf will also lead to increased activity.

22 of the 28 wells started in 1979, as well as 3 of the 4 on which drilling was going on when 1979 started, have primarily aimed at different Jura reservoirs. This therefore amounts to about 80% of the total number of wells drilled last year.

The other wells are divided on the prospects as follows:

1. Paleocen sandstone (Balder)
3. Danian/Maastrichtian Cretaceous rocks (the Ekofisk area).
2 Triassic sandstone tests (the two most northerly wells drilled this year, 33/5-1 and 34/4-1.)

The 11 delineation wells are divided on a total of 8 different fields (structures) as follows:

1 on Sleipner
1 on Ekofisk
1 on Hod
1 on Balder
1 on Brisling

1 on the 15/3-1 discovery
1 on the 30/6-1 discovery
4 on the 34/10-1 discovery

Among the operators, Statoil has drilled the largest number of wells. The company has been the operator of 11 wells, more than 1/3 of the wells. Otherwise, the operations have been conducted by 9 different operators.

The Jurassic prospects
Block 34/10

In 1979, Statoil has assigned priority to the exploration of block 34/10, where hydrocarbons in two different structures, Alpha and Delta had been discovered in 1978. All operations on the block (4 wells) have been concentrated on the Delta-structure, where a good picture of the Brent reservoir and the reserves contained therein is beginning to emerge.

In this connection, Statoil has shot a much denser seismic grid, making a 3D reservoir modelling of the structures in the block possible.

The structures in block 34/10, which is somewhat South-East of the Statfjord field between the Viking and the Shetland basin, are all conditioned on faults, and the layers are tilted to the west. At the turn of the year 1979/80, 1 well was being drilled and 1 well was being plugged on this block.

The Delta structure is a very shallow structure, where the top of the Brent reservoir is about 1,700 meters below the surface of the sea. The structure is divided into several smaller faults, and this means that a number of wells are required to establish the final potential of the field: Three wells on this structure have been tested in 1979. 34/10-3 produced 455 Sm^3 of oil per day through 2 chokes at the same time (8 mm and 6 mm), 34/10-4 yielded 945 Sm^3 of oil through a 15 mm choke opening and 34/10-5 produced 728 Sm^3 of oil through a 133 mm choke.

In the deeper Alpha-structure, only one well has been drilled, 34/10-2 (1978).

Contrary to the Delta structure, both the Brent and the Statfjord formation contains hydrocarbons in this case. Brent contains gas, while Statfjord contains oil. The well was tested in 1979 with very good results. The Brent formation produced 0.74 million Sm^3 of gas per day through a 13 mm choke, while the Statfjord formation yielded more than 170 Sm^3 of oil per day through a 19 mm choke.

Block 34/2

Amoco started the drilling of its first well in block 34/2, where the Brent and Statfjord formations are the primary prospects, but where Triassic reservoirs may also exist. This well will probably be finished some time this spring. The water depth at the location, 389 meters, is the deepest for operations in Norway until now.

Block 33/6

No wells have been dilled on Mobil's two Statfjord blocks this year, but Agip has drilled a well on a fault complex in the southern part of block 33/6.

Both the Brent and the Statfjord formation were penetrated without the discovery of any hydrocarbons.

Block 31/4

Norsk Hydro had to make two efforts to reach total depth in block 31/4 located on the Bergen Height between the gas discoveries in block 30/6 and 31/2. The first well had to be given up at a depth of about 1000 meters because of technical problems. However, 31/4-2 was drilled to Triassic, after having penetrated the expected Jurassic reservoirs recognized from 30/6-1 and 30/6-2. The difference is that they are all water-bearing in this location. A third well was being drilled at the turn of the year. This shall

test a new structure further east on the block. This well shall test the whole layer series down to Paleozoic.

Block 31/2

The greatest encouragement in 1979 was provided for the Statoil/Shell group when it discovered gas in a large, flat and very shallow Jurassic structure in block 31/2 on the Horda-Plattform. The whole interval from the top of the reservoir (1,415 meters below the sea surface) to a total depth of 2,409 below the sea surface is more or less sandy.

Paleo-dating indicates upper Jurassic age on this part of the reservoir which contains gas. The core material and the well logs show that the sand has excellent reservoir properties in the gas zone.

Testing of the well is temporarily postponed until the spring-summer of 1980 because of the poor weather conditions in the North Sea in the autumn and winter months. The discovery is further described in Section 2.10.2.3.

It is still to early to say anything certain about the reservoirs in the block, but it is likely that commercial quantities are present. The activity on the block will be high in the first 2-3 years. There are plans for the drilling of 3-4 wells in 1980 alone.

Blocks 30/4 and 30/7

Other interesting wells in this part of the North Sea are 30/4-1 and 2 with BP as the operator, and 30/7-7 drilled by Norsk Hydro. Two of these wells, 30/4-1 and 30/7-7 were started in 1978 but finished in 1979. 30/4-1 reached a total depth of 5,430 below the sea surface, the deepest well drilled in the North Sea until now.

Norsk Hydro's 30/7-7 was also very deep, more than 5,100 meters below the sea surface. Both wells were drilled on previously untested fault-related Jurassic structures in the deepest

part of the Viking basin where the formation pressures are high. 30/4-1 had to be given up at a somewhat lower depth than progonisticated because of the extreme pressure conditions.

None of the wells have been registered as discoveries, but measurements show that there are probably small quantities of gas dissolved in the water in the Jurassic sandstone reservoirs in both wells. 30/7-7 produced small quantities of gas during testing. 30/4-2 was still being drilling at the turn of the year. This well shall test the extent to the north of a Jurassic structure (Brent sand), where Norsk Hydro discovered hydrocarbons (gas) in 1978 (30/-6).

Block 30/6

Operator responsibility was assigned to Statoil for 3 new blocks, 30/2, 30/3 and 30/6 in 1979. The three are adjacent blocks in the north-easterly part of the Viking basin, and the prospects are Jurassic sandstones. The structures in block 30/6, which is located on the flank of the Viking basin op towards the Bergen Height, are very shallow. So far, 3 wells have been drilled on the block, all on the Alpha structure. From before, it was expected that there was a possibility to encounter reservoir rocks at four different levels. In addition to the Brent- and Statfjord formations, the opportunities for discovering developed Palaeozoic sand and Dunlin sand were regarded as being great. So far, it cannot be said that the results have measured up to the great expectations that this block was associated with.

Palaeozoic has not been found in developed sand-facies on this structure, whilst the other three (the Jurassic prospects) did all have reservoir properties.

The uppermost sand sequence was found to be gas bearing in the two wells which have penetrated the reservoir until now. This sand is probably not directly correlated to the

traditional Brent sand known from the Statfjord area. Palaeo-dating indicates that the 30/6 sand is older (Toarcian?).

The zone has been production tested in both wells with the following result: 30/6-1: 688,000 m^3 gas per day. The gas oil ratio is 3,900 m^3 gas/m^3 oil. The choke size is uncertain since some deformation in the equipment material was found after testing which may have reduced the efficiency of production. 30/6-2: 740,000 Sm^3 gas per day through a 19 mm choke. The gas/oil ration is 3680 m^3 gas/m^3 oil.

Both Dunlin sand and Statfjord sand have been found to contain water in the 2 wells which have been drilled so far. At the turn of the year, the third well has still not reached the reservoir level.

Blocks 30/2-2 and 30/3

The prospects in block 30/2 and 30/3 have still not been tested, with the exception of Palaeozoic in 30/3, which failed to turn out as a good sand. 30/2 and 30/3 are more centrally located in the Viking basin than 30/6, and the structures are therefore deeper. To be able to drill Jurassic prospects in this area, drilling rigs able to handle very high pressures are necessary (1000 bar BOP). Such a rig was not available to Statoil in the last half of 1979, so that the drilling start-up in 30/2 has been postponed until 1980, and it was decided that 30/3-1 should be drilled in two phases. Phase I (369 meters) was effected in 1979, whilst the deepening will take place in 1980 with a suitable rig.

Blocks 17/12 and 18/10 (the Brisling and Bream area)

Elf Aquitaine has drilled the first well in block 18/10 with encouraging results. This licence, which is located in the Egersund basin, was allocated to the group as early as in 1965. The well is located on a shallow Jurassic structure south-east of the Bream structure where Phillips

had earlier discovered hydrocarbons (oil in 17/12-1).

The well tested 295 Sm^3 of oil and 2,850 Sm^3 of gas per day through a 51 mm choke. The gas/oil ratio is 9.8 m^3 gas/m^3 oil. Phillips has also started a well in the Egersund Basin this year. 17-12-3 is a delineation well on Brisling (17-12-2), a Jurassic structure where Phillips has earlier discovered oil.

The results from this well were not available at the turn of the year.

Blocks 15/5 and 15/9 (the Sleipner area)

The activity in the Sleipner area has been extensive in 1979 as well, and the results have varied. The Sleipner structure is very divided because of a complicated fault pattern, and the surveying is therefore difficult. 15/9-3, a delineation well which was being drilled at the turn of the last year, discovered that the reservoir quality in the western part of the Sleipner structure is poorer than elsewhere in the field. It appears that the reservoir rocks turn into shales towards the west, and this has effects to the reserve estimates for block 15/8.

15/9-5, which also is a delineation well on the main structure (south), was still being drilled at the turn of the year and had still not reached the reservoir.

The results from 15/9-4, which tested a separate structure, Delta, in the south-east part of the block, and discovered gas/condensate in an Upper/Mid Jurassic sandstone reservoir, has provided the Sleipner field with a well-received addition to the reserve estimate. Because of technical problems, the well was not tested. Norsk Hydro has tested its 15/5-2 discovery from 1978 this year with the following result: 300,000 Sm^3 of gas per day through a 6 mm choke.

Block 15/3

Elf Aquitaine has drilled a new deep well (more than 5,100 meters) north of Sleipner in block 15/3. 15/3-3 is a delineation well on the same Jurassic structure in which 15/3-1 discovered hydrocarbons in 1975. The reservoir has high pressure and consists of several separate sand layers which are divided by several thin shale layers. The structure needs some further exploration before anything certain may be said about the potential.

Block 2/9

Earlier this year, the Amoco-Noco group drilled its second well in block 2/9. 2/9-2 tested a salt-related structure on the flank of the Mandal Height on the eastern side of the Central-basin. The primary prospect, Upper/Middle Jurassic sandstones have been discovered, but they do not hold hydrocarbons of significance.

Block 2/1

BP has drilled one of its two remaining liabilities in block 2/1. The well, a Jurassic test, is located on a down-faulted structure, which like most structures in this part of the North Sea has been formed by movements in the salt which has been deposited further down. At the turn of the year, this well has still not reached reservoir level.

TRIASSIC PROSPECTS

Block 34/4

Saga tested triassic rocks on a structure in the south-eastern end of the block through drilling of its first well in 34/4, where an oil-bearing reservoir was discovered. The lithology, and therefore also the reservoir properties, varied widely. This well was drilled at a water depth of 375 meters. The well was tested with the following result: 260 Sm^3 of oil per day through a 6 mm choke. The gas/oil ratio is 120 m^3/m^3.

Block 33/5

The other Triassic test this year was made on another block to the north. Norsk Hydro drilled a structure close to the British sector line without finding accumulations of hydrocarbons.

LIMESTONE PROSPECTS

Four of the wells this year were drilled on limestone reservoirs in the southern part of the North Sea.

Block 2/11 (Hod)

Amoco has explored the western part of the Hod structure without finding hydrocarbons of significance. 2/11-5 tested a down-faulted segment, where the possibilities of finding oil-bearing porous Danian limestone were considered to be great. The layers are strongly tilted at this location, and a possible explanation for the fact that no oil was discovered may be that the well is structurally at a lower level than previously anticipated.

Block 2/7

Phillips has been the operator of the other 3 wells in the area. They first drilled 2/7-12 on an extremely shallow salt-structure in the north-western part of the block. They wanted to check if this salt dome, extenting far up into the tertiary layers, had left a limestone reservoir on top. It turned out it hadn't, but very large gas readings were found throughout the well, which was drilled into Permian salt. Already before the drilling it was shown by seismic profiles that there is a natural gas leak to the surface, and this was also confirmed by divers. From a drilling technology point of view, this was a difficult task, and it is the first time that such a shallow salt structure has been drilled in Norway.

In addition, Phillips has drilled 2/7-13 east of this shallow

salt structure (Delta) at a location corresponding to 1/9-5 on the western side of the Delta structure. No traces of oil or gas were discovered.

2/7-14 is drilled on the southern part of the Ekofisk structure, and the extent of this oilfield to the south has been confirmed. The well penetrated an oil-bearing reservoir which was being tested at the end of the year.

TERTIARY PROSPECTS

Block 25/11

Esso has drilled still another well, 25/11-8, on the Balder field as part ot the efforts to prove commercial reserves. The well tested oil of the same quality as before.

To obtain a still better understanding of the geology of the structure, 3D seismic has been carried out this year.

2.3.2 Production wells

In 1979, 36 new wells have been started, so that a total of 146 production wells had been drilled on the Norwegian Continental Shelf at the end of the year. 12 of these wells have either been temporarily suspended or are still being drilled.

The activity in 1979 has been distributed on 6 different fields, Ekofisk, Eldfisk, Tor, Edda, Albuskjell and Statfjord.

The division between the fields looks like this:

	For 1979	Total
Ekofisk	4	44
Eldfisk	11	24
Albuskjell	7	13
Tor	5	12
Edda	5	5
Cod	-	8
West-Ekofisk	-	12
Frigg (Norwegian side)	-	24
Statfjord	4	4
	36	146

Table III shows a summary of the production wells which have been started and/or completed in 1979.

In 1980, about the same level of activity and distribution as in 1979 is expected.

Ekofisk	3 wells
Tor	4 wells
Eldfisk	16 wells
Albuskjell	7 wells
Edda	5 wells
Statfjord A	6 wells
Valhall A	2 wells

The only new field in this connection is the Amoco-Noco Groups Valhall field where it is expected that drilling will start in the autumn of 1980.

Ekofisk

To be able to maintain production at Ekofisk as long as possible, it was decided in 1978 that 7 new production wells should be drilled. This has later been expanded by a further 4 wells.

4 of these additional wells have been drilled and completed, while 1 is drilling.

Eldfisk

On Eldfisk, drilling was going on from two platforms (A and B), whereone one (A) has two drilling rigs so that a total of 3 wells may be drilled at the same time.

13 wells have been drilled and completed on the A platform, compared with 3 on the B platform. In addition, 1400 mm casing has been set on 7 other wells on the A platform, whereof two are being drilling. On the B platform, one well is being drilled. Production on the A platform was started in August. In total, 48 wells shall be drilled on this field.

Albuskjell

Also on Albuskjell there is production drilling from 2 platforms, 1 on Shell's block 1/6 (on the western part of the structure) and 1 on Phillips's block 2/4 (on the eastern part of the structure). At the turn of the year, 10 wells have been drilled and completed (5 wells on each platform), while one had to be given up at shallow depth because of technical problems. The drilling of a total of 30 wells on Albuskjell has been planned.2 wells are being drilled at this time. From the A platform, production was started in May, while the start-up of the F platform took place in July.

Tor

4 new wells on Tor have been drilled and completed in 1979, while one is still being drilled at the turn of the year. In total, the drilling of a total of 4 out of the 15 wells on the field remains to be done.

Edda

Edda is one of the 2 new fields on which production drilling was started in 1979. The progress has been good. 4 wells have been drilled and completed, while one well is being drilled. At total of 13 wells shall be drilled on the field.

Statfjord

The 4 first production wells on Statfjord in one shaft on the A platform have been drilled and completed, and production on the field was started in November. In total, 21 wells shall be drilled in each of the two well shafts on the A platform, giving a result of a total of 42 wells. At the turn of the year, work on the setting of 508 mm casing in a number of wells was underway.

2.3.3 Drilling activity at Svalbard

Like in 1978, no exploration drilling took place on Svalbard in 1979. The Petroleum Directorate is not aware of drilling plans for 1980.

2.4 NEW DISCOVERIES

Hydrocarbons (gas, condensate or oil) in widely varying quantities have been encountered in as many as 14 of the 24 wells drilled; where potential reservoirs were drilled in 1979. 5 of these were exploration wells, and the other 9 were delineation wells.

5 new discoveries have been registered in 1979. The five are: 18/10-1, a separate structure just south-east of the Bream field, 15/9-4, a new structure east of the Sleipner complex, as well as the 3 fourth round wells 30/6-1, 31/2-1 and 34/4-1. 30/7-7 proved hydrocarbons in so small quantities that it is not desirable at this time to call it a discovery.

All new discoveries, other than Saga's discovery in block 34/4, have been made in Jurassic sandstone reservoirs.

For more detailed comments about the various discoveries, reference is made to Chapter 2.3.1.

2.5 THE EKOFISK AREA

2.5.1 The exploitation of the resources

The Ekofisk area covers the fields Albuskjell, Cod, Edda, Ekofisk, Eldfisk, Tor, West Ekofisk and East Ekofisk (Figure 2 K). These fields were discovered in the period 1968-73. All fields, other than East Eldfisk, were in production at the end of 1979. The Ekofisk field was the first field to start producing. This field has now produced oil and gas since 1971. Phillips Petroleum Company Norway has directed the development and the operation of these fields.

they were made ready to receive all oil and NGL produced from the Ekofisk fields. The fields Albuskjell, Edda and Eldfisk are tied in to the processing and transportation facilities in the Ekofisk area and production was started in this report period.

The hydrocarbon stream from the fields is collected on the Ekofisk Center. At this place, the stream is separated into one oil and NGL part and one gas part. Oil and NGL is transported to Teesside, and the gas to Emden.

The reservoirs in the Ekofisk area consists of cretaceous layers of upper Cretaceous and lower Palaeozoic age. This means deposits which are about 55-70 million years old.

The Valhall and Hod reservoirs occur in the same geological layers as the other fields in the Ekofisk area. Valhall and Hod will be developed in accordance with separate plans, but will be tied in with the same transportation system as the Ekofisk fields. Amoco Norway Oil Company will be the operator for these fields as further described in litra 2.6.

The Petroleum Directorate has emphasized that ways must be found to increase the recovery in the oil fields in the Ekofisk area. Pursuant to the original plans for these fields, the production will take place by pressure displacement.

It seems quite likely that this production method will make it possible to produce 20 per cent of the oil and about 50 per cent of the gas. The differences in recovery factor of oil and gas makes the recoverable gas reserves of almost equal importance during the present production regimes.

The oil quantities present in these fields, namely Ekofisk, Eldfisk, the whole Valhall field and Edda, amounts to about 2,000 Sm^3. For each percentage increase in recovery factor, about 20 million Sm^3, or 16.5 million tons of oil will be recovered. As a comparison, the total consumption of primary energy in Norway (before conversion losses) was about 15.5 million tons of oil equivalents in 1978.

The time pressure to get started with assisted production is strong. The effect will taper off, as the reservoir pressure will decrease because of the ongoing production. In addition, the existing facilities have a limited life. These factors have the effect that the opportunity to increase the recovery factor is of limited duration. Assisted production may therefore be regarded as energy saving. The extent is large, as it appears from the numbers above. It is fully reasonable to expect that an energy quantity may be saved from the said fields which corresponds to Norway's total consumption in the years when such production is effective.

In earlier Annual Reports it has been pointed out that it must be expected that injection of gas into the Ekofisk field will increase the productivity as well as the recovery factor for oil in an efficient manner. This has been confirmed in 1979. Earlier on, it could not be excluded that the gas could force its way through cracks in the reservoir without displacing oil. The production history on the Ekofisk fields shows that this is still not a large problem. It has been found that a large part of the gas has gathered towards the top of the reservoir. Supply of injected gas and expansion of gas which is present displaces the oil so that a far greater part of this will be produced from the relevant parts of the reservoir.

Under the circumstances which have prevailed so far, one

volume unit of gas in the reservoir may displace one volume unit of gas saturated oil. By injecting 1000 Sm^3 of gas, the effect will roughly be to gain the recovery of 1 ton of oil in addition to that which would otherwise have been produced. I addition, a gas pocket is formed with will expand as the pressure in the reservoir declines. The gas will thereby contribute to maintain the productivity of the reservoir. As it expands, it may displace still more oil. As the pressure in the reservoir falls, and dissolved gas is released from the oil, it is feared, however, that this released gas will create flow-routes outside of the major oil volumes. It must therefore be expected that the present positive effect of gas injection will be reduced. The consideration for strict economizing of reserves therefore indicates that as large gas quantities as possible should be injected as early as possible.

The gas injected may be produced after it has been used to drive out oil. The gas prices are usually stipulated on the basis of the oil prices one or two years ago. A possible increase in the real value of oil will therefore lead to an increase in the price of gas which will be produced at a later point of time.

Gas injection will increase the recoverable oil reserves for most of the fields in the area. As long as there is not sufficient gas available in the Ekofisk area to both undertake injection into several fields at the same time and sell the contractual gas quantities, there is no reason to use natural gas as a displacement agent on a large scale.

The Ekofisk field is one of the fields where gas injection will have the highest effect on oil recovery. For this reason, gas injection has so far been limited to this field.

Ekofisk

At atmospheric conditions, the reservoir content in the Ekofisk field would correspond to about 850 million Sm^3 of oil and 191 billion Sm^3 of gas. At reservoir pressure and temperature,

the gas is dissolved in the oil, but to start with, this is not saturated with oil. The Ekofisk fields is therefore designated an oil field. The original recoverable reserves have been estimated at 184 million Sm^3 of oil and 112 billion Sm^3 of gas, whereof 78 millions and 12 billion Sm^3, respectively, have been recovered as per 31 December 1979.

Production from the field was started in 1971. A still larger part of the production is gas. This is related to the fact that the pressure is lower that the boiling point pressure as well as to the gas injection. The wells producing from these parts of the fields yield a relatively large gas production, which reduces the displacing effect of the gas. To avoid production from the gas pocket will in real life have the same effect as gas injection. In addition, the energy used to run the injection equipment is saved. A reduction in production from the relevant wells will,however, lead to a reduction of the oil productivity as well. It is therefore a question of balancing increased production and increased reserves in the long run against an immediate loss of production. So far, the operator has been directed to inject smaller quantities of gas into the Ekofisk field. This results in substantial economic gains to Norway and the operator, compared with these quantities.

Figure 2 L shows the annual gas injection and the increased oil quantities which represent the increase in reserves. The figure also shows the injection level at 90 per cent utilization of the injection capacity. In the same figure, the Norwegian oil consumption in the last years has been marked. The figure shows that in the period 1974-79, $12 \times 10^9 Sm^3$ have been injected. This has resulted in an increase of recoverable oil reserves of 12 million tons at a value, as per the second quarter of 1979, of about Nkr. 9.5 billion.

After the gas sales started in 1977, it would have been possible to inject a further $6.5 \times 10^9 Sm^3$. This would, in the assessment of the Petroleum Directorate, result in an increase in the oil production of 6.5 million tons at a value in the 2nd quarter

of 1979 of about Nkr. 5 billion over a period of 3-4 years. In this case, the gas deliveries in this period would have had to be reduced. This would have resulted in a reduction in income of about Nkr. 2.4 billion for the period 1977-79.

The licensees at the Ekofisk field has decided to start a pilot project with water injection. The aim of this project is to study if it is possible to inject sea water into the field and if water displacement is sufficiently effective to warrant that this is done on a large scale. As mentioned in the previous Annual Report, the theoretical studies provide positive results. The studies of the operator indicates that if injection of sea water is feasible, it may increase the recovery factor of oil from about 18 per cent to about 28 per cent. This may increase the recoverable oil quantities by about 100 million tons at a value, in the 2nd quarter of 1979 of about Nkr. 80 billion.

The effect of possible water injection provides the best result in the case of early application while the pressure in the field is still fairly close to the boiling point pressure. The time factor is therefore important. If water injection is undertaken after free gas has been allowed to develop because of pressure reduction, the injected water may quickly flow to the gas zones without displacing oil. It is therefore in everybody's interest to clarify the effects of water injection in the cretaceous reservoir as quickly as possible.

To maintain the oil production at Ekofisk, four new production wells have been drilling in 1979 and a previous gas injection well has been converted into a production well. A total of 8 new production wells have been planned on the Ekofisk field.

Eldfisk

Eldfisk is an oil field in the same way as Ekofisk. The reserves in place are 587 million Sm^3 of oil and 142 billion Sm^3 of gas. Out of this, the original recoverable reserves have been estimated at 83 million Sm^3 of oil and 52 billion

Sm^3 of gas, whereof 2 million and 0.4 billion, respectively, have been produced as per 31 December 1979. Production will take place from two platforms, 2/7-A and 2/7-B. Production on Eldfisk A was started on 8 August 1979 and on Eldfisk B on 28 October 1979. At the end of 1979, 7 wells were completed for production of the 2/7-A platform and 3 wells on the 2/7-B platform. East-Eldfisk will be produced from four wells which, according to the plans, will be tied in with the A-platform.

It appears that Eldfisk is more complex from a geological point of view than expected from the start. The field is divided by a number of faults which makes it difficult to survey. Still new and important information is obtained from the drilling of production wells.

In the last annual report it was pointed out that the recovery factor for Eldfisk would be low without assisted recovery. The possibilities for and the effects of assisted production on the field have been studied by the Petroleum Directorate and the operator. The studies show that the recovery factor may be considerably increased by water injection, but that the geological factors must be further surveyed by drilling of production wells before the extent of economically attractive injection may be calculated. In addition, the operator wishes to look at the result of the pilot project for water injection on Ekofisk before a further position on water injection into Eldfisk is taken.

It has been made clear that gas injection into this field could increase the recovery factor considerably.

Tor

The Tor field is also an oil field. The reserves in place are 125 million Sm^3 of oil and 25 billion Sm^3 of gas. Of the recoverable 28 million Sm^3 of oil and 17 billion Sm^3 of gas, 6 million and 1 billion Sm^3, respectively, have been produced as per 31 December 1979.

Production started from three wells on 28 June 1978. At the end of 1979, 10 wells were producing. Platform 2/4-E, which covers the field, will be equipped with a total of 15 producing wells. No decision has been made as regards any form of assisted production on this field. The operator plans to study the effects of a water injection project. The result of the pilot project at Ekofisk will be very important for the evaluation of a possible water injection project at Tor as well.

In 1979, the Petroleum Directorate has contracted Rogaland Research and the Institute for Nuclear Energy to make a reservoir simulation study for this field. This reservoir simulation study has produced a model for the production sequence and the reservoir behaviour for the Tor field.

Edda

Edda is a small oil field where the reserves in place have been estimated at 36 million Sm^3 of oil and 9 billion Sm^3 of gas. Of this, 8 million and 7 billion Sm^3, respectively, are recoverable. Production on Edda was started on 2 December 1979. Four production wells have been planned from platform 2/7-C. At this time, assisted production has not been evaluated.

West Ekofisk

West Ekofisk has been producing since 31 May 1977. This is a condensate field. Originally, petroleum in the reservoir is in gas form. When the petroleum vapour reaches the surface, a large part of this will condensate to liquids by retrograde condensation. Under atmospheric conditions, the reservoir content will amount to 103 million Sm^3 of oil and 31 billion Sm^3 of gas (in place reserves). Original recoverable reserves amounted to 16 million Sm^3 of oil and 28 billion Sm^3 of gas. Of this, 7 million and 10 billion Sm^3, respectively, have been produced as per 31 December 1979. The condensate in the West Ekofisk field is called a rich condensate since it releases a relatively large volume of oil

as it reaches the surface. As the field is being produced, the pressure in the reservoir will be reduced. At that time, some part of the gas will also condense down in the reservoir. This liquid will initially be released close to the wells where the pressure is lowest. Here it will "choke" the rock, leading to a significant reduction in productivity to each individual well.

Part of the liquid released in a condensate reservoir will be so finely distributed over the reservoir rock that it is impossible to recover it. In principle, it is nevertheless possible to arrive at a high degree of recovery. This presupposes that the condensate gas is displaced by dry gas at a pressure which is high enough to avoid the release of liquids, and that the injected dry gas is recovered by lowering the pressure towards the end.

Usually, such gas injection will have a higher efficiency factor than water injection in the case of recovery from a condensate reservoir. Since the supply of gas is limited, the possibilities for increasing the recovery factor at West Ekofisk by water injection must be taken into account. It is expected that the oil saturation in the reservoir will be so low in West Ekofisk that the yield will not be the same as that expected in the larger oil fields. Such an evaluation must await the studies made for the oil fields.

Albuskjell

Albuskjell is also a condensate field, but the condensate content per volume unit is less than at West Ekofisk. The reserves in place have been estimated at 39 million Sm^3 of oil and 45 billion Sm^3 of gas. Of this, it is estimated that 20 million Sm^3 of oil and 30 billion Sm^3 of gas are recoverable. The release of liquids will be a smaller problem in this case. From the point of view of geology, the field appears to be significantly different from what the licensees expected after the three exploration wells had been drilled. It has turned out that a larger part of the reservoir consists of zones with poor porosity and high water saturation. The

Albuskjell field has been drilled from two platforms.

Production on Albuskjell started from a well on the 1/6-A platform on 25 May 1979. At the end of 1979, five wells are ready for production. Production from the first well on the 2/4-F platform started on 26 July 1979. At the end of 1979, three wells are ready for production on this platform.

In 1979, the Company for Industrial and Technical Research at the Norwegian Technical University (SINTEF) and the Institute for Continental Shelf Research (IKU) have performed a numerical simulation of Albuskjell under a contract with the Petroleum Directorate. This simulation has pointed out how sensitive the recovery factor is to different recovery strategies.

The recovery factor for Albuskjell may be increased by gas injection. However, the gain by such injection will be small compared with the efficiency of injection of gas into the largest oil fields in the area. Water injection may hardly increase the recovery factor at Albuskjell. The condensate content will be so finely distributed in this field that it will neither flow nor let itself be displaced.

Cod

Cod is a small condensate field with 5 million Sm^3 of oil and 9 billion Sm^3 of gas in place. Recoverable reserves have been estimated at 3 million Sm^3 of oil and 4 billion Sm^3 of gas, whereof 1 million and 0.6 billion, respectively, have been recovered as per 31 December 1979. Production from this field was started in November, 1977. The field contains smaller quantities of condensate compared with the gas quantities. The recovery factor will therefore be high in the case of production by pressure relief. This field has been shut in for longer periods after the Ekofisk field came into full operation (phase IV). The reason is that the field has the highest gas/oil ratio in the whole Ekofisk area. Therefore, the oil production may be kept at the highest

possible level in the short range by shutting this field when the gas production must be limited.

2.5.2 Production facilities/fixed installations

In the course of 1979, production has started on the last three fields in the Ekofisk area, Albuskjell, Eldfisk and Edda, as mentioned before. (See figure 2 M). This took place on 26 May, 8 August and 2 December, respectively. The development has therefore entered phase IV, which is the last one so far. However, it is possible that a larger water injection project will be started some time in the 1980s. This is related to the results of the pilot project which will be started in 1981.

A new platform will be located on the north-west side of the Ekofisk tank with a bridge connection to the tank. This platform shall receive the oil and gas from the Valhall field.

For the necessary quartering of personnel in the Ekofisk area, three movable quarter platforms (flotels) have been used at Ekofisk in addition to the permanent living quarters. Of these, one has had 2 persons per room, while the two others have had four persons per room.

Towards the end of 1979, the flotel "Henrik Ibsen" came from the field to Stord Verft to be rebuilt from 228 to 600 beds. In converted state, "Henrik Ibsen" will satisfy the requirements of the Petroleum Directorate.

On the permanent living quarters, there are 2 men per room on only West Ekofisk, the Hotel platform and Cod. Otherwise, the personnel is quartered in rooms of 4 men per room.

To improve the quartering situation, a decision has been made to build new quarter modules on the quarter platform 2/4 Q, the Hotel platform 2/4 H and the oil pump platforms 37/4 A and 36/22 A. This will provide 176 new beds which satisfy the Petroleum Directorate's requirements.

2.5.3 Pipelines from Ekofisk

Ekofisk-Teesside

The pipeline from Ekofisk to Teesside is 345 km long and has a diameter of 860 mm.

The average daily flow through the pipeline has been about 61,500 Sm^3 in 1979.

Ekofisk-Emden

The pipeline from Ekofisk to Emden is 442 km long and has a diameter of 915 mm. In the course of 1979, about 34 million Sm^3 of gas per day have been transported to Emden.

The work of covering the pipeline on the Danish Sector was completed in September 1979. A total of 29 km of the pipeline has been covered.

Problems have been experienced with expansion in the pipeline. This has lead to problems in connection with movement in the riser on the 2/4 R platform on the Ekofisk field. To improve this, an anchoring project was undertaken on the pipeline 500 meters from 2/4 R in October.

Similar anchoring projects are presently evaluated at the gas pump platforms H 7 and B 11.

2.5.4 Reshipment of NGL from the Ekofisk fields

In connection with the landing licence for petroleum from the fields in the Ekofisk area, the Phillips group entered into an agreement with the Norwegian State about reshipment of NGL to Norway. Above all, the agreement was entered into to secure supplies of feedstock for the Norwegian petrochemical industry. The rights according to the agreement, which was entered into with the Norwegian State, have later been

assigned to Noretyl (Statoil, Hydro and Saga) which directs the development and operations of the Rafnes facilities.

It follows from the agreement that the Phillips group shall mainly deliver ethane and propane as feedstock to Noretyl. From the fields Ekofisk, West Ekofisk, Cod and Tor, the quantity delivered shall be sufficient for the production of 250,000 tons of ethylene per year. From the fields Eldfisk, Edda and Albuskjell, the quantity delivered shall be sufficient for the production of 80,000 tons per year.

The ethane and propane quantities which are produced from the individual fields are found both in the gas stream and in the oil stream. Large parts of the quantities in the gas stream are condensated in the final dehydration and dew point treatment at Ekofisk Center. This condensate is mixed with the oil stream and led by pipeline to Teesside. In Teesside, the Phillips Group has constructed facilities for stabilizing the oil, so that the lighter fractions of the oil coming from the pipeline are removed and further processed in a separate fractionation plant. The products from the facility are ethane, propane and butanes. For these NGL fractions, as well as the stabilized oil, storage and shipment facilities have been constructed.

