petroleum review

May
Vol. 41 No. 484 April 1987 £3.75
Subscription £33.00 inland £46.00 overseas

The Institute acquired its crest, designed by the College of Heralds, in 1949. Its motto, 'Conjunctione Potiores' (strength through unity), supports a shield portraying the Archaeopteryx, an avian fossil which was found in Jurassic strata similar in age to important oil-bearing formations in the North Sea.

Petroleum Review
is published monthly by
The Institute of Petroleum
61 New Cavendish Street
London W1M 8AR
telephone 01-636 1004 telex 264380

Printed by
Eyre and Spottiswoode Ltd,
London and Margate.

Cover: On the left, Professor Eric Ash, CBE, Rector of Imperial College of Science and Technology, London; centre, William Bell, CBE, Chairman of Enterprise Oil; and right, Professor John Archer, Head of Petroleum Engineering, Imperial College. Behind them the pressure-volume-temperature (PVT) cell, provided by the oil company for research at the Enterprise Laboratory at Imperial College into the fluid properties of North Sea gas condensate. The temperature-controlled cabinet is capable of accurately maintaining cell temperature in the range −20 to +175°C. To the left is the double cylinder pump (up to 15,000 psi), used to pressure samples in the cell by means of mercury. Article page 13.
Photo by Terry More.

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ISSN 0020-3076

THE SECOND OIL LOSS CONTROL CONFERENCE

Wednesday, 7 October, 1987

to be held at
The Cavendish Conference Centre
London

SCOPE OF PAPERS

Crude Oil Loss Analysis

An analysis of differences between Bill of Lading and Outturn quantities as supplied by major oil companies, to establish a pattern of loss distribution.

Examination of Losses, their Source, Magnitude and Influence

Four short papers:
Overall Review
Crude Oil Sample Handling
Measurement of Wet and Dry Density
Shore tank Calibration

Cargo Measurement and Inspection Guidelines

Preview of IP Codes of Practice for cargo measurement and inspection.

Gasoline Vapour Losses — Environmental Considerations

Environmental regulations applicable to vapour emissions in gasoline distribution – technical and economic considerations.

Gasoline Vapour Recovery

Operational experiences and IP viewpoint on various types of vapour recovery units as expressed by a panel of speakers from BP, Exxon, Mobil and Shell.

Computer Aided Loss Investigation and Monitoring

The application of statistical analysis of historical data to reveal source and magnitude of measurement errors.

Registration Fees will be **£95 (plus 15% VAT)** for IP individual members or nominated representatives of collective members, and **£120 (plus 15% VAT)** for non-members.

For further information and a copy of the registration form, when available, please contact **Caroline Little,** The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Telephone: 01-636 1004. Telex: 264380.

PETROLEUM RETAILING: EUROPE AND THE UK

20 and 21 May 1987

To be held at
The Institute of Petroleum

Day 1

An outlook on the role and future of oil in the European Community and the consequences on retailing activities (J. Bishop, Principal Administrator, Directorate General for Energy, Commission of the European Communities)

International aspects of retail developments of today (A. E. Gustaffson, Strategic Business Adviser in the Retail Business Development Unit, BP Oil International)

Retail profitability (J. J. F. Timmerman, Head of Retail Development, Shell International Petroleum)

Debit cards — Why did it take so long? (K. C. Bignall, Deputy Divisional General Manager, Barclays Bank)

The role of a major petrol retailer — Retailing is Detailing (G. W. Fisher, General Manager, Retail, Mobil Oil Co. Ltd)

The retailer today (C. K. B. Petter, Director, Petrol Retailers Association)

Day 2

Driver-controlled deliveries (M. E. J. Blount, Market Development Engineer, Micrelec)

Convenience store development (J. R. Hunt, Director of Oil and Licence, Circle K)

Twenty-four hours unattended self-service (P. G. Plumridge, Architect for Retail Petrofina (UK) Ltd)

Changes in distribution (P. G. Edgington, Marketing Distribution, BP Oil International)

Marketing of unleaded petrol in Europe (L. Liebaert, Retail Co-ordinator, Kuwait Petroleum International)

Registration fees to cover both days will be **£165 plus 15% VAT** for individual IP members, or nominated representatives of collective members, and **£185 plus 15% VAT** for non-members.

For a copy of the registration form please contact **Caroline Little**, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR.
Telephone: 01-636 1004. Telex: 264380.

18 March

A Statoil delegation will fly to China early this month to negotiate offshore acreage

Asamera Inc has sent a letter of intent to sell its Denver refinery to Total (North America) for an undisclosed sum

An Administration study says the growth in US oil imports and reliance on the Middle East could damage US national security

19 March

The Government intends to sell its remaining shares in BP during this financial year

Shell Francaise will close its refinery in Berre L'Etang to upgrade its CAT cracker

Petro Canada signs a CAN$19.1m agreement to provide personnel and technology to develop Jordan's oil and gas industry

The USSR is to raise the volume of construction in its oil and gas industry by one third under its twelfth five-year plan

20 March

Ten major oil companies are backing the second stage of a sub sea research programme that will cut costs of North Sea development

Technip SA and Institut Francaise du Petrole are to build a plant for the hydrotreatment of paraffin in China

Mexico has raised its oil prices of heavy Maya crude by Cts35 a barrel to the US and Cts 25 a barrel to Europe

23 March

Kuwait Petroleum Company may take a stake in BP to increase its presence in the downstream market

Figures from the Instituto Nacional de Hidrocarburos states Spain's import of LPG has slumped by more than 28 per cent

An Exxon official warned of an inevitable increase in oil prices as non-Middle East supplies diminished

24 March

British Coal won support from West German company Ruhrkohle for its pilot scheme to produce petroleum products from coal

25 March

Shell apply for permission to develop the Kittiwake and Osprey North Sea oil fields

Norske Shell announces that the Kr 10bn development of the Draugen oil field is nearly complete and will be declared commercial in the near future

An energy analyst says that Papua New Guinea has exciting prospects for oil production

26 March

The chairman of BP asks governments to match oil company cost cutting by cutting taxes, thus allowing them to develop new fields in an era of lower prices

The Abu Al-Bukhoosh oil field in the Gulf should reopen soon when new anti-aircraft defences are ready

Singapore will sign an agreement later this year to refine oil produced by wells off the coast of South Vietnam

The Canadian Energy Minister announces that the government will provide a CAN$350m oil industry aid package to cover one third of a company's exploration and development costs

27 March

Ecuador is negotiating with Nigeria to have a loan of 10,000b/d of crude oil for export

Russia has agreed to sell 250,000 tonnes of crude oil to Finland for re-sale to the world market

Tension between Turkey and Greece escalated when an oil exploration vessel was sent by Ankara to the Aegean Sea where both have conflicting claims over the continental shelf

30 March

BP's Exploration chairman outlines the company's plans for an integrated gas pipeline system in the central North Sea to a Commons select Committee on energy

Shell UK unveils an offshore drilling programme based on 45-50 string months of exploration and appraisal for 1987

Iraq claims its warplanes destroyed an Iranian oil pumping and pipeline facility at Ganaveh

Pemex will join Peru in projects to find, extract, refine and export petroleum

31 March

The Australian Petroleum Exploration Association says oil exploration dropped to its lowest level in six years in the first quarter of 1987

Total are to increase their investment in exploration, production and acquisition by FF 2bn in 1987

1 April

Drilling activity in the North Sea is set to recover in April as it expected to be a fruitful month for exploration

Chevron Corp. says its Chevron USA Inc unit and Nippon Oil Co Ltd agreed to a joint oil exploration and development venture

Kuwaiti Petroleum Corp. announces it has agreed to buy BP's oil market subsidiary for an undisclosed sum

2 April

Chase Manhattan has marketed a tool allowing clients to hedge against oil price movements for several years ahead

3 April

Charterhall announced the sale of its Rio Tinto-Zinc of North Sea oil assets for £3.2m in cash

A US Energy Department official told senators that a plan to cut the rate at which the US emergency oil reserve is being filled is being reviewed

A Western expert claims that the Chernobyl disaster has not changed Soviet plans for nuclear power stations, but will eventually cause problems for the electricity industry

A Wood MacKenzie study claims an increasing surplus of petrol products from the Middle East is expected as part of a general rise in the volume of the international products trade

6 April

Ulster will soon announce its first round of onshore oil and gas licences, in a move to correct its reliance on imported fuel

Brazil announced a second oil strike in the Amazon jungle which it says, confirms the discovery of a major oil field

Mexico received half of a S 500m loan to build a 150 mile oil pipeline to boost crude export capacity to the Far East

Latest figures from the IEA claim growth in oil consumption in the Western industrialised countries is likely to slow to 1% in 1987 compared with 2.3% in 1986

7 April

Statoil said that it expects to open gas sales talks with British Gas this spring

8 April

Occidental Petroleum Corp said the Shiviyacu -23 development well in the Amazon jungle is producing 6,593 b/d of oil

Du Pont's chairman said they expect oil prices to rise moderately, to $25 a barrel by 1995

9 April

In Canada, Neste and Hoechst Canada will join forces to build an octane enhancer petrochemical plant in Edmonton, Alberta

10 April

Shell and Esso's cost cutting drive is expected to result in the development of three North Sea oil and gas fields

Ecuador is due to resume limited crude output when a pipeline to Colombia is finished

Four exploration blocks offshore the Netherlands have been offered to Conoco, Louisiana Land & Exploration Co, and Oranje-Nassau Energie BV

Zenex Oil Pty has acquired Esso's interests in South Africa, including 160 service stations and bulk fuel distribution network

13 April

A cartel of British ship-owners in the North Sea supply boat market had a secret price-fixing pact to keep charter rates above break-even level

Salvage workers on the Herald of Free Enterprise are worried that chemicals carried by lorries could spill if the ship rolled

Dome Petroleum rejected a £2.1bn bid by Transcanada Pipelines for its takeover, and is pursuing discussions with other parties

