Oil and Gas in Denmark

Exploration and Production

Annual Report 1988

MINISTRY OF ENERGY

Danish Energy Agency

The Danish Energy Agency is an institution under the Ministry of Energy. Other institutions are Risø Research Centre and the Mineral Resources Administration (Greenland). The Ministry further represents public interests in Dansk Olie og Naturgas A/S (D.O.N.G.).

The Agency was established by law in 1976. The Agency assists the Minister of Energy and other government authorities in energy matters. It is the responsibility of the Agency to follow and evaluate the Danish and international progress in the fields of energy production, supply, and research.

The Agency in its executive capacity administrates energy legislation for power and heating supply, alternative energy, and production of oil and natural gas.

The Agency works closely with local, regional and departemental authorities, with energy distribution companies, licence holders and consumers. The Danish Energy Agency also participates in international energy co-operation.

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Foreword

The 1988 Annual Report is a review of oil and gas exploration and production in Denmark, prepared by the Danish Energy Agency. The outline of this report is basically compatible to that of 1987, enabling the reader to follow current and planned developments in the light of previous years. A new section adds a 20 year production forecast to the five year production forecast.

The reserves assessment per January 1st 1989, as prepared by the Energy Agency, indicates an increase of oil reserves of more than 10 per cent. This increase is based on improved drilling and completion technology, and expectations of enhanced oil recovery, in particular water injection.

Exploration activities in 1988 were primarily focused on preparations for the Danish 3rd Licensing Round.

During 1988, the Minister of Energy approved development plans for hydrocarbon discoveries at Valdemar, Kraka, and Nils. Implementation of these field developments is expected in the first half of the 1990's.

In 1988 Denmark attained a rate of self-sufficiency for oil and gas exceeding 70 per cent. With the expectations of a continuous increase in production, Denmark is now among the important oil producing countries in Western Europe.

Copenhagen, May 1989

Erik Lindegaard

Director

Conversion Factors

1 m^3 Crude Oil ≃ 0.84 tons ≃ 35.9 GJ

1,000 Nm^3 Natural Gas ≃ 37,240 SCF ≃ 39.0 GJ

1 Nm^3 ≃ 1.055 Sm^3

1 Barrel = 0.159 m^3

1,000 Sm^3 Natural Gas ≃ 1 t.o.e. (ton oil equivalent)

Nm^3 (Normal cubic metre) at 0°C, 101.325 kPa

Sm^3 (Standard cubic metre) at 15°C, 101.325 kPa

SCF (Standard cubic feet), at 15.6°C, 101.56 kPa

Contents

Organization

From the 1st of January 1989, the Energy Agency assumed new responsibilities and a new internal structure. This is basically the result of a reorganization development project finalized in November 1988. The new organization implies certain changes with regard to the allocation of responsibilities between the Department of Energy and the Energy Agency; hence, in the future departmental work will predominantly comprise ministerial assistance and supervisory functions with regard to planning, guidance and development. All other functions, in particular those professionally related, will be assumed by the Energy Agency.

The new organization of the Energy Agency comprises a board of directors, an executive secretariat and 12 divisions. This Annual Report is primarily focused on activities within the fields of oil and gas exploration and production. The report has been prepared in cooperation between the five divisions handling the various assignments related to the Danish oil and gas energy resources (4th-8th Division).

The five divisions and their major areas of responsibility are described in the following.

The 4th Division assumes the responsibility for general economic matters, i.e. including economic calculation procedures, investment analysis, medium and long-term planning and analysis and other related administrative assignments in connection with exploration and production of oil and gas.

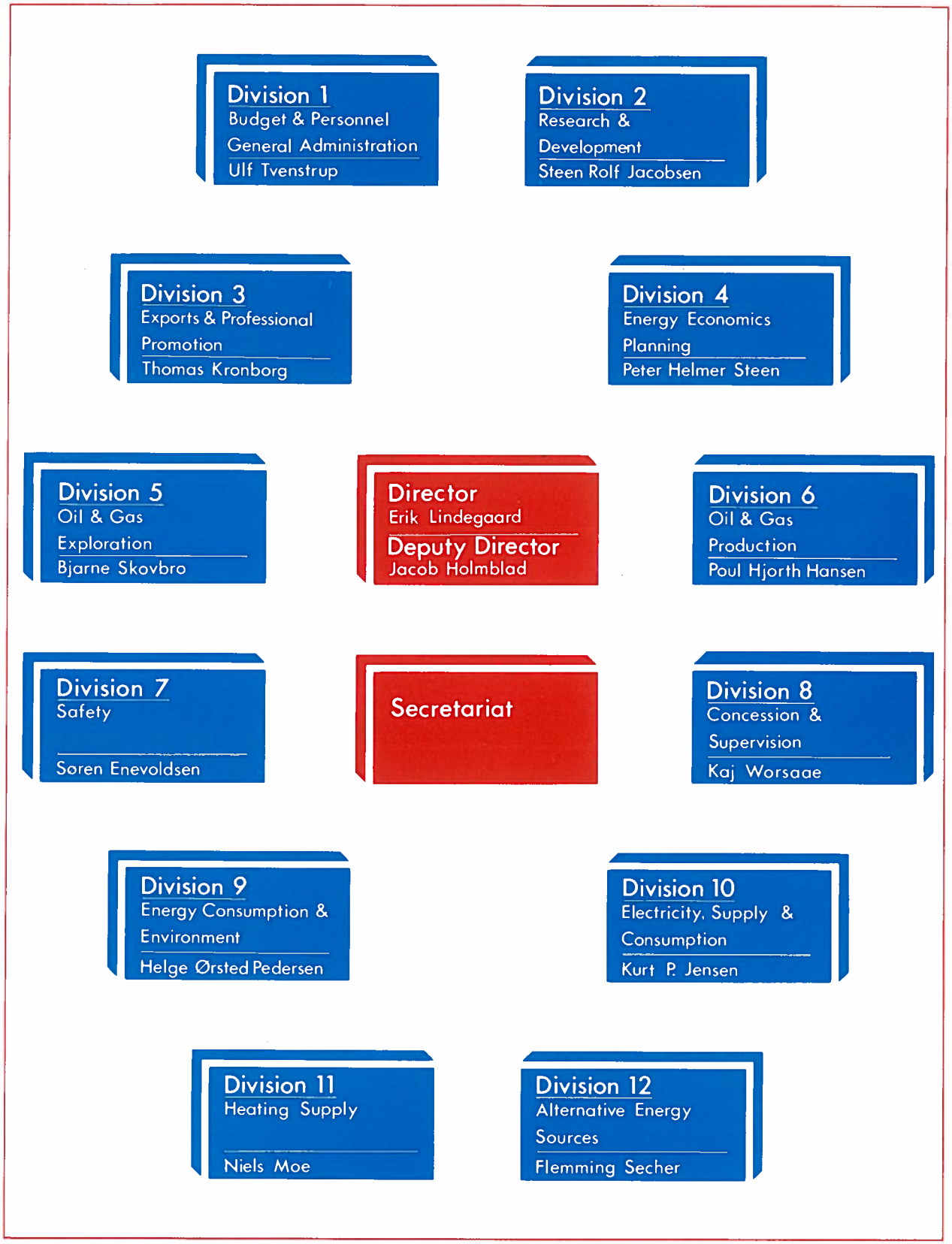
The 5th Division handles oil and gas exploration, comprising geophysical and geochemical surveying, prospect analysis and evaluation, approval of drilling programmes, and supervision and monitoring of drilling activities. The division further proposes work programmes and exploration strategies, participates in licensing negotiations and monitors exploratory work commitments.

The 6th Division assumes responsibility with regard to oil and gas production. The main work comprises reservoir engineering and geological evaluations in conjunction with declarations on commercial viability and with development plans. Assessments of oil and gas reserves, supervision and monitoring of the oil and gas production, and preparation of oil and gas production forecasts.

The 7th Division handles supervision with regard to safety and working environment on permanent and mobile offshore installations, approves manpower and organization plans; the division conducts supervision and approval of marine installations, including operation and maintenance of steel structures; approval of implementation and operation of new processing facilities.

The 8th Division handles the overall legal supervision and administration of concession matters, regulative work and preparation of guidelines, administration of licence commitments and matters pertaining to the use of the oil pipeline; the division deals with the settlement of royalties and fees, acts as a secretariat to the Coordination, Action and Emergency Committees.

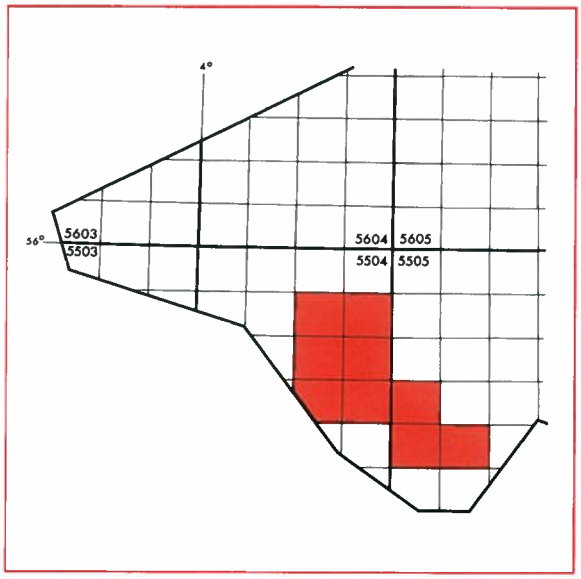
Fig. 1.1 Organization of the Danish Energy Agency



Drilling of three exploratory wells was conducted during 1988. This represents the lowest exploration activity in Denmark since 1979, (Fig. 2.5), primarily due to the fact that the work commitments under the 1st Danish Licensing Round are basically fulfilled. In addition the low oil prices during 1988 caused considerable company budget reductions and postponement of planned expense activities. During 1988 drilling efforts did not result in new discoveries.

The Danish Underground Consortium (DUC) is continuously engaged in exploration activities in the DUC Contiguous Area (Fig. 2.1). A revised work programme for the period 1988 to 1993 was approved by the Minister of Energy in 1988. The major part of the work comprises geological and geophysical in-depth studies. Decisions regarding implementation of further exploratory drilling in the Contiguous Area are depending on the results of these studies.

Fig. 2.1 DUC Contiguous Area



The 3rd Licensing Round was announced by the Minister of Energy at the turn of 1988/1989. The expiry date for submittal of licence applications was 31st March 1989.

At the end of 1988 nine licence groups were engaged in exploration in Denmark. The activity map enclosed at the back of this report shows the location of the various licence areas, summarises the composition of the licence groups and interests taken by the participating companies (Appendix A).

In September 1988 the Energy Agency issued a revised version of *Drilling Guidelines – Exploration,* first issued in February 1985.

Exploratory Surveys

In 1988 a total of 8,600 km of seismic data was conducted for exploration and production of oil and gas in Denmark. Appendix C shows the companies who conducted the surveys.

In 1987 the Energy Agency prolonged the five year confidentiality period for some proprietary seismic data till the end of 1988. Applications for further prolongation were forwarded by the seismic contractors with special reference to the *3rd Licensing Round,* but these did not meet the concurrence of the Agency.

The Energy Agency will maintain a five year period of confidentiality for future proprietary seismic data.

Representatives for the fishing industry have been present as observers on the seismic vessels during the acquisition of marine seismic data in Danish waters. This procedure is satisfactory, only few claims have been forwarded from individual fishermen. The claims are settled directly by the fishermen concerned and the seismic companies.

Non-exclusive Seismic Surveys

A total of 1,900 km of non-exclusive seismic data was collected in 1988 (Fig. 2.2). During August and September 1988, 1,762 km of marine seismic data were conducted offshore Bornholm by the British company Jebco.

Exclusive Seismic Surveys

In 1988 a total of 6,600 km of marine seismic data was collected on an exclusive basis. Approximately 6,400 km was conducted by Mærsk Oil and Gas A/S on behalf of DUC, comprising 3D surveys at the Dan and Gorm fields and a 2D survey in the Elly prospect area (Blocks 5504/05 and 06). The remaining seismic surveys were conducted by the Amoco Group offshore Bornholm and by the Norsk Hydro Group in the Central Graben area.

Miscellaneous Exploratory Surveys

The Amoco group conducted an airborne hydrocarbon sniffer survey in the Bornholm area, comprising 3,791 km of airtrace. This survey is the first of its kind conducted in Denmark.

Reprocessing of Seismic Data

The Energy Agency participates in seismic data reprocessing projects with the purpose of updating the Danish seismic data base.

During 1988 the Energy Agency marketed a reprocessed land seismic data package comprising 2,200 km of land data from Northern Jutland. Continuing this project the Agency prepared synthetic seismogrammes for 13 wells and carried out the seismic interpretation which was deciphered in a second report.

Fig. 2.3 Annual Seismic Survey Activities 1979-1988

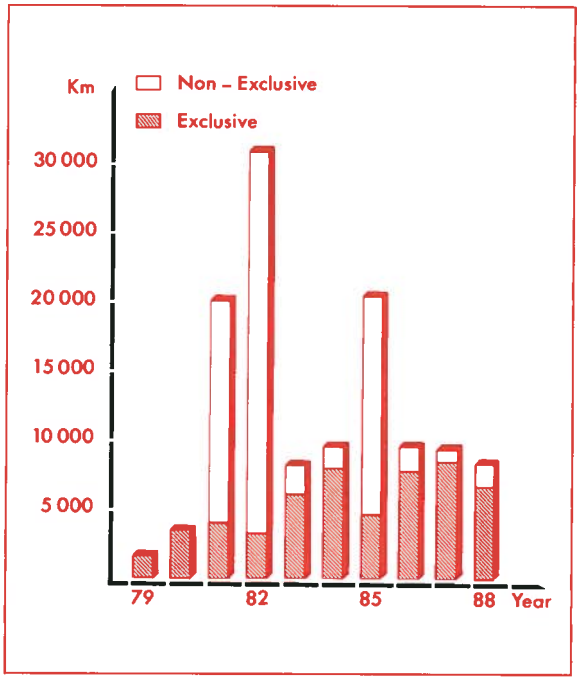
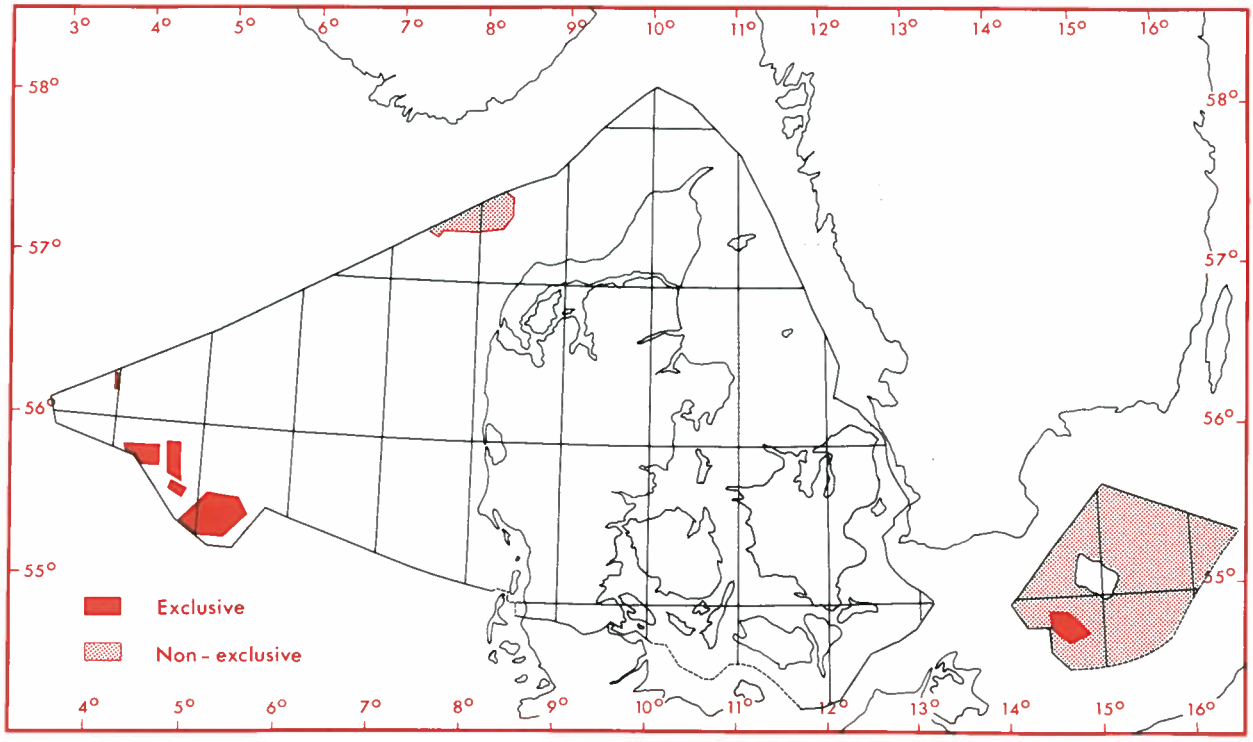
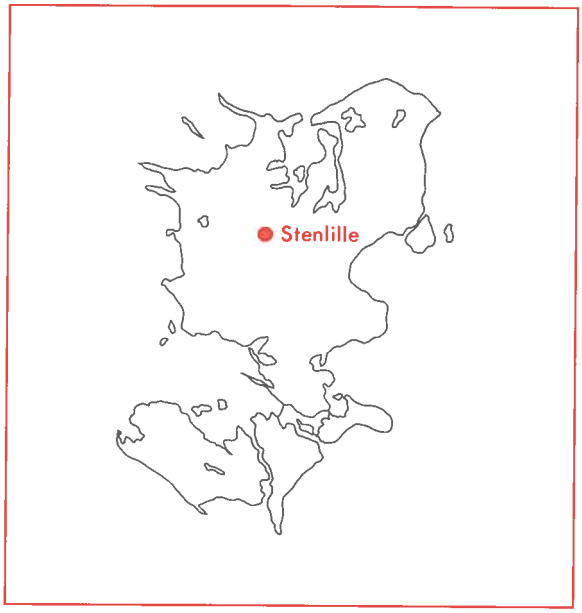


Fig. 2.2 Seismic Coverage, 1988



Further the Agency cooperated with DOPAS and Danpec A/S in a project comprising 3,500 km of reprocessed seismic data previously collected in South Denmark. A supplementary seismic interpretation is marketed by DOPAS and Danpec A/S.