According to the agreement, the Phillips group should deliver the first quantities of ethane/propane to Noretyl in the autumn of 1976. Because of delays in the development of Ekofisk Center and the facilities at Teesside, the delivery was initially postponed to the summer, 1977.

Because of further delays in the completion of the facilities at Teesside, and particularly in the factionation facilities for storage of NGL, it was anticipated that supplies of NGL could not be effected before the summer, 1979.

At the turn of the year 1978/79, however, the Phillips group presented a plan for stepping up the supply of propane, primarily for satisfying the obligations concerning supplies to Rafnes. The plan involved a gradual increase in the propane

content by a gradual change-over in the production plans at Ekofisk Center.

On 2 February 1979, the Petroleum Directorate gave its approval to Phillips to implement the plans for a gradual change-over. The plans were implemented in March and the first shipment of semi-refrigerated propane left Teesside on 22 March 1979. The surplus quantities of ethane were used for fuel the facilities. The butanes were spiked into the stabilized oil.

After some problems related to the storage facilities for propane at Teesside had been solved, regular supplies of NGL were started in August. Later, the production of NGL at Teesside and the reshipment have been effected without problems, and the production is currently higher than stipulated in the agreement.

2.5.5 Burning of gas on Ekofisk

The quantity of gas burnt at Ekofisk appears from Figure 2 N and Figure 2 O.

In Phase I of the Ekofisk development, from 1971 to 1974, test production and loading via a buoy were effected. All gas was burnt.

During Phase II, in 1974 and 1975, there was production from the Ekofisk Field Terminal Platform and loading via a buoy, and the gas was partly used as fuel and partly burnt at a flare. Initial injection was started in 1975. Because of problems associated with the gas injection equipment, gas was still burnt.

After the supplies of gas to Emden had been started, the burning of gas has been reduced. The burning which has taken place is mainly associated with problems in connection with the compressors and other gas processing equipment. In the report period, the production facilities at Ekofisk,

Albuskjell and Edda have been finished and tied in with Ekofisk Center. During the very start-up phase of these facilities, some gas has been burnt.

2.6 VALHALL-HOD

Valhall and Hod are two oil fields located about 35 km south-east of Ekofisk (Figure 2 K). They are of the same type as the other fields in the Ekofisk area, but are nevertheless discussed in isolation, since the licensees are different. The fields are in the southern part of block 2/8 and in most of block 2/11. The western flank of the structure extends into block 2/7.

2.6.1 Exploitation of the resources

From a geological and reservoir point of view, Valhall and Hod are related to the other fields in the Ekofisk area. The reserves in place in the Valhall field are estimated at 376 million Sm^3 of oil and 94 billion Sm^3 of gas. Of this, it is anticipated that 43 million Sm^3 of oil and 28 billion Sm^3 of gas will be produced through the Valhall A development. Whether further petroleum quantities will be developed depends on whether the field will be fully developed and if assisted development will be started. The experiende from the other fields in the Ekofisk area may probably be used in the evaluation of how the resources at Valhall and, in case, Hod may be exploited.

Production experience from the Ekofisk fields shows that gas injection has lead to a substantial increase in the recoverable oil quantities. The Petroleum Directorate is currently evaluating how both gas and water injection will influence the production from Valhall-Hod.

Approval for landing of petroleum has been given on the condition that the Amoco/Noco-group shall present a study program to clarify how the recovery factor may be increased

for oil by injection of gas, water or other substances. The program shall be approved by the Ministry." (Storting Report No. 92 for 1976-77). The Petroleum Directorate expects that the program will be proposed in the near future.

The Amoco/Noco group and the Phillips group has still not arrived at a negotiated solution for the transport of NGL from Valhall. If it is impossible to arrive at a negotiated solution, it is possible to pump NGL back into the reservoir. This would, in case, reduce the NGL quantities from the Norwegian Continental Shelf.

There are still no plans for the development of the remaining parts of Valhall and Hod. Hod may largely be considered as an isolated field. Production from Valhall will hardly influence the production behaviour of this. From an economic point of view, there will still be clear advantages in using existing facilities at Valhall and Ekofisk in case of production from Hod.

It is likely that also the parts of the Valhall field which are not involved in the development will be influenced by production on Valhall A. In this case, the resevoir conditions may deteriorate in these parts of the field.

In Storting Report No. 92 (1976-77) concerning the landing of petrolum from the fields Valhall and Hod, one of the assumptions for approval is "that the licensees develop the whole complex with sufficient well coverage". The Petroleum Directorate evaluates when a decision to develop the rest of the Valhall field must be made and the consequences from a resource point of view of refraining from making such a decision.

2.6.2 Production facilities/fixed installations

A landing licence based on stepwise development of the field was granted in May, 1977. Approval of the concept for a platform solution for the development of the first step,

the central part of Valhall in block 2/8, was give in august 1977. There are no concrete development plans for the next steps, but the processing equipment for oil and gas from Valhall A will be dimensioned with a view to later tying in of Hod and other parts of Valhall.

The first development phase of Valhall A, shown in Figure 2 P, comprises the development of the central part of the Valhall structure in block 2/8 with 3 platforms - one drilling platform, one production/compression platform and one quarters platform.

For the hook-up with Ekofisk Center, a new riser platform will be built in addition with will be tied in with a bridge to the western side of the Ekofisk tank.

The design work for all four platforms is almost finished. The drilling platform is scheduled to be set in the summer of 1980. The production/compressor platform shall also be set in the summer of 1980. For this platform, a modified steel jacket which had originally been intended for SE-Tor will be used. After modification, it will be towed from the USA to Norway. Large work tasks have been assigned to Norwegian companies in connection with the fabrication of decks and modules. The jacket for the quarters platform is being built and is scheduled for setting in the beginning of 1980. The new riser platform is scheduled to be set close to Ekofisk Center in the end of 1980 and shall be ready for operations in the autumn of 1981. At the turn of the year 1979/80, the steel jacket was being built, while the work on the deck and the bridge was out for bids.

The laying of pipelines from Valhall A to Ekofisk is scheduled to start in the spring of 1980.

Stabilized crude oil and gas, fit for transportation in a pipeline, will be transported separately by two 20" pipelines to Ekofisk Center, where the already existing transportation system to Emden and Teesside may be used. If it should become necessary to separate NGL at Valhall, this will be reinjected into the reservoir in case there is no transportation

capacity in the Ekofisk system.

Drilling of the first well may be started towards the end of 1980, and production is expected to be started sometime in the autumn of 1980.

2.7 THE FRIGG AREA

2.7.1 Exploitation of the resources

The Frigg area comprises Frigg and the satellite fields E-Frigg, SE-Frigg, NE-Frigg and Odin (Figure 2 Q). At the end of 1979, a decision concerning exploitation had still only been made for the main field. It is still evaluated whether NE-Frigg and Odin shall be developed. The main field has been in production since the autumn of 1977. The operator is the company Elf-Aquitaine Norge A/S.

Frigg is a gas field with a lower oil zone. The gas consists of about 95 per cent methane and has a relatively modest content of condensates. This will not be released until the gas has been brought to the surface, where it is separated and sold. The oil layer under the gas cannot be produced.

The in-place gas reserves in the Frigg field are estimated at 268 billion Sm^3, whereof it is anticipated that 194 billion Sm^3 may be recovered. Out of this, 118 billion Sm^3 is on the Norwegian Continental Shelf, and 13 billion Sm^3 of this share had been produced as per 31 December 1979.

In the earlier Annual Reports, the Petroleum Directorate has made reference to how gas will flow from the satellite fields to the main field when this is being produced. A separate development of the satellite fields may limit the loss of resources if the development takes place within a reasonable period of time (cf. the Annual Report for 1978). The operator, Elf Aquitaine Norge A/S in blocks 25/1 and 25/2, and Esso Exploration and Development Norway Inc., the operator in block 30/10, have worked continuously in 1979 on the

evaluation of different possible technical solutions for the exploitation of the satellite fields. Negotiations are proceding between Elf and Esso concerning the transport solution for the gas in NE-Frigg. The Petroleum Directorate has followed the development in the technical studies of the licensees closely.

The question of when, and to what extent, gas will flow from the satellite fields to the main fields will depend on pressure communication between the Frigg formation and the Heimdal formation. The Heimdal formation contains water and is considered to be deposited continuously over a very large area compared to the extent of the Frigg formation. The pressure communication may also influence the recovery factor on the Frigg field itself (cf. the Annual Report for 1977). The highest recovery factor will be achieved in the case of limited water influx, lowest in the case of strong water influx.

An observation well, 25/1-A22 (cf. the Annual Report 1978) was drilled in the spring of 1978 to register at an early time whether there is pressure and flow communication between the two geological formations. The well was completed in the Heimdal formation and is used to register the pressure decline in this formation.

In addition, well logs have been run in 25/1-A22 to discover the location of possible movements of the gas/oil and water/oil contact in the Frigg reservoir. The measurements in 1979 seem to indicate pressure communication throught the tuff zone, a shaly sand layer which separates the Frigg and the Heimdal formation, since the pressure in the Heimdal formation is reduced because of the gas production. The reduction in pressure is substantially lower than that measured in the Frigg formation, which may indicate a limited pressure communication through the tuff zone. The well logs further indicate a certain raising of the water/oil contact. Together with the pressure measurements, this indicates a certain natural water drive, meaning that the pressure in the reservoir is partly maintained by water flowing in as the gas is produced.

Important factors are that when the pressure in the Frigg formation is partly maintained, this will delay the gas ingress from the satellite fields. Furthermore, it will contribute to delay the pressure decline and thereby the need for compressors on the platform.

The knowledge obtained about the reservoir in 1979 indicates that the recovery factor for gas may be higher that previously expected. The licensees have therefore increased the estimate of recoverable reserves by about 6 per cent. The increase is caused by the pressure communication, both from the Heimdal formation and the satellite fields. In this case, the licensees have not taken into account the gas which will presumably migrate from the satellite fields.

2.7.2 Joint exploitation (unitization)

The Frigg field is unitized between Norway and Great Britain with a Norwegian share of 60.28 per cent and a British share of 39.18 per cent. The allocation does not include the Frigg satellites, and was adopted by the partners in 1977. The authorities of the two countries signed a protocol about joint exploitation in 1976. Within 1981, the allocation may be evaluated once more, based on earlier and newer data, as well as the production history on the field.

2.7.3 Production facilities/fixed installations

The location of the platforms on the Frigg field appears from Figure 2 R.

The development on the British side consists of:

CDP 1 - a combined drilling and production platform
QP - a platform for quartering and a control center
TP 1 - a process and gas treatment platform

In the late summer, 1978, the Petroleum Directorate issued

a production licence for both platforms on the Norwegian side:

TCP 2 - a gas treatment and compression platform
DP 2 - a combined drilling and production platform

2.7.4 Damage to the facilities

Frigg TCP 2

On 7 September 1979, the shutting mechanism for the end cover on the pig trap on the sea line from DP2 failed. The end cover blew out and cut a beam.

The shut-down system worked as it should, the field was shut in and pressure relieved. The reaction forces from the gas blow out moved the piping arrangements mounted on the pig trap about 30 cm out of position, and caused some other minor damages in the area. A change-over was made, and reduced production could be started on 1 October 1979. The repair of the pipe systems and other damages was effected and normal production could be resumed on 28 October.

The Frigg flare tower (flare)

In week 41, it was registered that sea water flowed into the seapipe between TP 1 and the flare. Gas had to be sent to the flare at still shorter intervals to get the water out, but the leak increased.

Elf Aquitaine Norge (EAN) had divers down on several occations to discover where the leak was located. On 12 November 1979, the leak was located to one of the two separate pipe systems in the tower. The defective pipe system was shut in, and normal flaring and pressure relief could be effected through the operative system.

EAN is currently working on plans for repair and supplementary solutions for the pressure relief system.

2.8 THE STATFJORD AREA

2.8.1 Exploitation of the resources

The Statfjord area comprises Statfjord, 33/9-Alfa and 33/9 Beta (Figure 2 S). Of these, only Statfjord has been declared commercial so far with a decision about development. This is an oil field which contains 811 million Sm^3 of oil and 142 billion Sm^3 of gas. Of this, 84.09322 is currently regarded as being Norwegian, or 682 million Sm^3 of oil and 119 billion Sm^3 of gas. Both the recoverable reserves and the quantities produced are shared in accordance with this ratio which is considered to be equal to the allocation of in place reserves, regardless of whether the gas reserves or the recovery factor under the area of the two countries are different. This is normal practice and will have the advantage that the allocation is not influenced by the way in which the field is developed. No element will therefore be introduced in the allocation agreement which may distort the parties' joint interests in relation to the development of the resources. The recoverable reserves which will be allocated to Norway are considered to be 341 million Sm^3 of oil and 48 billion Sm^3 of gas. The operator for the development is Mobil Exploration Norway Inc.

Murchison is another field which is both located in the same geographical area and in the same geological formation as the Brent reservoir in the Statfjord field. This is discussed as a separate field, however, since it is located on the British side with another operator and its own development plan.

The principles for the production of the resources in the Statfjord field have previously been described in the Petroleum Directorate's Annual Report from 1977. The intention is to have assisted production from the very start, with water injection into the Brent reservoir and gas injection into the lower Statfjord reservoir. In the report period, no decision has been made which changes these plans.

The point of time when it is necessary to start sale of gas is an important question which is still being studied. The planned gas injection will have a positive effect on the Statfjord reservoir, but this will last for a limited time. The duration of the gas injection must therefore be closely balanced with the advantages of and the possibilities for earlier revenue from gas sales. In 1979, the licensees have carried out reservoir studies to evaluate the consequences of different points of time for the start of the gas sales. Different transport alternatives for the gas will also be evaluated. The reservoir studies indicate that part of the injected gas may force its way to the producing wells in the Statfjord reservoir at a relatively early point of time, so that these will experience an increasing gas/oil ratio.

In the last half of the 1980s it will also be a problem that the Statfjord reservoir will be unable to receive all the gas which must be injected. The licensees are therefore working to find transport solutions for the gas from a relatively early point of time so as to guard against possible problems. This work must be considered in connection with the transport solutions which are desirable from this part of the continental shelf, and when a pipeline may be available.

The Petroleum Directorate has asked for an evaluation of the possibilities available for solving possible problems if difficulties should arise in the injection of gas pursuant to the original plan earlier than expected. The Petroleum Directorate assumes that it will be technically feasible to avoid both a reduction in the oil production and the flaring of gas because of possible problems.

4 wells have been drilled and completed from the Statfjord A platform in 1979, whereof 3 production wells and 1 gas injection well. The production on Statfjord A started on 24 November 1979. The gas injection equipment is still not ready for operation, but the work on this is presently given priority, and the gas injection is scheduled to start on 1 May 1980. For the time until May, a limited approval for burning of gas has been issued, so that sufficient oil may be produced for sound testing of the production facilities. The Petroleum

Directorate follows this work closely, and ensures that unnecessarily large gas quantities are not lost by flaring. At this point of time, the present development plan assuming reinjection of gas into the reservoir is kept.

2.8.2 Joint exploitation - unitization

The Statfjord field is located on the border between Norway and Great Britain. Following comprehensive studies and negotiations, the licensees have concluded that 84.09322 per cent of the reserves are located on the Norwegian side, while 15.09322 are on the British side. At the same time, the licensees have increased the reserve estimates for recoverable reserves from the whole field from 485 million Sm^3 to 571 million Sm^3.

Because of the number of resignations in the Petroleum Directorate in 1979, it has been impossible to reassess the reserves or the allocation. The allocation is only temporary, however, and it shall be reassessed already on 1 January 1981, 1 January 1983 and 1 January 1986, and every 4th year after this on the basis of the total amount of data which is available at these points of time. The present allocation, therefore, is not final. It will be possible, in the future, to determine the allocation with an increasing degree of accuracy as the density of production wells increases. The authorities approved the allocation proposed by the licensees in November 1979.

Rational development and production on the field presuppose an agreement between the licensees on both side of the border. Such a "Unitization and unit operating agreement" with various appendices was signed on 11 June 1979.

The location of the field also raises a number of problems for the authorities, and negotiations have been conducted for a long period of time. A treaty was signed on 16 October 1979. On the Norwegian side, this is conditioned on ratification by the Storting. In the main, the agreement follows

the same system as the corresponding treaty about joint utilization of the Frigg field.

2.8.3 Production facilities/fixed installations

Start-up on the Statfjord A platform took place in November 1979 without special problems.

Statfjord B is in the middle of the construction phase.

The quality assurance plans for parts of the project have been submitted to the Petroleum Directorate.

Reference is otherwise made to Section 2.7.2 Production facilities/fixed installations in the 1978 Annual Report for a further description of the fixed installations.

2.8.4 Burning of gas on Statfjord A

In connection with the start-up of Statfjord A, the need for burning of gas has been thoroughly evaluated.

The need for burning of gas is caused by the following circumstances:

a) clearing up of the production wells
b) pilot flare
c) emergency flaring
d) flaring of associated gas in the start-up phase before the reinjection equipment is ready for operation.

For each well which starts to produce, a certain quantity of oil and gas must be burned because of impurities in the well. These quantities are insignificant, however.

To avoid that air may enter the production equipment from the flare, it is necessary to have a certain flow of gas. For Statfjord A, this quantity has been stipulated at 0.002 million Sm^3/day.

In case of failures in the equipment and/or components, it may be necessary to relieve the pressure in the production systems. This may lead to significant flaring of gas over a shorter period of time. Tha maximum flaring capacity is 11 million Sm^3/day. In practice, this will mean that all the gas produced may be flared in certain periods.

During start-up and running in of facilities, flaring associated with items a), b) and c) is of little importance. The most important factor in this period is the time from the start-up of production from the first well until the gas injection equipment is operational.

To be able to operate a facility as Statfjord A at all, it is necessary to have a certain minimum production of oil. For the start-up phase, this quantity was estimated as corresponding to an average quantity of associated gas which is less than 1.6 million Sm^3 per day, for which flaring will be allowed. The average daily quantity of gas flared from the start-up on 24 November until 31 December 1979 was 1.42 million Sm^3.

2.9 MURCHISON

As in the case of Statfjord, Murchison is located partly on the Norwegian side and partly on the British side of the dividing line on the continental shelf (Figure 2 S). The largest part of the field is on the British side. The Operator for the Murchison development is Conoco North Sea Inc., and the Statoil/Mobil group represents the participation on the Norwegian side.

On 5 April 1979, an agreement between British and Norwegian licensees about joint exploitation of the field was entered into. It stipulates the Norwegian part of the Murchison field at 16.25 per cent. The agreement has still not been approved by the authorities of the two countries. Recoverable reserves which are allocated to Norway have been estimated at 9 billion Sm^3 of oil and 1 billion Sm^3 of gas.

The treaty between British and Norwegian authorities about joint utilization was signed on 16 October 1979 but has still not been ratified.

Murchison will be developed with a fully integrated platform in steel. The steel jacket carrying the platform was installed on the field in August 1979, and the work of lifting and hooking up the modules has been effected without major delays. The operator assumes that production may be started in October, 1980.

Murchison will have a production capacity of 20,000 Sm^3 (130 000 barrels) per day as an average over the year, corresponding to a maximum annual production of slightly more than 7.5 million Sm^3 of oil. The oil will be landed via the British Cormorant field to Sullom Voe on Shetland.

This oil also includes some NGL (wet gas) which is separated at the terminal in Sullom Voe.

2.10 PETROLEUM RESERVES AND EXPLOITATION STRATEGY

In the description of most of the fields which are producing or which are being developed, reference has been made to circumstances which are of importance to the exploitation of the reserves. In most of the cases, the fact is that even though the size and properties of the reservoirs are given by nature, the share of the reservoirs in place which will benefit the consumers will depend on how these circumstances are exploited. After a short summary of the circumstances which influence the exploitation, a short account will be given below about the size of the reserves in place and the recoverable reserves on the continental shelf. The recoverable reserves will be such that may be expected to be recovered with the plans which are available and the development traditions which have developed on the continental shelf. Reserves have not been accounted for when work on the surveying of their producibility through methods for increasing the recovery factor are in progress.

2.10.1 Exploitation strategy

There are many indications that scarcity of petroleum will be a central question for the rest of this century. The world's oil consumption is presently so high compared with the availability of new reserves that the relationship between known reserves and annual consumption is tapering off significantly. The size of the petroleum quantities which have still not been discovered and the point of time when alternative energy sources are ready for use are still unanswered questions. Regardless of the expectations for the world's petroleum availabity which are used as a basis, it is quite clear that it is necessary to have a strong economizing of the petroleum consumption, on the one hand, and an improved exploitation of the known petroleum reserves, on the other. Increased oil prices, among other things, will contribute to encourage an increase in the recovery factor from the petroleum resources, particularly in the parts of the world from which supplies of petroleum may be expected to be stable.

In many cases, it may be difficult to evaluate the economy in measures for increasing recovery. The additional income that may be the result of incremental production is hard to assess by itself. That the production without such measures is associated with uncertainty makes the task particularly challenging.

The rate of return associated with the methods for increasing the recovery will frequently be lower than in the case of the original production. The reason is, above all, that the period of delay between the additional investments and the additional revenue is usually longer. A strong increase in the real price of oil and gas is nevertheless having the effect that it is more attractive, also from the point of view of a true commercial interest, to recover more from the reservoirs. The conflict between the consideration for a high rate of return and the consideration for economizing in connection with the petroleum resources will be less in periods when the real prices increase.

The question of the exploitation of the petroleum reserves on the continental shelf was submitted to the Storting as late as in 1979 in Storting Report No. 42 (1978-79) concerning energy economizing, Section 5.4, where, i.a., this is said:

> "The Government considers it to be a main point in its energy policy to contribute to a sound exploitation of petroleum from a social economic point of view".

One of the most important tasks of the Petroleum Directorate is to ensure that the reserves on the Norwegian Continental Shelf are exploited in a sound manner. The rules for this work were prepared on the basis of the temporary regulations for sound exploitation of petroleum resources which entered into force on 17 October 1978.

The recovery factor for oil from an oil field will normally be 15-25 per cent at primary production, meaning production by only reduction of the reservoir pressure. This means that at least 3/4 of the oil is left in the subsoil, usually under low pressure and with such a distribution that it becomes difficult to get to it. There are many methods for increased recovery, and a number have been tested on onshore fields with varying technical and economic success. Most methods include injection of different types of gas or injection of water with or without chemical additives. The method or methods which should be applied must be evaluated in isolation in each individual case on the basis of, i.a. the properties of the reservoir and the availability of injection fluid. So far, only the most simple forms of gas and water injection have been applied for offshore oil production. This relates to the fact that much research still remains to be done on better suited methods. In addition, the tests which have been made in an onshore field may not necessarily be applied in the case of offshore production, where the distance between the wells is large, the costs are high and the life of the installations is short. On an international basis, however, intensive research is going on to find methods for increasing the recovery, and new methods may be applied to fields on the Norwegian Continental Shelf in the next 5-10 years.

Both the education and research capacity in Norway is very limited in the professional areas which must be mastered in order that the petroleum resources may be exploited as optimally as possible. Improvement in these areas, both from the point of view of quantity and from the point of view of quality, is still a major challenge. This will be very beneficial to the licensees. They are, of course, themselves responsible for an important part of the training and research which is presently carried out. The responsibility of the authorities as both the owner of the ground and the administrator of the resources makes it necessary for them, as well, to use independent technical and economic knowhow in the decisive sectors.

With the scarce resources which have been available up to now, the Petroleum Directorate has assigned priority to the evaluation of production methods which have the most obvious potentials. In substance, this is good, conventional production practice through surveying and exploitation of the circumstances provided by nature, and, as mentioned, injection of natural gas and water.

In the case of fields for which development decisions have recently been made on the Norwegian Continental Shelf, there are plans for gas and/or water injection on all of them. The plans for production from the Ekofisk area were laid in the beginning of the 1970s without methods for increased recovery with the exception of the Ekofisk field, where some gas was reinjected into the reservoir. This limited gas injection has been effective, and has produced an increase in the oil reserves corresponding to 1.5 times the Norwegian annual consumption of petroleum products.

As mentioned in Section 2.5.1, such a modest increase in the recovery factor for oil as 1 per cent from the oil fields in the Ekofisk area will result in an oil production which corresponds to one year's energy consumption in Norway. The licensees are presently in the process of preparing a pilot project, in which water will be pumped into the Ekofisk reservoir to check whether the recovery of oil may increase

further by the flushing of oil out of the rock. It is too early to say whether this will be successful, but it is possible that this method may increase the recovery considerably The Petroleum Directorate has worked actively to clarify the effect of both gas and water injection in the Ekofisk area (cf. Section 2.5).

It is not only the very exploitation method which influences the exploitation of the petroleum resources. Great energy quantities are also lost by the burning of gas on the different platforms. In 1979, a total of about 300 million Sm^3 of gas was burnt, and this amounts to somewhat less than 4 per cent of the total petroleum consumption in Norway. For safety reasons it will always be necessary to burn some gas. The Petroleum Directorate monitors closely the quantities of gas which are burnt and evaluates whether it is possible to reduce these quantities on the basis of the expicit position that burning of gas shall be minimized. (Cf. also Section 2.5.5).

2.10.2 Reserves

Major changes have not been made in the total estimates for probable recoverable reserves on the Norwegian Continental Shelf south of $62^{\circ}N$ since the last Annual Report, Figure 2 T. Measured in millions of tons of oil equivalents and rounded off to the nearest 100 million tons, the estimates as per 31 December 1979 are therefore as follows:

- proven reserves	1600
- undiscovered recoverable reserves	2500 - 3500

The estimate for proven recoverable reserves includes new fields in the blocks 34/10, 30/7 and 15/3. In connection with the 4th concession round, a substantial adjustment upwards of the proven reserves may be expected. It is anticipated that these blocks may contain between 1000 and 1500 million tons of oil equivalents, whereof some have already been proven in blocks as 30/6, 31/2 and 34/4. Because of

great uncertainty in the reserve estimates, and the possibility that some discoveries extend into areas which have not been licensed, these have not been included in the estimates of proven reserves for the time being.

The undiscovered recoverable reserves have been indicated with an upper and a lower limit. The large uncertainty associated with these figures is caused by, i.a. that a high percentage of the reserves is expected to be found in a limited number of larger structures. If one of these "larger" structures should turn out to contain no petroleum, or have a higher petroleum content than expected, this may distort the basis for the analysis which the estimates have been based on.

2.10.2.1 Fields decided to be developed

No new fields have been decided to be developed in the course of 1979. In total, 11 fields have been decided to be developed. Compared with last year's report, certain adjustments have been made in the reserves for some fields. This is basically caused by new evaluations based on an improved data basis. The changes are largest for the fields Albuskjell, Valhall A and Statfjord.

The reserves in Albuskjell have been reduced by about 20 per cent compared with earlier estimates. This is based on data from new production wells in the structure. There is still great uncertainty in relation to the reserves in the field, mostly because of the geological conditions. The field is still being evaluated by the Petroleum Directorate.

The numbers for Valhall A are based on a new evaluation of the available data basis, and represents an increase of 40-50 per cent compared with earlier estimates. The reserve potential is very uncertain and depends, to a high degree, on the geological model on which the calculations are based. The numbers refer to the first development phase - Valhall A - and the results of this development phase may form the basis

for possible later development of the rest of the field.

For Statfjord, the adjustment is caused by the change in the Norwegian share from 88.89 per cent to 84.09322 per cent. The reserve estimate for the whole field has been increased by the licensees to 571 million Sm^3, while the Petroleum Directorate's number is unchanged for the time being, cf. Section 2.8.2.

Except for the said fields, no major changes have been made in the table. In total, the changes made produce small variations as regards oil and a certain upwards adjustment of the gas reserves.

Table IV shows reserve estimates, accumulated production and remaining, recoverable reserves.

2.10.2.2 Fields not decided to be developed

In this group, the fields may be divided into three types:

- Fields which are being explored
- Economically marginal fields
- Smaller fields which cannot be exploited commercially at present.

All these fields, together with estimates for in place and recoverable reserves have been listed in Table V.

Compared with the last Annual Report, the 25/2-4 field has been removed from the column New Fields. 25/2-4, for which Elf Aquitaine is the operator, was not satisfactorily tested, but the Petroleum Directorate has made its own reserve estimate as listed in Table V based on the available data.

The column "New Fields" comprises the fields 15/3-1, 30/7-6, 34/10-Alfa and 34/10-Delta, and in the case of these fields, the Petroleum Directorate has so far only been able to prepare rough estimates based on partly incomplete data. These estima-

tes are provisionally regarded as being very uncertain and incomplete, an it has therefore been decided that the reserves should be given as a combined figure in this column. It appears from the table that these fields make up a substantial part of the total reserves in the fields not decided to be developed.

In the 15/3 block, where Elf Aquitaine is the operator, gas has been proven in Jurassic sandstone reservoirs. The deposit has provisionally been called 15/3-1. Norsk Hydro has proven gas in 30/7-6. It is possible that these two deposits may, between them, contain from 50 to 100 billion Sm^3 of recoverable gas, but to get a better reserve estimate, more exploration is necessary.

In block 34/10, hydrocarbons have been proven in two structures; 34/10-Alfa and 34/10-Delta, both in Jurassic sandstones. Both fields contain oil with dissolved gas. With the data presently available, it appears that these two discoveries contain a minimum of 100 million Sm^3 of recoverable oil. Several delineation wells will be drilled in 1980, and the operator, Statoil, is aiming at clarifying the commerciality of the field.

2.10.2.3 Discoveries in the 4th round blocks

In concessions allocated in the 4th concession round, hydrocarbons have been proven in blocks 30/6, 31/2 and 34/4. The deposits are in sandstone rocks of Jurassic and Triassic age.

For the discoveries in 30/6 and 34/4, there is at present insufficient information to evaluate whether the deposits are sufficiently large to be exploited. Further delineation drilling will be necessary before even this question may be answered.

The seismic material and the one well which has been drilled so far in block 31/2 shows that this is a deposit with substantial reserves. Everything indicates that the reservoir extends into the blocks 31/3, 31/5 and 31/6 with substantial reserves in these as well. All together, the deposit covers

an area of about 800 square kilometers. It is apparent that the rock properties over such a large area will vary considerably. This variation may only be surveyed by drilling. It is rather unlikely that the properties in well 31/2-1 will be representative for all parts of the reservoir. Well 31/2 showed a rich gas-zone over an oil-zone. The sand in the gas-zone appeared to be relatively pure, but in the oil-zone it appeared to be of poor quality. Even if the well has still not been tested, it seems clear that the gas is producible. The recoverable reserves will depend on the reservoir quality in the hole of the area mentioned and may not be accurately determined at this time. It is estimated, however, that this involves a relatively large part of the reserves expected to be found in the 4th round blocks, cf. Section 2.10.2.

Whether the oil is producible in well 31/2-1 is uncertain. Even if this should not be the case, it is highly probable that sand of good quality is present at the level where the oil is located in other parts of the reservoir. The oil-zone's richness, properties and producibility must be surveyed by future drilling. The extent of the deposit indicates that possible oil reserves in place may be large.

It will take time to evaluate the availability of the reserves in the 31/2-1 deposit. It is highly probable that possible oil reserves will only be available if they are produced before substantial gas production is started. The reason is that the oil will probably flow into the gas zone as the gas volume is being extracted. A large part of the oil reserves will thereby get fixed to the grains of sand in the gas-zone and will thereby be lost for exploitation purposes.

The discovery is also located at such deep water that thorough technical studies will be necessary to find the most practical development form.

The circumstances have the effect that both the point of time of and the extent of production from the area may not be estimated with accuracy before exploration and report work has progressed significantly further.

2.10.3 Perspective analyses

As the petroleum activity has grown, the need for more comprehensive and discriminating analyses of the effects of planned activities has been expressed. For a long period of time, prognoses have been prepared for the most decisive factors, namely production and revenue, cf. Section 2.11.

In the general planning, there is also a need to evaluate the effects on other central factors, such as drilling activity, investment figures, operating expenses, material quantities, labour, processing and transportation capacity and capacity utilization. These factors may be estimated with varying degrees of certainty. The estimates for fields which have already been developed and where there is operating experience and measured capacities may be made fairly reliable. On the other hand, the factors associated with prospects in undrilled areas will be relatively speculative. On the other hand, this is where the possibilities for influencing the exploitation are largest.

In 1979, the Petroleum Directorate has emphasized to facilitate the routines and information which are necessary to evaluate the different sizes for the fields of different categories.

The division of reserves has been classified as follows:

1. Reserves from fields in production
2. Reserves from fields in development
3. Reserves from fields where development is being planned
4. Reserves from fields where development is being considered (marginal)
5. Reserves from undrilled prospects in allocated blocks
6. Reserves from undrilled prospects in blocks which have not been allocated

In order to estimate the investment requirement associated with development of production facilities for the individual prospects, it has been necessary to establish definite development and landing patterns for the individual prospects or groups thereof.

When a development pattern has been established on the basis of technical and reservoir evaluations, an economic analysis is made of the relevant development pattern where the optimal development is being evaluated.

The optimal development patterns may then be combined in the time context to evaluate different total development strategies. A strategy may, for instance, be the establishment of a definite production level within a certain period of time followed by stable production, and it may then be evaluated which effects this will have in relation to investment requirements and employment.

The work on perspective analyses is naturally associated with a number of uncertainties, and this applies in particular to the estimates from undrilled prospects. Likewise, the cost estimates may be uncertain, and particularly for development at greater sea depths where it is difficult to establish cost data and available interrelationships and for development which belongs to a relatively distant future.

To obtain as good results as possible, it has been necessary in this period to systematize cost data for fields in development and operation and to follow up new technical solutions.

With the 4th concession round, substantial new reserves will be proven over a short period of time. In this situation, it is of the utmost importance to evaluate the extent of production and the development of the various discoveries correctly, if not necessarily accurately in all details. The system which the Petroleum Directorate has prepared for perspective analyses ensures that all substantial known circumstances are evaluated to the extent that this is possible in a systematic manner. This facilititates both more complex analyses and analyses of sectors of particular interest. Further work will be done on the development of these in 1980 and later.

