THE NORWEGIAN PETROLEUM DIRECTORATE

ANNUAL REPORT, 1977

NORTH SEA OPERATORS
COMMITTEE — NORWAY

[1978]

The Norwegian Petroleum Directorate

Annual Report, 1977

CONTENTS

.../...

.../...

.../...

.../...

PART IV STATISTICS/SURVEYS

A. EXPLORATORY DRILLING IN NORWEGIAN SECTOR OF NORTH SEA

B. UNITS OF MEASUREMENT

C. EMPLOYEES in 1977

D. SPECIFICATION OF BOARDS/COMMITTEES/WORKING GROUPS ON WHICH THE PETROLEUM DIRECTORATE HAD REPRESENTATIVES IN 1977

E. PUBLICATIONS FROM THE PETROLEUM DIRECTORATE

F. ORGANIZATION TABLE

} omitted

FOREWORD

The Board of Directors hereby submits the Petroleum Directorate's Annual Report for 1977.

It has been considered expedient this year also for the Board of Directors' Report to form Part I; Part II describes the undertaking in general, and as in previous years Part III contains general specialist articles within the Directorate's subject area. Part IV consists of statistics and surveys.

Stavanger, 2 February 1978.

The Board of Directors of the Petroleum Directorate

(signed) Martin Buvik

(signed) Andreas Lønning (signed) Erik Setsaas

(signed) Gunnar Berge (signed) Aksel Olsen

(signed) Fredrik Hagemann (signed) Bjørn Bratbak

PART I

The Board of Directors' Report

The uncontrolled blow-out on the Bravo platform in the Ekofisk field is the one event in the reporting year that brought most strongly into focus the safety conditions on the Continental Shelf and consequently the Petroleum Directorate. The Board of Directors has carefully examined the available material concerning the cause of the blow-out and the measures taken during the operations to check it. It will be seen from this that some routines and procedures must be changed, and steps have been taken to implement such changes. During the operation, many employees of the Directorate were subjected to a very great work pressure. Individual employees may have also suffered severely from the criticism that arose in connexion with the blow-out. The Board of Directors wishes to emphasize that, in its view, the employees deserve to be praised for the work carried out, often under difficult circumstances.

.../...

The Board of Directors' decision in November 1976 not to approve the proposal submitted for an integrated Statfjord "B" platform led to extensive re-thinking among licensees. A new draft proposal was submitted at end November/beginning December 1977, following the preparation of detailed reports. On 19 December 1977, the Directorate was able in principle to approve the new draft proposal. In a period during which the section of industry engaged in the construction of such platforms is in difficulties, one year's delay is particularly regrettable, but the explanatory work and the new technical solutions that have arisen during this period will be of great importance, in the opinion of the Board of Directors, in increasing safety levels on Statfjord "B" and on other platforms yet to be constructed.

During the Report period plans have been submitted for expansion of the Valhall-Hod field. The Petroleum Directorate has approved in principle a proposal that assumes that a separate accommodation platform will be built. For efficient progress, it is important that the main guidelines for this expansion should be drawn up and approved by the authorities at an early stage. The Board of Directors intends that this case should form a model for the future, in line with the intentions of the safety regulations of 9 July 1976.

During the Report period the new Act on Working Environments also became applicable to the Continental Shelf. The Petroleum Directorate has been made responsible for implementation of the Act relating to fixed installations. Whereas on land there is a national tradition to build upon, with a known pattern of work between employees, employers and authorities, the situation is somewhat different on the Continental Shelf. The great number of foreign companies and foreign workers, some with short-term assignments, makes it particularly difficult to achieve a uniform pattern and to implement satisfactory control. In the opinion of the Board of Directors, however, there is no doubt that considerable progress has been made during the Report period, and that understanding of the intentions of the Act and the will to carry it into effect have greatly increased.

.../...

It is usually possible to extract only a very small part of the oil and gas present in a reservoir. Much depends upon the way in which production is organized, the pace selected for extraction, etc. The proportion extracted can in many cases be increased by various methods, including the injection of gas or water. We are confronted here with difficult financial considerations in which the interests of the licensees and of the authorities will not always coincide. As guardian of the State's interests, the Petroleum Directorate has an important and complicated task in this sphere. With several fields in operation, the Board anticipates that specific matters relating to the proper utilization of petroleum resources will increasingly require the Directorate's attention.

During last year 11,200 km of reflection seismology was carried out under the Directorate's management North of 62°N. The intention of the surveys was, apart from completing earlier surveys, to chart the geological conditions at transitions between the continents and the deep sea.

In the areas North of 62°N, where conventional reflection-seismic gathering has given poor results, investigations with a long energy source, which the Petroleum Directorate introduced on the Norwegian-Shelf in 1976, has markedly improved the data.

A new method has been developed within the Directorate for use in seismic data processing. The method has improved results in difficult areas.

In the Barents Sea, geological and geo-seismic investigations have provided useful additional information for assessing the possibility of hydro-carbons in these areas.

During the Report period a group appointed by the Ministry of Industry submitted a report on the need for safety and preparedness research on the Continental Shelf. The work resulted in the Storting allocating 20 million kroner for the purpose. The Petroleum Directorate has been made responsible for the use of 8 million kr. of this amount. The Board expresses its satisfaction that it has been possible by this means to carry out a number of projects that will undoubtedly contribute to safety and preparedness on the Continental Shelf.

.../...

Part II. ACTIVITIES DURING THE REPORT PERIOD

1. Functions of the Directorate, Board of Directors and Administration

1.1. Petroleum Directorate Directives

The object and function of the Petroleum Directorate were set out in a brief originally issued by the Ministry of Industry on 30 March 1973 and adopted by delegation.

As a result of the authority for filling individual posts being transferred in 1976 from the Board to a newly established Employment Board, the directives were replaced by new directives from the Ministry of Industry on 17 June 1976.

Sec. 1 - Object

The Petroleum Directorate has its seat at Stavanger, and is administratively under the Royal Ministry of Industry. It has authority to decide in matters concerning exploration for and utilization of petroleum deposits on the sea bed or its sub-soil in domestic Norwegian waters, Norwegian sea territory and that part of the Continental Shelf under Norwegian sovereignty, in so far as matters are not to be decided by the Crown, the Ministry of Industry or other public authority. Furthermore, the Petroleum Directorate is to enforce safety regulations etc. in the exploitation of and drilling for petroleum deposits and the like in the areas set out in the Svalbard Treaty of 17 July 1925, Sec. 1, and in the territorial waters of these areas.

Sec. 2 - Function

The function of the Petroleum Directorate, within its sphere of authority, is

a. to exercise administrative and financial control of exploration for and production of petroleum in accordance with the applicable legislation, regulations, resolutions, concessionary conditions, agreements etc. (see Sec. 1);

b. to ensure that the applicable safety regulations are observed;

c. to ensure that exploration for and exploitation of petroleum deposits are not unnecessarily injurious or cause damage to other activities;

.../...

d. to ensure that exploration for and exploitation of petroleum deposits are at all times in accordance with the directives established by the Ministry of Industry;
e. to collect and process geological, geo-physical and technical material on natural underwater deposits, including assessment thereof and the potential this provides to assist in the planning of Government oil policy and in its negotiations, and to plan and undertake petroleum-geological and geophysical surveys;
f. to maintain continuous supervision of exploration for and exploitation of petroleum deposits;
g. to grant exploration permits and, upon request, to assist the Ministry in processing applications for other permits, drafting of regulations, etc.;
h. to keep in contact with scientific institutions, and to ensure that material is made available to interested companies, scientific institutions, etc. in so far as this is possible under the rules relating to the confidential treatment of material submitted by licensees, and in general in accordance with the Ministry's regulations;
i. to keep the Ministry of Industry continuously informed of the activities set out in Sec. 1, and to submit those cases not falling under Sec. 2, a - h, with which the Directorate may be concerned to the Ministry;
j. to prepare and submit for decision by the Ministry of Industry matters of importance to flora and fauna, or which otherwise affect important natural conservation interests in the areas referred to in Sec. 1, last sentence;
k. to submit to the Ministry of Industry regulations and individual resolutions relating to the proper exploitation of petroleum deposits (conservation);
1. to act as advisory body to the Ministry of Industry in matters relating to exploration for and utilization of natural underwater deposits.

Even if a matter falls under the Directorate's sphere of authority under Sec. 2, a-h, it must be submitted to the Ministry if it is of special importance or is a matter of principle.

.../...

1.2. BOARD OF DIRECTORS AND ADMINISTRATION

1.2.1. Board of Directors

During the Report period the Board of Directors consisted of:

- Mr Gunnar Hellesen, Haugesund
- Mr Andreas Lønning, Oslo
- Ms Kirsten Myklevoll, Skanland
- Mr Aksel Olsen, Hammerfest
- Mr Erik Setsaas, Stavanger
  (elected by and from among the employees).

Deputies:

- Mr Gunnar Berge, Stavanger
- Mr Hans Chr. Rønnevik, Stavanger
  (personal deputy for employees' representative on the Board).

In Autumn 1977 Mr Gunnar Hellesen asked to be relieved of his office as Chairman of the Board, and at a Cabinet Meeting on 23.12.77 Mr Martin Buvik, Tromsø, was appointed a member and Chairman of the Board.

During the Report period the Board held 12 meetings. The Board has carried out an inspection of the Statfjord field.

1.2.2. Staff

In its budget proposals for 1977 the Board of Directors asked for 47 new posts. A Final Resolution of the Storting in Autumn 1976 decided that 31 new posts should be established, of which one was permitted to be filled in 1976.

In connection with the Petroleum Directorate's being assigned authority over parts of the new Working Environment Act on the Continental Shelf, the Ministry of Finance agreed that two positions for engineers and one for a consultant should be advertised for employment in 1977.

.../...

At the end of the Report period the Petroleum Directorate had 176 employees, including employees engaged for a fixed term of years, permanent staff and staff under contract. There are in addition three salaried staff who have not as yet taken up their employment. 25 vacancies are under discussion, and two posts have not yet been advertised.

During the Report period 16 persons left the Directorate's employment. As can be seen from Table 1, most of these have transferred to posts in other oil activities.

There was also great difficulty in finding applicants with sufficient experience in 1977. This is particularly true of the more senior positions in the Control Department.

1.2.3. Organization

From 1.1.78 the Control Department of the Petroleum Directorate will have two new sections. It has been found expedient to separate the measuring technology function in the Production Section to form a Measuring Technology Section.

A separate section for Diving Control will be established as a result of the transfer of responsiblity for the public control of diving operations from the State Works Inspectorate to the Petroleum Directorate during the first quarter of 1978.

As pointed out in the previous Annual Report,it was realized in 1976 that a thorough analysis of the Directorate's organization was desirable. On 1.11.77 the Director appointed an internal committee consisting of one official from each of the Directorate's four departments, including representatives of the salaried staff organizations, to report on any need for changes in the organization. The committee submitted its report on 1.12.77.

1.2.4. TRAINING

Training activities have also been extensive during the Report period. Offers have been taken up from consultants, universities, colleges and oil companies. The total number of course-days in 1977 was 1,384, of which 744 were abroad and 640 in Norway.

.../...

In 1977 the Directorate organized six internal courses with the assistance of the oil companies. All these courses were held at Stavanger. Further internal training will enable more officials to participate, while at the same time reducing the cost per participant.

1.2.5. INFORMATION

During the Report period there has been a large inflow of information from Norwegian and foreign public institutions, the mass media, companies and individuals. The Directorate's Management and other employees who have taken part in information activities see this as an important task. In 1977 the Directorate established its own post of Information Consultant. His duty is to organize the many visits at which information is given on the oil industry. The Information Consultant will also provide a service to the press and the radio.

During the year 33 press releases have been issued, including monthly reports on activities on the Shelf.

In November an information day was arranged in which some 20 representatives of the mass media participated. It is intended to follow this up with similar events in future.

1.2.6. PREMISES

During 1977 the Directorate took over the remainder of the premises at Lagårdsveien 80, which had been sub-let to STATOIL.

On the basis of the large number of posts to be filled in 1978, it is expected that the space situation will continue to be difficult.

To solve the short-term space problem, particularly in view of staff expansion in the Control Department, the Directorate has rented further accommodation. This is expected to be ready for occupation at the turn of 1978/79.

Problems of both an administrative and a technical nature are created by having the individual departments of the Directorate in different locations. The Directorate has therefore asked the Ministry of Industry to be allowed to undertake the planning of a building of its own in which it will be possible to assemble the entire Directorate.

.../...

1.2.7. BUDGET

In the National Budget for 1977, kr. 75,160,000 was allocated for the Directorate's operations. Of this 49,000,000 kr. was allocated to cover costs in connection with safety control. Holders of rights refund control costs.

Kr. 26,000,000 was allocated for the Directorate's geophysical and geological surveys etc. on the Continental Shelf.

1.2.8. JOINT INDUSTRIAL COUNCIL

The Joint Industrial Council of the Petroleum Directorate held seven meetings in 1977.

Following local negotiations between management and salaried staff organizations, agreement was reached that the Joint Industrial Council's representatives should also form a Work Environment Committee of the Directorate, but that they should hold separate meetings with their own agenda.

During the Report period the Joint Industrial Council had the following composition:

Members appointed by the Management
- Mr Fredrik Hagemann
- Mr Farouk Al-Kasim
- Mr Dag Meier-Hansen
- Mr Bjørn Bratbak

Deputies:
- Mr Nils Vogt
- Mr Egil Bergsager
- Mr Magne Ognedal
- Mr Nic B. Askvik.

Members appointed by the organizations:
- Mr Bjørn Frøyland (AF)
- Mr Erik Talleraas (AF)
- Mr Hans Chr. Rønnevik (NOPEF)
- Mr Thomas Houge-Thiis (STATO)

.../...

Deputies:
- Mr Hallvard Tunheim (AF)
- Mr Arne B. Wermundsen (NOPEF)
- Ms Torunn Fraser (NOPEF)
- Ms Brit Borvik (STAFO)

Committee's permanent secretary:
- Mr Kare Asbjørn Tjønneland.

1.2.9. THE NORTH NORWAY OFFICE

The post of local representative for the Petroleum Directorate in North Norway was filled on 1 September 1977. The first year will be spent in training the person concerned in the Directorate's various departments at the main office in Stavanger. It is at present anticipated that the branch office in North Norway will be in operation by 1 January 1979.

The branch office in North Norway will have a modest start, with an executive and a clerk. Its further build-up will depend upon future activities initiated on the Shelf in the North.

TABLE I.
Staff leaving the Petroleum Directorate in 1977, giving new employment.

Department	Oil Industry	Other private business	Other public (municipal) undertaking	Further training	Miscell-aneous	Total
Control Dept.	3	1	1			5
Planning Dept.	2			1		3
Legal-Financial Dept.						
Admin. Dept.	4	1	1		2	8
Total	9	2	2	1	2	16

2. ACTIVITIES SOUTH OF 62°N

2.1. Geophysical surveys

2.1.1. Reflection-seismic profiles

In 1977, 21,000 profile kilometres of reflection seismology were shot in the Norwegian section of the North Sea south of 62°N. Some 6,500 km of this was shot by a geo-physical contracting company with a view to resale to oil companies; so-called "spec survey". The remainder was shot on the orders of various oil companies. Since 1962, a total of 213,000 profile kilometres has been shot.

Fig. 2A shows that, as concerns seismic surveys, activities in 1977 were of the same order as during the four previous years. The substantially greater activity in 1971 and 1972 probably results from preparations preceding the third licencing round in 1973. The fact that there has been no corresponding halt to activity before the coming fourth licensing round is probably because the Norwegian section of the North Sea south of 62°N has gradually been covered by a satisfactorily dense network of seismic lines.

2.1.2. Reconnaissance licences

A total of 65 reconnaissance licences have been issued. The following licences were granted in 1977:

Licence No.062	Amoco Norway Oil Company
Supplement to Licence No.061	Den norske stats oljeselskap A/S
Licence No.063	Esso Exploration and Production Norway Inc.
Licence No.064	Norske Hudbay A/S
Licence No.065	Texaco North Sea Norway A/S.

2.2. Drilling

2.2.1. Exploration and delineation drilling

At the end of 1976, three exploration wells were being drilled. Of these, two have been completed, and the third, Statoil 1/9-1, has been temporarily plugged and left. Some testing remains for this well, and this is expected to be carried out in 1978.

In 1977, 11 new exploratory wells and 9 delineation wells were commenced. Two of the delineation wells - 7/12-3 and 2/11-3 - were deflection-drilled, and were given the designations 7/12-3A and 2/11-3A.

Two of the wells begun in 1977 - 1/9-3 and 30/7-6 - have been temporarily abandoned, but are expected to be completed in 1978.

FIG. 2A

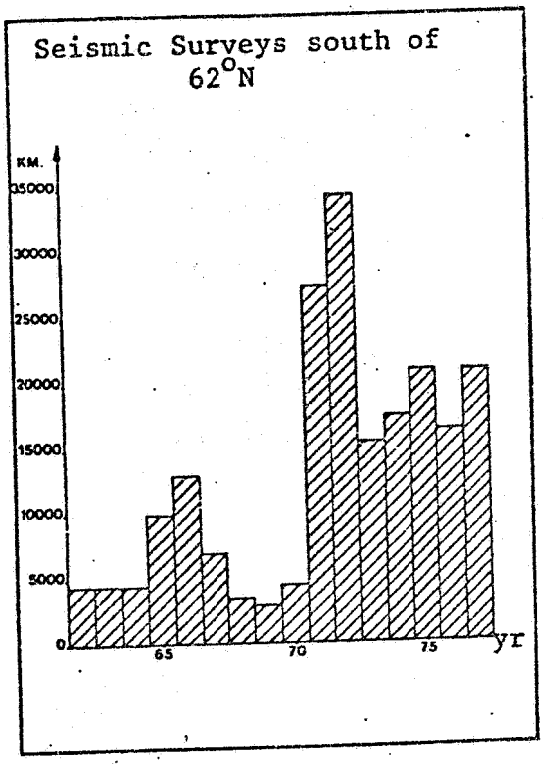


FIG. 2B

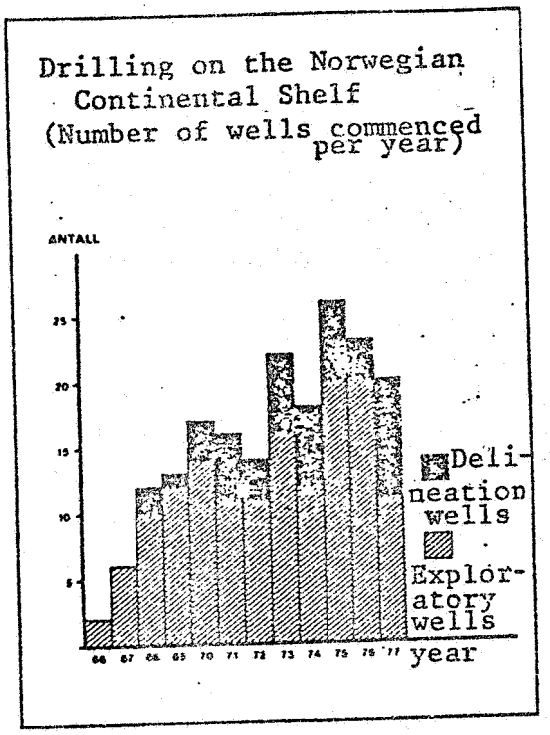


FIG. 2C

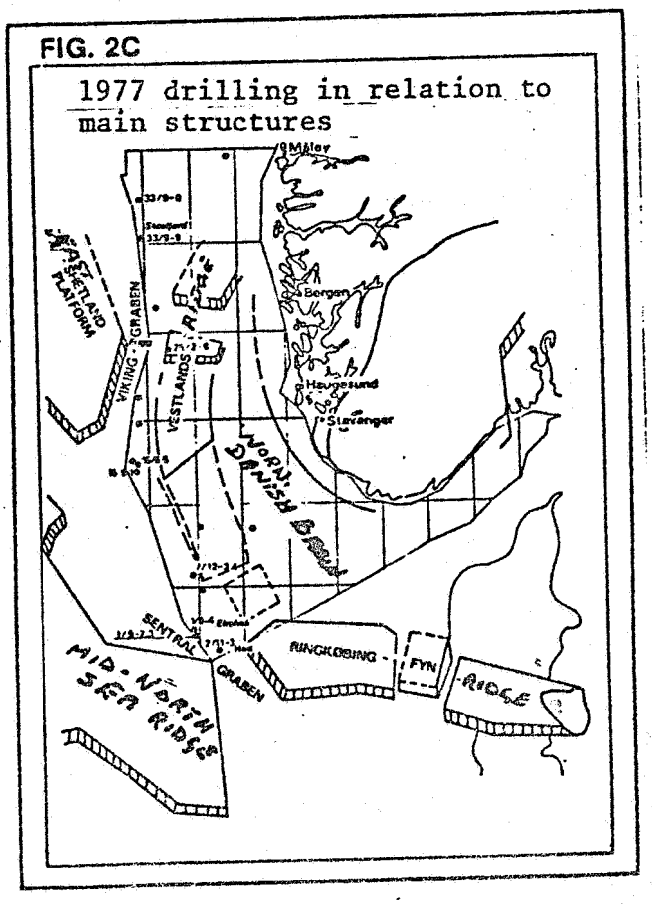
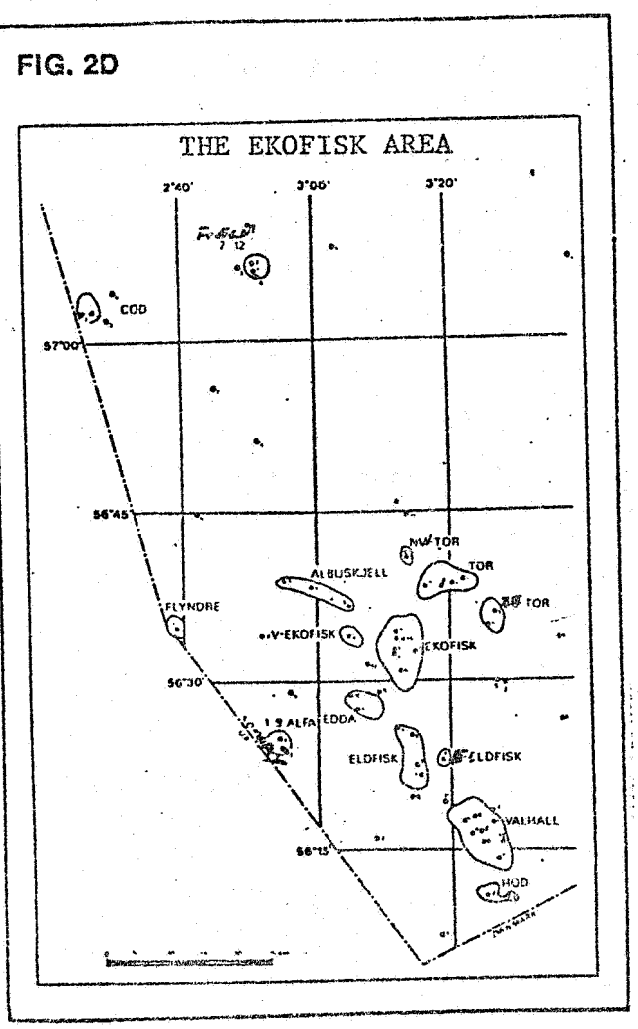


FIG. 2D



At the end of 1977, two of the exploratory wells - 15/5-1 and 2/1-2 - and two of the delineation wells - 1/9-4 and 2/11-3A - were still being drilled.

Drilling activities in 1977 are shown in Fig. 2B. They are in accordance with the forecast presented by the Petroleum Directorate in its 1976 Annual Report.

The Petroleum Directorate expects a certain increase in activity in 1978, particularly because of the coming block allocation. Some 25 wells is considered a reasonable estimate.

Fig. 2C shows the wells in 1977 in relation to the main structural features.

Interest in Jurassic sandstone reservoirs has dominated search activities in 1977. This was the main object of as many as 14 of the wells commenced. These 14 wells are geographically distributed over large parts of the Norwegian Continental Shelf south of 62°N. Five of these were delineation wells - 33/9-9 on Statfjord, 15/9-1 and 15/6-5 on Sleipner, and 7/12-3 and 7/12-4 on the so-called 7/12 field which BP discovered when drilling 7/12-2 in 1976.

33/9-9 was drilled in the Northern part of Statfjord near the top of the structure. The bore was intended to test the thickness of the Brent and Statfjord formations in this structural position, and to test the Statfjord formation's reserves in the northern part of the field. Both of these formations tested oil, but the thickness of the Brent formation was somewhat less than expected. However, the wells showed sand development in the normally slate-rich and silt-containing Dunlin formation that lies between the Brent and Statfjord formations (see Fig. 2L). The Dunlin sandstone showed good reservoir properties and tested oil. This is a new discovery, but provisionally thicknesses are relatively modest.

Statoil's 15/9-1 confirmed that Sleipner extends into Block 15/9. Esso's 15/6-5 which was to test the eastern part of the structure resulted in a reduction of the field's assumed extension eastwards.

7/12-3 was drilled on the flank of the 7/12 structure south-west of 7/12-2. During testing, the bore initially produced merely water, and deflection drilling was started towards a point higher up on the structure. This test also resulted merely in water in this position, whereas the logs indicated oil. 7/12-4 tested the south-eastern part of the 7/12 structure and established oil.

In addition to the delineation wells referred to, a number of exploratory wells also showed prospects, with the Jurassic formation as the main target.

Elf Aquitaine have completed 15/3-2, which was temporarily abandoned in 1976 to await equipment [illegible]

lower part of the well. Only insignificant traces of hydrocarbons were found. Technically, however, the drilling was satisfactory in spite of the high pressures.

At well 25/2-6, Elf Aquitaine have also tested in a Jurassic structure in Block 25/2. The company have established hydrocarbons in Jurassic sandstone in an earlier drilling of 25/2-5 on another structure in this block. 25/2-6 established oil in a Jurassic sandstone stratum, but in very modest quantities. There are large local variations in pressure conditions in this block, depending upon the location in relation to the Vestland ridge. 25/2-6 is situated on the ridge and displayed completely normal pressures, whereas 25/2-5, which is situated in the Viking Trench, had abnormally high pressures. In the Trench area, pressure begins gradually to increase, in relation to the normal, somewhere in the lower chalk.

Norsk Hydro wished to test Jurassic sandstones in a structure in Block 30/7. Technical problems led to abandonment of the two first trials, 40/7-4 and 30/7-5, at a shallow depth. During the third trial - 30/7-6 - unexpectedly high pressures were recorded in strata of the Jurassic period before the primary prospect had been reached. The well was however abandoned, and will probably be deepened in 1978 using equipment designed for high pressures.

On the basis of new seismology, Saga drilled a fourth well in Block 9/4 on a possible dislocation-delineated Jurassic structure. This was a relatively shallow prospect in the Danish Norwegian basin, but the well was dry.

A Jurassic structure drilled by Union Oil in Block 8/4 also proved to be dry.

At the end of 1977, two other wells (2/1-2 and 15/5-1), primarily to test Jurassic reservoir rock types, are being drilled. BP's 2/1-2 is located about 20 km south-east of the 7/12 field, in a corresponding position in relation to the Vestland ridge extension southwards. Norsk Hydro's 15/5-1 is located north-west of Sleipner. Norsk Hydro is employing for this drilling a new type of rig with more automation than other rigs. The chances of encountering abnormally high pressures in this area are considered high, and the rig has therefore been provided with 15,000 psi BOP equipment to overcome these conditions.

The other main types of reservoir on which interest was concentrated in 1977 is the Ekofisk type, i.e. limestone deposits of the older Tertiary and upper Cretaceous Periods.

Statoil has established oil in two different structures in Block 1/9, one to the south and one to the north of the block. The southern structure is referred to as 1/9-Alfa, and was tested by well 1/9-1 at the end of 1976.