Fig. 2.4 Gas Storage project, Stenlille



The Gas Storage Project

At Stenlille on Zealand (Fig. 2.4) a gas storage project was continued during 1988. The purpose of the project comprises evaluation of the feasibility for natural gas storage in water-bearing sands located at approximately 1,500 m depth. Three wells were drilled in 1988, following the two wells in 1987. The project is coordinated by DANGAS, with DANOP as drilling operator.

After evaluation of the investigations a contingent decision for implementation of the project is to be taken in 1989. Utilization of the Stenlille gas storage facilities could then be initiated in 1991-1992.

Drilling Activities

A total of 19 deep wells were spudded in Denmark during 1988: Three oil and gas exploratory wells were drilled, three wells were drilled in order to assess the feasibility of natural gas storage at Stenlille, and 13 production wells were drilled in the Danish part of the North Sea. Among those nine wells were completed in connection with water injection projects at the Gorm and Skjold fields, two conventional oil production wells (at Skjold and Tyra), and eventually, two production wells with horizontal completion (at Dan and Tyra).

In the Central Graben area four wells were spudded in 1987 and terminated in 1988, comprising the exploratory well Jeppe-1 (Norsk Hydro Group), the appraisal well Elly-2 (DUC) and two production wells, Skjold-5 and Dan MFB-15 (both by DUC).

The following drilling equipment was used: The jackups Neddrill Trigon, Dyvi Sigma, Mærsk Guardian, Glomar Moray Firth I, Glomar Baltic I, Mærsk Endeavour; land drilling was performed by the rigs Kenting 34 and 36.

Fig. 2.7 highlights the drilling activities in terms of number of active wells versus months.

Danish engagement in drilling activities is strongly dependent on the use of Danish drilling rigs and supply and stand-by vessels. In 1988, only one Danish jackup rig was used for exploratory drilling, i.e. the Mærsk Endeavour for well Gulnare-1

Fig. 2.5 Exploration and Appraisal Wells 1979-1988

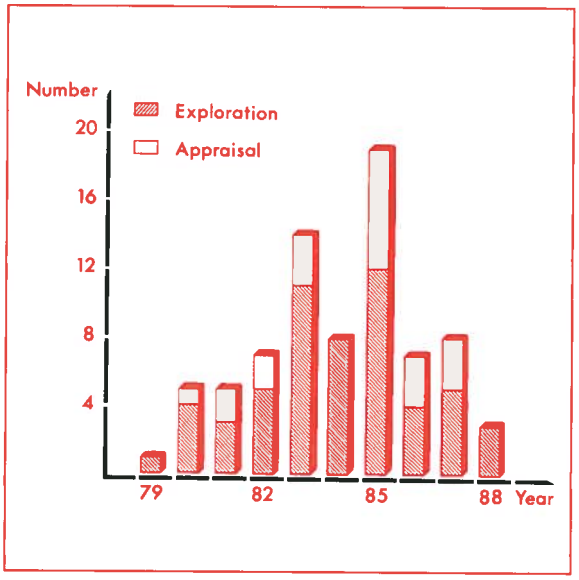
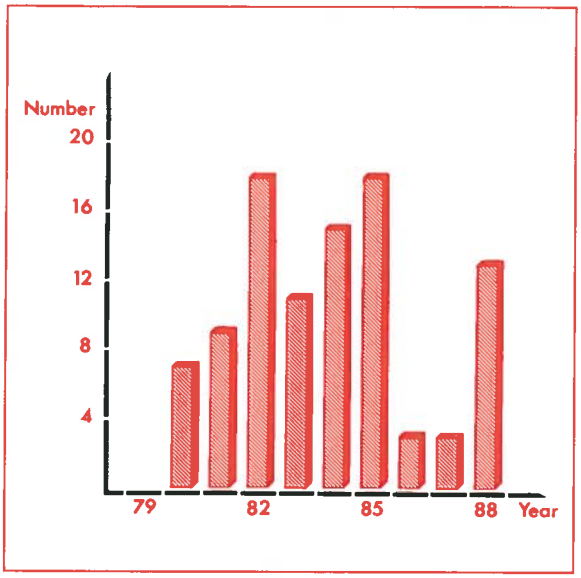


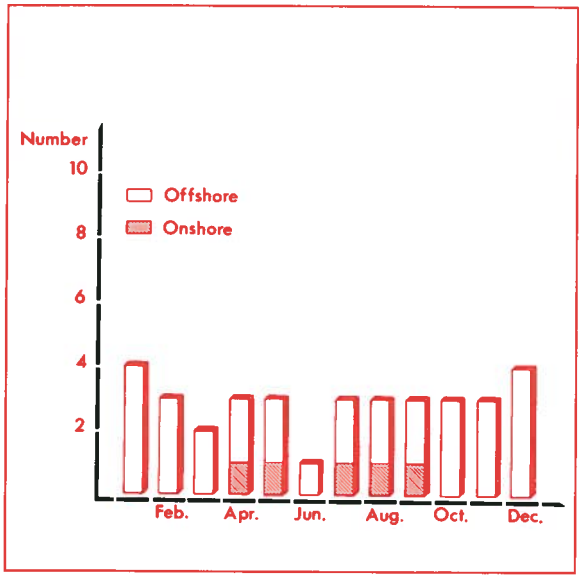
Fig. 2.6 Production Wells 1979-1988



on behalf of the Statoil Group. The remainder of the work was performed using non-Danish equipment; this also applies for the required supply and stand-by vessels.

Appendix B is a summary of exploratory and appraisal wells, also including deep wells drilled for purposes other than oil and gas activities in the period 1978-1988. Information about wells drilled prior to 1978 is summarised in the Danish Energy Agency's Annual Report of 1987.

Fig. 2.7 Wells in 1988

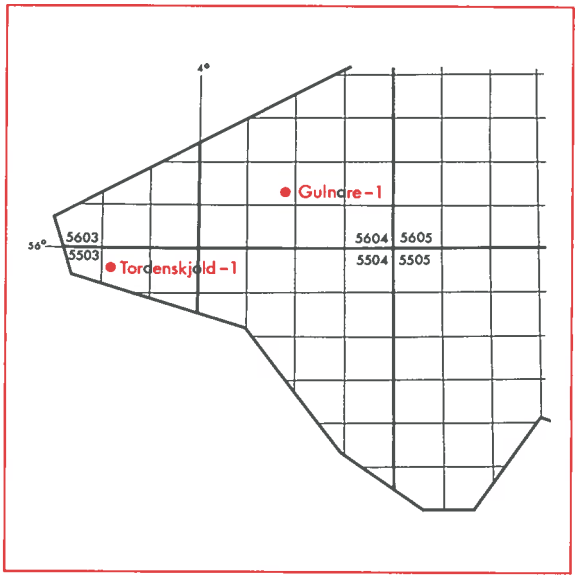


Exploratory Wells

The Statoil Group conducted the drilling of two exploratory wells in 1988, i.e. well Borg-1 located in Southern Jutland and well Gulnare-1 in the North Sea. Well Tordenskjold-1 was spudded by DANOP, also in the North Sea on behalf of the Norsk Hydro Group. Norsk Hydro terminated well Jeppe-1 in the North Sea, Jeppe-1 was spudded in December 1987.

Information of each individual well is given in the following.

Fig. 2.8 Exploratory Wells 1988 Located in the Central Graben



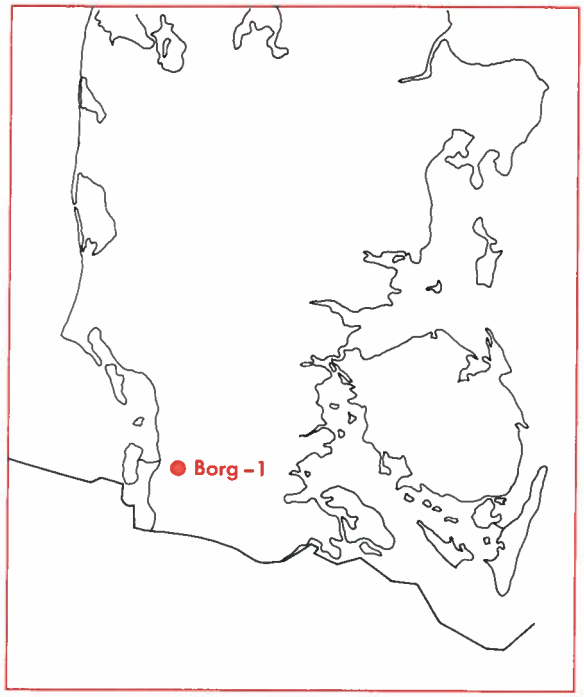
Well Borg-1 5508/32-2

Well Borg-1 was drilled by DANOP on behalf of the Statoil Group according to the requirements of the 2nd Danish Licensing Round. The drilling was performed during April and May 1988. Total depth was reached at 3,074 m in metamorphic strata. Faint shows of hydrocarbons were recorded in Zechstein carbonates. No flow test was made.

Well Gulnare-1 5604/26-1

Well Gulnare-1 was drilled by Statoil between June and September 1988 under commitment of the 2nd Licensing Round. The well reached total depth at 4,735 m in the Jurassic; shows of hydrocarbons were recorded in the well, but did not justify testing.

Fig. 2.9 Exploration Well 1988 Onshore



Well Tordenskjold-1 5503/03-2

Well Tordenskjold-1 was drilled by DANOP on behalf of the Norsk Hydro Group between December 1988 and February 1989. The drilling was performed according to the 2nd Licensing Round. Total depth was reached at 3,703 m in the Rotliegendes. Presence of hydrocarbons recorded did not justify flow testing.

Well Jeppe-1 5603/28-3

Jeppe-1 reached total depth in the Permian at 5,050 m, hydrocarbon shows recorded in Jurassic sandstone did not justify flow testing. Further information on well Jeppe-1 is summarized in the 1987 Annual Report.

Appraisal Activities

Mærsk Olie og Gas A/S drilled and completed well Elly-2 on behalf of DUC during the period November 1987 to May 1988. Subsequently, the Elly prospect was declared commercial.

Further appraisal work comprised revised mapping of the Gert and Elly prospects. The Gert prospect is further discussed under *Production*.

Prospects under Appraisal in 1988

Elna Blocks 5604/19 and 23

The Elna prospect extends into the Norwegian Sector. Hydrocarbon presence was encountered in well Elna-1, drilled by Chevron on behalf of DUC in 1985. After the expiry of the two year appraisal period DUC relinquished the Elna area in March 1988.

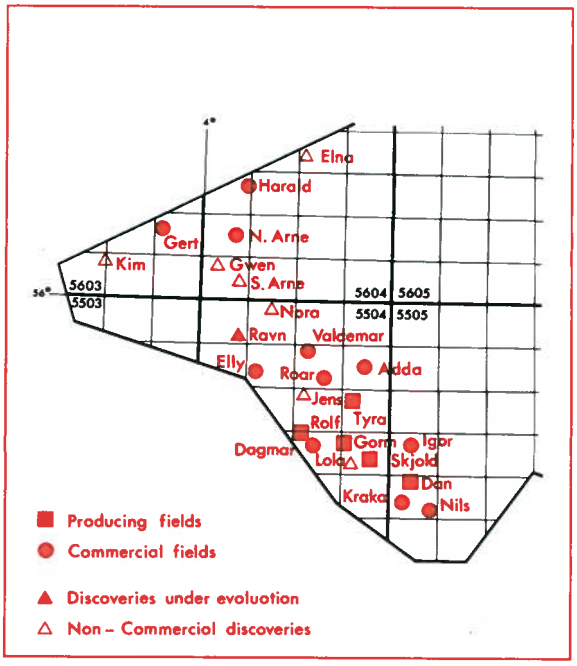
Kim Blocks 5603/26, 27, 30 and 31

Well Kim-1 was drilled by Chevron on behalf of DUC in 1985 and encountered presence of hydrocarbons. After the expiry of the two year appraisal period, DUC relinquished the prospect in September 1988.

Elly Blocks 5504/05 and 06

The well Elly-1, drilled by Chevron on behalf of DUC in 1984 showed presence of hydrocarbons at Elly. The appraisal well Elly-2 was drilled by Mærsk Oil and Gas A/S between November 1987 and May 1988. A 2D seismic survey was completed in the autumn 1988.

Fig. 2.10 Discoveries and Fields



Originally, the appraisal period for Elly was to expire by December 1987; but it was prolonged to the 6th of June, 1988, and on this date the Elly structure was declared commercial. In February 1989 DUC had the time-limit postponed for transmitting of a development plan till December 1991. Simultaneously, the dead-line for a revision of the field boundaries has been postponed accordingly.

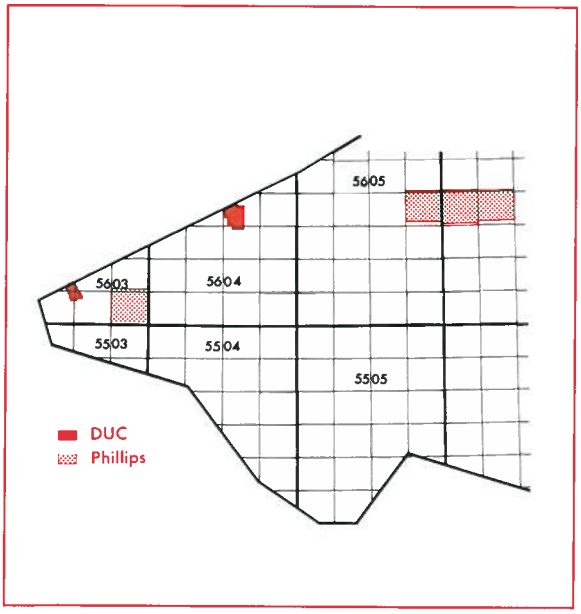
Ravn Blocks 5504/01, 02, 05 and 06

Two wells have been drilled by Amoco in this area, i.e. the exploratory well Ravn-1 in 1986 and the appraisal well Ravn-2 in 1987. Presence of oil in Jurassic sandstone at Ravn-1 was confirmed by flow-testing. Hydrocarbon presence was recorded in Ravn-2, but this well was not flow-tested. The Amoco Group is continuing work in the area for further exploration and evaluation of the discovery.

Boundary Delineation

An agreement with regard to delineation of the continental shelf between Denmark and DDR was signed in September 1988. The delineation comprises two areas, i.e. one westerly located in the waters of the Baltic Sea south and southeast of the Danish islands Lolland, Falster and Møn, and an easterly area in the Baltic Sea southwest of the Danish island Bornholm (Appendix F).

Fig. 2.11 Relinquished Acreage Offshore 1988



To the west, the boundary coincides with the median line, whereas the eastern boundary was modified to satisfy the claims from both countries with regard to a disputed area of the Adler Ground, located approximately half-way along the boundary line. This modification resulted in a diversion from the median line in the Adler Ground area.

The agreement is to be presented to the Danish Parliament for ratification.

Relinquished Acreage

In accordance with the Agreement of 1981 between the Minister of Energy and A.P. Møller, DUC relinquished the Kim and Elna prospects in 1988 (Fig. 2.11).

The Phillips Group completed the relinquishment of acreage awarded under the 1st Licensing Round in 1984, comprising Blocks 5603/32 (Central Graben), 5605/20, 5606/17 and 18 (North Sea), and Blocks 5512/02 and 5612/30 (Zealand).

The Britoil Group relinquished Block 5710/22 located in North Jutland (Fig. 2.12).

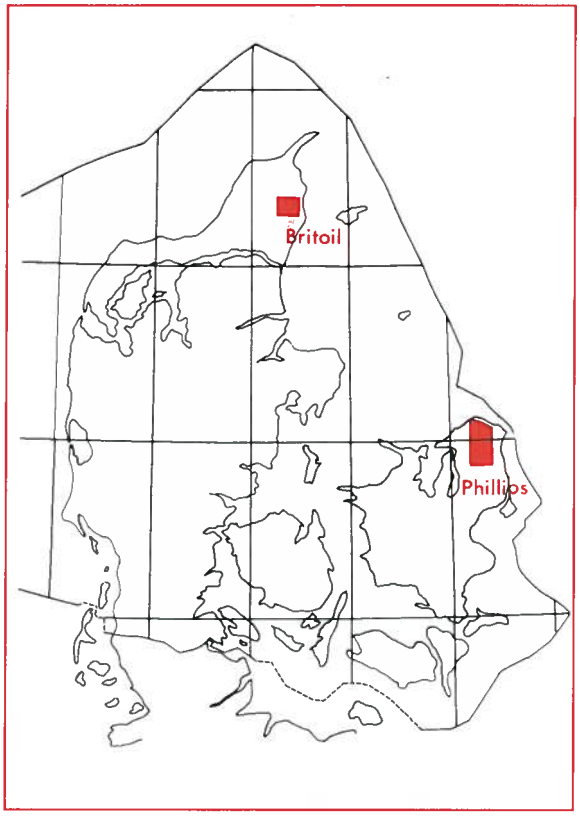
In connection with the final delineation of the Harald Field located in Blocks 5604/21 and 22, a minor adjustment has been made of the western delineation of the field. As a result an insignificant acreage was relinquished by DUC in Block 5604/21; this is not shown in fig. 2.11.

Released Well Data

Generally, data and information retrieved under the Subsoil Act are protected by a five year confidentiality clause. However, well data retrieved within relinquished acreage under the 1st and 2nd Round awards are released two years after the well termination date.