2.11 PRODUCTION PROGNOSES

The Petroleum Directorate's prognoses for production of oil and gas forms the basis for calculation of the state revenue from the operations on the continental shelf. For this reason, the requirements concerning accuracy in the production prognoses are high. The Directorate has emphasized the be able to perform an individual evaluation of the production sequence for each individual field and of the behavoir of joint production and transportation facilities. This, together with the access to the evaluation of the licensees, has the effect that the prognoses may be made on the most realistic basis.

During the last couple of years, the Petroleum Directorate has been able to indicate the production with a relatively high degree of accuracy. The reason is, firstly, that several fields have entered a phase of stable production, so that the prognoses are not totally dependent on the occurances on one individual field or of the future or other uncertain factors associated with development and drilling. In addition, substantially better knowhow in the practical problems associated with the development of fields in the North Sea has been gained by both the licensees and the Directorate.

Figure 2 U shows how the Directorate's estimate for total petroleum production from the Norwegian Shelf has changed in the period 1974-79. The increase is close to constant, but the production curves have been moved still further back in time. The production behaviour of the individual fields have been relatively accurately prognosticated, while the time before production start-up has regularly been underestimated.

The accuracy of the short-term prognoses are moving closer to the border of that which may be obtained from a practical point of view. For instance, total production in 1979 was less than 3 per cent lower than estimated by the Directorate in June 1978 in a report to the National Budget for 1979. However, a caution should be expressed to the effect that the same degree of accuracy may not be expected in the future as well.

In the course of 1979, the Petroleum Directorate has developed calculation models in cooperation with Chr. Michelsen's Institute for analysis of the uncertainty associated with the production prognoses. This instrument may systematize the treatment of uncertainties related to the most important circumstances and calculate the effect of these on the individual final prognosis. Instead of providing a definite figure for the production in a given period, it will now also be possible to quantify the probability of definite variations from this figure. With such information, it will be possible to use so pessimistic, or optimistic, estimates as a basis for the production and revenue estimates from the continental shelf as predicated by the application of the estimates.

The Petroleum Directorate's prognoses for production of petroleum to year 2000 is shown in Figure 2 V. The prognosis for fields decided to be developed is to all intents and purposes identical with the prognoses in the 1978 Annual Report.

A substantial part of the recoverable reserves proven on the continental shelf is located in fields for which a development decision has still not been made. Some of these are smaller discoveries which will probably be developed in isolation or in connection with existing facilities.

Moreover, substantial discoveries have been made in the 4th concession round blocks in 1979, and at the same time, explorati drilling or delineation drilling has been planned in 1980 on promising prospects. These are still not sufficiently explored to be used as a basis for a discriminating evaluation of production sequence. The Petroleum Directorate is working on the study of alternative exploitation strategies for these, cf. 2.10.3.

In case of assisted exploitation (for instance injection of gas or water), further oil quantities may be produced. This applies in particular to the fields in the Ekofisk area, where the oil recovery factor will be low if the fields are produced

in accordance with the plans presently available in the future as well. Assisted production has so far increased the oil reserves by about 12 million tons. Assisted production from the Statfjord and Murchison will probably lead to an increase in the oil recovery factor from about 28 per cent to roughtly 50 per cent.

On this basis, assisted production which has been effected or planned accounts for more than 170 million Sm^3 of total recoverable reserves on the Norwegian Continental Shelf. The prognoses are based on the production plans available at the end of 1979. If new decisions are made concerning assisted production, this will lead to higher production than presently shown by the prognoses.

2.12 Relinquishment of licensed areas

As per 31 December, licensed areas have been relinquished on three occations in 1979.

The first was licence 010, block 25/12, where A/S Norske Shell is the operator. The relinquishment is voluntary, and the whole block has been relinquished.

The second was a compulsory relinquishment and related to licence 037, blocks 33/9 and 33/12, where Mobil is the operator. The allocation and the shape of the areas relinquished and retained was not totally in accordance with the rules, but the Petroleum Directorate's Board of Directors made use of the opportunity to grant a dispensation, and as per 31 December 1979, 291.677 sq.km. is licensed under licence 037 as against 586.834 sq.km. from before. The third relinquishment was voluntary and related to licence 022, block 3/5, where Norske Gulf Production Company A/S is the operator. In this case, as well, dispensation from the relinquishment rules was granted. The application covered voluntary relinquishment and differed from the rules since the relinquished area was not continuous, but divided in two parts of 157 sq. km. and 46 sq. km. respectively. The area retained is 100.729 sq. km.

In 1979, a further 1 block has been totally relinquished from among the blocks allocated in 1965. This relates to block 25/12. 52 of the blocks allocated in 1965 have now been totally relinquished. This relates to the blocks 2/2, 3/1, 3/2, 3/3, 6/3, 7/1, 7/2, 7/4, 7/6, 7/8, 7/9, 8/1, 8/2, 8/3, 8/4, 8/5, 8/6, 8/7, 8/9, 8/12, 9/4, 9/7, 9/8, 9/9, 9/10, 9/11, 9/12, 10/5, 10/7, 10/8, 10/9, 10/10, 10/11, 10/12, 11/7, 11/8, 11/9, 11/10, 16/2, 16/3, 16/5, 16/7, 16/9, 16/12, 17/4, 17/8, 17/9, 17/10, 17/11, 18/7, 18/11, 25/12.

In total, there are licenced areas as per 31 December 1979 as specified in Table VI, divided on production licences as specified in Table VII.

2.13 Allocation of new concessions

8 new production licences were allocated in 1979.

Production Licence 051.
By Royal Decree of 6 April 1979, Production Licence 051, covering block 30/2, was allocated to the following companies:

Statoil 50 % (Operator)
Union Oil Norge A/S 25 % (Technical Assistant)
Tenneco Oil Company Norsk A/S 25 %

Production Licence 052.
By Royal Decree of 6 April 1979, Production Licence 052, covering block 30/3, was allocated to the following companies:

Statoil 50 % (Operator)
Union Oil Norge A/S 30 % (Technical Assistant)
Norsk Hydro Produksjon A/S 10%
Petrocanada Norway A/S 5 %
Deminex Norge A/S 5 %

Production Licence 053.
By Royal Decree of 6 April 1979, Production Licence 053, covering block 30/6, was allocated to the following companies:

Statoil 50 % (Operator)
Elf Aquitaine Norge A/S 13.33 % (Technical Assistant)

Total Marine Norsk A/S 6.67 %
Norsk Hydro Produksjon A/S 12.5 %
Mobil Expl. Norway Inc. 10%

Production Licence 054.
By Royal Decree of 6 April 1979, Production Licence 054, covering block 31/2, was allocated to the following companies:

Statoil 50 %
Norske Shell A/S 35 % (Operator)
Norske Conoco A/S 5 %
Superior Oil Norge A/S 5 %
Norsk Hydro Production A/S 5 %

Production Licence 055.
By Royal Decree of 6 April 1979, Production Licence 55, covering block 31/4, was allocated to the following companies:

Statoil 50 %
Norsk Hydro Produksjon A/S 15 % (Operator)
Esso Exploration and Production Norway A/S 20 % (Technical Assistant)
Arco Norge A/S 10 %
BP Petroleum Development of Norway A/S 5 %

Production Licence 056.
By Royal Decree of 6 April 1979, Production Licence 056, covering block 34/2, was allocated to the following companies:

Statoil 50 %
Amoco Norway Oil Corp. A/S 25 % (Operator)
Phillips Petroleum Co. Norway A/S 5.80 %
Norsk Agip A/S 3.35 %
Norske Fina A/S 3.35 %
Mobil Development of Norway A/S 12.5 %

Production Licence 057.
By Royal Decree of 6 April 1979, Production Licence 057, covering block 34/4, was allocated to the following companies:

Statoil 50 %
Saga Petroleum A/S 15 % (Operator)
Amoco Norway Oil Co. A/S 10 % (Technical Assistant)
Amerada Petroleum Corp. Norway A/S 5 %

Texas Eastern Norway Inc. 5 %
Deminex Norge A/S 15 %

Production Licence 058.
By Royal Decree of 6 April 1979, Production Licence 058, covering block 35/8, was allocated to the following companies:

Statoil 50 %
Norske Gulf Production Co. A/S 30 %
Norske Getty Exploration A/S 20 %

The participation interests provided above may be changed in accordance with a sliding scale which applies to each of the blocks, and which regulates Statoil's participation interest. Statoil's share may reach 80 % for block 30/6, 70 % for block 35/8 and 75 % for the rest of the 8 blocks. Statoil's equity interest will depend on the top production level from the block.

2.14 Assignment of shares

During 1979, the following assignment of a share has been approved pursuant to § 48 of the Royal Decree of 8 December 1972.

Production Licence 008.
Norsk Hydro Produksjon A/S has sold 50 % of its share in 008. After this, the distribution in licence 008 is as follows:

Elf Aquitaine Norge A/S	32.376 %
Norsk Hydro Produksjon A/S	13.400 %
Cofranord A/S	1.216 %
Eurafrep Norge A/S	1.824 %
Coparex Norge A/S	1.596 %
Total Marine Norsk A/S	16.188 %
Phillips Petroleum Comp. Norway	14.780 %
Norsk Agip A/S	5.220 %
The Austrian State Oil Company (ØMV)	11.400 %
Statoil	2.000 %
	100.000 %

3. SCIENTIFIC EXPLORATION AND RELEASE OF DATA

3.1 SCIENTIFIC EXPLORATION

As per 31 December 1979, a total of 116 licences for scientific research on the Norwegian Continental Shelf have been granted. As its appears from Table VIII, 13 such licences were granted for 1979. The number was 18 in 1978 and 7 in 1977.

In this main, this relates to geophysical and geological surveys, and some biological surveys.

As regards geography, the surveys are distributed over the whole Norwegian Continental Shelf.

Some surveys relate to deep seismic measurements of the same type as in the commercial exploration. The Directorate has worked on drawing the line between scientific and commercial exploration. The most important difference is that data from scientific surveys are publicly available and that the results shall be published.

In 1979, the Petroleum Directorate has started to use a new form for the licence. The most important difference compared with earlier forms is that the duty to publish the data is tightened up.

3.2 RELEASE OF DATA

The Petroleum Directorate may release geological material and uninterpreted data from the continental shelf when they have become older than 5 years. The Directorate does not release the interpretations of the oil companies.

A summary of the wells which have been completed five years in advance is issued each year. This publication, "Well data summary sheet", gives information about each individual well in the form of a rough geological summary, tables showing the logs which have been run, possible test results, etc.

Uninterpreted logs are free when the well has been presented in the "Well data summary sheets".

A more detailed geological description in presented in the series "NPD Papers" which shows a detailed lithologic/ stratigraphic log, geological interpretations and a summary of the geological material which is available. At the end of 1979, 33 wells have been published in 24 folders.

In most of these, the wells are presented individually in each folder.

With this publication form, it has turned out to be difficult to keep up with the wells which satisfy the requirements for release. To get up-to-date, the future publications will present several wells in each folder in accordance with regional priorities.

Geological material can only be released when the well has been presented in "NPD Papers".

Seismic data has previously been released and sold in the form of simple, seismic lines. For practical purposes, larger packages have now been made of lines which have been specially selected. This is seismic which has been shot in the years 1963-1974 in blocks which have now (with one exception) been surrendered. Each package provides a relatively good coverage of one concession block.

The data is preferably sold in whole packages, but it is also possible to purchase individual lines. The price is the copying expenses plus a reasonable addition for administration and postage.

Up to now, 17 packages have been made, spread over the shelf south of 59°N, Figure 3 A. They cover the following blocks: 2/2, 3/1, 3/2, 7/8, 7/9, 7/11, 8/5, 8/6, 8/12, 9/4, 9/10, 10/7, 16/2, 16/5, 16/12, 17/11 and 18/11.

3.2 SUPPORT TO RESEARCH PROJECTS

Partly on the initiative of the research institutions, and partly on the Petroleum Directorate's initiative, surveys are made by geological and geophycial research institutions with economic support from the Petroleum Directorate.

In 1979, Nkr. 2 million (Nkr. 1,982,000) was allocated to such projects.

The surveys are clearly related to the work tasks which have been assigned to the Petroleum Directorate and they represent an integral part of the petroleum-directed exploration on the continental shelf. In most cases, the tasks are so specified and detailed that the Petroleum Directorate is unable to direct the surveys by itself.

In 1979, work was done on 23 research projects with economic assistance from the Petroleum Directorate:

- Sedimentary studies of Mesozoic rocks in the North Sea and Great Britain, Geological Institute, Dept. A, Bergen University.

- Regional Permian - Triassic project, Geological Institute, Dept. A, Bergen University

- Petroleum-related exploration of sedimentary rocks along the Hornsund-Sørkapp Height, Svalbard,
  The Geological Institute, Dept. A, Bergen University

- Sedimentary studies of Carboniferous and Jurassic deposits at Andøya,
  Geological Institute, Dept. A, Bergen University.

- Marine geological surveys on the continental shelf,
  Geological Institute, Dept. B, Bergen University.

- Comparison of the sedimentation environment in a fjord (Sognefjorden) and on the adjacent continental shelf,

Geological Institute, Dept. B, Bergen University.

- Surveys in connection with the earthquake activity at Meløy,
  Earthquake Station, Bergen University.

- Geophysical surveys in the areas Helgeland-Vøring Plateau, Lofoten-Vesterålen,
  Earthquake Station, Bergen University.

- Geophysical and geological surveys on the Yermak plateau, north-west of Svalbard,
  Earthquake Station, Bergen University.

- Sedimentary studies of Mesozoic rocks from the Norwegian Danish Basin, the North Sea,
  Institute for Geology, Oslo University

- The North Sea and Tertiary deposits on the Norwegian Continental Shelf Margin,
  Institute for Geology, Oslo Unversity

- Marine-geophysical research 1979,
  Institute for Geology, Oslo University.

- Palynological surveys from the North Sea, Norskehavet, the Barents Sea and the Svalbard area,
  Institute for Geology, Oslo University.

- Palaeontological and sedimentary surveys in the Jurassic series in North-East England,
  Institute for Geology, Oslo University.

- Tertiary (Eocene - Pliocene) sediments' textural, lithological and geochemical compositions,
  Institute for geology, Oslo University.

- Seismic speed measurements on Svalbard,
  Institute for Geology, Oslo University.

- Integrated analysis of the break-tectonic on the Norwegian territory (including Svalbard) and adjacent shelf areas, Institute for Geology, Oslo University.

- Studies of diagenesis in post-Caledonian rocks at Svalbard, Norwegian Polar Institute.

- Studies of the extent of Pleistocene ice-caps in the Barents Sea,
  Norwegian Polar Institute.

- Processing of magnetic data from the shelf area around Spitsbergen and Bjørnøya,
  Norwegian Polar Institute.

- The North Sea Continents landscape history in late Quaternary times (about 15,000 - 70,000 BP),
  Archeological Museum, Stavanger.

- Organic - geochemical surveys of Mesozoic shale rocks from Svalbard,
  Institute for Continental Shelf Surveys.

- Stability surveys on the continental shelf slope,
  Institute for Continental Shelf Surveys in cooperation with Bergen University and the Norwegian Geotechnical Institute.

4. SAFETY CONTROL

4.1 EVALUATION OF PLATFORM CONCEPTS

The Petroleum Directorate does not approve a platform until the installation has been completed and the use in the intended service is about to start.

In practice, however, special approvals are given at certain stages during the planning and fabrication of a platform. This is done to avoid situations where large and costly changes must be made at a late point of time in the planning and construction phase.

The first such approval which the Petroleum Directorate issues covers the platform concept. In the evaluation which the approval is based on, the Directorate makes an effort to evaluate whether it will be possible, based on the proposed concept, to design and build a platform with an acceptable safety level for people, environment and material values.

The Petroleum Directorate's evaluation at this stage in the control work is in particular covering the following aspects of the platform:

- the main design of the load-bearing constructions
- the reciprocal location of the individual primary functions and service functions
- special protection in case of major accidents
- location and protection of the main escape ways
- design and efficiency of the evacuation systems

Most of the evaluations are tied to the risk on the platform in connection with major accidents, such as uncontrolled blow-outs, fires, explosion, etc.

The risk associated with a specific accident depends on both the probability of an accident occurring and the consequences of the accident.

The probability level may largely be reduced below a acceptable limit with an adequate design of the different components and systems on a platform. In the selection of the platform concept, emphasis should be given to reducing the consequences of major accidents.

The Petroleum Directorate's evaluation of platform concepts mainly consists in an evaluation of whether the consequences to people and environment of major accidents will be under certain limits.

4.2 PRODUCTION SYSTEMS AND AUXILIARY SYSTEMS

On the basis of "Regulations for production systems and auxiliary systems on production facilities, etc.", issued on 3 April 1978, the Petroleum Directorate's control has been performed in the design phase, fabrication phase and the operative phase. The operative control has been performed by the Directorate's own inspectors, while some assistance from consultants has been used in the fabrication and installation control. In addition to Det norske Veritas, this has been the Norwegian Waterfalls and Electricity Administration and the Norwegian Technical University.

In addition to the true control, the work has consisted in advise and information, participation in research projects, training of own employees and preparation of internal work routines.

In 1979, the regulations have been revised, and a draft of the new regulations was submitted for comments in November, 1979. The revision takes into account the experiences made by the Petroleum Directorate since the regulations were prepared in 1977, and an effort has been made to harmonize them with the guidelines for the licensees own control. The demands will thus, to the extent possible, be formulated as functional requirements and will thus provide greater flexibility in the design concept and detailed systems. Technical solutions are also indicated to achieve the desired safety

level. It is expected that the regulations, in a revised edition, will be stipulated in March, 1980.

4.2.1 Electrical installations

The basis for the control work has been various foreign standards and regulations, and this has made the task of our inspectors very demanding.

A number of inspections of the operations at Ekofisk has been performed. The control work has taken most time in the case of Frigg and Statfjord, since the electrical facilities on Frigg and Statfjord "A" were started up in 1979. From an overall point of view, there has been a significant increase in the inspection of operations compared with 1978.

4.2.2 Safety systems

The control comprises the systems for active and passive fire protection, detection systems, process safety and emergency shut-down systems. The control in the construction phase has mainly been performed by our own personnel, while consultants within the different professional fields have been used for the design stage. The interrelationship between the various safety systems can only be verified when the facility has been completed. For this reason, the main body of the work has been the control of the finished facilities, as well as the maintenance and inspection routines for these.

4.2.3 Mechanical equipment

The control of mechanical production equipment in the design and construction phase has in the main been performed in cooperation with a consultant, Det norske Veritas. In the operations phase, however, the control is based on our own personnel.

A substantial amount of work has been done in the follow-up and control of specifications and quality assurance plans.

As concerns maintenance and inspection systems for mechanical equipment, these have been subject of constant development. As the fields enter the operating phase, an increasing effort will be required to follow up in this area.

The work which was started in 1978 to establish criteria for the control activity within control of well equipment and under-water completion, was carried further in 1979.

4.2.4 Problems in connection with freezing of equipment

In the very cold periods in the winter of 1979, we witnessed freezing of equipment on the production platforms in the North Sea, to some extent serious freezing. The equipment generating the largest problems was the fresh water supply, the firewater systems, instrumentation, pumps, and alike. These problems were experienced on all fields in the Norwegian part of the North Sea, but not all the fields where hit to the same degree.

The problems which were experienced show that serious problems may arise during very cold periods in the North Sea. From before, this had not been taken into account to the necessary extent in the construction of this equipment.

The licensees have therefore been required to initiate measures to avoid a repetition of the problems which were experienced.

4.3 DRILLING

4.3.1 Exploration drilling

27 licences for exploration and delineation drilling were issued in 1979. At the turn of the year 1979/80, 11 exploration wells were in progress.

Also in 1979 it has been possible to register an increasing tendency to drill deeper wells and particularly at greater depths. A new depth record was set by BP's well 30/4-1 which reached a total depth of 5430 m below the sea surface. In addition, a new record as regards water depth was reached by Amoco's well 34/2-1 which was drilled on 389 m water depth.

Within exploration drilling, several "kicks" have been experienced, meaning an unintentional flow of formation fluid/gas into the well. These have been detected relatively quickly, however, and have been controlled in the normal manner with the help of the safety equipment.

In October/November, the weather was difficult with strong winds and large wave heights. This resulted in suspension of drilling operations, since the rigs experiences too much heave. Many rigs also had to disconnect from the well since they had problems keeping stationary. Disconnecting and connecting up again are, however, routine operationsand were effected without difficulties.

The Petroleum Directorate has routinely worked with the registration and processing of well data when drilling since 1976. These data are included as an important part of the geological safety control exercised by the Petroleum Directorate in connection with drilling on the Norwegian Shelf. The highest variations from normal pressure have been registered in rocks of Jurassic age. In general, it may be said that the highest pressures occur in the deepest basins (the Viking, East-Shetland and Central basins) and the areas in communication with these.

The quantity of data available is relatively limited, and there is therefore a need to broaden the information with data from wells on the British side. In this connection, the Petroleum Directorate is in the process of establishing cooperation with the Department of Energy for the exchange of safety related data.

4.3.2 Production drilling

Since 1979, the activity on the fixed platforms has been at a high level, with 8-10 drilling rigs in operation. The highest level of activity has been registered in the Ekofisk area, where there are several heavier maintenance jobs on production wells in addition to normal production drilling. The drilling of additional wells has also gone on at Ekofisk A and B. The maintenance of older wells in the Ekofisk area has increased considerably and will increase as more wells have been in production for a while.

The follow-up of such maintenance work has been an important part of the control work within drilling, particularly since such work often involves unforseen difficulties during the work itself, so that the work program must be revised. The reason for much of this maintenance has been leaks in seals, buckled production pipe, lost equipment, etc.

Guidelines for simultaneous drilling and production at Ekofisk have also been prepared, so that drilling and production has gone on simultaneously on most platforms in The Ekofisk area.

In the report period, drilling was started on two new platforms in the Ekofisk area, Edda 2/7-C and Eldfisk 2/7-B.

On Frigg, the drilling was finished on 18 September 1979. There are 23 producing wells on DP-2, while one well is used for pressure registration. The two last wells were completed in a different manner than the others to gain experience with other equipment and other methods with a view to exploitation of other, adjacent fields.

On Statfjord A, the first four wells in the southern shaft have been drilled and completed for production. The drilling rig was afterwards moved to the northern shaft where drilling started on 3 December.

In connection with the development of new fields and the further

development of fields, the Petroleum Directorate has done much work on improvement of equipment and working conditions in connection with the drilling activity. Great emphasis has been given to a better and safer working environment, at the same time that control and evaluation of new equipment has been intensified.

Up to now, the regulations for exploration drilling from 1975 have been used for production drilling.

The need for separate regulations for production drilling has been felt, and in the report period, new draft regulations have been prepared.

4.4 Diving

The diving activity on the Norwegian Continental Shelf has been highest in the months April/August.

In this period of time, about 570 divers have been working, whereof about 140 Norwegian divers. On an annual basis, about 200 surface oriented dives have been performed, meaning dives from the surface without the use of a diving bell. The number of hours in saturation has been about 180,000.

There has been no fatal accident in connection with diving operations on the Norwegian Continental Shelf in 1979.

The Petroleum Directorate has inspected all diving systems which have been used on the Norwegian Continental Shelf in 1979. This has resulted in an increase in the standard of the equipment. A further task is to make efforts to have the diving systems more standardized in general. As a step in this work, we will require, starting with 1980, that all gas containers and distribution systems for diving gas shall be marked in accordance with international standards for gas to medical uses.

A group with representatives for the authorities, the employers

and the trade unions has prepared a proposal for working time provisions for divers.

Diving operations in the North Sea are performed from barges, skips, movable drilling rigs and fixed installations. In order to try to arrive at unified provisions about working time and the lenght of the rest period, regardless of the type of installation or ship where the activity is carried on, and to adjust the set of rules to the special working situation of the divers, the work of the group has taken longer time than expected. Differing views within the group have had the result that the recommendation was presented with 3 minority statements.

The recommendation has been submitted to the Ministry of Local Government and Labour which has sent it for comments by the involved institutions and companies. At the turn of the year, the comments were evaluated by the Ministry.

For a long time, there has been a need for control that the divers working in the North Sea are sufficiently competent.

In the autumn of 1979, the first Norwegian education offer for deep-water divers was started at the Norwegian Underwater Institute under state direction.

The Petroleum Directorate is of the opinion that this will be the right time to start the issuing of diving certificates to those who have passed this education. We will also evaluate the diving education in other countries which may, in case, be approved as an adequate diving background for issuance of the certificate.

From January 1980, the Petroleum Directorate will start to issue certificates. It is anticipated that a provision that divers working on the Norwegian Shelf must have the certificate will enter into force on 1 July 1980.

To cover the future demand for divers, certificates will as a transitional arrangement be issued to divers with practical

diving experience. It is nevertheless important that an educational offer for those already working on the job be extended to divers which do not have the necessary theoretical education.

As concerns research in connection with the underwater activities, projects of great importance to the safety of the divers have been started, i.a. at the Norwegian Underwater Institute.

Delays at the NUI has had the effect that the completion of the projects may be delayed.

A coordination of the reseach activities in connection with the diving operations has been started between the Department of Energy, the Association of Offshore Diving Contractors and the operators' associations.

The Petroleum Directorate has noted that there is a tendency that the operators do not wish to have diving systems onboard the rigs, particularly in connection with exploration drilling. In the cases where there is a need for diving services, a diving ship in a short-time engagement is used instead. We have also noted that an increase in the use of manned subsea vessels may be expected where the operator/diver remains under atmospheric pressure, and also in the use of unmanned, remote controlled vessels. The operations in still deeper waters will probably accelerate a further development of such systems. Economic and safety reasons are strongly in favour of this, but such systems may never fully replace the diver.

4.5 PIPELINES

All pipeline on the Ekofisk field have now been put in service.

The pipeline from Statfjord A to the loading buoy was put in service in November, 1979.

The Frigg pipeline to Scotland has been out of service for some time this autumn because of a damaged, so-called "pig trap"

The work of covering the 915 mm pipeline from Ekofisk to Emden in the Danish Section was completed on 15 September 1979. The total cost of the work has been Nkr. 0.5 billion, and 38 km have been covered. The Ekofisk pipelines to Teesside and Emden have also been shut some days in October 1979 for the installation of an anchoring arrangement for the Emden pipeline.

Two 550 mm pipelines from Valhall to Ekofisk are scheduled to be installed in the summer of 1980. Each of them will be 34 km long.

The total length of all pipelines in service is 1350 km.

Pipeline regulations are being prepared and are expected to be finished in the summer of 1980.

4.6 CLEANING THE SEABED

The work of surveying and cleaning around abandoned drilling locations has continued in 1979 and has now been almost completed. The cleaning of new drilling locations is now done routinely.

The cleaning which has been effected seems to have been satisfactory and the revised procedures for abandoning wells should ensure that the seabed around the well is clean when it is abandoned.

The fishermen's applications for damages also show that the cleaning effected has removed the obstacles at the very drilling locations. There are now only a few applications for damages which may be related to the well locations. The number of applications for damages has nevertheless increased considerably, and the Petroleum Directorate has prepared, in cooperation with the Fisheries Directorate, a proposal for a pilot project for cleaning outside of the well locations. It is proposed that this pilot project shall be initiated in about April/May 1980.

4.7 REGULATIONS

The Petroleum Directorate shall, pursuant to delegation-decisions coordinate the practical implementation of the control activity which is carried out by the cooperating public control instiututions in connection with fixed installations on the Norwegian Continental Shelf.

The Directorate has considered it to be an advantage to collect the regulations applicable to these facilities. The set is now consisting of three parts. Part I and Part II include the regulations issued by the Petroleum Directorate. Part II covers regulations issued by the other public control institutions. It is possible to subscribe to the set of regulations.

In the course of 1979, the Petroleum Directorate has stipulated the following regulations and guidelines:

Regulations concerning access ways, staircases, ladders and guard rails on production facilities, etc.

Temporary provisions for living quarters on production facilities, etc.

Regulations for the transfer of personnel to and from production facilities, etc.

Guidelines for the licensees' own control.

Regulations concerning collection of fees by the Government for inspection and control of temporary and permanent facilities.

4.8 GUIDELINES FOR QUALIFICATIONS

With authority in Royal Decree of 9 July 1976, authority has been delegated to the Petroleum Directorate to stipulate qualification requirements for personnel working on fixed installations on the continental shelf. Even small errors

committed by this personnel because of lack of knowledge of the work may have disastrous results. It is therefore important that a high safety and professional standard hs established for the personnel, and the requirement that the personnel has sufficient qualifications for the work they are doing is a natural consequence.

As concerns the theoretical educational capacity, this has unfortunately been insufficiently developed to cover the need on the basis of the drilling activity presently going on. This has had the effect that a significant number of persons are presently working with dispensation from the applicable qualification requirements to drilling personnel.

"The Leiro Committee II" which evaluates the educational requirements for the personnel which shall serve on the production facilities in the North Sea has submitted the part reports covering:

- Safety training
- Safety personnel training
- Operating personnel training
- Production drilling personnel training

The Petroleum Directorate has informed the operator companies that the proposed qualification standards in the part-recommendation about safety training are satisfactory.

In the near future, the Directorate will deal with the part-recommendations concerning training of safety personnel and operating personnel.

As concerns the recommendation concerning production drilling personnel, this will be considered with a view to indicate the qualification requirements.

It is anticipated that the requirements will be coordinated with those applicable on fixed platforms.

4.9 SUBSTANCES WITH HEALTH HAZARDS

The Working Environment Act lays the basis for an improvement of the environmental standard at the place of work. It has been established in the act how the work of improving the environment shall be done and the requirements which the working environment must satisfy.

The enterprise itself shall uncover and solve its environmental problems, and the individual employer has primary responsibility to see that the act is complied with.

It is hardly possible to specify the individual working environment requirements in detail in an act. The act must by necessity contain certain criteria referring to discretion. However, it makes reference to the working environment factors which the enterprise must take into consideration. These working environment factors must be evaluated both individually and collectively with a view to possible influence on the physical and psychological health and welfare of the empoyees.

Some of the working environment factors are regulated in regulations established by the Petroleum Directorate. In addition, the inspectors of the Petroleum Directorate supervise that the working conditions on the offshore installations are within acceptable standards by regular inspections.

From a principal point of view, a distinction may be made between the "inner environment", the place of work, and the "outer environment", the surroundings where the free time is spent, that is to say the conditions outside of the enterprise. The very "outer environment" is in many ways associated with the working environment, for instance in case of pollution of the air with dust, gas or vapours.

The required securing of a long number of work places by the help of suction facilities is not, unfortunately, authomaticly combined with a demand for cleaning of the "out-air" before it is let out. Thereby, the experience may be that a required securing of the place of work may lead to

increased pollution of the "outer environment". It is important to be aware of the unfortunate consequences which this may have for the offshore installations where the outer and inner environment make up an integrated unit.

4.10 WORKER PROTECTION AND WORKING ENVIRONMENT

The most important event in this area in 1979 was the introduction of the new regulations concerning worker protection and working environment, etc. in connection with the exploration for and exploitation of submarine petroleum resources. These regulations entered into force on 1 June 1979 and were relatively quickly absorbed by the trade by way of meetings and information in writing.

After the hearing round, and the content of the proposal which was accepted, it may be said that the final proposal appeared as a compromise where all parties had been heard to some extent.

The most important change from yearlier regulations was a more simple language, a more systematic structure, and finally that a number of contested questions had found a solution. It may also be pointed out that a section has been added which clearly establishes the right to union activities in accordance with normal Norwegian conditions, so that this problem should be clarified.

The lenght of the shift periods, which was an area of major contention during the work with the regulations, seems to have been accepted by both parties in the employment sector after having been tightened up somewhat. Also after the regulations entered into force, some questions of interpretation have occurred. These questions have usually been tied to the interpretation of the working environment act itself.

Also in 1979, a number of inspections have been made. All the relevant installations have been covered a number of times. It may be established that fewer violations have been uncovered. This is probably related to the fact that the understanding

of the set of rules has improved and that the possibilities of becoming subject of control have increased.

In terms of information, this year as well has been active. The officers of the Petroleum Directorate have assisted as speakers at a number of courses and conferences, and this has also taken place under the Directorate's own direction. There has also been frequent meeting activity as well as contact with representatives of the different trades, both in writing and by way of telephone.

In terms of conflicts, it may be said that 1979 has been a quiet year, even if two events stand out.

The first occurred in the beginning of the year at the Ekofisk field. A work stoppage had the effect that Phillips Petroleum Company Norway's safety guard demanded the production shut in for safety reasons. After an evaluation, the Petroleum Directorate found that the work could continue until representatives from the Petroleum Directorate had arrived to take a decision on the situation. When this took place, however, the strike was over. The Petroleum Directorate's decision was appealled by the Ekofisk Committee to the Ministry of Petroleum and Energy.

The last occurred in the second half of the year on the Statfjord field. In this case, the justification was that the safety guards in Mobil Exploration Norway Inc. laid down their assignments in connection with disagreement with the enterprise covering both safety and trade union aspects. The Directorate found that the work on the platform was of such a nature that it could continue, and determined that the safety guards had no right to lay down the work. The Statfjord Workers Union disagreed in this and reported Mobil Exploration Norway Inc. and the Petroleum Directorate to the police for violation of the Working Environment Act.

As concerns the number of employees covered by the Petroleum Directorate's jurisdiction in 1979, this is higher than anticipated. At the start of the year, the number was about

8,600, and at the end of the year about 7,500. It is emphasized that this applies to fixed installations.

4.11 THE SAFETY SERVICE

The total protective work in the continental shelf may be divided into 3 functional areas:

- Safety of personnel and working environment
- Safety of equipment
- Outer environment

Even if these are associated to some extent, it is the general view that the companies which presently have operator status wish to look at the function areas independently.

The safety service (the area of work of the safety department) has so far emphasized the safety of equipment - technical safety and quality control.

The installations on the shelf have much equipment and many activities compressed on a small area. These activities are of 24-hours a day nature, on units located far offshore in a hostile environment.

The basic element in the safety chain is the individual person in his own working situation and environment. If he is satisfied with and adjusted to:

- the shift system
- the organization
- the living quarters and the recreation
- the onshore rest periods
- the work assignments

and if he also has the ability to see and think ahead to envisage possible dangerous situations and facilitate the work of avoiding these, a substantial part of the work of the safety service would be redundant.