TABLE II - EXPLORATORY WELLS (U) AND APPRAISAL WELLS (A) IN 1977

Licence No.	Well	N.lat	E.long.	Drilling commenced	Drilling completed	Operator	Platform	Well type
167	1/9-1	56° 24' 5.10"	2° 54' 6.50"	13.10.76	16.02.77	Statoil	Ross Rig	U
168	15/3-2	58° 59' 0.50"	1° 47' 12.60"	29.10.76	20.01.77	Elf	Polyglomar Driller	U
168	15/3-2	58° 59' 0.50"	1° 47' 12.60"	26.07.77	22.11.77	Elf	Pentagon 84	U
169	33/9-8	61° 26' 17.40"	1° 55' 4.90"	11.11.76	18.02.77	Mobil	Deep Sea Saga	U
170	30/7-4	60° 29' 28.56"	2° 03' 21.47"	25.01.77	05.02.77	N. Hydro	Plyglomar Driller	U
171	15/9-1	58° 28' 19.00"	1° 45' 11.76"	24.01.77	30.05.77	Statoil	Ross Rig	A
172	30/7-5	60° 29' 30.19"	2° 03' 27.40"	05.02.77	14.02.77	N. Hydro	Polyglomar Driller	U
173	30/7-6	60° 29' 29.72"	2° 03' 24.32"	14.02.77	29.07.77	N. Hydro	Polyglomar Driller	U
174	7/12-3	57° 06' 24.54"	2° 48' 41.56"	05.04.77	03.06.77	BP	Norskald	A
175	1/9-2	58° 23' 52.77"	2° 55' 34.63"	01.06.77	12.08.77	Statoil	Ross Rig	A
176	24/9-2	59° 16' 12.43"	1° 55' 12.26"	13.06.77	22.07.77	Conoco	Borgny Dolphin	U
177	8/4-1	57° 44' 50.24"	3° 00' 3.86"	21.06.77	25.07.77	Union	Norjari	U
178	9/4-4	57° 42' 1.48"	4° 13' 20.79"	19.07.77	20.08.77	Saga	Deep Sea Saga	U
179	33/9-9	61° 17' 10.19"	1° 54' 24.05"	27.07.77	17.11.77	Mobil	Borgny Dolphin	A
180	25/2-6	59° 45' 33.55"	2° 33' 5.96"	02.08.77	14.11.77	Elf	Polyglomar Driller	U
181	1/9-3	56° 24' 56.20"	2° 54' 15.15"	13.08.77	27.11.77	Statoil	Dyvi Gamma	U
182	1/9-4	56° 29' 13.76"	2° 56' 0.29"	13.08.77		Statoil	Ross Rigg	U
183	7/12-4	57° 05' 38.13"	2° 51' 37.02"	11.09.77	12.12.77	BP	Norskald	A
184	2/11-3	56° 10' 53.74"	3° 27' 51.78"	10.10.77	05.12.77	Amoco	Dyvi Beta	A
185	15/6-5	58° 30' 29.84"	1° 45' 50.72"	10.10.77	29.11.77	Esso	Drillmaster	A
186	15/5-1	58° 35' 4.39"	1° 39' 8.35"	26.11.77		Hydro	Treasure Seeker	U
187	2/1-2	56° 57' 30.24"	3° 12' 33.79"	14.12.77		BP	Norskald	U
191	7/12-3A	57° 06' 24.54"	2° 48' 41.56"	04.06.77	06.09.77	BP	Norskald	A
192	2/11-3A	56° 10' 53.74"	3° 27' 51.78"	05.12.77		Amoco	Dyvi Beta	A

TABLE III - PRODUCTION WELLS COMMENCED IN 1977

Prod. well No.	Well	Position	Begun from 20" or 18" casing	Operator	Field	Remarks
P 051	UK 10/1-A-8	59°52'31.39" 02°03'41.75"	24.01.77	Elf	Frigg	completed
P 052	UK 10/1-A-5		30.01.77	Elf	Frigg	
P 053	7/11-A-2		31.01.77	Phillips	Cod	
P 054	2/4-E-10	56°30'26.90" 03°19'39.30"	03.02.77	Phillips	Tor	
P 055	2/4-D-13		06.02.77	Phillips	V-Ekofisk	
P 056	UK 10/1-A-2		07.02.77	Elf	Frigg	
P 057	UK 10/1-A-11		23.03.77	Elf	Frigg	
P 058	2/4-D-11		26.03.77	Phillips	V-Ekofisk	
P 059	7/11-A-9		30.03.77	Phillips	Cod	
P 060	2/4-D-12		22.04.77	Phillips	V-Ekofisk	
P 061	UK 10/1-A-1		23.04.77	Elf	Frigg	
P 062	2/4-E-15		28.04.77	Phillips	Tor	
P 063	2/4-E-9		01.05.77	Phillips	Tor	
P 064	7/11-A-1		08.05.77	Phillips	Cod	
P 065	UK 10/1-A-10		29.05.77	Elf	Frigg	
P 066	UK 10/1-A-12		03.06.77	Elf	Frigg	
P 067	UK 10/1-A-3		07.06.77	Elf	Frigg	
P 068	UK 10/1-A-9		10.06.77	Elf	Frigg	
P 069	7/11-A-8		04.07.77	Phillips	Cod	
P 070	2/4-E-13		29.07.77	Phillips	Tor	
P 071	UK 10/1-A-4		07.08.77	Elf	Frigg	
P 072	UK 10/1-A-7		12.08.77	Elf	Frigg	
P 073	2/4-D-7		17.08.77	Phillips	V-Ekofisk	
P 074	UK 10/1-A-6		18.08.77	Elf	Frigg	
P 075	7/11-A-4		01.09.77	Phillips	Cod	
P 076	25/1-A-23	59° 53'10.07" 02 04'20.60"	10.11.77	Elf	Frigg	
P 077	25/1-A-21		15.11.77	Elf	Frigg	
P 078	25/1-A-22		24.11.77	Elf	Frigg	
P 079	2/4-E-16		25.11.77	Phillips	Tor	
P 080	25/1-A-24		01.12.77	Elf	Frigg	
P 081	25/1-A-18		12.12.77	Elf	Frigg	
P 082	25/1-A-19		17.12.77	Elf	Frigg	
P 083	25/1-A-17		22.12.77	Elf	Frigg	
P 084	25/1-A-14		28.12.77	Elf	Frigg	

FIG. 2E

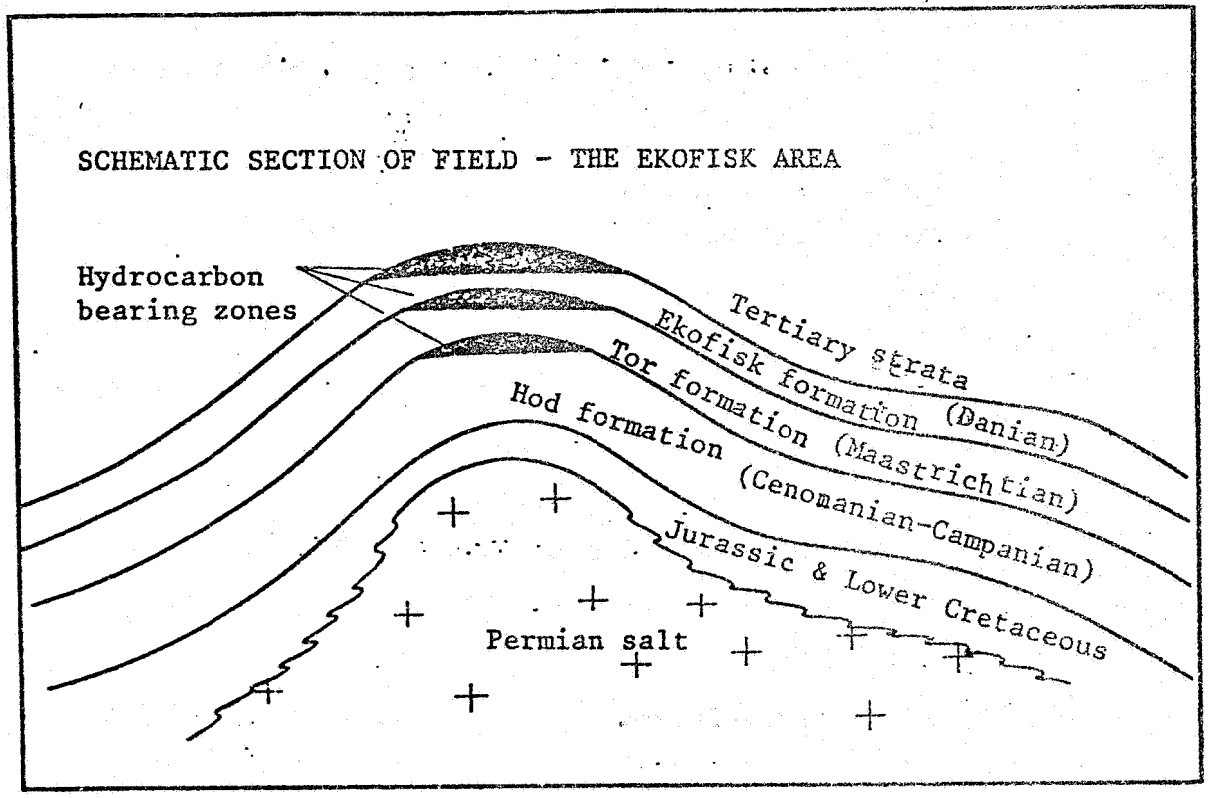


FIG. 2F

UPPER CRETACEOUS		PALEOCENE	EPOCH
CENOMAN - CAMPANIAN	MAASTRICHT.	DANIAN	PERIOD
HOD FM	TOR FM	EKOFISK FM	FORMAT.
			Ekofisk
			V.-Ekofisk
			Tor
			Albuskjell
			Eldfisk
			Edda
			Valhall
			Hod

Geological location of reservoirs in the Ekofisk area

1/9-2 and 1/9-3 are delineation wells drilled in 1977 on this structure. The northern structure is referred to as 1/9-Gamma, and was drilled in 1977 by well 1/9-4. The strata pack from central to lower Tertiary has abnormally high pressures in this section of the North Sea. During the earlier exploratory phase, this caused a number of drilling-technology problems, but as knowledge increased and safety equipment improved this is no longer a problem for the companies.

Amoco has tested the eastern part of Hod. The first well - 2/11-3 - was too low on the structure and merely tested water. A deflection well from this - 2/11-3A - towards a point higher on the structure was being drilled at the end of 1977 for any showing of oil. The western part of the field had been tested earlier with good results.

The only well in 1977 in which the prospect types referred to were not the main target was Conoco's 24/9-2 in the central part of the Viking Trench. New seismic data indicated the possibility here of a reef structure in the lower Tertiary. This interpretation proved to be incorrect, and the well was dry.

Shallow gas pockets, i.e. minor accumulations of gas under pressure in the upper few hundred metres, is a not unusual phenomenon, but may represent real danger because of the problems of controlling and handling this gas at such an early stage in drilling. Shallow pockets of gas can normally be charted on the basis of ground-seismic surveys. In areas where shallow pockets of gas are expected, the normal procedure has been for companies to carry out ground-seismic surveys in association with the preparation of drilling programmes to avoid drilling into them. As part of the work of securing optimum safety during drilling, in 1977 the Petroleum Directorate gave orders that in future ground-seismic data must be enclosed with all applications for drilling licences.

Overall, the result of 1977 drilling has not increased recoverable reserves on the Continental Shelf. Further, the drilling has not created a basis for increased drilling activity in blocks already covered by licences.

Table II gives a survey of exploratory and delineation wells completed or commenced in 1977. The deflection wells 7/12-3A and 2/11-3A were not at first given their own licence numbers. For practical reasons, this was later changed, which explains the apparent discontinuity in licence numbers (see Table).

2.2.2. Production wells

In 1977, four new wells were drilled at V-Ekofisk. Drilling in this field is now considered to be complete, with a total of ten wells.

The drilling of the Cod wells was also completed in 1977. A total of eight production wells was drilled at Cod, of which two were shown to be dry.

In the Tor field, all 20" line-pipes were laid during 1977, and the drilling of three wells was completed. One well was still being drilled at the end of 1977, and for technical reasons one had to be abandoned at a shallow depth in 1977. The plan is to drill a total of 18 production wells, and the completion of 14 wells thus remains.

Production drilling on Frigg increased in 1977, both by the British and the Norwegians. The drilling platform on the British side is referred to as CDP1, and in 1977 it completed the drilling of 12 wells of a total of 24. All have penetrated the reservoir on the British side of the boundary.

The DP2 drilling platform, which is located on the Norwegian side of the boundary, also commenced to drill production wells in 1977. In all, 23 production wells plus one observation well are to be drilled. 30" and 20" line-pipes have been placed in all of these, and at the end of 1977 13 3/8" line-pipes were placed in 8 of the wells.

Table III gives a survey of the production wells on the Norwegian Continental Shelf commenced in 1977.

2.3. New finds

In 1977, finds of hydrocarbons were made in one new structure - 1/9-4 - with Statoil as operator. This structure is located in the northern part of Block 1/9, and is referred to by the operator as 1/9 Gamma. This is a salt-related structure of the same type as elsewhere in the Ekofisk area. Hydrocarbons have been encountered in Cretaceous limestone rock.

2.4. Ekofisk area

2.4.1. Exploitation of deposits

The Ekofisk area comprises the Ekofisk, V-Ekofisk, Eldfisk, Ø-Eldfisk, Tor, Albuskjell, Edda and Cod fields (Fig. 2D). Phillips Petroleum Company Norway is the operator for expansion and operation of the fields. Valhall and Hod are geographically in the same area, and are also geologically comparable with the other fields. However, these two will be dealt with separately, as development of the field is carried out under a separate development plan and by a different operator - Amoco Norway Oil Company.

Apart from Cod, hydrocarbons have been established in all fields in a very fine grained, pure chalk rock type deposited during the late Cretaceous and early Tertiary Periods. Fig. 2E shows a generalized profile through a typical field in the Ekofisk area.

The chalk rock type is divided into three formations. From the top downwards they have become referred to as the Ekofisk, Tor and Hod formations respectively. In the Ekofisk area, hydrocarbons have been found in workable quantities in all three formations.

Fig. 2F illustrates the formations that comprise the reservoirs in the individual fields of the Ekofisk area. Valhall and Hod, which will be referred to separately, have also been included in the diagram as they are of the same geological development.

Geologically, Cod, about 70 km north-northwest of Ekofisk, is a different type of field from the others in the Ekofisk area. The reservoir rock type in Cod is limestone, which is younger than the chalk rock type in the other fields. The sandstone is of Palaeocene (Lower Tertiary) age, and part of the so-called Forties formation.

The oil reservoirs in the Ekofisk area contain hydrocarbon mixtures in an unsaturated condition, i.e. at the pressures and temperatures present in the reservoirs all gas is dissolved in the oil.

The hydrocarbon mixtures are light and poor in sulphide, with mixtures gradually becoming lighter towards the north-west of the area, i.e. towards the centre of the Central Trench. Edda, Eldfisk, Ekofisk and Tor may be characterized as oil fields. V-Ekofisk, Albuskjell and Cod, however, are condensate fields.

The driving mechanism for production in the Ekofisk area fields varies with the type of field. In the oil fields, production is due from the outset to the expansion of the oil and compression of the rock. Later, when the pressure falls below saturation pressure, gas released from the liquid will expand and so represent the greater part of the driving power. In the condensate fields, expansion of gas is the driving mechanism from the outset.

Forcing gas into the reservoir and allowing it to expand there will displace the oil. While the pressure is high, the gas will be miscible with the oil and displace it very efficiently. Injection of gas in this manner makes it possible to extract something over one ton of oil for every 1,000 Nm^3 of gas injected, apart from that obtained by normal extraction (pressure relief). It is scarcely possible to extract these additional quantities in any other way. The injection that has already taken place has increased extractable reserves by about 9 million tons of oil, and is expected to lead to an increase in production rates of about 10% from the end of 1978 and for some years thereafter. At the same time, 9 of the 15 billion Nm^3 of gas extracted to date is so located that it can be recovered later.

As pressure gradually decreases, oil and gas will appear in separate phases with an ever greater dividing layer between them. Surface tension will gradually prevent gas from penetrating into the small pores of most rock types. Therefore, as pressure drops, gas will break through quickly into the production wells, while at the same time the displacement of oil becomes less efficient.

Ekofisk is the only field in the area where extraction is assisted - or where there are plans for assisting it - by the injection of gas. Although by this injection the licensees' intention was to create storage facilities for gas while awaiting sales and during seasons of low gas consumption, the venture has in practice proved also to be successful in increasing oil extraction from the field.

2.4.2. Production facilities/fixed installations

The development of the Ekofisk area was planned in the following phases:

Phase I: Tests and preliminary production

Phase II: Permanent production with offshore loading direct into tankers and injection of gas.

Phase III: Expansion of Ekofisk Center, linking up with V-Ekofisk, Cod and Tor fields and laying of pipelines for oil and gas to Teeside and Emden.

Phase IV: Construction and link-up of platforms for Edda, Eldfisk and Albuskjell fields.

Phases I and II of the development has been completed.

Phase III was almost complete by the end of 1977, and Phase IV is well advanced.

The location of platforms and installations in the Ekofisk area is shown in Fig. 2 G.

The last of the main structures planned for Ekofisk - accommodation platform 2/4H - is the only one erected in 1977. It was set in place on 10 May. The deck was positioned and the platform connected by a bridge to Charlie platform 2/4C in August. Installation work has been progressing, and it is expected that the platform will be ready for use in April/May 1978. The platform will provide accommodation for 212 personnel in double rooms.

A new separator was installed in 1977 at the Ekofisk processing terminal (FTP). This increases processing capacity for the production from the A, B and C platforms.

V-Ekofisk was brought into production on 31 May 1977, but was stopped again on 8 July because the riser pipe ran too near to the platform structure because of expansion in the pipeline. Extensive work was necessary on the riser pipes and the pipelines before the platform could be brought into production again on 30 November. It is possible that this platform will have to be taken out of production again for a short period in 1978 if expansion of the pipeline continues to cause problems.

Problems with the gas flaring system, the pipeline and various production equipment has delayed the start-up of production from Cod. Gas production began on 26 December, and oil production began from one well two days later.

Production drilling on Tor was begun in 1976. The pipelines were laid in Spring 1977. Testing the pipelines proved to take substantially longer than planned. Testing, inspection and covering of the gas pipeline (14") has been completed, apart from in the neighbourhood of Ekofisk Center. Repair of damage to the oil pipeline ($12\frac{3}{4}$") has however been slowed down by bad weather. At the end of 1977, tests on this pipeline were not complete. The vessels that are to cover this pipeline are dependent upon good weather to carry out their work. The operators plan to put the field into production in March 1978, but it is more than likely that delays will arise. Three wells were complete on Tor at the end of 1977.

Installation work on the two platforms on Albuskjell - 2/4F and 1/6A - have gone according to plan. Accommodation quarters and helicopter deck were put in position on 1/6A on 8 July, and approved by the Petroleum Directorate for use in September. The accommodation unit on 2/4F was approved for use in August. This meant that the two platforms which have acted as floatels, "Alexander Kielland" and "Henrik Ibsen", could be moved to Eldfisk 2/7B and Edda 2/7C.

The substructure of the gas flaring installations, their decks, and bridges from the platforms were positioned in October on 2/4F and 1/6A. On 2/4F, the drilling modules have been positioned, and work is in progress on installing 30" line-pipes. The operator expects the first well on 2/4F to be completed by 1 July 1978, and on 1/6A by 1 October 1978. According to the Phillips Group's plans, laying and jointing of pipelines must be completed by October 1978.

Progress of the work on the three platforms - 2/7A, 2/7B and 2/7FTP - on Eldfisk has gone according to plan. The bridge between 2/7A and 2/7FTP was positioned on 8 July. On FTP, the gas flaring installation was positioned in July, and the riser pipes were installed in October. The accommodation unit on 2/7A was approved for use, by the Petroleum Directorate, in August, and in September the installation of drilling modules was begun. The 2/7B deck was

installed on 22 July, and its accommodation unit and helicopter deck on 11 August. At the turn of the year work was in progress here on the gas flaring plant. The operator expects the first well on 2/7A to be completed on 15 August 1978, and on 2/7B on 1 March 1979. The pipeline connexion should be complete by 15 September 1978.

Edda is the last field to be brought into production in the Ekofisk area. This is expected to take place in 1979. The accommodation module and helicopter deck on Edda platform 2/7C was positioned in September. The accommodation quarters are expected to be brought into use in early 1978. The operator plans completion of the first well on 15 December 1978, the pipeline being connected at the same time.

Activity in the construction section of the Ekofisk area will gradually decrease throughout 1978. The operator has planned to lay and connect the pipelines for Eldfisk, Albuskjell and Edda in the 1978 season. It may prove to be somewhat optimistic to expect to carry out all this work in one season. The Petroleum Directorate has assumed in its production forecasts (see Chapter 2.10) that production from Eldfisk, Albuskjell and Edda will commence during 1979.

Production wells will be drilled in 1978 on Tor, Eldfisk 2/7A, Albuskjell 2/4F and 1/6A, Edda 2/7C and perhaps Ekofisk 2/4B. What is of interest in this connexion is the extent to which drilling time production must be stopped because of the Petroleum Directorate's new rules for simultaneous drilling and production. These rules have not been applied in the past.

The Phillips group expects the Ekofisk expansion to have cost 31,450 million kroner when all platforms, production facilities, pipelines and processing terminals for oil and gas have been completed.

On the production installations in the Ekofisk area, oil, gas and water extracted are separated and processed to render the various products suitable for sale, injection, fuel or discharge. Separation is effected in three stages, first by leading the stream through a high pressure container, then through a medium pressure container and finally through a low pressure container.

Oil from Ekofisk is led either for storage in the Ekofisk tank or directly through the pipeline to Teeside. From the other fields the oil goes direct to the Teeside pipeline.

Gas can either be led to Emden through the gas pipeline or injected into the Ekofisk reservoir. The gas is treated during the separation process to prevent its depositing liquid in the pipeline (dehydration and dew-point processing).

The Ekofisk field has its own processing terminal (Ekofisk FTP) at which all three separation stages are carried out. The streams from the 2/4A, 2/4B and 2/4C drilling platforms are led to this platform.

The Cod, Tor, Eldfisk, Edda and Albuskjell installations all have high-pressure separation containers and dehydration facilities for gas. The latter are necessary to dry the gas to prevent wax forming in the pipelines to the central installation in the Ekofisk field. With the exception of Cod, an oil pipeline and a gas pipeline run from all these fields to the riser platform on Ekofisk (2/4B). From here, oil and gas continue via a bridge to Ekofisk Center. The streams are here gathered for second and third stage separation. Final dehydration and dewpoint processing of the gas is also carried out on Ekofisk Center.

Oil from the high-pressure container on Cod and the dehydrated gas are led in a common pipeline to Ekofisk Center.

The streams from the drilling platform on V-Ekofisk (2/4D) are led without processing to Ekofisk Center, where the first separation stage is carried out before the oil and gas streams are mixed with streams from the other fields.

The recovery facilities in the Ekofisk area link the fields and provide a certain potential for optimizing the exploitation of deposits as a whole. This potential consists mainly in distributing the intake to the facilities between the fields, controlling the oil (condensate) deposited by the gas into various pressure vessels, varying pressure and temperature conditions in separation and cooling facilities, using the gas and NGL as an oil displacement agent in the Ekofisk field and using the Ekofisk field as a store for gas and NGL. The common facilities also give opportunities for more favourable financial operations and for the exploitation of reserves that are otherwise only marginally worthy of consideration.

2.4.3. Return of NGL (wet gas) to Norway

In association with the landing licence for petroleum from the Ekofisk area fields, the Phillips Group entered into an agreement with the Norwegian Government for the return of NGL to Norway. The agreement was concluded primarily to ensure deliveries of raw materials for the Norwegian petrochemical industry. Licences under the agreement concluded with the Government were later assigned to Noretyl (Statoil, Hydro, Saga), which is responsible for expansion and operation of the Rafnes installations.

The agreement mainly concerns the Phillips Group's supply of ethane and propane as raw materials for Noretyl. The Ekofisk, V-Ekofisk, Cod and Tor fields must supply enough to produce 250,000 tons of ethylene a year. The Eldfisk, Edda and Albuskjell fields are to supply enough for a further

FIG. 2G

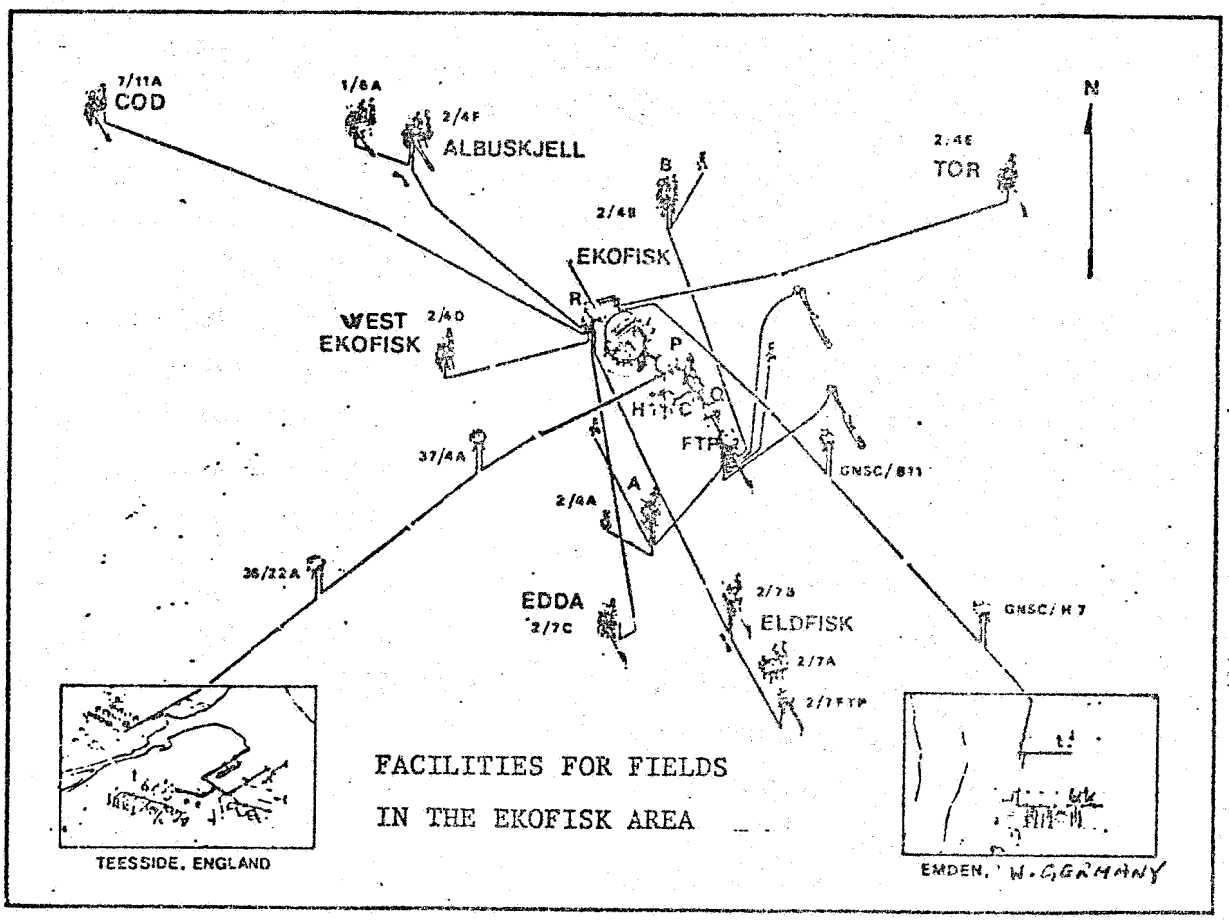
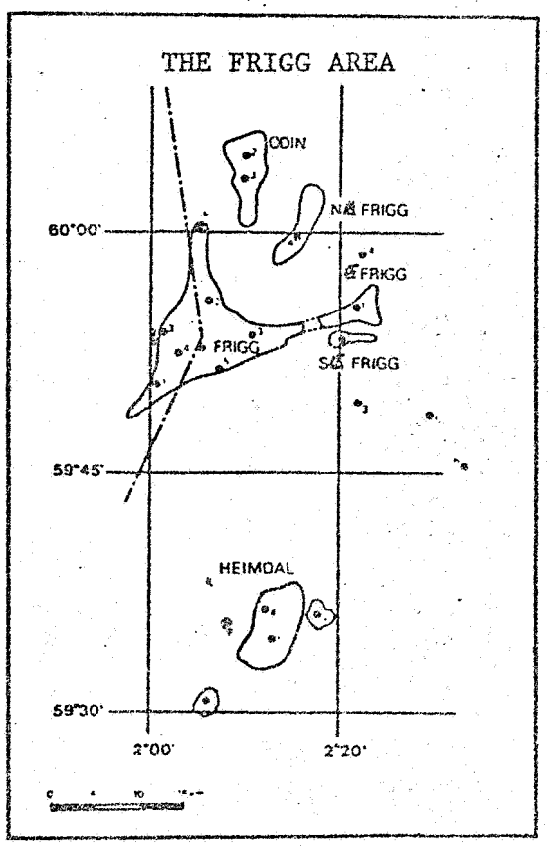

7/11A
COD
1/6A
2/4F
ALBUSKJELL
2/4E
TOR
N
B
2/4B
EKOFISK
R
WEST
EKOFISK
2/4D
P
H
C
Q
FTP
37/4A
2/4A
A
GNSC/811
36/22A
EDDA
2/7C
2/7B
ELDFISK
2/7A
2/7FTP
GNSC/H7
FACILITIES FOR FIELDS
IN THE EKOFISK AREA
TEESSIDE, ENGLAND
EMDEN, W. GERMANY

FIG. 2H


THE FRIGG AREA
ODIN
NW FRIGG
60°00'
E FRIGG
FRIGG
SW FRIGG
59°45'
HEIMDAL
59°30'
2°00'
2°20'

80,000 tons a year.

The ethane and propane produced from the individual fields are found in the streams of both gas and oil. Large propertions of the gas stream are condensed-out during final dehydration and dewpoint processing on Ekofisk Center. This condensate is mixed with the oil stream and led to Teeside by pipeline. Because of the condensate content, the oil must be kept under pressure at normal temperature so that the condensate does not evaporate. The Phillips Group are constructing at Teeside facilities for stabilizing the oil and for storing and shipping it. The Group is also constructing facilities for fractioning the condensate into liquid ethane, propane and butane, and for storing and shipping these fractions.

Under the agreement, the Phillips Group was to supply the first ethane/propane to Noretyl in autumn 1976. Delay in the extension of Ekofisk Center and the Teeside facilities caused supplies to be postponed first to summer 1977 and later to the end of 1977. Because of further delays in the Teeside facilities, particularly the fractioning and ethane/propane storage installations, the Phillips Group considers that no deliveries can be made until autumn 1978. This has caused great problems for Noretyl, since the Rafnes installations were ready to receive the raw material in summer 1977.

Since conclusion of the NGL agreement, the Petroleum Directorate has followed developments, in the first place to ensure that the sea facilities were so designed that they would represent no restriction in supplies of NLG.