The USSR and another major oil company are negotiating the sale of Urals Blend crude, at a Brent crude-related price

14 April

Petrobras has claimed that a find in the Upper Amazon Basin could double Brazil's natural gas reserves

Gulf Canada Corp has acquired a 25 per cent working interest in a major acreage block in the Gulf of Suez

Proven and probable West German oil reserves have fallen by 4.6m tonnes between early 1986 and early 1987

15 April

The Norwegian government is proposing an investment calling for the development of oil and gas fields of £2.25bn pa through to 1995

Oman hopes to be among the OPEC countries allowed to increase oil output in the second half of this year

Independent directors of Standard Oil are delaying making a decision on the fairness of BP's $70 a share tender for 45 per cent of the Company

16 April

Amoco is to go ahead with its development of the Arbroath oil field in the North Sea, east of Aberdeen

Nigeria has agreed to lend Ecuador 1.5m barrels of crude to enable it to export oil to foreign customers

A group of Swedish companies will begin drilling for an estimated 15-30m barrels of oil along the country's southern tip

South Yemen announced an oil find of commercial quantities in the north-west of the country

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granted Lloyds Approval

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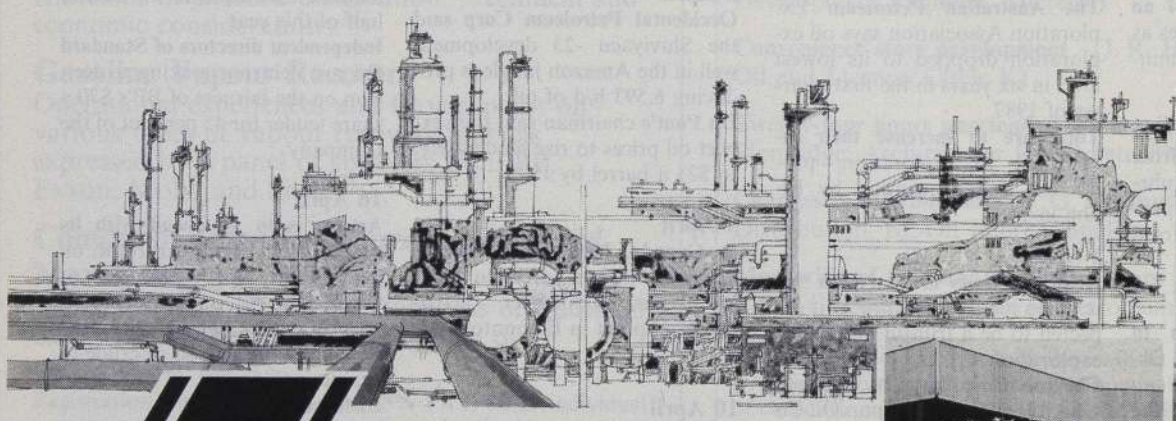

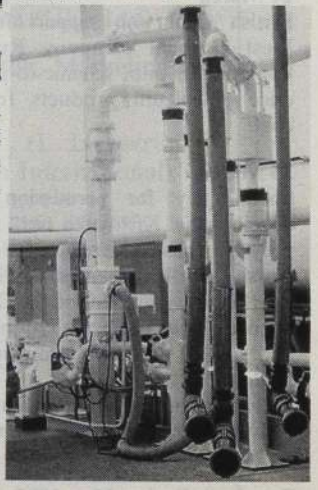

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A MEMBER OF THE FMA GROUP

The President of the Institute of Petroleum, Dr Pierre Jungels, greeting the Minister of State for Energy, the Rt Hon. Alick Buchanan-Smith, MP, on the steps of the Institute in New Cavendish Street, when the Minister arrived to address the 1987 IP Council Symposium

The Energy Minister offers the services of his DG, Petroleum Engineering, for co-ordination

'The Institute of Petroleum should create more offshore codes within a year'

The Rt Hon Alick Buchanan-Smith, MP, Minister of State for Energy, chose the 1987 Council Symposium to make a remarkable proposal to the Institute of Petroleum. It was:

- The Institute of Petroleum should give priority to creating UK engineering standards and operating codes of practice for the offshore oil industry, and be well advanced in this new activity within a year

- The object of these upstream standards and codes would be to attain for them the world-wide reputation which the IP downstream codes etc already enjoy because of their comprehensiveness

As a measure of the need and his confidence in the Institute's ability to carry out this function, he:

- Offered the services of his Director General, Petro leum Engineering Division, Department of Energy, Mr Peter Walmsley, to be the chairman of a committee which, he suggested, would co-ordinate the drive to establish the offshore codes of practice

'Codes have more authority when produced outside Ministry'

The Minister stated that the Institute's member companies had the staff who possessed the knowledge to produce codes that would ultimately help UK offshore exports.

The President of the Institute, Dr Pierre Jungels, and Mr JTC Hay, Chairman of the IP Exploration and Production Committee, expressed their delight with the Minister's announcement.

'As long as members think they cannot touch a subject because someone somewhere else is into it, we shall not progress,' said Dr Jungels. 'We must produce codes.'

New style

This year's IP Council Symposium at 61 New Cavendish Street, London, was also different in another respect. Technical committee chairmen included in their presentations estimates of the large sums which had and can be saved by the oil industry through the voluntary work of their members.

Mr Buchanan-Smith said, in part: I was recently elected a Fellow of this Institute. I feel privileged to have this position. Having worked in the Department of Energy for four years, I do appreciate what an honour this is.

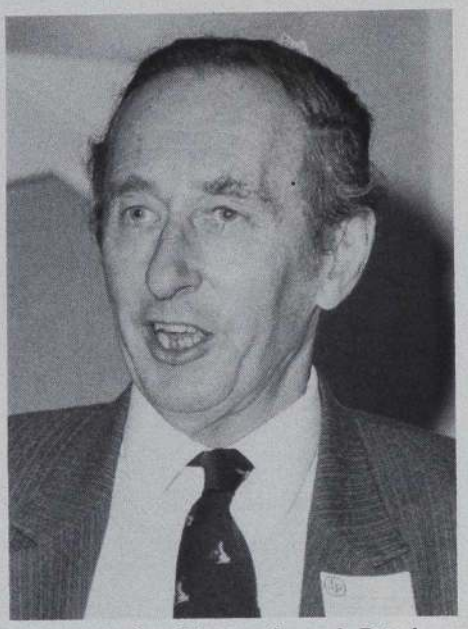
I have been very conscious of the role of the IP. It is a very important role. I have attended meetings of branches outside London and have met many members around the country.

Standards

In particular, I recognise the work of the IP in setting standards and codes of practice.

In the downstream sector, these have been developed over many years by the Institute acting as a respected learned society for the industry, and they enjoy a world-wide reputation for their comprehensiveness. They are the product of a lot of active support by Member Companies in making sure that their in-house experts have the time to sit on the Institute's subcommittees and are able to use company facilities to evaluate test methods etc. These are recognised world-wide.

I know there are pressures on everyone's budgets, but I hope that companies are not becoming reluctant to support the Institute's activities, as they have so magnificently in the past. If this did happen, and, for example, the IP Measurement and Test Methods became obsolete, because of new advances in analysis and instrumentation, then the IP would lose its world-wide standing in this sector. I believe that would be a tragedy.



Peter Walmsley, Director General, Petroleum Engineering Division, Department of Energy

Upstream

Disappointingly, standards and codes of practice have not made so much progress in the upstream.

Although the UK offshore industry is of recent origin, it has made very fast progress and this gives the UK the opportunity to ensure that we set standards and codes of practice.

The Department of Energy, as the regulatory authority, requires offshore installations to be designed and constructed to recognised standards and codes of practice. While the Department does not make standards or codes of practice, nevertheless these must exist to support our regulatory requirements.

The IP has revised and updated one of the several parts of its Model Code of Safe Practice relating to drilling and production on land. Some other parts of this model code are in need of revision.

The American Petroleum Institute (API) is the only other source of comprehensive standards for upstream petroleum operations.

'Surely wrong'

As one of the largest established producers of offshore oil, and in many areas a leader in world technology, it is surely wrong that the UK has no wide-ranging standards or model codes of our own which are widely used in the offshore sector—other than my own Department's Guidance Notes and a few peripheral codes and standards.

Surely the time has now come when we should turn our experience built up over the years into standards and codes of practice, to become models for use by other countries.

The American Petroleum Institute works closely with the US regulatory authorities and even my Department monitors closely the API's activities because we depend heavily on their standards.

The UK's wealth of offshore experience should be translated into standards and codes of practice, building on UK expertise.

I recognise that the creation and maintenance of codes is not an easy task. But I hope that there will be no lack of commitment by the industry to such a task. Standards and Codes of Practice are essential and the Institute of Petroleum's membership comprises many of the organisations and individuals who have the expertise to contribute to making standards and codes.

They have got to be prepared to allow the time of senior and able people to carry out this task. Within the oil industry lies all the ability and capacity and expertise that is needed.

I hope that the IP will be a catalyst, that the IP Council will give priority to this work and that it will be supported in it by member companies. There is a case for urgent discussions to be held to identify the areas of shortage, to identify who can best provide expertise to fill the deficiencies and to identify who can carry on the impetus and overall co-ordination.

I hope that by this time next year, the preparation of several offshore Codes of Practice are well underway.'

Co-ordination

The Minister then made a proposal that surprised and interested the audience. 'To this end,' he went on, 'I do think that there is a case for urgent discussions to be held, possibly under the initial Chairmanship of the Director General of my Petroleum Engineering Division, Mr Peter Walmsley, who can best carry out the co-ordination.

I hope my offer of his assistance will be a trigger and that the Institute will make sure that it has a positive role across the industry—and that it is looked up to from every part of the world.'

The audience appreciated the importance of this suggestion. There were some questions, in reply to which

Mr Buchanan-Smith stressed that more authority was given to a code that was produced outside the Ministry, as these were seen to be the work of the industry itself.