This relates to attitudes, reflection, matureness, level of knowledge, experience and ability to act in stress situations as concerns each individual working on the installations.

4.11.1 The safety personnel

Relevant personnel categories whithin a shelf-based organization whose task is safety of personnel, protection and environmental questions, may be:

- the safety supervisor
- the safety inspectors
- the safety roustabouts
- the health personnel

In addition, there are the elected representatives in protection and environmental questions:

- the safety representatives
- the main safety representatives

The organization of safety personnel varies according to the installation type, the development phase, etc.

Likewise, it varies with the type of company, meaning operator company, construction contractor, drilling contractor, etc.

The interrelationship between the management and the safety service is shown schematically in Figure 4 A. Two factors should be made clear in this connection:

1. The safety and environmental matters shall be dealt with in the line organization and efforts to solve them should be made as close to the source as possible.

2. Pursuant to § 30.3 of the Working Environment Act, the safety and health personnel shall have a free and independent position in working environment questions.

4.11.2 The responsibility, authority and function of the safety service

The responsibility, authority and function of the safety service is largely appearing from the Working Environment Act. The responsibility is frequently formulated in instructions and description of positions.

A joint feature is, however, that the safety service within the companies is often based on control of the technical systems. An element within the safety work which is lacking is the cooperation between the safety service of the company and the safety guard system. This has had the result that the safety guards are frequently using the direct reporting line to the Petroleum Directorate instead of solving the matter as close to the problem as possible.

4.12 FIRE DAMAGE

Fires which the Petroleum Directorate has received reports about pursuant to the provisions of the National Prosecuting Officer have been referred in Table IX. The reporting practice which has been implemented is so comprehensive that it shall include practically all fires and near fires.

In 1979, the Petroleum Directorate has registered 36 fires (against a total of 43 in 1978) on fixed installations. Only one case lead to injury to persons, in that a man received injuries in his face when the fire was put out.

4.13 REGISTRATION OF INJURIES

All personal injuries shall be reported in writing to the Petroleum Directorate. In case of serious occupational injuries and fatalities, the Petroleum Directorate and the Stavanger Police Station shall be informed at once by telephone. Representatives of both authorities investigate the accident.

4.13.1 Occupational accidents

Tables X and XI provides a review of the occupational accidents which have been reported to the Petroleum Directorate for the years 1976-79, and which have lead to absence or have resulted in fatalities. No account has been taken of the lenght of the absence, and the review does not provide a basis for direct comparison with statistics from other activities.

As concernes the back accidents reported, several of these will normally not be accepted as occupational injuries under the National Insurance Act.

The numbers for 1976-78 are corrected numbers, and the Petroleum Directorate is therefore withdrawing the reviews which have been published in the reports for these periods. The reviews comprise occupational accidents on fixed facilities on the Norwegian Continental Shelf, as well as the pump platforms connected with the pipelines to Teesside (Great Britain) and Emden (West Germany). The basis for the review is the occupational injury reports which the employer is obliged to submit to the Petroleum Directorate. Occupational injuries should be taken to mean accidents or sickness caused during work at the work place during working hours. All employees and nationalities and all activity phases within the activities on the facilities mentioned above have been included in the report basis.

4.13.2 Fatal accidents

No accidents with fatal results have occurred on the fixed facilities in 1979.

4.13.3 Occupational accidents in general

In connection with the review for 1978, about 23 million working hours was used as a basis. In the course of 1979,

the Petroleum Directorate has received several indications that this figure cannot be correct, also from a group of scientists who have performed a risk analysis for the activities on the shelf. The group has made a comment to this fact in its report and has been unable to find a satisfactory explanation for the increase from 1978 to 1979.

Further investigations have proven that the estimates from one of the oilfields have been too high. The corrected figures are shown in Tables X, XI and XII.

The injury factor for 1979 is below the average for the period 1976-79.

Reference is otherwise made to the subject paper in Chapter 10.3 about occupational accidents.

Four reasons for injuries are predominant in the review: hand-tools, persons falling to a lower level, persons falling at the same level and persons being stepped on, impact from or against an object which the injured person did not handle, including squeeze injuries.

The most exposed parts of the body are: hand/finger, foot/leg and the back.

The injury factor for the last 3 years appears to have stabilized. It still appears, however, as if the follow-up at the place of work, particularly in relation to new employees with little experience in the work operations which they have been assigned to, is not good enough.

General training and more frequent control that the work is carried out in a sound manner and that the right tools and safety equipment are used must be better implemented.

In the report period, the Petroleum Directorate has, i.a., prepared a data program for registration of injuries. By processing injures with the help of data, it is possible to analyse the information received in a better and more

efficient manner in relation to injury distribution, etc. to be able to arrive at measures to prevent injuries in a better manner.

The Petroleum Directorate will intensify the work with measures to prevent injuries in cooperation with all parties involved.

5. CONTROL OF THE QUANTITIES OF HYDROCARBONS PRODUCED

5.1 TECHNICAL CONTROL OF THE MEASUREMENTS

Control of the produced quantities of oil and gas is performed both on the measurement before landing and on the measurements which are made on the processed products sold from the onshore terminals. The former measurements are made to calculate royalty and to calculate the contribution of the individual field. Measurement of processed products relates to sales where the Petroleum Directorate has been directed to perform the control in connection with the determination of the income of the companies. The control comprises all stages in the development of a field, meaning control of the structure of the measurement systems in the planning and fabrication stage, control of testing of the systems before they are put in service and control in the operative phase.

The control in the operative phase represents a heavy burden on the resources. This is not only caused by the extent and complexity of the measurement systems, but also the fact that the control must encompass the routines for operation and maintenance of the equipment, as well as further processing of data. Another factor which makes it necessary to use large resources on control in the operative phase is that the companies are almost at all times struggling with one or more technical problems in connection with the measurement systems which are in service. The work of solving

these problems, as well as the evaluation of the improvised systems which are used before a solution is found, will frequently require a high degree of follow-up on the part of the Petroleum Directorate.

A short description of the activity which has been carried out in 1979 in connection with the different measurement stations in service or under planning is given below.

The measurement systems on the fields in the Ekofisk area, as well as at the terminals in Tesside and Emden

The control out at the field has, since January 1979, been performed by the Petroleum Directorate's own inspectors. The Petroleum Directorate has a technical measurement inspector present at the field at all times. In the course of 1979, a large number of satellite fields have also come on stream, and in addition, the operations on Ekofisk Center has entered phase III. This means that a large number of new measurement systems have been put in service, and that a large part of the control has been concentrated on this. The control at Ekofisk has represented a heavy burden on the resources. In connection with the turn-over to Phase III operations at Ekofisk, problems have arisen in connection with the price stipulation and the interpretation of the royal decrees on which the royalty collection is based. Work is still being done on this matter.

In the course of 1979, the Petroleum Directorate has participated in the testing of measurement stations at Teesside. Parts of the errors which have been discovered are still not corrected. At the present time, oil and NGL is measured by level measurements in storage tanks and tankers. In connection with loading of NGL, the level measurements are supervised by a measurement expert firm which has been contracted by Phillips upon demand from the Petroleum Directorate. For its part, the Petroleum Directorate may control the loaded quantities in a rough fashion by comparing loaded quantities with the quantities shipped from Ekofisk.

Monthly inspections are currently made in Emden in accordance with a fixed routine.

The measurement systems on Frigg, MCP01 as well as at the onshore terminal in St. Fergus

As known, measurement of gas from the British Piper field to the Frigg pipeline is made on the compressor platform MCP01.

On Frigg and MCP01, the Petroleum Directorate has planned a joint inspection program with the Department of Energy. Each of the measurement stations are inspected monthly in accordance with established routines, either by the Petroleum Directorate or by the Department of Energy.

In St. Fergus, technical measurement inspection is performed monthly.

Statfjord "A"

The last stage of the testing will be performed around the turn of the year immediately before loading on the field will be started. The extent of the operations control will be decided on the basis of experience made in the first period when the measurement systems are in service.

Murchison

Design control was performed in 1978. There have been no significant activities in connection with this field since then. It is anticipated that tests will be made around 1980-81. The extent of the operations control must be decided on the basis of experience gained in the first period when the measurement systems are in operation.

In case of the measurement systems associated with the Valhall field, the Petroleum Directorate is presently performing control of the design.

In the case of fields like NE-Frigg, 1/9 and 7/12, the Petroleum Directorate has discussed measurement arrangements in general forms with the field operators.

The activity in 1980 and further will be characterized by an increasing need for operations control in step with the number of fields put in service.

Moreover, we have reached the stage where there is a need for mechanical processing of the measurement data from the fields tied in with joint pipeline arrangements. This applies to the socalled allocation calculations where the individual field's ownership in the flow downstream the main terminal at the field and the onshore terminal is determined. It is presumed that the preparation of data programs for this prupose will be started in 1980.

Measurement technique for oil and gas is a rather special professional area where there has not been any significant competence in Norway up to now. The development of the professional environment in measurement technology within the Petroleum Directorate has partly taken place by emphasis on the need for familiarization with the accepted standard measurement techniques as well as to follow and participate in the further development in this area. Thus, the Petroleum Directorate is Norway's representative in several of the committees within the International Standardization Organization which work on the measurement technology for oil and gas.

Moreover, the Petroleum Directorate participates in two research projects related to measurement technique, one performed by SINTEF, and the other performed in Great Britain under the direction of the Institute of Petroleum. In the latter project, the Petroleum Directorate and the Department of Energy are among the main participants. In the case of most activities, however, it has been necessary to assign a low priority to such projects compared with the directs measurement control assignments. It is nevertheless an aim that it shall be possible to maintain a somewhat higher level of activity in this area in the future.

6. SAFETY AND EMERGENCY PREPAREDNESS RESEARCH

6.1 Background

With a starting point in Storting Proposition No. 1, Addition 2 (1977/78) "Concerning an increase in the grants to safety and emergency preparedness research in connection with the petroleum activity on the continental shelf", the Petroleum Directorate has started the implementation of two research programs concerning preventive safety and emergency preparedness.

The SSB-program is carried out with assistance from the Steering Committee for Emergency Preparedness on the Shelf (SSB), and the SPO-program is carried out with assistance from the Steering Committee for Safety, Procedures and Surveillance (SPO). The joint aim of the two programs has been described in Section 6.5. There are representatives from the oil companies, the employees and public institutions in both committees. The chairman of SSB is Section Manager Arne Stavland, and the chairman of SPO is Assistant Director General Dag Meier-Hansen.

Steering groups for the individual projects assist the executive institutions, and the Petroleum Directorate takes part in the project management.

The Petroleum Directorate's tasks in connection with the administration of the two research programs are taken care of by the Research Group. The Research Group is also taking care of the secretariat functions for the two steering committees.

6.2 Development and status

At the end of 1979, the SSB and SPO programs had been active for about 1½ years. The first half of 1978 was used for planning, and no means were used over the budgets of the research programs.

The year 1979 was the second year in the SSB and SPO programs, and the two programs are currently in an intermediate phase. The initiation phase was characterized by a large number of research programs which, to some extent, were started within narrow economic limits and time limits. The intermediate phase is characterized by a widening of the economic limits for some projects, some new projects have been added and the more short-term projects are being completed.

The financing of the research programs consists of an annual allocation over the budget of the Ministry of Local Government and Labour of about Nkr. 8 million. For 1980, allocations in the same order of magnitude are expected.

In the case of 1980, the operator companies have been asked to assist the research programs with a direct financial contribution of Nkr. 10,375,000. Individual operators have in addition been asked to assume the responsibility for special projects.

The two programs are planned on the basis that they should, as integrated programs, be completed within the end of 1981.

In the future, it must be an aim to integrate a number of areas in the SSB and SPO programs in other projects which are not specially related to safety, but where safety is a part-aim.

6.3 The areas of the two programs

The SPO program comprises preventive safety, and the SSB program comprises emergency preparedness.

Preventive safety comprises safety which is built into facilities and systems, as well as the relationship between people and machines, procedures and administrative measures to prevent accidents and danger situations.

Emergency preparedness comprises the human resources which are activated and brought into action to bring accidents and danger situations under control, as well as the administrative apparatus and material resources which people use in their efforts in this connection.

Emergency preparedness and preventive safety are complementary concepts which in very many respects cover the same professional areas. A simple safety measure may thus often have both emergency preparedness elements and elements preventive safety. The purpose of bringing the content of these two concepts up on the conscious level must be to take care of both the emergency preparedness elements and the elements relating to preventive safety.

The SPO-program comprises projects within preventive safety which are particularly directed towards the Petroleum Directorate's areas of responsibility. There is, moreover, no clear delineation against the SPS-program directed by NTNF, which also covers preventive safety.

The SSB-program comprises projects within emergency preparedness which are mainly directed towards the areas of responsibility of the Petroleum Directorate, the Maritime Directorate, the Ministry of Justice, the Health Directorate and, to some extent, the Ministry of Environment. The SSB program also comprises collection of oil in the immediate vicinity of the well head. Oil recovery and processing of the oil which floats on the sea are taken care of by the Ministry of Environment under the PFO-program.

6.4 Project review

THE SSB PROGRAM

1. THE EMERGENCY PREPAREDNESS SYSTEM

1.1	The emergency preparedness system	Not started

1.2	Supreme - emergency preparedness - cooperation (the OBS project)	Performed by the Norwegian Institute for Ship Research. Up to now, the project cost has been Nkr. 75.000. In addition, others have granted Nkr. 45.000. The planned cost of the project for 1980 is Nkr. 600.000.
1.2.1	Emergency preparedness plan for floating drilling rigs	Performed by the Norwegian Institute for Ship Research. Up to now, the project cost has been Nkr. 112,000.
1.2.2	EDP-based information system for the preparedness and rescue service	Evaluated for start-up at the Norwegian Institute for Ship Research
1.3	Decision basis	Ref. SSB projects 2.1, 3.1, 4.1, 4.6 and 4.10.

1.4 Tasks related to the emergency preparedness system.

1.4.1	Simulation - Disaster - Shelf (SIKAS project)	Performed by the Norwegian Institute for Ship Research. Up to now, the project cost has been Nkr. 148,000. In addition, others have financed Nkr. 485,000. In 1979, the project was carried on under the direction of the State Pollution Control Authority.
1.4.2	Design of a Main Rescue Central	Evaluated for start-up by the Norwegian Institute for Ship Research in 1980 within a financial budget of Nkr. 465,000.

1.5.1	Authority and responsibility relationships	Performed by Det norske Veritas. So far, the project cost has been Nkr. 217,000.
2.	HUMAN LIVES AND HEALTH	
2.1	Human lives and health. Analyses - criteria	The project is evaluated for start-up in 1980 within a budget of Nkr. 75,000.
2.2	Evacuation of personnel by way of the sea	Performed by Det norske Veritas. Up to now, the project cost has been Nkr. 1,680,000. In addition, others have financed Nkr. 435,000. The planned project cost for 1980 is Nkr. 6 millio
2.2.1	Evacuation aspects concerning "Offshore system for personnel transport and evacuation".	The project was performed by Kongsberg Engineering A/S, Maritime Project Group. The SSB's involvement was completed after Nkr. 300,000 had been used.
2.2.2	Free-fall rescue system for the offshore oil activity	The project was performed by the Norwegian Institute for Ship Research. The project cost was Nkr. 225,000 before it was carried on within SSB-project 2.2.
2.2.3	Transfer of personnel and goods between constructions in the sea.	The project was carried out by Jarle Wanvik. The cost of the project was Nkr. 90,00 before it was carried on under SSB project 2.2.
2.3	Evacuation with helicopters	The project was carried out by the Norwegian Institute

for Ship Research. The project was temporarily shelved in 1978 after Nkr. 24,823 had been used. Start-up of the project in 1980 is being considered.

2.4 Rescue suits/helicopter transportation

The project was carried out by the Norwegian Institute for Ship Research. Up to now, the project cost has been Nkr. 175,000.

2.5.1 Medical information

Start-up of the project in 1980 is being considered with a financial budget of Nkr. 250,000.

3. EMERGENCY PREPAREDNESS FOR DIVERS

3.1 Risk analysis.

The project is performed by the Norwegian Underwater Institute in cooperation with Det norske Veritas. Up to now, the project cost has been Nkr. 780,000. The planned project cost for 1980 is Nkr. 1,000,000.

3.2 Manned test of rescue chambers /diving bell, connection to the surface interrupted

3.3 Energy systems/energy package for rescue chambers

3.4 Testing of existing gas pre-heaters, and, in case, improve these.

3.5	Emergency preparedness/actions/ operational guidelines. Technical evalutaion of equipment.	
3.6	Connecting of Life Support to sunk/lost manned submarine vessel	
4.	FIGHTING THE SOURCE	
4.1	Fighting the source. Analyses - criteria	Start-up of the project in 1980 is being considered with a financial budget of Nkr. 75,000.
4.2	Emergency preparedness in case of indications that a well is not completety under control	Carried on by SINTEF in cooperation with Rogaland Research So far, the project cost has been Nkr. 70,000, and the planned cost for 1980 is Nkr. 355,000.
4.3	Well shut-down in case of uncontrolled blow-out	Carried on by SINTEF in cooperation with the Norwegian Institute for Ship Research and the Central Institute for Industrial Research. The cost to date is Nkr. 240,000. On request from the Petroleum Directorate, Statoil has assumed the task of carrying on the project in 1980.
4.4	Drilling of relief wells in case of uncontrolled blow-outs.	Carried on by Rogaland Resear in cooperation with PETCON. Up to now, the cost of the project has been Nkr. 273,000 and the planned cost for 1980 is Nkr. 1,400,000.

4.5	Spill quantities in case of uncontrolled blow-outs.	Not started.
4.6	Fire and explosion danger in connection with gas spreading and uncontrolled release of hydrocarbons.	Carried out by OTTER in cooperation with SINTEF, the Norwegian Institute for Air Research and the Waterways and Harbour Laboratory. Up to now, the cost of the project is Nkr. 365,000, and the cost planned for 1980 is Nkr. 441,000.
4.7	Fire preparedness	
4.7.1	Fire preparedness on the platform.	Carried out by Det norske Veritas. Up to now, the cost of the project is Nkr. 194,000, and the planned cost in 1980 is Nkr. 204,000.
4.7.2	External fire preparedness	Carried out by Det norske Veritas. Up to now, the cost of the project has been Nkr. 275,000, and the planned cost for 1980 is Nkr. 850,000..
4.8	The vessel's abilities	
4.8.1	Evaluation of the requirements concerning dynamically positioned ships and platforms	Carried on by Chr. Michelsen's Institute. Up to now, the cost of the project has been Nkr. 95,000.
4.8.2	Ship in seas (the SIS-project).	Carried on by the Norwegian Institute for Ship Research. Up to now, the cost of the project has been Nkr. 50,000. In addition, Nkr. 1,070,000 has been allocated to the project by others.

4.9	Emergency preparedness in case of collision danger.	Not started
4.10	Decision criteria in case of damage to constructions	Not started

THE SPO PROGRAM

1. DRILLING

1.1	Safety optimalization in connection with drilling	Carried out by SINTEF. The project was started in March, 1978. The allocation for 1978: Nkr. 145,000 which was paid to NTNF. No allocation for 1979.
1.2	Simulator for well control	Carried out by SINTEF. The project was started in 1977. The allocation for 1978: Nkr. 300,000. Allocation for 1979: Nkr. 257,000. It is expected that the project will be completed in 1980.
1.3	Completing the maintenance on production wells	Carried out by Rike Service i cooperation with the Petroleu Directorate. The project was started in April 1978. The allocation for 1978/79: Nkr. 155.000. The project complet in 1979.
1.4	Subsea systems for oil and gas production	Carried out by Kongsberg Våpenfabrikk. The project was started in 1974. Allocated for 1978: Nkr. 130,000. SPO support via NTNF.

1.5	Inpection routines for drilling equipment	Carried out by the Norwegian Institute for Ship Research. The project was started in May 1978. The grant for 1978: Nkr. 189,000. Grant for 1979: Nkr. 600,000. Completion of the project is extected in 1980
1.6	Casing design	Executed by SINTEF. The project was started in January 1979. The allocation for 1979: Nkr. 65,000. Additional grant for 1979: Nkr. 120,000. Completed in 1980.
1.7	Cementing in wells	Executed by SINTEF. The pilot project was started in 1979. Grant for 1979: Nkr. 40,000.
1.8	Damage in connection with the handling of pipe on the drilling deck	Executed by Rogaland Research. The project was started in April 1979. Grant for 1979: Nkr. 125,000.

2. CONSTRUCTION

2.1	Control of the state of pipelines	Performed by the Petroleum Directorate. The project was started in 1978 and completion is estimated in 1979. Grant for 1978/79: Nkr. 225,000.
2.2	Internal corrosion	Executed by Det norske Veritas. The project was started in 1976 and completion is expected in 1980. Grant for 1978: Nkr. 100,000.

2.3	**Accident loads**	Executed by the Petroleum Directorate. The project was started in 1978, and completion is expected in 1979 Grant for 1978/79: Nkr.270,000
2.4	**Procedures for submarine pipelines**	Executed by the Petroleum Directorate. The project was started in February 1979, and completion is expected within the end of the year. Grant for 1979: Nkr. 200,000.
2.5	**Control of the state of structures**	Executed by Hollobone Hibbert & Ass. Project completed.
2.6	**Mounting a corrosion probe inside the concrete in the shaft wall of Statfjord B**	Executed by the Research Institute for Portland and Concrete. The project has received a grant for 1979, but has temporarily been shelved. Grant for 1979: Nkr. 62,500.
2.7	**Fatigue in offshore steel structures**	Executed by the Petroleum Directorate. The project was initially started in 1978, but was financed by SPO for the first time in 1979. Grant for 1979: Nkr. 400,000.

3. SAFETY

3.1	**Protection and environmental work I**	Executed by the Norwegian Institute for Ship Research and the Petroleum Directorate Organization of a conference at Jæren Hotel, Bryne, 19. 23. February 1978. Grant: Nkr. 50,000.

3.11	Protection and environmental work II	Executed by the Norwegian Institute for Ship Research and the Petroleum Directorate. Organization of a conference at Jæren Hotel, Bryne, 28 January - 1 February 1979. Grant: Nkr. 70,000.

4. PRODUCTION

4.1	Data collection and processing (Pilot project, part I).	Executed by PA Management Consultants. The project was executed in 1978. Grant: Nkr. 150,000.
4.11	Data collection and processing (Pilot project, part II).	Executed by T. R. Moss. The project was executed in 1978. Grant: Nkr. 15,000.
4.2	Safety valve arrangement	Executed by SINTEF. The project was started in 1978 and is expected to be completed in 1980. Grant for 1978/79: Nkr. 360,000.
4.3	Fire classification	Executed by System for Safe Ship. Small pilot project executed in 1978. Grant: Nkr. 5,000.
4.4	Detection systems for gas/fires	Executed by Det norske Veritas. The project was started in 1978, and is expected to be completed in 1980. Grant for 1978: Nkr. 305,000. Grant for 1979: Nkr. 650,000.

4.5	Minimum criteria for inspection of process equipment	Executed by Atkins Planning. The project was started in 1978 and was finished in 1979. Grant for 1978: £ 69,00 Grant for 1979: £ 9.500.
4.6	IFAC/IFIP "Authorization for safety" conference	Executed by SINTEF. Grant to the organization of a symposium in June 1980. Grant: Nkr. 25,000.
4.7	Supervising the state of process equipment	Executed by Det norske Veritas and Cranfield Institut of Technology. The project was started in April 1979. The grant for 1979: Nkr.320,00

5. ADMINISTRATION/STRATEGY/ECONOMY

5.1	Basic control strategy	Executed by the Petroleum Directorate. Organization of a "brain-storming" meeting at Hovda Gård, 4.- 6. September 1978. Grant: Nkr. 21,500.
5.2	Collecting, processing and application of data (Main project)	Executed by Rogaland Research. The project was started in 1979 and Phase I will be finished within the end of the year. Grant for 1979: Nkr. 400,000.

6. DIVING

6.1	Detection of decompression bubbles	Executed by the Norwegian Underwater Institute. The project was started in 1979 and is expected to be completed in 1981. Grant for 1979: Nkr. 50,000.
6.2	Personal diving equipment	Executed by the Norwegian Underwater Institute. The project was started in 1979 and is expected to be completed in 1980. Grant for 1979: Nkr. 50,000.
6.3	Criteria for diving communication	Executed by the Norwegian Underwater Institute. The project was started in January 1979 and is expected to be completed in 1983. Grant for 1979: Nkr. 200,000.
6.4	Limitation to work loads	Executed by the Norwegian Underwater Institute. The project was started in January 1979 and is expected to be completed in 1981. Grant for 1979: Nkr. 500,000.
6.5	Physiological surveillance of divers	Executed by the Norwegian Underwater Institute. The project was started in March 1979 and is expected to be completed by the end of the year. Grant for 1979: Nkr. 150,000.

6.5 Objectives

The Petroleum Directorates program for research within preventive safety and emergency preparedness has the overall objective to contribute to an increase in the safety for people, environment and technical installations on the Norwegian Continental Shelf. This applies primarily to obtaining new knowledge, and to systematize and process existing knowledge and information and coordinate this in such a way that it forms a basis for taking care of the safety on the shelf within sound, economic boundaries

The strategic objectives are the following:

1. The individual projects shall be structured and managed in such a way that they may as directly as possible be applied by the industry and the authorities involved.

2. The research shall be based on the technical questions and shall emphasize the entirety formed by the administrative systems and routines, training and exercise and on the people who are a part of the technical system.

3. The administrative and professional area of responsibility of other authorities shall be surveyed, and the clarification of questions relating to several professions shall be ensured, and problems on the border lines shall be raised.

4. The structure and management of projects shall to the extent possible take place by using those experts of public agencies who in their day-to-day work are the natural candidates for involvement in the project.

   Emphasis should also be placed on advice from the operators, contractors, organization of employees and other with special qualifications - both in the formulation of the projects and in proposals for implementation of measures.

5. Through systematic information, the Petroleum Directorate will try to make projects and project results known among all user groups.

6. The research activities shall have the long-term objective of arriving at the most concrete balancing possible between emergency preparedness and preventive safety.

7. The research activities initiated by the Petroleum Directorate will to the degree possible be coordinated with similar activities in Norway, so that the total national research effort will be coordinated and so that it covers the safety problem as widely and completely as possible.

   The activity will also be evaluated in view of corresponding projects abroad when known.

7. ASSISTANCE TO FOREIGN COUNTRIES

The Petroleum Directorate's assistance to Norad, the Ministry of Foreign Affairs and the Ministry of Petroleum and Energy in connection with cooperation with other countries within the petroleum sector has continued in more or less the same extent as in earlier years. A number of the Petroleum Directorate's experts have participated in petroleum-related projects in connection with follow-up of projects initiated from before, evaluation of new projects for surveying petroleum resources and general advisory tasks in connection with organization of petroleum activity. The countries which these projects apply to are Tanzania, Portugal, Jamaica, Sri-Lanka, Pakistan, India and the People's Republic of China.

The Petroleum Directorate, in cooperation with Norad and Rogaland District University, has also organized a course in petroleum administration, from 1 October to 23 November 1979, for key personnel from a number of developing countries showing and interest in this. The following countries sent representatives to the course: India, Jamaica, Kenya, the People's Republic of China, Sri Lanka and Tanzania.

As already mentioned in earlier annual reports, the Petroleum Directorate's engagement in this sector has continued to

increase in later years. Possible solutions which will increase the work capacity of the Petroleum Directorate to the desired level are presently being discussed with NORAD.

8. INTERNATIONAL HARMONIZATION OF SAFETY REGULATIONS - INTERNATIONAL COOPERATION

The second North-West European Conference about "Safety and pollution safeguards in the development of North-West European mineral resources" was arranged in Haag in the period 13.-17. November 1978. The countries participating in the international harmonization work are as follows: Belgium, Denmark, Ireland, France, the Netherlands, Norway, Great Britain, Sweden, the Federal Republic of Germany. The Haag Conference prepared new terms of reference for Working Group II, which is chaired by Norway, and Working Group III, which is chaired by the Netherlands.

Working Group II has arranged 3 meetings in 1979 and had its final meeting on 11 and 12 December.

The Working Group has, pursuant to its terms of reference, prepared a proposal for a certification arrangement with a view to simplify the control procedures when movable drilling vessels shall be moved from the continental shelf of one country to another.

The final report was being written at the end of 1979 with a view to providing the member countries with the final report in the course of January 1980.

Working Group III has arranged two meetings in 1979 and plans to have its last meeting on 15 and 16 January 1980 in Haag. The terms of reference of the Working Group comprise special subjects in relation to safety, health and welfare of personnel.

As concerns Working Group I, Great Britain is the leader of

a group of experts in various subjects who were requested by the Haag Conference to prepare a final report within the end of 1979. The report will deal with data concerning the physical environment in the North Sea.

The Haag Conference decided that a new conference should be arranged in the last quarter of 1980. The host country for this conference was not appointed.

In connection with the work in the international maritime organization IMCO, the Petroleum Directorate was represented in 1979 with 2 representatives appointed as members of the Norwegian delegation to IMCO's Sub-committee on standards of training and watchkeeping, 13th session.

The said sub-committee deals with, i.a. questions concerning manning and qualifications for personnel on mocable drilling vessels.

9. FEES PAID TO THE PETROLEUM DIRECTORATE

9.1 PRODUCTION FEES

For 1979, Nkr. 1,607,551,121.37 has been paid in production fees, divided in this manner:

Group	Prod.lic.	Field	Oil/NGL Gas/Cond.	Amount in Nkr.
Phillips gr.	18	Ekofisk	Gas/NGL	291,587,340.68
Petronord gr.	24	Frigg	Gas/cond.	156,006,026.23
Amoco/Noco gr.	6	Ekofisk	Gas/NGL	3,956,847.76
Shell		Ekofisk	Gas/NGL	2,667,526.60
Dyno Industrier		Ekofisk	Gas	97,422,020.36
Statoil		Ekofisk	Oil	1,055,911,359.74
				1,607,551,121.37

The settlement for oil in 1979 has taken place pursuant to the normprice. The development of this appears from Figure 9 B.

In the case of NGL, gas and condensate, the settlement has been based on contractual prices and sales in the free market.

In 1980, the Petroleum Directorate will collect royalty on oil, NGL, gas and condensate. Royalty on oil will come from the oil produced on the Ekofisk field and the Statfjord field. NGL production will come from the Ekofisk field. Gas production will come from the Ekofisk field and the Frigg field. Condensate production will come from the Frigg field.

The Norwegian share of the Frigg field has been stipulated at 60.28 per cent. On the Statfjord field, the Norwegian share has been stipulated at 84.09322 per cent.

Total revenue from production fees in 1980 are estimated at Nkr. 3 billion.

9.2 AREA FEES FOR THE CONCESSION AREAS

In the course of 1979, the Petroleum Directorate has collected Nkr. 53,007,015 i area fees. These are divided in this way:

Concessions allocated in 1965		Nkr. 50,108,226
"	" " 1969	Nkr. 13,225,000
"	" " 1971	Nkr. 1,100,400
"	" " 1973	Nkr. 525,600
"	" " 1977	Nkr. 73,500
"	" " 1979	Nkr. 3,008,306
		Nkr. 68,041,032
Repaid in 1979		Nkr. 15,034,017
Net amount paid		Nkr. 53,007,015

The amount repaid refers to repayment of area fee to the Phillips group and the Amoco/Noco group.

9.3 FEES FOR EXPLORATION LICENCES

The Petroleum Directorate issues exploration licences pursuant to the provisions in Chapter 2 of the Royal Decree of 8 December 1972. Exploration licences are issued for a period of three calendar years, and before a licence is issued, a fee of Nkr. 20,000 per calendar year shall be paid in advance. The Petroleum Directorate takes care of the collection of this fee.

For 1979, fees for a total of 21 licences have been paid.

9.4 REIMBURSEMENT OF CONTROL EXPENSES

The reimbursements received by the Petroleum Directorate cover the expenses to the Directorate's consultant companies, as well as travelling costs of employed inspectors when executing controls.

For the technical and safety control, the payments in 1979 are divided in this way:

Det norske Veritas	Nkr.	29,121,800
Dr. ing. A. Aas-Jakobsen A/S	"	3,637,300
Otter Group	"	4,815,800
Skandinavisk Kontroll A/S	"	117,900
Petroleum Directorate's own control	"	880,500
SUM	Nkr.	38,537,300

The full amount will be covered by the licensees.

As per 31 December 1979, Nkr. 47,358,300 had been paid.

10. SUBJECT PAPERS

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10.2 SOMETHING ABOUT QUANTITY MEASUREMENTS OF OIL AND GAS

Gas measurement

A sketch illustrating the principle of an orifice meter system, which is presently the predominent system for gas measurement within the oil industry, is shown in Figure 10 G. Measurement by an orifice is by itself a usual and relatively well known method, and it has through the ages been used by traditional Norwegian industry for measurement of great steam or water flows. The difference between the gas measurement systems on the continental shelf and the traditional application of orifice metering in the industry is the improvements introduced by instrumentation and microprocessors, advanced routines for analyzing the gas and advanced mechanical design.

In principle, the orifice meter consists of a pipe with a constriction in the form of a plate with a hole drilled through it which is mounted in the pipe. The gas stream which shall be measured will experience a restriction in its flow diameter as it passes the bore of the plate. This results in a pressure drop in the gas and this pressure drop may be measured. On the basis of the pressure drop measured, measured statistical pressure, data for the density of the gas and different thermodynamic properties, as well as a set of empirical formulae, the mass flowing through the meter may be computed. This computation is continuously made by the miniprocessor or microprocessor shown in Figure 10 H. As we can see from the figure, the data processor received data about pressure, temperature and pressure drop by direct electrical signals. The gas composition, or in case processed thermodynamic data must be fed in advance. The same applied to data about the dimensions of the orifice meter. Since the orifice plate is exchanged relatively frequently, and also since the composition of many gas flows varies from day to day, we must in practice make frequent changes of manual data in the data processor.

In practice, the mechanical part of an orifice meter system occurs as a set of two or more parallel straight pipes where the orifice-plate holder is located quite close to the end of the pipe run. The long pipe runs which are necessary for flow technology reasons will on some platforms have a diameter of more than 700 mm and a lenght of 40-50 meters.