2.4.4. Pipelines from Ekofisk

Ekofisk - Teeside

The oil pipeline from Ekofisk to Teeside was brought into use in autumn 1975. The length of the pipeline is 345 km, and its diameter 34".

By the end of 1977, some 60,000 m^3 of oil a day was conveyed through the pipeline from Ekofisk to Teeside. When the two pumping platforms are ready, it will be possible to pump 160,000 m^3 of oil a day through the pipeline. The oil now led through the pipeline is processed at Ekofisk Center, and NGL separated off. When the Teeside extensions are complete, the NGL will run together with the oil at a pressure of 7 bar.

During 1977, extensive checks on the state of the pipeline were carried out. Sections were found in which the pipeline was not covered as was assumed, and repair work was carried out. This work will continue into 1978. In September 1977 the pipeline was damaged near Teeside by an anchor. The damage caused great reduction in the pipeline's corrosion resistance at this point. Norpipe are to submit a plan to the Petroleum Directorate in early 1978 for repair of the damage. It is planned to carry out the repair in April 1978.

This is estimated to take six weeks. The work depends upon good weather. While the work is in progress, buoy loading will be carried out on Ekofisk. Bad weather could lead to reduced production during this period.

Ekofisk - Emden

The gas pipeline from Ekofisk to Emden was brought into operation on 14 Sept. 1977. The pipeline has a diameter of 36" and a length of some 442 km, 40 km of which is on land. At the end of 1977, 25 million Nm^3 of gas a day was conveyed to Emden through the pipeline. When extension of the pumping platforms is completed, it will be possible to convey 60 million Nm^3 a day to Emden.

There was some delay in commissioning the pipeline. Part of this delay resulted from Danish demands for improvements, since it was shown that the burial of the pipelines did not meet the original requirements. To rectify this, 600,000 sandbags were placed around the pipeline on Danish territory as a temporary solution. Permanent burial will be carried out by a special vessel. It is planned to carry out the work during spring 1978, and completion is estimated for autumn 1978.

2.4.5. The Bravo blow-out

In 1977 occurred the greatest uncontrolled blow-out on the Norwegian Continental Shelf. This was in the Ekofisk field on production platform 2/4B, the so-called Bravo platform. On 22 April 1977 at 22.15 hrs., the Phillips Petroleum Company Norway's Head Office at Tanager received a message that production well B-14 was out of control.

The blow-out occurred during overhaul work on B-14. This included withdrawing the entire production pipe from the platform down to the reservoir. Before this work could be commenced, the valve arrangement on the production deck, the so-called Xmas tree, had to be replaced by a special arrangement of anti-blow-out safety valves. These safety valves are technically referred to as blow-out preventers - BOP. From the time the Xmas tree is taken down and the BOP put into position there is no mechanical possibility of closing off the well on the platform. This must therefore be ensured in another way before the Xmas tree is removed, and drilling mud and mechanical safety arrangements in the production pipe are used for this. Drilling mud is a heavy liquid which is forced down into the production pipe to hold back the oil and gas in the reservoir. This operation is normally referred to as "killing" the well. A mechanical safety valve, a so-called DHSV (down hole safety valve), was placed about 150 m down in the production pipe after several unsuccessful attempts. The blow-out itself occurred during erection of the BOP.

All personnel on Bravo had been evacuated and brought to safety within an hour of the accident. The authorities, i.e. the Petroleum Directorate, the Ministry of the Environment and the National Pollution Inspectorate, had been notified. A few hours later, Phillips asked for the assistance of the Red Adair Company in Texas in stopping the blow-out.

An action group chaired by Mr. Hans Chr. Bugge of the National Pollution Inspectorate was established at Sola some four hours after Phillips had received information of the blow-out.

After four unsuccessful attempts, Phillips Petroleum Co., with the help of Red Adair and his men, managed to stop the escape of oil and gas on 30 April.

The Petroleum Directorate estimates that 22,500 tons of oil and between 10.5 and 12 million Nm^3 of gas escaped.

Action was called off on 3 May. The escape had been stopped, but much work remained in cleaning up the platform and in preparing it for production again. Production was not resumed until 17 July.

To clarify the cause of the blow-out, an investigation committee was set up by Royal Decree of 26 April 1977. The Committee was made up as follows: Mr. John Fr. Meyer (Chairman), Dr. Techn. Johannes Moe and Police Inspector Johan Schanche. The Committee submitted its report to the Ministry of Justice and Police on 10 October 1977.

The Committee's conclusions may be summarized as follows:

The direct cause of the blow-out was that when the DHSV was lowered during the night of 22 April it did not engage with a nipple in the production pipe as intended. It could not therefore hold back the drilling mud when the well became unstable during the morning.

However, the Committee also says that in spite of this the blow-out need not have occurred. There were two warnings during the day that something was wrong. The first warning was when drilling mud began to run out of the DHSV control pipe during the morning. The second warning occurred when the Xmas tree was removed in the afternoon. At that time also drilling mud came up through the production pipe. Insufficient attention was given to these warnings, and at 22.15 hrs. the uncontrolled blow-out occurred.

The Bravo blow-out caused the Petroleum Directorate to carry out during 1977 a thorough investigation of the Directorate's control routines, approval procedures, regulations etc. This investigation resulted in immediate and long-term measures on the part of the Directorate.

The Petroleum Directorate has noted that the Investigation Committee found no reason to question the Petroleum Directorate's general control policy.

The Bravo blow-out, the subsequent unravelling of the causal relationships and disclosure of weaknesses in various areas have provided valuable experience in the control field.

2.5. Valhall - Hod

Valhall and Hod are two fields located about 35 km south-east of Ekofisk. Fig. 2D shows the geographical location of Valhall and Hod in relation to the Ekofisk area fields. The fields are located in a structural development that covers the southern half of Block 2/8 and most of Block 2/11. The western flank of the structure runs into Block 2/7. The structure is oblong in shape, with its greatest extension in a NNW-SSE direction. Its extent is about 10 x 20 km. Reservoirs are found only in parts of the structure. Fig. 2F shows the geological formations which form the reservoirs.

Valhall consists of the northern and largest part of the structure. The main part of the reservoir is located in Block 2/8, but it also extends into Block 2/11. The Hod field consists of two ridges separated from Valhall by a saddle.

Up to the present, 13 wells have been drilled in the structure, including one deflection well. Valhall was discovered by well 2/11-1 in September 1969, and Hod by well 2/11-2 in January 1975. It is expected that Bore No. 14 - 2/11-3 - which is exploring the most easterly of the two ridges on Hod, will be completed in early January 1978. The drilling of a further delineation on Hod and another on Valhall is planned for the near future.

Blocks 2/8 and 2/11 have been allocated under two different production licences. Production licence No. 006 covering Block 2/8 was issued on 17 August 1965, and production licence No. 033 covering Block 2/11 was issued on 30 May 1969. The same licensees, the Amoco/Noco Group, participate in the two production licences, but with different shares. When production licence No. 033 was issued, there was an agreement with the licensees that they would pay to the Government an amount equivalent to 10% of the net profit from the sale of petroleum from areas covered by the licence. This sum is in addition to royalties. Because of this agreement, and because the ownership of Blocks 2/8 and 2/11 differs, it will be necessary to establish precisely Valhall's distribution between the two blocks.

Storting Report No. 92 (1976-77) refers to the landing of petroleum from the Valhall and Hod fields. The landing licence was issued in May 1977. The licensees have planned development in stages. The work on detail planning of the first stage -development of the central section of Valhall in Block 2/8 - has been taking place since the landing licence was issued. In association with the Petroleum Directorate's work on the plans, a series of meetings have been held with the Amoco/Noco Group. These meetings resulted in amendment of

the plans from a two-platform solution to development using three platforms: one drilling platform, one production and compression platform and one separate accommodation platform. The three-platform solution chosen is the result of an assessment of the safety aspect of several alternative solutions. The deck on the drilling platform is dimensioned for the drilling of 24 wells. The processing equipment on the production/compression platform will be dimensioned to handle any production resulting from the subsequent development stages on Valhall and Hod. It is planned to develop the remaining parts of Valhall and Hod by integrated platforms. The characteristics of the field make it essential to obtain production history and well data as early as possible so that optimal location for the subsequent wells can be determined. A certain amount of simultaneous drilling and production will therefore be necessary. The location of the wells will decide the amount of petroleum that can be recovered.

The Amoco/Noco Group is to submit a study programme for increasing the oil recovery factor by injecting gas, water or other substances. The Petroleum Directorate will follow this work very carefully with a view to achieving optimal recovery.

Development of Valhall and Hod is planned over the following four stages:

First stage of development, Valhall A, which comprises

- development of the central part of the Valhall structure in Block 2/8;
- 3 platforms;
- Drilling platform, planned to be positioned in summer 1979. The structure for this platform is to be built at Aker Verdal, and the deck at Kvaerner in Egersund;
- production/compression platform, planned to be positioned in spring 1980. A modified jacket previously planned for use on SE Tor will be employed for this platform;
- Accommodation platform, planned to be positioned in spring 1979. The modules for the accommodation quarters on this platform are expected to be built in Norway, but where the steel base is to be constructed is not yet decided;
- stabilized raw oil and gas of pipeline quality will be conveyed separately in two 20" pipelines to Ekofisk Center, where the existing transport system to Emden and Teeside will be employed. The laying of the pipelines from Ekofisk Center is expected to commence in spring 1979. For connexion to Ekofisk Center, a new riser pipe platform will be built, which is to be connected by a bridge to the western end of the Ekofisk tank. If it becomes necessary to separate off NGL on Valhall, it will be re-injected into the reservoir if there is no transport capacity available in the Ekofisk system.

Drilling of the first well will commence in spring 1980, and production in January 1981;
- cost of the first stage of expansion is preliminarily estimated at 3.6 billion kroner.

Second development stage, Hod, comprising:

- development of Hod in Block 2/1;
- an integrated drilling and production platform;
- it is planned that petroleum extracted will be sent by pipeline for processing on Valhall A;
- drilling of production wells begins in 1981. The development of Hod depends upon positive results from the delineation drilling in progress and planned.

Third development stage, Valhall B, comprising:

- development of the south-western part of Valhall;
- an integrated platform;
- petroleum extracted conveyed by pipeline for processing on Valhall A;
- drilling of production wells begins in 1982.

Fourth development stage, Valhall C, comprising:

- development of the south-eastern part of Valhall;
- an integrated platform;
- drilling of production wells begins in 1983;
- petroleum extracted conveyed by pipeline for processing on Valhall A.

The third and fourth development stages depend upon positive results from the planned delineation drillings on Valhall and good production results from Valhall A.

2.6. The Frigg area

2.6.1. Exploitation of deposits

The Frigg area comprises Frigg and the satellite fields of East Frigg, South-east Frigg, North-east Frigg and Odin (Fig. 2H). At the end of 1977, only Frigg has been declared to be commercial, and it is undergoing development. East Frigg and Odin are being assessed for development and are expected to be declared commercial during 1978. As described in detail in the 1976 Annual Report, the fields are considered to be local structures on a continuous sand body of the Eocene age - the Frigg formation - of limited lateral extent.

The sand in the Frigg formation is in part consolidated, and has an average porosity of about 25%. Flow properties are relatively good. The gas which has accumulated in the structures is some 97% methane, and has a

relatively modest condensate content. Between the gas zone and the underlying water zone there is a thin layer of oil, which is not commercial.

Under the Frigg formation is an older sand deposit, the Heimdal formation (formerly called the Cod formation). This formation is seen as being deposited continuously over a very large area compared with the extent of the Frigg formation. Heimdal is located 40 km south of Frigg, and is a condensate-bearing structure in this formation.

The Frigg and Heimdal formations are separated by a zone consisting of alternating sand and slate strata. This zone also contains some volcanic ash (tuff), and is therefore usually referred to as the tuff zone. Fig. 2 I shows a generalized section through the Frigg/Heimdal formation.

If the tuff zone proves to be impermeable to liquid and gas, and also to be continuous under the deposit area of the Frigg formation, the Frigg formation will have a closed pressure system. In the 1976 Annual Report, the Petroleum Directorate gave an assessment of the negative effects such a situation would have on production in the satellite fields, and concluded by stating that for reservoir reasons it would be desirable to develop the satellite fields as soon as possible.

It is however possible that the tuff zone is discontinuous, or that it otherwise permits pressure and flow connexions between the two formations. In that event, water from the Heimdal formation will flow into the Frigg formation when the Frigg reservoir is producing. The strength of this inflow of water will depend upon the flow properties in the tuff zone and the Heimdal formation, and also on the content of gas and water in the Heimdal formation. A strong inflow of water will cause the pressure in the Frigg formation to be maintained, wholly or in part. In that event, production from the Frigg field will not have a significantly negative effect upon the satellite fields' production.

However, a strong inflow of water will reduce the recovery factor of the Frigg field itself. This is because the water front will be able to reach the well area more quickly than if the inflow of water was small or nil. The field will then have to be shut down because of excessive water production, even if the reservoir pressure is still sufficiently high to act as an effective driving mechanism. The water flowing in will also 'catch' some of the gas, so preventing it from flowing towards the well area.

A reservoir study carried out co-operatively by the Petroleum Directorate and Rogalandsforskning (research institute) indicates that the recovery factor for the Frigg field may vary between 60% and 90%, depending upon the existing inflow and expansion conditions. The highest recovery factor is obtainable

FIG. 2I

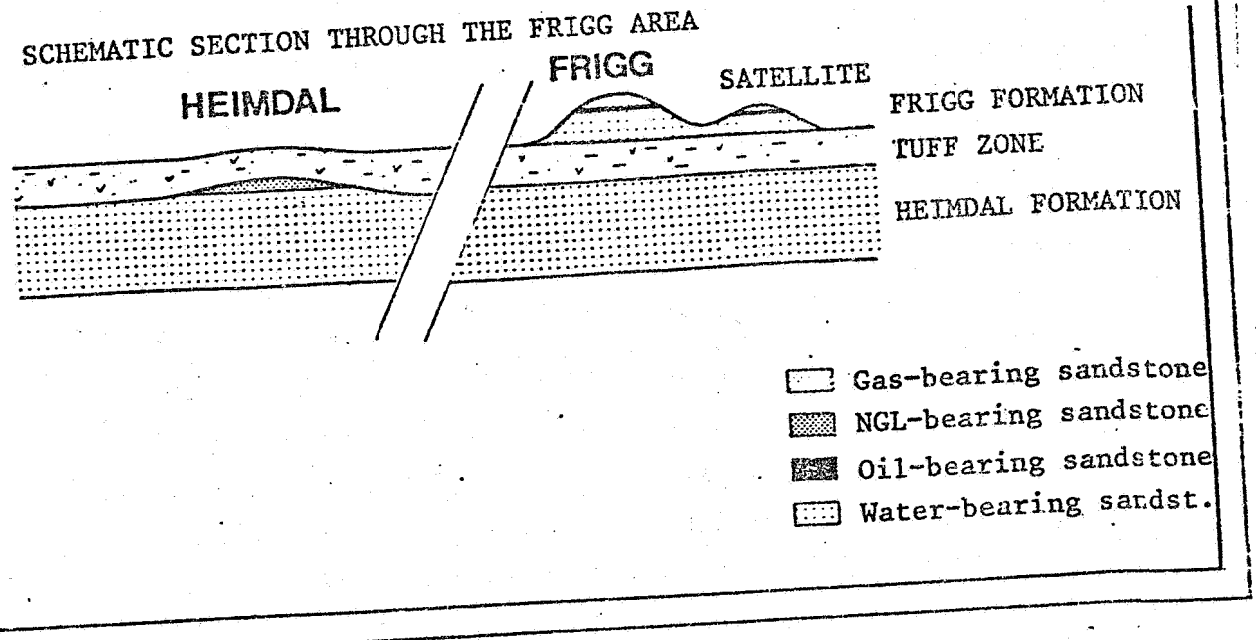
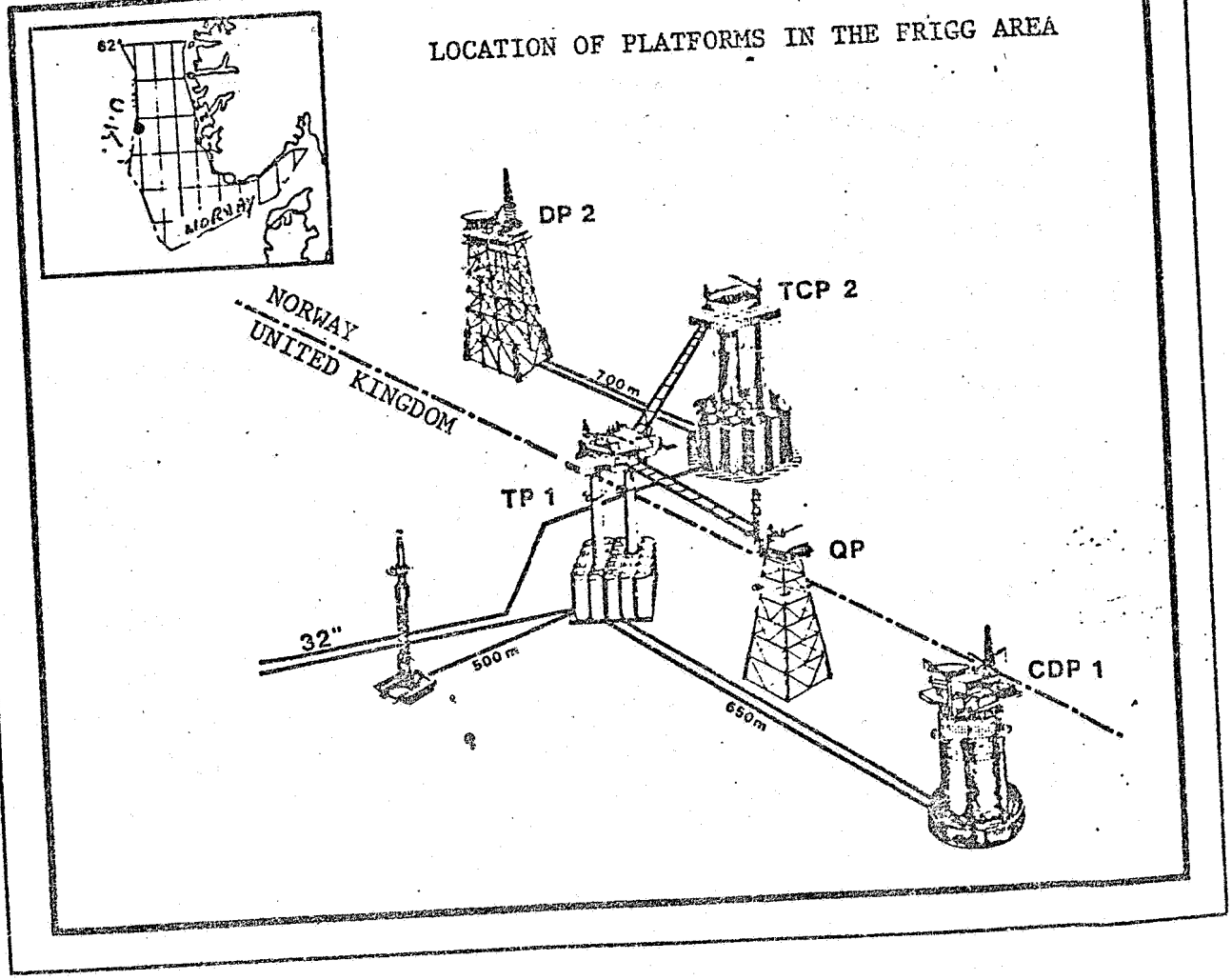

SCHEMATIC SECTION THROUGH THE FRIGG AREA
HEIMDAL
FRIGG
SATELLITE
FRIGG FORMATION
TUFF ZONE
HEIMDAL FORMATION
Gas-bearing sandstone
NGL-bearing sandstone
Oil-bearing sandstone
Water-bearing sandst.

FIG. 2J


LOCATION OF PLATFORMS IN THE FRIGG AREA
62°
U.K.
NORWAY
DP 2
TCP 2
NORWAY
UNITED KINGDOM
100 m
TP 1
QP
32"
500 m
650m
CDP 1

with a limited inflow of water, and the lowest with a strong inflow of water (i.e. free pressure connexion between the Heimdal and Frigg formations). It is at present uncertain which of the two situations outlined will assert itself during the extraction process. An observation well will be drilled from the DP2 drilling and production platform in 1978. This will penetrate the Frigg formation, the tuff zone and the Heimdal formation. Observation of liquid movements and pressure variations in this well over a period will resolve the question of whether there is an inflow of water during production, and to what extent. It is assumed however that observations will have to cover a period of 1-2 years under full production from the Frigg field before a relatively reliable answer can be obtained.

It is still desirable to expand the satellite fields as soon as possible. If the tuff zone is dense, pressure in the satellite fields will fall during production from Frigg, and the recovery factor will be reduced as described in the 1976 Annual Report. If the tuff zone is permeable, pressure will be maintained by an inflow of water from the Heimdal formation. In that event, the time aspect is unimportant as concerns the satellite fields' recovery factor, but it will be important for the economy of the fields that development should take place within the lifetime of the transport systems from Frigg.

The first gas was produced from the Frigg field and supplied to the pipeline on 4 September 1977. The field was in commercial production from 13 September of the same year. The rate of production has been gradually increased, and was about 18 million Nm^3 a day at the end of 1977.

Total production for 1978 will be about 7.3 billion Nm^3, and the field will reach a production plateau of 15 billion Nm^3 a year from 1980 onwards.

Daily production will be subject to seasonal variation under an agreement with the British Gas Corporation, who purchase the gas from the Frigg field. The average rate will be about 40 million Nm^3 a day, with a seasonal variation of $\pm$ 40%.

2.6.2. Joint development (unitization)

In spring 1977, a report was submitted by the American consultants, DeGolyer & MacNaughton, on distribution of the Frigg gas between Norway and Great Britain. The report came to the conclusion that 60.82% of the reserves are located on the Norwegian side of the line and 39.18% on the British side. By prior agreement, the licenseeswere required to acknowledge the consultants' results.

The Norwegian and British authorities have been assessing the report, and have agreed in an exchange of letters dated 12 Dec. 1977 to maintain the above

distribution. In this connexion, the Petroleum Directorate carried out an extensive check of the results submitted in the report. The distribution may be amended every fourth year with retrospective effect if new data and/or calculations give grounds for this.

2.6.3. Production facilities/fixed installations

On the Norwegian side, Elf Aquitaine Norge A/S is the Frigg operator concerned with development and operations. Total Marine Norsk A/S are responsible for constructing and operating the transport systems, and for terminal installations at St. Fergus, Scotland.

On the British side, the field has been developed with

CDP 1 - a combined drilling and production platform;

TP - a processing and gas treatment platform;

QP - a platform for accommodation and a control centre.

The Norwegian side has the following installations:

TCP 2 - a gas treatment and compression platform;

DP2 - a combined drilling and production platform.

Fig. 2J shows the location of the various platforms.

DP2

The steel foundation for the DP2 drilling platform was positioned in May 1976 and the piling of the platform was complete at the end of December 1976. Installation work was undertaken in 1977, and the production licence was issued in July. Drilling of production wells has since been in progress, and production is expected to commence in 1978.

TCP 2

TCP 2 is a concrete platform of the Condeep type. The concrete structure consists of 19 cells, three of which are extended to form the legs of the platform. The deck is located on top of these legs. The deck is of steel, and is designed as a box frame structure. The modules, together with the processing equipment, are situated on and in the deck. 53,000 m^3 of reinforced and pre-stressed concrete was used in the concrete structure. The deck weighs 3,500 tons, and the modules weigh 8,000 tons. In total, the platform will weigh 30,000 tons complete with equipment and ballast.

An inner cylinder containing some of the equipment has been placed in one of the concrete legs. The risers pass through the two other legs, which are filled with water. One of the legs contains six risers four from DP 2,

one going to Scotland and one to the flare stack. Pipes for future pipelines pass through the other leg. These are from Heimdal and East Frigg, and to Norway.

The concrete structure was built at Åndalsnes and was completed in 1976. The deck was built partly at Stord and partly at various yards in France. The parts were assembled in France into two large deck components, and shipped by barge to Stord in winter 1977. These components were connected together at Stord and shipped by barge to Åndalsnes in early April. At Åndalsnes the deck was loaded on to two barges, which were towed over the concrete structure while it was submerged. When the deck had been secured by large bolts through the steel ring on the underside of the deck and the top of the legs, the platform was lifted and the barges towed away. Some of the modules and equipment were hoisted on board while the platform was at Åndalsnes.

The platform was towed from Åndalsnes on 8 June, and arrived at the Frigg field on 14 June. Because of bad weather conditions, the platform was not positioned until 22 June. As the platform was to be situated very close to the platforms already in position, very stringent weather requirements were necessary. In addition, the current is such that positioning could be carried out only twice in 24 hours. This is the most difficult positioning that has taken place, and also the most accurate. When the platform was in position, the shortest distance to TP 1 was merely 34 m, a few metres from the desired position but well within the tolerance limits.

The Petroleum Directorate followed the work of constructing the TCP2 platform. Supervision was carried out partly by consultants and partly by own personnel. The necessary approvals were given as the work progressed, for example approval for towing out of the dock, lowering for fitting the deck and towing to and lowering on to the field.

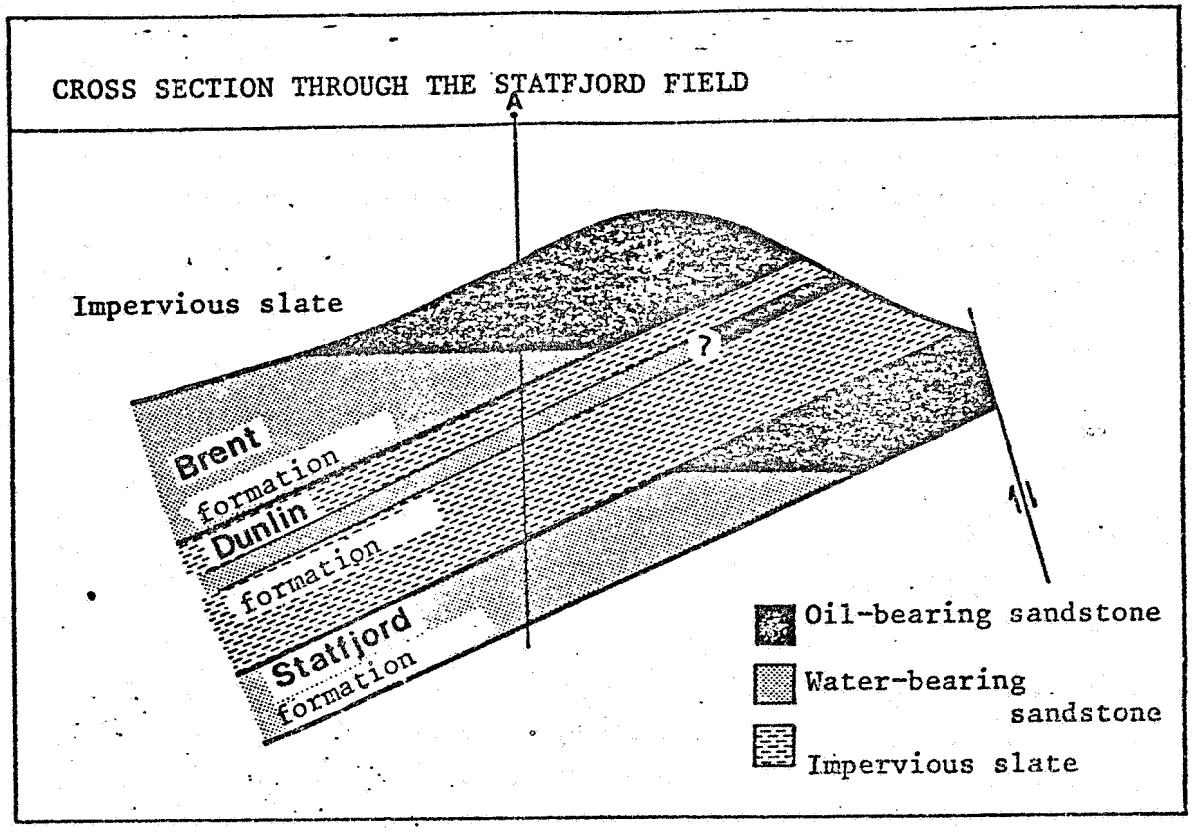
In order to monitor the structural section of the platform, various types of instrument to give information on the platform's behaviour under the effects of wind, wave and current have been embedded in accordance with the Petroleum Directorate's requirements. In addition, instruments have been mounted in the base under the platform with the same object.

A bridge has been erected between TCP2 and TP1. This is 75 m long and weighs 560 tons. The bridge was positioned on 11 August 1977, and is the first "bridge link" between Great Britain and Norway.

2.6.4. Pipelines from Frigg

Two parallel pipelines have been laid between the Frigg field and St.Fergus in Scotland, one from TP 1 on the British side and one from TCP 2 in the Norwegian part of the field.

FIG. 2L



The pipelines have a length of 365 km and a diameter of 32". Apart from the pipeline itself, a compressor platform MCP-01 is included in the transportation system. This is located midway between Frigg and St Fergus, and is common to both pipelines. The total capacity of the transportation system is 60 million Nm^3 per day before the compressors on the pumping platform have been brought into service. It will be 80 million Nm^3 when they are in operation.

The British pipeline (Phase 1 of the development) was completed and brought into use in the autumn of 1977. The Norwegian pipeline (Phase 2 of the development) was connected up in 1977, and is expected to be ready for operation later in 1978.