'We feel we have more authority when we have the total support of the industry,' he explained. 'It gives us more authority and it gives you more authority.'

Welcome

When he summed up the day's presentations, the President, Dr Jungels, observed of Mr Buchanan-Smith's proposal:

'I was extraordinarily pleased to hear what the Minister had to say. As long as members think that they cannot touch a subject because someone somewhere else is into it, we shall make no progress.

'We are an unbiased body, unlike many organisations. We are unbiased because of our broad membership.

'The IP means something world-wide. Overseas governments will accept something written by the IP.

'And so the Minister's message was extremely clear—to take advantage of the upstream and export it abroad. We must produce codes. I am pleased that at this meeting the Minister has given a lead.'

Mr JTC Hay, Chairman of the Exploration and Production Committee, commented on this in his presentation: 'I was delighted to hear the Minister put emphasis on trying to get more involvement in the upstream area, and particularly the offshore.'

There had not been many 'demarcation lines' difficulties with other bodies, he pointed out.

'But of greater concern,' he observed, 'is whether no one party is looking at it. So it is an excellent suggestion that a group be set up under Peter Walmsley to look at the whole area of upstream activities.'

Presentations

The Council Symposium was based on presentations by IP committee chairmen, and members of their committees, and work in progress was reviewed.

The Symposium's range of topics of current vital interest to the oil industry was vast, a numbr of points from these being reported below.

Ted Williams, recently appointed Director-General of the Institute, followed Mr Buchanan-Smith with a review of the IP's current background. He stated: 'As the President said, it is gratifying to see such a good turnout. This is

The Minister giving the keynote address

very reassuring and shows the measure of support and interest available to the Institute from those close to its activities.

I say this because, as brand-new Director-General, I have become aware that all is not entirely well with certain of the Institute's relationships. People who have little idea what the IP does criticise it, and companies to whom the total IP cost is less than the thickness of the line on their financial graphs, complain about their subscription fees.

Why is this, when the Minister can talk as he has about our international professional reputation?

Firstly, there is the British tendency to grumble at all our institutions, noted a few weeks ago by our President. We cannot do much about that, except perhaps to respond to the wind of change that has swept our industry in recent years (indeed perhaps our country), by following this example in simplifying our decision-making and administrative procedures, by using more direct English and by tolerating the occasional mistake made in good faith. Nobody has been able to tell me of anything which the Institute has said or done which was "wrong". An intriguing thought.

Role of the Institute

It is more urgent, however, to deal with the company relationships. The first step must be to get across to key senior people in the major companies, and the Government Departments and other Associations to whom they relate, what the Institute does.

That is what we shall attempt to do at today's Council Symposium to a wider audience than previously.

In particular, we are giving a longer but more specific presentation from each of the main technical committees this morning: Standardisation, Measurement and Engineering. The exchange of expertise and the reaching of consensus between companies and other users, which takes place in these committees and their working panels, results in codes and standards which would have to be produced by a new, similar UK organisation if the IP no longer did the work. The ensuing confusion and reconstruction might cost many times one year's subvention to the IP.

The three main technical committee chairmen will ask a colleague to illustrate a specific project and why it was worth doing.

'An under-utilised UK asset in the offshore area'

The next stage in our review of IP/company relationships is to look at what we should be doing differently from our current activity. We have heard the Minister on one deficit, namely the production of up-to-date offshore safety codes. At present, there are, in this area, Department of Energy and UKOOA guidance notes, plus each company's own practices — in the case of US majors, often based on API.

It seems to me that the IP has become an under-utilised UK asset in this offshore area (unlike in the fields of crude oil measurement and testing) and we look forward to discussing this under the Chairmanship of Peter Walmsley.

One other area where the Institute's present role is perhaps unsatisfactory is in atmospheric and land environment matters.'

Engineering and resources

Mr MJ Salter, Chairman, Engineering Committee, said that the tightening of industry's belt since the oil price collapse had made it much more difficult to find resources. As many companies had placed severe constraints on manpower, many committee members were under great pressure to curtail their IP activities.

This situation seemed unlikely to improve in the short term and was exacerbated when senior managements were not in a position to evaluate the benefit of the involvement of their people in IP Engineering Committee work, especially when not related to codes of practice.

It was the intention in 1987 to review all representational activities and to assess the likely benefit to the oil industry

against the downside risk arising from non-participation.

Methods of resourcing effort for the preparation of codes of practice would also be reviewed with the aim of reducing the time spent by working groups on non-technical matters.

He invited **Mr B Veale** to explain the work of one of the panels — Panel C — and the benefits that arose.

Savings through vehicle design

'Most of what we do has a commercial benefit,' said Mr Veale. 'For example, the Bottom Loading Code (for road tank vehicles) has attracted much interest in European countries.

'We have produced in conjunction with the Health and Safety Executive a code of practice covering the up-to-date approach to vehicle design and construction, which will shortly be published. Our industry will be able to make significant change and have more efficient and safer vehicles.

'Using the combined experience of safety features, we have been able to show the HSE that it is not necessary to remove pressure vacuum valves from vehicles for annual test, saving an estimated £850,000.

Brian Veale, Chairman of the Conveyance Panel of Marketing Sub-Committee of the IP Engineering Committee

'Nor that it is necessary to replace valves on existing vehicles with the valves of the latest design, which would have cost the industry between £1½m and £2m.'

More technical sophistication

Peter Jones, Technical Secretary, described the development of the new IP code on Area Classification, for the reason that petroleum industry operations had become infinitely more sophisticated, creating the need for far more detailed guidance.

'The objective of the new one-volume IP Code is, therefore, to consolidate and replace and update previous guidance on area classification in other IP Codes, and to use the fund of experience which has been gained within the petroleum industry to promote the consistent interpretation and application of the definitions in IEC 79/10 and BS 5345 over the whole range of situations which occur throughout the industry,' he said.

'An annual saving of £850,000 on valve removal — and another of £1½m on valve replacement'

Mike Salter, Chairman, IP Engineering Committee

'More details on this project will be given at the forthcoming Second Oil Loss Conference to be held in the Cavendish Conference Centre on 7 October this year. I hope that even if you do not attend this conference yourselves, you will make sure your company or association is represented. It will be a worthwhile day.'

A member of the committee, **Derek Brown**, gave specific examples of the problems of petroleum measurement and the practical use of IP codes. He said:

'At two, or less, dollars a barrel, the world-wide petroleum industry approach to oil loss was that if any movement or handling resulted in a loss less than 0.5 per cent, then there was nothing to be concerned about. In fact this philosophy was even incorporated into the legal systems of many countries and also formed a 'Usage of Trade' benchmark that was universally accepted by the courts in respect of cargo claims. With the then low cost of crude this possibly made good economic sense.

Power station under billed

'Today it is recognised that the level of oil loss is a prime indicator to the efficiency of our operations and by improved measurement, controls and understanding of the statistical aspects of monitoring we can improve profitability.

'By 1983 about half of the IP's Petroleum Measurement Manual had been updated. This was only possible because the companies within the industry had made available sufficient experts to con-

Growing awareness of oil loss

John Miller, Chairman of Petroleum Measurement Committee, spoke in part, on oil loss.

'I would like to draw your attention to a group that recently came together, representatives from eleven oil companies, including most, but not all, of the majors, to exchange, in strict confidence, crude oil data which will show differences between Bills of Lading and Outturn Quantities for tanker loadings,' he said. 'This will enable a pattern of loss distribution for various loading and discharge ports throughout the world to be established.

John Miller, Chairman, IP Petroleum Measurement Committee

tribute towards the development, updating and review of standards. I will give you three examples of the importance of the use of the correct measurement standard and how these have to be updated to meet the changing market conditions.

'First, in the past both IP and API standards for tank calibration referred to the corrections which allow for the bulging of a tank wall during filling (hydrostatic head) and for changes in the temperature of the steel tank plates as factors that "may" or "can" be included in the tank tables, few bothered to do so. This was $2 a barrel thinking and when looked at with $10 a barrel eyes presents a totally different picture.

'For example, without these corrections deliveries to one power station were underbilled by approximately £3m per annum. In this case, once the problem had been recognised, a simple change in the wording to include "must" or "should" was all that was necessary.

'Slightly more complicated is where data is handled by the "black box". Often this has resulted in computer programmers, who are not necessarily petroleum measurement experts, developing systems which are difficult to monitor. In one such case a gas distribution system was found to have incorrectly allocated the entitlement between owners and adjustments of approximately £70m had to be made. Awareness of "black box" technology and the inherent security problems are areas that have now been addressed by those issuing standards.

'Thirdly, I should like to mention the industry's approach to the sediment and water (BS&W) content in crude oil. This is normally present in crude and has to be deducted to ascertain the net oil for billing purposes. Since the escalation in price from $2 a barrel we have issued three new standards to improve this measurement.

Derek Brown, Chairman, Oil Loss Control Sub-Committee of the IP Petroleum Measurement Committee

'New petroleum measurement tables gave improvements worth £20m a year'

Moving from unheated centrifuge to heated centrifuge, distillation and extraction and lastly to the Karl Fischer Titration System. This coupled with the issuing of the new volume reduction tables in 1980, which recognised modern crude oils, meant an improvement in crude oil measurement by approximately 0.2 per cent, which is equal to approximately £20m per annum in respect of the UK activities.

Oil measurement problem not yet dealt with

'The "Era of Misconception" started to appear about two years ago and is intensifying. How do we recognise this new era? There is the belief evident in some managements that they have dealt with the oil measurement problem in responding to the $10 barrel price in the seventies and now their efforts belong elsewhere. This misunderstanding of the situation is strengthened by citing that oil prices have fallen from $30 to $15.