Data and information of the following exploration and appraisal wells were released in 1988:

Fig. 2.12 Relinquished Acreage Onshore 1988



Offshore:

Diamant-1	5603/32-2	Phillips
Edna-1	5504/10-1	DUC
Elin-1	5504/2-1	DUC
Hans-1	5612/21-1	DUC
John-1	5504/20-1	DUC
Karl-1	5604/21-2	DUC
Midt Rosa-2	5504/14-1	DUC
Mona-1	5604/21-1	DUC
Nord Arne T-3	5604/25-3	DUC
Olaf-1	5503/3-1	DUC
Sten-1	5603/27-1	DUC
Sydøst Igor-1	5505/14-1	DUC
Øst Rosa-1	5504/15-3	DUC

Onshore:

Sæby-1	5710/22-1	Britoil
Thisted-3	5608/3-2	D.O.N.G.
Tønder-4	5404/4-5	D.O.N.G.
Tønder-5	5408/4-4	D.O.N.G.

Distribution of these data is handled by the Danish Geological Survey.

Oil production mainly takes place at four fields, the Dan, Gorm, Skjold and Rolf fields. Furthermore liquid hydrocarbons are produced at the Tyra gas field, comprising condensate from the gas production and crude oil from a thin oil rim underlying the gas cap.

All the producing fields are located in the DUC Contiguous Area in the southern Central Graben area.

Oil and Gas Production, 1988

The total Danish oil and condensate production amounted to 5.6 million m^3 (4.7 million t.o.e.) in 1988, an increase of 3 per cent compared to 1987.

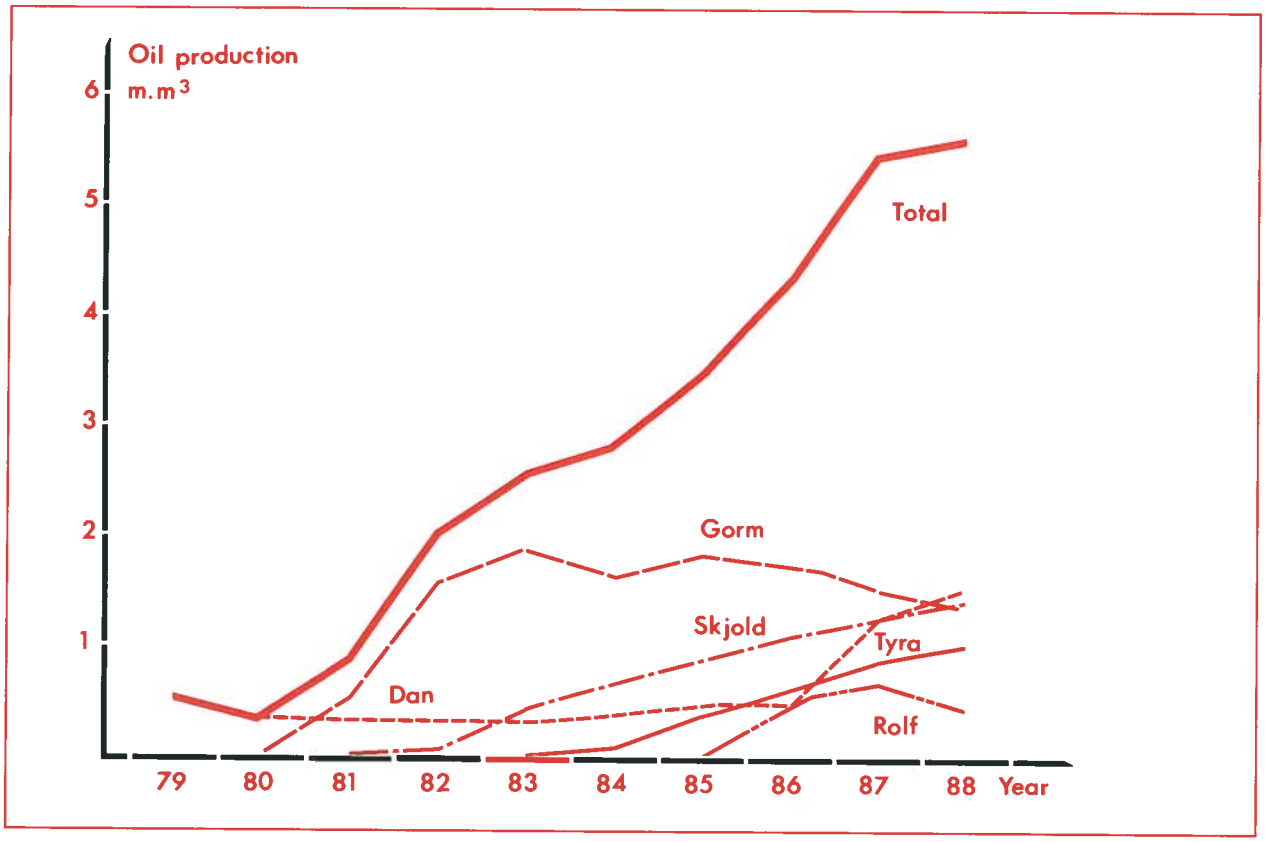
Gas production totalled 5.1 billion normal cubic metres (Nm^3), an increase of 24 per cent compared to 1987. The major part of the gas production takes place at the Tyra field, while the remainder is derived from the oil fields as associated gas. Approximately 45 per cent was sent ashore. 48 per cent was reinjected at Gorm and Tyra. The remaining 7 per cent comprised gas shrinkage, of which 2.5 per cent was flared.

In 1988 the total hydrocarbon production corresponds to approximately 10.1 million t.o.e., of which 7.1 million t.o.e. was transported ashore via the existing gas and oil pipelines; this represents an increase of 1.5 per cent compared to 1987.

Total consumption of oil and gas amounted to 10.1 million t.o.e.; this means that domestic production in 1988 covered 71 per cent of the energy consumption, compared to a rate of self-sufficiency of 64.5 per cent in 1987.

The annual oil and gas production from 1972 to 1988 is shown in Appendix D together with a survey of the monthly production for 1988.

Fig. 3.1 Annual Oil Production 1979-1988



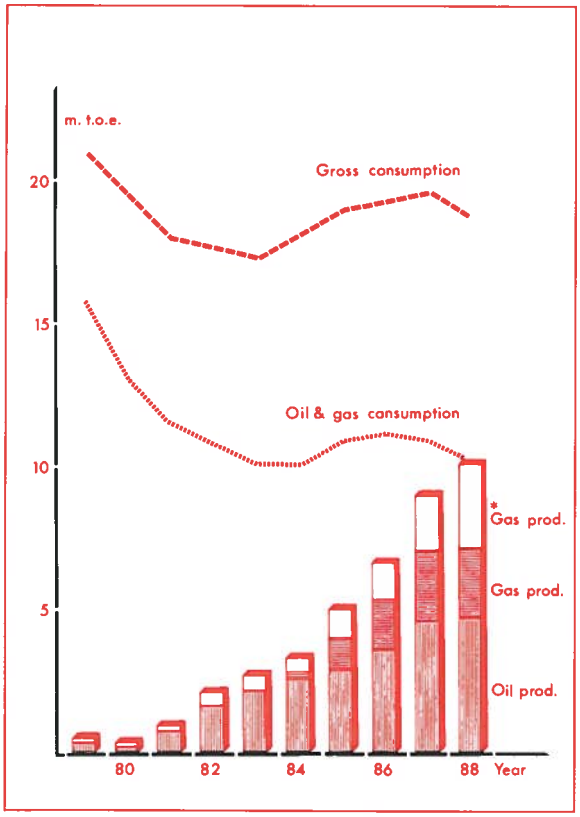
Gas Flaring

Evaluation and adjustments of the guidelines for gas flaring are currently going on in cooperation with the concessionaires.

The permitted rate of gas flaring was reduced to 350,000 Nm^3 per day in March 1988, based on operating experience from the Dan F processing plant and a tail gas recovery project at Tyra. In line with this, a new set of guidelines for gas flaring was issued in December 1988. Here it was laid down as a principle that during abnormal operating situations, gas flaring should be kept at a minimum by shutting down oil wells with excessive GOR (gas/oil ratio).

Gas flaring exceeding the permitted rate requires approval by the Energy Agency.

Fig. 3.2 Consumption and Production of Oil and Natural Gas 1979-1988



*) Gas shrinkage and injection gas

Peak gas production during the winter months is approx. 16 million Nm^3 per day, including sales gas, injection gas and gas shrinkage. The ratio of gas flaring to production shows a considerable decline over the last few years.

The total gas flaring in 1988 amounted to 128 million Nm^3, i.e. 5 million Nm^3 below the permitted 133 million Nm^3.

Prospect and Field Designations

The DUC concessionaries normally change the name of a prospect in conjunction with decision on development. Prospect to field name changes until the end of 1988 are shown below. Dagmar and Valdemar were added to the list in 1988.

Prospect Name	Field Name
Abby	Dan
Vern	Gorm
Cora	Tyra
Ruth	Skjold
Mid Rosa	Rolf
Bent	Roar
Anne	Kraka
Lulu/West Lulu	Harald
East Rosa	Dagmar
Boje/North Jens/Bo	Valdemar

Producing Fields

Relevant data on the producing fields are summarised in Appendix E.

The Dan Field

Dan is an oil field with a free gas cap; production was initiated in 1972.

Continuous development has been implemented at Dan; by the end of 1988, the facilities comprised three six-slot wellhead platforms (A, D and E) and two 12-slot wellhead platforms (FA and FB). FB has been expanded to accommodate three additional slots; production from the field is separated and processed on the Dan FC processing platform and brought ashore via Gorm (oil) and Tyra (gas).

Initially, a horizontal well completion was conducted at Dan in 1987. The experience gained from this project provided a basis for further devel-

opment, approved by the Minister of Energy in July 1988. The approved development plan implies a continued phased field development by drilling and completion of horizontal wells. The first step of the approved plan is to establish drainage of the formation with a 40 acres well spacing.

This implies drilling of five additional horizontal wells. Two of these were completed and put into operation during 1988, while the remainder are planned for 1989.

Preliminary production experience from the two horizontal wells drilled in 1988 is encouraging; the production rates from the horizontal completions exceed the production from conventionally completed production wells by a factor 2-4. The completions extend horizontally approx. 775 m and comprise 7 intervals with induced hydraulic acid fracs for drainage of the 100 metres thick pay zone.

A water injection pilot project was implemented in 1988 at Dan. The project comprises installation of provisional water treatment and pumping facilities and conversion of a producer to an injector. The purpose of the project is to establish the feasibility of enhanced oil recovery through implementation of water injection.

The 1988 production from Dan corresponds to 1.5 million m^3 oil and 600 million Nm^3 gas, of which 530 million Nm^3 was exported as sales gas. The remainder was utilized as fuel gas or flared.

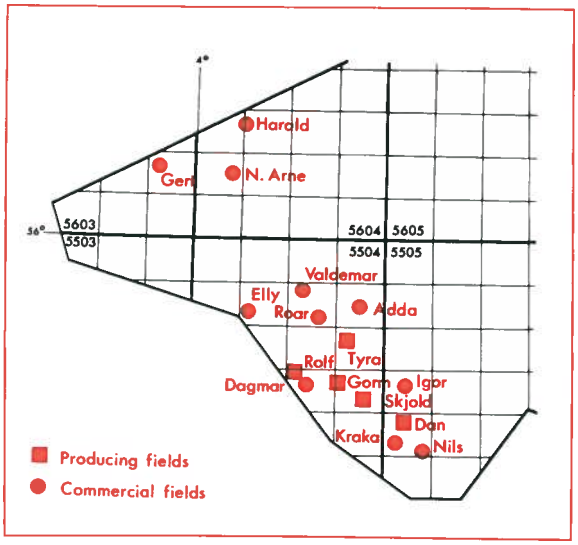
The Gorm Field

Gorm is located 27 km northwest of Dan; oil production was initiated in 1981. By the end of 1988, 18 oil wells were in production; gas injection takes place in the western fault block from two crestally located gas injection wells.

A water injection project was initiated in 1988. The project comprises drilling of three injectors and three additional producers, and is expected to be implemented during the second quarter of 1989. Conditional upon the experience from the water injection project, implementation of full water injection in the field will be considered.

Application for installation of an additional platform at Gorm was submitted in December 1988. Initially, the platform Gorm F is to accommodate processing facilities for sour production from the Dagmar field and permanent water treatment and injection facilities required for water injection at Gorm and Skjold.

Fig. 3.3 Danish Oil and Gas Fields



In November 1988 a new two-phase pipeline was commissioned for transport of hydrocarbons from Skjold to Gorm. The old pipeline will temporarily be utilized for transportation of treated sea water for injection at Gorm.

The oil production from Gorm amounted to 1.35 million m^3 in 1988 compared to 1.50 million m^3 in 1987. Approx. 88 per cent of the produced gas was reinjected for pressure maintenance. GOR for the two fault blocks is 240 and 1,261 Nm^3/m^3 respectively, the higher GOR basically being related to gas break-through in the western block.

The Skjold Field

Skjold is located 10 km southeast of Gorm; oil production was initiated in 1982 according to a test production scenario approved by the Minister of Energy.

Initially, Skjold was produced from a single oil well.

Based on the experience gained during the initial production period, the Minister of Energy in 1986 approved a phased development plan for Skjold, comprising a water injection pilot project implemented as the first step the same year. The next step comprises drilling of one additional producer and two additional injectors and enlargement of the transportation capacity with a new 12″ pipeline for the production from Skjold to Gorm. The objekt is to increase the Skjold production to 40,000 bopd.

These facilities were commissioned towards the end of 1988 except for one water injector, and oil production was increased to approx. 35,000 bopd. Full production is expected to be achieved when the third injector is put on stream.

Reservoir pressure and changes of the oil/water inter-phase are continuously being recorded in an observation well, located on the flank of the formation.

The 1988 oil production from Skjold amounted to 1.37 million m^3, an increase of 0.16 million m^3 compared to 1987. GOR corresponded to 81 Nm^3/m^3.

The Tyra Field

Gas production at Tyra is conducted from a large free gas cap overlying a thin black oil rim. The field is located 15 km northwest of Gorm; gas production was initiated in 1984, and a gas recycling project was implemented in 1987 to improve the condensate recovery.

During 1988 an appraisal well was drilled in the southwestern part of the formation, with the purpose of evaluating the oil rim. The outcome was encouraging and the well was subsequently completed as an oil producer.

Towards the end of 1988, another appraisal well was initiated on the eastern flank of the field. The purpose is to evaluate the flanks of the field and further to complete the well as a horizontal gas producer. It is the first time this technique is applied in gas exploitation in Denmark.

The total gas and hydrocarbon liquid production from the Tyra field during 1988 comprised 3.36 billion Nm^3 and 0.95 million m^3 respectively; 1.59 billion Nm^3 gas was reinjected.

The Rolf Field

Rolf is located 15 km west of Gorm. Oil production was commenced in 1986 from a single well. An observation well located on the flank of the field provides continuous information on reservoir pressure and water level conditions. The produced oil and gas is transported via a two-phase pipeline to Gorm for processing and export. The oil production is maintained by employing gas lift.

The 1988 oil production from Rolf corresponded to 0.40 million m^3, the GOR being 43 Nm^3/m^3, a decline from last year of approximately 35 per cent.

Planned Developments

So far 9 development plans have been submitted to the Minister of Energy. In 1988 three plans were approved by the Minister (Kraka, Valdemar, and Nils), two developments have been approved in princip (Igor and Roar), one development plan was revised and resubmitted to the Minister in 1988 (Dagmar), and approval of three development plans submitted in 1986 and 1987 is pending (Adda, North Arne, and Harald).

Development of Roar is closely connected to the Danish gas project approved in 1979, the timing depending on the requirements for gas delivery from other than the present gas producing fields, Tyra, Gorm, and Dan.

The submittal of a development plan for the Gert oil discovery has been postponed until the 30th of December 1990, in accordance with an approval by the Minister of Energy.

The DUC concessionaires declared the gas discovery Elly commercial on the 6th of June, 1988. The submittal of a development plan for Elly has been postponed until the 6th of December 1991, in accordance with an approval by the Minister of Energy.

The current status of hydrocarbon prospects are briefly mentioned below, except for Elly, where reference is made to the *Exploration* chapter.

The Kraka Field

Kraka is an oil accummulation with a small gas cap located 7 km southwest of Dan. The discovery was made in 1967. A framework for development of Dan with adjacent fields was approved in 1987 by the Minister of Energy. In accordance with this plan the Minister of Energy in July 1988 approved a development plan for Kraka.

Phased development will be applied; implementation of the initial phase comprising drilling of two wells from an unmanned satellite platform to Dan is expected to be conducted towards autumn 1990. Transportation of the hydrocarbons will take place via pipeline to Dan.

The Valdemar Field

In terms of hydrocarbons-in-place, Valdemar represents the largest Danish hydrocarbon discovery. The prospect covers an area of approx. 200 km^2, located 20 km northwest of Tyra. The oil and gas bearing zones comprise thin limestones of a predominantly low permeability.

Valdemar comprises the prospects Bo, discovered in 1977, Boje, discovered in 1982, and North Jens, discovered in 1985.

In March 1988 the Minister of Energy approved a development plan for Valdemar. Phased development will be applied at Valdemar, the initial phases comprising installation of an unmanned satellite platform to Tyra, located in the North Jens area, and drilling of four horizontal production wells.

The produced hydrocarbons will be transported via pipeline to Tyra East for processing and export. Commissioning is expected in 1991.

The Nils Field

Nils is a small oil accumulation located approximately 10 km southeast of Dan.

The Nils discovery was made in 1979; a development plan was approved by the Minister of Energy in July 1988. The development comprises drilling of one production well from a satellite platform tied back to Dan via a two-phase pipeline.

Initiation of production from Nils is expected in 1994.

The Roar Field

Roar comprises a free gas accumulation with a thin underlying black oil rim; the prospect is located 10 km northwest of Tyra.

The Roar gas discovery was made in 1968. Development of the field was approved by the Minister of Energy in 1980 in connection with approval of the Danish natural gas project. The time-schedule for development of Roar is contingent on sales gas requirements according to the Gas Sales Contract of 1979 between DUC and D.O.N.G. A/S.