Liquid measurement

Figure 10 H illustrates the principle for oil measurement. The drawing provides an illustration of how the mechanical part of the measurement equipment works. The instrumentation is sketched, however, in a strongly simplified form. The primary meter element used is a so-called turbin meter (incidated as "METER" in Figure 10 H). As the name indicates, the turbine meter consists of a turbine where the rotor is put in a rotating motion by the liquid flow to be measured. See Figure 10 I. The rotation speed is approximately propostional with the velocity of the liquid. An electromagnetic signal relay is located on the outside of the turbine house, and this issues an electrical pulse for every turbine place passing. These pulses are transmitted to a data processor which counts the puses within a time intervall, and moreover, the data processor multiplies the number of pulses with the calibration factor of the turbine meter as well as with special correction factors calculated from the oil composition and signals from different meters for pressure and temperature in the oil.

One of the quite special circumstances which the metering system must handle is the fact that the calibration factor for the turbine meter is not constant. The value will change whith the wear of the meter and with changes in the temperature and the properties of the oil. It is therefore necessary to have permanent equipment to be able to measure the calibration factor at any time. This measurement is performed with the help of the socalled standard pipe shown in Figure 10 I. The measurement of the calibration factor is made when the oil flow, after having passed the turbine meter, is led through the standard pipe. The mid-part of the standard

pipe has a volume which has been measured accurately and is limited by two switches which are activated from the inside of the standard pipe. A rubber ball is pushed towards the calibrated volume and moves through this as a piston, forced by the oil flow. The switches are activated when the rubber ball passes. The first signal from the switches means that the ball enters the calibrated volume, and the second that it leaves it. In the time period between the two signals, the data processor counts the pulses from the turbine meter in a special register. The calibration factor may thereby be computed from data about calibrated volume, number of pulses, as well as direct signals concerning pressure and temperature conditions in the oil and in the walls of the standard pipe. Figure 10 J shows how the mechanical part, meaning the turbine meter and the standard pipe, for a platform on the shelf looks. Three turbine meters are mounted on each side of the standard pipe. As it may be seen, great emphasis has been placed on saving space by designing the standard pipe as a double loop.

10.3 WORK ACCIDENTS

"Paavo, Paavo, unfortunate man". From J. L. Runeberg's poem: Farmer Paavo.

INTRODUCTION

As all other technological activities, the oil activity has negative and positive aspects. Central in the worker protection and working environment context are injuries and health damage, referred to as occupational accidents, personal/occupational injuries in everyday speech.

In general, the occupational accidents are a cause of great cost to the producing sector and the society. Behind the economic compensations, however, there are sufferings and worries among those directly affected by occupational accidents, their families and among those who live with the possibility of being affected themselves.

As regards the fixed facilities, etc. on the continental shelf, the Petroleum Directorate is responsible for supervising that the working environment in the operations is completely sound both from an individual and from a total evaluation of the factors in the working environment which may influence the physical and psycological health and welfare of the employees. The expression "completely sound" does not necessarily mean that all risks have been eliminated. All human activities - also at the place of work - involve a certain risk.

REPORTING OF OCCUPATIONAL INJURIES AND INJURIES TO PERSONS

Basic for the preventive work in the struggle against occupational accidents is satisfactory registration and report systems for occupational accidents.

The Petroleum Directorate, which started its formal work on 1 April 1973, based its occupational accidents reviews for fized installations on the reviews of the Directorate for Work Inspection up to 1 January 1976. The basis for this was the National Insurance Administration's report form for occupational accidents, which the Petroleum Directorate received in copy form after the form had gone via the local Social Insurance office and the Directorate for Work Inspection. To reduce the long transit time for the report, and on the basis of the indications that less than all occupational injuries were reported, the Petroleum Directorate found it necessary to prepare its own reporting forms. These reports should be submitted to the Petroleum Directorate as soon as possible and no later than 5 days after the occupational accident. Use of the forms was started on 1 January 1976.

The involved parties within the oil activity, the employer/ employees and the public authorities, wanted to have a simplified and more rapid reporting procedure - i.a. by a joint reporting form for all public agencies, at the same time that the statistical processing of the material should be improved. The work on this was started, and a joint reporting form, the RTV-form 11.01 E, for the social security and inspecton

authorities, could be implemented in the first half year of 1979.

Without regard to the residence of the injured person, the form shall be used in case of all injuries occurring in offshore operations on installations as mentioned in litras 1 and 2 below, in connection with exploration for and exploitation of subsea natural resources. The same applies when a person is affected by occupational illness because of such activities:

1. On the Norwegian Continental Shelf, the report duty applies to all diving operations as well as all employees on fixed facilities and installations and other movable installations.

2. Outside of the Norwegian Continental Shelf, the report duty applies to all employees on Norwegian movable drilling rigs, quarter platforms and drilling ships as well as on facilities which are subject to Norwegian jurisdiction because of legislation or special agreement.

Figure 10K shows the front page and reverse of the copy of the report form which shall be submitted to the Petroleum Directorate.

The report shall serve several purposes - of which may be mentioned:

- To provide the social security authorities with a basis to evaluate whether the injury/illness may be approved as an occupational injury or occupational illness so that so that the special provisions of the Social Security system concerning occupational injuries shall apply.

- To provide the inspection authorities with information which may be of assistance in the work of evaluating safety questions and protection measures, etc. at the place of work.

- To form a basis for preparation of injury/accident statistics.

On the basis of well established practice and in close cooperation with the operating companies on the continental shelf, the reporting duty to the Petroleum Directorate covers: All occupational injuries which have lead to medical treatment or inability to perform the work, provided the inability to work extends into the next 12 hour shift. This contributes to the fact that the Petroleum Directorate has had a more rapid and more extensive supply of information about accidents and occupational injuries than is the case at present for the onshore supervising authorities.

The Petroleum Directorate's investigations of occupational accidents aim at clarifying two circumstances. One is to clarify the reasons for the accident and to implement measures to prevent similar accidents in the future. The other is to clarify whether any laws, regulations or instructions have been violated.

An effort is made to prevent occupational accidents, for instance by the continuous activity exercised by the Petroleum Directorate, police investigation in connection with occupational accidents and not least by the processing of investigation results with a view to measures to prevent similar accidents. Nevertheless, serious accidents are still taking place.

It is very important to be aware of the importance to the preventive efforts of clarifying occupational accidents which uncover failures of general or special character. That the accident leads to fatalities is not by itself a decisive criterion for the nature of the risk. A fatal accident may have reasons which it is easy to uncover and which will not justify comprehensive investigation. On the other hand, circumstances/occurances may sometimes we of a very serious nature even if injuries or major damage to property are not caused.

STATISTICS

General

In later years, extensive work has been done to arrive at good reviews of work accidents, i.a. by preparation of injury statistics. Some have argued that the state of the protection and environmental work may be read directly from the injury statistics. However, this is a contention which too often is not sufficiently justified. In practice, it is difficult to draw clear conclusions from possible relationships between the level of activity of the protection and environmental work and the frequency of injuries.

For the activities on the fixed installations, this applies both to the individual installations and to the activity as a whole.

The injury statistics for the different trades are frequently used as a basis for establishing which trade is the "best" and "worst" from the safety point of view. Unfortunately, such comparisons are to frequently based on a number of assumptions which fail. In particular, this applies to the public occupational statistics which, for instance in the case of the onshore industry until present has comprised injuries leading to absence for 11 days or more. In spite of the fact that the statistics show that a number of trades/professions are not completely covered, the figures are frequently used in a manner which seems to reduce the life and health of people to a quantitative, measureable problem.

During the preparatory work for preparation of accident statistics for the fixed installations, an effort has been made to adapt the means to the objectives. One of the main objectives has been to arrive at the best possible picture of the extent of injuries which has lead to absence, independent of the length of the absence. The main reason for this is the fact that all experience has shown that the number of accidents is most effectively reduced by preventing the more "everyday" accidents.

On the basis of the national and international statistics already existing, as well as development work which has been started, all occupational statistics for fixed installations will comprise a comparatively small number of tables of general and easily understandable character. By and large, these shall give information about the accident situations. In addition, it shall be possible to process the statistics in particular based on the wishes of different users. By this, it should be possible to satisfy different needs.

In addition, it should be possible to register "quick" statistics, even if these will, to some degree, be associated with uncertainty as for instance lack of information about the estimated number of working hours.

A further development of the occupational accident statistics will hopefully also be involved in the coming RVM system. RVM means: Registration of Protection and Environmental matters. It is prepared by and in accordance with wishes from elected representatives and employer representatives among those who work on a daily basis on fixed installations. With a departure point in dangerous circumstances and dangerous actions, the wish is to register "near"-accidents and "invitations to injuries".

The development of this registration system is a result of two work conferences arranged by the Petroleum Directorate with the help of the Norwegian Institute for Ship Research and with economic funds from the research program SPO (Safety, Procedures, Surveillance). 1980 will be a test year for these registrations, and it is hoped that a better surveying of the total work environment will be the result.

In a short summary, the occupational injury statistics shall contribute to:

a possibility to uncover/trace dangers of injuries and health risks in the work on fixed installations.

a basis for study, research and development work

a higher degree of efficiency and follow-up in the work of the Petroleum Directorate.

Injury development

Figure 10 L shows the development as concerns occupational injuries and fatalities per 1000 man-years on the fixed installations for the years 1976-79.

In total, it may be said that the development is positive, but included in these numbers are also occupational groups and work operations where there have been few or no positive trends. This concerns, for instance, the drilling personnel and the associated activities, where the injury numbers are still too high. In order to clarify this in a better way, an SPO project which covers injuries in connection with pipe-handling on the drilling deck has been started.

In is important to remember, when the statistics for trades like the oil activity shall be considered, that the injury ratio and the seriousness may decrease rapidly because of a strong increase in the number of employees, without any changes in the risk situation for the individual work operations.

In the review of accidents per 1000 man-years, a hatched area has been included (A). Surveys within certain, partly comparable trades/occupations have shown that about 30 per cent of all occupational injuries lead to absence of 11 days or more. (A) has been calculated in respect of 30 per cent and 40 per cent of the reported injuries on fixed installations, covering injuires with absence of about 1 day or more.

Such calculations and comparisons are associated with a number of uncertainties and errors, but it may provide an approximate "picture" for comparison. It should also be born in mind that the injury frequency may vary to a high degree within the individual trades/activities.

Since 1972, when the first fixed installation was installed on the Norwegian Continental Shelf, 18 persons have died in connection with occupational accidents. Cf. Table XIII.

EXPERIENCE

The experience in connection with occupational injuries on fixed installations has clearly shown that "human errors" are an accident factor also in our new industry sector. It may therefore be useful, in the further work of preventing occupational accidents, to include some excerpts from Odelsting Proposition No. 3 (1975-76) concerning an Act relating to worker protection and working environment, etc.:

- As concerns the "human errors" as an accient factor, we are faced with a complicated question. It is quite clear that some accidents are caused by carelessness and negligence on the part of the employee. The ministry is of the opinion, however, that the assertion that 75-80 per cent of the occupational accidents may be assigned to human error as the predominant cause is an expression of a much to superficial evaluation of the circumstances associated with the cause. If all factors in the working environment are considered as a whole, as is the aim of the Working Environment Aim, it seems obvious that the large majority of the accidents where the reason is assigned to "human error" in the statistics are really caused by the working environment. The real or underlying reason for the accident will often be that the employees are not sufficiently trained or that the place of work is so dangerous by itself that only a moments inattention may have serious consequences. The salary system may also be arranged in such a way that it creates pressures or makes it economically attractive for the employees to take larger risks than they would otherwise have accepted.

Another important reason is that the thinking around the reason for occupational accidents has largely been characterized by the notion that the dangerous acts by individuals is the most important reason for occupational accidents. An early tra-

dition in the accident research, for instance, worked on the assumption that the most important reasons for occupational accidents could be found by studying characteristics of the persons who were most often injured the so-called "accident-prone persons theory". At present, this theory has been left by virtually all those engaged in accident research.

Studies have been made which should show that 80 per cent or more of all occupational accidents were caused by the human factor or "human shortcomings". From a scientific point of view, these studies are associated with decisive weaknesses which have the effect that dangerous acts by individuals have been given a quite unreasonable emphasis. One of the weaknesses which is associated with several of these studies is that the way in which the work has been organized and prepared has been brought up as a possible reason for the accident to a far too little extent.

It seems reasonable to assume that the unilateral emphasis which has often been placed on "the human shortcomings" as a cause of accidents has hurt the work of preventing accidents in that important factors have been disregarded in this way, and in that the emphasis has been placed on circumstances which it is difficult to master and control in a system for accident prevention. Another aspect is that this way of thinking has sometimes also been characterized by the fact that the human and legal responsibility for occupational injuries have been put on those who have been hurt instead of, for instance, the employers, planners and designers and suppliers of machines and other technology. In this instance, it is important to balance the one-sidedness which has frequently characterized the thoughts concerning the reasons for occupational accidents.

10.4 PREDICTING OF SHALLOW GAS

Introduction

Statistics for uncontrolled blow-outs in connection with drilling for oil and gas on a world-wide basis show that

a disproportionate number of accidents take place during the drilling of the shallow part of the well.

In spite of this fact, it is only in the last 4-5 years that there has been real speed in the work of surveying potential shallow gas pockets before drilling is started.

Conventional seismic sections may only in certain cases provide indications about the existence of shallow gas.

To get optimal seismic information about the shallow layers, usually defined as more shallow than 1000 meters, or the setting point for 510 mm (475 mm) casing, it is necessary to effect special geophysical registrations (high resolution seismic).

Briefly, this consists of shooting with a high-frequency energy source so that maximum solution in the uppermost layers is obtained, while little energy is reflected from deeper layers.

Earlier, analog data were used, but in later years, it has become the usual practice to obtain digital registrations. With the help of data processors, these registrations may be optimalized.

The Petroleum Directorate is of the opinion that digital registrations with subsequent data processing may provide substantially better information about the shallow layers, and since 1977, it has been a directive on our part to the companies that a report including interpreted base-seismic sections shall be provided as part of the drilling program.

The reason is that it is particularly important to have detailed information about the most shallow sediments is that the BOP (Blow-out preventer) is usually installed after the 510 mm casing has been placed, and that there is thus no shutting mechanism on the well if it should start to blow. The reason for this, again, is that the formation strength in the uppermost strata is relatively weak so that there is

little reason to shut the well in case of a blow-out. The only effect obtained by this would be to cause a rupture in the formation and give the liquids an opportunity to flow outside the casing.

Instruments

The basis for predicting shallow gas before drilling is substantially base-seismic data, most frequently show with a high-energy energy source, for instance a sparker.

Concurrently with sparker registration, data is collected with other alternative sources of energy, as well as side-scan sonar, used for, among other things, the discovery of shallow gas pockets. To the extent possible, conventional seismic is employed. This seismic may further be processed in a special way so that a better solution of the uppermost layers is obtained.

In addition to this, the geological knowledge in the relevant region will of course be used, and if wells have been drilled in the area, it will be of the utmost importance for an optimal predicting to have information about these. In the case of new operators on the shelf with limited well information, the Petroleum Directorate considers it to be a substantial task to assist in the exchange of relevant data securing an optimal safety planning before drilling.

In some cases, shallow cores are drilled into the seafloor. Above all, this is done to examine the geotechnical properties of the rocks, but it will frequently result in valuable information in the work of surveying shallow gas.

Origin

Shallow gas may either occur as accumulations in the rocks in which they have been formed, and will then usually exist without overpressure, or it may have leaked into more shallow formations through faults or similar features from deeper layers

where the pressure may be abnormal. The last category represents a far greater risk than the former.

Figures 10M and 10N illustrate the two types of circumstances involved in this.

Methods

In general, three different methods are mentioned to identify possible shallow gas pockets.

1. Leaks to the seafloor.
This type of evidence that gas exists in the uppermost layers will usually always be visible on side-scan sonar. The larger the leak, the easier it is to detect. To result in effects to seismic lines, particularly in the case of conventional seismic, the leak must be of a certain magnitude before it can be detected. Until now, only one such leak has been discovered in the preparatory studies before drilling in Norwegian waters. Figure 10 O shows this case. This happened in 1978 in the southern part of the North Sea. On the British side, however, there are several such examples. Most of the cases known from the North Sea are related to salt diapirs which have forced their way up to the uppermost layers.

2. Shallow faults forming communication to deeper layers.
Even if surveying of faults will not lead to direct evidence of the existence of shallow gas pockets, it is nevertheless particularly important to survey faults which fade out in shallow layers. It these faults have caused gas to leak from deeper layers to the more shallow layers, the gas will usually be under pressure and will therefore represent a substantial danger element. It is therefore good policy in the oil industry to try to avoid drilling into such faults.

3. Direct seismic detection.
The far most important element in the efforts to survey shallow gas pockets, is to search for anomalies on seismic sections which may indicate their existence. This is best

known as the bright spot technique.

Abnormally high refraction amplitudes, polarization inversions, frequency variations, time delays for reflections just below the gas, etc. are elements which may indicate the presence of shallow gas accumulations. The size of the gas accumulations decides whether or not they will be visible on conventional seismic. Under all circumstances, we will get a far better definition on the depth of, and horizontal boundaries of the gas pocket by analysing shallow-seismic profiles.

Another seismic picture which may indicate a high gas content in shallow formations appears as a "chaotic" area on the seismic sections. This means that it is impossible to follow the various reflections through this area on a seismic section. This means that it is impossible to follow the various reflectors through this area on a seismic section. There are a number of such examples in the North Sea, Figure 10 P shows one of them.

Shallow gas in the North Sea

Shallow gas accumulations are found over a wide area in the whole of the North Sea and at several different layers. There is nevertheless a significant increase in the number as we move from the south (the Ekofisk area) to the north (the Statfjord area).

Most of the shallow gas pockets known from the North Sea are accumulated in the rocks where the gas has been formed. This will usually mean that they are not overpressured. We know of very few examples from the Norwegian Shelf of shallow gas pockets under pressure.

10.5 ENVIRONMENTAL FACTORS

The Working Environment Act is facilitating an improvement of the environmental standard at the work locations. It is stipulated in the act how the work of improving the environment

shall be pursued and which requirements the working environment must satisfy.

The enterprise itself shall uncover and solve its environmental problems, and the indivual employee has main responsibility for ensuring compliance with the act.

It would hardly be possible to spell out the individual working environment requirements in detail in an act. The act must by necessity contain criteria referring to appraisal. It does point out, however, the working environment factors which must be evaluated, both individually and in view of the possible effect to the workers physical and psycological health and welfare.

Some of the working environment requirements are regulated in regulations stipulated by the Petroleum Directorate. Furthermore, the Petroleum Directorate's inspectors supervise on regular inspections that the working conditions on the offshore installations are within acceptable standards.

From a prinsipal point of view, a distinction may be made between the "inner environment", the work location, and the "outer environment", the surroundings where the rest periods are spent, that is the conditions outside of the enterprise. The very "outer environment" is linked with the working environment in many ways, for instance in case of pollution of the air with dust, gases or vapours.

The required cleaning of a number of work locations with the help of suction facilities is unfortunately not automaticly combined with required cleaning of the "out-air" before it is released. Therefore, the unfortunate combination may be experienced that a securing of the work location may lead to increased pollution of the "outer environment". It is important to be aware of the unfortunate consequences this may have for offshore installations, where the outer and inner environment make up an integrated whole.

If we look at some of the working environment problems which

the Petroleum Directorate has made an effort to solve in 1979, this applies, above all, to the work of reducing the nuisance/damage of oil-based drilling mud.

Oil-based drilling mud

It is accepted that drilling mud makes up a substantial factor both as concerns drilling, production and safety. The purpose of the drilling mud may be divided into the following points:

1) To remove cuttings and dust from the bottom of the well and to bring it to the surface.

2) To cool and lubricate the drilling bit and the drilling pipe.

3) To build up a filter cake on the wall of the well.

4) To control the "downhole" formation pressure.

5) To keep cuttings and dust floating by continuous circulation.

6) To release cuttings, sand and dust at the surface.

7) To provide buyancy to the drilling pipe and casing.

8) To reduce the adverse effects that the drilling may have to adjacent formations to a minimum.

9) To facilitate that as much information as possible is provided about the formations penetrated by the drilling bit.

10) To transfer hydraulic forces to the drilling bit.

In the case of the extensive deviation drilling performed at, for instance, Statfjord A, as well as the properties of the formation, points 2 and 8 have been of decisive importance

for the selection of oil-based mud. In relation to point 8 it is of importance that the formation of the reservoir is not damaged by blocking the producing zone.

General: The occupational hygiene problems arising in the case of day-to-day contact with oil or oil products are usually a result of skin irritation. Mineral oils have a drying and fat-removing effect to the skin, and this may lead to irritation and increased susceptibility to infections. Oil abscesses may start as small points in the skin and may grow to measure in centimeters and become permanent (oil abscesses). Allergic eczema may occur for patients coming in contact with mineral oils.

It has been known for a long time that mineral oils may release skin cancer in case of long-term influence. It is considered that the substances causing cancer (agents) in mineral oils are first and foremost compounds in the group polycyclic aromatic hydrocarbons (PAH). At present, however, it is generally mineral oils (solvent refined, hydrofined) which are used, and this has lead to a substantial reduction of the PAH content.

It can nevertheless not be ignored that such compounds may be formed in the oil before use. However, it has been difficult to make investigations in this area.

Depending on the temperature of the oil, it will vapourize and pollute the atmosphere. Some of it may also be condenced into small drops (aerosoles) which may be suspended in the air for a long period of time.

By inhalation, the oil may be introduced into the lungs. An addition to irritating the lungs and the bronchies, it may also be assimilated by the blood. This may cause general solvent symptoms which, depending on the concentration may cause head-ache, nausea and intoxication.

Lasting and strong exposure may lead to so-called chemical pneumonia.

In the stomach, the oil drops may irritate the mucous membrane, with may lead to catarrh in the stomach with pains, nausea and vomiting.

In view of measurements, the Petroleum Directorate has issued directives concerning improvement of the ventilation. Recommended measures may be:

- Closed mud return - the mud is lead under the surface in the mud tanks.

- Maximum covering of the mud pits, combined with suction points over remaining open areas.

- Suction points over the shale-shakers.

To survey the occupational hygiene consequences of day-to-day contact with oil-based drilling mud, the Petroleum Directorate has started a project cooperation together with the Institute for Occupational Hygiene with the title:

- Qualities and quantitatively determination of components in diesel-based drilling mud. Establishment of data for a health-wise evaluation.

The project is divided into sub-groups:

- Qualities and quantitative determination of components in diesel-based drilling mud.

- Examination of the composition and quantity of solvents in oil-based drilling mud which drilling personnel is exposed to on fixed installations in the North Sea.

- Examination of how the same parameters are changed as the drilling program progresses.

- Evaluate the results both from a health risk point of view as well as from the point of view of establishing

data for an evaluation from a health point of view.

Mercury

The Petroleum Directorate has been advised that the personnel on the offshore installations has been exposed to mercury in concentrations exceeding the level which is acceptable from the present protection technical and occupational hygiene standards.

In connection with well testing, the use of mercury will be normal in the case of

1) - transfer of formation liquid from submersible probes, and in the case of

2) - transfer of oil separated in the test separator to transportable steel containers.

1) In the case of transfer of wellbottom samples to transportable containers, this is done by the help of a manually operated piston in a closed cylinder filled with mercury. When assembled, the very transfer system consisting of the sample collector, the mercury pump and the transport container makes up a closed system. The transfer is usually taking place inside a special cabin (Field Laboratory Cabin) which the operator leases from the firm which specialized in collecting tests (test contractor).

It is difficult to quantify to what extent the testing crew may be exposed to mercury with this transfer method. Since the transfer takes place inside a closed system, we will characterize the risk for exposure as small. The danger for exposure may, however, be present in case of the hooking up and disconnection of the test collector/transportation container and in the case of charging the pump sylinder with mercury if caution is not exercised. It may be stated that the transfer itself takes about 2 hours per test, while the hooking up and disconnection period will be on the order

of magnitude of 5 to 10 minutes. The number of transfers per well will naturally show variations three to four transfers per well is not unusual.

2) It the case of transfer of oil from a the separator to the steel container, this takes place when the separator pressure forces the separated oil into a steel bottle filled with mercury is installed in a fixed position. As the oil fills the bottle, the mercury is displaced and this is collected in a measurement sylinder of glass.

All the mercury collected is filled into bottles located in the Field Laboratory Cabin The transfer of oil to the steel bottle takes place close to the test separator and thus in near association with the test seperator and thus in free air.

Here, as under (1), it is difficult to estimate the degree in which the crew involved may be exposed to mercury. The risk for such exposure is present in that mercury may be spilt during the transfer from measurement glass sylinders to bottles and/or by filling mercury on steel bottles. It may be stated that the transfer period per separator sample is about 30 to 45 minutes, and that the usual practice is to take two such tests from each oil-producing "drill stem" test.

Health hazard

Mercury vapours are very poisonous. They are introduced in the lungs by inhalation. In case of swallowing, it appears that the pure mercury metal is not very poisonous. In older medical practice, patients with volvolus were given large quantities of mercury through the mouth, and no effects of poisoning were observed. The purpose was that the mercury, because of its weight, should release the part of the intestine which was squeezed.

Mercury and its compounds may be locally irritating and

etching to the skin and mucous membranes.

Mercury may easily be received through the skin, particularly in a finely dispersed form. The toxicity varies depending on the dissociations, but the joint mechanism is that the mercury ions are connected to the thiol-group of the enzymes and block their activity. In addition, the albumin molecules are denaturated.

The most usual clinical picture after exposure to mercury is, beside injured organes, psychological disturbances.

The early stages of the poisoning appears in that the poisoned person becomes nervous and easily irritated, with mood variations and sudden bursts of temper. The risk is large that these initial symptoms will not be associated with the mercury vapours.

Another indication of illness is trembling hands, which at a later stage may spread to other parts of the body, for instance eyelids, lips, tongue and bones. The inhalation of high concentrations over a longer period of time may lead to serious damage to the nervous system and the kidneys.

The work with mercury requires not only good personal hygiene, which is a requirement in all work with chemical substances and products, but also the implementation of a number ot technical safety measures. In addition, it is necessary to have regular control by a doctor (urine tests, etc.). The Hg-determination in air only takes a few seconds with the help of modern "Hg-sniffers". The limit value for mercury vapour, unorganic Hg-compounds and organic non-alkyl-Hg-compounds is stipulated at 0.05 mg/m^3.

Polymer fever

The Petroleum Directorate has been informed about cases of illness among electricians using polyethylene shrinking plastic for marking PVC-isolated wires. The symptoms described are

shivering, fits of coldness, limpness and temperature rises, and these are typical for the toxic reaction described as polymer fever.

It has for a long time been known that pyrolysis products of polytetrafluorethylene may lead to this illness, but since polyethylene does not contain any fluorcarbons, it was a completely unexpected result. Later information from the producer to the effect that polytetrafluorethylene and freon were used as lubricants on the marking sleeves seems to provide the answer, since the worker under heating/shrinking of marking sleeves exposed to pyrolysis products containing fluorcarbons.

Later investigations have shown that it is rather unlikely that pyrolysis products are formed at the temperatures occurring during shrinking. The present opinion is that polymer fever is released in connection with smoking because of inhalation of plastic pyrolysis products with the cigarette smoke. This theory is supported by the fact that at least in one of the case the poisoning took place although the marking sleeve was not beir shrinked. It is thus an absolute requirement that smoking does not take place during work with shrinking of marking sleeves, and at the same time, extensive requirements are stipulated for personal hygiene, particularly in connection with smoking breaks.

Noise

The workers on offshore installations are generally exposed to high noise strains. Exposure to high noise levels over a long period of time may cause permanent damage to the hearing. It is a general experience among offshore personnel that a certain acclimatization period is necessary to adjust to the high noise level on the platform after a relatively noise-free onshore period. In the same way, an acclimatization period for the lower onshore noise level is necessary when the rest period is started.

These variations may in some cases have the effect of lack of sleep and irritation, and may thus influence the psychological heath of the employees. Distortion of speech will take place in noisy surroundings, and misunderstandings in oral communications will lead to a safety risk, which may in the most extreme cases lead to fatal results.

It is a demand in the public environmental debate to employ substantial resources to reduce the damage because of noise. Storting Report No. 50 (76-77) draws up the general objectives and principles for the work with noise problems, and lays the plans for an action program against noise.

This is carried further in the Work Inspectorate's hearing draft about new noise regulations which will apply to onshore activities.

In the near future, the Petroleum Directorate will raise the question of noise on offshore installations for a close examination. The Petroleum Directorate's objective is that the working conditions on offshore installations shall be of the same standard as those of the onshore activities. In view of this, it seems clear that a strengthening in the struggle against noise pollution will be one of the areas where resources must be applied in the near future.

CHAPTER 11. STATISTICS/REVIEWS

11.1 EXPLORATION DRILLING AND DELINEATION DRILLING IN THE NORWEGIAN SECTOR OF THE NORTH SEA

Since the exploration activity started in the Norwegian sector of the North Sea in 1966, a total of 238 exploration and delineation wells have been started as of 31 December 1979. Of these, 229 had been completed on the same date. Information from these wells are listed in statistics to clarify some aspects of the activity which has taken place.

A total of 642,246 meters have been drilled in the wells

included, whereof 95,343 meter have been drilled in 1979. The average well depth for the wells started in 1979 is 3287 meters. The average costs of the wells started in 1979 is about 40 million kroner, this gives an average cost of 13,230 kroner per meter.

Table XIV shows the "rig months" per quarter up until 1980.

Table XV shows how many wells have been started each calendar monght over the same period.

Table XVI shows the average water depth and total depth of the wells started each year.

The deepest well in the Norwegian sector of the North Sea is 30/4-1 with BP as the operator. The drilling was started in November 1978 and completed in March 1979 at 5430 meters depth.

The deepest water in which drilling has taken place up until now is 371 meters. The well was 34/4-1 with Saga Petroleum as operator. At the turn of the year 79/80, Amoco started drilling on 34/2-1 with a water depth of 388 meters.

For the drilling of the wells covered by the statistics, 39 different drilling rigs have been used (Table XVII). Of these, 27 are of the semisubmersible type, 8 are jack-ups and 4 are drilling ships.

11.2 SHIPMENT OF CRUDE OIL FROM TEESSIDE

The distribution of crude oil from Teesside appears from Figure 11 A.

It appears from Figure 11 A that the largest part of the exported quantities goes to the USA and Great Britain. The oil in the North Sea has a low content of sulphur, and this makes the oil particularly well suited for refining in American refineries. It also appears that West Germany receives

an increasing part of the oil exported onwards from Teesside.

11.3 NORM PRICE DEVELOPMENT

The norm price development from 1975 to and including the 2nd quarter of 1979 appears from Table XVIII.

11.4 MONTHLY PRODUCTION FROM EKOFISK, FRIGG AND STATFJORD IN 1979.

The monthly production from Ekofisk, Frigg and Statfjord appears from Tables XIX, XX and XXI.

Board of Director's Report

There has been a very high level of activity on the Norwegian Continental Shelf in 1979, and a corresponding number of tasks for the Norwegian Petroleum Directorate.

The hydrocarbon production increased considerably by comparison to the preceding year. The exploration activity showed encouraging results and several new reservoirs were found. Even though it is still too early to say anything about the magnitude and possible commercial production from these discoveries, the fact that they have been discovered makes it necessary for the directorate to prepare extensive and complicated analyses and reports. Not least on this background it is very regrettable that the Directorate has lost so many of its experienced employees in the year gone by. During the year, about 14% of the staff has resigned. The Board of Directors is very concerned about this and considers it to be a very important task to make the directorate more competitive as consern salary and other conditions of emplyment.

The world's present and expected oil supply situation emphasizes a steadily increasing demand for improved exploitation of oil resources. In this connection, early utilization of methods to increase recovery (by supplementing the natural driving force in the recervoirs) has been a point of considerable interest in Norway. In cooperation with the licensees, the Norwegian Petroleum Directorate has stressed the study of methods to increase recovery from fields in the Ekofisk area and Statfjord. There is great interest in the possibilities for water injection at the Ekofisk Field, and possibly at other fields in the area. At the same time, we note with satisfaction that production from Statfjord has been planned with both water and gas injection. It is important that the professional environment that is being established in Norway will be strengthened with increased efforts in the research sector and as regards study of methods, among other things.

An important event in 1979 was the granting of 8 blocks in the 4th licensing round. This granting has not only led to a significant increase in the drilling activities, but has also led to discovery of several hydrocarbon reservoirs. The results so far imply an important confirmation of the expected reserves south of 62°N and have therefore given an improved basis for further planning of the activity. In the years to come there will be important planning tasks which need to be followed up to secure effective operation, both at the individual field and as a whole. The Norwegian Petroleum directorate considers it to be an important task to continue to contribute effectively in this connection.

Another imortant development in 1979 is the preparations undertaken for drilling on Troms I and offshore. Møre/Trøndelag. It is estimated that drilling will be started in these areas within the summer of 1980, and this will have natural consequences for the extent of the Norwegian Petroleum directorate's tasks. The Norwegian Petroleum directorate's survey of the conditions in these two areas is an important basis for the activity. The Directorate considers it to be important that the survey activity on the rest of the shelf north of 62°N continues at the same level.

New regulations pursuant to the Work Environment Act were issued on 1 June 1979. The regulations amplify some points which appeared to need clarification, but are not significantly different from the provisional regulations of 24 June 1977.

The Norwegian Petroleum Directorate has arranged a working conference concerning work environment conditions (Bryne II) in the period covered by this report. The conferences, Bryne I in 1978 and Bryne II in 1979 have uncovered a clear need and desire for continous follow up of such projects wherein the involved employees themselves participate in the planning and establishment of a basis for better and safer work environments.

In the course of the year, considerable work has been done to get more detailed and accessible statistics for those parts of the activity on the continental shelf with which the Norwegian Petroleum Directorate is occupied. This will not only assist the registration, but is also an aid in the Directorate's work, such as bringing risk factors to light, preparing forecasts of produktion and activity, cost assessment, etc.