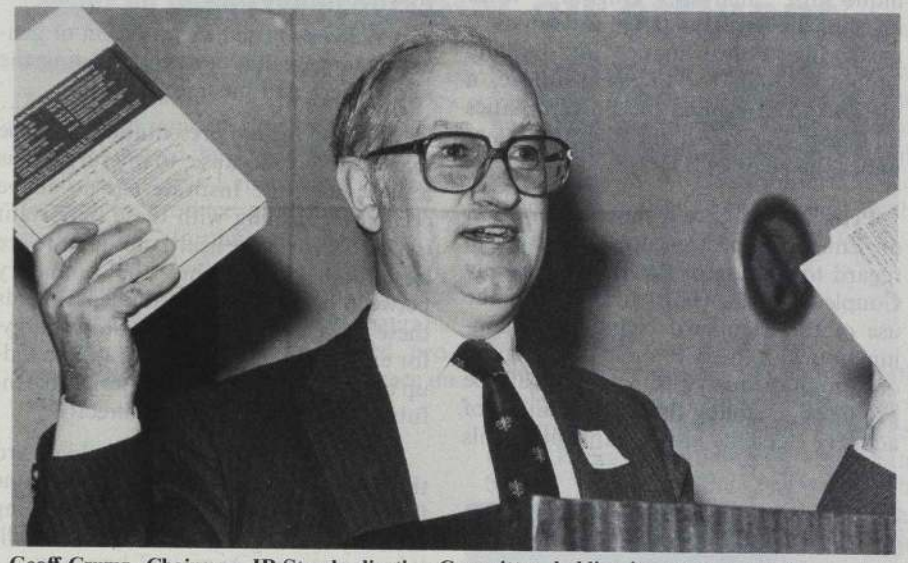
'Neither attitude is correct. It has to be recognised that standards take several years to develop, new technology and implementation also require time to review and install, most importantly, that the standard bodies efforts have been geared to ten dollar a barrel oil. We never reached the $30 plateau.

'Unfortunately, and it may not be entirely unrelated, the era of misconception has coincided with a general cut back within the industry. Both here in the UK and in another major standards contributor, the USA, there has been a substantial reduction in company resources allocated to assist standard bodies and this in itself has become a major concern.

'This is perhaps an opportune moment to cite another benefit of standards, particularly as it relates to the "in vogue" area of cost savings.

'During the past few years the IP and other standard bodies have been developing a standard relating to a simplified method of tank calibration. This system, called "optical reference line", saves the construction of platforms around the tank and in the case of insulated tanks the removal of the insulation when a tank is recalibrated.

'The IP issued a paper on this method in 1983 and the procedure has been widely adopted. Savings can amount to one thousand pounds per tank and I should also mention that the safety aspects of this system have considerable advantages over the previous method.'



Geoff Crump, Chairman, IP Standardisation Committee, holding its magnum opus

Standardisation has solid support

Geoff Crump, Chairman, Standardisation Committee, highlighted the organisation and activities of the Standardisation Committee (ST). He quoted that the two volumes of Standard Test Methods contained some 258 Full Methods and 24 Proposed Methods. Of the Full Methods, 82 are joint with the American Society of Testing and Materials (ASTM) and 70 are incorporated in the BSI 2000 Series. ST membership

(including sub-committees and panels) is about 350, which indicates solid support from many petroleum companies.

The generation of a test method stems mainly from the needs of industry, pressures from the Health and Safety Executive, the appearance of new equipment, eg Inductively Coupled Plasma, and the continuing awareness of ST members of new technology possibilities.

Input into the International Standards Organisation is effected by IP membership of BSI and hence CEN. ASTM, ANSI and API contribute for the US and AFNOR, DIN and NNI for Europe. IP co-operation with the ASTM D2 Committee is an invaluable assistance to ISO 'penetration'.

Giving examples of analytic techniques, Mr Crump mentioned High Performance Liquid Chromatography and quoted existing Full Standard Methods IP 343, IP 368 and IP 374, plus Proposed Method AT, all of which use this technique for analysis. Ongoing work involves the development of a method for measuring Polyaromatics in Drilling Mud Oils and, for the near future, a method to determine the Polyaromatics in Diesel Fuels. All these methods are under the aegis of ST-G-2.

Peter Mason gave a short dissertation on Emission Spectroscopy with especial regard to the use of the RF Inductively Coupled Plasma (ICP) torch. With the use of the Meinhard Nebuliser in conjunction with the ICP torch, a Sequential or Simultaneous Spectrograph can be produced, enabling the determination of additive elements in new lubricating oils and additionally wear metals in used lubricants. A strong feature of the ICP technique is its ability to measure non-metals such as Boron and Sulphur and hence Vanadium, Nickel and Sulphur in fuel oils with one pass.

Peter Mason, IP Standardisation Committee

'A UK-Europe early warning group for environmental problems'

Medical studies

John Brothwood, Chairman, Advisory Committee on Health, said companies should be making prospective studies on health of employees in relation to their jobs and analysing the results — an activity which could be co-ordinated by the Institute.

Environment gap to be filled

Ted Williams raised the question of general environmental matters affecting the atmosphere and onshore. He said:

'There is no formal presentation on these matters today, because, to my surprise as a newcomer, the Institute has no active committee dealing with these important issues. As you have heard our doctors are alive and kicking, but the boundary between health and environmental fields these days is indistinct — ecotoxicology, for example, is concerned with the build-up in the environment of materials harmful to health, directly or indirectly.

In any case, many people would regard the environmental field as a natural one for the Institute to play its part in helping industry and legislators to reach a well-informed concensus.

Going back to the days of *Torrey Canyon*, the Institute was then very active and significant environmentally, and of course the Marine Environmental Committee has kept up that tradition, as you will hear shortly. For some years an Air Conservation Committee which included much of the available expertise did sterling service and it is interesting to see so many current issues in the old minutes — lead, acid rain, exhaust standards, etc. Certainly, this reminds one that few environmental issues are black and white and they stay around for a long time.

This convenient arrangement disappeared in the aftermath of the lead controversy when, in spite of papers presented by the IP to a Commons select committee, the companies felt in the end that they had the worst of both worlds.

Ted Williams, IP Director General

They found themselves labelled as reactionary and uncaring and yet lost virtually all the economic points at issue. The public at large will always believe that lead in petrol is proven to be directly damaging to health, rather than simply preventing the use of catalytic exhaust convertors.

The companies realised that they had to deal co-operatively and speedily with increasing actual or threatened legislation in the UK, through UKPIA or, in the EEC, through Concawe. Only trade associations could act in this way and those whose job it was to react quickly, had little time to spare for the more detached and objective IP, whose activities faded, apart from some unheralded back-up from the Technical Officers.

So what? you may say.

Well, I believe there are now visible some consequent and harmful gaps in the cover. UKPIA would not claim that it has the remit or the resources to be proactive rather than largely reactive to the threat of legislation in this field. It has excellent rapport with UK Government Departments, but by that stage the European battle lines have been drawn.

Picture left: Ian Berwick, Director General, UKPIA (left), and Jim Turner, Director OPITB. Picture right: Left to right: Chris Willy, External Affairs Director, UKOOA; Charles Smith, Managing Director, Chevron Petroleum (UK) Ltd, and Member of IP Council; John Leonard, Chairman, Carless, Capel & Leonard plc, and an IP Vice-President; Jimmy Hay, General Manager, Operations, Britoil plc, and Chairman, IP Exploration and Production Committee, Aberdeen.

'A need to know more about heavy oil effluent'

Concawe is now a most professional and well-resourced organisation, but it is a company association — the international arms of the majors plus the smaller nationals. People at the sharp end of UK operations are at a distance from what went on in the earlier stages, before reaction to a problem perhaps has become a matter of compromise resistance to the latest German Government diktat driven by "Green" votes.

A good example is the current move to agree through Concawe an "industry standard" of 35 mg/litre hydrocarbon content of vapour emitted during vehicle, ship or tank loading (96% recovery) in order to fend off a TA Luft Standard 40 times as severe. The former standard would confer no obvious benefit and would be expensive, while the latter would be horrendous.

I propose therefore to try to bring together in the name of the Institute a few concerned people from industry (not just the companies) who are not tied up in day to day troubleshooting, to act as a UK/European early warning system, to help communication among the many actors in the game and to sponsor environmental research of interest to the UK and complementary to Concawe.

I know already from my travels that a number of the appropriate people are interested in this and it has the support of Concawe, who are concerned about National interactions, and of our friends in UKPIA in whose true interests we should largely be acting. I am sure that you will also support us in the European Year of the Environment.'

Microbiology guidance

Ted Hill, on behalf of the Microbiology Committee, reported that a 'Fuels Task Force', chaired by Dr Bob Watkinson, Shell Biosciences Laboratory, had been formed to produce guidelines for use, particularly throughout Europe, to ensure that fuel samples for microbiological analysis are taken from the most appropriate points using suitable techniques and tested by agreed procedures. It was intended that guidance on interpretation will be given.

Good standing as employers

David Jamieson, reporting for the Education and Training Committee, said that during the coming year, designated *Industry Matters 1987*, the Committee would expand on the new objectives established in 1986, and in particular will be seeking to build on the schools initiatives developed in previous years. It was planning to hold a Seminar for Careers Teachers in London, in conjunction with the London Branch, to serve as a potential model for similar events with other Branches. It would help to ensure the industry's good standing as employers in the 1990s. The potential for the establishment of an Education Trust was under consideration.

Heavy oil effluent

Brian Goodland, Chairman, said that the Marine Environment Committee would be attempting a more dynamic approach, with clearer objectives. Richard Bavister said there was a need to know more about heavy oil effluent. Research would be financed in 1987. An important ecological conference was to be held in the autumn.

E&P Group

Don McFann, retiring Chairman, said the Exploration and Production Discussion Group had found its niche — between the IP Energy Economics Group and the Society for Petroleum Engineers. The Group was well able to handle the series of meetings it had and was enlarging its upstream mailing list.