The Dagmar Field

Dagmar is an oil accumulation located approx. 10 km west of Gorm. The discovery was made in 1983; a development plan was submitted in June 1987; after negotiations with the Energy Agency the plan was reviewed and a revised plan submitted in December 1988.

A phased development of Dagmar is proposed, the initial phase comprising installation of a satellite platform to Gorm and drilling of two production wells.

As Dagmar production contains hydrogen sulphide, the processing of the Dagmar production will be performed separately. The current plan therefore includes installation of special processing facilities installed on a new platform, Gorm F. Initially, the sour gas will be partly utilized as fuel on Gorm F, the remainder will be flared. At a later stage with increased production from Dagmar, processing facilities for cleaning of the gas will be established, enabling full gas utilization.

Start of production from Dagmar is expected early 1991.

The Igor Field

Igor is a gas discovery located approx. 10 km southeast of Dan.

The Igor discovery was made in 1968. The development plan was approved in principle by the Minister of Energy in 1987. The plan includes development of Igor as a satellite to Dan. The time-schedule is pending available processing capacity at the Dan field and gas market demand.

The Adda Field

Adda is an oil and gas accumulation located 10 km north of Tyra.

The Adda discovery was made in 1977; a development plan was submitted to the Minister of Energy in 1986.

The plan comprises development of Adda as a satellite to Tyra; the time-schedule has not yet been settled.

The Harald Field

Harald is located 80 km north of Tyra and comprises two gas accumulations discovered at Lulu in 1980 and at West Lulu in 1983. A development plan was submitted to the Minister of Energy in December 1987.

The proposed development comprises the installation of an integrated processing and accommodation platform connected to a wellhead platform. Final processing including the stabilization of the condensate will take place at Tyra and Gorm, prior to transportation ashore. Timing for the initiation of development and production at Harald is basically contingent on gas market demand.

The North Arne Field

North Arne is an oil accumulation located 60 km northwest of Tyra.

The discovery was made in 1975; a development plan was submitted in 1986.

The plan comprises a satellite development to Harald located 20 km to the north. It is proposed that the produced hydrocarbons are transported via the Harald processing facilities to Gorm (oil) and Tyra (gas) for export ashore.

The time-schedule for development at North Arne is contingent on the timing of development at Harald and receptor capacity at Gorm and Tyra respectively.

The Gert Field

Gert is an oil accumulation located 80 km northwest of Tyra. The accumulation extends northwards into the Norwegian Sector (Block 2/12).

Gert was discovered in 1984 and declared commercial in 1987. The Minister of Energy has approved postponement of submittal of a development plan for Gert until the 30th of December 1990.

A dispute concerning field delineation of Gert is currently under arbitration between A.P. Møller and the Danish government.

Separation of the produced oil and gas takes place at the processing facilities located at Dan, Gorm and Tyra; associated gas is produced together with the oil and condensate recovery takes place with the gas production.

After stabilization, the crude oil and the condensate are transported via pipeline to the Gorm E booster platform, where the export outlet into the 20″ main oil pipeline is located.

The natural gas is transported to Tyra East for final treatment in accordance with the specifications of the Gas Sales Contract. The gas sales outlet is located at the Tyra East E platform, from where the sales gas is transported ashore via the 30″ main gas pipeline. The distance to shore is approximately 230 kilometres.

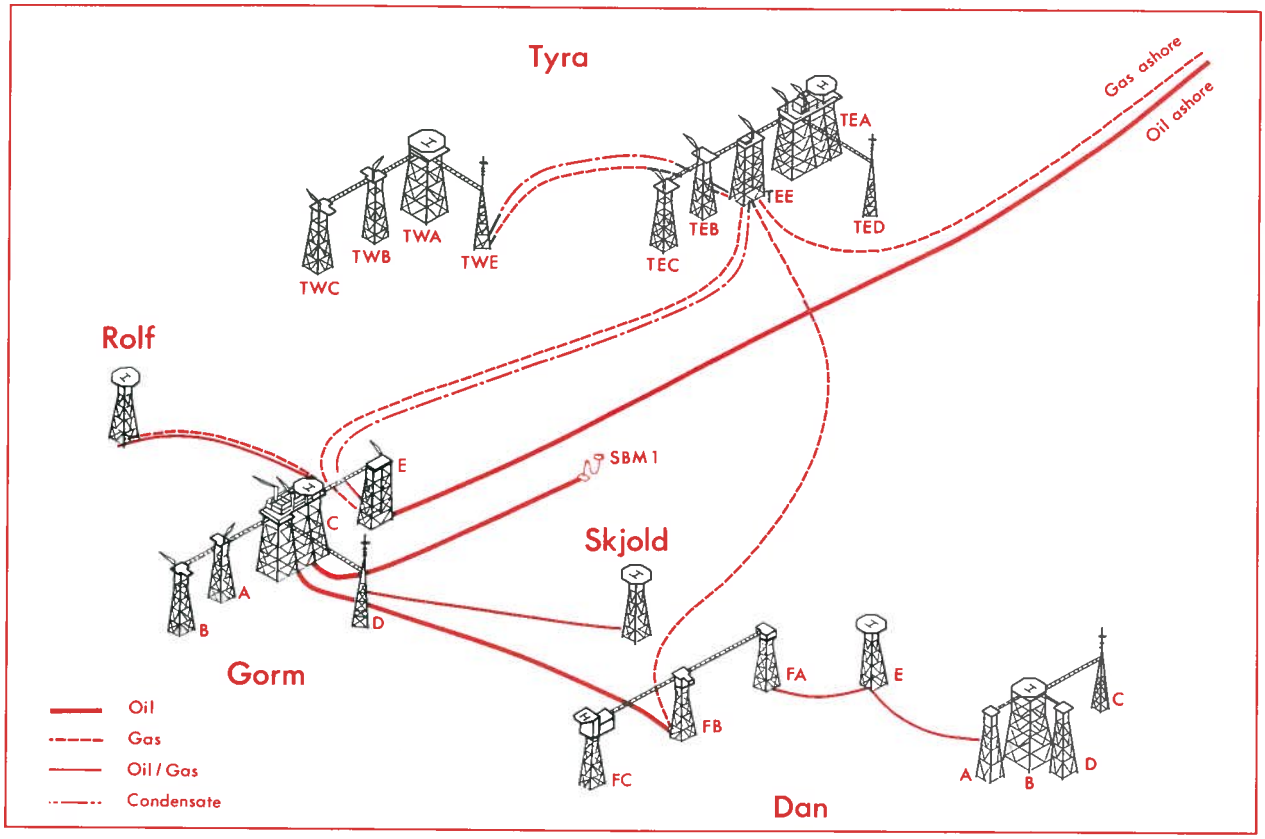
Production and transportation facilities in the Danish North Sea are shown in fig. 4.1.

The main pipelines are owned and operated by D.O.N.G. A/S via its subsidiary companies DORAS and DANGAS.

Crude Oil and Condensate

With the use of friction reducing additives the booster capacity at Gorm E corresponds to 7.5 million m^3 per year. Improved booster capacity requiring installation of additional pumping facilities could increase the capacity to 9.8 million m^3 per year. The oil and condensate production during 1988 amounted to 5.6 million m^3.

Fig. 4.1 Developments in the North Sea.



Distribution

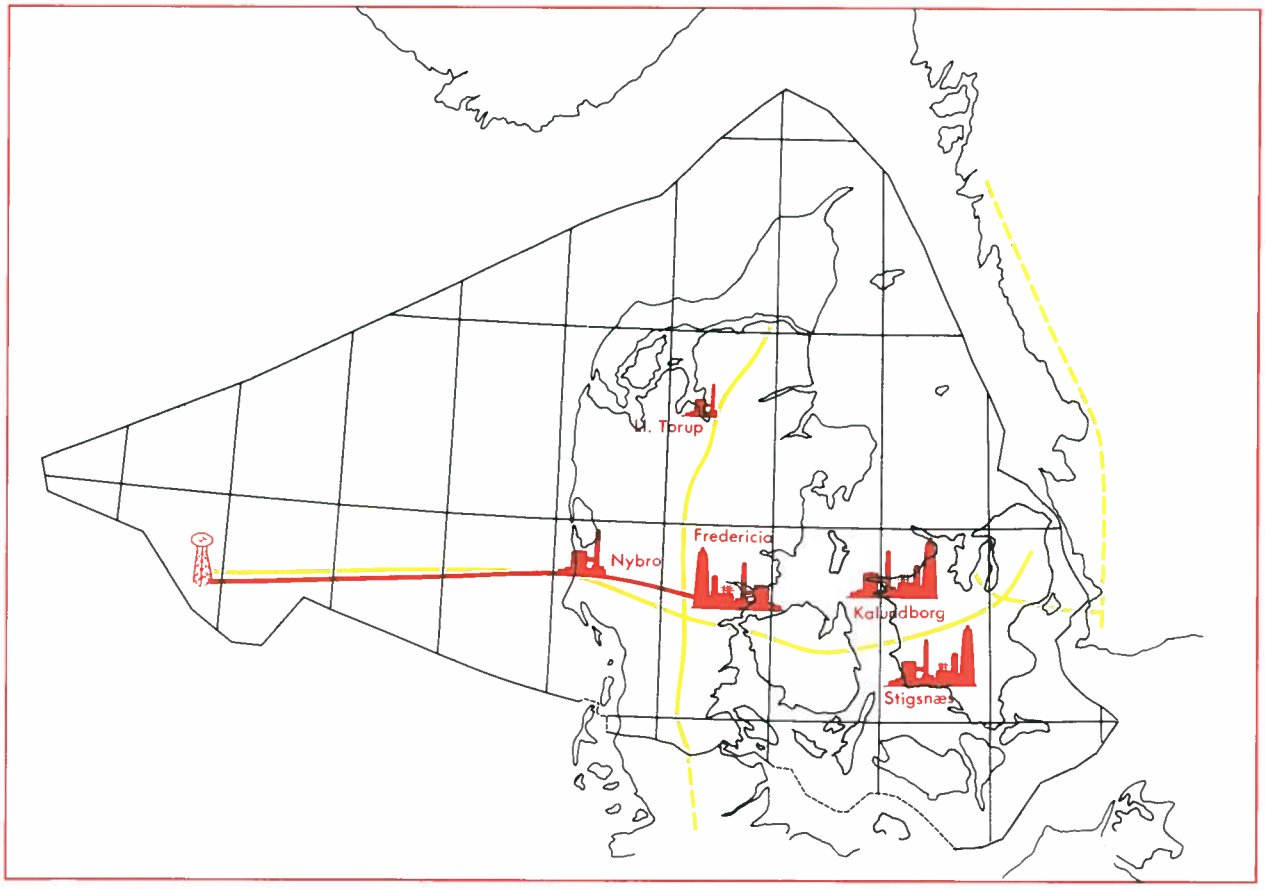
The oil is transported to the oil terminal located adjacent to the Shell Refinery at Fredericia. Further transport of the crude may take place directly to the Shell Refinery or to the harbour loading facilities via pipeline for refining at other Danish refineries (Q8, Statoil) or for export abroad. From the Shell Refinery further transportation takes place via truck, or via pipeline into tanker.

The Danish crude oil is a sweet light crude, i.e. containing 15-20% condensate with only a minor content of sulphur. Hence the refined products mainly comprise gasoline and gasoil with subordinate amounts of the less valuable fuel oil. When being refined the Danish crude oil is mixed with imported crudes in order to meet the market demand.

All crude oil produced in Denmark is owned by DUC and is shared between A.P. Møller (39%), Shell Olie og Gasudvinding (46%) and Texaco (15%).

The Danish state secures domestic supply either by settlement of the royalty payment (8.5%) in kind or/and by exercising a first purchase option of up to 40% of the total oil production on a competitive basis. All oil supply transactions for the Danish state are handled by Dansk Olieforsyning A/S (DOFAS), a subsidiary of D.O.N.G. A/S.

Fig. 4.2 Distribution of crude oil and natural gas



The allocation of the crude oil between DUC and DOFAS is summarized in table 4.1.

Table 4.1 Crude Oil Allocation 1984-1988 million tons

Year	Pro-duction	DUC	DOFAS
1984	2.3	1.8	0.5
1985	2.9	2.0	0.9
1986	3.6	2.2	1.4
1987	4.6	3.1	1.5
1988	4.7	3.2	1.5

DOFAS refines the crude oil in Danish, Norwegian and Swedish refineries. The refined products are mainly sold in Denmark, a minor part is delivered to the Scandinavian countries and Germany.

The main part of the crude oil export is of Danish orgin. The total capacity of the Danish refineries corresponds to approximately 8.8 million tons per year, currently fully utilized.

Table 4.2 Danish Oil Supply, 1984-1988, million t.c.o.e.

Crude Oil [1])

Year	Import	Produc-tion	Storage change[2])	Exports	Refined
1984	5.8	2.3	0.1	0.9	7.3
1985	5.0	2.9	0.1	1.1	7.0
1986	5.0	3.6	0.1	0.9	7.7
1987	4.9	4.6	-0.1	1.8	7.6
1988	5.1	4.7	0.1	2.0	7.9

Refined Products

Year	Import	Produc-tion	Storage change[2])	Exports	Consump-tion[3])
1984	5.7	7.8	-0.7	2.7	10.1
1985	6.5	7.3	-1.0	2.4	10.5
1986	6.1	8.2	-1.3	2.8	10.3
1987	5.5	8.0	-1.1	2.8	9.7
1988	5.1	8.4	-1.5	3.1	8.9

[1]) Including feed stock.
[2]) Including storage reduction, statistic corrections, foreign bunkering and shrinkage.
[3]) Including non energy consumption.

Natural Gas

DANGAS takes delivery of the gas at the sales gas outlet located at the Tyra East E platform for further transportation to the gas treatment facilities located at Nybro on the west coast of Jutland. After pressure modification according to transmission requirements (ref. Fig. 4.2), the gas is distributed to the various local gas distribution companies for delivery to the consumers. With regard to major gas deliveries the distribution is performed in co-operation with DANGAS. DANGAS solely delivers gas to the power plants and to Copenhagen. Foreign export outlets are located on Zealand for Sweden and in southern Jutland for Germany.

Furthermore, part of the gas is delivered to the natural gas storage located at Lille Torup. This storage has a capacity of 260 million Nm^3 and mainly serves the purpose of meeting peak demands during winter.

Table 4.3 Natural Gas Supply 1984-1989 million Nm^3

Year	Import	Produc-tion	Storage change[1])	Export	Consump-tion
1984	36	221	-18	132	107
1985	–	1,042	-8	424	610
1986	–	1,805	-126	581	1,098
1987	–	2,300	-191	714	1,395
1988	–	2,272	19	791	1,500

[1]) Including statistic corrections and shrinkage.

An assessment of the hydrocarbon reserves is made annually by the Energy Agency.

The reserves as assessed correspond to those amounts of recoverable oil and gas that may be produced with currently recognized technology and under prevailing economic conditions.

The reserves assessment does not include speculative reserves, i.e. oil or gas not supported by drilling and testing.

Method and Definitions

A probabilistic reserves estimate is provided in terms of low, medium and high values. The arithmetric mean of these values represents the expectation value. The *expected* reserves represent the likely amount of recoverable hydrocarbons that may be produced under a specific development scenario by application of currently known technology.

The confidence level of the various reserves calculations is dependent on the underlying data and information available for each individual field and prospect. Hence a reserves calculation based on etablished field production carries a higher level of confidence than a calculation based on the drilling and testing of a single well in a prospect. In view of this the reserves calculations are allocated into three categories in descending order of confidence level, i.e. reserves calculations based on established or decided production, planned production, and possible production respectively.

The definitions of reserves and reserves categories are summarised as follows:

Reserves

The reserves are the quantities of oil, condensate or gas expected to be produced through the use of existing technology. Only part of the hydrocarbons-in-place in a reservoir can be recovered. The recovery in terms of reserves that can be produced during a field's lifetime is referred to as the *ultimate* recovery. The difference between the reserves under ultimate recovery and the produced quantities of hydrocarbons corresponds to the remaining reserves at any given time.

Established and Decided Recovery

Established recovery comprises hydrocarbons technically producible from the existing fields through the use of existing production facilities. It is assumed that the required maintenance of the equipment is performed.

Decided recovery is calculated for hydrocarbon discoveries, for which an approved development plan exists; reserves in this category apply to new field developments as well as approved supplementary developments in producing fields.

Planned Recovery

Planned recovery for the producing fields comprises projects described in a development plan not yet approved by the authorities.

Furthermore, reserves pertaining to prospects which have been declared commercial are included in this category.

Possible Recovery

Possible recovery is calculated for discoveries under appraisal. Further reserves in this category comprise oil and gas that may be produced by enhanced recovery methods, not yet planned or approved.

Unit System

The metric unit system (SI) is applied in this report.

Oil reserves are reported in cubic metres at standard conditions, i.e. m^3 (15°C).

The gas reserves are reported in cubic metres at normal conditions, i.e. Nm^3 at 0°C and 101.325 kPa (1 atmosphere).

1988 Reserves Assessment

The current reserves estimates prepared by the Energy Agency have been summarized in tables 5.1 and 5.2 respectively in terms of *low, expected* and *high* values. This was done in order to illustrate the uncertainty attributed to the calculations. In practice, the expectation values are applied as a basis for the Danish hydrocarbon reserves potential.