The Directorate considers it to be important

that the divers have the necessary qualifications for carrying out their tasks. We are therefore pleased that special training of divers has been started in 1979 under the direction of the Interim Board for diving Education. The Directorate has on its part worked towards stipulation of provisions for issuing diving certificates which will evidence that the divers have the qualifications that are required. They are available and will be made applicable to anyone diving on the Norwegian Shelf after 1 July 1980.

The diving operations will be regulated by different sets of legislation, depending on wheter they take place from fixed installations, movvable drilling vessels or from Norwegian or foreign ships. A splitting-up of responsibility as a consequence of this for a relatively small group of employees such as the divers, is undesirable. It should be a goal to have a uniform set of regulations for divers and a limitation of the number of responsible government authorities.

It is regarded as positive that compounding of interests on the part of employees and employers has taken place. It is anticipated that this coordination will contribute to a greater degree of solving conflicts at the organizational level rather than bringing conflicts before the Directorate.

Guidelines for the licensees's own inspection and control were stipulated by the Norwegian Petroleum Directorate on 7 June 1979. The intention of the guidelines is to clarify one of the basis principles for the control regarding the petroleum activity on the continental shelf. The guidelines elucidate important aspects of the licensees' own inspection and control tasks and the development of the licensee's organization to look after this task, as well as the authorities' supervision of this control. A licensee's own inspection and control is to control and, if necessary, order implementation of measures to ensure that planning, design, construction, installation and operation take place in a sound manner in accordance with applicable laws and regulations.

The guidelines have been submitted for comments by the parties involved, and the comments received have been taken into account to the extent that this was considered appropriate. A meeting has also been arranged with the licence operators and other institutions associated with the activity on the continental shelf with a view to start a discussion about the basic principles and special aspects of the draft that was submitted for comments.

After 1 January 1979, the Directorate has been reporting to the Ministry of Local Government and Labour in matters concerning safety and work environment. The directorate has thereby been in the somewhat unusual situation of reporting to two ministries, namely both the Ministry of Petroleum and Energy and the Ministry of Local government and Labour. The system has not appeared to create particular problems so far.

The Ministry of Local government and labour has impressed upon the control institutions reporting to the Ministry that the economic aspects of work environment measures and safety measures must be studied before decisions to implement such measures are made. Such studies have been prepared by the Directorate at previous occations also, and experience shows that this involves considerable work and presupposes a comprehensive data basis. The Board of Directors therefore finds it necessary to strengthen the economic/technical expertise in the Directorate.

Parts of the directorate moved into new premises in the autumn of 1979. Even though this has provided a solution to the office problem in the short run, it is awkward and cumbersome to have to continue to operate with premises at several locations. The Board of Directors considers it necessary to bring the Directorate together in one building, and the Board of Directors was pleased to receive notice that the Rogaland County Council had made a decision in principle that the Directorate should be granted a site in the Ullandhaug area. The Ministry of Petroleum and Energy has received the Directorate's «room program» and will continue the work on this matter.

On the background of the organizational study carried out by the Board of Directors in 1978, the Board of Directors submitted its proposal for changes to the Ministry in June of 1979. In the main, the proposal was followed up and the changes were implemented on 1 January 1980.

FIG. 1A

Sverdrupsgt. 27 — der deler av Oljedirektoratet flyttet inn høsten 1979.

Sverdrupsgt. 27 where parts of the Norwegian Petroleum Directorate moved in in the autumn of 1979.

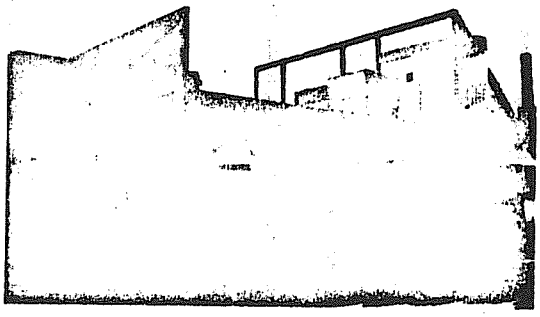
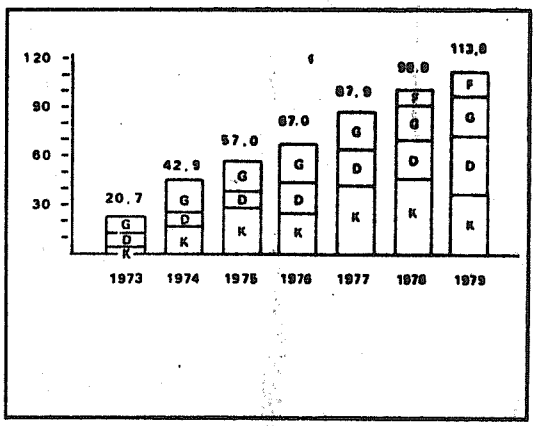


FIG. 1B

Bokførte utgifter fordelt på budsjettkategorier i årene 1975—1979.

Expenses divided into budget categories in years 1975—1979.



K - REIMBURSALBLE CONTROL EXPENSES
D - OPERATING COSTS
G - GEOPHYSICAL AND GEOLOGICAL EXPENSES
F - SAFETY AND EMERGENCY PEPAREDNESS COSTS

FIG. 1C

Innbetaling til statskassen ved salg av geofysiske data pakker.

State revenues from sale of data packages.

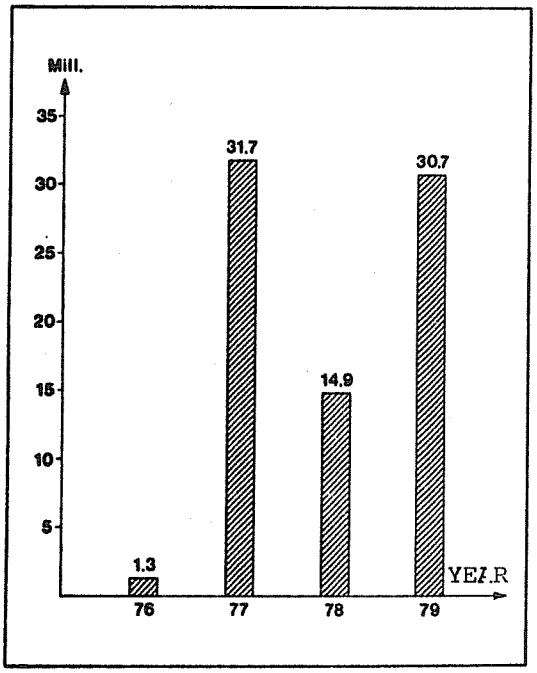


FIG. 2A
Seismiske undersøkelser i Barentshavet 1979
Seismic surveys in the Barents Sea 1979.

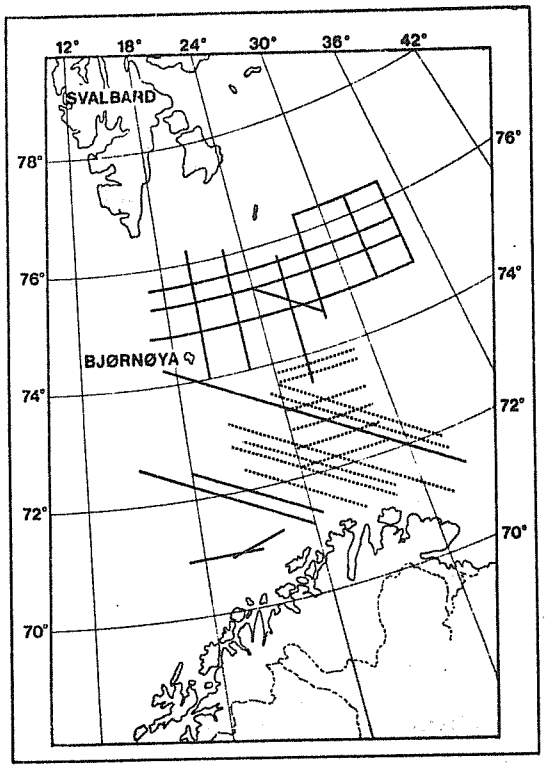


FIG. 2B
Helgeland. Seismiske undersøkelser i 1979.
Helgeland. Seismic surveys in 1979.

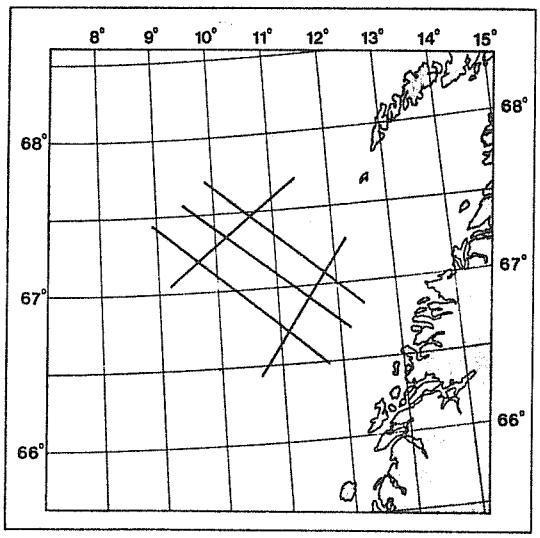


FIG 2C
Undersøkelsesnett, Jan Mayen 1979.
Seismic grid, Jan Mayen 1979.

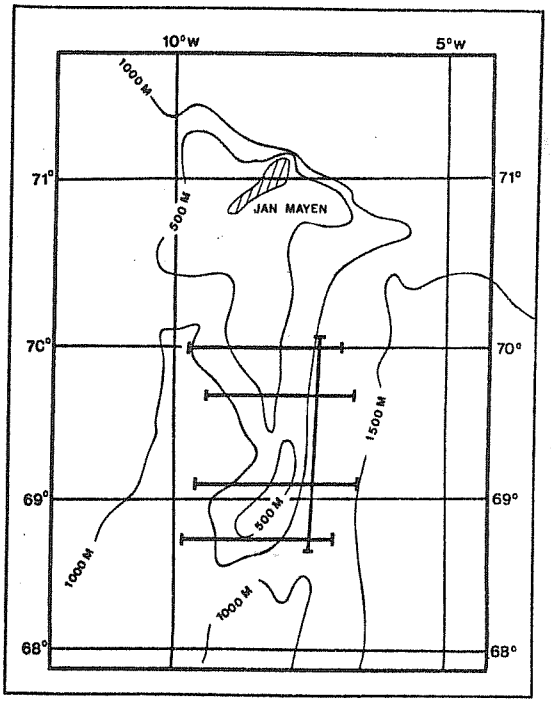


FIG 2D
Seismiske linjer i Norskehavet 1979.
Seismic lines in the Norwegian Sea 1979.

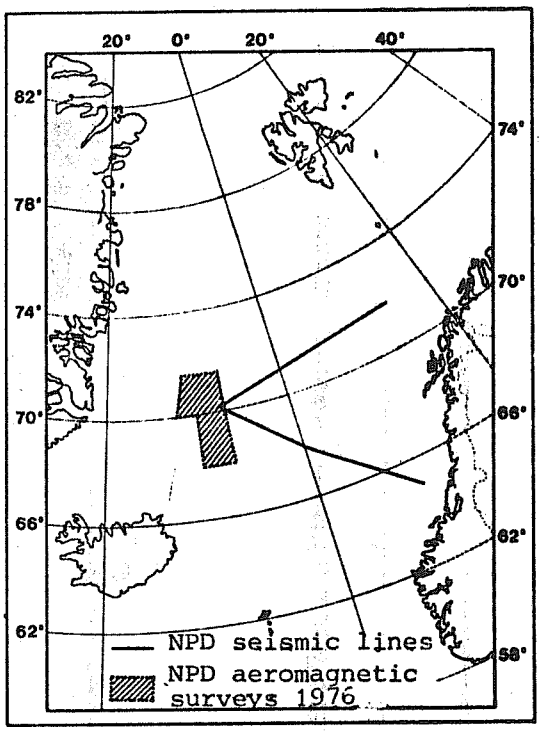


FIG. 2F
Geofysiske undersøkelser utført av selskaper på den norske kontinentalsokkel (inkl. nord for 62°N).
Geophysical surveys carried out by companies on the Norwegian Continental Shelf (areas north of 62°N).

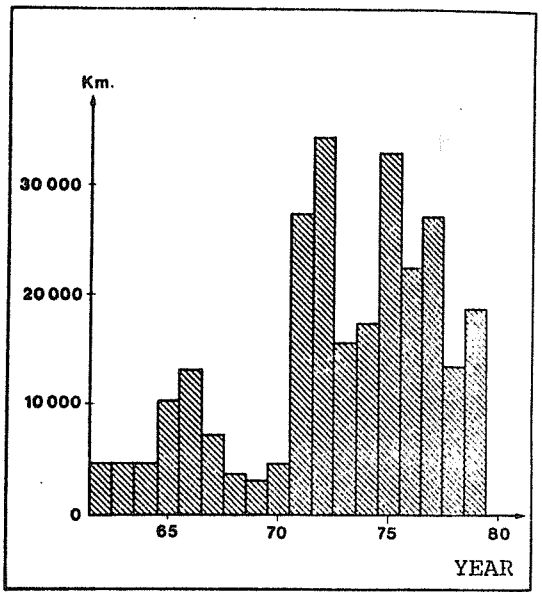


FIG. 2E
Statlige seismiske undersøkelser nord for 62°N.
Governmentally conducted seismic surveys north of 62°N.

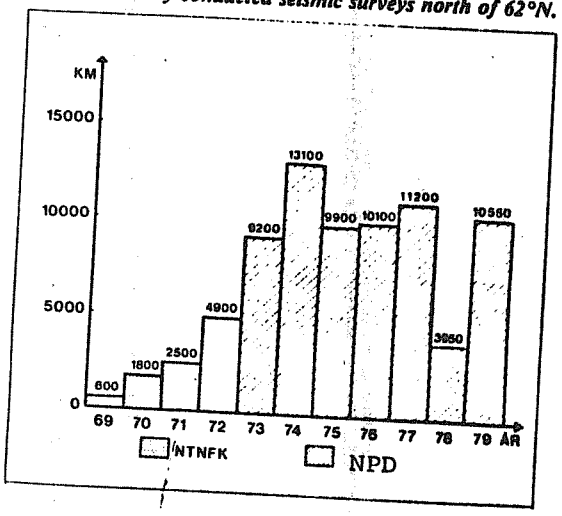


FIG. 2G
Nummerering av blokkene i Troms I-området.
Block numbers in the Troms I area.

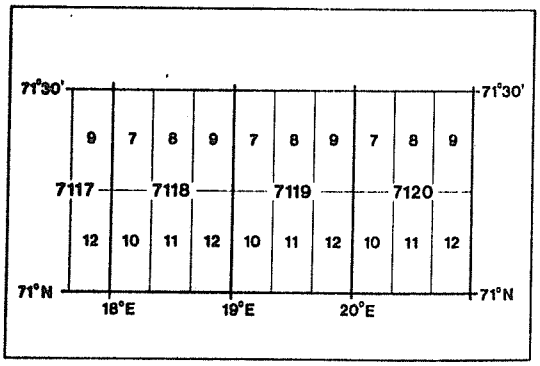


FIG. 2H
Nummerering av blokker på Haltenbanken.
Block numbers in the area west of Haltenbanken.

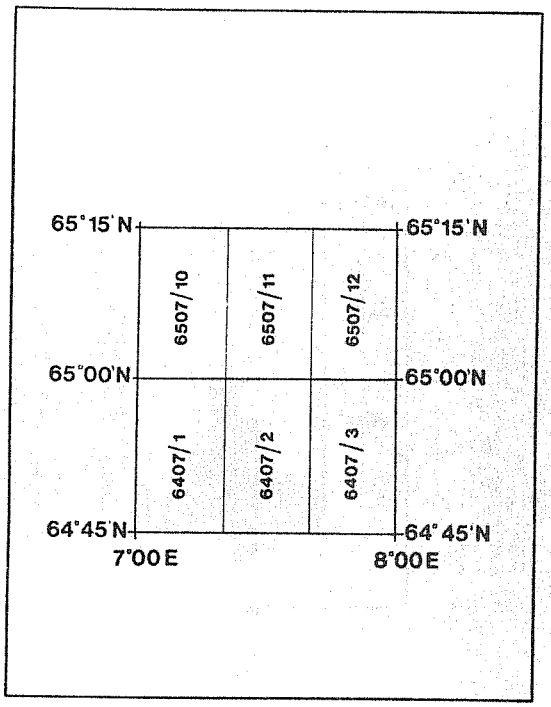


FIG. 2I
Boreaktiviteten på den norske kontinentalsokkel (antall borehull påbegynt pr år).
Drilling activity on the Norwegian Continental Shelf (number of wells spudded per year).

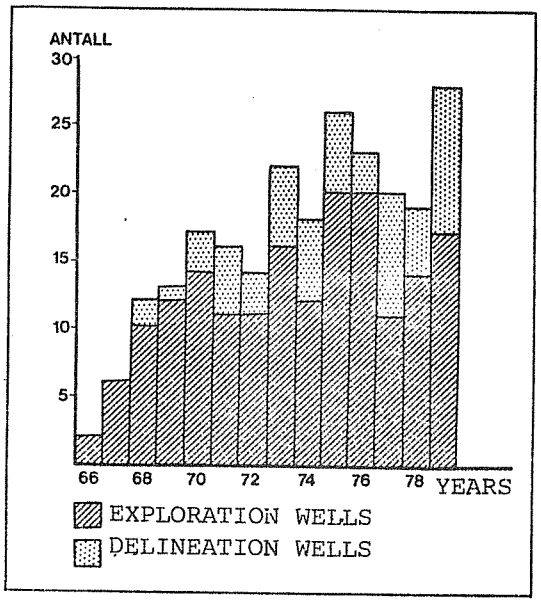


FIG. 2J
Borehull i 1979 i forhold til de strukturelle hovedtrekk.
Wells drilled in 1979 in relation to main structural elements.

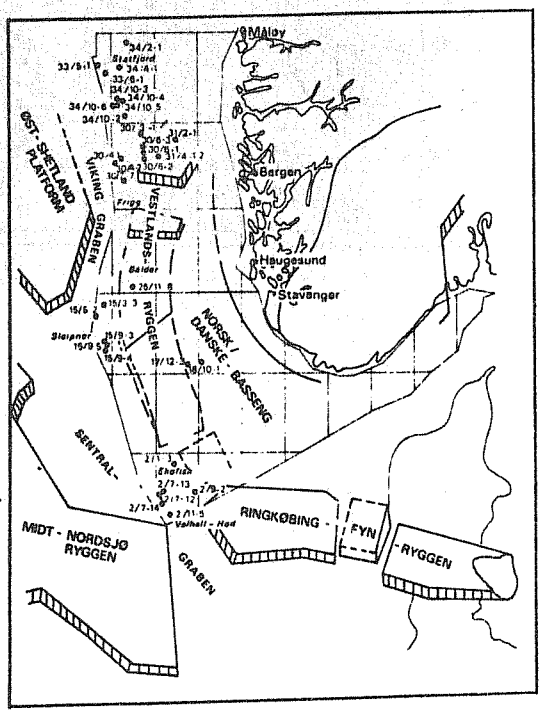


FIG. 2K
Ekofisk-området.
The Ekofisk area.

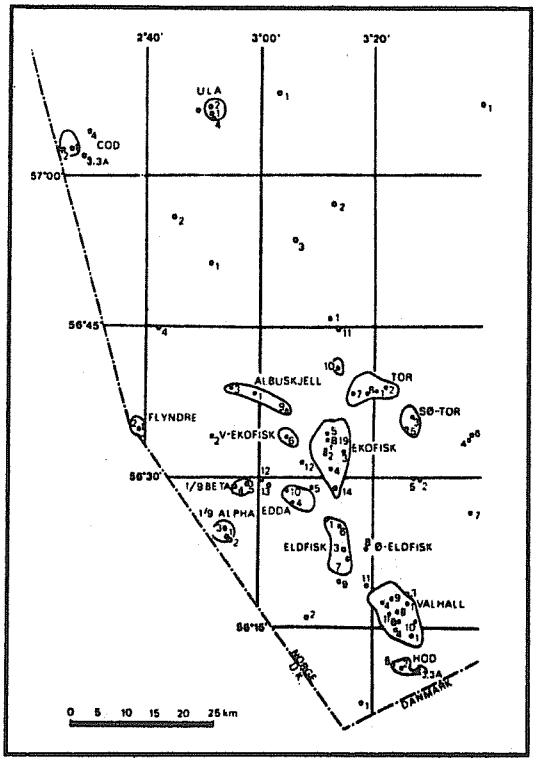


FIG. 2L

Figuren viser gassmengdene som er injisert i Ekofisk-feltet i årene 1975—1979. 90% kapasitetsutnyttelse av injeksjonsutstyret er avsatt som en rett linje fra året 1975 til 1979. Tilgjengelig gass for injeksjon var ca 3 x 10^9Sm³ i 1975. Ordinataksen til høyre viser hvorledes utvinnbare oljemengder har økt for hvert av årene som følge av gassinjeksjonen. Figuren viser også at ved 90% kapasitetsutnyttelse av injeksjonsutstyret ville de utvinnbare oljemengder kunne økes med over 4 mill. tonn olje.

This graph shows the quantity of gas injected into the Ekofisk field during 1975—1979. The use of 90% injection capacity is shown by a straight line at 4,13 x 10^9Sm³/year. The quantity of gas available for injection was 3 x 10^9Sm³ in the year 1975. The right hand ordinate axis of the graph shows the increase in oil reserves in the Ekofisk field due to gas injection each year. If the 90% capacity of injection equipment had been used, the reserves in the Ekofisk field could have been increased by about 4 x 10^6 tons of oil.

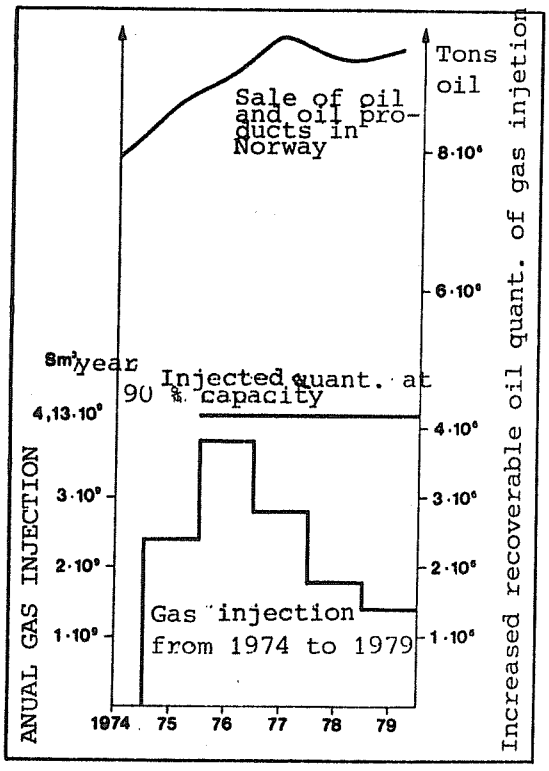


FIG. 2M
Anlegg for felt i Ekofisk-området.
Installations in the Ekofisk area.

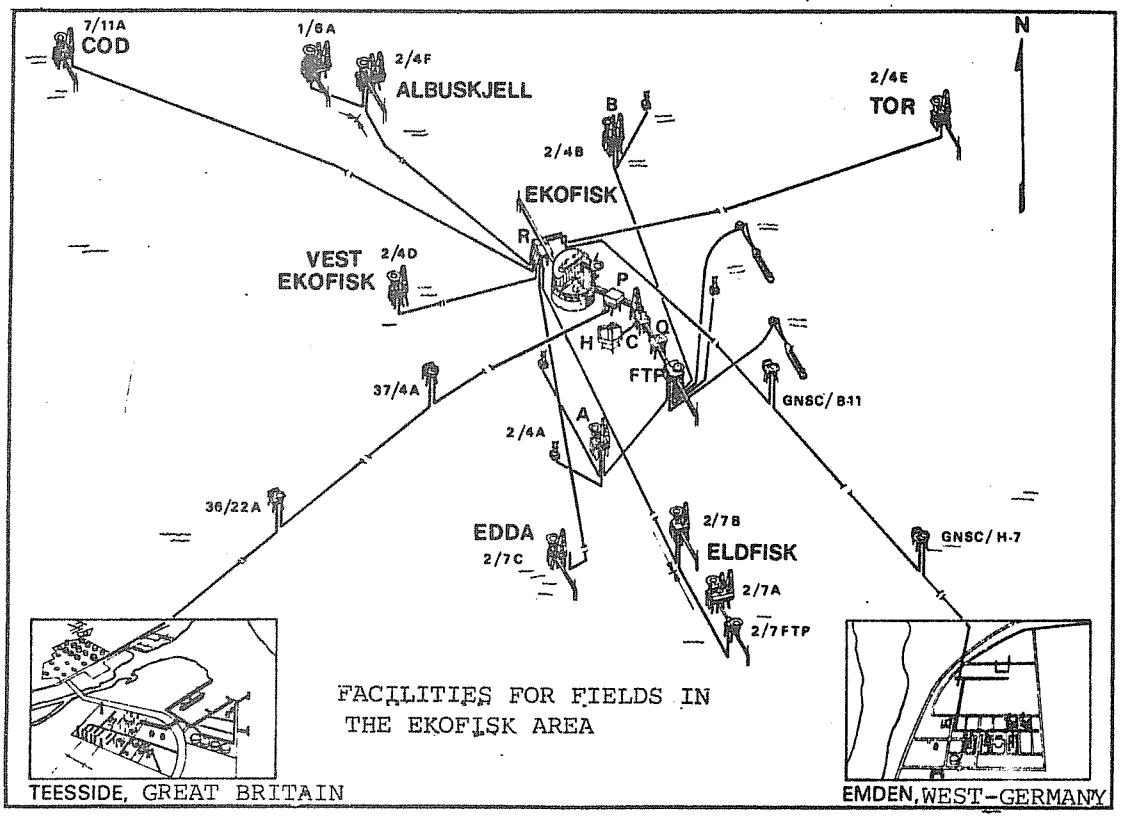


FIG. 2N
Gjennomsnittlig gassmengde brent på Ekofisk.
Average quantity of gas flared on Ekofisk.

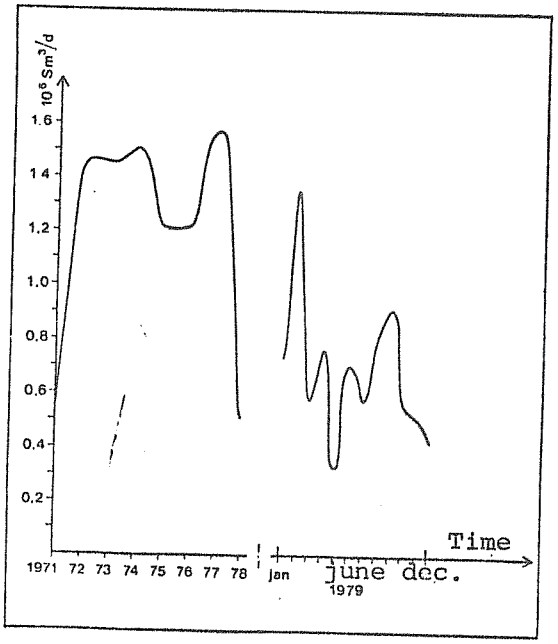


FIG. 2O
% gjennomsnittlig gassmengde brent av total gassproduksjon på Ekofisk.
Percentage average flared gas out of total gas production on Ekofisk.

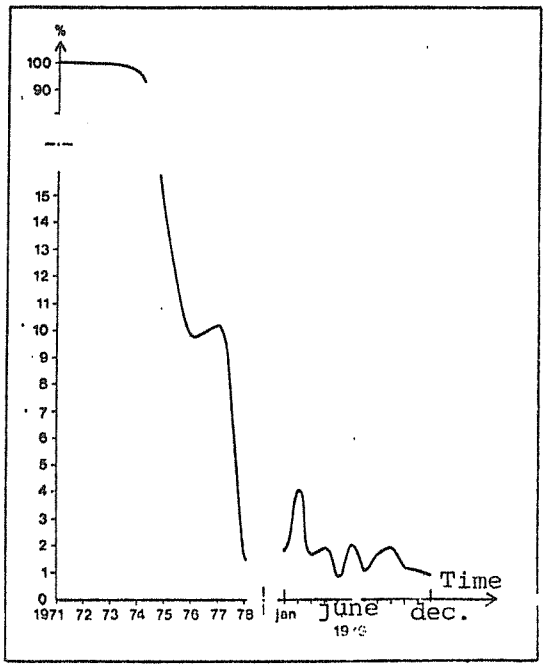


FIG. 2P
Installasjoner på Valhall.
Installations on Valhall.

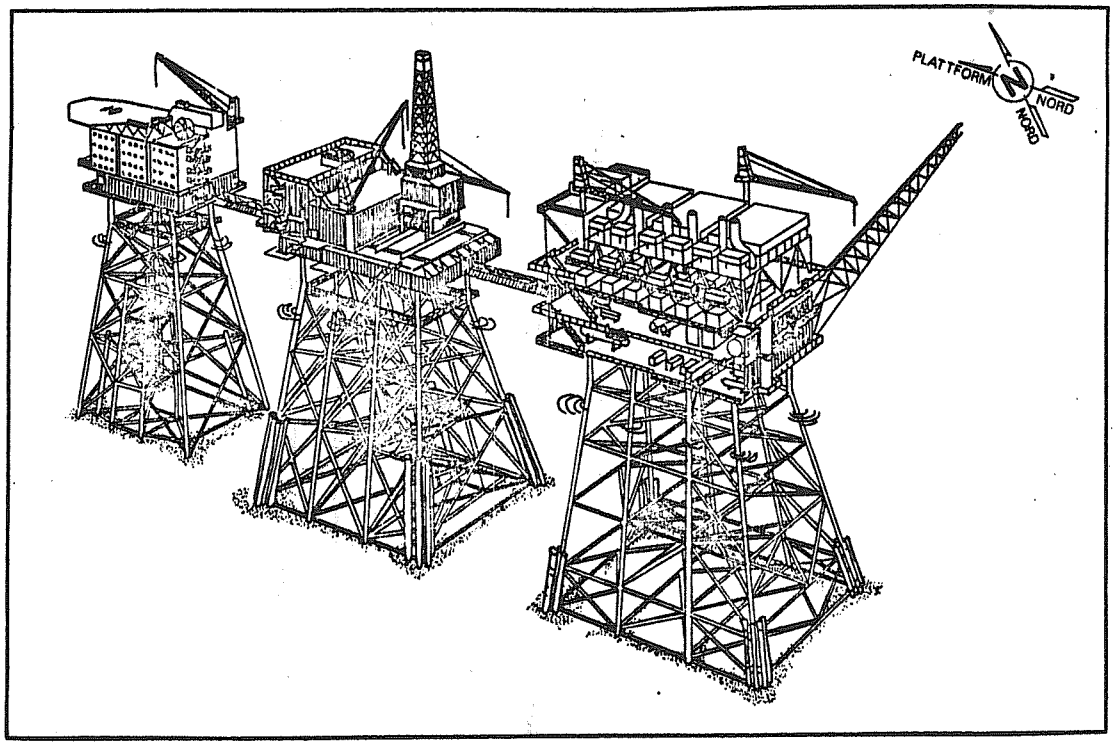


FIG. 2Q
Frigg-området.
The Frigg area.

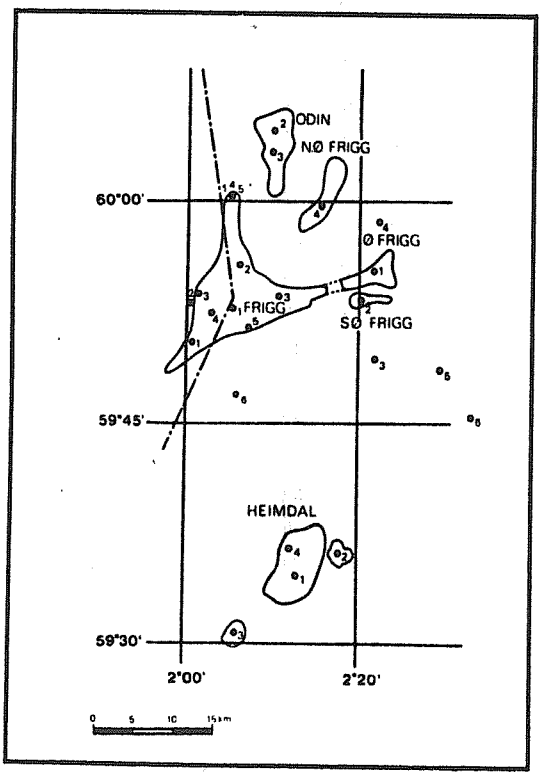


FIG. 2R
Installasjoner på Frigg.
Installations on Frigg.