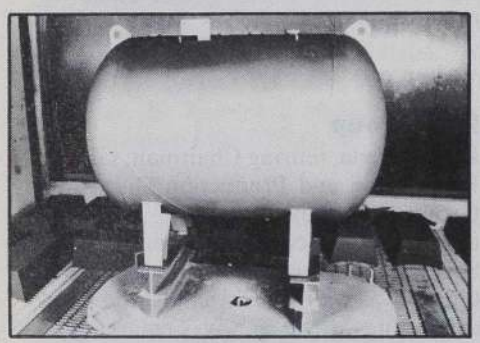
Information

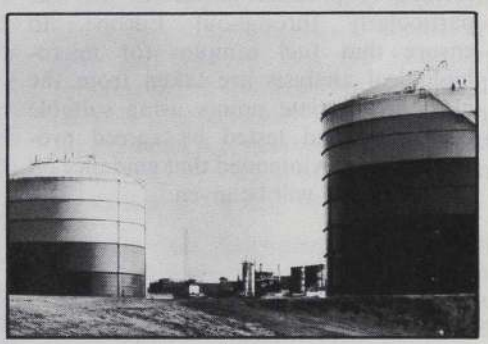
Peter Ellis Jones, Chairman of the Publications and Information Services Committee, said that *Petroleum Review*, conferences, IP publications and the Library and Information Services were a major IP resource and an important way of providing information about the work of the Institute. He urged technical committee chairmen to bring developments to the notice of the respective parts of P&I.

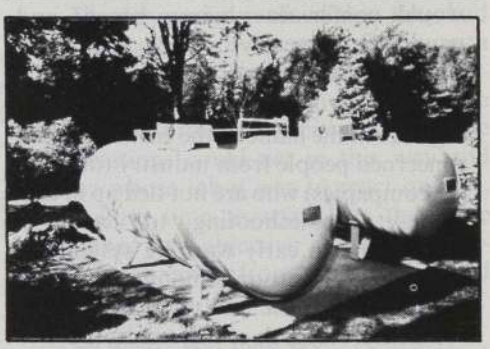
Jean Etherton described the increasing development of the Information for Energy Group (IFEG).

WHETHER YOU'RE THINKING SMALL,

HUGE, OR IN-BETWEEN.







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Preparing for the major production of gas condensate in the North Sea

● Enterprise Oil plc has recently equipped the Royal School of Mines at Imperial College of Science and Technology, London, with the means to study the thermodynamic behaviour of petroleum fluids and gas condensates in particular

● Peter Kingston, Technical Director, Enterprise Oil, describes the background to this investment, which gives the opportunity to take new directions in experimental research

Peter Kingston

Geoffrey Mayhew: Enterprise Oil recently made a very significant investment in petroleum research at the Imperial College of Science.

Peter Kingston: Our specific investment at Imperial College needs to be seen in the context of how Enterprise has approached its programme of research and development and how that investment evolved as part of the overall strategy.

As with everything in Enterprise, we had to formulate an R & D policy from scratch.

We had no operations of our own, so the direct advantage of research and development could not be identified clearly with things we were already doing. We had ambitions to be an operator but the time at which we could be operating was clearly sometime in the future.

This had to be borne in mind, but of more immediate importance was the UK Ninth Round, which was in progress when the company was formed, with clear identification of R&D as an important factor being taken into account.

We decided as a first step that a sizeable programme amounting to about £1m should be put in place. The favoured areas for investment included gas condensate, which we considered to be important for the future. Enterprise was formed as a company with five production ventures and no developments. We felt that the new developments we would become involved with would almost certainly include some gas condensates and, therefore, it was important for us to be familiar with the state of the art in gas condensate developments.

We also wanted to have a major involvement in subsea technology and have invested a large sum of money in a subsea R&D project.

Why did you choose Imperial College?

One of our early objectives was to develop a relationship with the universities. The universities play too small a role, or have traditionally done so, in research and development within the UK oil industry; their role is much more important in countries like France and the United States. I think we should get greater benefit from the universities here in the UK. I had discussions with Imperial College at a fairly early stage, suggesting that we would be prepared to fund some research and asked if they could come up with some ideas. Imperial proposed the idea of creating a gas condensate laboratory which Enterprise could fund and as part of the arrangement, this could be called the Enterprise Laboratory.

The sums of money involved, which were about £¼m for the equipment to go into the laboratory, were of the order of magnitude that I was prepared to spend on one or two major projects. Because Enterprise is a company which has relatively few people, but very experienced people, I wanted our R&D expenditure to be split between relatively few projects which we could take an active part in formulating and processing.

This implied that the size of funds in any one project would have to be fairly large. Therefore the Imperial proposal did fit the bill in the sense that it was gas condensate and it was with a university.

There were also some public relations benefits in the sense that the Enterprise Laboratory at Imperial College placed our name in front of the students whom we would be likely to want to recruit in the future as part of our long term aims. These were the factors which led us along the path of investing in this particular facility. It has been very well received, and we see it as being successful.

Recently, the Minister of State for Energy said the development of major gas condensate fields in the central part of the North Sea was the big challenge of the decade. I take it you would agree with that?

It certainly is one of the big challenges. The reason for this is that, at least by the mid-nineties, a large part of our gas supply will have to come from gas condensate fields. There are a number of very large gas condensate fields with reserves of perhaps two or three trillion cubic feet. The technology involved in developing gas condensate fields is more complicated than with oil fields of similar size.

The cost of this development will also be that much greater than for equivalent oil fields because of the equipment required to process the hydrocarbons. The reservoir engineering problems associated with developing and producing a gas condensate field are also very much more complicated than for an oil field. All these factors lead me to support what the Minister has said, that the type of technology in terms of hardware and the reservoir problems will make it that much more complicated and much more of a challenge to develop than oil fields of equivalent size. Therefore, I agree with him.

Will these fields be spread wider than the central part of the North Sea?

One of the biggest fields, the Bruce field, is probably just outside what we call the central North Sea. The Brae and Marnock fields, as well as one or two others which are still being evaluated, are in the central North Sea. Probably most of the stand alone condensate fields in the UK will be in the central North Sea. There will be perhaps some outside that area associated with large oilfields.

Enterprise is involved in the Beryl field, where there are gas condensate accumulations, and there is also Alwyn (operated by Total) and Brent, much of this present in gas caps above producing oil.

Can you clearly identify you have a gas condensate field as opposed to an oil field or an oil and gas field?

Yes. When an exploration well is drilled and you conduct production tests there may be two things which will tell you whether you have a gas condensate field. First, there is the gravity of the oil. If it is 40° API or higher there is a good chance that you have a gas condensate, or perhaps a volatile oil. Second, the gas-oil-ratio will be high.

The definition of a gas condensate in technical terms is a hydrocarbon mixture which has a dew point rather than a bubble point, but many of the fields fall on the borderline and technically it is perhaps difficult to differentiate. However, whether it is gas condensate or volatile oil, the same production problems will apply and we tend to group them together as gas condensate fields.

UKOOA made an estimate of the number of gas condensate fields there might be.

UKOOA did prepare a report on developments up to the year 2000 which showed that there could be as many as 10 gas condensate fields in operation by the end of the century. That figure is based on sound information, so it is fairly accurate.

Is this related to the research you have sparked off at Imperial College, because knowledge is limited, is it not? One is only just beginning to know about condensate production?

Gas condensate fields have been produced in different parts of the world. A lot of research has been done. What is important is that more and more gas condensate accumulations, particularly in the North Sea — UK and Norwegian —

Continued on page 15

'Gas condensate significant'

Professor John Archer, Head of Petroleum Engineering, Imperial College, said at the opening ceremony that the equipping of the Enterprise Laboratory for Gas Condensate research represented a significant milestone in the development of Petroleum Engineering education in the university.

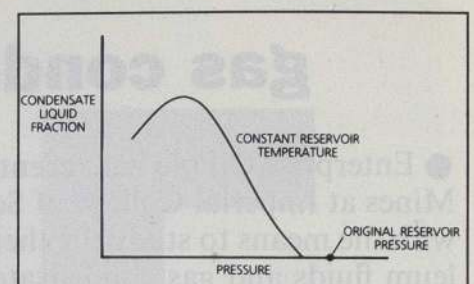
'Petroleum science has been taught here in the Royal School of Mines since 1913', he said. 'It was originally associated with the Department of Geology, and for many years the subject matter was encompassed in an undergraduate course called Oil Technology. The importance of inter-related research activity and teaching was recognised from these early times. The graduates from these courses tended to make a career abroad in the International divisions of the Petreoluem Industry and many have become leaders in their profession.

'The discovery and development of oil and gas fields on the United Kingdom Continental Shelf in the late sixties and early seventies resulted in a demand for highly proficient Petroleum Engineers in numbers greater than were then available. Professor Colin Wall, who moved from Birmingham to the College in 1967, was instrumental in arranging a new 12 month MSc course in Petroleum Engineering to help meet this demand.

'The College, together with Heriot Watt in Edinburgh, was designated a centre of excellence in Petroleum Engineering, and in 1973 we moved down a couple of floors in the RSM from the Department of Geology to the Department of Mineral Resources Engineering.

'The next twelve years, under the guidance of Colin Wall and with the support of the Industry, saw the establishment of our Petroleum Engineering MSc and BSc (Eng) degrees as highly prized qualifications and our graduates in great demand.

'The practical difficulties of establishing a new section in a department already making full use of space cannot be underestimated. Petroleum Engineering research directions were influenced then by availability and adaption of existing laboratory space. The section built a research reputation based on theoretical and numerical modelling work,



EFFECT OF RESERVOIR PRESSURE DURING PRODUCTION ON FRACTION OF CONDENSATE LIQUID

together with innovative small scale phenomenological studies.

Laboratory expansion vital

'In the early part of this decade it became apparent that some of our theoretical and numerical research was limited by our inability to conduct crucial experiments and to observe important nuances of physical behaviour in hydrocarbon recovery processes. In short, it was vital that laboratory expansion should occur, and that we increase our experimental research capabilities in support of theoretical research.