Table 5.1 Oil and Condensate Reserves
January 1989, million m^3

	Ultim. Rec.			Prod.	Reserves		
	Low	Exp.	High		Low	Exp.	High
Established and Decided Recovery:							
Dan	33	42	52	8	25	34	44
Gorm	20	26	33	12	8	14	21
Skjold	18	24	30	6	12	18	24
Rolf	2	2	3	1	<1	1	1
Tyra	9	12	15	3	6	9	12
Roar	3	4	5	–	3	4	5
Kraka	1	2	4	–	1	2	4
Igor	<1	<1	<1	–	<1	<1	<1
Nils	<1	<1	1	–	<1	<1	1
Valdemar	1	4	9	–	1	4	9
Sub Total		116 (88)		30 (24)		86 (64)	
Planned Recovery:							
Dan	3	4	5	–	3	4	5
Skjold	4	5	6	–	4	5	6
Valdemar	2	8	15	–	2	8	15
Kraka	1	2	2	–	1	2	2
North Arne	4	7	10	–	4	7	10
Dagmar	2	3	5	–	2	3	5
Adda	<1	1	2	–	<1	1	2
Harald	6	8	10	–	6	8	10
Gert	6	11	17	–	6	11	17
Elly	<1	<1	1	–	<1	<1	1
Sub Total		49 (73)		–		49 (73)	
Possible Recovery:							
Prod.fields	25	33	43	–	25	33	43
Comm.fields	2	8	13	–	2	8	13
Pot.fields	8	17	28	–	8	17	28
Sub Total		58 (38)		–		58 (38)	
Total		223 (199)		30 (24)		193 (175)	

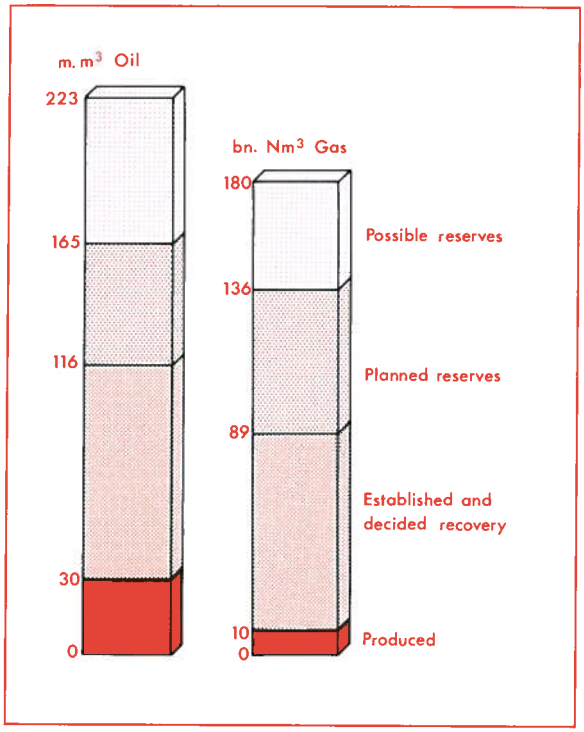
Table 5.2 Gas Reserves
January 1989, billion Nm^3

	Ultim. Rec.			Prod.	Reserves		
	Low	Exp.	High		Low	Exp.	High
Established and Decided Recovery:							
Dan	11	14	17	3	8	11	14
Gorm	5	6	8	<1	5	6	8
Skjold	2	2	3	<1	1	2	2
Rolf	<1	<1	<1	<1	<1	<1	<1
Tyra	35	45	54	7	28	38	47
Roar	9	13	17	–	9	13	17
Kraka	<1	1	2	–	<1	1	2
Igor	1	2	3	–	1	2	3
Nils	<1	<1	<1	–	<1	<1	<1
Valdemar	2	6	12	–	2	6	12
Sub Total		89 (78)		10 (8)		79 (70)	
Planned Recovery:							
Dan	1	1	1	–	1	1	1
Skjold	<1	<1	1	–	<1	<1	1
Valdemar	5	13	24	–	5	13	24
Kraka	1	1	1	–	1	1	1
North Arne	1	1	2	–	1	1	2
Dagmar	<1	<1	1	–	<1	<1	1
Adda	<1	1	1	–	<1	1	1
Harald	20	26	32	–	20	26	32
Gert	1	1	2	–	1	1	2
Elly	2	3	5	–	2	3	5
Sub total		47 (46)		–		47 (46)	
Possible Recovery:							
Prod.fields	6	8	9	–	6	8	9
Comm.fields	4	12	23	–	4	12	23
Pot.fields	9	24	43	–	9	24	43
Sub total		44 (54)		–		44 (54)	
Total		180 (178)		10 (8)		170 (170)	

Last year's reserves assessment in brackets

As shown in Figure 5.1 the combined expected reserves range between 116 and 223 million m^3 of oil and condensate and between 89 and 180 billion Nm^3 of net gas production, i.e. not including reinjected gas.

Fig. 5.1 Oil and Gas reserves



A comparison with the 1987 reserves assessment reveals an increase in the hydrocarbon reserves potential, due to a number of adjustments in line with the submittal of new development plans, improved production experience and the implementation of new wells, seismic interpretations etc.

Production and expenditure forecasts are prepared annually by the Energy Agency with regard to the exploitation and exploration of oil and gas in Denmark.

The current five year forecast is presented per 1st of January 1989, reflecting the envisaged activities as well as an evaluation with regard to rate of self sufficiency and the net currency expenditure for energy imports.

A twenty year oil and gas production forecast is furthermore included in this report, based on a reserves assessment prepared autumn 1988.

Five Year Production Forecast

The five year production forecast is based on the reserves as calculated by the 1st of January, 1989. Reserves, calculated for development projects still pending the timing of implementation, are allocated under *planned* production.

Table 6.1 Oil and Condensate Production Forecast 1989-1993 million m^3

	1989	1990	1991	1992	1993
Established and Decided Production[1])					
Dan	1.9	1.7	2.6	2.1	1.8
Gorm	1.5	1.3	1.2	1.0	1.0
Skjold	2.3	2.3	2.1	1.8	1.4
Rolf	0.2	0.2	0.1	0.1	0.0
Tyra	0.9	0.8	0.7	0.5	0.3
Kraka	–	0.1	0.3	0.2	0.2
Valdemar	–	–	–	0.4	0.4
Sub Total	6.8	6.4	7.0	6.1	5.1
Planned Production	–	–	0.8	1.4	1.5
Expected Production	6.8	6.4	7.8	7.5	6.6
April 1988 Forecast	7.3	8.5	8.2	7.9	–

[1]) Includes current production and production under development.

The oil and condensate production forecast assumes the utilization of currently existing facilities and further includes the planned expansion of these facilities.

With regard to natural gas the production forecast reflects the expected delivery of sales gas to DANGAS.

Compared to the April 1988 production forecast, this year's forecast reflects a considerable increase of the *established* and *decided* oil recovery. This increase is due to decisions for implementation and development of previously *planned* projects, including the implementation of horizontal completions at the Dan Field, the water injection projects initiated at the Skjold and Gorm Fields, and the approved development of the Valdemar and the Kraka Fields respectively.

Planned production was reduced compared to the April 1988 forecast. This is primarily due to transfer of previously *planned* projects to the category *established* and *decided*.

Table 6.2 Sales Gas Production Forecast 1989-1993 billion Nm^3

	1989	1990	1991	1992	1993
Established and Decided Production[1])					
Dan	0.7	0.6	0.8	0.7	0.6
Gorm, Skjold, Rolf	0.2	0.2	0.2	0.3	0.2
Tyra	1.8	2.0	2.0	2.1	2.4
Sub Total	2.7	2.8	3.0	3.1	3.2
Planned Production	–	–	0.1	0.1	0.2
Expected Production	2.7	2.8	3.1	3.2	3.4
April 1988 Forecast	3.0	3.0	3.1	3.2	–

[1]) Includes current production and production under development.

Table 6.3 Investments, Development Projects 1989-1993 DKK billion (1989)

	1989	1990	1991	1992	1993
Established and Decided Projects					
Dan	0.2	0.3	0.3	0.2	0.4
Gorm	0.2				
Skjold	0.1				
Rolf					
Tyra	0.1				
Kraka	0.1	0.1	0.2	0.2	0.1
Valdemar	0.1	0.3	0.4		
Sub Total	0.9	0.7	0.8	0.4	0.5
Planned Projects	0.2	0.4	1.0	1.6	0,0
Expected Investments	1.1	1.1	1.8	2.0	0.5
April 1988 Forecast	2.2	2.2	1.7	1.2	–

Expenditure forecasts with regard to investments, operations and transportation costs are summarized in tables 6.3, 6.4 and 6.5 respectively. The envisaged expenditures with regard to exploration and appraisal are shown in table 6.6.

Table 6.4 Operation and Maintenance Costs 1989-1993 DKK billion (1989)

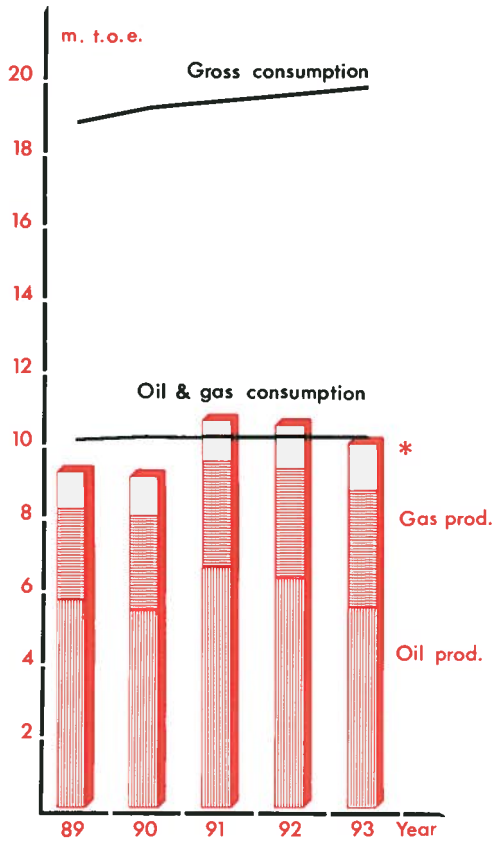
	1989	1990	1991	1992	1993
Established and Decided Costs					
Dan	0.3	0.3	0.3	0.3	0.3
Gorm	0.3	0.3	0.3	0.3	0.3
Skjold	0.2	0.2	0.2	0.2	0.2
Rolf	0.0	0.0	0.0	0.0	0.0
Tyra	0.4	0.4	0.4	0.4	0.4
Kraka		0.0	0.0	0.0	0.0
Valdemar			0.0	0.0	0.0
Sub Total	1.2	1.2	1.2	1.2	1.2
Planned Costs			0.0	0.1	0.1
Expected Costs	1.2	1.2	1.2	1.3	1.3
April 1988 Forecast	0.8	0.9	0.9	1.0	–

Table 6.5 Transportation Costs, the Oil Pipeline 1989-1993 DKK billion (1989)

	1989	1990	1991	1992	1993
Total	0.7	0.7	0.7	0.7	0.7
April 1988 Forecast	0.8	0.8	0.8	0.8	

The increase in operation costs (table 6.4) compared to the 1988 forecast is due to the inclusion of administration and insurance costs.

Fig. 6.1 Energy Consumption and Production 1989-1993



* Alternative Energy

Table 6.6 Exploration and Appraisal Costs 1989-1993 DKK billion (1989)

	1989	1990	1991	1992	1993
Total	0.4	0.4	0.2	0.2	0.1
April 1988 Forecast	0.5	0.3	0.2	0.2	–

Self-sufficiency and Net Currency Expenditure for Energy Imports.

The expected hydrocarbon production is compared to the domestic oil and gas consumption (A) and the total domestic energy consumption (B). The rate of self sufficiency (C) in terms of total domestic energy production is furthermore calculated and compared to the total domestic energy consumption. The compilation is shown in table 6.7.

Table 6.7 Rate of Self-sufficiency and Net Currency Expenditure for Energy Imports, 1989-1993.

	1989	1990	1991	1992	1993
Production					
Crude Oil (million m^3)	6.8	6.4	7.8	7.5	6.6
Natural Gas (billion Nm^3)	2.7	2.8	3.1	3.2	3.4
Total Energy Consumption (PJ)	793	809	819	826	833
Rate of Self-sufficiency (%)					
A	82	79	93	91	86
B	44	42	49	48	44
C	49	47	55	54	51
Net Currency Expenditure (DKK billion)	5.6	6.2	5.3	5.8	6.8
Crude Oil Price USD/barrel	16	16	16	16	16
DKK/USD	7.0	7.0	7.0	7.0	7.0

A: Oil and gas production versus domestic oil and gas consumption.
B: Oil and gas production versus total domestic energy consumption.
C: Total energy production versus total domestic energy consumption.

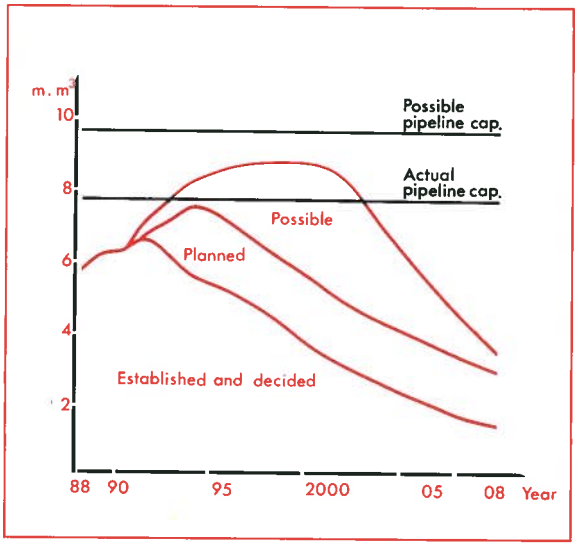
The net currency expenditure is expressed in terms of its immediate effect on the trade balance. In this context imports incurred due to field development or revenues transferred abroad were not included in the calculations.

Energy consumption and production are shown in fig. 6.1 in terms of t.o.e. for convenient comparison.

Twenty Year Production Forecast

The twenty year production forecast has been prepared in accordance with the systematics of the reserves assessment, i.e. the production predictions are expressed in terms of *established* and *decided, planned* and *possible* production. The first five years of the twenty year forecast approximately correlates with the five year forecast. Minor divergencies are the result of a different basis of reserves used in the preparation of the two forecasts; thus the twenty year forecast was primarily based on the reserves assessment prepared autumn 1988.

Fig. 6.2 Oil and Condensate Production 1988-2008 million m^3



Crude Oil and Natural Gas Production Forecast

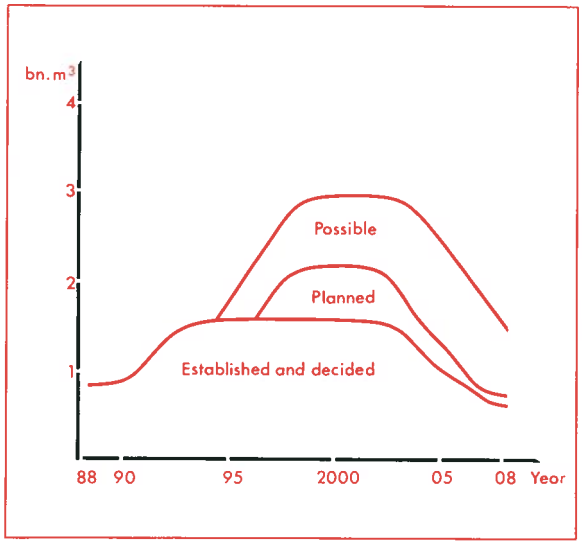
The twenty year production forecast for liquid hydrocarbons is shown in fig. 6.2. The time of implementation concerning the planned and possible production scenarios has been estimated.

The high forecast, including possible production, reflects early development of Roar and of the prospects located in the northern part of the Danish Central Graben area. Postponement of this development carries lower peak production extending, however, over a longer period of time.

The production is expected to be within the range of seven to eight million m^3 per year during the mid 1990's, and is expected to be maintained until about the year 2000, when the oil and condensate production will decline.

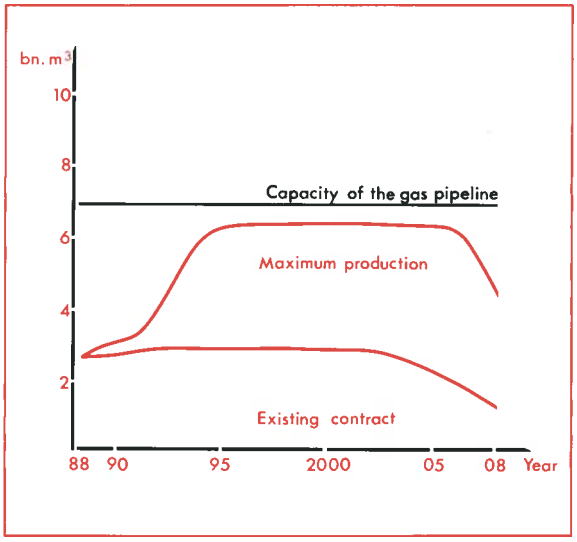
The cumulative production corresponds to 85 million m^3 under the *established* and *decided* category, 115 million m^3 including the *planned*, and 145 million m^3 including the *possible* production category.

Fig. 6.3 Associated Gas Production Forecast 1988-2008 billion Nm^3



The reflected production scenarios are based on known technology and currently prevailing economic conditions. Enhanced oil recovery procedures

Fig. 6.4 Natural Gas Production Forecast 1988-2008 billion Nm^3



may increase the reserves, hence extend the plateau rate production.

Associated gas is produced together with the oil. A minor portion of this gas has been allocated to shrinkage, i.e. power supply and flared gas; a proportionally larger share of the associated gas may be reinjected for the purpose of pressure maintenance, the remaining gas comprises sales gas.

The various gas production scenarios are shown in fig. 6.4. Contrary to the oil production, which are sold at currently prevailing market prices, the gas production requires long-term contracts.

The low gas production scenario as shown in fig. 6.4 corresponds to the requirements of the existing Gas Sales Contract between DUC and DANGAS.

The high scenario assumes maximum production at a reasonable plateau rate requiring, however, additional sales contract(s). Associated gas production has been included.

The cumulative gas production in the high scenario corresponds to 115 billion Nm^3; the low gas production scenario amounts to 55 billion Nm^3, including the 1988 sales gas production.