2.7 THE STATFJORD AREA

2.7.1 Production of the deposits

At present the Statfjord area comprises the Statfjord 33/9-Alpha and 33/9-Beta fields, Fig. 2 K. Of these only Statfjord has so far been declared commercial, and the decision taken to develop it. Murchison is another field lying both in the same geographical area and on the same geological trend. However this field will be dealt with separately as an individual field, as it will be developed under a plan of its own.

The Statfjord field consists of two sandstone reservoirs of the Jurassic Age, termed the Brent reservoir and the Statfjord reservoir according to the geological formations in which they were discovered. The Brent reservoir lies over the Statfjord reservoir, Fig. 2 L. Their geology was described in the Directorate's Annual Report for 1974.

The Brent reservoir contains almost three times as much hydrocarbons as the Statfjord reservoir. Both reservoirs contain unsaturated oil, that is to say that at the pressures and temperatures in the reservoirs all the gas present is dissolved in the oil, and further quantities of gas could be dissolved in it. The oil in the Brent reservoir contains rather more dissolved gas than does the oil in the Statfjord reservoir (approx. 250 Nm^3 gas/ton oil, as against approx. 200 Nm^3 gas/ton oil). Pressure and temperature in the Brent reservoir is about 382 bar and 90°C as against approx. 406 bar and 94°C in the Statfjord reservoir. The pressure that will liberate gas in each reservoir (saturation pressure or boiling point) is approx. 278 bar in the Brent reservoir and approx. 219 bar in the Statfjord reservoir.

During production of these reserves the pressure will be maintained well above saturation pressure. This will be done in order to optimalize the delivery capacity of reservoir and well. In the Brent reservoir the pressure will be maintained by means of water injection. The principle is that each unit of volume of hydrocarbons extracted from the reservoir is replaced by the same volume of water being injected into the reservoir. This means that the hydrocarbons are prevented from expanding and the pressure remains constant. The water will be injected at the bottom of the reservoir, and the oil extracted from a higher level. This creates an oil/water interface that moves from the injection wells up towards the production wells. Some oil that cannot be dislodged will remain behind this interface. Displacement efficiency is relatively uncertain, one of the factors on which it depends being the pore structures of the rock formations.

The operator, Mobil, assumes in its reservoir studies that 30% of the oil in place will be left intact behind the interface, i.e. a displacement efficiency of 70%. However, measurement of core samples from the reservoir indicate displacement of from 50% to 80%.

The ultimate recovery factor is found by multiplying displacement by that fraction of the reservoir's total volume from which displacement takes place. Basing on studies of mathematical models the operator has calculated this fraction at approx. 0.85. The total recovery factor would thus be (0.85) x 70% = 60%.

Mathematical models represent a simplification of flow techniques and do not incorporate to any great extent the, at times, complex geology of the reservoir. Therefore great uncertainty prevails as to how large a proportion of the total volume will be drained effectively from the number of wells available. In view of the above mentioned studies and the probability of more complex reservoir conditions, the licensees have reduced the recovery factor from 60%, as calculated above, to 50%. This agrees with the Petroleum Directorate evaluation.

The large quantities of gas produced from the Brent reservoir make it possible to maintain the pressure in the Statfjord reservoir by re-injecting produced gas. This gas can thereby be saved for eventual future utilization. Gas will be injected at the top of the reservoir and oil will be produced from a lower level. Displacement of oil by gas is usually less efficient than displacement by water if the gas is not miscible with the oil. However, laboratory tests have indicated that the gas injected will mix with the oil. In that event all the oil will be displaced from that part of the reservoir that the gas permeates. Nevertheless there is some risk that the gas will flow through only a small part of the reservoir, prematurely reaching the production wells. Output of gas would then increase sharply, oil production from the reservoir decreasing at the same time. We would then have a situation where large quantities of gas circulate without yielding very much in the way of oil. The sale of gas would solve such a problem. At present no reliable estimate is available as to when reservoir conditions may necessitate sales of gas. The question of when gas sales will become technically/financially feasible is being studied by the Statoil/Mobil Group.

Maximal exploitation of the Statfjord field depends primarily on minimizing the oil remaining behind the displacement water; in other words, displacement efficiency is maximalized. Displacement by miscible gas is far better than displacement by water, which in its turn is better

than displacement by insoluble gas. Secondly, maximum recovery depends on displacement being effective in the greatest possible volume of reservoir. In general, water will penetrate better into all the "nooks and crevices" of the reservoir than gas will, so that water injection gives the best coverage in terms of volume. Furthermore, the degree of success in reaching maximum volume coverage by water or gas injection will largely depend on where the wells are located and the producing rates allowed the individual wells. Optimalization of well-siting and production rates aimed at maximum recovery of the reserves depends on the development plan for the field being such that well locations and production rates can be changed as and when knowledge of the reservoirs increases.

2.7.2 Joint production (Unitization)

A small part of Statfjord lies on the British side of the boundary line between Norway and Great Britain. This entails that agreements on joint production must be concluded both between the licensees on the Norwegian and British sides and between the Norwegian and British authorities.

The licensees are working on such an agreement, which in English is called a "Unitization Agreement", without any final draft agreement having been produced by the end of 1977. Until further notice the provisional agreement of 17 June 1976 will apply.

An agreement between the Norwegian and British authorities is also in preparation. When the licensees have their agreement ready and accordingly have agreed how the reserves in the field shall be divided, the agreement must be submitted for approval by the two national authorities. In this connection the Petroleum Directorate acts as the official organ of the Norwegian authorities.

The aim is to reach concensus on an agreement before production from Statfjord commences.

2.7.3 Production facilities/fixed installations

The development plans for Statfjord were submitted in Storting Report No.90 (1975-76). According to these plans development will take place in two phases. Phase I comprises a combined drilling, production and accommodation platform linked to a loading buoy by means of a pipeline. Phase II was to have comprised two new platforms of the same type as the first, facilities for buoy loading and possibly a pipeline to shore.

The Phase II development has however been under review during 1977, and fresh plans will be submitted early in 1978.

The first platform, Statfjord "A", was commenced in 1974 and was installed on the field in May 1977. It is a concrete platform of the Condeep type, with steel deck. The concrete structure was built in Stavanger, and the steel deck at Stord.

The platform is still being fitted out. Drilling is scheduled to commence in the summer of 1978, and the operator expects to be able to start production a year later.

Statfjord "A" will have a maximum production capacity of approximately 40,000 tons (300,000 bbls) per day. However, average daily output over a year will be approximately maximum 33,000 tons (250,000 bbls) per day, i.e. a maximum annual production of about 12 million tons.

Statfjord "A" has 42 wellhead slots, i.e. apertures through which drilling can take place. It is planned at the outset to use 20 of these for production wells, four as gas injection wells and eight as water injection wells.

The platform will be equipped with four water injection pumps, each with a capacity of 13,000 m^3 of water per day. The injection water will be sea water from about 50 m depth, and entrained air will be removed from the water before it is injected. The platform will have installed purifying capacity for 8,000 m^3 of produced water per day, which after cleansing will go overboard.

The process facilities will consist of four stages for separating gas from oil. Capacity is about 39,000 tons of oil per day, with an associated gas volume of up to 220 Nm^3/ton. Because it will be landed via tankers the oil must have a low steam pressure (10 RVP). This means that practically all the NGL will have to accompany the gas and in the first instance be re-injected into the reservoir. When the gas is ultimately sold via an eventual gas pipeline, a sufficiently low gas dew-point will be required. This entails a limitation of the amount of heavier components (NGL) that can accompany the gas without condensation taking place in the pipeline. This could mean that a residual stream of NGL can accompany neither the gas nor the oil. However, the operator considers that the formation of this third stream of NGL can be avoided in the process planned.

A large boom will be installed on the platform for flaring gas if the necessity arises.

The loading buoy to be used for landing oil via tankers is of French design. It has been built partly in Norway and partly in France, and will be installed and ready for service in the summer of 1978.

The pipeline that will connect Statfjord "A" to the loading buoy has a diameter of 36 inches. It was placed on the field in June 1977.

The platform is calculated to cost 7,150 million kroner.

In 1976 Mobil had plans ready to order a new platform, Statfjord "B", to be built largely along the same lines as Statfjord "A".

After evaluating the safety aspects of the concept the Petroleum Directorate concluded in the autumn of 1976 that a separate accommodation platform ought to be built in conjunction with the proposed Statfjord "B" platform. The Petroleum Directorate considered that a separate platform would solve several serious safety problems within acceptable financial limits, without delaying development.

However, the Statfjord group decided to postpone the project in order to try to solve the safety problems without building a separate accommodation platform. Throughout the past year the Petroleum Directorate and Mobil have maintained continuous contact to discuss the prerequisites for the new platform scheme for Statfjord "B". The plan was submitted in the autumn of 1977 and was approved by the Directorate on 19 December, being an integrated platform for drilling, production and accommodation.

The new platform scheme represents a considerable safety improvement compared with the original Statfjord "B" plans. However, when giving its consent, the Directorate stipulated that certain foreseeable problems must be solved. The Directorate believes this is feasible.

A further condition of approval is that current work on the development of improved evacuation systems results in satisfactory solutions.

Statfjord "B" will have a maximum production capacity of approximately 24,000 tons (180,000 bbls) per day. However, average daily production over a year will be about 20,000 tons (150,000 bbls) per day maximum, i.e. a maximum annual production of about 7 million tons.

Statfjord "B" will have 42 wellhead slits from which 15 production wells, four gas injection wells and seven water injection wells will be drilled at first.

Water injection capacity will be three times 13,000 m^3 per day,

and cleaning capacity of produced water 4,000 m^3 per day.

The processing facilities will consist of four oil separation stages with a capacity of about 24,000 tons of oil per day and some 5.2 million Nm^3 of gas. Gas injection capacity will match processing capacity. The platform will have a storage capacity of about 200,000 tons of oil.

Statfjord "B" is calculated to cost 7,191 million kroner. Mobil believes that if the ordering of main items of equipment begins in January 1978 and the concrete structure is ordered early in 1978, the platform could be towed out and placed on the southern part of the Statfjord field fully fitted out in the middle of 1981. Production could start in 1982.

The Directorate considers it only proper to stress that Mobil's time schedule involves a number of uncertainties that could easily entail a year's delay.

In conjunction with Statfjord "B" a loading buoy will be built, similar to the one at Statfjord "A".

It is expected that the northern part of Statfjord will be developed for a production capacity at least as great as for Statfjord "B". In conjunction with development of the northern part it will also be natural to examine other finds in that area.

2.8 MURCHISON

Murchison is a sandstone reservoir in the same geological formation as the Brent reservoir in Statfjord (Fig. 2 K). So far the field has been mapped by means of three boreholes, all on the British side of the boundary line. The underlying Statfjord formation is water-bearing in these holes, but as they are so low down in the structure it is possible that oil may exist further up (cf. Fig. 2 L). In such case this would mean a small addition to the field's reserves.

Murchison, like Statfjord, lies partly on the Norwegian and partly on the British side of the dividing line. The major part lies on the British side.

The same groups of licensees as in Statfjord participate in exploitation of this field. The licensees on the Norwegian side declared the field commercial in the autumn of 1977. A Storting Proposition on Statoil's participation will be submitted in the spring of 1978.

It will be necessary to enter into the same types of agreement for joint utilization of Murchison as for Statfjord, and a Unitization Agreement is being drawn up by the licensees.

Reservoir properties (porosity, permeability) are somewhat poorer than in the Brent reservoir on the Statfjord field. The pressure in the reservoir is about 443 bar and the temperature approximately 110°C. Oil saturation pressure in the reservoir is about 132 bar.

In the same manner as for Statfjord, the reservoir pressure on Murchison will be kept higher than the saturation pressure by means of water injection. In addition, gas produced will be re-injected until gas sales are feasible. This means that water will be injected at the bottom of the reservoir and gas at the top, oil being produced from a point between top and bottom. Such a production plan makes very great demands as to the correct location of production wells and injection wells in relation to each other, and the well completion intervals. There will be a fairly large risk that production wells may begin to draw water or gas prematurely. The operational problems this would entail could reach such proportions that gas injection would have to stop.

Murchison will be equipped with a fully-integrated steel platform. Production capacity will be 17,000 tons (130,000 bbls) per day as the yearly average, i.e. a maximal annual output of just over 6 million tons. Production is scheduled to commence in 1980.

The oil will be landed via the British Cormorant field to Sullom Voe, Shetland Islands. Therefore the processed oil could have a high steam pressure (100 RVP), making it possible to retain NGL in the oil stream. This NGL will be extracted at terminals at Sullom Voe, and crude oil can be carried from there in tankers.

2.9 PETROLEUM RESERVES

2.9.1 Status

The year 1977 was hardly encouraging as regards increases in petroleum reserves on the Norwegian continental shelf. On the one hand no new data were recorded that gave reason to alter the quantity of undiscovered resources, i.e. estimated risk-evaluated resources in structures not so far drilled. Expectations in respect of unlicensed blocks south of 62°N can therefore be said to be the same as they were a year ago.

On the other hand, as regards indicated reserves, only one new find was made in 1977, namely 1/9-Gamma. The finds made in 1976, 33/9-Alpha, 33/9-Beta and the 7/12 field associated with 1/9-Alpha that were tested around the turn of the year 1976/77, resulted in a slight increase in indicated reserves compared with the position described in the Directorate's previous annual report. However, the increase is not as much as there seemed reason to expect, considering that the reserves of several new fields were to be added. This is due to the reserves in several previously discovered fields having been reduced, some of them drastically, on the strength of new data that became available in 1977.

Therefore it is appropriate to call attention to the uncertainty attached to figures for reserves, as has also been done in earlier annual reports.

For the Norwegian shelf south of 62°N the Petroleum Directorate has the following figures for probable recoverable reserves as at the end of 1977 in millions of tons of oil equivalents (rounded off to the nearest 100 million tons):

- Indicated recoverable reserves 1,400
- Undiscovered, risk-evaluated, recoverable reserves 2,000

Cumulative production from Ekofisk and Frigg up to 1 January 1978 amounts to 48 million tons of oil equivalents. This is some 3% of total indicated reserves south of the 62nd parallel and about 1% of the total probable reserves (indicated reserves + undiscovered, risk-evaluated reserves). Fig. 2 M illustrates this, and shows that production from the continental shelf has barely commenced. The figure also shows that exploration of the shelf is virtually still in its infancy, in that it seems probable that more than half of the recoverable reserves south of latitude 62°N have still not been identified.

2.9.2 Fields it has been decided to develop

So far it has been decided to develop altogether 13 fields that lie wholly or partly in the Norwegian sector (Table IV). These are the same fields of this category as a year ago.

New drillings during the year led to a reduction in the estimate of reserves for Cod. Two new holes were drilled in Hod. The results from these drillings are still being evaluated. A new exploratory well was

drilled on Statfjord in 1977. Testing in this well (33/9-9) produced oil from the Dunlin formation but the quantity of reserves in this formation is insufficient to alter the total reserves for the field. New figures for reserves have also been worked out for Murchison, Eldfisk, East Eldfisk, Tor, Albuskjell, Valhall, Hod and Frigg, based on new interpretations and evaluations. For Edda, Ekofisk and West Ekofisk the estimated existing reserves of oil and gas are unchanged from last year. However, recoverable reserves in Ekofisk have increased somewhat. This is because of the favourable effect of gas injection into the field.

Three of the fields, Frigg, Statfjord and Murchison, lie partly on the Norwegian and partly on the British continental shelves. Agreements have been reached on joint production (unitization) from Frigg, both between the licensees and between the authorities of the two countries.

The figures for reserves in Frigg in Table IV show the Norwegian share under these agreements, with the total reserves in parentheses. It will be seen that the Norwegian share in Frigg has increased considerably compared with the earlier, arbitrarily agreed division in the previous annual report.

Only provisional estimates of the division of Statfjord and Murchison are given in Table IV, as no definitive agreements have yet been made. In the table the Norwegian share of Statfjord is based on a provisional estimate made by the licensees, whilst division of Murchison was calculated by the Petroleum Directorate.

The total quantity of oil in place in fields which it has been decided to develop shows a reduction (80 million tons) compared with the estimates given in the previous annual report, whilst gas in place shows a slight increase in quantity (4,000 million Nm^3).

In actual fact the gas reserves are reduced for certain fields (Albuskjell, Cod, Valhall), but total gas reserves have increased owing to the larger Norwegian share of Frigg.

The recoverable quantity of oil is reduced by 6 million tons compared with the previous annual report, whilst the recoverable gas quantity shows an increase of 4,000 million Nm^3.

The recovery factor has been adjusted somewhat for most of the fields, so that alterations in reserves in place are not always proportionate to changes in recoverable reserves.

TABLE IV. PROBABLE RESERVES IN AREAS IT HAS BEEN DECIDED TO DEVELOP

Name of field	In place		Recoverable	
	Oil - 10^6 ton	Gas - $10^9 Nm^3$	Oil - 10^6 ton	Gas - $10^9 Nm^3$
Albuskjell	40	45	21	35
Cod	4	9	2	5
Edda	26	8	6	6
Ekofisk	690	174	139	123
W-Ekofisk	60	36	21	22
Eldfisk	399	140	58	52
E-Eldfisk	38	13	6	8
Frigg (60.82%)	–	(247) 150	–	(185) 113
Hod	28	10	9	3
Murchison (17.1%)	(96) 16	(8) 1	(44) 7	(4) 1
Statfjord (88.88%)	(660) 590	(136) 120	(330) 295	(66) 59
Tor	96	29	26	18
Valhall	206	54	50	38
Total Norwegian reserves	2193	789	640	483

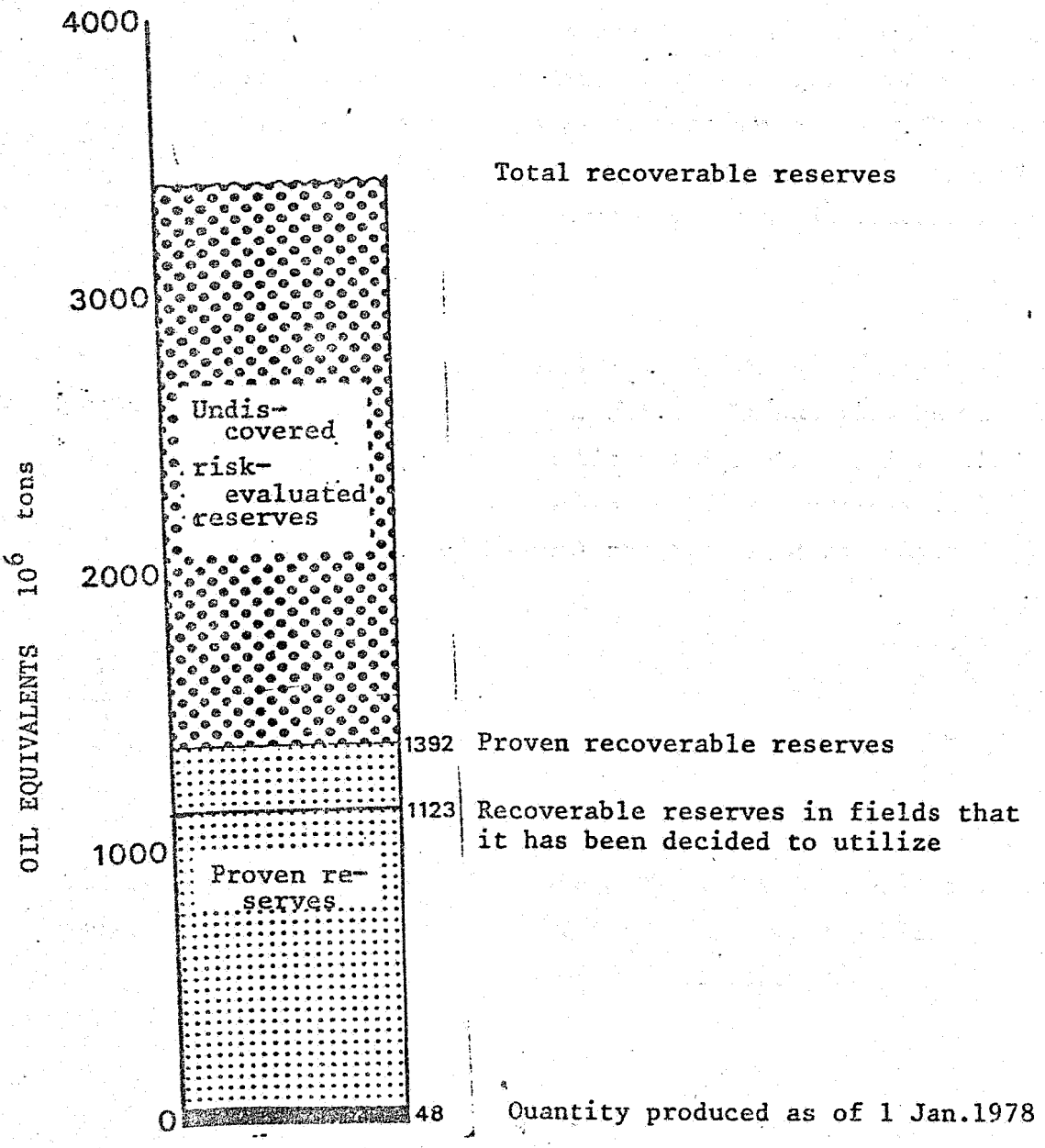
TABLE V. PROBABLE RESERVES IN FIELDS FOR WHICH DEVELOPMENT IS STILL UNDECIDED

Name of field	In place		Recoverable	
	Oil - 10^6 ton	Gas - $10^9 Nm^3$	Oil - 10^6 ton	Gas - $10^9 Nm^3$
Balder	70		14	
Bream	<1		<1	
Brisling	<1		<1	
Flyndre (36.2%)	<1		<1	
NE-Frigg		18		14
SE-Frigg		2		1
E-Frigg		8		6
Heimdal		50		40
Murphy		<2		<2
Odin		40		30
Sleipner	53	64	10	44
SE-Tor	14	4	3	3
1/9-Alpha	40	30	4	23
7/12	50	7	18	2
33/9-Alpha	31	4	15	2
33/9-Beta	65	3	33	2
TOTAL	326	232	100	169

FIG.2M

RECOVERABLE RESERVES SOUTH OF 62° N

as of January 1 1978



2.9.3 Fields for which no development decision has been adopted as yet

We have three types of field in this category:

a) Fields still being explored for better appraisal of size.
b) Economically marginal fields.
c) Minor fields that are not economically exploitable today.

All these fields are listed together with their probable reserves in Table V.

The table contains five new finds since last year's report. Flyndre has not been mentioned previously because of its modest size, whilst 33/9-Alpha, 33/9-Beta, 1/9-Alpha and 7/12 are new, promising fields. Of the older fields Sleipner, Heimdal and the Frigg satellites including Odin are still the most likely as regards development for production. Some of the figures for reserves shown in the table have been adjusted since the previous annual report because of fresh interpretation.

Sleipner

On 3 December 1976, Statoil/Esso/Norsk Hydro were allocated blocks 15/8 and 15/9 (production licence 046). It was then known that Sleipner, which was discovered by Esso in block 15/6, extends into 15/9. The results of delineation wells 15/6-5 and 15/9-1 drilled in 1977 led to a drastic reduction in the reserves for the field as compared with previous estimates.

Heimdal

No new drilling was performed on Heimdal in 1977. The planned well to test the prospects in the Jurassic has been temporarily postponed pending a new interpretation based on fresh seismic data. It is possible that this well will be drilled in 1978. The development plans for the field have been put on ice until further notice and will be considered in conjunction with the result of the Jurassic test.

The Frigg satellites

Odin, North-East Frigg, East Frigg and South-East Frigg are regarded as the Frigg satellites. Odin is the biggest of these and Esso is working on development plans for the field, although at present nothing concrete is known about the result of this work. East Frigg is also being evaluated for development. The operator, Elf Aquitaine, is considering using a new

technique, sub-sea completion, on this field. In that event the field will be connected by pipeline to the Frigg field production facilities. If East Frigg can be developed commercially by this method, this might pave the way for similar development of e.g. North-East Frigg too.

1/9-Alpha

The 1/9-Alpha field lies in block 1/9 about 20 km south-west of the Ekofisk field. The licence for block 1/9 (production licence 044) was granted to the Statoil/Phillips group in 1976, with Statoil as operator.

1/9-Alpha was discovered by the drilling of 1/9-1 at about year-end 1976/77. Extensive testing revealed gas and oil from a fine-grained chalk deposit belonging to the Ekofisk and Tor formations. Water depth above the field is about 70 m.

The find was confirmed by delineation well 1/9-2, although the tests were less favourable. A third well on the field, 1/9-3, was commenced in the autumn of 1977, but owing to technical problems was abandoned before the reservoir was reached. It probably will be completed in 1978.

The find has not yet been declared commercial.

33/9-Alpha

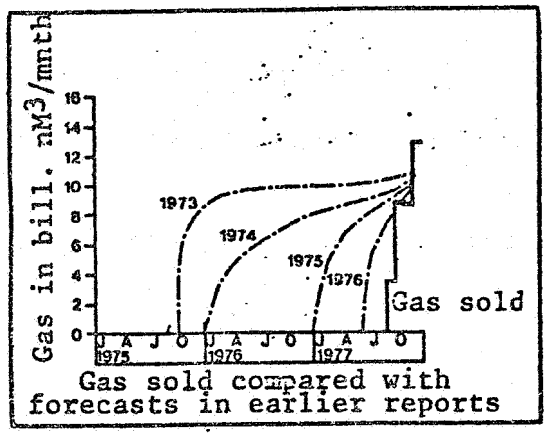
This field lies due north-east of Statfjord, and was discovered by the drilling of 33/9-7. So far only one well has been drilled in the structure. Oil was found in the Brent formation at a depth of about 2,450 m. The water depth over the field is about 140 m, but varies widely in this area as it is on the flank of the Norwegian trough.

The licensees of 33/9 are the Statoil/Mobil group. It is possible that 33/9-Alpha extends into the non-licensed adjacent block 34/7. The field lies so near to the northern part of the Statfjord field that it will be natural to consider any production in conjunction with the development of Statfjord.

33/9-Beta

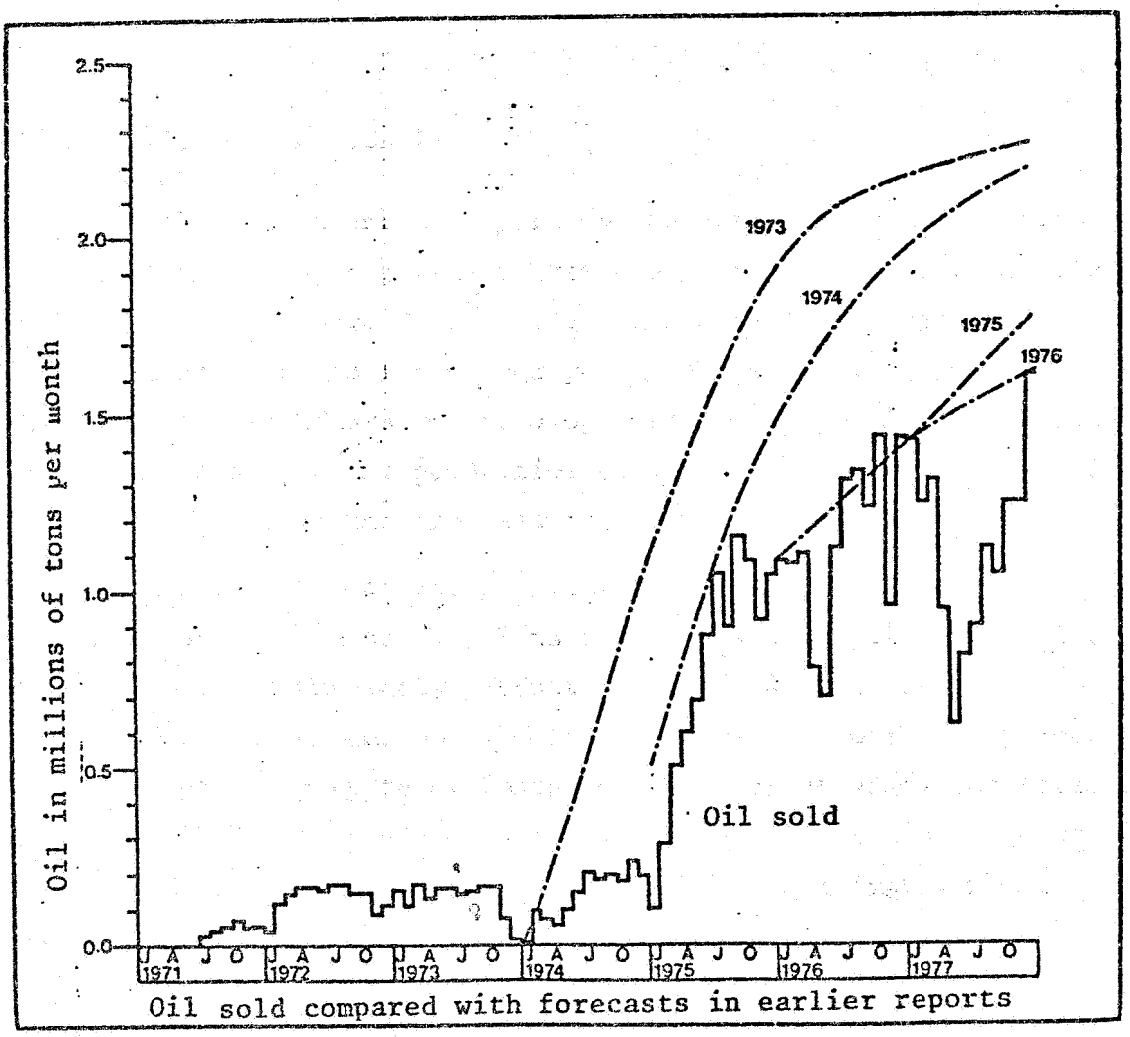
This field lies in the north-eastern corner of block 33/9 and was proved by the drilling of 33/9-8. This is the only well in the structure so far. Oil was found in a sandstone of the Upper Jurassic age at a depth of approximately 2,650 m. Oil was also found in the Brent formation

FIG. 2N



Gas sold compared with forecasts in earlier reports

FIG. 2O



Oil sold compared with forecasts in earlier reports

(Middle Jurassic) at about 2,700 m. Water depth increases steeply towards the north-east across the field, as this field too is on the flank of the Norwegian trough. At the location of the borehole 33/9-8 the water depth is approximately 260 m.