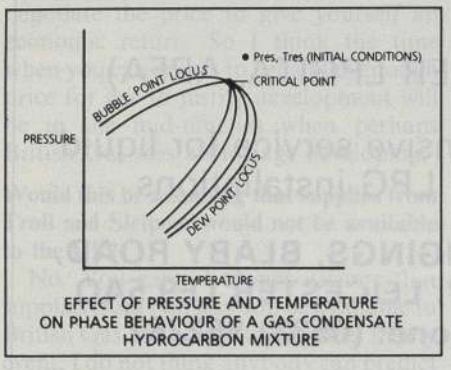
'One of the research areas in which we have made important contributions to knowledge is in the theoretical behaviour of gas condensates and the manner in which they might be recovered from deep reservoir traps. Gas condensates are particular mixtures of hydrocarbons which exist in the gas phase near their critical pressures and temperatures. Changes in reservoir pressure, by production for example, can result in phase changes in the hydrocarbon mixture and liquid formation in the reservoir. The optimisation of liquid recovery in gas condensate reservoirs is of great commercial importance.

Gas condensate may equal 2.5 bn stock tank barrels

'It is now fairly well recognised that in the near future a significant proportion of the UK North Sea hydrocarbon production must come from gas condensate fields — maybe as much as 2.5 billion stock tank barrels of liq-

uid, and 25 trillion standard cubic feet of gas.

'One of the starting points for design of suitable recovery mechanisms for gas condensate fields is a detailed understanding of phase and compositional behaviour of the reservoir fluid under different conditions of temperature and pressure. We proposed to Enterprise Oil (who are very much involved in

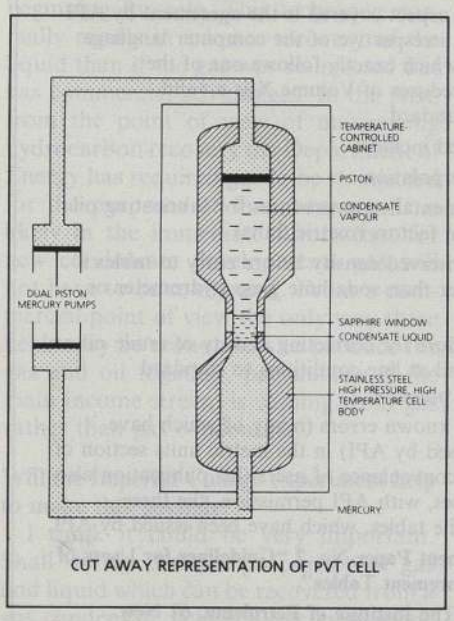


EFFECT OF PRESSURE AND TEMPERATURE ON PHASE BEHAVIOUR OF A GAS CONDENSATE HYDROCARBON MIXTURE

development of gas condensate resources) that an experimental facility to study the PVT thermodynamic character of gas condensates should be set up here at Imperial College. To our delight, Enterprise were very enthusiastic and their generous support has underwritten the costs for a novel, state-of-the-art equilibrium cell and its control equipment, worth around a quarter of a milion pounds. In addition, they have funded a research scholarship and the support of a full-time technician.

Relationship with industry

'The excellent relationships that the Section enjoys with industry have been built on professional respect and ability. The Enterprise Laboratory marks an outstanding example of this relationship, and we thank all concerned for its birth and look forward to the fruits of its applications.'●



CUT AWAY REPRESENTATION OF PVT CELL

Technical Specification of ROP Cell Volume 4 Litres. Max. Working Pressure 15000 psi. Working Temperature Range −20°C to +175°C.

Continued from page 14

are at very high pressures and very high temperatures.

I think many of the gas condensate fields produced worldwide in the future are likely to have very high pressures and temperatures.

The equipment which has been available to study the behaviour of fluids has been limited in terms of the pressure and temperature which it can handle. This equipment at Imperial which advances the state of the art in terms of physical measurement, allows us to study fluids at pressures up to 15,000psi and temperatures up to 350°F. This covers most of the conditions we are likely to experience in the North Sea, and perhaps worldwide.

It allows physical research to be carried out beyond that which has been carried out before—so it is extending the limits of gas condensate laboratory measurement rather than allowing original research, because much research has been done at lower temperatures and pressures.

Is other research of a comparable nature going on internationally at the present time?

Yes. The French have been studying gas condensate for many years and I am sure the international majors have comparable research programmes. French companies have extensive gas condensate reserves in North Africa, for example, and also in France, but again mostly at lower pressures and temperatures than we are perhaps encountering in the North Sea. North Sea fields are extending the conditions beyond those for which substantial research has already been carried out.

It is perhaps a little unusual for a small company to engage in this type of research—it must be very important for it to have engaged your attention?

Yes. It is perhaps not the most important of our short term objectives, but it does loom quite large in our long term thinking. For our own particular short term benefit we would probably like to undertake some studies of the Beryl field using the Imperial equipment. The gas in the Beryl field, in gas caps within the field, is present as gas condensate accumulations, and we would expect these reserves to be developed within the next few years. We like to take a strong interest in the developments in which we take part, even though we are not the operator, partly to protect our interest but also partly to develop our technical expertise for the future when we will be operating fields ourselves. We see some short term use for the equipment.

It is important from our own long term point of view. We are a relatively small company at the moment but we intend to grow in terms of our UK operating activities and, therefore, it is important for us to be involved now in the front end of future technology.

Is it possible to give an estimate of when you might become an operator?

We are as active as we feel we can be at the moment in exploration drilling. Some of our exploration drilling in the coming year will be in the central North Sea, and, were we to make a discovery, it is possible for us to have a gas condensate. Then we would be looking at appraisal and then perhaps ultimately development of it. So development operations may evolve out of our exploration activities. As you know, we have also made acquisitions and shall be considering other acquisitions. It is possible that we may assume an operating capability in the course of this activity, although we have no obvious short term plans in that respect.

So, you are going for gas condensate; you are really looking hard for it?

We have always been interested in gas condensate because we feel that many of the big projects in the North Sea in future will almost certainly be in gas condensates. We want to be involved in these projects not necessarily as operator, but because we see a major part of our profits and a major part of our future cash flow in the North Sea being generated from these big projects.

The price of oil and the current uncertainties are not a hindrance in that respect?

These factors are certainly a hindrance in starting a new gas condensate project, but we all live in hope for future improvement. The time frame over which one can discover and develop a gas condensate field is probably of the order of 5–10 years. Even development of the existing gas condensate fields will have a time frame of five or more years because they are large projects involving significant investment over quite a long period of time. So we are really looking to the mid-nineties, or perhaps 1993 at the earliest, before major production from gas condensates is really viable, and prices at that time, not today, are what matter.

At that time you would hope there might be a fair amount of it?

I believe so. The importance of gas condensate is that your income stream is split into two. You have gas production and condensate production, hopefully both at a high price. The advantage of producing the gas early on is that you need to negotiate the price before you start development. Clearly, in terms of

'We take a very robust view of the North Sea. We are more active than we have ever been'

supply and demand, if British Gas needs the gas, as long as you can produce more cheaply than alternative supplies of gas from Norway, for example, then you negotiate the price to give yourself an economic return. So I think the time when you can expect to get a high enough price for gas to justify development will be in the mid-nineties when perhaps British Gas sees a shortage developing.

Would this be assuming that supplies from Troll and Sleipner would not be available to the UK?

No. You cannot always assume that supplies from Norway will be available to British Gas at a competitive price. In any event, I do not think anybody can predict the discussions which may take place with respect to Norwegian gas. I work on the basis that if we can provide gas more cheaply than Norwegian supplies there is a very good chance that we will be supplying it from the UK.

Can one take it you have studied Marathon's North Brae gas condensate production?

To a limited extent. The Marathon North Brae gas condensate field is the first major gas condensate field to be developed in the UK. At the moment the licensees have a programme which assumes that gas will be re-injected. As you know, a gas condensate field can be produced in two major ways. Instead of gas injection the oil and gas can be produced together and transported from the beginning for sale. This technique normally results in a lower recovery of the liquid than if the gas was re-injected but has commercial advantages. In the past, from the point of view of maximising hydrocarbon recovery the Department of Energy has required gas to be re-injected for the purposes of that recovery. It is likely in the immediate future that for new condensate developments gas will not have to be re-injected. From a commercial point of view the only way these fields may be economic is to produce the gas and oil together, particularly if the main income stream is coming from gas rather than gas condensate.

Will the Imperial College experiment help to make this possible?

I think it could be very important. Shall we say that the proportion of gas and liquid which can be recovered from a gas condensate field is never known one hundred per cent from the beginning. Because of the difficulties of sampling the gas condensate fluid from an exploration well there are always large uncertainties in predicting the amount of condensate and the amount of gas. What this equipment will allow us to do is measure the proportion more accurately and measure more accurately the composition of the hydrocarbon fluids. This should enable us to make more reliable comparisons between the physical separation of the fluids at different pressures and temperatures and these can be calculated from mathematical techniques. Therefore, in these important areas, it will allow us to predict more closely from the beginning, prior to development, just what we can expect to recover in terms of liquid and gas from the reservoir.

I guess this will take a year or two?

That is right. The equipment we have at Imperial College will be available to companies to use, and I am hoping that those companies evaluating gas condensate development will consider using it.

It is not just for yourself?

No. The equipment is certainly not intended merely for our own use. A large part of the usage will be to support research and education at the university. There are one or two studies, particularly in the Beryl field, that we would like to undertake but there should be considerable time available for the equipment to be used by other oil companies, and I hope it will be used in that way.

I imagine they are aware of this?

Yes. At the opening of the laboratory we were careful to invite the senior reservoir engineers from most of the companies who operate in the North Sea, so they are now aware of the capabilities of the equipment. For those companies who do not already have equivalent equipment it is important that they know the equipment is there to be used.

Is there an export potential in the research you are doing into gas condensate?