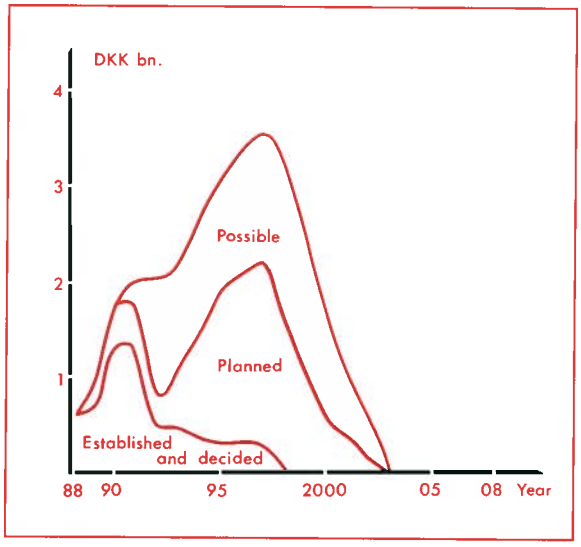
Twenty Year Expenditure Forecast

Figures 6.5 and 6.6 illustrate the rate of investment and operational costs related to the production forecasts.

The capital costs under *planned* and *possible* production are expressing an order of magnitude rather than an accurate rate of investment, due to the uncertainty with regard to the time of implementation of the related development.

Decided capital investment exceeds DKK 6 billion and planned investment approximately DKK 12 billion; the investment according to the possible production forecast would require an additional DKK 13 billion.

Fig. 6.5 Rate of Investment 1989-2008 DKK billion

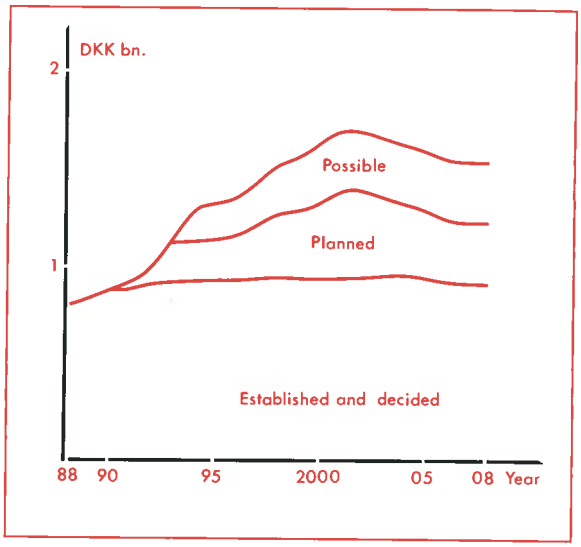


The rate of operational costs is more uniform and is estimated to reach approximately DKK 1.5 billion per year about the year 2000. Administrative and insurance costs are not included in this forecast.

Enhanced Oil Recovery

Improvements of the current production scenarios are contingent on continued development and intensified implementation of enhanced oil recovery procedures. Improved production rates can also be realised, pending continued application of horizontal well completions and further technological advancement.

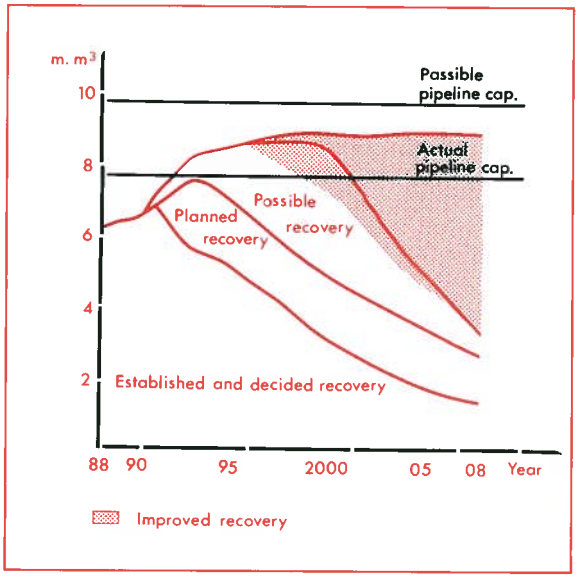
Fig. 6.6 Operational Costs Forecast 1989-2008 DKK billion



The current low oil prices prevent, however, the extensive implementation of enhanced oil recovery measures.

A production scenario reflecting extensive implementation of enhanced recovery measures is shown in fig. 6.7.

Fig. 6.7 Possible Oil Production Scenarios at Full Implementation of Enhanced Oil Recovery



The crude oil price was declining in 1988. At the beginning of 1988 the price for Brent oil approached USD 18.00 per barrel. The price dropped during the spring and reached a minimum of approximately USD 11.00 per barrel during the summer. Towards the autumn the price increased and reached approximately USD 16.00 per barrel in December 1988.

The crude oil price (Brent) in 1988 averaged USD 14.94 per barrel. The corresponding 1987 oil price was USD 18.38 per barrel. The US dollar rate averaged DKK 6.74 in 1988 compared to the average rate in 1987 of DKK 6.84.

Totally, the Danish oil and gas production brought ashore during 1988 increased to 7.1 million t.o.e. (7.0 million t.o.e. in 1987). The sales value of the production shows, however, a decline from DKK 5,930 million in 1987 to DKK 5,100 million in 1988 (Ref. table 7.1).

Table 7.1 Sales Value and Production of Oil and Gas

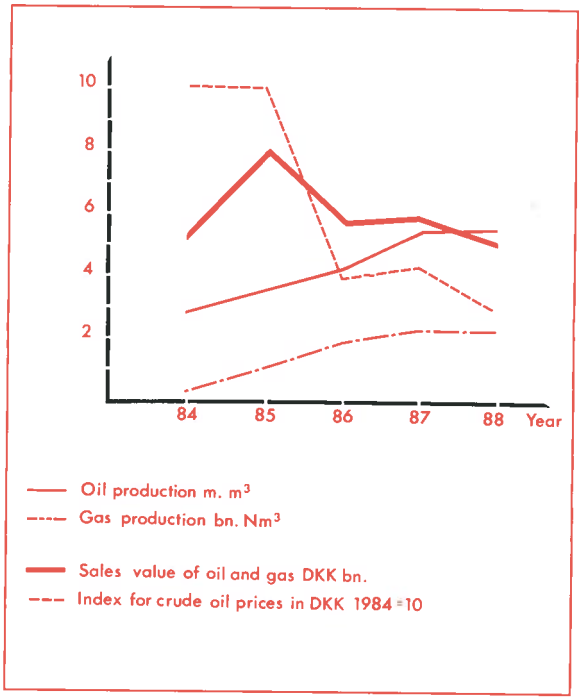
	1984	1985	1986	1987	1988*)
Sales Value (DKK million)					
Oil	4,900	6,280	3,270	4,270	3,500
Gas	400	1,680	2,440	1,660	1,600
Total	5,300	7,960	5,710	5,930	5,100
Production					
Oil million m^3	2.71	3.46	4.29	5.42	5.57
Gas billion Nm^3	0.22	1.04	1.80	2.30	2.27
International Crude Oil Price *(Brent)*					
USD/barrel	28.31	27.61	14.45	18.38	14.94
DKK/USD	10.36	10.60	8.09	6.84	6.74
DKK per m^3	1,845	1,841	735	791	633

Nominal prices, *) Estimate

Exploration, Development and Operations Expenditure

The total capital outlay with regard to exploration and production of oil and gas is estimated at DKK 2,400 million in 1988, compared to DKK 2,600 million in 1987.

Fig. 7.1 Sales Value and Production of Oil and Gas



Three exploratory and 13 development wells were drilled during 1988.

The total costs for the combined exploratory and appraisal activities implemented during 1988 are estimated at DKK 370 million, considerably less than in 1987 (DKK 739 million).

The development costs for 1988 are estimated at DKK 1,000 million, primarily comprising the expenses incurred for drilling and completion of the horizontal wells and the water injection projects at the Dan, Gorm and Skjold Fields.

The operation costs in table 7.2 are considerably higher than those quoted in the 1987 Annual Report. This is due to the inclusion of administrative and insurance costs into the operation costs in this report.

Table 7.2 Costs of Exploration, Development and Operations DKK million

	1984	1985	1986	1987	1988*)
Exploration and appraisal					
DUC	893	873	309	234	150
Licence Groups 1st and 2nd Rounds	211	500	304	505	220
Total	1,104	1,373	613	739	370
Development (DUC)	1,985	2,025	1,766	914	1,000
Operations (DUC)	693	756	981	995	1,000

Nominal prices, *) Estimate

The development costs allocated to the individual fields are summarised in table 7.3; the 1988 costs are estimates. Non allocated costs comprise joint field expenses, certain costs incurred in conjunction with accounting and costs allocated separately to the individual companies.

Table 7.3 Development Investments by DUC DKK million

	1984	1985	1986	1987	1988*)
Dan	311	1,266	1,303	641	215
Gorm	70	21	23	11	375
Skjold	10	92	44	62	260
Rolf	8	366	163	10	–
Tyra	1,197	137	134	188	100
Not allocated	388	143	99	2	50
Total	1,985	2,025	1,766	914	1,000

Nominal prices, *) Estimate

Transportation Costs

The crude oil and natural gas produced in the Danish North Sea are brought ashore via two pipelines. The gas pipeline is owned and operated by DANGAS, a subsidiary of D.O.N.G. A/S.

The natural gas is delivered to DANGAS at the sales gas outlet (Tyra East) in accordance with The Gas Sales Contract between DANGAS og DUC.

DORAS, a subsidiary of D.O.N.G. A/S, owns the oil pipeline, including the booster platform Gorm E. DUC being the sole user of the oil pipeline, covers all costs incurred in conjunction with the oil transportation.

Transportation costs for the crude comprises operational costs, financing costs and repayment of the capital expenditure for the transporation facilities. In addition, the oil pipeline tariff includes a profit element corresponding to 5% of the value of the transported crude oil. DORAS transfers 90% of this profit to the treasury.

Table 7.4 Transporation Costs DKK million

	1984	1985	1986	1987	1988*)
Tanker	38	–	–	–	–
Operations	86	68	99	107	100
Financing	405	526	357	306	325
Miscellaneous	5	24	30	31	30
Profit Element (5%)	146	266	131	206	145
Total	680	884	617	650	600

Nominal prices, *) Estimate

Taxes and Fees

Accumulated, assessed taxes and fees with regard to the DUC production are allocated as follows for the period 1972-1987:

- Royalty payment DKK 2,800 million
- Profit element DKK 700 million
- Corporate tax DKK 1,600 million
- Hydrocarbon tax DKK 600 million

The royalty payment and profit element for 1988 are estimated at DKK 385 million and DKK 145 million respectively. The corporate tax will be comparatively small; hydrocarbon taxation is not applicable for 1988 in view of the low oil price.

Royalty

The royalty payment with regard to the DUC production corresponds to 8.5% of the value of the landed production after deduction of the transportation costs, (table 7.4).

The royalty payment with regard to the licence holders in the 1st and 2nd Rounds was assessed in conjunction with the licence awards. In the Danish 3rd Round the royalty has been abolished.

Table 7.5 Royalty Payments DKK million

	1984	1985	1986	1987	1988*)
Oil	362	458	212	307	250
Gas	26	143	211	130	135
Total	388	601	423	437	385

Nominal prices, *) Estimate

In accordance with the Agreement of 1979 the royalty payment may be settled in cash or *in kind*. Settlements in kind were made in the period 1981-1985. Thus DOFAS purchased the crude from the Ministry of Energy for refining and marketing.

From 1986 onwards the royalty payment has been settled in cash.

In addition to the crude oil supply according to the royalty payment settlement, DOPAS secured further oil supply. This was done through an exclusive purchase option on a commercial basis for a certain quantity of the crude oil production; the quantity in 1988 was 32 per cent. The treatment and distribution of this oil is further described in the section *Distribution*.

Table 7.6 Royalty Payments, Crude Oil DKK million

	1984	1985	1986	1987	1988 *)
Total Royalty crude	362	458	212	307	250
Settlement in Cash	0	86	212	307	250
Settlement in Kind 10^3m^3	208	563	0	0	0

Nominal prices, *) Estimate

The royalty payment is allocated to the year of production, settlement is due the following year.

The Energy Agency supervises safety and working environment regarding offshore exploration and production of oil and gas.

The activities attributed to the preparation and issuing of rules for applications on safety and working environment are discussed in the following, including concerns related to supervision.

During 1988, the regulative activities of the Energy Agency focused on preparation of rules related to the Operator's internal control systems, health conditions, training and rules on safety, accomodation conditions, and the statutes of the Safety Coordination Committee.

Operator's Internal Control

In 1988 the Energy Agency initiated preparation of guidelines for control systems for permanent offshore installations. The guidelines constitute an extension of the underlying principles with regard to internal control systems in pursuance of Order No. 711, issued by the Minister of Energy and entitled *Safety etc. on Marine Installations* of the 16th of November 1987.

The regulations address the operator, who has the full responsibility for adherance to the regulations or related instructions by personnel, contractors and subcontractors. The implementation and compliance of the internal control system will inter alia be ensured by systematic revision.

The internal control system, comprising all phases of the life of a marine installation, may be developed in accordance with recognised quality management standards, e.g. the Danish Standard *ISO 9000* on quality assurance. In practice, this means that the requirements with regard to internal quality control are fulfilled by implementation of such standards by the operator.

Working Environment

In pursuance of the Act on Certain Marine Installations of 1981, labour environmental work was continued in close cooperation between representatives from the labour market and the Coordination Commitee.

Instructions were issued during 1988, concerning accomodation conditions and noise levels on mobile marine installations, including safety training and drills respectively. Guidelines for health services and personnel are under consideration.

Supervision of Mobile Offshore Facilities

General supervision under the Act on Certain Marine Installations of 1981 involves labour environment, approval of manpower, organisation plans, and monitoring and statistic revision of accidents and injury.

During 1988, the Energy Agency performed inspections of environmental working conditions for operational maintenance of the production installations at Gorm, Dan F, Tyra East, and Tyra West. The inspections are conducted together with representatives for the Operator's personnel and management. Subsequently, inspections are reported by the Energy Agency in writing.

The Energy Agency continuously monitors operations and maintenance and forwards requirements with regard to the compliance of inspection and maintenance programs. The programs comprise steel structures, pipelines, safety equipment, processing equipment, working areas, living quarters etc.

Furthermore, a number of inspections were performed on mobile marine installations in the Danish area.

Accidents and Injury

A total of 38 work accidents concerning offshore activities were reported during 1988, i.e. 22 on mobile and 16 on permanent installations. No fatal accidents or serious personal injury were reported during the year. In terms of accidents versus man hours, the reported accident rate corresponds to 10.3 accidents per million working hours for permanent installations.

Reported accidents allocated to type of working activity and technical cause are summarised in tables 8.1 and 8.2.

Accident frequency for permanent marine installations is shown in table 8.3.

Table 8.1 Accidents, Type of Work

Type of Work	Permanent installations 1987	Permanent installations 1988	Mobile installations 1987	Mobile installations 1988
1. Administration/ supervision	0	0	0	0
2. Catering, cleaning	11	2	0	2
3. Instrument set-up, electrical jobs	6	2	0	1
4. Scaffolding	11	2	0	0
5. Pipeline installation, welding, forging	15	2	0	2
6. Painting and sand blasting	1	2	0	0
7. Insulation	3	0	0	0
8. Unloading, moving of materials	1	0	1	0
9. Building's installation, smith's work	1	0	0	0
10. Crane driving	0	0	0	0
11. Drilling floor work	0	0	7	15
12. Processing control and other maintenance	0	2	4	2
13. Safety drills, training	0	1	0	0
14. Work area transportation	8	1	4	0
15. Diving	0	0	0	0
16. Other	7	1	2	0
17. Unreported	0	1	0	0
Total	64	16	18	22

Table 8.2 Accidents, Technical Cause

Technical Cause	Permanent installations 1987	Permanent installations 1988	Mobile installations 1987	Mobile installations 1988
1. Power engines, compressors, driving devices	0	0	0	0
2. Work machines	7	0	2	0
3. Cranes	0	0	1	0
4. Hoisting devices and motor winches	0	0	0	2
5. Working transport equipment	0	0	0	0
6. Manual transport equipment and hand winches	1	2	0	0
7. Lifting and working positions of working persons	5	1	2	1
8. Process plants	0	0	0	0
9. Devices and electrical instruments	0	1	0	0
10. Tools	7	1	0	3
11. Mechanically driven tools	8	0	1	1
12. Drilling equipment	0	0	7	8
13. Chemical substances and materials	2	0	0	2
14. Goods (store supply, elements and materials)	12	3	1	1
15. Work space	16	6	3	3
16. Other	6	2	1	1
Total	64	16	18	22

No accident frequency for mobile installations has been compiled prior to 1988. For the year 1988, however, the accident frequency was assessed to 31 per million working hours.

Table 8.3 Accident Frequency, Permanent Installations

	1984	1985	1986	1987	1988
Accidents per million man hours	36	34	40	40	10

The Action Committee

The objective of the Action Committee is to coordinate the activities of the Danish authorities involved, in case of emergency situations on marine installations.

Furthermore, the committee provides supervision of the preventive measures taken by the operator regarding emergencies and major accidents on marine installations.

The Energy Agency chairs and also serves as a secretariat to the committee. The Action Committee further includes:

Flag Officer Denmark
The Esbjerg Police Authorities
The Agency of Environmental Protection
The Danish Marine Authority

In 1988 the Action Committee held three meetings concerning contingency measures. A prevailing subject discussed at these meetings was the repeated emergencies due to ships adrift in the North Sea. In this context, meetings were held with Mærsk Oil and Gas A/S in order to discuss aversion measures. As a result, Mærsk Oil and Gas A/S established emergency measures on the major stand-by vessels, including a harpoon system for towing away drifting ships from the emergency zone.

Training

In conjunction with the licence awards of the 1st and 2nd Licensing Rounds the licence groups and the Ministry of Energy entered an agreement concerning research commitments and training/educational offers.

Educational offers may comprise courses provided in Denmark, internal company courses and on-the-job training with the various companies. Utilization of the educational offers with the companies has taken place according to plans.

During 1988 nine courses paid by the licence groups were arranged in Denmark with participation of 180 persons from Danish authorities. 39 staff members from these institutions participated in 36 internal company courses. Six persons attended on-the-job training with the companies.

The agreements on educational services furthermore provided scholarships related to special hydrocarbon studies at universities and organizations abroad, a guest professor scholarship at the Technical University of Denmark, and the implementation of a video training programme.