33/9-Beta is closer to Murchison than to Statfjord, and it is expected that possible production will be considered in conjunction with one of these fields where development has already been decided.

Flyndre

This field lies in the south-east part of block 1/5 and straddles the boundary line into the British sector. The licence for block 1/5 (production licence 018) was granted to the Phillips group in 1965. The field was discovered early in 1974 by the drilling of 1/5-2. Hydrocarbons were tested in a sandstone of the Paleocene age and in a chalk formation of the Upper Cretaceous era. The water depth over the field is approximately 70 m. The field is not considered to be commercially viable at the present juncture.

2.10 PRODUCTION FORECASTS

In this fifth annual report on the Petroleum Directorate's activities, it may be appropriate to start an account of the production forecasts by looking back. Figures 2 N and 2 O show the gas and oil production forecasts for the first four years, compared with the output attained. Clearly these forecasts were too optimistic. The forecasts from 1973 over-estimated e.g. the production of oil equivalents by 225, 120, 150 and 120% in each of the four ensuing years.

Although from an early stage the Petroleum Directorate based its forecasts on its own calculations of reserves, the licensees' forecasts were applied for the early production, which depends largely upon the progress of development work. At that time the Petroleum Directorate had insufficient capacity to evaluate the development plans for forecasting purposes. Work to study data for short-term production forecasts first started in 1975. Although this brought a marked improvement, it nevertheless proved difficult to avoid being unduly optimistic. The fire on platform 2/4A and the subsequent replacement of risers resulted in the forecasts being about 10% too high in 1976. The blow-out at well 2/4B-14, unexpected postponement of the start of production from West Ekofisk and unexpectedly long delay in the commencement of gas sales, led to the forecasts in our annual reports for 1975 and 1976 over-estimating the 1977 output by 50-60%.

Far greater reliability has been required of the more recent forecasts. Furthermore, expansion of the Petroleum Directorate made it possible to evaluate more of the assumptions on which the licensees' forecasts are based. The most important of these are described in Chapter 12.

However this still does not eliminate the uncertain factors in the forecasts.

The Petroleum Directorate's forecasts of petroleum production up to the year 2000 are shown in Figure 2 P. The forecast for fields that it has been decided to develop show a somewhat lower production up to 1980 than did the corresponding forecast in the previous year's report.

For the period 1981 to 1983 the Directorate no longer expects any marked decline in production. This is because it has now been decided to develop Valhall A. Moreover production is no longer expected to culminate in 1985. This is because the Directorate did not consider that the development plans for the remaining platforms on the Statfjord field were sufficiently concretized for basing production forecasts on the provisional development schedule indicated by the licensees. Development here will be followed closely, so that forecasts can be adjusted in due time should progress differ from the present expectations.

One-quarter of the recoverable reserves that have been discovered on the continental shelf are in fields that are under evaluation. Some of these fields will presumably be developed. Figure 2 P also gives an estimate of the output that can be expected from such fields. In favourable circumstances this production could become considerable from 1983, so that aggregate output from all fields discovered so far could approach 80 million tons of oil equivalents in the second half of the 1980s. This is 10 million tons less than shown in the previous year's forecasts.

The position regarding reserves is shown in Figure 2 O. The upper curve shows the remaining reserves over the period. The lower curve shows the recoverable reserves remaining in finds that it has been decided to develop.

The increase in recoverable reserves is recorded in this graph as from the year when approval was given for the first main development plan for the field. The increase in the reserves in place is recorded as from the year when the first hole was drilled in the field.

The recoverable reserves are too low to be able to sustain a stable output of approximately 90 million tons of oil equivalents per year.

FIG. 2P

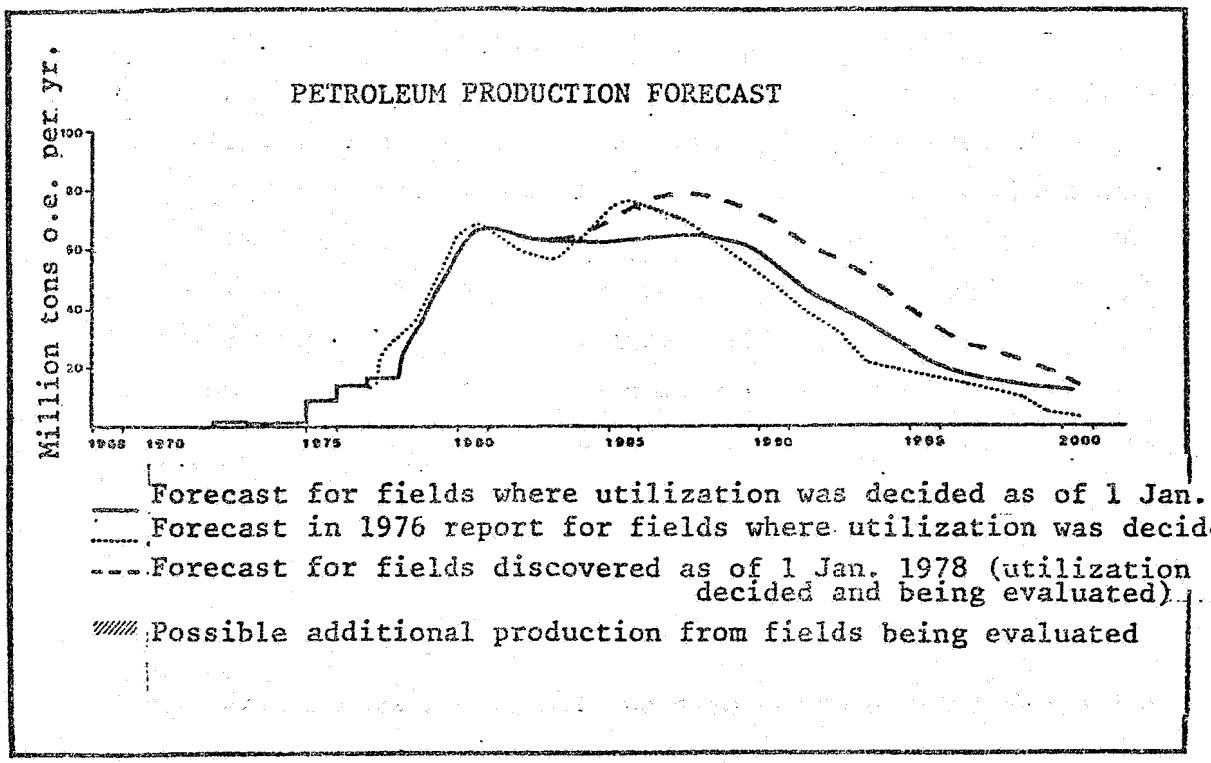
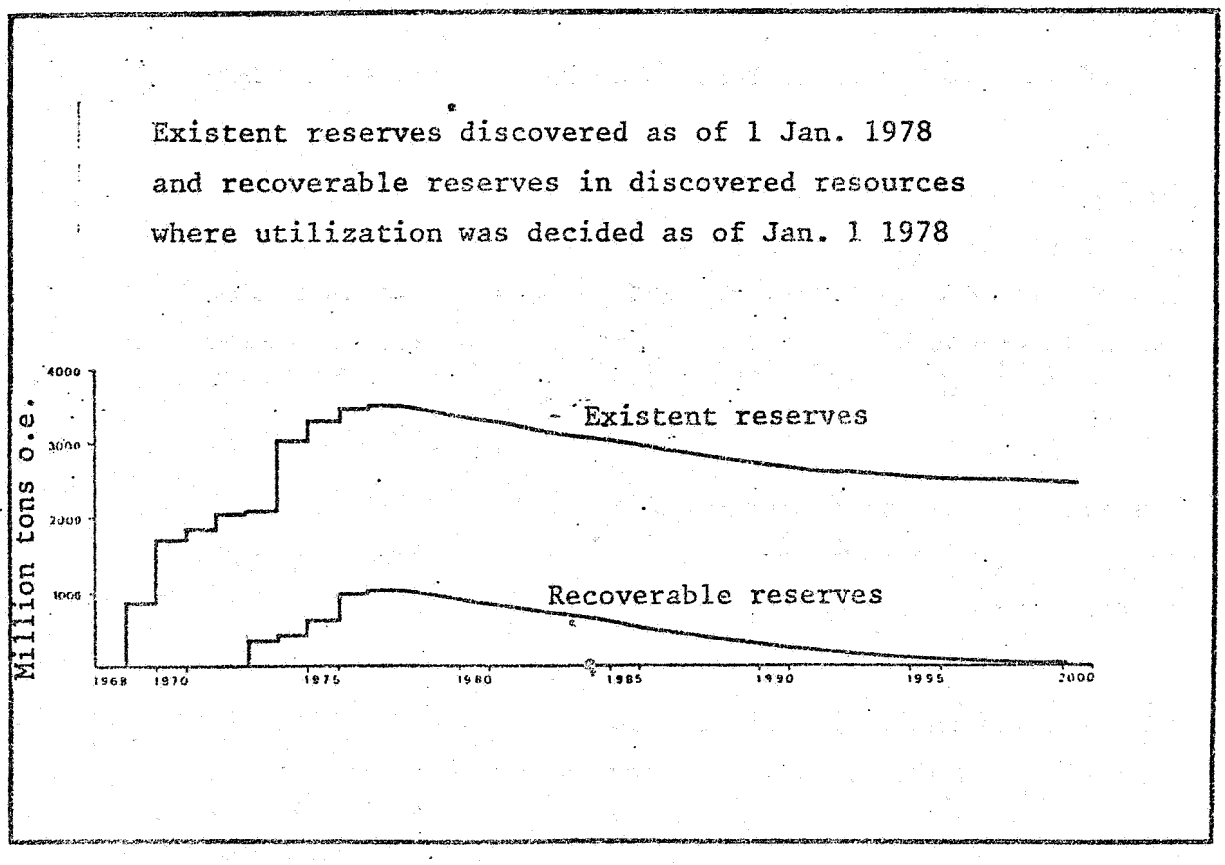

PETROLEUM PRODUCTION FORECAST
Million tons o.e. per yr.
100
80
60
40
20
1968
1970
1975
1980
1985
1990
1995
2000
Forecast for fields where utilization was decided as of 1 Jan. 1978
Forecast in 1976 report for fields where utilization was decided as of 1 Jan 1977
Forecast for fields discovered as of 1 Jan. 1978 (utilization decided and being evaluated)
Possible additional production from fields being evaluated

FIG. Q


Existent reserves discovered as of 1 Jan. 1978
and recoverable reserves in discovered resources
where utilization was decided as of Jan. 1 1978
Million tons o.e.
4000
3000
2000
1000
Existent reserves
Recoverable reserves
1968
1970
1975
1980
1985
1990
1995
2000

Indicated recoverable resources amounted as at 1 January 1978 to some 1,400 million tons of oil equivalents, of which about 1,100 from fields that it has been decided to develop. Over the past three years the average annual increase in indicated recoverable reserves was about 70 million tons. In order to achieve a stable output of 90 million tons per annum, recoverable reserves from fields that it has been decided to develop must be increased from 1,100 to minimum 1,500 million tons through fresh finds, and by deciding to develop other fields under evaluation. Secondly, further prospecting activity must ensure an average annual increase in recoverable reserves that is rather higher than 90 million tons, as experience shows that some of these resources are not exploited. However, the resources situation may easily change if one or more big finds are made in the near future.

From Figure 2 Q it will be seen that about 2,500 million tons of oil equivalents have been discovered that cannot be developed or are not scheduled for development. Some 300 million of these are considered to be recoverable from fields still under evaluation.

By means of stimulating production (i.e. injection of displacement media), particularly in the fields in the Ekofisk area, further quantities can be made recoverable. For instance, some small quantities of gas have so far been injected into the Ekofisk field. This has probably resulted in the recovery of an extra 9 million tons of oil. (See also the account under Chapter 2.4.1 above).

It is planned to exploit Statfjord and Murchison by displacing petroleum by water and gas. This means that the recovery will be some 50% instead of about 28%, so that the recoverable Norwegian oil reserves are about 130 million tons more than they would otherwise have been.

2.11 RETURN OF LICENSED AREAS

During 1977 compulsory relinquishment of licensed areas took place under two production licences. This was the first relinquishment for production licence 036, granted in 1971, and the second such for production licence 034, awarded in 1969.

In 1977 dispensation from the relinquishment rules was given under production licence 019, when upon application the areas in blocks 7/12 and 2/1 voluntarily relinquished by the BP/Conoco group in 1976, were returned to them.

Considerable areas were relinquished voluntarily in the course of 1977. In all 7,902 km of the licensed areas allocated in 1965 were relinquished, so that only 7,399 km^2 of the 42,106 km^2 allocated in 1965 are now under licence.

Of the blocks awarded in 1965, 46 have now been relinquished entirely. These are blocks 2/2, 3/1, 3/2, 3/3, 6/3, 7/1, 7/2, 7/4, 7/8, 7/9, 8/1, 8/2, 8/3, 8/5, 8/6, 8/7, 8/9, 8/12, 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, 16/7, 16/9, 16/12, 17/4, 17/8, 17/9, 17/10, 17/11, 18/7, 18/11.

As at 1 January 1978 total licensed areas were as specified in Table VI, distributed over the production licences as specified in Table VII.

2.12 ALLOCATION OF NEW LICENCES

Four new production licences were awarded in 1977:

Production licence 047

By Royal Decree of 7 January 1977, production licence 047, comprising blocks 33/2 and 33/5, was awarded to the following companies:

- Den norske stats oljeselskap (Statoil)	50.000%
- Norsk Hydro Produksjon A/S	13.840%
- Elf Aquitaine Norge A/S	17.440%
- Total Marine Norsk A/S	8.720%
- Deminex (Norge) A/S	10.000%

Statoil will not bear any of the costs in the exploratory phase. Statoil's participation will increase in accordance with an agreed scale if commercial finds are made, Statoil's share being determined by the peak production from the blocks.

Norsk Hydro is operator for these blocks, and a technical assistance agreement has been entered into between this company and Elf/Total. The obligatory work program includes the drilling of three exploratory wells, with the option to reduce this to two if the results from the first two boreholes clearly show that further drilling is not justified.

Production licence 048

By Royal Decree of 18 February 1977 production licence 048, comprising blocks 15/2 and 15/5, was awarded to the following companies:

- Den norske stats oljeselskap A/S	50.000%
- Norsk Hydro Produksjon A/S	17.300%
- Elf Aquitaine Norge A/S	21.800%
- Total Marine Norsk A/S	10.900%

Norsk Hydro is the operator, having a technical assistance agreement with Elf/Total. The licensees have undertaken to drill three exploratory wells, and the first of these 15/5-1 was commenced in November 1977 by the rig "Treasure Seeker".

Production licence 049

By Royal Decree of 23 December 1977 production licence 049, comprising block 33/6, was awarded to the following companies:

- Den norske stats oljeselskap A/S	50.000%
- Norsk Agip A/S	30.000%
- Deminex (Norge) A/S	20.000%

This was the final allocation in what is termed the third licensing round. The block lies under comparatively deep water due north of the Statfjord blocks.

The licensees under production licence 019 have obtained dispensation from the relinquishment rules in respect of those parts of blocks 7/12 and 2/1 that they voluntarily relinquished in 1976. The group has been permitted to retain these parts on terms and conditions as for fresh licences. Distribution of the above areas among the licensees is as follows:

- Den norske stats oljeselskap A/S	50.000%
- BP Petroleum Development of Norway A/S	26.625%
- K/S Pelican & Co. A/S	4.000%
- Norsk Conoco	19.375%

It is proposed to offer allocation of the following blocks in the fourth licensing round:

34/2, 34/4, 34/10, 34/11, 35/8, 29/3, 30/1, 30/2, 30/3, 30/6, 31/2, 31/4, 31/7, 24/6, 25/5 and 1/2.

2.13 ASSIGNMENT OF INTERESTS

During 1977 the following assignments of interests were approved under Section 48 of the Royal Decree of 8 December 1972:

Licences 013, 014, 015

These licences originally covered 11 blocks and were granted to the Texaco/Chevron group in 1965. All the blocks, except for block 9/4 (licence 013), have now been relinquished in their entirety.

On 1 December 1975 Deminex (Norge) A/S, Petroswede Norway A/S and K/S Pelican & Co.A/S were granted permission to acquire one half of the

interests belonging to Texaco Overseas Petroleum Company and Chevron Petroleum Company of Norway, which amounted to 50%. Consent was granted on condition that the parties undertook to drill two new exploratory wells and that Statoil's participation be increased from 10% to 20%. In the same way as for new licences, Statoil was not to pay exploration costs.

After having drilled the two exploratory wells the group requested that Conoco, Texaco, Chevron and Petroswede be allowed to transfer their shares to the other companies. Consent was granted on condition that no drilling operations be undertaken in the licensed area until a new operator had been appointed and approved. After this the distribution among the licensees became:

- Deminex (Norge) A/S	75%
- K/S Pelican & Co. A/S	25%

On 31 July 1977 Saga, Petroswede and Scandinavian Sun Oil A/S were permitted to join the group, Saga being nominated as operator. After this the division is:

- Den norske stats oljeselskap A/S	20%
- Saga Petroleum A/S	16%
- Deminex (Norge) A/S	32%
- K/S Pelican & Co. A/S	4%
- Petroswede Norway A/S	8%
- Scandinavian Sun Oil A/S	20%

Licence 005

Union Oil Norge A/S has taken over a 54% share in this licence, which comprises blocks 7/3, 7/6 and 8/4, the original licensees (Amoco, Texas Eastern, Amerada and Noco) having reduced their shares proportionately. The assignment was approved on 20 January 1977 on condition that Statoil receives a 10% participation, that an exploratory well be drilled and that the companies involved issue a general guarantee. Union Oil has taken over as operator. After this the distribution is as follows:

- Union Oil Norge A/S	54.0%
- Den norske stats oljeselskap A/S	10.0%
- Amoco Norway Oil Company	10.2%
- Amerada Petroleum Corporation of Norway	10.2%
- Norwegian Oil Consortium A/S & Co.	5.4%
- Texas Eastern Norwegian Inc.	10.2%

Licence 036

An indirect assignment of participation in production licence 036 (block 25/4) has taken place. Sunningdale Oil Norge A/S holds a 3.875% interest after Statoil had exercised its option for 40%. The share

TABLE VI. LICENCED AREAS AS AT 1 JANUARY 1978

Licences awarded	Original area km^2	Relinquished area km^2	Licensed area km^2	Number of blocks covered
1965	42 106 041	34 706 575	7 399 466	32
1969	5 878 647	1 665 643	4 213 004	13
1971	523 937	130 726	393 211	1
1973	586 834	0,0	586 834	2
1975	2 329 206	0,0	2 329 206	8
1976	2 066 872	0,0	2 066 872	7
1977	1 075 727	0,0	1 075 727	5
	54 567 264	36 502 944	18 064 320	68

TABLE VII. PRODUCTION LICENCES AS AT 1 JANUARY 1978

Awarded with effect from	Production licence No.	Total area km^2	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
10 Aug. 1973	037	586 834	2
1 April 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
		54 567 264	114

majority in that company's parent company, Sunningdale Oil Ltd., Canada, has been purchased by the Kerr-McGee Corp., USA. This means that the last-named company obtains control over the above mentioned participation. The assignment has been approved on condition that Kerr-McGee Corp. issues a general guarantee to cover the operations of Sunningdale Oil Norge A/S.

Licence 022

This licence was originally issued to the Murphy group in 1965. On 30 September 1977 Norsk Gulf Production Company A/S was allowed to acquire a 25.4% participation provided Statoil came in with 11%. Norske Gulf took over as operator. The licence comprises blocks 2/3 and 3/5. After this the distribution is as follows:

- Norske Gulf Production Company A/S	25.400%
- Den norske stats oljeselskap A/S	11.000%
- Norsk Murphy Oil Company	7.300%
- Wintershall Norge A/S	32.175%
- Amax Petroleum Norge A/S	12.300%
- Norske Ocean Exploration Co.	7.300%
- K/S A/S Polaris Oil Consortium	4.525%

Licence 025

Norske Hudbay A/S has acquired 15% of Norsk Hydro's share of this licence, which covers block 15/3. After this the distribution is:

- Elf Aquitaine Norge A/S	43.6%
- Norsk Hydro A/S	19.6%
- Total Marine Norsk A/S	21.8%
- Norsk Hudbay A/S	15.0%

Consent was granted on 11 August 1977.

3. ACTIVITIES NORTH OF 62° N.

3.1 Geophysical investigations

Long-term planning for the proper management of the resources on the continental shelf makes it necessary to prepare a survey of the possible scope and geographical location of the resources as soon as possible. The government geophysical, geological and geochemical surveys north of latitude 62 °N for which the Petroleum Directorate is responsible are a stage in the preparation of a regional survey for this purpose.

As in 1976, the main emphasis of the geophysical surveys in 1977 was in the Barents Sea. Minor surveys were also undertaken west of Troms I, in Vestfjorden and along the Helgeland coast. These investigations were mainly reflection seismic surveys of the deep seismic type, although gravimetric and magnetic data were also recorded at the same time. A ground seismic survey was also carried out within Troms I.

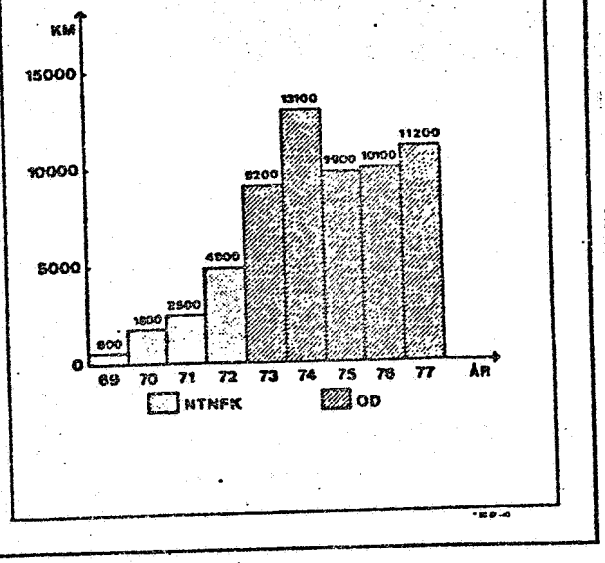
The geographical distribution of the surveys was as follows:

Helgeland coast and Vøring Plateau	1,638 km
Troms I	1,056 km
Barents Sea	7,188 km
Vestfjorden	449 km
Troms I (ground seismic)	900 km
Total	11,231 km

During the years 1969-1977 the state has carried out a total of 63,000 km of reflection seismic surveys north of latitude 62 °N. As shown in Fig. 3A the average extent of the surveys carried out by the Petroleum Directorate has been about 10,000 km per annum.

Since 1975 Statoil have been carrying out detailed surveys in the areas that the Petroleum Directorate has suggested should be open for further investigation. In 1977 Norsk Hydro and Saga also participated with Statoil.

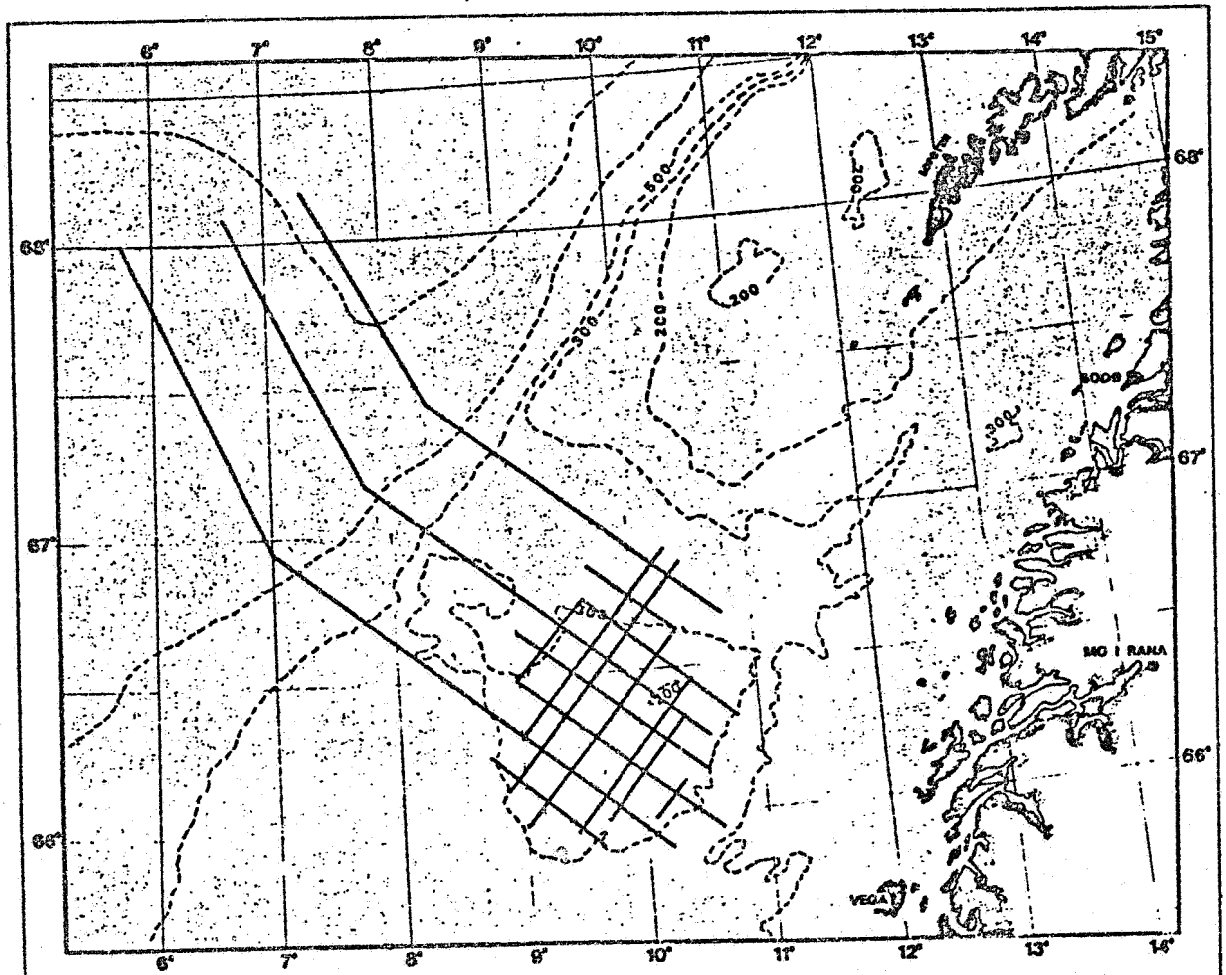
FIG. 3A



OD – Norwegian Petroleum Directorate

NTNFK – Continental Shelf section of the Norwegian Council for Scientific and Industrial Research

FIG. 3B



GEOPHYSICAL SURVEYS OFF THE COAST OF HELGELAND 1977

3.1.1 The Helgeland coast and Vøring Plateau

The investigation covered 1,638 km of reflection seismic, gravimetric and magnetometric surveys. The grid is concentrated on the Traena Bank, but data were also recorded along three profiles across the Vøring Plateau right out into deep water (Fig. 3B). The data were obtained and the seismic data processed by a Norwegian company, Geco A/S. The data are now being interpreted by the Petroleum Directorate and charts and reports are being prepared.

3.1.2 Vestfjord

A few regional reflection seismic lines were surveyed in Vestfjorden in 1972 and 1973. However, the area presented difficult technical problems and the profiles did not provide sufficient information to form the basis for a survey.

Nevertheless, the results of the experiment in 1976 with long energy sources (see Chapter 8.4) were so favourable that it was thought desirable to use this method for a systematic survey over a limited area.

Vestfjorden was considered to be a suitable area for such a survey and Geco A/S carried out a programme for the Petroleum Directorate over 449 km in which long energy sources were used. The grid is shown in Fig. 3C. As usual, gravimetric and magnetometric data were also recorded at the same time.

Geco A/S are now processing the seismic data and the preliminary results show a distinct improvement in the data compared with the previous surveys. However, until the data have been processed and interpreted it is impossible to make any forecast regarding the significance of the area for oil prospecting.

3.1.3 Barents Sea

During the year a total of 7,188 profile kilometres of reflection seismic surveys, with simultaneous recording of gravimetric and magnetometric data, was carried out in the Barents Sea on a grid that is shown in Fig. 3D. The surveys were carried out by Geco A/S (1,520 km) and Seismograph Service Ltd (5,668 km).

The purpose of the surveys during the year was to complete previous grids, to survey the transitional zone between the Norwegian Sea and the Barents Sea northwards to Svalbard and to determine the geological conditions in the deep water immediately west of the Barents Sea.

A small portion of the planned programme was postponed till spring 1978 due to bad weather.