Much new technology will evolve in the UK. Development of UK gas condensate fields will lead many other similar worldwide developments. There are, I believe, some immediate opportunities in Norway. The Norwegians are and will continue to be very interested in research activities in this area of technology.

Is that because there is more condensate in Norwegian waters?

I believe there are very significant gas reserves in Norwegian gas condensate reservoirs. We know of Troll and Sleipner, which we have already mentioned, but there are also significant gas condensate discoveries in the northern waters of the Norwegian continental shelf, outside the North Sea. Of course, these will be developed over a long time frame. Outside the UK and Norwegian continental shelves significant potential reserves are likely to be established. There are already vast reserves of gas in certain Middle East gas condensate fields. As we deplete existing oil reserves outside the Middle East emphasis will be placed on drilling deeper for new discoveries, leading inevitably to more and more gas condensate discoveries. Many of these new fields will be offshore, so any lead in technology that British industry gains from UK activity can yield significant potential for exports in the long term.

It is gas from gas condensate fields, not gas condensate from gas fields?

That is generally correct. I think that in the longer term there will be a continuing need for gas to be used as a fuel. The amount of condensate normally present in a gas condensate field is not generally enough to justify development in its own right, purely for the liquid. At current crude prices, you have to have a very high liquid content to justify just going for the condensate; it does happen, but handling the gas is pretty expensive. It is more likely, given current gas markets, that local need for a large gas supply will lead to development of gas condensate accumulations. It can happen the other way round as well, and it may be that in the shorter term, because of the limited need at present for large new supplies of gas, the development of a few gas condensate fields may be purely for stripping out of the condensate economics allowing.

Obviously Enterprise Oil takes a robust view of the future of the North Sea?

We take a very robust view of the future of the North Sea. We are more active than we have ever been, being involved in five new developments, at least three of which will, we hope, gain Annex B approval this year from the UK Government, and are not the only company involved in new developments. There has been a serious hiatus in development activity which has fallen very hard on the supply industry, but I hope that within six months to a year some of the projects we are engaged in, and others likewise, will start to come through and create at least a level of work which is consistent with making the longer term future for the UK industry a healthy one.●

The resource base and market forces of future UK gas supply options

by Jonathan P Stern, Head of the Joint Energy Programme based at the Royal Institute of International Affairs, London

The privatisation of British Gas should have meant that in 1986, discussion of the future of the gas industry became a subject of immense public importance. The reality was entirely different.

As one quarter of the nation's energy balance made its way into the private sector, the media concentrated on a catchy advertising campaign and speculation about how much revenue the flotation would raise for the Government.

Thus, as the dust settles from the flotation and British Gas adjusts to life in the private sector, 1987 is a good time to look again at the options for natural gas supply beyond the end of the century.

The research in this article on the UK gas resource base arose from the assertion by the Minister of State for Energy that satisfactory development prospects for gas have been created as a result of the decision to reject the import of Norwegian Sleipner gas. *(1)*

'That decision was taken in the light of our very much improved figures of reserves of gas which would be available into the 1990s, and it is even more clear that it was the right decision... using current figures for supply and demand there is a potential there for a 25% gap between supply and demand into the 1990s. Because we have the reserves, we have the ability to fill that gap from our own resources.' *(2)*

The view of most companies producing in the North Sea is the same as that of the Minister: that there is sufficient gas discovered on the UKCS for the country's supplies to be met from its own resources up to the end of the century. *(3)* United Kingdom continental shelf (UKCS) producers are anxious, particularly at a time when activity in the North Sea has dropped to comparatively low levels, that nothing should prevent the earliest possible development of their resources. Any import of foreign gas, potentially sets back UKCS developments and improves the negotiating position of British Gas vis a vis the sellers.

This article deals with two issues: **the adequacy of the UK reserve base,** and **the question of whether Government wishes to create competitive conditions for the supply of gas to Britain** or **whether it prefers to retain control of supply.**

The reserve position

Looking closely at the UK Department of Energy *Brown Book* statistics leads to the conclusion that while there is no need for panic over the adequacy of the UKCS reserve base up to the end of the century, neither is there any reason for complacency. *(4)* **Table 1** shows the progression of remaining recoverable UKCS reserves since 1973. Total (proven plus probable plus possible) reserves remained roughly constant during the period 1975–82 and rose strongly during the following three years. **Tables 2–5** examine in more detail the evolution of the resource base over the past five years to see where the changes have taken place. **Table 2** shows the resource base broken down into proven, probable and possible categories and also subdivided to show the quantities of dry gas, associated gas and gas from condensate fields, within those categories. **Table 2** clearly shows that the proven category is very largely composed of dry gas, while the probable and possible categories are dominated by dry gas and condensate reserves. This table illustrates the relative lack of importance, within the total resource base, of gas associated with oil.

Further subdividing the reserve categories, **Table 3** shows the evolution of possible reserves. Virtually all of the increase during the period 1983–85 has been in Southern Basin dry gas **'B'** category fields, ie in significant discoveries which have not been fully appraised.

Table 1

Remaining Recoverable UKCS Gas Reserves 1973–85 (end year)

(billion cubic metres and percentages of total)

	PROVEN		PROBABLE		POSSIBLE		TOTAL (P+P+P)
		(%)		(%)		(%)	
1985	648	(32)	594	(29)	773	(38)	2015
1984	725	(37)	600	(30)	643	(33)	1968
1983	712	(42)	437	(26)	540	(32)	1689
1982	633	(43)	308	(21)	526	(36)	1467
1981	664	(47)	343	(24)	398	(28)	1405
1980	739	(47)	362	(23)	458	(29)	1559
1979	754	(50)	323	(21)	436	(29)	1513
1978	706	(48)	326	(22)	448	(30)	1480
1977	744	(48)	354	(23)	448	(29)	1546
1976	809	(56)	272	(19)	362	(25)	1443
1975	815	(57)	325	(23)	290	(20)	1430
1974	761	(61)	269	(21)	226	(18)	1255
1973	787	(67)	201	(17)	187	(16)	1175

SOURCE: Adapted from Department of Energy, Brown Books for respective years.

Table 2

Remaining Recoverable UKCS Gas Reserves by Category 1981–85 (end year)

(percentage of total in each category)

	PROVEN			PROBABLE			POSSIBLE		
	Dry	Assoc	Cond	Dry	Assoc	Cond	Dry	Assoc	Cond
1985	77	16	6	54	9	37	47	10	44
1984	78	16	6	45	8	47	42	6	52
1983	77	17	6	42	11	47	39	7	54
1982	74	20	6	33	16	52	27	9	64
1981	78	19	3	31	13	56	23	11	66

SOURCE: As Table 1

Mr JP Stern's article is the development of a presentation he gave to the IP Exploration and Production Discussion Group during IP Week, 1987.

Table 3

Remaining Possible UKCS Gas Reserves 1981–85 (end year)

(BCM)

	DRY GAS				CONDENSATE (all in Northern North Sea)	
	A		B		A	B
	SB	F+M	SB	Other		
1985	26	31	241	62	14	323
1984	20	31	176	42	14	320
1983	8	31	128	42	14	278
1982	14	34	51	42	—	337
1981	11	34	45	—	—	263

A: Fields in production and under development **B:** Other significant discoveries not yet fully appraised **SB:** Southern Basin **F+M:** UK Frigg and Morecambe.

'Possible reserves': those reserves which at present cannot be regarded as probable but are estimated to have a significant but less than 50% chance of being technically and economically producible.

SOURCE: As Table 1.

Table 4

Remaining Probable UKCS Gas Reserves 1981–85 (end year)

(BCM)

	DRY GAS			CONDENSATE (all in Northern North Sea)	
	A		B	A	B
	SB	F+M	SB		
1985	34	65	221	8	212
1984	25	37	210	8	275
1983	31	34	118	8	198
1982	31	28	42	6	153
1981	40	28	37	—	193

A: Fields in production and under development **B:** Other significant discoveries not yet fully appraised **SB:** Southern Basin **F+M:** UK Frigg and Morecambe.

'Probable Reserves': those reserves which are not yet proven, but which are estimated to have better than a 50% chance of being technically and economically producible.

SOURCE: As Table 1.

Although condensate fields still constitute nearly half of the resource base, their share of the total has been falling. This trend is likely to continue for some time unless, at an oil price of less than $20 per barrel, these reserves can be said to have (following the Department's definition) 'a significant chance of being economically producible'.

Table 4 shows probable reserves where the same pattern as that observed in the possible category is evident. Condensate reserves have remained at roughly the same level (although they moved sharply down in 1985) but their share of the total has fallen to just over one third with the very large increase in Southern Basin **'B'** reserves.

Table 5 shows proven dry gas reserves and here the picture is rather more complicated. In Southern Basin fields which are in production and under development, reserve levels in 1985 were the same as in the level of 1981, having fallen somewhat in the intervening period. Although gas reserves in the Morecambe field (in the Irish Sea) had scarcely been touched, the British sector of Frigg showed a steady decline which quickened in 1985 due to a downward reassessment of Frigg reserves. *(5)*

However, it is the reserves in significant Southern Basin discoveries not yet fully assessed which is the most interesting. This category increased dramatically during the 1982–84 period and then suffered a considerable reverse in 1985. Looking back at **Table 1,** it is evident that the cumulative effect of those shifts in proven reserves caused a fall in this category of more than 10% in 1985, which is the sharpest annual fall during the entire period under consideration.

The right hand column of **Table 1** supports the general assertion of both the Government and the producers that total recoverable reserves have evidently risen to levels which, in aggregate, would guarantee current levels of production well into the next century.

However, the recent large fall in proven reserves in fields where we have the best knowledge, and therefore the best estimates, means that aside from the single year of 1982, this category is at its lowest level since the statistics were recorded in their present form. Moreover, in 1973, proven reserves amounted to two thirds of the total recoverable reserve base, the remainder split between probable and possible reserves. By 1985, proven reserves amounted to less than one third of the total, and possible reserves (16% in 1973) had risen to 38%.