Research and Development

A total of DKK 65 million was allocated to research and development in the 1st and 2nd Rounds. The status at the end of 1988 for the use of these funds is as follows:

– Completed Projects	DKK 18 million
– Current Projects	DKK 30 million
– Planned Projects	DKK 3 million
Total	DKK 51 million

The funds were primarily allocated to:
- Geology and Geophysics
- Reservoir conditions
- Installations and Platforms
- Environmental protection
- Automation, sound and signals
- Computer software

Research Programme, the Ministry of Energy, 1989

The Energy Agency assumes the responsibility for evaluating project applications within the field of oil and gas.

A total of 65 applications had been received at the expiry of the application period on the 1st of June, 1988, with a total request for financial support corresponding to DKK 92 million.

The Ministry of Energy recommended financial support of 25 projects corresponding to DKK 20 million. The awarded financial support amounted to DKK 13.3 million.

EEC Hydrocarbon Research Programme

The total annual financial support from the EEC members corresponded to approximately DKK 290 million. Project support may be provided up to 40% of the total costs. Three Danish projects received financial support from the EEC research programme during 1988 corresponding to DKK 10.8 million.

The Hydrocarbon Committee

The Hydrocarbon Committee was established by the Ministry of Energy in 1986. Industry, research institutions and Government authorities are represented.

The Committee advises the Ministry of Energy on adequate utilization and allocation of financial sources with a view to an optimised Danish development and involvement in the oil and gas area.

Five areas of priority have been specified with a view to future research and development.

- Basin Analysis
- Enhanced Oil Recovery
- Reservoir Simulation
- Field Development
- Arctic Conditions

Appendices

Concessionaires in Denmark, 1988

(31st December, 1988)

Group	Share
Dansk Undergrunds Consortium, DUC:	
A.P. Møller (Concessionaires)	39,00%
Shell Olie- og Gasudvinding Danmark	46,00%
Texaco Denmark Inc.	15,00%
Mærsk Olie og Gas A/S is operator	
The Agip Group:	
Agip Danmark Olie- og Gasefter-forskning Aps (operator)	40,00%
Fina Exploration Denmark S.A.	28,80%
ÖMV (Dänemark) Exploration G.m.b.h.	11,20%
DOPAS	20,00%
The Amoco Group:	
2nd Round, Bornholm Area	
Amoco Denmark Exploration Co. (operator)	75,00%
FLS-Energy A/S	5,00%
DOPAS	20,00%
1st Round, Kattegat Area and onshore	
Amoco Denmark Exploration Co. (operator)	75,00%
FLS-Energy A/S	10,00%
DOPAS	15,00%
1st Round, Central Graben	
Amoco Denmark Exploration Co. (operator)	66,70%
FLS-Energy A/S	10,00%
DOPAS	23.30%
The Britoil Group:	
Britoil Denmark (operator)	38,75%
Amerada Hess Denmark A/S	38,75%
Dansk Landbrugs Grovvareselskab a.m.b.a.	1,25%
Danoil Exploration A/S	1,19%
Olieselskabet Danmark a.m.b.a.	0,06%
DOPAS	20,00%

Group	Share
The Norsk Hydro Group:	
Norsk Hydro Udforskning a.s (operator)	19,50%
Texas Eastern Denmark A/S	19,50%
Gas Council (Exploration) Ltd.	13,70%
Amerada Hess (Denmark) A/S	9,80%
Dansk Oliesøgning K/S	7,50%
A/S Korn og Foderstof Kompagniet	2,50%
DENERCO K/S	7,50%
DOPAS	20,00%
DANOP is operator in licence no. 4/86, Dogger West	
The Statoil Group:	
Statoil Efterforskning og Produktion A/S (operator offshore)	26,50%
BHP Petroleum (Denmark) Inc.	21,00%
Total Marine Danmark	12,00%
LD Energi A/S	7,50%
EAC Energy A/S	4,00%
DENERCO K/S	9,00%
DOPAS	20,00%
DANOP is operator onshore	
The Texaco Group:	
Getty Oil (Denmark) Inc. (operator)	20,00%
Murphy Denmark Oil Co.	10,00%
Canam Offshore Ltd.	10,00%
Clyde Petroleum plc.	12,00%
Petrex S.p.A.	12,00%
Enterprise Oil Exploration Ltd.	16,00%
DOPAS	20,00%

Appendix B

Exploration and Appraisal Wells, 1978-1988

Well name Number	Operator Rig	Lat. North Long. East	Total depth Formation	Spud Compl.
Tostrup-3	DONG	56°38'06"	1593 metres	1978-04-21
5609/10-3	DST SMG FB-291	09°24'06"		1978-05-26
Tove-1	Chevron	55°15'17"	1878 metres	1978-08-09
5505/21-3	Mærsk Explorer	05°09'45"	U. Permian	1978-10-15
Vagn-2	Chevron	55°19'21"	1930 metres	1978-08-09
5505/21-2	Mærsk Explorer	05°09'44"	U. Permian	1978-09-04
Per-1	Chevron	55°47'30"	2781 metres	1978-10-18
5505/05-1	Mærsk Explorer	05°05'01"	Precambrian	1978-11-23
Års-1/1A	Dong	56°47'44"	3401 metres	1978-11-06
5606/07-1	CH 1400E	09°30'32"	U. Triassic	1979-09-03
Nils-1	Chevron	55°23'15"	2033 metres	1978-12-03
5505/17-5	Mærsk Explorer	05°13'37"	U. Permian	1979-02-19
Tostrup-4	Dong	56°39'06"	1610 metres	1979-03-10
5609/10-4	DST 1400/23	09°20'39"		1979-10-22
Dan M-9	Chevron	55°26'48"	2093 metres	1979-09-10
5505/17-6	Mærsk Explorer	05°06'33"	U. Cretaceous	1979-12-04
Linde-1	Elsam	56°26'04"	2237 metres	1979-11-22
5608/18-2	Cabot Franks 900	08°26'35"	U. Triassic	1980-01-24
Lulu-1	Chevron	56°20'03"	3720 metres	1980-01-03
5604/22-1	Sedco J.	04°17'37"	U. Permian	1980-09-17
Tostrup-5	Dong	56°38'32"	1609 metres	1980-04-21
5609/10-5	Ideco BIR-800	09°24'59"		1980-10-19
Stenlille-1	Dong	55°32'38"	1664 metres	1980-06-07
5511/15-1	Ideco BIR-800	11°37'06"	U. Triassic	1980-07-10
Tostrup-6	Dong	56°38'24"	1614 metres	1980-07-14
5609/10-6	Ideco BIR-800	09°25'17"		1980-08-27
Løgumkloster-1	Dansk Boreselskab	55°02'33"	2724 metres	1980-07-31
5508/32-1	Deutag T-14	08°57'04"	Ordovician	1980-10-31
Tostrup-7	Dong	56°38'40"	1746 metres	1980-08-30
5609/10-7	Ideco BIR-800	09°25'22"		1980-10-13
Tønder-3	Dansk Boreselskab	54°57'30"	1840 metres	1980-10-10
5408/04-3	Deutag T-14	08°51'28"	L. Triassic	1980-11-10
Varnæs-1	Dansk Boreselskab	55°02'13"	2236 metres	1980-11-20
5509/31-1	Deutag T-14	09°35'32"	Pre U.Permian	1980-12-23
Adda-2	Chevron	55°48'20"	2743 metres	1981-01-03
5504/08-2	Dyvi Beta	04°50'41"	U. Jurassic	1981-03-03
Brøns-1/1A	Dansk Boreselskab	55°12'04"	2539 metres	1981-01-11
5508/27-1	Deutag T-14	08°44'08"	Pre U.Permian	1981-04-11
Midt Rosa-1	Chevron	55°35'39"	2143 metres	1981-03-16
5504/15-2	Dyvi Beta	04°30'05"	U. Permian	1981-06-06
Tostrup-8	Dong	56°38'20"	1435 metres	1981-05-31
5609/10-8	Ideco BIR-8085	19°24'56"		1981-07-14
Tostrup-9	Dong	56°38'10"	1456 metres	1981-07-19
5609/10-9	Ideco BIR-8085	09°25'15"		1981-08-30
Roar-2/2A	Chevron	55°45'10"	2683 metres	1981-08-08
5504/07-3	Dyvi Beta	04°39'56"	L. Cretaceous	1981-11-07
Tostrup-10	Dong	56°38'14"	1594 metres	1981-09-03
5609/10-10	Ideco BIR-8085	09°24'34"		1981-10-21
Farsø-1	Dong	56°46'53"	2952 metres	1981-10-22
5609/06-2	Ideco BIR-8055	09°21'50"	U. Triassic	1982-01-24

Well name Number	Operator Rig	Lat. North Long. East	Total depth Formation	Spud Compl.
Otto-1	Chevron	56°09'07"	2682 metres	1981-12-21
5604/25-2	Dyvi Beta	04°11'23"	U. Permian	1982-03-20
Thisted-2	Dong	56°57'56"	3287 metres	1982-02-04
5608/03-1	Ideco BIR-8085	08°42'57"	Triassic	1982-03-28
Jens-1	Chevron	55°42'49"	4420 metres	1982-03-24
5504/11-2	Dyvi Beta	04°32'12"	Triassic	1982-09-23
Boje-1	Chevron	55°50'02"	2779 metres	1982-04-01
5504/07-4	Dan Earl	04°40'40"	U. Jurassic	1982-06-08
Mona-1	Chevron	56°16'36"	4239 metres	1982-10-03
5604/21-1	Dyvi Beta	04°00'16"	U. Jurassic	1983-02-09
Emma-1	Chevron	55°29'31"	2736 metres	1982-10-26
5505/18-1	Mærsk Explorer	05°21'28"	Triassic	1982-11-28
Søllested-1	Dansk Boreselskab	54°48'05"	2694 metres	1982-10-27
5411/06-1	Deutag T-14	11°17'55"	L. Permian	1982-12-11
Dan M-10	Dansk Boreselskab	55°28'30"	2018 metres	1982-12-16
5505/17-7	Mærsk Explorer	55°05'07"	Cretaceous	1983-02-16
Elin-1	Chevron	55°56'51"	4719 metres	1983-01-27
5504/02-1	Dyvi Epsilon	04°22'21"	U. Jurassic	1983-04-27
Tønder-5	Dong	54°57'03"	1915 metres	1983-02-13
5408/04-4	National 80 U	08°49'55"	L. Triassic	1983-03-09
Sten-1	Chevron	56°07'48"	4115 metres	1983-02-17
5603/27-1	Dyvi Beta	03°37'35"	Jurassic	1983-04-17
Sydøst Igor-1	Chevron	55°33'55"	3297 metres	1983-02-20
5505/14-1	Mærsk Explorer	05°16'02"	U. Jurassic	1983-04-01
Tønder-4	Dong	54°57'35"	1870 metres	1983-03-13
5408/04-5	National 80 UE	08°50'50"	L. Triassic	1983-03-30
Olaf-1	Dansk Boreselskab	55°58'21"	4395 metres	1983-04-17
5503/03-1	Mærsk Explorer	03°44'06"	Jurassic	1983-07-26
Nord Arne T-3	Chevron	56°10'44"	2819 metres	1983-04-23
5604/25-3	Dyvi Beta	04°10'48"	U. Permian	1983-07-07
Øst Rosa-1	Chevron	55°34'47"	1525 metres	1983-05-01
5504/15-3	Dyvi Epsilon	04°36'41"	U. Permian	1983-07-03
Midt Rosa-2	Chevron	55°36'18"	2069 metres	1983-07-07
5504/14-1	Dyvi Epsilon	04°29'21"	U. Permian	1983-09-08
Edna-1	Chevron	55°39'12"	4125 metres	1983-07-12
5504/10-1	Mærsk Endeavour	04°25'12"	Triassic	1983-10-08
Karl-1	Chevron	56°17'43"	4717 metres	1983-07-12
5604/21-2	Dyvi Beta	04°03'12"	L. Permian	1983-10-04
Hans-1	Dansk Boreselskab	56°21'55"	3031 metres	1983-08-04
5612/21-1	Mærsk Explorer	12°00'51"	Permian	1983-10-09
Thisted-3	Dong	56°57'59"	1242 metres	1983-08-10
5608/03-2	Kenting 21E	08°44'26"	Trias./Juras.	1983-08-26
Vest Lulu-1	Chevron	56°20'26"		1983-09-11
5604/21-3	Dyvi Epsilon	04°13'28"		1984-01-18
Nora-1	Chevron	55°58'09"		1983-10-10
5504/02-2	Dyvi Beta	04°24'04"		1984-02-28
John-1	Chevron	55°24'48"	817 metres	1983-10-24
5504/20-1	Mærsk Endeavour	04°48'45"	U. Permian	1983-11-10
Øst Rosa-2	Chevron	55°35'14"		1983-11-14
5504/15-4	Mærsk Endeavour	04°35'08"		1984-01-25

Appendix B

Well name Number	Operator Rig	Lat. North Long. East	Total depth Formation	Spud Compl.
Kraka A-3	Chevron	55°23'38"		1984-01-31
5505/17-8	Mærsk Endeavour	05°04'47"		1984-06-04
Cleo-1	Chevron	56°23'23"		1984-02-06
5604/18-1	Dyvi Epsilon	04°25'23"		1984-04-29
Gert-1	Chevron	56°13'09"		1984-05-01
5603/27-2	Dyvi Epsilon	03°43'57"		1984-07-29
Elly-1	Chevron	55°47'15"		1984-06-08
5504/06-1	Mærsk Endeavour	04°17'40"		1984-08-15
Liva-1	Chevron	55°55'32"		1984-08-02
5503/04-1	Dyvi Epsilon	03°49'31"		1984-09-30
Adda-3	Chevron	55°47'50"		1984-08-31
5504/08-3	Dan Earl	04°53'26"		1984-10-25
Nils-2	Chevron	55°23'10"		1984-10-31
5505/17-9	Dan Earl	05°13'41"		1984-12-29
Iris-1	Britoil	56°06'45"		1984-11-05
5604/30-1	Dan King	04°18'21"	Jurassic	1985-02-24
Dyb Adda-1	Chevron	55°48'13"		1985-01-01
5504/08-4	Dan Earl	04°58'24"		1985-02-17
Vest Lulu-2	Chevron	56°19'48"		1985-02-21
5604/21-4	Dan Earl	04°12'13"		1985-04-23
Gert-2	Chevron	56°11'50"		1985-02-27
5603/28-1	Mærsk Endeavour	03°46'50"		1985-07-29
Elna-1	Chevron	56°26'55"		1985-05-01
5604/19-1	Dan Earl	04°31'43"		1985-06-14
Ugle-1	BP	55°43'15"	3057 metres	1985-05-07
5505/09-2	Transocean 7	05°12'10"	Paleozoic	1985-06-24
Thisted-4	Amoco	57°01'19"	3418 metres	1985-05-19
5708/31-2	Kenting 31	08°42'07"	Permian	1985-07-18
Terne-1	Amoco	56°20'39"	3361 metres	1985-05-29
5611/23-1	Dyvi Epsilon	11°30'20"	Pre-/Cambrian	1985-08-16
John Flanke-1	Chevron	55°24'28"		1985-06-20
5504/20-2	Dan Earl	04°50'10"		1985-07-19
Lone-1	Chevron	56°08'35"		1985-06-30
5603/27-3	Mærsk Endeavour	03°31'58"		1985-09-03
Kværs-1	Mærsk Olie og Gas	54°56'28"		1985-07-27
5409/02-1	Kenting 31	09°28'49"		1985-09-09
Nord Jens-1	Chevron	55°49'59"		1985-08-07
5504/07-5	Mærsk Endeavour	04°33'35"		1985-11-12
Sæby-1	Dopas	57°21'24"	1854 metres	1985-08-07
5710/22-1	Boldon-41	10°23'44"	Paleozoic	1985-08-28
Kegnæs-1	Texaco	54°50'51"	2591 metres	1985-08-21
5410/05-1	Dyvi Epsilon	10°05'15"	U. Permian	1985-10-05
Skive-2	BP	56°35'37"	1456 metres	1985-09-02
5609/13-1	Boldon-41	09°00'21"	U. Triassic	1985-09-25
Vest Lulu-3	Chevron	56°20'58"		1985-09-12
5604/21-5	Mærsk Endeavour	04°12'34"		1985-12-11
Kim-1	Chevron	56°07'02"		1985-10-03
5603/30-1	Glomar Labrador 1	03°29'53"		1985-12-31
Nord Jens-2	Chevron	55°49'59"		1985-11-16
5504/07-6	Mærsk Endeavour	04°33'36"		1985-12-28