3.1.4 Troms I

With the existing grid within and immediately outside Troms I it was not possible to define any closings on individual structures in the eastern area of Troms I. Reflection seismic surveys were therefore carried out over 1,056 km in this area. Long energy sources were used (see Chapter 8.4) and the data were obtained by Geco A/S. The location of the lines is shown in Fig. 3E.

In addition to this deep seismic survey, 900 km of ground seismic surveys were also carried out with sparkers as the energy source. The grid is shown in Fig. 3F. The ground seismic data are revealed to a better degree than the deep seismic details in the more shallow strata. They often provide a useful supplement to the deep seismic surveys with regard to geological interpretation and also can often be used to survey possible shallow gas pockets. Nowadays the oil companies in the North Sea usually carry out ground seismic surveys in conjunction with the planned drilling so as to avoid placing drilling locations over shallow gas pockets, which may create problems during the drilling. As was mentioned above, from 1977 this has also been a practice advocated by the Petroleum Directorate.

The Norwegian company, Geoteam A/S, was chosen to collect and process the data. A small portion of the work (190 km) was carried out for Statoil by the Petroleum Directorate.

The data have not yet been processed and it is too early to determine whether the method is appropriate for the Troms area.

3.1.5 Companies' surveys

Statoil have carried out detailed seismic surveys in the areas which have been open for further petroleum activity north of 62 °N since 1975. The scope of these surveys was 12,100 km in 1975, 6,600 km in 1976 and 4,585 km in 1977, spread over the open areas off Møre-Trøndelag and Troms.

In 1977 a management committee, the Geophysical Supervisory Committee (GSC), was set up for geophysical surveys in Troms I. The members of this committee are Statoil, Norsk Hydro and Saga and the Petroleum Directorate attended meetings as an observer. The purpose of this committee was to coordinate the collection and processing of geophysical data in Troms I in 1977 on behalf of its members.

The result of this work was that a deep seismic survey was carried out by GSC over 1,937 km in the Troms area. Of this 1,670 km was in the centre of Troms I, while the remaining 267 km was immediately east of Troms I in conjunction with the Petroleum Directorate's grid (see Fig. 3E). As a result of the Directorate's experiment in 1976 (see Chapter 8.4) the whole of GSC's survey was carried out with long energy sources.

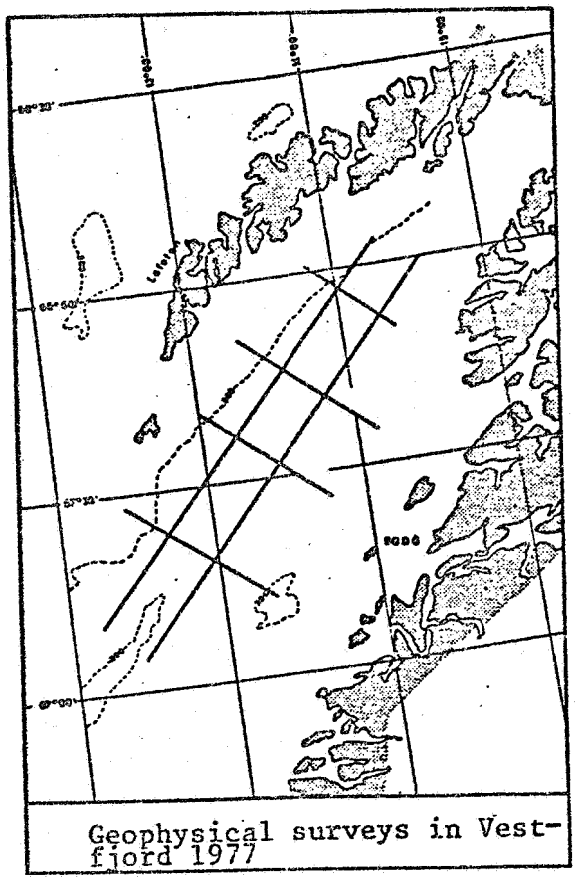
The total scope of the geophysical surveys carried out by the companies north of 62 °N up to the present is shown in Fig. 3G.

A new committee, the Northern Operations Committee (NOC), was set up in 1977 corresponding to the North Sea Operators' Committee in the North Sea. The members of this committee at present are Statoil, Norsk Hydro and Saga. It has three sub-committees: the geophysical and geological committee, the operations committee and the emergency committee.

3.2 Geological and geochemical surveys

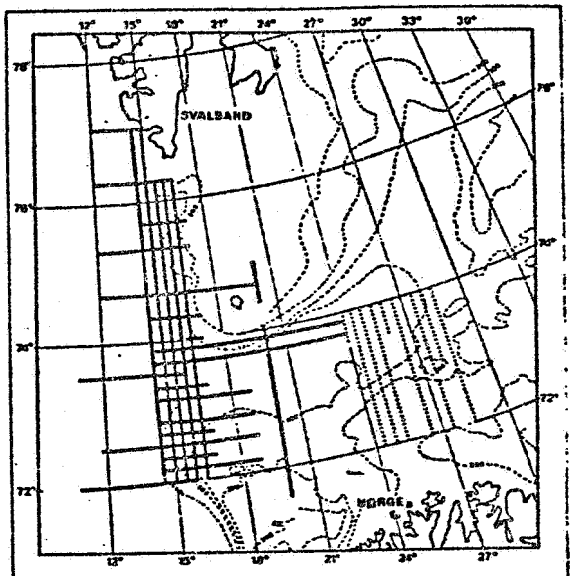
In 1976 the Petroleum Directorate carried out research on a regional geological and geochemical survey of the Barents Sea based on an analysis of seabed tests. The purpose of these studies was to attempt to combine data from the sea-bed tests with the information on the area obtained by the Petroleum Directorate from systematic geophysical surveys.

FIG. 3C



Geophysical surveys in Vest-fjord 1977

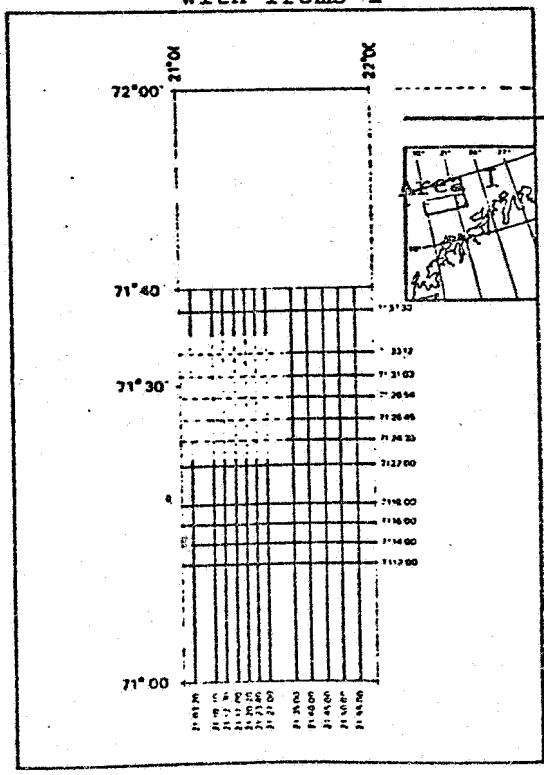
FIG. 3D



Geophysical surveys in the Barents Sea 1977

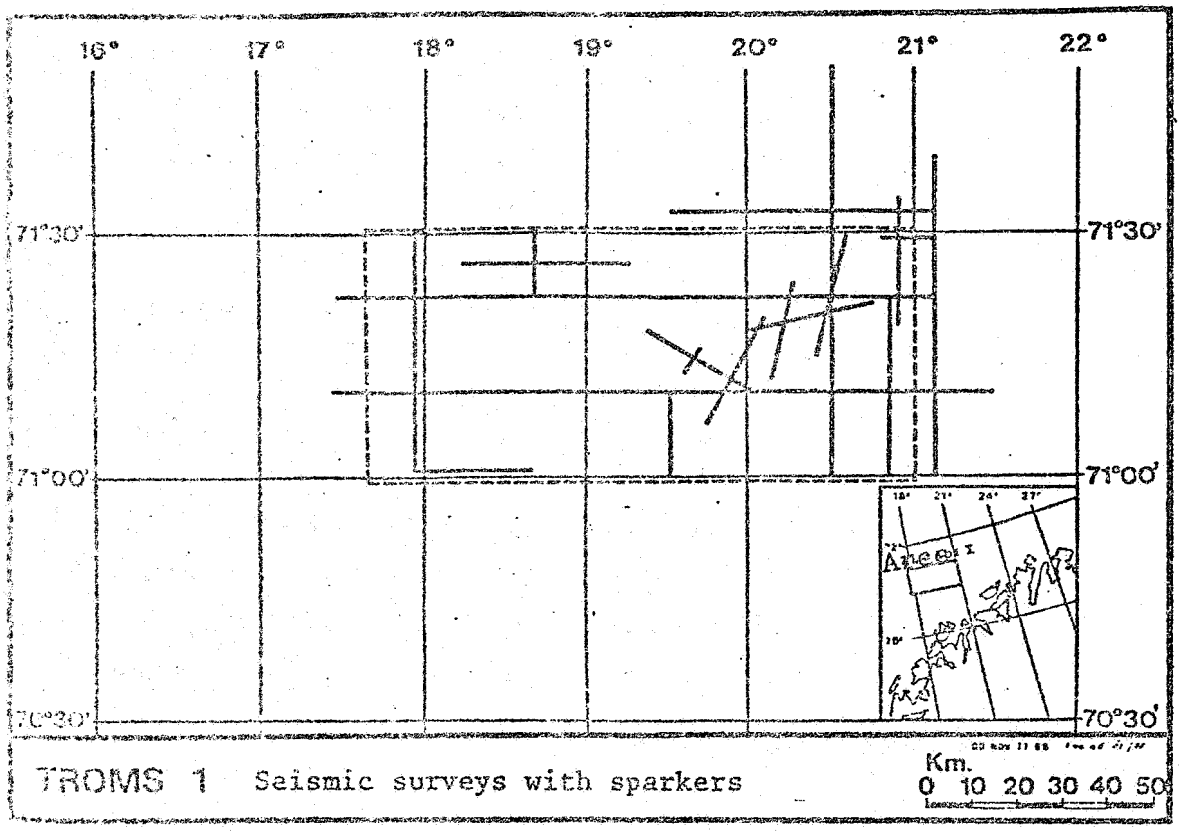
— surveys by SSL
— surveys by Geco

FIG. 3E
Geophysical surveys in connection with Troms I



Statoil (GSC) lines
Petroleum Directorate lines

FIG. 3F



TROMS 1 Seismic surveys with sparkers

FIG. 3G

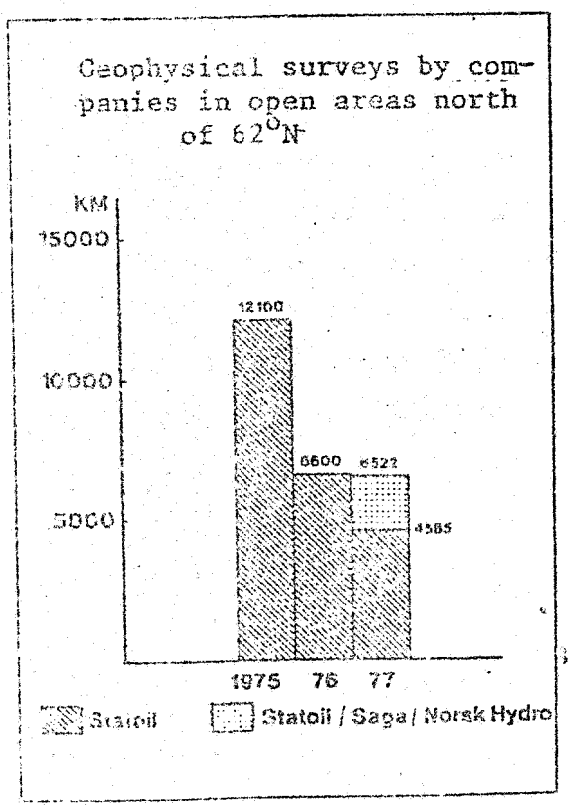
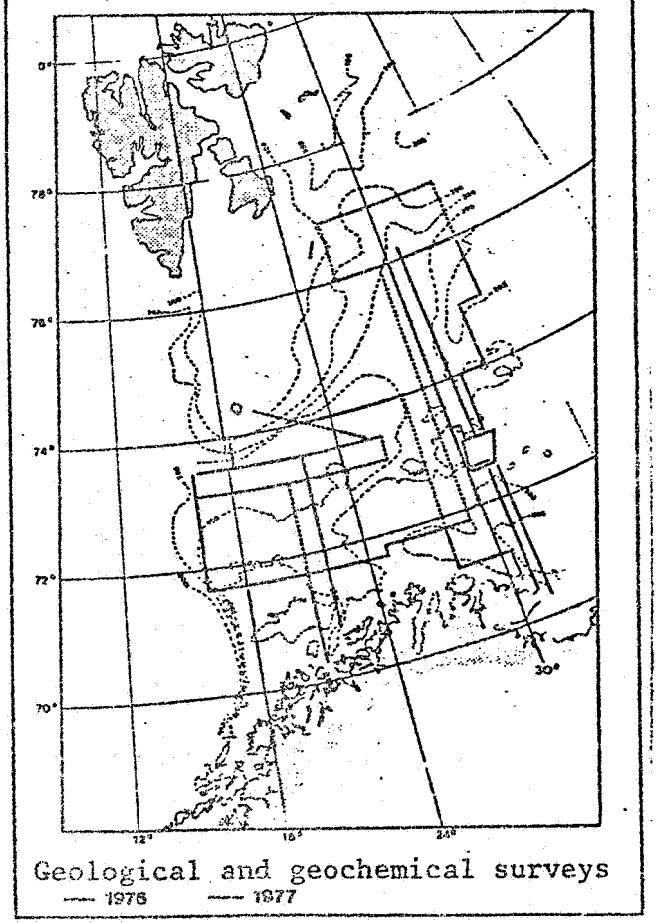


FIG. 3H



The 1976 sea-bed tests showed that such combination was possible. The rock tests provided more information regarding the age of the geo-seismic units and to some extent provided a better basis for assessing the qualities of the rock as a source and reservoir for petroleum. The geochemical analyses of the hydro-carbon content of the clay showed that there were considerable differences from area to area, depending on the structure of the underlying rock.

On this basis the Petroleum Directorate took 530 samples from the Barents Sea for geological and geochemical analysis in 1977 (Fig. 3H). The sampling commenced on the banks off Troms and Finnmark with M.V. "Stril Flower". The tests in the northern and eastern parts of the Barents Sea were done with M.V. "Nordvarg". Geoteam A/S were responsible for navigation and the Petroleum Directorate for the technical sampling.

The results of the geochemical analysis of the clay samples were available in December 1977 and they will be interpreted by March 1978. The geological analysis of the rock material takes longer, so that the combination of the geological and geochemical data will not be completed before summer 1978.

3.3 Interpretation results

3.3.1 Møre-Lofoten

The main structural features that have been surveyed so far off Møre-Lofoten are shown in Fig. 3I. The continental shelf between 62 °N and Lofoten may be described as a passive continental margin, but the various sections have undergone different geological development. The area is considered to have been an active sedimentation area since the end of the Caledonian folding and sediments from the Devonian and subsequent eras may be expected to be present.

The area of the shelf between 62 °N and 64 °N covers the eastern part of the Møre basin (Fig. 3I) and shows a separate basin with a depth increasing steadily as far as the various strata off the coast. The only complicating factor in this picture is a series of bedrock ridges under the western part of the continental

shelf. These ridges were all covered by the sea in the course of the Jurassic and Lower Cretaceous periods. The ridges are not connected and thus have not made any barrier that has prevented the free circulation of the water between the areas inside and outside the ridges, at least not from the Jurassic period onwards.

The area between 64 °N and Lofoten also has Upper Jurassic and Lower Cretaceous strata. The ridges do not form a homogeneous basin. In the transition from Lower to Upper Cretaceous there was a remarkable structuring stage in Trøndelag and the Helgeland area. This disturbance in the earth's crust led to the formation of the Nordland ridge and the Vega ridge, and the area was divided in the Upper Cretaceous into various basins and ridges which meant that sedimentation in this period was very varied in this part of the shelf. Thus the area inside the Nordland ridge was stable compared with the areas in the Møre basin, the Vøring basin and the Traen-Vestfjord basin, which sank more rapidly (Fig. 3I). The Helgeland basin was active during the deposit of the Upper Cretaceous strata but the sinking was small compared with those areas. Parts of the Nordland ridge were an erosion area during the Upper Cretaceous period.

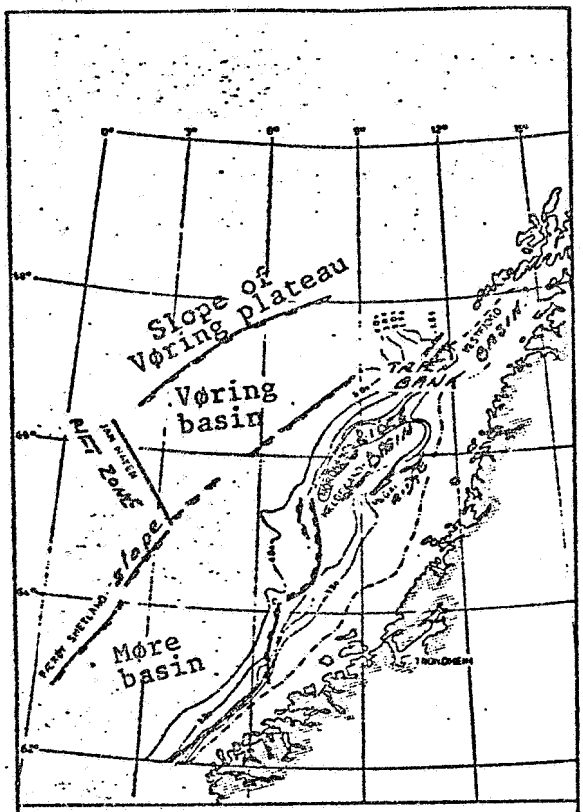
During the tertiary era the whole shelf between 62 °N and Lofoten was part of a wide basin that was not very structured. The sinking was asymmetrical with large sinking in the west and relative raising with consequential erosion in the east and north.

3.3.2 Barents Sea

The main structural features that have been surveyed so far in the Barents Sea are shown in Fig. 3J.

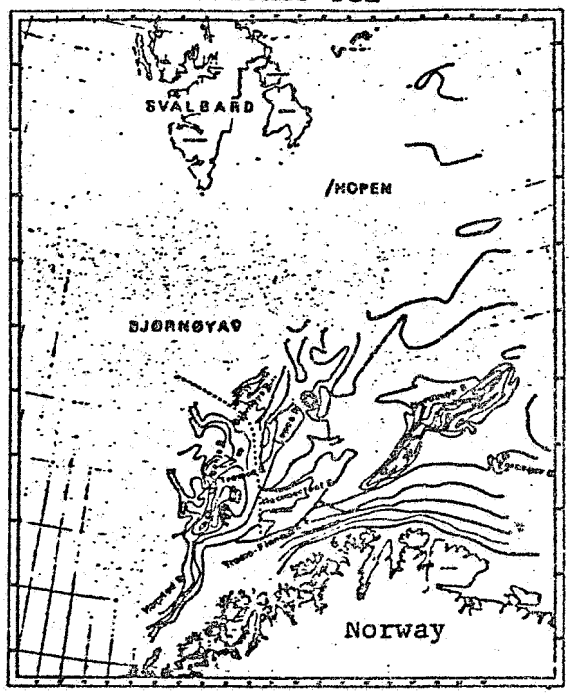
During the past 300 million years the Norwegian part of the Barents Sea west of 25 °E and south of 75 °N has been a sedimentation basin that has been sinking steadily. In the middle of this basin there is a sub-basin running NE-SW, the Nordkapp basin, which is connected with the Cretaceous movement. South-east of this sub-basin there is a corresponding sub-basin, the Varanger basin.

FIG. 3I



Main structural features off Møre - Lofoten

FIG. 3J
Main structural features in Barents Sea



During the period from 300 to 150 million years ago the area between 20°E and 25°E was a sedimentation area that was steadily sinking like the area further east. Movements in the earth's crust about 150 million years ago led to the formation of two sub-basins, the Bjørnøya basin and the Hammerfest basin, respectively north and south of a non-sinking ridge area called the Loppa ridge. A large Cretaceous prominence was observed in the north of this ridge area.

For the purposes of regional geology the area west of longitude 20 °E may be classified as a passive continental margin. In this area there was considerable structuring of the geological strata up until 30 million years ago. The area may be divided into three structural elements: the Harstad basin, the Tromsø basin and the Senja ridge.

The geophysical surveys in the Barents Sea outside Troms I are too approximate to determine structures of the volume that is required for petroleum reservoirs. It is therefore impossible at present to speculate the limits of reserves on the basis of structural magnitudes.

3.3.3 Jan Mayen

In 1976 the Petroleum Directorate carried out magnetic surveys from the air in the Jan Mayen area. These measurements were done and processed by the French company, Compagnie Générale de Géophysique (CGG). A scientific survey was also carried out in the area in 1975. The French body, Centre National pour l'Exploitation de l'Océan (CNEXO), obtained reflection seismic data. These data have been interpreted and provide an important contribution to our knowledge of the geology. There is also the drilling done by the Deep Sea Drilling Project in the Jan Mayen ridge.

The interpretation of these data has provided considerable information on both the thickness of the sediment in the area and details of the sedimentary deposits. The area on the west flank of the Jan Mayen ridge has only a thin covering of a few hundred metres but on the east flank the thickness of the sediment increases steadily and reaches more than 2 km.

3.4 Areas open for further petroleum activity

3.4.1 Møre-Lofoten

On the basis of the seismic grid, part of which is detailed, that was available in 1975 the Petroleum Directorate recommended that two small areas should be opened for further activity, six blocks in Area I northwest of Romsdalsfjorden and seven blocks in Area II on the Halten bank (see 1976 report). All these blocks meet the technical criteria of the Petroleum Directorate to a sufficient degree:

- geological conditions providing an opportunity for good prospects;
- various types of prospects to ensure continuity in the activity;
- a central geological location;
- a water-depth within the technological and safety limits.

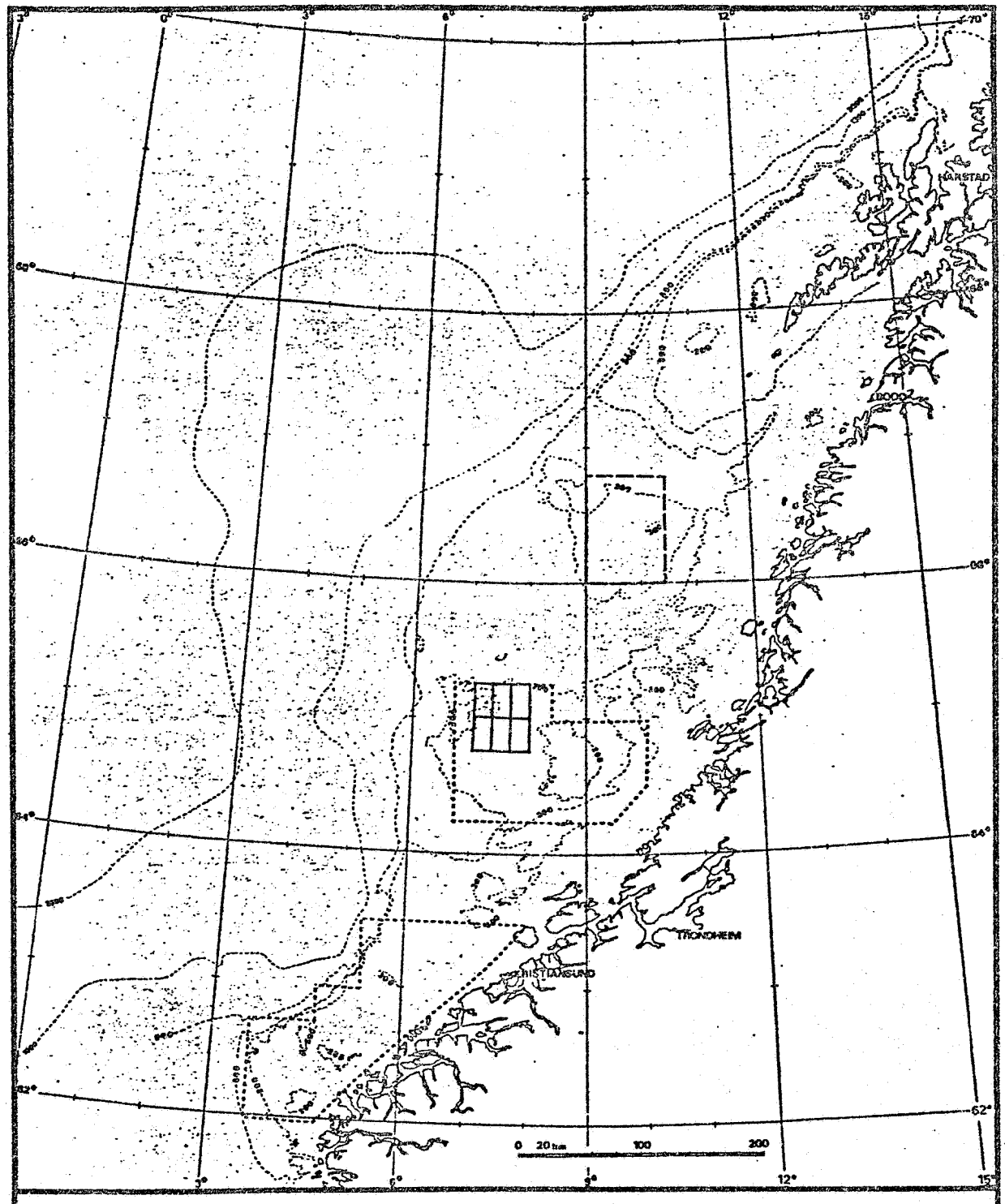
However, the choice of areas aroused strong opposition from the fishing sector and discussions were held with the Central Norway Oil Council regarding alternative blocks. As a result of these discussions the Central Norway Oil Council gave its approval in 1977 for six blocks to be opened for test drilling in the north-western part of the Halten bank (Fig. 3K), stipulating that only one block could be drilled at a time.

As a result of the surveys along the Helgeland coast in 1977 the Petroleum Directorate selected an area on the Traena bank that seemed to meet the criteria for further petroleum activity. This area consists of twelve blocks with a total area of 4,900 square kilometres (Fig. 3K). The area has not yet been discussed with the Oil Council or the fishing organisations.

3.4.2 Troms I

At the end of 1976 only Statoil, Norsk Hydro and Saga had purchased the geophysical data for Troms I. In 1977, 35 foreign oil companies were invited to purchase these data. At 1 January 1978, 22 companies (including Norwegian companies) had acquired the data: Statoil, Norsk Hydro, Saga, Esso, Conoco, Phillips, Mobil, Fina, Shell, Elf, BP, Agip, Petroswede, Texaco, Union, Amoco,

FIG. 3K



----- Areas opened for further activity in 1975

—— Træna Bank, opening this area for further activity has been proposed by the Petroleum Directorate

—— Blocks on the Halten Bank which it is proposed to open for drilling

Total, Deminex, Arco, Gulf, Cities Service and Hudbay.

The sale of the data has brought in Nkr. 30,907,000 to the Petroleum Directorate and the government.

These same companies have also been offered the experimental line that was surveyed with long energy sources in Troms I in 1976 and geochemical data for the area. At 1 January 1978, four companies had bought the experimental line and three companies had taken the geochemical data. These sales brought in Nkr. 679,000 to the Petroleum Directorate and the government.

The 1977 surveys in the Troms area will be offered for sale in the form of two data packages. One contains data obtained within Troms I and will be sold by Statoil. The other contains data obtained immediately east of Troms I and will be sold by the Petroleum Directorate.

3.5 Drilling activities on Svalbard

3.5.1 Haketangen

Norsk Polarnavigasjon commenced work on a well at Haketangen near Tromsbreen on 11 September 1976 (Fig.3L). The drilling was interrupted shortly afterwards by technical problems and was not resumed until May 1977 after improvements ordered by the Petroleum Directorate had been carried out. The drilling was terminated for the time being on 20 September 1977.[1)]

4. Scientific surveys and relase of geological material

4.1 Scientific surveys

At 31 December 1977 a total of 85 permits had been granted for scientific surveys on the Norwegian continental shelf. Table VIII shows those granted in 1977.

These were mainly geophysical and geological surveys. Some of them were continuations of surveys begun in previous years. Geographically the surveys are spread over the whole of the Norwegian continental shelf, from Skagerak in the south to Svalbard in the north.

---

1) Translator's note: The Norwegian says 1976, but it is assumed that this is a misprint.