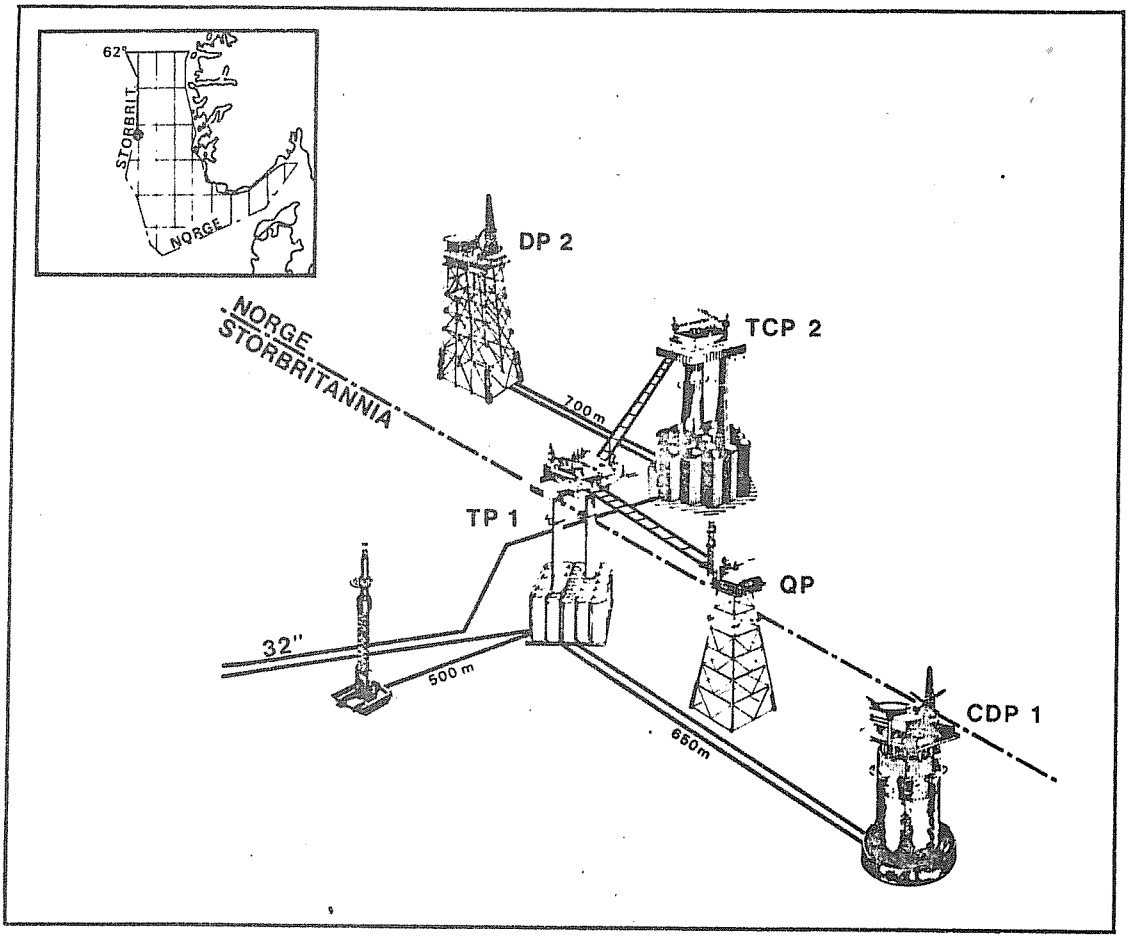


FIG. 2S
Statfjord-området.
The Statfjord area.

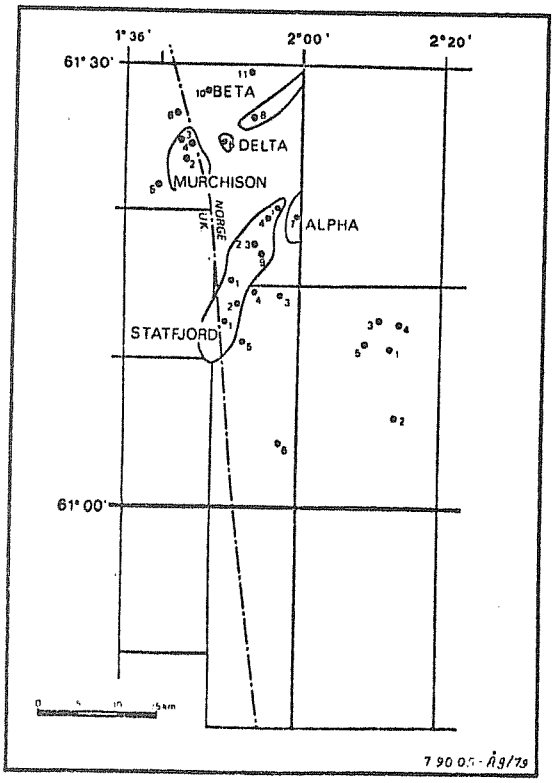


FIG. 2T
Utvinnbare reserver sør for 62°N pr 31.12.79.
Recoverable reserves south of 62°N.

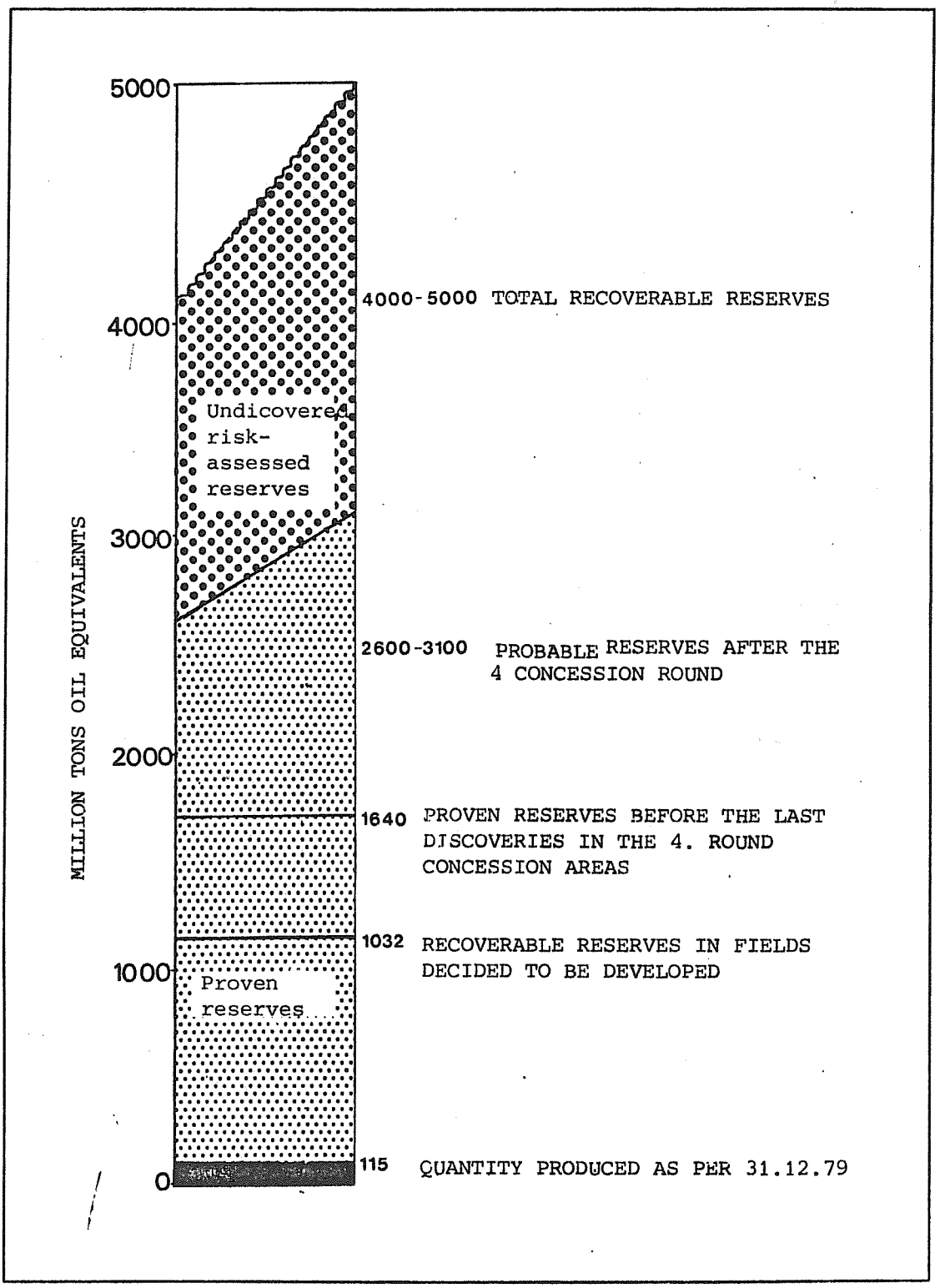


FIG. 2U

Prognoser for samlet uttak og faktisk produksjon av petroleum fra norsk sokkel (mill tonn oljeekvivalenter).

Prognosis for total recovery and actual production of petroleum on the Norwegian Continental Shelf (mill ton oil equivalents).

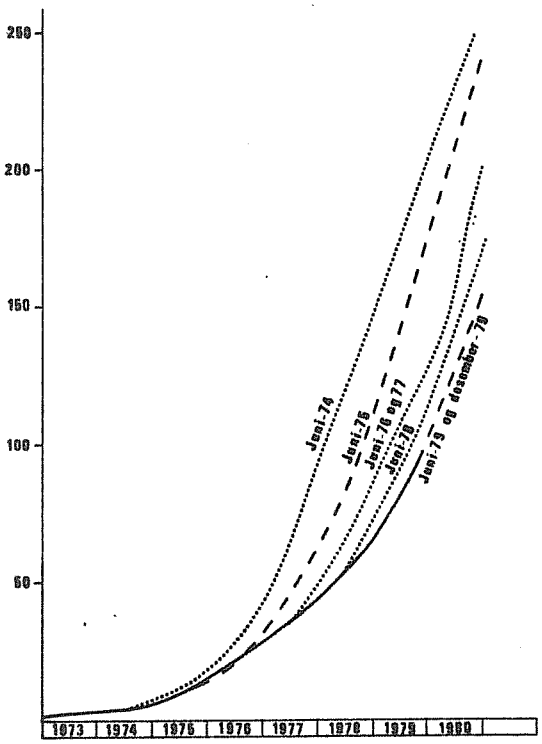


FIG. 2V

Prognose for produksjon av petroleum.

Prognosis for production of petroleum.

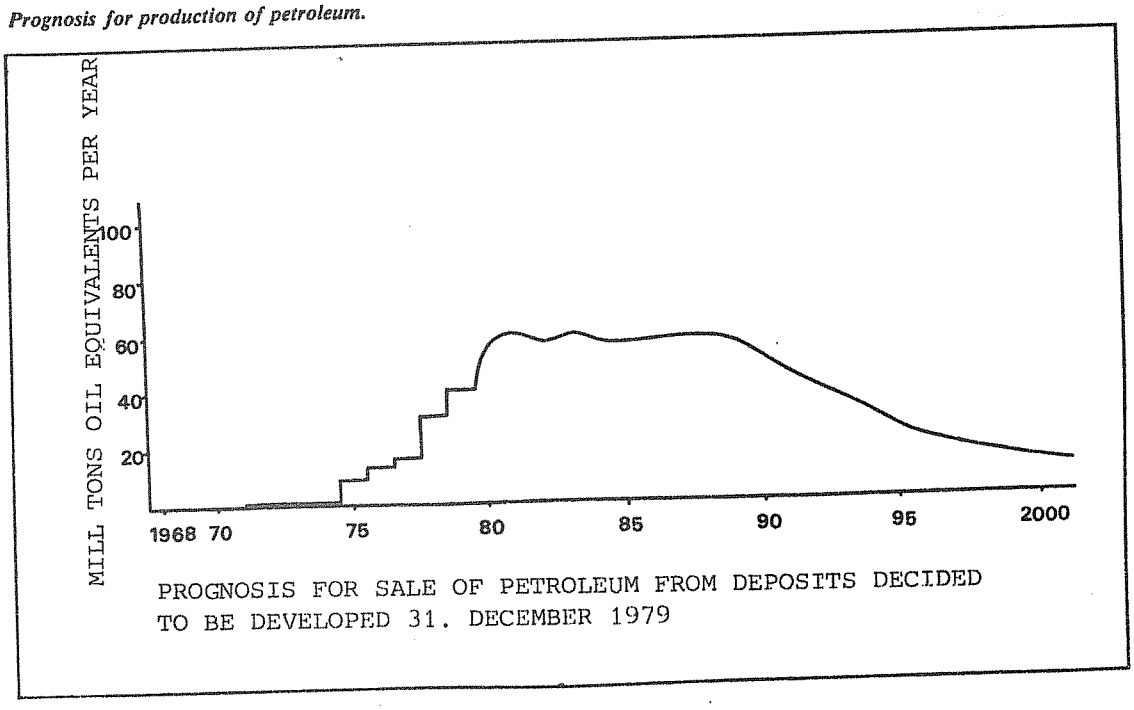


FIG. 3A
Områder med frigitte seismiske data.
Areas with released seismic data.

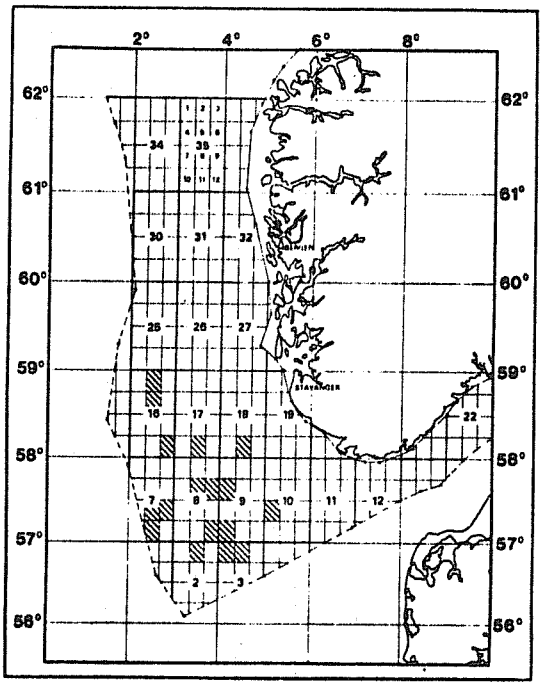


FIG 4A
Skjematisk framstilling av oppbygging av og samarbeid innenfor vernetjenesten.
General outline of structure of and cooperation within the safety organization.

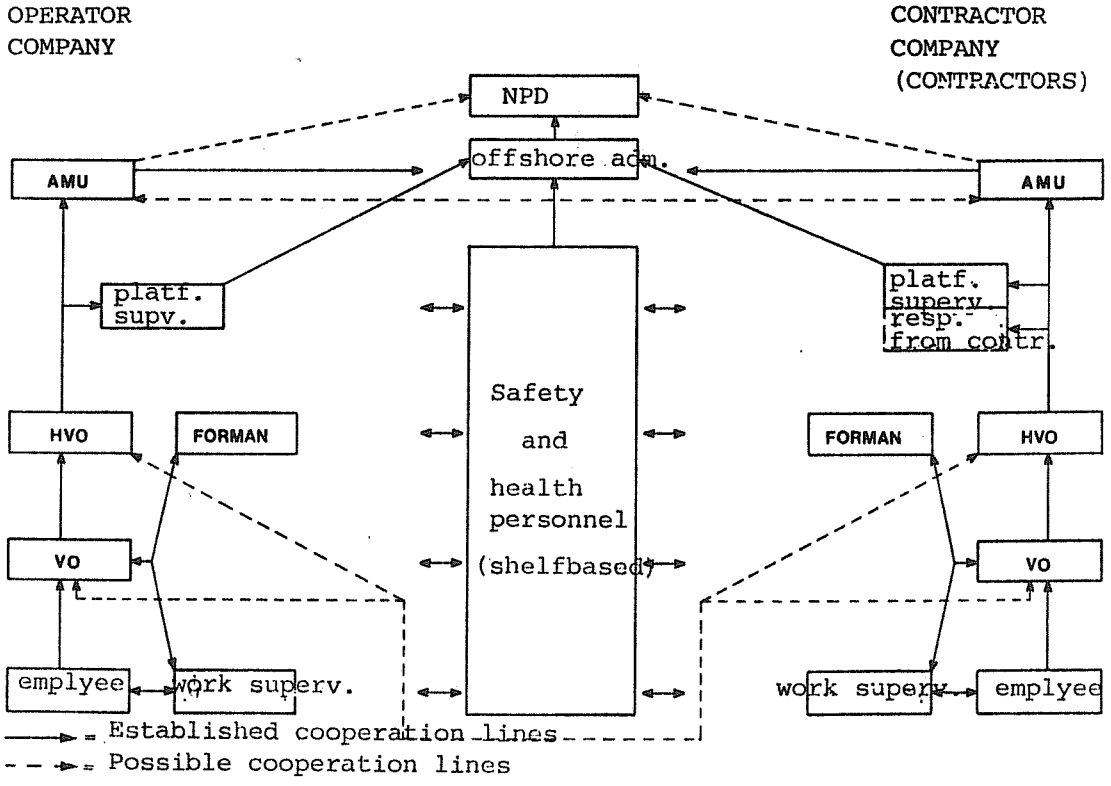


FIG. 9A
Produksjonsavgift 1974—79 — Prognose 1980—81.
Royalties 1974—79 — Prognosis 1980—81.

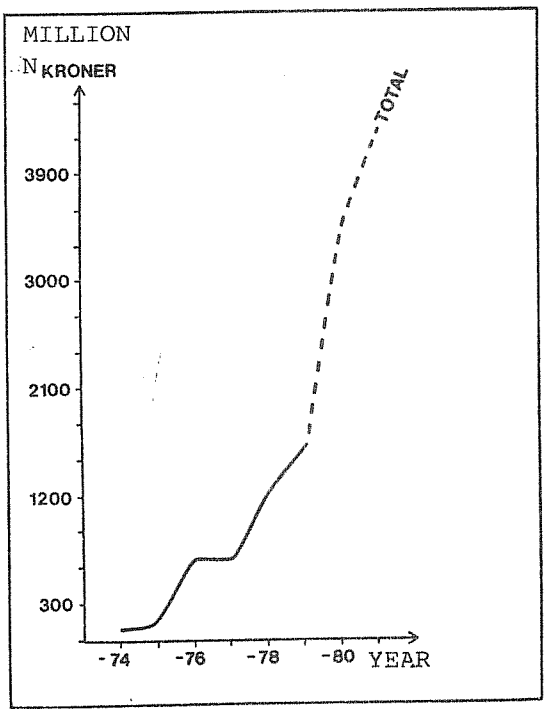


FIG. 9B
Utviklingen av normpris på råolje for royalty-formål.
Development of normprice on crude oil for royalty purposes.

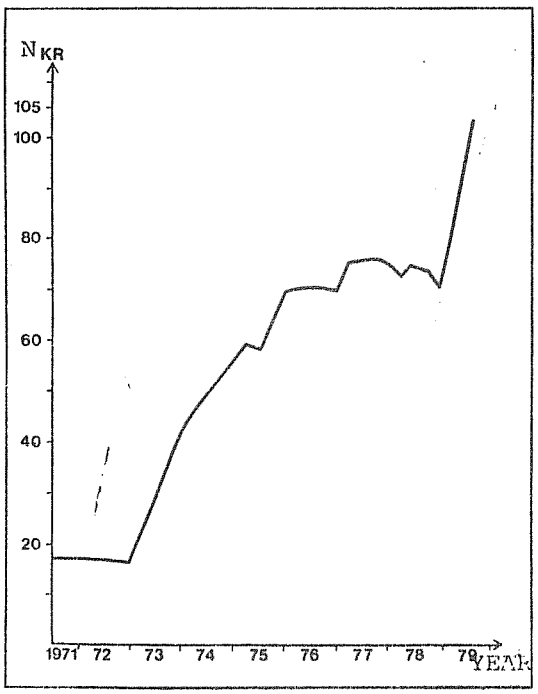


FIG. 9C
Utgiftene til teknisk og sikkerhetsmessig kontroll i perioden 1973—1979, fordelt på produksjonsfelt.
Technical and safety control expenses for the period 1973—1979.

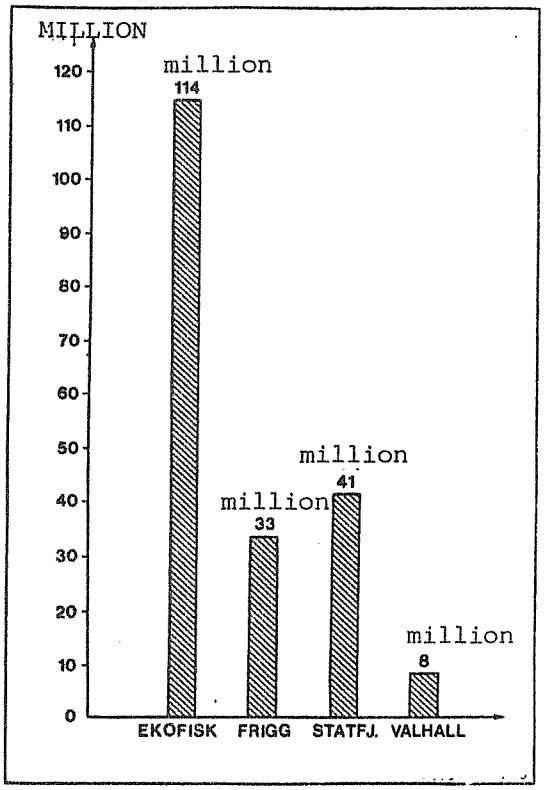


FIG 10G
Prinsippskisse av gassmåler.
Principle of gas metering.

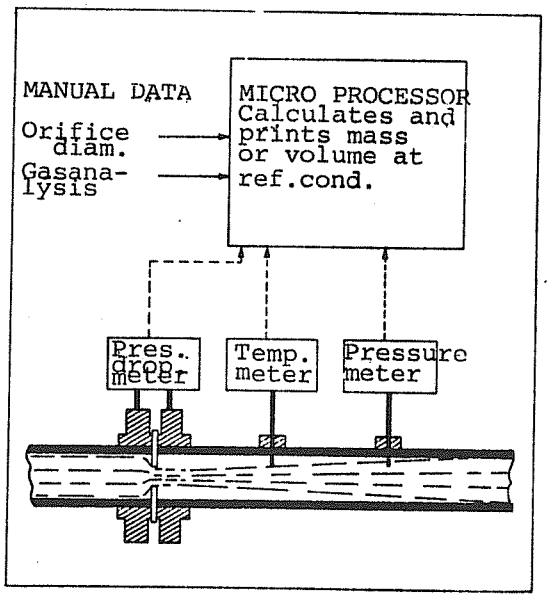


FIG 10H
Prinsippskisse for oljemåler.
Principle of oil metering.

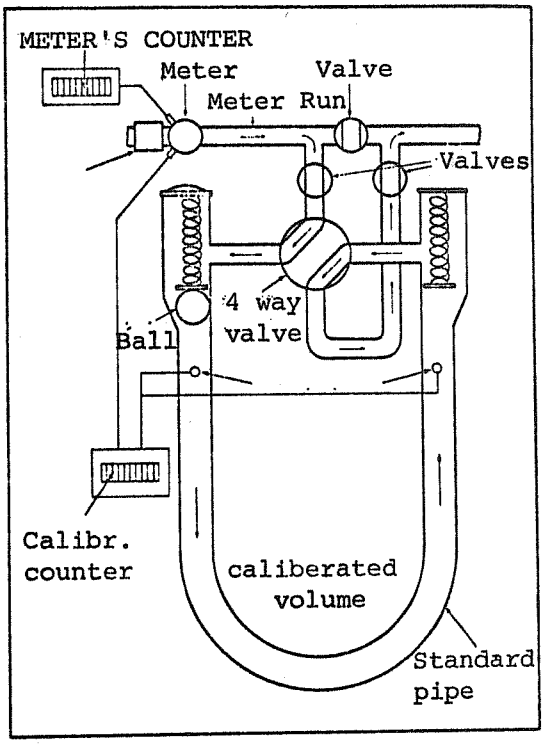


FIG. 10I
Turbinmåler.
Turbine meter.

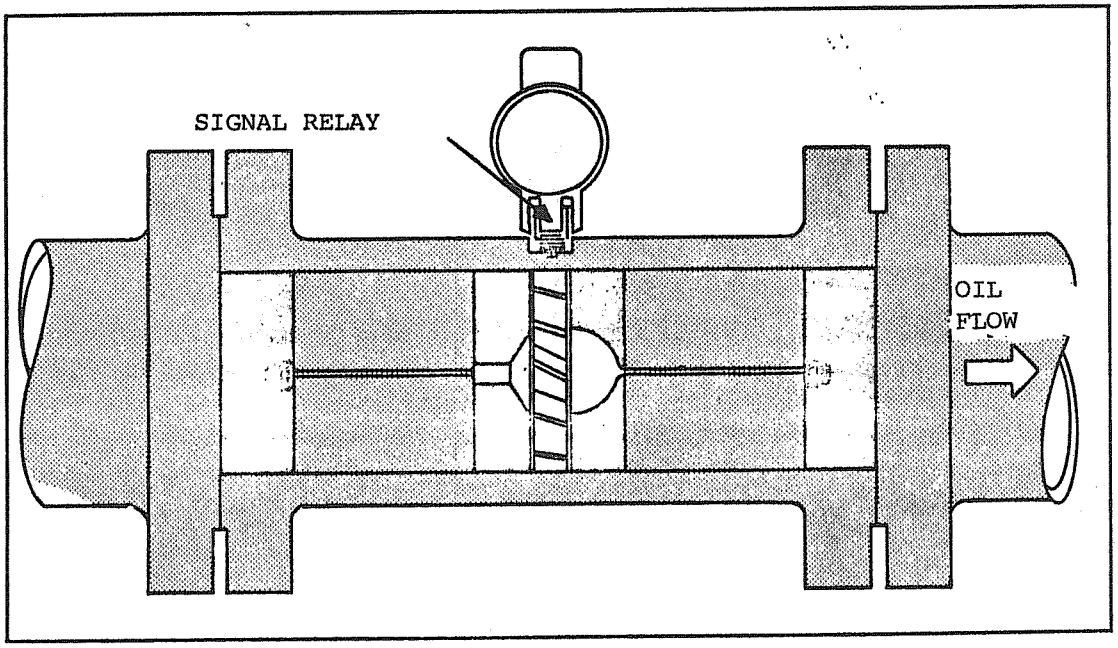


FIG 10J
Målerør og rørnormal.

Meters and prover

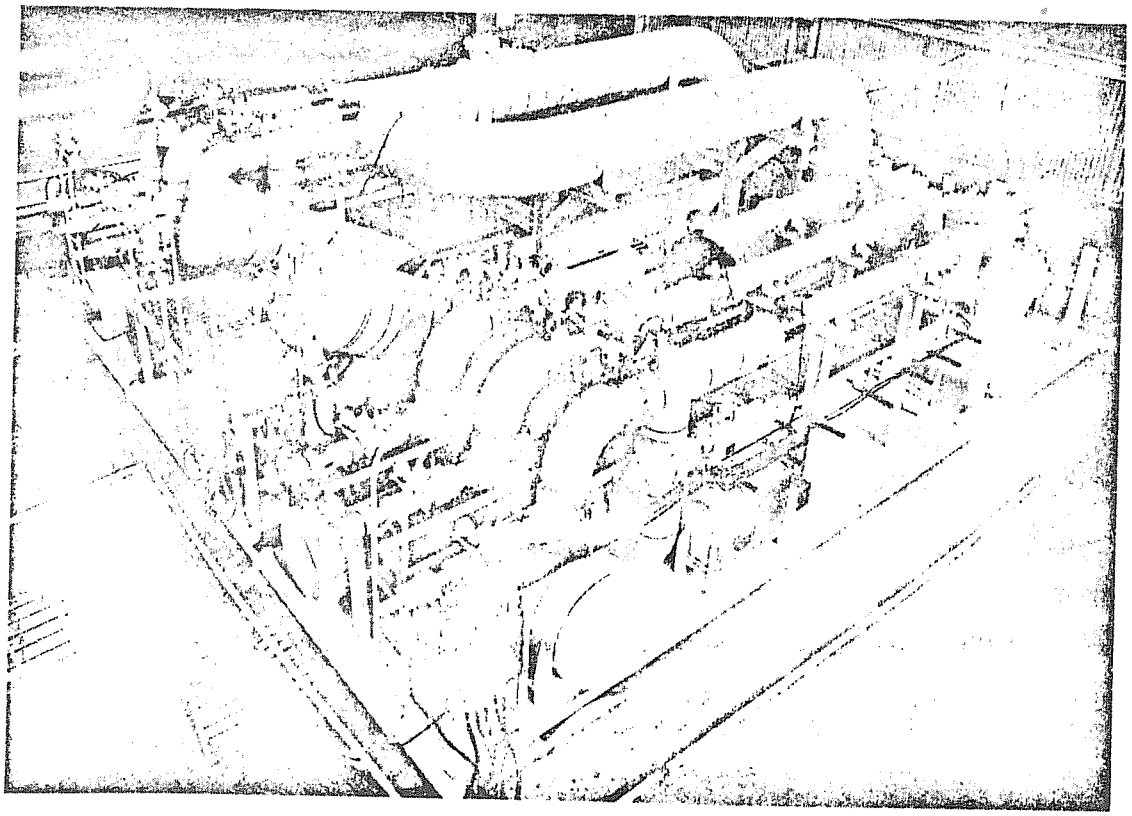
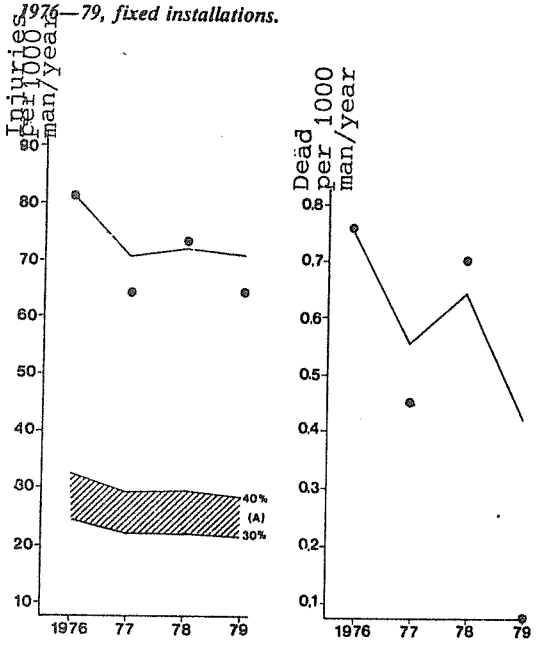


FIG. 10L
Yrkesskader og døde pr 1000 årsverk på de faste anlegg m v for årene 1976—79.

Occupational accidents/fatalaties/1000 man years 1976—79, fixed installations.



- Per year
— Per year accumulated
▨ Per year accumulated assuming that 30-40 % of (A) The industries have caused absence of 11 days or more

FIG. 10M
Grunn gasslomme som er akkumulert i de bergarter den er dannet i. Prosessert digital sparker seksjon fra Nordsjøen.

Shallow gas pocket accumulated in the rock where it was generated. Processed digital sparker section from the North Sea.

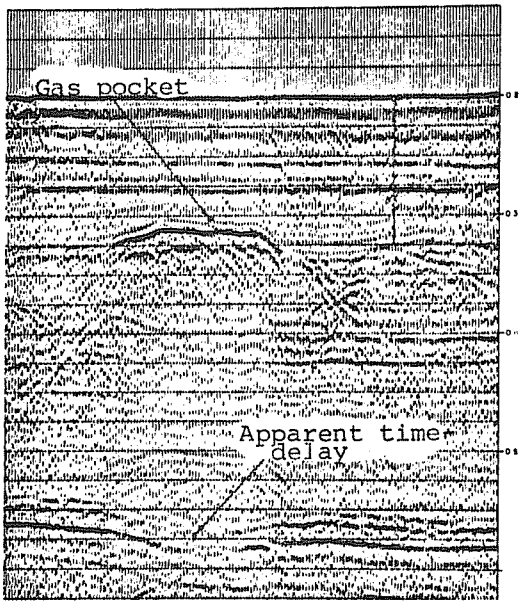


FIG. 10N
Grunn gasslomme som er oppstått ved at gass har lekket fra dypere lag via en forkastning.

Shallow gas pocket generated by leakage of gas from deeper strata through a fault.

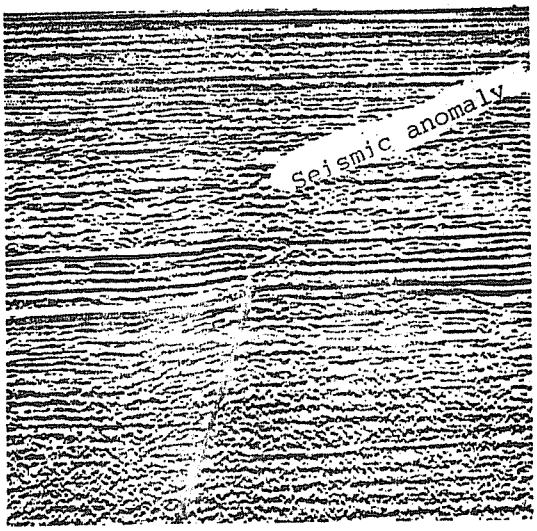


FIG. 10O
Gasslekkasje til havbunnen.

Gas leakage to sea bottom.

FIG 10P
Et eksempel på grunn gass som forårsaker et «knotisk» seismisk bilde.
Example of shallow gas causing a «chaotic» seismic picture.

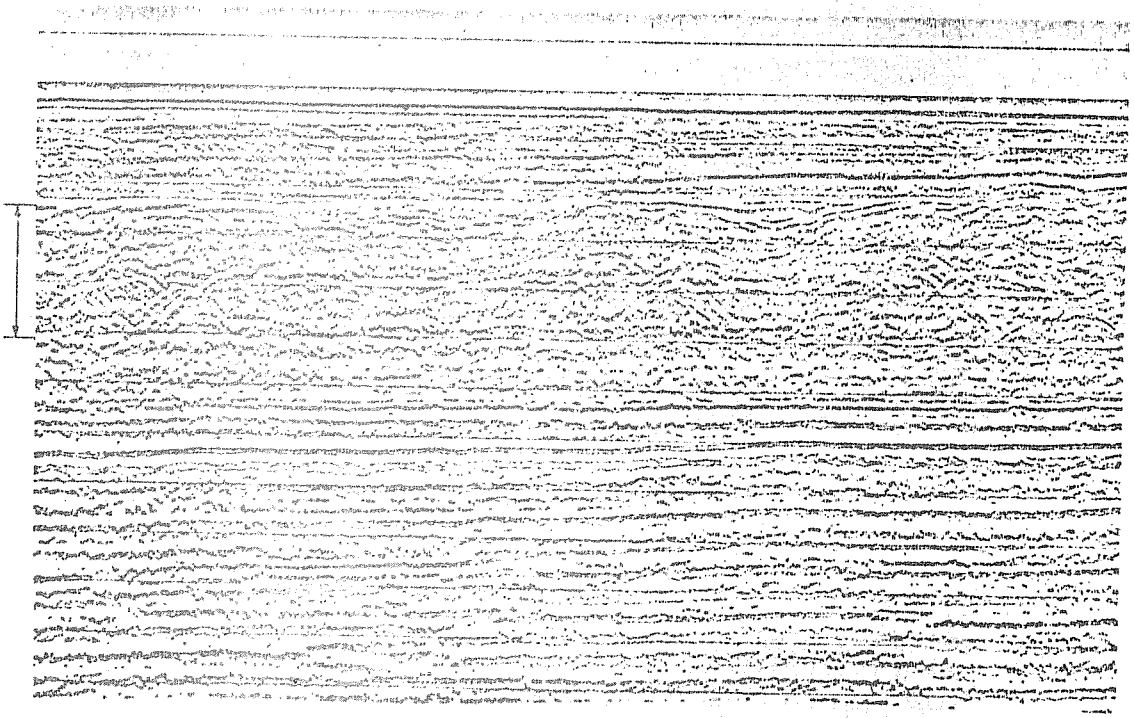
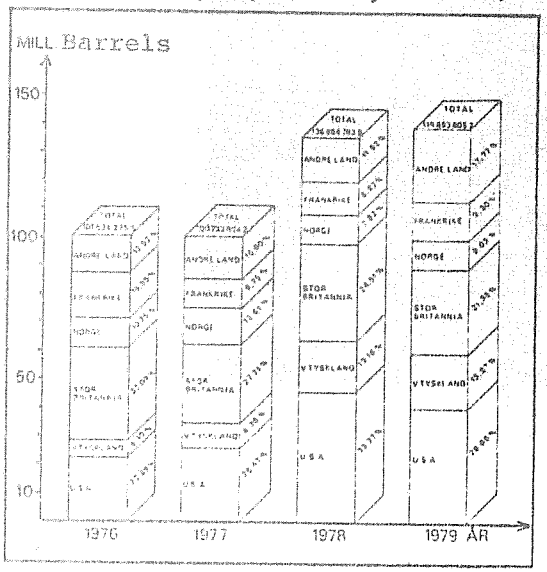


FIG. 11A
Årlig fordeling av videre eksportert råolje fra Teesside.
Yearly distribution of reexported crude from Teesside.