Well name Number	Operator Rig	Lat. North Long. East	Total depth Formation	Spud Compl.
Lulu-2	Mærsk Olie og Gas	56°19'06"		1985-12-15
5604/22-2	Mærsk Endeavour	04°17'31"		1986-03-18
Diamant-1	Phillips	56°00'23"	4242 metres	1986-01-10
5603/32-2	Glomar Labrador 1	03°53'44"	L. Permian	1986-03-18
Øst Rosa-3	Mærsk Olie og Gas	55°35'36"		1986-01-20
5504/15-5	Dyvi Epsilon	04°36'31"		1986-03-10
Ravn-1	Amoco	55°52'35"	5013 metres	1986-03-24
5504/01-2	Dyvi Epsilon	04°13'52"	Permian	1986-07-17
Øst Rosa Fl.-1	Mærsk Olie og Gas	55°33'51"		1986-03-24
5504/15-6	Mærsk Endeavour	04°37'50"		1986-04-30
Midt Rosa Fl.-1	Mærsk Olie og Gas	55°35'27"		1986-05-04
5504/15-7	Mærsk Endeavour	04°31'33"		1986-06-11
Vest Lulu-4	Mærsk Olie og Gas	56°19'05"		1986-07-27
5604/21-6	Mærsk Endeavour	04°10'16"		1986-09-12
Gwen-2	Mærsk Olie og Gas	56°06'52"		1986-09-30
5604/29-3	Mærsk Endeavour	04°04'10"		1986-12-15
Mejrup-1	Phillips	56°22'39"	2532 metres	1987-03-22
5608/19-1	Kenting 36	08°40'36"	Triassic	1987-04-29
Felicia-1	Statoil	57°26'18"	5321 metres	1987-07-03
5708/18-1	Mærsk Guardian	08°18'41"	Permian	1987-12-03
Gert-3	Mærsk Olie og Gas	56°12'43"		1987-07-21
5603/28-2	Mærsk Endeavour	03°45'49"		1987-10-28
Stenlille-2	Danop	55°32'17"		1987-07-27
5511/15-2	Kenting 36	11°36'18"		1987-08-28
Ibenholt-1	Phillips	56°23'26"	2599 metres	1987-08-11
5605/20-1	Dyvi Sigma	05°58'29"	Precambrian	1987-09-24
Dyb Gorm-1	Mærsk Olie og Gas	55°34'04"		1987-08-18
5504/16-5	Zapata Scotian	04°45'50"		1987-12-04
Stenlille-3	Danop	55°32'17"		1987-08-30
5511/15-3	Kenting 36	11°36'18"		1987-09-16
Ravn-2	Amoco	55°50'35"	4507 metres	1987-09-16
5504/05-1	Dan Earl	04°13'41"	Triassic	1987-11-17
Tostrup-11	Danop	56°37'55"		1987-10-10
5609/10-11	Kenting 36	09°25'24"		1987-11-07
Elly-2	Mærsk Olie og Gas	55°47'19"		1987-11-15
5504/06-2	Neddrill Trigon	04°19'05"		1988-05-31
Jeppe-1	Norsk Hydro	56°11'04"	5050 metres	1987-12-10
5603/28-3	Mærsk Guardian	03°54'36"	Permian	1988-03-02
Borg-1	Danop	55°02'57"	3074 metres	1988-04-18
5508/32-2	Kenting 34	08°48'23"	Paleozoic	1988-05-29
Gulnare-1	Statoil	56°10'13"	4735 metres	1988-06-02
5604/26-1	Mærsk Endeavour	04°26'41"	Jurassic	1988-09-19
Stenlille-4	Danop	55°31'06"		1988-07-19
5511/15-4	Kenting 36	11°35'14"		1988-08-09
Stenlille-5	Danop	55°32'08"		1988-08-14
5511/15-5	Kenting 36	11°37'33"		1988-09-03
Stenlille-6	Danop	55°33'29"		1988-09-07
5511/15-6	Kenting 36	11°39'09"		1988-09-27
Tordenskjold-1	Danop	55°56'19"	3703 metres	1988-12-14
5503/03-2	Neddrill Trigon	03°32'31"	L. Permian	1989-02-04

Appendix C

Exploratory Surveys, 1988

Survey	Operator Contractor	Type	Initiated Terminated	Area	Acquistion
Non-Exclusive Seismic Surveys					
JS88B	Jebco Seismic Ltd., Digital Exploration	Offshore	1988-09-02 1988-09-11	Baltic Sea Bornholm	1,762.2 km
NP88S	Nopec A/S Prakla Seismos	Offshore	1988-05-08 1988-05-15	Skagerrak	155.6 km
Exclusive Seismic Surveys					
DK88C	Mærsk Olie og Gas A/S Digital Exploration	Offshore 2D	1988-04-08 1988-04-21	Central Graben DUC Contiguous Area	896.5 km
DK88C	Mærsk Olie og Gas A/S Prakla Seismos	Offshore 3D	1988-07-02 1988-10-17	Central Graben DUC Contiguous Area	5,062.3 km
DK88C	Mærsk Olie og Gas A/S Geco	Offshore 2D	1988-09-09 1988-09-23	Central Graben Elly	477.8 km
AM88B	Amoco Denmark Western Geophysical	Offshore	1988-09-14 1988-09-15	Baltic Sea Bornholm	159.3 km
NH88C	Norsk Hydro Western Geophysical	Offshore	1988-11-17 1988-11-18	Central Graben	41.6 km
Airtrace Survey					
AM88B	Amoco Denmark Barringer Research Ltd.	Airtrace	1988-05-27 1988-06-16	Baltic Sea Bornholm	3,791.0 km

Danish Oil Production 1972-1988, million m^3

Year	Dan	Gorm	Skjold	Tyra	Rolf	Total
1972	0.11					0.11
1973	0.15					0.15
1974	0.10					0.10
1975	0.19					0.19
1976	0.23					0.23
1977	0.58					0.58
1978	0.49					0.49
1979	0.49					0.49
1980	0.34					0.34
1981	0.34	0.53				0.88
1982	0.31	1.64	0.02			1.97
1983	0.28	1.84	0.40			2.52
1984	0.36	1.63	0.65	0.07		2.71
1985	0.45	1.80	0.85	0.35		3.46
1986	0.47	1.72	1.07	0.57	0.47	4.29
1987	1.23	1.50	1.21	0.84	0.65	5.41
1988	1.50	1.35	1.37	0.95	0.40	5.57
Total	7.63	12.01	5.58	2.78	1.50	29.50

Danish Gas Production 1972-1988, billion Nm^3

Year	Dan	Gorm	Skjold	Tyra	Rolf	Total	Sales Gas
1972	0.02					0.02	
1973	0.03					0.03	
1974	0.03					0.03	
1975	0.06					0.06	
1976	0.07					0.07	
1977	0.17					0.17	
1978	0.16					0.16	
1979	0.16					0.16	
1980	0.07					0.07	
1981	0.08	0.08				0.16	
1982	0.08	0.27				0.35	
1983	0.08	0.43	0.04			0.55	
1984	0.13	0.51	0.06	0.26		0.96	0.22
1985	0.21	0.65	0.08	1.12		2.06	1.04
1986	0.24	0.78	0.10	1.63	0.02	2.77	1.80
1987	0.44	0.88	0.10	2.65	0.03	4.10	2.30
1988	0.60	0.98	0.11	3.36	0.02	5.07	2.27
Total	2.64	4.58	0.49	9.02	0.07	16.80	7.63

Part of the gas has been reinjected.

Appendix D

Danish Production of Oil and Condensate 1988, thousands m^3

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	1988
Dan	122	110	140	133	128	139	140	128	112	123	112	108	1,497
Gorm	124	118	121	114	119	109	115	110	105	109	101	109	1,354
Skjold	107	101	108	102	107	105	107	106	97	105	155	168	1,370
Tyra	89	87	92	77	68	55	64	69	66	90	100	99	953
Rolf	40	35	37	36	35	32	32	31	30	30	30	29	396
Total	482	451	498	462	457	440	458	444	410	457	498	514	5,570

Danish Production of Gas 1988, million Nm^3

	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	1988
Dan	51	47	50	48	50	52	54	53	44	52	49	48	598
Gorm	83	82	87	78	87	82	83	81	79	73	79	81	976
Skjold	9	8	9	9	9	8	9	9	8	8	13	14	111
Tyra	330	319	329	274	231	182	212	233	219	314	365	356	3,364
Rolf	2	1	2	2	1	1	1	1	1	1	1	1	17
Total	475	458	476	411	378	325	359	377	352	448	507	500	5,066

Field name:	**Dan**
Prospect:	Abby
Location:	Block 5505/17
Concessionarie:	A.P. Møller
Operator:	Mærsk Olie og Gas A/S
Discovered:	1971
Year on stream:	1972
Producing wells:	44
Injection wells:	1
Water depth:	40 m (131 ft)
Areal extent:	30 km^2 (7,500 acres)
Reservoir depth:	1,850 m (6,070 ft)
Reservoir rock:	Chalk (Danian/Maastrichtian)

Reserves Expectation

Oil:	46 million m^3 (289 MMBBLS)
Gas:	15 billion Nm^3 (559 BSCF)

Cumulative Production

Oil:	7.6 million m^3 (48 MMBBLS)
Gas:	2.6 billion Nm^3 (97 BSCF)

Review of Geology

Dan is an anticlinal structure induced through deep seated salt tectonics of the Zechstein/Triassic. The chalk reservoir has adequate porosity, although strongly reduced permeability. A major northeast-southwest fault subdivides the field into two independent reservoirs.

Production Facilities

The field installation comprises five wellhead platforms (A, D, E, FA and FB), two processing/accommodation platforms (B and FC) and one gas flare jacket (C).

Processing of the produced oil and gas takes place at Dan FC, the older processing facilities at Dan B are only used for temporary, individual well production testing. Final processing of the produced oil is performed at Dan FC prior to export ashore via the booster platform at Gorm E. The gas is preprocessed at Dan FC and further transported to Tyra East for final processing and export ashore. Water treatment and pumping facilities for water injection were also installed at Dan FC. The accommodation capacity at the Dan Field corresponds to 94 persons.

Field name:	**Gorm**
Prospect:	Vern
Location:	Blocks 5504/15 and 16
Concessionaire:	A.P. Møller
Operator:	Mærsk Olie og as A/S
Discovered:	1971
Year on stream:	1981
Producing wells:	18
Injection wells:	2
Water depth:	39 m (128 ft)
Areal extent:	12 km^2 (3,000 acres)
Reservoir depth:	2,200 m (7,218 ft)
Reservoir rock:	Chalk (Danian/Maastrichtian)

Reserves Expectation

Oil:	26 million m^3 (164 MMBBLS)
Gas:	6 billion Nm^3 (223 MSCF)

Cumulative production

Oil:	12.0 million m^3 (76 MMBBLS)
Sales gas:	0.3 billion Nm^3 (11 BSCF)
Injection gas:	4.3 billion Nm^3 (160 BSCF)

Review of Geology

Gorm is an anticlinal structure due to Zechstein salt tectonics at depth. A major fault extending north-south subdivides the field into two individual reservoirs. The western reservoir block is considerably fractured.

Production Facilities

The Gorm Field consists of two wellhead platforms (A and B), one processing/accommodation platform (C), one gas flare jacket (D) and one riser/booster platform (E).

Final processing of oil and gas takes place at Gorm C prior to export ashore via Gorm E (oil) and Tyra East (gas). The gas reinjection facilities are installed at Gorm C. Total accommodation facilities correspond to 98 persons.

Appendix E

Field name:	**Skjold**
Prospect:	Ruth
Location:	Block 5504/16
Concessionaire:	A.P. Møller
Operator:	Mærsk Olie og Gas A/S
Discovered:	1977
Year on stream:	1982
Producing wells:	2
Injection wells:	2
Water depth:	40 m (131 ft)
Areal extent:	10 km^2 (2,500 acres)
Reservoir depth:	1,600 m (5,250 ft)
Reservoir rock:	Chalk (Danian/Maastrichtian)

Reserves Expectation

Oil:	29 million m^3 (182 MMBBLS)
Gas:	3 billion Nm^3 (112 BSCF)

Cumulative Production

Oil:	5.6 million m^3 (35 MMBBLS)
Gas:	0.5 billion Nm^3 (19 BSCF)

Review of Geology

The Skjold Field is an anticlinal structure induced through Zechstein salt tectonics. The structure is heavily fractured which resulted in favourable reservoir conductivity, in particular within the crestal part of the structure.

Production Facilities

The Skjold Field comprises a satellite development to the Gorm Field, including one unmanned wellhead platform. The produced oil and gas are transported by pipeline to Gorm C for processing and export ashore.

Temporary water treatment and injection facilities have been installed on a modified jack-up drilling platform, attendant to the Skjold wellhead platform.

Field name:	**Tyra**
Prospect:	Cora
Location:	Blocks 5504/11 and 12
Concessionaire:	A.P. Møller
Operator:	Mærsk Olie og Gas A/S
Discovered:	1968
Year on stream:	1984
Producing wells:	28
Injection wells:	8
Water depth:	37-40 m (121-131 ft)
Areal extent:	52 km^2 (13,000 acres)
Reservoir depth:	2,000 m (6,562 ft)
Reservoir rock:	Chalk (Danian/Maastrichtian)

Reserves Expectation

Oil and condensate:	12 million m^3 (76 MMBBLS)
Gas:	45 billion Nm^3 (1,675 BSCF)

Cumulative Production

Oil and condensate:	2.8 million m^3 (18 MMBBLS)
Sales gas:	6.8 billion Nm^3 (253 BSCF)
Reinjected gas:	2.2 billion Nm^3 (82 BSCF)

Review of Geology

The Tyra Field is an anticlinal structure, probably related to tectonic inversion or salt tectonics or both. A marked hardground separates the Danian and the Maastrichtian chalk reservoir rocks.

Production Facilities

The production facilities include two major structural complexes, i.e. Tyra West and Tyra East, each consisting of two wellhead platforms, one processing/accommodation platform, and one gas flare jacket; a riser platform was installed at Tyra East housing the gas export outlet into the main gas pipeline.

Final processing of gas and stabilization of condensate take place at Tyra East. The stabilized condensate is transported to Gorm E for export ashore. A gas recycling facility has been installed at Tyra West for enhanced condensate recovery. The total accommodation facilities at the Tyra Field hold 176 persons (96 at Tyra East and 80 at Tyra West).

Field name:	**Rolf**
Prospect:	Middle Rosa
Location:	Blocks 5504/14 and 15
Concessionaire:	A.P. Møller
Operator:	Mærsk Olie og Gas A/S
Discovered:	1981
Year on stream:	1986
Producing wells:	1
Water depth:	34 m (112 ft)
Areal extent:	not released
Reservoir depth:	1,800 m (5,900 ft)
Reservoir rock:	Chalk (Danian/Maastrichtian)

Reserves Expectation

Oil:	2 million m^3 (13 MMBBLS)
Gas:	< 1 billion Nm^3 (36 BSCF)

Cumulative Production

Oil:	1.5 million m^3 (9 MMBBLS)
Gas:	0.1 billion Nm^3 (4 BSCF)

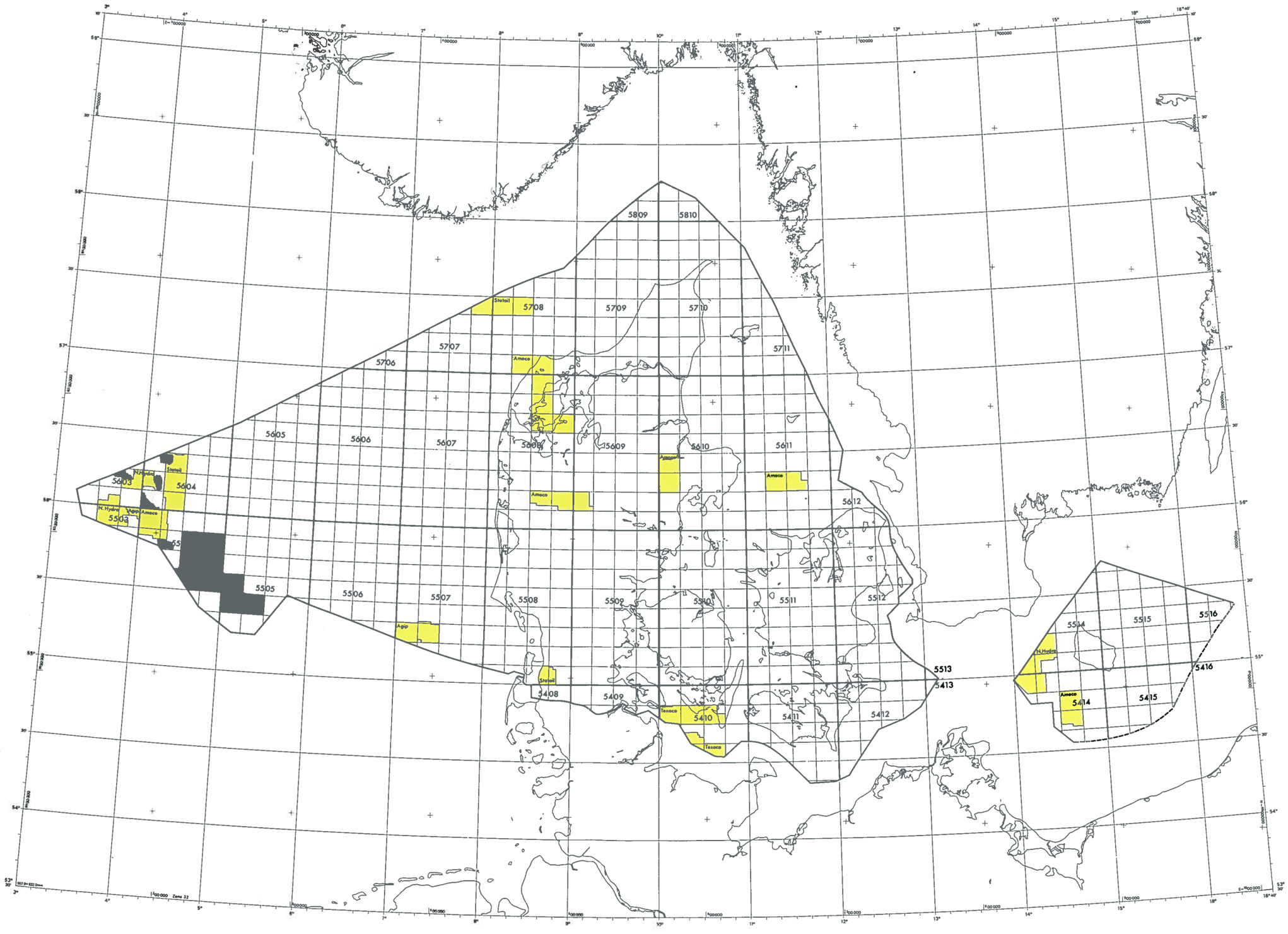
Review of Geology

The Rolf Field is an anticlinal structure due to Zechstein salt tectonics. The chalk reservoir is heavily fractured resulting in favourable reservoir conductivity (compare Skjold).

Production Facilities

The Rolf Field comprises a satellite development to the Gorm Field including an unmanned well-head platform. The produced oil and gas are transported to the Gorm C platform via pipeline.

The Danish Licence Area January,1 1989



DUC Licence Area

1. & 2. Round Licence Area

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