FIG. 3L

EXPLORATORY DRILLING IN SVALBARD DURING PERIOD 1965 - 77

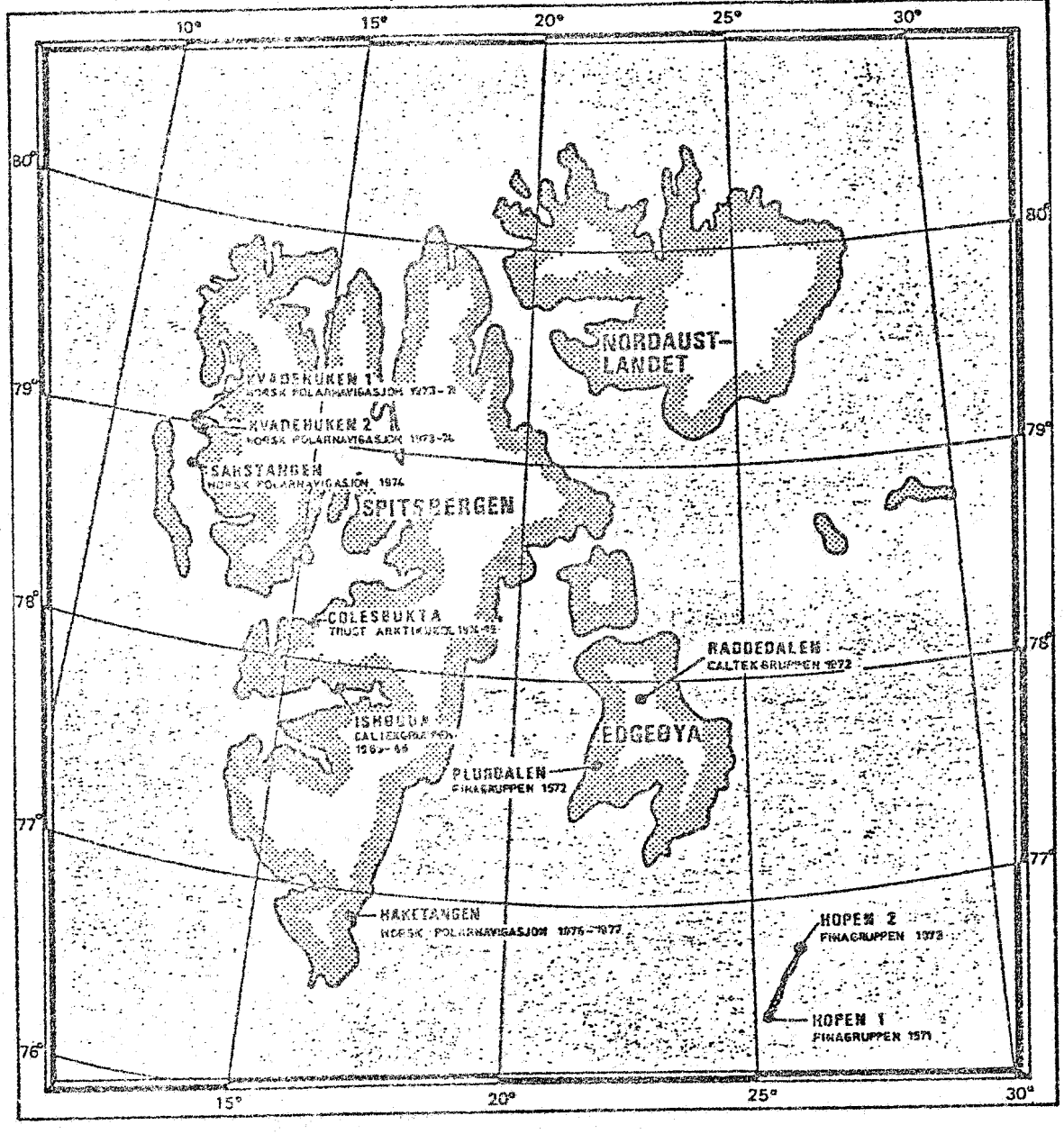


TABLE VIII. PERMITS FOR SCIENTIFIC EXPLORATION FOR NATURAL RESOURCES, GIVEN PURSUANT TO ROYAL DECREE OF 31 JANUARY 1969

Permit	Name	Science			Area
		Geophysics	Geology	Biology	
079/77	University in Bergen Earthquake Sect.	x			North of Svalbard
080/77	University in Bergen Geological Inst. Div.B		x		Sognefjord and shelf outside
081/77	Inst.for Continental Shelf Surveys	x	x		Haltenbanken - Storegga Areas of Møre
082/77	Inst.für Geophysik det universität Hamburg	x			Lofoten - Vesterålen
083/77	Nederlands Institut voor Onderzoek der Zee		x		North Sea and Skagerak
084/77	Deutsches Hydrographisches Institut	x	x		North Sea and Skagerak
085/77	University in Tromsø, Inst.of Biology & Geology		x		The shelf off Troms and West Finnmark

A number of the surveys were deep seismic surveys of the same kind as the commercial surveys. The most important difference is that the results from the scientific surveys must be published.

In addition to the formal permits for scientific surveys the Petroleum Directorate has also permitted some scientific institutions to carry out surveys partly extending into the Norwegian continental shelf.

4.2 Release of geological material

The Petroleum Directorate may release geological material more than five years old. A survey is published every year listing the wells that have been closed for more than five years.

This publication, "Well data summary sheet", shows what logs have been run and also provides a rough geological survey.

The Petroleum Directorate does not release the companies' interpretations but it examines the material from the various wells and publishes it in its own publication series, NPD Papers.

TABLE IX. RELEASED SCIENTIFIC MATERIAL FROM THE PETROLEUM DIRECTORATE GEOCHEMISTRY SURVEY

Institution	Sample stations and type	Geographic spread	Purpose
University in Tromsø, Institute of Biology and Geology	64 core samples, max. 3 m beneath the sea-bed	Continental shelf off Troms and Finnmark	Samples processed for basic research and results used both for theses and for long-term scientific projects. Investigations concentrated on: 1) General quaternary geology 2) Quaternary litho and biostratigraphy 3) Recent and sub-recent sedimentation environment (marine geology)
University in Bergen, Inst.for Quaternary Geology, Geomorphology and Marine Geology	23 cores max. 2 m beneath seabed	Måløy blocks 35/3 and 36/1	
University in Oslo, Institute of Geology	22 cores max. 3 m beneath the seabed	Måløy blocks	
University in Oslo, Institute of Geology	114 rock samples from 60 stations. 18 parts of cores from 18 stations	Barents Sea	Palynological studies
University in Oslo, Institute of Geology	7 surface samples	North Sea	World-wide investigation of micro flora and fauna
University in Bergen, Institute for Quaternary Geology, Geomorphology and Marine Geology	221 seabed samples	Barents Sea	Investigation of radiolarites and coccoliths
Institute for Continental Shelf Surveys	77 samples max. 3 m beneath the sea-bed Field data	Måløy blocks and continental shelf off Troms and Finnmark	1) Testing of equipment for geochemical prospecting 2) Geotechnical evaluation and grain distribution analyses 3) Charting of surface sediments
Norwegian Geological Survey	16 core samples max. 3 m beneath the sea-bed	Balder Field in the North Sea	Chemical and mineralogical investigations

TABLE X. INJURIES DUE TO FIRE

Injury(ies) resulting from fire / Type of installation	Construction phase	Operation phase	
		a	b
Injury and heavy material damage	0	0	0
Injury(ies) and little or no material damage	2	0	0
No injury, but heavy material damage	1	0	0
No injury and little or no material damage	12	5	5
Total	15	5	5=25

a - Cause of fire: construction work

b - Fire resulting from operations/ operating accident

At the end of 1977, 20 wells had been released and published in 15 volumes (see list of publications in Part IV).

Seismic profiles are only released for areas that have been surrendered. However, individual oil companies have released data for use in research and educational institutions.

The material from the upper 2 to 3 metres of the sea-bed that was obtained during geological and geochemical surveys carried out by the Petroleum Directorate itself has been released to Norwegian research and educational institutions. Such material has been given to all the universities and IKU, NGU and the Polar Institute. This material is listed in Table IX.

In view of the increasing activity in this sector the Petroleum Directorate has actively contributed by providing material for both education and research. It receives all the reports based on this material and issued by the research and educational institutions. The Directorate thus obtains valuable

information and its technical staff is strengthened by this extensive contact with those institutions. This contact is formalised through annual meetings between the Directorate and Norwegian and foreign scientific institutions that are working on the Norwegian continental shelf. At these meetings the institutions present both results from the preceding year's work and plans for future work.

4.3 Surveys and work commissioned from other institutions

Sometimes on the initiative of the institution and sometimes at the request of the Petroleum Directorate, geological and geophysical institutions carry out surveys that are supported financially by the Directorate. In 1977 Nkr. 1.65 million was granted for such projects.

The surveys are all clearly connected with the tasks of the Directorate. In many cases the work is so specialised and detailed that it cannot be done by the Directorate itself. Moreover, this type of work serves to maintain and develop active research, which is necessary for the proper training of personnel for the oil sector.

In 1977 support was given to the following fifteen projects:

- The preparation of a contour map and automatic methods for the interpretation of magnetic aerial survey data obtained during 1973, 1974 and 1975 by the Norwegian Geological Survey.
- Geophysical surveys on the Norwegian continental shelf for charting the larger structures in the earth's crust carried out by the Bergen University Earthquake Station.
- Seismic and magnetic surveys on the continental shelf carried out by the Bergen University Earthquake Station.
- Processing of marine geophysical data from the continental margin and extension of the Marine Geophysical Data Library, Oslo University Geological Institute.
- Geophysical surveys in the Svalbard area, Norwegian Polar Institute.
- Geological studies of well core material from the North Sea, Bergen University Geological Institute.

- Geological surveys in Svalbard, Bergen University Geological Institute.
- Measurement of the speed of sound and gravimetry in rocks in Svalbard, Oslo University Geological Institute.
- Survey of sedimentation conditions in a fjord area and out on the continental shelf, Bergen University Geological Institute.
- Survey of sediments and sedimentation conditions on the continental shelf and out in deep water, Bergen University Geological Institute.
- Palynological surveys of geological material from the Barents Sea, Oslo University Geological Institute.
- Sedimentation conditions in the large oceans, Oslo University Geological Institute.
- Detailed studies of Jurassic rocks from the Norwegian-Danish basin, Oslo University Geological Institute.
- Sedimentation conditions on the continental shelf off Troms and Vest-Finnmark, Tromsø University Institute of Biology and Geology.
- Micro-palaeontological studies (radiolarites and coccoliths) from sea-bed samples taken from the Barents Sea, Bergen University Geological Institute.

5. Safety control

5.1 Co-ordination of control activities

In accordance with the regulation for co-ordinated control activities issued by the Departments of Industry, Environmental Protection and Social Security of 24 January 1977, a contact committee was appointed for control activities. The committee consists of representatives of all the control bodies to which authority is delegated to exercise supervision regarding the design, construction, installation and operation of production plant, pipe-line systems and tanker loading installations that are located in a permanent position on the Norwegian continental shelf. The following bodies are represented: the Shipping Directorate, the Telecommunications Directorate, the Coast Directorate, the Directorate of Civil Aviation, the State Pollution Board, the Health

Directorate and the Petroleum Directorate.

The task of the committee is to discuss the theoretical aspects of control activities. An annual report will be prepared for each project covering the control areas of the relevant body and other experience obtained.

The regulation lays down guidelines for the practical execution of the co-ordination activities. There is to be direct contact between the licensees and the control body and the control body may carry out any checks or inspections that it considers necessary. The Petroleum Directorate will be kept informed of the inspections carried out and of any instructions issued to the licensees.

The Petroleum Directorate will approve the main plan and grant authorisation for the operation of each installation on behalf of the authorities who are responsible for control on the continental shelf. Methods have been laid down to strengthen the contact with those authorities.

Approval is granted for the operation of living accommodation, production drilling, petroleum production, pipe-line systems and tanker loading installations.

The control authorities may engage consultants to carry out the detailed inspection of installations. However, the formal authorisation will always be issued by the public control authorities.

The authorisations mentioned above will not be granted unless there are satisfactory emergency plans. Examination of these plans and the establishment of approval criteria are an integral part of safety control. Such control will ensure that the plans covering manning, vessels and equipment are operable both during practice and in real emergencies.

5.2 Regulations

The Petroleum Directorate is now preparing a collection of the regulations issued in accordance with the Royal Decree of 9 July 1976 and other regulations. The Directorate has

The location and design of accommodation must be approved by the Petroleum Directorate before the construction work commences. The Directorate must make a final inspection and grant final approval for its use before the accommodation is occupied.

It is expected that the regulations will be brought into force at the beginning of 1978.

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

Personnel must be transferred between land and an installation or between installations without a permanent bridge connection by helicopter or another approved method.

In cases where such a transfer cannot be made and the transfer cannot be postponed for reasons of safety of the personnel or the installation, the transfer may be made by means of an approved 'bosun's chair'.

Such a transfer may also be made where special reasons make it necessary or reasonable. The Petroleum Directorate must be informed immediately of such a situation.

The regulations give guidelines regarding the equipment that must be used and contain rules to be applied to the use of bosun's chairs.

It is expected that the regulations will be brought into force at the beginning of 1978.

5.2.9 Regulations for walkways, staircases, ladders and guardrails on production installations, etc.

The Directorate has decided that it is necessary to adopt detailed regulations regarding means of access. These provisions are now being discussed and it is expected that they will be brought into force during the first half of 1978.

5.3 Qualification requirements

In order to achieve greater safety the Petroleum Directorate has decided that it is necessary to lay down certain requirements regarding the qualifications of some personnel on the platforms.

5.3.1 Qualifications for management staff on fixed installations

The qualifications required for personnel on floating drilling platforms were laid down by the Shipping Directorate on 28 February 1975.

The corresponding requirements for personnel on fixed installations have not yet been finally determined. The Petroleum Directorate has set up an internal group that is working on this problem. The group will produce a proposal early in 1978. On the basis of this work and any comments that may be received, the Directorate considers that the qualification requirements for management personnel on fixed platforms can be brought into force in 1978.

5.3.2 Qualification requirements for electrical specialists

In a letter of 14 October 1976 to the oil companies and the North Sea Operators' Committee the Petroleum Directorate made the provisions in the Royal Decree of 19 September 1975 applicable to all fixed installations on the continental shelf. The qualification requirements apply to electrical specialists and are initially restricted to shift foremen, electricians and fitters of Grades L and H. The requirements came into force on 1 January 1977, with reasonable access to exemption up to the end of the year.

These provisions entailed a lot of extra work for the Petroleum Directorate in this field and a lack of trained personnel has made it difficult for the oil companies to comply with the requirements in the Royal Decree of 19 September 1975 to the full. It was necessary to lay down these requirements so as to achieve a satisfactory degree of safety on both workplaces and installations.

5.3.3 Qualification requirements for drilling personnel

The qualification requirements laid down by the Petroleum Directorate for drilling teams are in accordance with the manning provisions for floating drilling vessels. Since few employees fulfil those requirements it has been necessary to grant a series of exemptions. The evaluation of the qualifications of individual employees has proved very time-consuming.

5.3.4 Qualification requirements for crane drivers

The qualification requirements for crane drivers are included in the Regulations for Cranes issued by the Directorate on 25 May 1955.

5.4 Electrical installations

The supervision of electrical installations is based on the Royal Decree of 9 July 1976 and the Delegation Decision of the Ministry of Industry of 12 July 1976. Various foreign provisions and standards have been used as guidelines for this work, and this has made it more time-consuming.

The Petroleum Directorate has put in much work on the supervision of the design and construction of the electrical installations in the Ekofisk, Statfjord and Frigg fields. Seven new platforms have been under construction in the Ekofisk field and major modifications have been carried out on six or seven other platforms. The supervisory work on Statfjord A has been time-consuming. The electrical installations on that platform are extensive and complex and difficult to inspect.

As the electrical installations come into operation on the platforms the operational checks will take up an increasing proportion of the supervisory capacity. This is a natural development and in the years ahead this work will have a high priority. During the year much work was put in on operational checks on the Ekofisk installations. All the electrical installations there had at least one inspection. The rectification of defects discovered still takes a fairly long time, but there has been some improvement in this respect.

The checks during the design and construction stages are carried out with the aid of consultants. The main consultants have been Det Norske Veritas, but the Electricity Board's research institute has also been used. The operational checks have been carried out by the Petroleum Directorate's own staff, without any appreciable outside assistance.

In addition to its supervisory activities the Directorate

has also provided advice and information to promote the highest possible degree of safety in the use of electrical installations on the platforms.

5.5 Production and auxiliary systems

During the year the Directorate has exercised extensive supervision at the design, construction and operational stages.

The basis for this work has been the draft of the Regulations for Production and Auxiliary systems etc. in internal Norwegian waters, the Norwegian sea territory and the portion of the Continental Shelf under Norwegian jurisdiction. This draft was revised twice in 1977 and it is expected that these provisions will be adopted definitively at the beginning of 1978. Accepted standards and guidelines in specific fields, e.g. the construction of pressure vessels, have also been used.

In connection with design control, large quantities of drawings, specifications and other documents are received from the licensees and examined by the Petroleum Directorate. Some of the design monitoring is carried out by consultants, but most of it is done by the Directorate's own staff.

With regard to construction supervision, the converse applies. The main consultants have been Det Norske Veritas, while the Directorate's inspection of construction sites has been more sporadic. Operational checks have been made exclusively by the Directorate's own staff.

Much experience has been gained during the year of operational supervision and the instructions for the routine checks made by the Directorate's inspectors have been subjected to continuous appraisal. Important safety systems, such as emergency cut-out systems and fire precautions, have been checked at least twice during the year on all installations in operation.

The supervisory work has also included the scrutiny of maintenance routines and operational procedures. This work will continue in the future and routines and procedures will be adjusted as new experience is gained.

Replacement and improvement of equipment has been initiated on some older installations so that it may comply with the present provisions, e.g. better firefighting equipment on helicopter decks and fireproofing of emergency generators and fire-pumps.

In addition to the supervisory work the Directorate has also provided advice and information in conjunction with the licensees and Norwegian industry in general.

5.6 Workers' safety and working environment

The safety of workers and the working environment have been among the main fields of the Directorate's activities. Its work in this area has been confirmed by the entry into force on 1 July 1977 of the Provisional Regulations concerning the Safety of Workers and the Working Environment in connection with exploration for for and exploitation of underwater petroleum deposits. The Directorate is responsible for the implementation of these provisions.

The Working Environment Act which replaces the Regulations concerning the Safety of Workers of 9 July 1976 has laid down a series of new criteria as the requirements for creating a good working environment. Its scope is comprehensive and it will take some time before these new requirements are satisfied. Both employers and employees have expressed a wide commitment to the new legislation and this has already taken concrete form. However, great attention must be given to training. Progress has been made, in particular, with the work done by the workers' safety and working environment committee, even though at certain stages in the development of an installation it is difficult to get everything operating satisfactorily at all times.

The Directorate has had a close and confident collaboration with the parties in the petroleum sector and the other supervisory authorities involved to establish the best possible conditions for the performance of its tasks under the new statute.

5.7 Control of diving operations

Diving operations are carried out in connection with test-drilling, production drilling, pipe-laying, the installation or removal of underwater production wells, construction work and underwater inspection work. The volume of diving operations increases steadily as activity moves out into deeper water. Six Norwegian and a number of foreign diving companies are operating on the Norwegian continental shelf. The diving operations are carried out from fixed installations, floating drilling platforms, diving vessels, barges, etc. Underwater vessels are also being used to an increasing extent. The Norwegian companies now employ about 400 divers.

Various methods are used for diving, each requiring its own special technique, depending on the type of work and the depth at which it has to be done. The extremely advanced techniques used nowadays in the North Sea make great demands on divers. It is considered that it takes several years of training to become a skilled diver.

The Directorate of Labour Inspection has formal responsibility for diving activities. However, it was decided in 1977 that this responsibility should be transferred to the Petroleum Directorate during the first quarter of 1978.

A separate section will be set up in the inspection department to perform this function. It will consist of five persons and, in addition to the technical personnel and diving specialists, will include a doctor to deal with medical problems connected with diving.

5.8 The blow-out on the Danish shelf

A blow-out occurred on Friday, 14 October 1977, at 11 a.m. on the Danish shelf in the Vagn I well being drilled with the Maersk Explorer, which is a telescopic rig. The well had been drilled down to 1,222 m and 9 5/8" line-pipe had been inserted to 1,218 m. When the line-pipe had been cemented it was suspected that there was something wrong with a circulation port in the line-pipe close to the sea-bed. It was therefore decided to take

up the portion of the 9 5/8" line-pipe above the port and it was during this work that the blow-out started. What came out of the well was mainly gas, water and sand. It came from a shallow gas pocket at 550 m in a porous, almost unconsolidated sandstone of the pliocene age. The mixture of gas, water and sand flowed up on the outside of the 9-5/8" line-pipe and into the pipe at the circulation port. The gas ignited after about 45 minutes and the heat melted the drilling tower so that it collapsed after two hours. The fire was extinguished at midnight on Friday, but the blow-out of water and sand continued until 24 November, when it ceased spontaneously. There was no loss of life.

After a request from the Danish authorities both to the Ministry of Industry and direct to the Petroleum Directorate for assistance, it was decided to send a geologist and two drilling engineers from the Directorate. They went to Denmark in the evening of the day on which the blow-out started and assisted the Danish authorities during this initial period.

The Petroleum Directorate was subsequently asked for assistance during the important stages of the shutting down and safety operations. It provided from one to three men, particularly during the approval of the programme for the relief well, maritime declaration and approval for the final plugging and securing of Vagn I. During the period when the Petroleum Directorate had no personnel in Denmark it was kept continuously informed of the progress of the work.

The experience obtained from this collaboration with the Danish authorities was extremely useful, since there are shallow gas pockets on the Norwegian shelf as well. The experience gained during the work to suppress the blow-out was also very valuable, as it was the first time that the Directorate was able to follow the daily progress during the drilling of a relief well.

5.9 Damage control and sea-rescue training

The Petroleum Directorate examined the plans submitted by licensees for fire and rescue training. These plans appear to be good, but their implementation will be severely limited by the

lack of facilities for practical training in this sector in Norway.

The problem was raised by the trade unions' co-operation committee on the installations with the result that a committee has been set up by the Ministry of Church and Education to examine the possibility of intensifying the training at the Academy of Damage Control and Sea Rescue in Haugesund. The Petroleum Directorate is represented on this committee. However, this alone will not provide a complete solution as it will take time to effect in any event.

It seems clear that some provisional scheme is necessary to meet the acute need. It may be possible to utilise free capacity at the existing fire protection facilities in Bergen, Horten/Croftholmen and something may possibly be done in Haugesund.

5.10 Fire damage

The Petroleum Directorate recorded a total of 25 fires on fixed installations in 1977. Seen in relation to the number of installations (23), the number of workers involved (6,000 to 9,000) and the high activity on the continental shelf, the installations come out well compared with corresponding industry on land. Moreover, the reporting procedure has been so developed that it includes literally every outbreak of fire, which is not the usual practice on land.

Table X shows the fires in respect of which the Directorate has received reports in accordance with the Attorney-General's regulations. The two cases where there was personal injury involved slight burns to the hands.

5.11 Burial of pipe-lines

In order to protect pipe-lines from the effects of the current and external mechanical effects and to prevent conflicts with other users of the North Sea it was decided that pipe-lines must be buried. The requirements for burial are as follows:

- 1 m in open sea (1 m between the top of the pipe and the natural level of the sea-bed);
- 3 m in coastal waters to a water depth of 50 m;

- 3 m around platforms out to about 3.2 km (2 miles) from an isolated platform and out to about 8 km (5 miles) from a platform complex.

It was found that great problems arose in fulfilling the original requirements in full, particularly in the case of large pipe-lines.

The burial results are considerably better with regard to the smaller pipe-lines where there is a greater danger of serious damage being caused to the pipe-line by external effects. This is due to the fact that these are much shorter and that they are buried in fairly uniform loose soils.

With regard to the larger pipe-lines which pass through areas with varying loose soils, burial and covering has been satisfactory in some areas. The most recent checks showed that the covering of pipe-lines is steadily improving.

However, these checks also showed that pipe-lines were unsupported in places. This was found mainly where the sea-bed is hard but with local variations so that the dredging hoses have washed away considerably more loose material in the softest areas. A trench was found with large local variations in its depth. The pipe is supported in the shallowest areas of the trench but unsupported spans may occur in between. All such large spans (over 25 m) have been improved by means of sandbags.

5.12 Record of injuries

All personal injuries are reported to the Petroleum Directorate according to a fixed procedure. The police and the Directorate are notified immediately by telephone of serious industrial accidents and fatal accidents. Representatives of both authorities investigate the accident. A detailed report is also required from the employers.

5.12.1 Industrial accidents 1977 (1976)

Table XI shows the industrial accidents reported to the Directorate in 1977 (1976) which caused absence from work or had fatal consequences.

No account is taken of the length of absence and the table does not provide a basis for direct comparison with statistics for other sectors, as these are usually based on absence of at least 11 days.

Eight back injuries in 1977 and eight in 1976, which are included in the figures, are not normally eligible for classification as industrial injuries for the purposes of the Social Security Act.

The table covers industrial accidents on fixed installations on the Norwegian continental shelf and fixed installations connected with the pipe-lines to Teesside, England, and Emden, West Germany.

The basis of the figures is the industrial injuries reported to the Directorate by employers. An industrial injury is defined as an injury or illness caused while working at the workplace during working hours.

The table covers workers of all categories and nationalities and all stages of activity within the sector on the installations defined above.

5.12.2 Fatal accidents

There were two fatal accidents on fixed installations in 1977. One occurred in connection with the operation of a crane. The crane fell into the sea when a case which was being lifted from a supply ship got caught in the ship. The other fatal accident occurred when a worker fell to a lower level during construction work.

On 24 November 1977 twelve persons were killed when a helicopter crashed into the sea on its way to the Ekofisk field from Stavanger.

5.12.3 Industrial accidents in general

The increase in reported industrial injuries from 213 in 1976 to 287 in 1977 was due to the increase in activity in the oil sector. This increase covered in particular work on new

installations in all fields. The figures for 1977 cover a total of about 6,000 to 9,000 persons who are regarded as working on the fixed installations. The large variation in the number of workers is due partly to the increase in activity during the year. Provisional figures indicate that about 7.9 million hours were worked on the installations in 1977.

The picture is dominated by four causes of injury: hand tools, falls to a lower level, falls at the same level, and lifting and carrying. Falls to a lower level were clearly the most important and this is confirmed by the fact that three of the four fatal accidents that occurred during the past two years were in this category.

Three parts of the body seems the most exposed: eyes, hands/fingers and feet. This is partly due to the many simultaneous operations, crowded working conditions (a large number of workers), varying weather conditions and extensive construction work.

In general it may be said that the number of injuries can certainly be reduced with better arrangements at the workplace, better organisation, planning and execution of the work and greater vigilance by the workers themselves.

The organised protection service provided by the working environment committee and the safety committees and the co-operation of the employees' organisations already seem to have strengthened self-supervision, which is a good sign for future progress in the fight against industrial injuries.

TABLE XI. OCCUPATIONAL ACCIDENTS
FIXED PRODUCTION INSTALLATIONS ETC.

Cause of injury / Injury to	Motors, generators, transmission	Power tools, splinters etc. from same	Hoists, cranes, lifting devices, transporters	Vehicles, vessels, aircraft, helicopters	Hans tools, splinters etc. from same	Hot or cold substances, solids, liquids, gases	Electricity	Explosion, fire, etc.	Toxic and/or corrosive substances, rays	Falls (persons, to lower levels)	Falls (persons, same level)	Falling objects not handled by the injured	Stepping on, blow from or collision with object not handled by the injured	Lifting, carrying by the injured	Other causes	TOTAL	%
Head	1		1		5 (2)	2			2	1 (2)	(1)	3 (2)	2 (1)	1 (2)	1	19 (9)	6,6 (4,1)
Eye					36 (28)	2			7	(1)					11 (34)	56 (67)	19,5 (31,4)
Chest			(1)			1				5 (5)	2 (1)	1	(1)	1	(1)	10 (9)	3,5 (4,1)
Back			1		1					12 (3)	2 (1)	1	1 (1)	9 (9)	1	28 (14)	9,8 (6,5)
Hand/finger	1	3 (1)	3 (4)		12 (21)	2 (2)	1	1		3 (1)	4	2	3 (6)	30 (5)		65 (40)	22,6 (18,7)
Arm/shoulder					1	1				4 (1)	6 (2)	1	3 (1)	3 (2)	1 (1)	20 (7)	7,0 (3,0)
Toe/ankle		(1)			1 (3)	(1)				4 (5)	10 (7)	2 (2)	5 (7)	1 (1)	1	24 (27)	8,4 (12,6)
Foot		(1)	1		1 (3)					9 (3)	14 (2)	3 (1)	11 (6)	7		46 (16)	16,0 (7,5)
Other					(4)	2	1 (1)		1	9 (10)	3 (2)	(1)	1 (3)	(2)		17 (24)	5,9 (11,2)
Deaths			1							1 (2)						2 (2)	0,7 (0,9)
TOTAL	2 (0)	3 (3)	7 (5)		57 (61)	10 (3)	2 (1)	1 (0)	10 (0)	48 (34)	41 (16)	13 (8)	26 (26)	52 (21)	15 (36)	287 (213)	
%	0,7 (0)	1,1 (1,3)	2,4 (2,3)		19,9 (28,6)	3,5 (1,3)	0,7 (0,5)	0,3 (0)	3,5 (0)	16,7 (15,9)	14,3 (7,5)	4,5 (3,7)	9,1 (12,2)	18,1 (9,8)	5,2 (16,9)		100 (100)

6. Other control.

6.1. MANAGEMENT OF RESOURCE UTILIZATION (CONSERVATION)

Report No. 2 of the "Committee for drawing up draft safety regulations ... on production facilities and equipment for pipelines and storage plant on the seabed, and Rules for exploitation of oil deposits" (The Vogt Committee), was submitted by the Department of Industry to the Petroleum Act Committee in order to determine how further work on the specifications must adapt to the new Petroleum Act.

As was mentioned in the previous Annual Report, management of the petroleum resources is based on the existing legislation, pending enactment of the Petroleum Bill. The Petroleum Directorate has however noted a major need for stricter directives as regards implementation of the current Acts and Rules. In this connection the Petroleum Directorate has formulated draft regulations ... on proper petroleum resource exploitation. This draft has been circulated to the licensees, industrial organizations, and the public authorities concerned, for comment by the beginning of January 1978. The Petroleum Directorate hopes to implement the regulations soon after comments are received from the parties concerned.