TAB II.
Undersøkelsesborehull (U) og avgrensningsborehull (A) i 1979

EXPLORATION WELLS (U) AND DELINEATION WELLS (A) IN 1979

Licence No.	Well	Position North	Position East	Drilling started	Drilling completed	Operator	Platform	Well
200	15/5-2	58°38'36.70''	1°36'16.50''	16.08.78	10.12.70	N. Hydro	Treasure Seeker	U
200	15/5-2	58°38'36.70''	1°36'16.50''	02.11.79	07.12.79	N. Hydro	Treasure Seeker	U
202	34/10-02	61°06'07.92''	2°13'39.96''	09.09.78	08.12.78	Statoil	Ross Rig	U
202	34/10-02	61°06''07.92''	2°13'39.96''	07.07.79	10.08.79	Statoil	Ross Rig	U
205	30/04-01	60°37'20.87''	2°09'34.61''	01.11.78	14.05.79	BP	Sedco 707	U
206	15/09-03	58°29'10.04''	1°41'38.46''	16.12.78	03.04.79	Statoil	Ross Rig	A
207	30/07-07	60°16'19.30''	2°16'07.30''	18.12.78	01.07.79	N. Hydro	Treasure Seeker	U
208	02/07-12	56°29'43.76''	3°00'36.37''	17.12.78	30.01.79	Phillips	Dyvi Beta	U
209	15/03-03	58°52'31.25''	1°46'46.24''	05.01.79	09.08.79	Elf	Pentagone 84	A
210	02/07-13	56°29'34.74''	3°01'58.38''	01.02.79	21.04.79	Phillips	Dyvi Beta	U
211	34/10-03	61°12'49.48''	2°11'55.03''	13.03.79	07.06.79	Statoil	Norskald	A
212	33/06-01	61°32'14.83''	1°51'57.55''	09.04.79	06.07.79	Agip	Fernstar	U
213	15/09-04	58°24' 0.26''	1°47' 6.93''	05.04.79	14.06.79	Statoil	Ross Rig	U
214	02/11-05	56°09'57.70''	3°26' 6.42''	18.05.79	05.07.79	Amoco	Dyvi Alpha	A
215	30/03-01	60°54'15.35''	2°40'11.71''	11.06.79	07.09.79	Statoil	Norskald	U
216	30/06-01	60°33'15.10''	2°46'38.36''	19.06.79	22.09.79	Statoil	Deepsea Saga	U
217	34/04-01	61°32'49.23''	2°16'23.66''	11.07.79	09.12.79	Saga	Byford Dolphin	U
218	33/05-01	61°44'46.10''	1°34'57.40''	19.07.79	18.10.79	N. Hydro	Treasure Seeker	U
219	31/02-01	60°46'19.16''	3°33'15.87''	17.07.79	10.11.79	Shell	Borgny Dolphin	U
220	02/09-02	56°20'56.12''	3°56' 2.78''	07.07.79	04.09.79	Amoco	Dyvi Alpha	U
221	02/07-14	56°29'20.30''	3°14' 2.65''	09.08.79	—	Phillips	Haakon Magnus	A
222	34/10-04	61°12'15.65''	2°13'55.96''	12.08.79	15.10.79	Statoil	Ross Rig	A
223	25/11-08	59°11'17.45''	2°21'40.07''	08.09.79	16.10.79	Esso	Dyvi Alpha	A
224	31/04-01	60°36'18.20''	3°00'32.30''	09.09.79	25.09.79	N. Hydro	Norskald	U
225	30/06-02	60°32'12.16''	2°46'11.11''	24.09.79	10.12.79	Statoil	Deepsea Saga	U
226	31/04-02	60°36'14.60''	3°00'26.70''	26.09.79	15.11.79	N. Hydro	Norskald	U
227	18/10-01	58°04'38.25''	4°07' 0.83''	19.10.79	—	Elf	Dyvi Alpha	U
228	34/10-05	61°11'25.35''	2°10'23.39''	17.10.79	—	Statoil	Ross Rig	A
229	02/01-03	56°54'42.30''	3°06'30.95''	03.11.79	—	BP	Sedco H	U
230	30/04-02	60°31'01.10''	2°02'46.22''	16.11.79	—	BP	Sedco 707	U
231	34/10-06	61°14'37.09''	2°13'43.68''	14.11.79	—	Statoil	Borgny Dolphin	A
232	15/09-05	58°24'12.47''	1°42'28.20''	20.11.79	—	Statoil	Norskald	A
233	17/12-03	58°11'33.00''	3°51'44.00''	14.12.79	—	Phillips	Nortrym	A
234	30/06-03	60°34'52.90''	2°47'01.45''	16.12.79	—	Statoil	Deep Sea Saga	A
235	34/02-01	61°46'27.00''	2°33' 6.90''	29.12.79	—	Amoco	Byford Dolphin	U
236	31/04-03	60°35'12.00''	3°85'41.00	24.12.79	—	N. Hydro	Treasure Seeker	U

TAB. III
Produksjonsbrønner påbegynt i 1979

Production wells spudded in 1979

Prod. Well No.	Well	Position	Started from 510 mm 470 mm casing	Operator	Field	Comment
P 135	2/7-a-21	56°22'36.40'' 03°15'56.80''	08.01.79	Phillips	Eldfisk	Dril.compl
P 136	33/9-a-33	61°15'20.46'' 01°51'13.95''	09.01.79	Mobil	Statfjord	"
P 137	2/4-e-17	56°38'26.90'' 03°19'39.30''	11.01.79	Phillips	Tor	"
P 138	1/6-a-15	56°38'33.97'' 02°56'23.95''	14.01.79	Phillips	Albuskjell	"
P 139	2/4-f-20	56°37'13.51'' 03°03'14.13''	31.01.79	Phillips	Albuskjell	"
P 140	2/7-c-2	56°27'52.99'' 03°06'15.66''	09.03.79	Phillips	Edda	"
P 141	33/9-a-23		12.03.79	Mobil	Statfjord	"
P 142	2/4-e-1		22.03.79	Phillips	Tor	"
P 143	2/7-a-14		05.04.79	Phillips	Eldfisk	"
P 144	2/7-b-11	56°25'09.0'' 03°13'06.0''	20.04.79	Phillips	Eldfisk	"
P 145	33/9-a-29		01.05.79	Mobil	Statfjord	"
P 146	2/7-a-18		19.05.79	Phillips	Eldfisk	"
P 147	2/7-c-14		20.05.79	Phillips	Edda	"
P 148	2/4-e-3		03.06.79	Phillips	Tor	"
P 149	2/4-b-8	56°33'54.85'' 03°12'13.20''	03.06.79	Phillips	Ekofisk	"
P 150	33/9-a-38		29.06.79	Mobil	Statfjord	"
P 151	2/7-b-14		02.07.79	Phillips	Eldfisk	"
P 152	2/7-c-5		02.07.79	Phillips	Edda	"
P 153	2/4-e-2		19.07.79	Phillips	Tor	"
P 154	1/6-a-3		26.07.79	Phillips	Albuskjell	"
P 155	2/4-a-10		27.07.79	Phillips	Ekofisk	"
P 156	2/7-b-19		19.08.79	Phillips	Eldfisk	"
P 157	2/4-b-24		28.08.79	Phillips	Ekofisk	"
P 158	2/7-c-9		03.09.79	Phillips	Edda	
P 159	2/4-f-2		07.09.79	Phillips	Albuskjell	Aband tech. pr.
P 160	2/4-e-7		13.09.79	Phillips	Tor	ril.compl.
P 161	2/4-f-3		11.09.79	Phillips	Albuskjell	
P 162	1/6-a-8		18.09.79	Phillips	Albuskjell	
P 163	2/7-b-10		08.10.79	Phillips	Eldfisk	
P 164	2/7-c-11		15.10.79	Phillips	Edda	
P 165	2/7-a-5		20.10.79	Phillips	Eldfisk	
P 166	2/4-a-4		08.11.79	Phillips	Ekofisk	
P 167	2/7-a-23		19.11.79	Phillips	Eldfisk	
P 168	2/7-a-24		26.11.79	Phillips	Eldfisk	
P 169	2/4-f-18		04.12.79	Phillips	Albuskjell	
P 170	2/7-a-11		22.12.79	Phillips	Eldfisk	

TAB. IV

Sannsynlige tilstedeværende og utvinnbare petroleumsmengder i felt som er besluttet utnyttet pr 31.12.79.

Probable reserves in place and recoverable reserves in fields declared commercial as of 31.12.79.

Field	Original reserves in place		Original recoverable reserves		Petroleum quantities recovered		Remaining recoverable reserves	
	Oil 10^6 Sm³	Gas 10^9 Sm³	Oil 10^6 Sm³	Gas 10^9 Sm³	Oil 10^6 Sm³	Gas 10^9 Sm³	Oil 10^6 Sm³	Gas 10^9 Sm³
Albuskjell[1]	39	45	20	30	1	1	19	29
Cod[1]	5	9	3	4	1	0.6	2	4
Edda[1]	36	9	8	7	0.04	0.04	8	7
Ekofisk[1]	849	191	184	112	78	12	106	100
Eldfisk[1]	587	142	83	52	2	0.4	81	51
Frigg[2]	—	158	0.6	118	0.1	13	0.5	105
Murchison[3]	19	1	9	0.3	—	—	9	0.3
Statfjord[4]	682	119	341	48	0.3	—	341	48
Tor[1]	125	25	28	17	6	1	22	16
Valhall A	216	54	43	28	—	—	43	28
V. Ekofisk[1]	103	31	16	28	7	10	9	18
Totals	2661	784	736	444	95	38	641	406

1. NGL included in the oil. 2. The Norwegian share: 60,82%
3. The Norwegian share: 16,25%. 4. The Norwegian share: 84,09%.

TAB. V

Sannsynlige tilstedeværende og utvinnbare petroleumsmengder i felt som ikke er besluttet utnyttet pr 31.12.79.

Probable reserves in place and recoverable reserves in fields not declared commercial as of 31.12.79.

Field	In place		Recoverable	
	Oil 10^6 Sm³	Gas 10^9 Sm³	Oil 10^6 Sm³	Gas 10^9 Sm³
Balder	77	—	16	—
Bream	< 1	—	< 1	—
Brisling	< 1	—	< 1	—
Flyndre	< 1	—	< 1	—
N. Ø. Frigg	—	19	—	14
S. Ø. Frigg	—	1	—	1
Ø. Frigg	—	6	—	5
Heimdal	4	49	2	36
Hod	59	15	12	9
Murphy	—	2	—	2
Odin[3]	—	33	—	25
Sleipner	40	210	14	145
S. Ø. Tor	21	6	4	3
Valhall[1]	160	40	32	24
1/9-Alfa[3]	49	32	5	24
1/9-Gamma	18	18	4	13
7/12	61	7	22	2
25/2-4	23	25	4	12
33/9-Alfa	37	4	18	2
33/9-Beta	78	4	39	2
New fields[2]	270	137	128	99
Totals	897	608	300	418

1. The part not covered by the Valhall A-development
2. 34/10-Alfa, 34/10 Delta, 30/7-6, 15/3-1.
3. Reassessment in progress at the turn of the year 1979/80.

TAB. VI
Konsesjonsbelagte areal pr. 31.12.79

Licensed areas as of 31.12.79

Concessions granted	Original area km²	Relinquished area as of 31.12.79	Licensed areas	Licensed areas in precent of original	Numbers of blocks allocated
1965	42 106,041	36 161,546	5 936,495	14,10	26
1969	5 878,647	3 004,037	2 874,610	48,90	13
1971	523,937	130,726	393,211	75,05	1
1973	586,834	295,157	291,677	49,70	2
1975	2 329,206	—	2 329,206	100,00	8
1976	2 066,872	—	2 066,872	100,00	7
1977	1 075,727	—	1 075,727	100.00	5
1978	500,509	—	500,509	100,00	1
1979	4 007,887	—	4 007,887	100,00	8
Totals	59 075,660	39 591,466	19 476,194	32,97	71

Tabell VII
Utvinningstillatelser pr. 31.12.79

Production licenses as of 31.12.79

Granted with effect from	Production licence no.	Total area km²	Number of blocks
1. Sept. 1965	001-021	39 842,476	74
7. Dec. 1965	022	2 263,565	4
23. May 1969	023-031	4 107,833	9
30. May 1969	032-033	746,255	2
14. Nov. 1969	034-035	1 024,529	2
11. June 1971	036	523,937	1
1. Sept. 1973	037	586,834	2
1. Apr. 1975	038-042	2 329,206	8
6. Aug. 1976	043	604,559	2
27. Aug. 1976	044	193,077	1
3. Dec. 1976	045-046	1 270,682	4
7. Jan. 1977	047	266,979	2
18. Feb. 1977	048	321,500	2
23. Dec. 1977	049	485,802	1
16. Jun. 1978	050	500,509	1
6. Apr. 1979	051-058	4 007,887	8
		59 075,660	123

TAB. VIII
Tillatelser til vitenskapelige undersøkelser etter naturforekomster meddelt i henhold til kgl. res. av 31.1.69.

Licenses for scientific research for natural resources granted pursuant to Royal Decree of 31.1.69.

Licence	Name	Subject			Area
		Geophysics	Geology	Biology	
104	Universitet i Tromsø Institutt for biologi og geologi		×		Area Andsfjorden - Tromsøflaket
105	Institute of Geological Sciences, Marine Geophysics Unit, Edinburgh	×			Touching the Norwegian shelf in field 30 in connection with turning the equipment
106	Bundesanstalt für Geowissenschaften und Rohstoffe	×			Møre basin - Færøy/Shetland channel
107	Universitetet i Tromsø Institutt for biologi og geologi	×		×	Inner waters in Troms
108	Universitetet i Bergen Geologisk institutt avd B	×	×		The Norwegian trench offshore Western Norway
109	Institutt for kontinentalsokkelundersøkelser	×	×		Offshore Trøndelag Norland and Troms
110	Senckenberg naturforschende Gesellschaft, Frankfurt/M			×	Skagerak
111	Admiral Netherlands Home, Nederland	×			The shelf offshore Lista
112	Universitetet i Bergen Jordskjelvstasjonen	×	×		TNT blasting offshore Magerøya. Examination of seismic long profile trough Scandinavia.
113	Natural Environment Research Council Research Vessel Services S Wales	×	×		Survey of the western side of the Norwegian trench between 58°N-62°N west of 0°.
114	Universitetet i Bergen Jordskjelvstasjonen	×	×		North and northwest of Svalbard
115	North Sea Geophysical Limited, England		×		The Trænabank
116	Geologisk Centralinstitut Københavns Universitet	×			The Oslofjord between Jæløya and Holmestrand

TAB. IX
Brannskader på faste installasjoner
Fire damages on fixed installations

Updated 10.12.1979

Damage caused by the fire	Construction phase	Operation phase A	Operation phase B
Injuries and large material damage	0	0	0
Injuries and smaller or no material damage	1	0	0
No injuries but larger material damage	0	0	0
No injuries and minimal or no material damage	17	7	11
Total:	18	7	11

A - Reason for fire: Construction work
B - Reason for fire: Because of operations/operational accidents.

TAB. XII
Skader/døde pr årsverk (1976—79), faste produksjonsanlegg m v.
Occupational accidents/fatalities/1000 man years (1976—79), fixed installations.

Year	Hours of work	Hours per man/year	Man/ years	Injuries	Injuries 1000 man/year	Dead	Dead per 1000 men/years
1976	4.876.316	1852	2.633	213	80,9	2	0,76
1977	4.926.742	1802	4.399	282	64,1	2	0,45
1978	14.932.154	1752	8.523	624	73,2	6	0,70
1979	14.588.728	1752	8.327	571	68,6	0	0,00
Totals	42.323.940		23.822	1690	70,9	10	0,42

TAB. X
Arbeidsulykker 1976-79. Faste produksjonsanlegg m.v.
Occupational accidents 1976--79. Fixed installations.

Injured part of the body / Cause of injury	Head	Eye	Bowel Chest	Back	Hand Finger	Arm Shoulder	Toe Ankel	Foot Leg	Dead	Others	Sum	%	Year
Motor generator transmission	0	0	0	0	0	0	0	1	0	0	1	0,47	-76
	1	0	0	0	0	1	0	0	0	0	2	0,71	-77
	1	0	0	0	3	0	0	0	0	0	3	0,48	-78
	0	0	0	0	1	0	0	0	0	1	2	0,35	-79
Work machine Fragments etc. from the same	0	0	0	0	1	0	0	1	0	0	2	0,94	-76
	0	0	0	0	2	0	0	0	0	0	2	0,71	-77
	2	2	0	1	3	0	0	2	0	0	10	1,60	-78
	0	0	0	0	1	0	0	0	0	0	1	0,18	-79
Lift, crane, lifting arrange-ment transporter	0	0	1	0	5	0	0	0	0	0	6	2,82	-76
	1	0	0	1	3	0	0	1	1	0	7	2,48	-77
	2	0	1	1	9	1	4	1	0	3	22	3,53	-78
	0	0	0	1	3	0	0	0	0	0	4	0,70	-79
Vehicle vessel airplane	0	0	0	0	0	0	0	0	0	0	0	0,00	-76
	0	0	0	0	0	0	0	0	0	0	0	0,00	-77
	0	0	0	0	1	0	0	0	0	0	1	0,16	-78
	0	0	0	0	0	0	0	0	0	0	0	0,00	-79
Hand tool fragments etc. from the same	0	28	0	0	13	0	0	3	0	1	45	21,13	-76
	5	34	0	1	12	1	1	0	0	0	54	19,15	-77
	4	36	1	0	33	3	0	4	0	1	82	13,14	-78
	7	28	3	1	25	3	3	4	0	0	74	12,96	-79
Motor cold sub-stance - solid, liquid, gaseous	1	27	0	0	1	0	0	2	0	1	32	15,02	-76
	2	11	1	0	2	1	0	0	0	0	17	6,03	-77
	1	29	0	0	3	2	0	1	0	1	37	5,93	-78
	0	10	0	0	2	1	0	0	0	1	14	2,45	-79
Electric current	0	0	0	0	0	0	0	0	0	1	1	0,47	-76
	0	0	0	0	1	0	0	0	0	1	2	0,71	-77
	0	1	0	0	4	0	0	0	0	2	7	1,12	-78
	0	0	0	0	3	0	0	0	0	1	4	0,70	-79
Explosion detonation fire, etc.	0	0	0	0	0	0	0	0	0	0	0	0,00	-76
	0	0	0	0	1	0	0	0	0	0	1	0,35	-77
	2	2	0	0	0	0	0	0	5	0	9	1,44	-78
	2	0	0	0	2	0	0	1	0	3	8	1,40	-79
Poisonous or caustic sub-stances, radia-tion	0	2	0	0	0	0	0	0	0	1	3	1,41	-76
	2	8	0	0	0	0	0	0	0	3	13	4,61	-77
	1	1	0	0	0	1	0	0	0	5	8	1,28	-78
	1	14	0	0	1	0	0	0	0	1	17	2,98	-79
Fall (by person to lower level)	2	0	4	5	1	2	1	6	2	11	34	15,96	-76
	1	0	5	12	3	4	5	13	1	8	52	18,44	-77
	2	0	6	16	5	7	8	18	1	15	78	12,50	-78
	6	0	7	7	5	12	4	12	0	7	60	10,51	-79
Fall (by person at the same level)	1	0	1	1	0	2	5	6	0	2	18	8,45	-76
	0	0	2	1	3	5	8	14	0	2	35	12,41	-77
	4	0	8	16	13	4	13	14	0	3	75	12,02	-78
	4	1	8	10	12	6	16	17	0	3	77	13,49	-79
Falling subject not handled by the injured	2	1	0	0	0	0	2	4	0	1	10	4,69	-76
	2	1	1	1	2	1	2	3	0	1	14	4,96	-77
	5	1	0	0	20	3	6	17	0	1	53	8,49	-78
	10	0	0	2	12	2	2	23	0	1	52	9,11	-79
Stepping on, shock from or on subject. Squezing	1	1	1	0	14	4	4	7	0	4	36	16,90	-76
	3	0	0	1	6	3	4	10	0	0	27	9,57	-77
	10	2	5	5	67	10	20	38	0	0	157	25,16	-78
	24	1	9	12	89	14	19	37	0	4	209	36,60	-79
Lifting, carry-ing by the injured	0	0	0	10	3	2	0	0	0	0	15	7,04	-76
	1	0	1	9	28	3	1	7	0	0	50	17,73	-77
	0	0	5	36	9	6	3	1	0	0	60	9,62	-78
	0	0	0	26	2	7	1	2	0	0	38	6,65	-79
Other causes	0	9	1	0	0	0	0	0	0	0	10	4,69	-76
	1	2	0	1	0	1	1	0	0	0	6	2,13	-77
	0	9	0	7	2	0	0	2	0	2	22	3,53	-78
	1	1	0	1	4	2	0	2	0	0	11	1,93	-79
Sum	7	68	8	16	38	10	12	30	2	22	213	99,99	-76
	19	56	10	27	63	20	22	48	2	15	282	99,99	-77
	33	83	26	82	172	37	54	98	6	33	624	100,00	-78
	55	55	27	60	162	47	45	98	0	22	571	100,01	-79
%	3,29	31,92	3,76	7,51	17,84	4,69	5,63	14,08	0,94	10,33	99,99		76
	6,74	19,86	3,55	9,57	22,34	7,09	7,80	17,02	0,71	5,32	100,00		77
	5,29	13,30	4,17	13,14	27,56	5,93	8,65	15,71	0,96	5,29	100,01		78
	9,63	9,63	4,73	10,51	28,37	8,23	7,88	17,16	0,00	3,85	99,99		79

TAB. XI

Arbeidsulykker akkumulert for 1976—79. Faste produksjonsanlegg m.v.

Occupational accidents accumulated for 1976—79. Fixed installations.

Cause of injury \ Injured part of the body	Head	Eye	Bowel Chest	Back	Hand Finger	Arm Shoulder	Toe Ankel	Foot Leg	Dead	Others	Sum	%
Motor generator transmission	1	0	0	0	4	1	0	1	0	1	8	0,47
Work machine Fragments etc. from the same	2	2	0	1	7	0	0	3	0	0	15	0,89
Lift crane, lifting arrange-ment transporter	3	0	2	3	20	1	4	2	1	3	39	2,31
Vehicle vessel airplane	0	0	0	0	1	0	0	0	0	0	1	0,06
Hand tool fragments etc. from the same	16	126	4	2	83	7	4	11	0	2	255	15,09
Motor cold sub-stance - solid, liquid, gaseous	4	77	1	0	8	4	0	3	0	3	100	5,92
Electric current	0	1	0	0	8	0	0	0	0	5	14	0,83
Explosion deponation fire, etc.	4	2	0	0	3	0	0	1	5	3	18	1,07
Poisonous pr caustic sub-stances, radia-tion	4	25	0	0	1	1	0	0	0	10	41	2,43
Fall (by person to lower level)	11	0	22	40	14	25	18	49	4	41	224	13,25
Fall (by person at the same level)	9	1	19	28	28	17	42	51	0	10	205	12,13
Falling subject not handeled by the injured	19	3	1	3	34	6	12	47	0	4	129	7,63
Stepping on, shock from or on subject. Sqezing	38	4	15	18	176	31	47	92	0	8	429	25,38
Lifting, carry-ing by the injured	1	0	6	81	42	18	5	10	0	0	163	9,64
Other causes	2	21	1	9	6	3	1	4	0	2	49	2,90
Sum	114	262	71	185	435	114	133	274	10	92	1690	100,00
%	6,75	15,50	4,20	10,95	25,74	6,75	7,87	16,21	0,59	5,44	100,00	

TABLE XIII.

Number of fatalities on the fixed installations. The Norwegian Continental Shelf.

Year	Number of fatalities	Description	Totals
1972	1	Fell into the sea	1
1974	1	Fell with a crane into the sea.	
	1	Disappeared on the installation	2
1975	1	Fell into the sea/failure in scaffolding	
	3	Fell into the sea with a rescue capsule	
	1	Hit by a suspended load as a crane boom fell down	5
1976	1	Fell into the sea/failure in scaffolding	
	1	Fell to a lower deck	2
1977	1	Fell with a crane into the sea	
	1	Fell to a lower deck	2
1978	5	Fire in a utility shaft	
	1	Fell from a drilling derrick	6

Total number of fatalities on fixed platforms 1972-79 18

TAB. XIV
Riggmåneder pr kvartal 1966—1979.
Rigg months per quarter 1966—1979.

Year	1. Qu.	2. Qu.	3. Qu.	4. Qu.	Sum per.year
1966			2	3	5
1967	3	3	5	6	17
1968	5	11	9	8	33
1969	6	7	9	6	28
1970	5	8	16	15	44
1971	12	12	14	9	47
1972	9	13	18	13	53
1973	5	7	10	17	39
1974	19	15	8	12	54
1975	9	16	17	13	55
1976	17	8	13	8	46
1977	5	10	17	18	52
1978	10	14	14	11	49
1979	5	14	20	25	64
Sum per. qu.	112	138	172	164	

TAB. XV
Sesongsvingninger i aktivitet 1966—1979.
Seasonal variations in activity 1966—1979.

Month	Numbers of wells started
Januar	12
Februar	13
Mars	8
april	22
Mai	17
Juni	22
Juli	32
August	30
September	23
Oktober	21
November	16
Desember	22

TAB. XVI
Gjennomsnittlig vanndyp og boredyp.
Average water depth and total depth.

Year	Average water depth	Average total depth (m)
1966	110	2 737
1967	93	2 599
1968	75	3 495
1969	70	3 143
1970	89	2 983
1971	82	3 101
1972	79	5 313
1973	86	3 089
1974	109	3 078
1975	109	2 954
1976	124	2 949
1977	94	2 719
1978	109	3 502
1979	153	3 375

TAB. XVII

Borerigger på norsk sokkel.

Drilling rigs on the Norwegian Shelf.

Drilling rig	Number of wells	Rig type
Ocean Viking	29	Semi-sub.
Neptune 7	13	Semi-sub.
Zapata Explorer	13	Jack-up
Norskald	23	Semi-sub.
Glomar Grand Isle	11	Drillship
Ross Rig	22	Semi-sub.
Ocean Traveler	9	Semi-sub.
Deepsea Driller	8	Semi-sub.
Orion	7	Jack-up
Polyglomar Driller	11	Semi-sub.
Zapata Nordic	5	Jack-up
Ocean Tide	5	Jack-up
Maersk Explorer	5	Jack-up
Deepsea Saga	9	Semi-sub.
Drillmaster	5	Semi-sub.
Sedneth 1	3	Semi-sub.
Gulftide	3	Jack-up
Dyvi Alpha	8	Semi-sub.
Sedco 135 F	2	Semi-sub.
Endeavour	2	Jack-up
Transworld Rig 61	2	Semi-sub.
Ocean Voyager	2	Semi-sub.
Ocean Victory	1	Semi-sub.
Chris Chenery	1	Semi-sub.
Drillship	1	Drillship
Waage Drill	1	Semi-sub.
Sedco 135 G	1	Semi-sub.
Norjarl	2	Semi-sub.
Odin Drill	3	Semi-sub.
Saipem II	1	Drillship
Borgny Dolphin	4	Semi-sub.
Treasure Seeker	7	Semi-sub.
Dyvi Beta	6	Jack-up
Dyvi Gamma	1	Jack-up
Sedco H	1	Semi-sub.
Sedco 707	2	Semi-sub.
Haakon Magnus	2	Semi-sub.
Byfjord Dolphin	2	Semi-sub.
Pentagone 84	2	Semi-sub.
Fernstar	3	Semi-sub.

TAB. XVIII
Normprisutvikling.
Development of norm price.

Quarter		Price per barrel Norwegian kroner	Price per barrel (U.S.$)
1975 1. quarter	Offshore	kr 59.62	U.S. $ 11.90
2. quarter	»	kr 58.35	U.S. $ 11.80
3. quarter	»	kr 63.38	U.S. $ 11.70
4. quarter	»	kr 68.89	U.S. $ 12.45
4. quarter	Teesside	kr 69.12	U.S. $ 12.60
1976 1. quarter	»	kr 70.40	U.S. $ 12.70
2. quarter	»	kr 70.50	U.S. $ 12.79
3. quarter	»	kr 71.00	U.S. $ 12.89
4. quarter	»	kr 69.25	U.S. $ 13.15
1977 1. quarter	»	kr 75.50	U.S. $ 14.33
2. quarter	»	kr 76.00	U.S. $ 14.39
3. quarter	»	kr 76.25	U.S. $ 14.26
4. quarter	»	kr 75.75	U.S. $ 14.04
1978 1. quarter	»	kr 73.25	U.S. $ 13.98
2. quarter	»	kr 75.25	U.S. $ 13.94
2. quarter	Offshore	kr 75.90	U.S. $ 14.06
3. quarter	»	kr 74.60	U.S. $ 14.13
3. quarter	Teesside	kr 74.00	U.S. $ 14.02
4. quarter	»	kr 71.75	U.S. $ 14.29
1979 1. quarter	»	kr 81.65	U.S. $ 16.05
2. quarter	»	kr 103.50	U.S. $ 20.05

TAB. XIX
Månedlig liquid- og gassproduksjon fra Ekofisk-området i 1979.
Monthly liquid- and gasproduction from the Ekofisk-area in 1979.

Month	Liquid production 10³ Sm³	10³ tonn	Gas production 10⁶ Sm³	Gas for fuel 10⁶ Sm³	Gas flared 10⁶ Sm³	Gas sold 10⁶ Sm³
Jan.	1.769,1	1.436,0	1.227.238,9	60.000,0	25.000,0	1.009.454,9
Feb.	1.623,0	1.317,0	1.087.124,2	55.000,0	36.000,0	902.872,8
March	1.764,6	1.426,0	1.152.373,0	59.000,0	28.000,0	949.383,7
April	1.874,1	1.494,0	1.193.203,0	59.000,0	7.000,0	1.010.839,3
May	1.862,3	1.473,0	1.185.607,0	56.000,0	12.000,0	990.983,5
June	1.696,9	1.342,0	1.060.887,8	53.000,0	19.000,0	879.409,0
July	1.854,1	1.461,0	1.188.441,3	59.000,0	17.000,0	994.269,9
Aug.	2.045,2	1.607,0	1.384.024,8	59.000,0	30.000,0	1.171.822,3
Sept.	2.259,2	1.779,0	1.457.878,5	62.000,0	23.000,0	1.254.296,8
Oct.	1.758,0	1.404,0	1.058.656,6	53.000,0	19.000,0	869.641,0
Nov.	2.387,1	1.889,0	1.440.868,3	63.000,0	12.000,0	1.206.045,9
Dec.	2.483,9	1.971,0	1.689.754,5	67.000,0	13.000,0	1.265.070,2
	23.377,5	18.599,0	14.926.077,9	705.000,0	241.000,0	12.504.089,3

TAB. XX
Månedlig gassproduksjon på Frigg-feltet i 1979.
Monthly gasproduction from the Frigg-field in 1979.

Mounth	Gas production 10^3 Sm³	Gas for fuel 10^3 Sm³	Gas flared 10^3 Sm³	Gas sold 10^3 Sm³
Jan.	858.863,8	2.493,4	9,5	852.904,6
Feb.	717.870,5	2.064,3	47,7	722.385,5
March	796.565,9	2.631,0	35,1	795.515,9
April	608.508,4	1.902,8	338,8	609.829,7
May	585.701,2	1.775,4	241,7	581.667,5
June	344.222,7	1.349,2	119,6	326.819,6
July	522.376,8	1.885,2	27,5	526.004,1
Aug.	552.387,7	1.977,5	52,5	549.771,3
Sept.	500.217,6	1.792,6	70,1	507.170,2
Oct.	809.199,0	2.192,7	72,9	814.686,6
Nov.	949.017,5	2.289,0	656,1	960.536,2
Dec.	1.047.048,3	2.351,5	50,5	1.045.866,5
	8.291.979,4	24.704,6	1.721,7	8.283.157,7

The numbers are the Norwegian share, 68.82 per cent.

TAB. XX
Månedlig olje- og gassproduksjon fra Statfjord-feltet i 1979.
Monthly oil- and gasproduction from the Statfjord-field in 1979.

	Oil production Sm³	tonn	Gas production Sm³	Gas burned Sm³
Nov.	34.132	28.296	6.141.000	6.141.000
Dec.	226.438	187.717	40.544.000	39.076.000
	260.570	216.013	46.685.000	45.217.000

The numbers are the Norwegian share, 84.09322 per cent.