6.2. CONTROL OF HYDROCARBON QUANTITIES PRODUCED

The control of the oil and gas quantities produced is based on both shore metering and metering of the finished products sold at the shore terminals. The former measurements are undertaken for calculation of the royalty and the individual yields of the production areas. The finished-product measurements relate to sales for which the Petroleum Directorate has a control function in connection with determining Company income.

The controls cover all stages of exploitation of a production area, i.e. control of development ... of the measurement systems at the planning and construction stages, control of the testing of the systems prior to use, and control of maintenance and operation at the operational stage.

External consultants and laboratories were employed to a certain extent as additional aids in specific instances.

The technical measurement control was carried out at the operational stage in the Ekofisk phase II. Control was also undertaken in connection with the start of operation of the Ekofisk phase III systems.

.../...

The operational control and the routine tasks in connection with the start of operation, were effected by the offshore inspectors of the Petroleum Directorate. The offshore inspectors, as earlier, are personnel employed by an external specialist measurement firm. This firm works for the Petroleum Directorate on a contract basis. The Petroleum Directorate will arrange for its own personnel to undertake this work in 1978. The control of the operation of the sales measurement systems in Emden was undertaken insofar as the 1977 personnel situation permitted this.

The control of the development of the Frigg offshore measurement system, and the trials and operation of the measurement systems at the Frigg shore terminal, were very comprehensive, and were undertaken in conjunction with the British authorities. The follow-up work was complicated somewhat, because it was decided that the gas from the Piper area on the British continental shelf would be brought ashore via the same transport facility as the Frigg gas. This means that the Petroleum Directorate also has to recognize the Piper gas measurement points, since the Piper gas will be mixed with the Frigg gas.

The control of the development of the Statfjord and Murchison measurement systems was also undertaken in conjunction with the British authorities. This collaboration was based on the finding that the unitization agreement would run along the same lines as for Frigg.

The measurement systems in Teesside, just like that in Emden, were already installed and partly assembled when the Petroleum Directorate was put in charge of its control. The 1977 work on Teesside involved evaluation of the design of some of these systems and participation in their trials. So far as continuation of the work on the Teesside measurement systems in 1978 is concerned, the Petroleum Directorate believes that it will have to make large-scale use of external consultants. This is necessary from both the technical and the work capacity viewpoints.

Efforts in 1977 were based far more on operation factors than in the previous year. This was due to the commencement of gas supplies from Frigg and Ekofisk. The need for an increase in personnel became apparent because of the work on operational control. The authorities accepted the consequences of this, and seven new posts were created in the measurement sector for 1978. This increase in the personnel in turn resulted in the need for reorganization of the measurement function, so that

.../...

a special section has been set up for this work in 1978.

The Petroleum Directorate, in connection with the measurement system specifications, emphasized the need to follow up the work being carried out by the International Standards Organization, and it is now a member of the ISO subcommittees. The Directorate will also participate in an inquiry into oil metering technique arranged by the U.K. Institute of Petroleum. This inquiry is due to commence at the turn of the year 1978/79.

6.3. CLEARING OPERATIONS ON THE SEABED

In the autumn of 1976 the Petroleum Directorate carried out two seabed investigations on abandoned drilling sites of nine different operators.

On the basis of the first investigation Esso and Elf were asked to clear the sites studied. These companies were also asked to inspect all their other drilling sites and if necessary to clear them.

On the basis of the second investigation the companies Amoco, Conoco, Shell, Phillips, Statoil and Murphy were asked to inspect all their drilling sites and where applicable to clear these.

The companies asked to undertake further investigations and clearing operations, carried out varying proportions of this work in the course of 1977. In addition, Mobil on its own initiative investigated and cleared its drilling sites. It is expected that only Esso and Mobil will be found to have completed the work concerned. The other companies will continue the work in 1978.

All the companies elected to make the initial study of the sites with the aid of side-looking sonar. Data from this type of study yield an acoustic picture of the seabed. Interpretation of the sonar recordings gives an indication of whether any objects have been left on the seabed. In many cases it will be difficult to distinguish between rock and waste from the drilling operations, but the method is considered very useful in delimiting the area which might have to be studied by means of other equipment.

.../...

The companies then considered the advisability of further operations on the basis of the sonar recordings. In certain cases these recordings showed that the seabed was so clean that no further operations were required. In other cases it proved necessary to proceed with a visual inspection or direct clearing. The visual inspection was carried out by means of manned and unmanned underwater vessels, and the Petroleum Directorate required submission of a copy of the video tapes from such studies. The clearing was done by using divers, a trawl, or a submarine with manipulators. Divers had to be used whenever it was found that the entire wellhead or traces of this were still in place.

In the course of the inspection and clearing work by the oil companies, gas leaks from various wells were detected. At the request of the Petroleum Directorate, gas samples from these leaks were analysed, and reports were drawn up concerning their assumed causes, origins, etc. All the reports concluded that the gas comes from gas pockets in the bed and that they are probably due to formation of fine channels in the cement around the outer pipes. According to the marine biologists the leaks do not endanger sea life or constitute pollution. The Petroleum Directorate will request a fresh inspection on site in 1978, to see whether the situation has altered.

Divers' certificates are available for all the areas, to the effect that the seabed is clean. In several cases the divers reported that the wellhead had been blown up, whereas subsequent inspection showed it to be intact and without any trace of any attempt having been made to blow it up.

With only occasional exceptions however, it would appear that there has been a definite improvement from the first drillings to the present-day operations. The Petroleum Directorate has also intensified its control and requires a sonar investigation after completion of drilling, in addition to a fairly detailed examination by divers.

The reports received by the Directorate show that the companies and the crews of the drilling rigs are now more alert to the danger of negligence and take greater care as regards objects thrown or "lost" overboard.

Royalty and fees paid to Petroleum Directorate

9.1. ROYALTY

The total payment in 1977 was kr. 651,005,493.23 royalty on oil, broken down as follows:

Quarter	Amount
4th quarter of 1976	kr. 190,405,066.27
1st quarter of 1977	kr. 216,358,782.67
2nd quarter of 1977	kr. 128,324,157.01
3rd quarter of 1977	kr. 115,917,487.28
	kr. 651,005,493.23

In 1978 the Petroleum Directorate will collect royalty on both oil and gas. The oil royalty will be based on the oil production in the Ekofisk area, while the gas royalty will be based on the Ekofisk area and the Frigg area. The Norwegian share of the Frigg area is set at 60.82%.

The 1977 accounts were based on the norm prices. However it was not found possible to set a norm price for the 3rd quarter of 1977 and an adjustment will be made once the final norm price is known.

9.2. FEES FOR LICENSED AREAS

The Petroleum Directorate collected kr. 61,624,300.00 in such fees. The breakdown is as follows:

licences issued in 1965	kr.48,080,500.00
licences issued in 1969	kr.11,793,600.00
licences issued in 1971	kr. 353,700.00
licences issued in 1976	kr. 952,500.00
licences issued in 1977	kr. 444,000.00
Total	kr.61,624,300.00

.../...

9.3. FEES FOR RECONNAISSANCE LICENCES

The Petroleum Directorate issues reconnaissance licences according to the rules of Chapter 2 of the Royal Decree of 8 December 1972.

The reconnaissance licences are issued for a period of three calendar years, but before the licence can be issued advance payment of a fee of kr. 20,000.00 per calendar year is required. The Petroleum Directorate is responsible for collecting these fees.

In 1977 fees were paid for a total of 12 licences.

9.4. APPORTIONMENT OF CONTROL COSTS

The following sums were paid out on technical and safety controls.

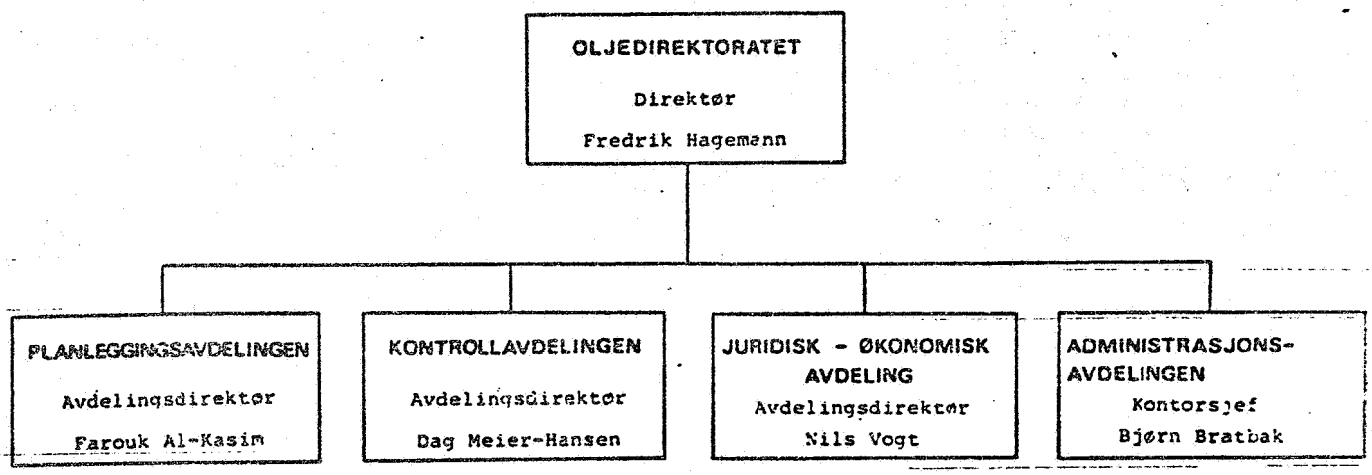
Breakdown of costs:

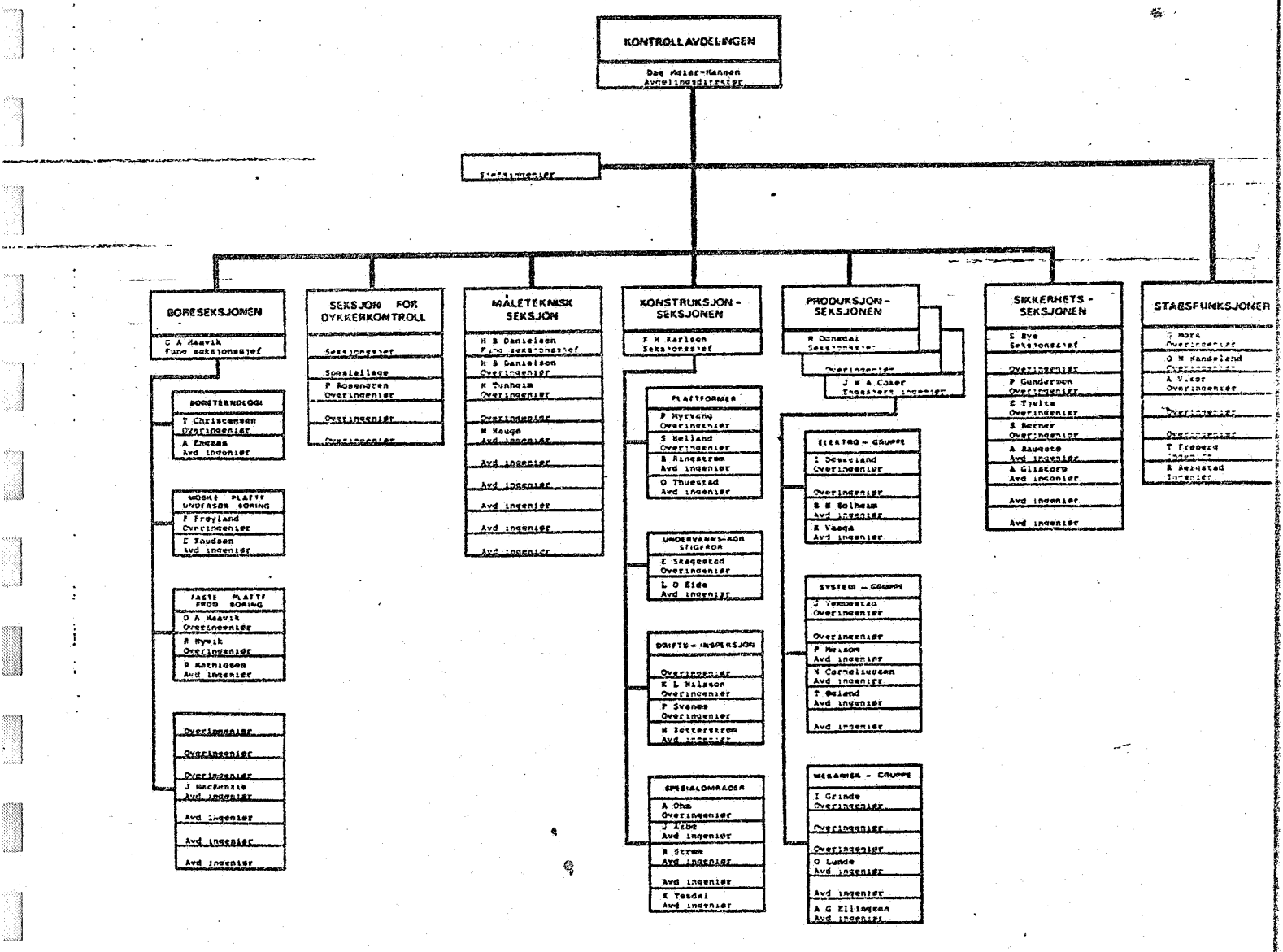
Norske Veritas	kr. 34,077,600
Mr. A. Aas-Jakobsen	kr. 1,625,500
The Otter Group	kr. 2,434,000
Lloyds	kr. 143,600
Geoteam A/S	kr. 933,000
Skandinavisk Kontroll A/S	kr. 352,300
Others	kr. 65,400
Petroleum Directorate internal control	kr. 934,600
Total	kr. 40,566,000

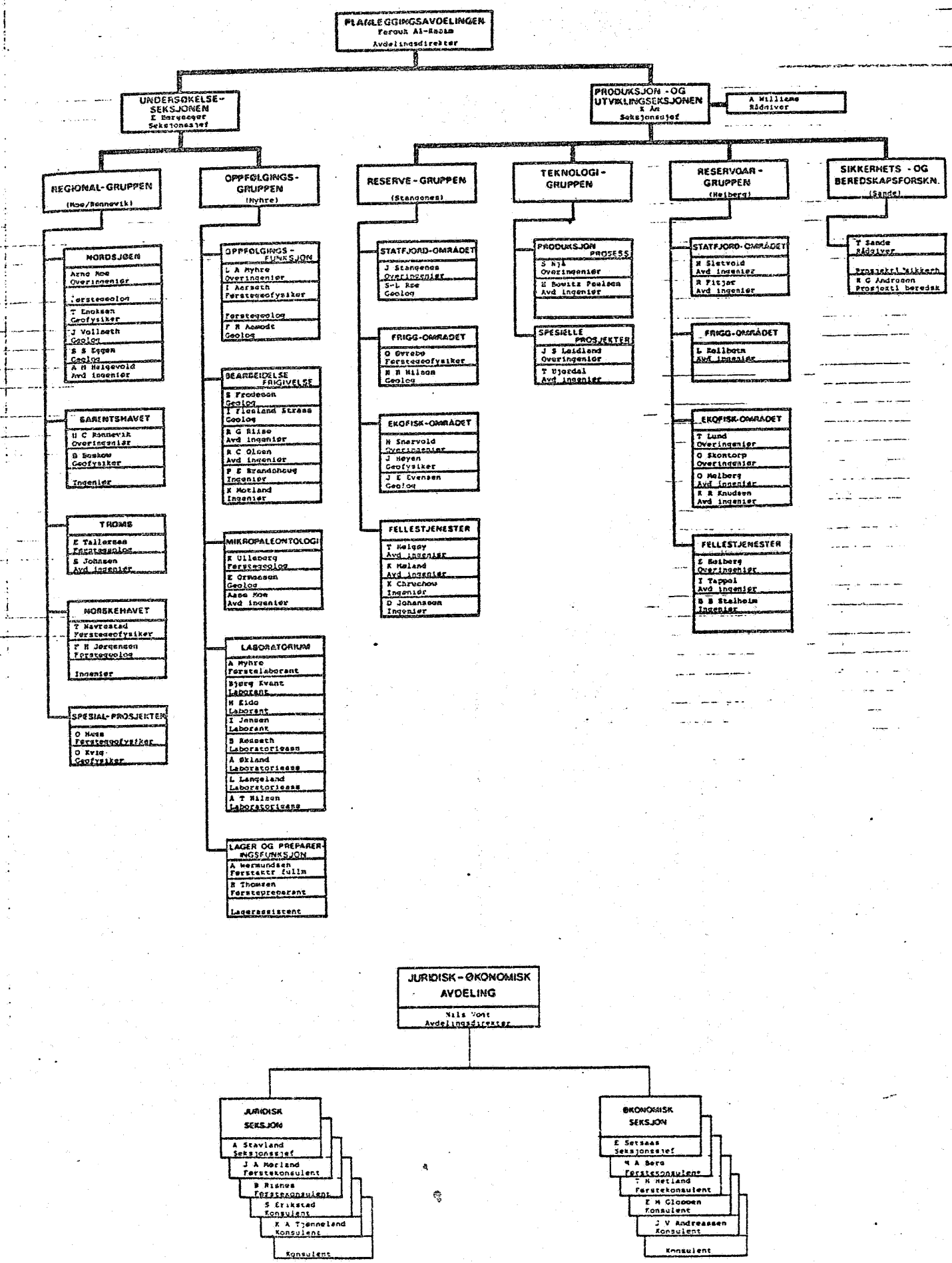
This sum will be covered 100% by the licensees.

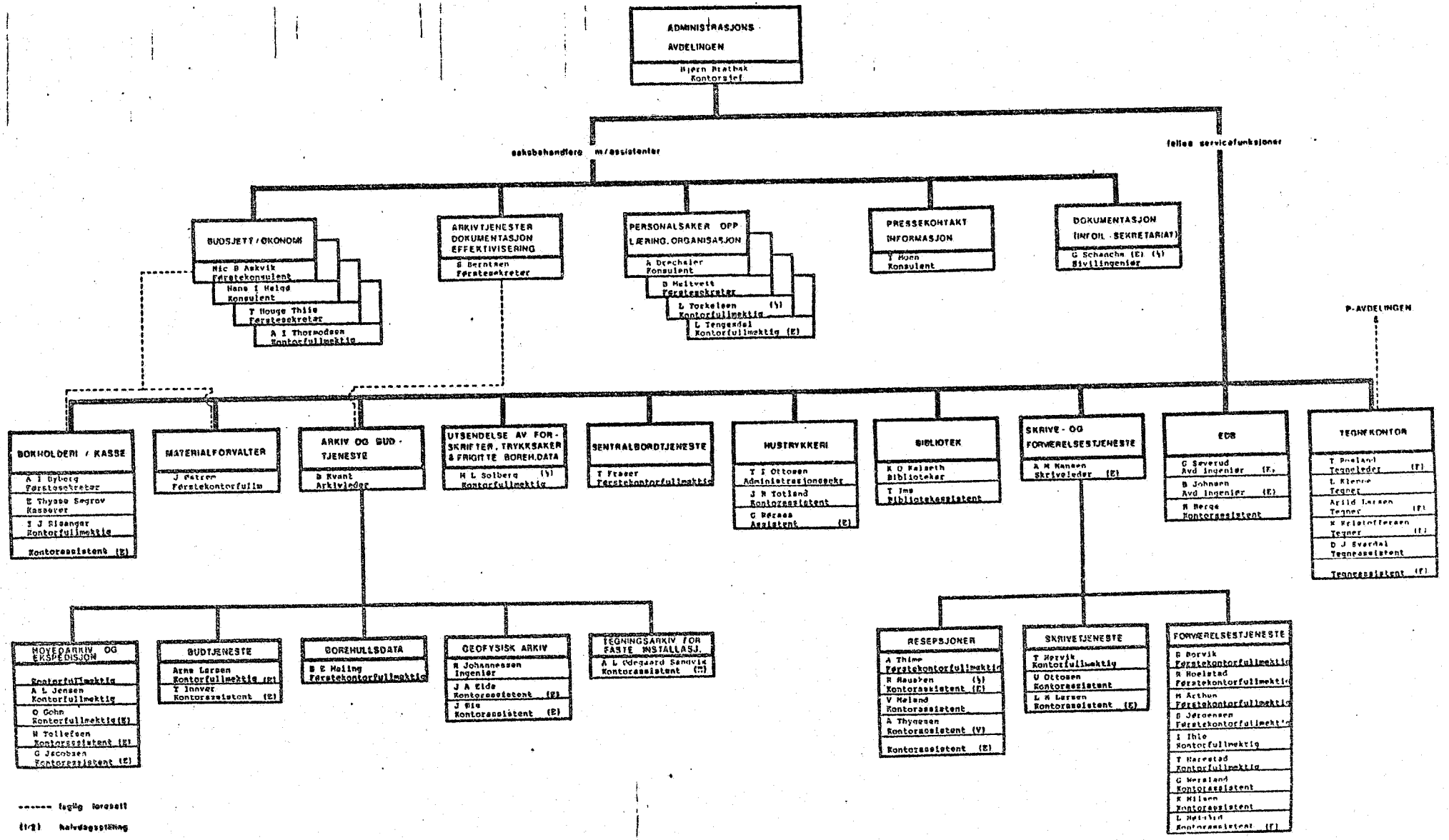
The total sum paid in by 31st December, 1977 was kr. 42,037,500

F. ORGANISASJONSTABLÅ AJOUR PR. 1.2. – 1978.






PLANLEGGINGSAVDELINGEN
Ferouk Al-Hasan
Avdelingsdirektør
UNDERSØKELSE-SEKSJONEN
E Berg-Hansen
Seksjonssjef
PRODUKSJON - OG UTVIKLINGSSEKSJONEN
K An
Seksjonssjef
A Williams
Rådgiver
REGIONAL-GRUPPEN
(Moe/Rønnevik)
OPPFØLGINGS-GRUPPEN
(Nyhre)
RESERVE-GRUPPEN
(Stangenes)
TEKNOLOGI-GRUPPEN
RESERVOAR-GRUPPEN
(Helberg)
SIKKERHETS - OG BEREDSKAPSFORSKN.
(Sande)
NORDSJØEN
Arne Moe
Overingeniør
Førstegeolog
T Knutsen
Geofysiker
J Vollseth
Geolog
S S Eggen
Geolog
A M Helgevold
Avd ingeniør
BARENTSHAVET
U C Rønnevik
Overingeniør
B Bruskov
Geofysiker
Ingeniør
TROMS
E Tallerasen
Førstegeolog
S Johnsen
Avd ingeniør
NORSKEHAVET
T Navestad
Førstegeofysiker
F H Jørgensen
Førstegeolog
Ingeniør
SPESIAL-PROSJEKTER
O Moen
Førstegeofysiker
O Kvig
Geofysiker
OPPFØLGINGS-FUNKSJON
L A Myhre
Overingeniør
I Aarseth
Førstegeofysiker
Førstegeolog
F H Asmodt
Geolog
BEARBEIDELSE FRIGIVELSE
S Frodesen
Geolog
T Fjeldstad Strøm
Geolog
R G Riise
Avd ingeniør
R C Olsen
Avd ingeniør
P E Brandshaug
Ingeniør
K Mørland
Ingeniør
MIKROPALEONTOLOGI
K Ullenberg
Førstegeolog
E Ormaasen
Geolog
Aase Moe
Avd ingeniør
LABORATORIUM
A Myhre
Førstelaborant
Bjørg Kvant
Laborant
H Eide
Laborant
I Jensen
Laborant
B Rossseth
Laboratørassa
A Økland
Laboratørassa
L Langeland
Laboratørassa
A T Nilsen
Laboratørassa
LAGER OG PREPARERINGSFUNKSJON
A Hermundsen
Førstekr fullm
B Thomsen
Førstepreparant
Lagerassistent
STATFJORD-OMRÅDET
J Stangenes
Overingeniør
S-L Roe
Geolog
FRIGG-OMRÅDET
O Øvreby
Førstegeofysiker
H R Nilsen
Geolog
EKOFISK-OMRÅDET
N Snarvold
Overingeniør
J Høyen
Geofysiker
J E Evensen
Geolog
FELLESTJENESTER
T Helgøy
Avd ingeniør
K Haland
Avd ingeniør
K Chruchou
Ingeniør
D Johansson
Ingeniør
PRODUKSJON PROSESS
S Nji
Overingeniør
K Bowitz Poulsen
Avd ingeniør
SPESIELLE PROSJEKTER
J S Leidland
Overingeniør
T Ujordal
Avd ingeniør
STATFJORD-OMRÅDET
N Sletvold
Avd ingeniør
R Fitjar
Avd ingeniør
FRIGG-OMRÅDET
L Hellbotn
Avd ingeniør
EKOFISK-OMRÅDET
T Lund
Overingeniør
O Skontorp
Overingeniør
O Helberg
Avd ingeniør
R R Knudsen
Avd ingeniør
FELLESTJENESTER
S Reiberg
Overingeniør
I Tappel
Avd ingeniør
B B Stalheim
Ingeniør
T Sande
Rådgiver
Prosjektl Sikkerh
H G Andreasen
Prosjektl beredsk
JURIDISK - ØKONOMISK AVDELING
Nils Vont
Avdelingsdirektør
JURIDISK SEKSJON
A Stavland
Seksjonssjef
J A Mørland
Førstekonsulent
B Risnes
Førstekonsulent
S Eriksstad
Konsulent
K A Tjønneland
Konsulent
Konsulent
ØKONOMISK SEKSJON
E Setsaas
Seksjonssjef
T A Berg
Førstekonsulent
T H Hetland
Førstekonsulent
E H Glosaaen
Konsulent
J V Andreassen
Konsulent
Konsulent


ADMINISTRASJONS AVDELINGEN
Bjørn Bratbak
Kontorsjef
saksbehandlere m/assistenter
felles servicefunksjoner
BUDSJETT / ØKONOMI
Nic B Askvik
Førstekonsulent
Hans I Helgø
Konsulent
T Houge Thiis
Førstesekretær
A I Thormodsen
Kontorfullmektig
ARKIVTJENESTER DOKUMENTASJON EFFEKTIVISERING
S Berntsen
Førstesekretær
PERSONALSAKER OPP LÆRING. ORGANISASJON
A Drechsler
Konsulent
D Meltvedt
Førstesekretær
L Torkelsen (½)
Kontorfullmektig
L Tengesdal
Kontorfullmektig (E)
PRESSEKONTAKT INFORMASJON
T Hønn
Konsulent
DOKUMENTASJON (INFOIL - SEKRETARIAT)
G Schaacha (E) (½)
Sivilingeniør
P-AVDELINGEN
BOKHOLDERI / KASSE
A I Dyberg
Førstesekretær
E Thyssø Sægrov
Kasserer
I J Risanger
Kontorfullmektig
Kontorassistent (E)
MATERIALFORVALTER
J Petrem
Førstekontorfullm
ARKIV OG GUD - TJENESTE
B Kvant
Arkivleder
UTSENDELSE AV FORSKRIFTER, TRYKKSAKER & FRIGITTE BOREH.DATA
M L Solberg (½)
Kontorfullmektig
SENTRALBORDTJENESTE
T Fraser
Førstekontorfullmektig
HUSTRYKKERI
T I Ottosen
Administrasjonssekr
J M Totland
Kontorassistent
G Reraas
Assistent (E)
BIBLIOTEK
K O Kalseth
Bibliotekar
T Ims
Bibliotekassistent
SKRIVE - OG FORVERELSESTJENESTE
A M Hansen
Skriveleder (E)
EDB
G Severud
Avd Ingeniør (F)
B Johnsen
Avd Ingeniør (E)
M Berge
Kontorassistent
TEGNEKONTOR
T Prøland
Tegneleder (F)
L Kleppe
Tegner
Arild Larsen
Tegner (F)
K Kristoffersen
Tegner (F)
D J Svardal
Tegneassistent
Tegneassistent (F)
MOVE/ARKIV OG EKSPEDISJON
Kontorfullmektig
A L Jensen
Kontorfullmektig
O Gohn
Kontorfullmektig (E)
N Tollefsen
Kontorassistent (E)
G Jacobsen
Kontorassistent (E)
BUDTJENESTE
Arne Larsen
Kontorfullmektig (E)
T Innver
Kontorassistent (E)
BOREHULLSDATA
B E Haling
Førstekontorfullmektig
GEOFYSISK ARKIV
R Johannessen
Ingeniør
J A Eide
Kontorassistent (E)
J Bie
Kontorassistent (E)
TEGNINGSARKIV FOR FASTE INSTALLASJ.
A L Ødegaard Sønqvist
Kontorassistent (½)
RESEPSJONER
A Thime
Førstekontorfullmektig
R Rausken (½)
Kontorassistent (E)
V Meland
Kontorassistent
A Thyagesen
Kontorassistent (V)
Kontorassistent (E)
SKRIVETJENESTE
T Horvik
Kontorfullmektig
U Ottosen
Kontorassistent
L M Larsen
Kontorassistent (E)
FORVERELSESTJENESTE
S Borvik
Førstekontorfullmektig
R Hoelstad
Førstekontorfullmektig
M Arthun
Førstekontorfullmektig
B Jørgensen
Førstekontorfullmektig
I Thie
Kontorfullmektig
T Hørestad
Kontorfullmektig
G Hegland
Kontorassistent
K Nilsen
Kontorassistent
L Hetland
Kontorassistent (F)
faglig forbindelse
(½) halvdagsstilling
(E) engasjementsstilling