The key issue, which needs to be resolved, before the more cheerful total recoverable reserve estimates are accepted, is whether it is right to be so optimistic about probable and possible reserves which have respectively a 50–90% and a 'significant but less than 50%' chance of being technically and economically producible, when we are at the same time revising downwards our proven reserves — both in absolute terms and as a percentage of the total resource base — which according to the Department, '. . on the available evidence are virtually certain to be technically and economically producible (ie, those reserves which have a better than 90% chance of being produced).' *(6)*

Since the beginning of indigenous natural gas production twenty years ago, the UK has relied on five large fields in the Southern Basin **(Table 6)** with reserves considerably in excess of those in fields currently being identified in the Southern Basin. Of the 552 BCM of gas produced on the UKCS in the period up to 1985, 84% has come from these fields. Moreover, of the 287 BCM of remaining recoverable reserves from Southern Basin fields in production and under development (shown in **Table 5**), more than 70% is to be found in those same five fields. *(7)* This puts a slightly different perspective on the large numbers of new fields which have been located in the Southern Basin and elsewhere.

Import options and "Market Forces"

With the signing, in late 1986, of the Norwegian Troll gas contracts with Continental European utilities, the import options open to Britain have increased dramatically.

Elsewhere, I have set out options for Britain in respect of the Troll development and expressed regret at the public lack of enthusiasm shown by the present Government in investigating the possibilities for participation in the largest and most exciting West European gas project since the discovery of Groningen. *(8)* The options are much greater than simply importing gas from the Troll and/or Sleipner fields.

What is at stake is whether the present Government and its successors want to see real competition between gas suppliers, both domestic and foreign, a trend which is already well advanced on the Continent.

This would open up the possibility of choosing between a number of sources of imported gas in competition both with each other, and with domestic UKCS gas.

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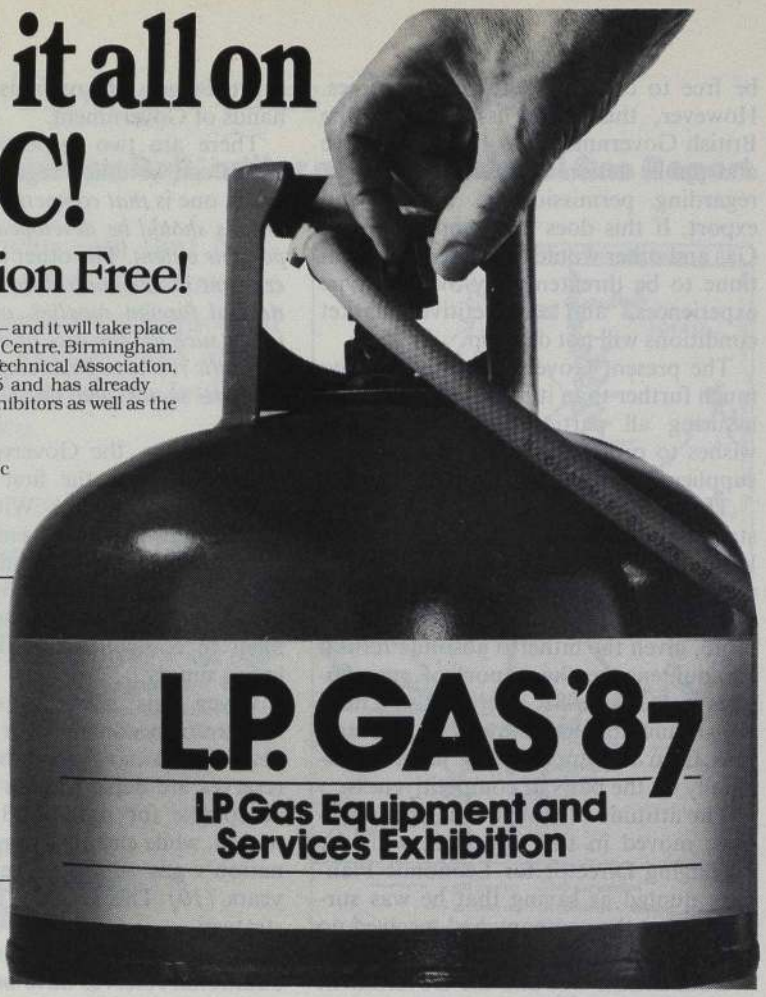

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be free to compete with other sources. However, this is an issue where the British Government has to take decisive and public action to relax its oversight regarding permission to import and export. If this does not happen, British Gas and other would-be traders will continue to be threatened by Sleipner-type experiences, and competitive market conditions will not develop.

The present Government needs to go much further than it has done thus far in assuring all parties that it genuinely wishes to promote competition between suppliers in the gas market.

There has not been an unambiguous statement from the Government that, so long as imported gas supplies are competitive with UKCS supplies, there will be no objection to imports. Furthermore, given the hitherto absolute refusal to countenance the import of gas supplies from the USSR, there is also a need for an unambiguous statement that supplies from *all* sources will be judged principally on the basis of competitiveness.

The attitude of British Gas appears to have moved in this direction, with the Managing Director for Economic Planning quoted as saying that he was surprised that the company had received no formal proposals from the USSR. *(9)*

Both British Gas and the Government appear to be taking the public position that, with the utility in the private sector, the choice and timing of future imports rests solely with British Gas. However, the *de facto* position on imports is unchanged: British Gas (and any other aspiring importer) has to consult with the Government regarding permission to import with no guarantee of success. In short, British Gas remains totally in the hands of Government.

There are two respectable positions which can be taken regarding this situation: one is *that competitive market conditions should be developed to the fullest possible extent*. The other is *that the Government should control the mix of domestic and foreign supplies, on the basis of issues such as: the rate of depletion of the domestic resource base, employment in the offshore sector and the balance of payments*.

At present, the Government appears to be espousing the first position, but operating the second. With continuing, and perhaps increasing, employment and balance of payments difficulties, there seems little likelihood that any future Government will have a serious commitment to competitive market conditions in gas supply.

Given this situation of continuing Government control over supplies, is a need for a strategy whereby UKCS reserves are depleted at a pace which is acceptable for both producers and the nation, while ensuring the security of the nation's gas supplies over the next 30 years. *(10)* This need not be an inflexible strategy.

If it genuinely appears that sufficient additional reserves have been discovered on the UKCS which can be produced at a competitive price without running the risk of either plunging the national into rapid import dependence, or sharply constraining the domestic gas market in the first decade of the next century, then additional imports, after the expiry of the Norwegian Frigg contract, may not be necessary.

However, on present evidence, there is some reason to doubt that this will be the case. ●

References

1 I have told the story of the Sleipner contract in, 'After Sleipner: A Policy for UK Gas Supplies,' Energy Policy, *February 1986, pp.9–14.*

2 The Rt Hon Alick Buchanan Smith interviewed in Petroleum Review, *October 1986, p 11.*

3 In recent memoranda to the House of Commons Energy Committee, all of the oil companies, with one exception, which expressed an opinion on this issue, suggested that imports would not be needed prior to the year 2000. House of Commons Energy Committee, Session 1986–87, The Effect of Oil and Gas Prices on Activity in the North Sea, *HC175–i, February 4, 1987, pp. 47–56, 65, 72, 81–83.*

4 The 'Brown Book' refers to the Department of Energy publication: Development of the Oil and Gas Resources of the United Kingdom.

5 Frigg reserves were downgraded during the course of 1985 by around 12%. Ibid, *1986 p 41.*

6 Ibid, Table 2, p 7.

7 Remaining reserves in fields in production can be estimated from the operator's estimate of recoverable reserves originally present in the field, found in Ibid, *Table 4.10 (b), pp. 40–43.*

8 'Norwegian Troll gas: the consequences for Britain, continental Europe and energy security,' The World Today, *January 1987, pp. 1–4.*

9 'BG keeps an open mind on supply options,' World Gas Report, *February 13, 1987, pp. 1–3.*

10 I have suggested such a strategy in: Natural Gas in the UK: Options to 2000, *(Aldershot: Gower, 1986).*

Table 5

Remaining Proven UKCS Dry Gas Reserves 1981–85 (end year)

(BCM)

	IN PRODUCTION AND UNDER DEVELOPMENT		OTHER SIGNIFICANT DISCOVERIES NOT YET FULLY APPRAISED
	SB	*F+M*	*SB*
1985	287	116	99
1984	269	143	156
1983	264	157	128
1982	251	169	48
1981	287	175	54

SB: Southern Basin **F+M:** UK Frigg and Morecambe.

'Proven Reserves': those reserves which on the available evidence are vitually certain to be technically and economically producible (ie. those reserves which have a better than 90% chance of being produced).

SOURCE: As Table 1.

Table 6

Major UKCS Gas Fields: Reserves and Production

(BILLION CUBIC METRES)

SOUTHERN BASIN DRY GAS FIELDS	INITIAL RESERVES	REMAINING RESERVES END 1985	PRODUCTION IN 1985	TOTAL PRODUCTION TO END 1985
West Sole	48	17	1.8	30.9
Leman Bank	298	91	10.9	207.5
Hewett Area	112	25	3.4	86.7
Indefatigable	127	46	5.3	80.4
Viking Area	84	24	3.4	59.7
Victor	20	18	1.5	1.9
Other (i)	16	15	0.9	0.9
	705	236	27.2	468.0
OTHER DRY GAS				
Frigg (UK)	79	33	6.2	46.4
Morecambe	119	119	0.1	0.1
ASSOCIATED GAS FIELDS				
Gas Fields	127 (ii)		8.4 (iii)	33.2 (iii)
Total UKCS (iv)	1184 (ii)		42.9	552.2 (v)

(i) Esmond, Forbes, Gordon, (ii) Proven reserves. (iii) FLAGS line, Piper/Tartan group, other associated gas. (iv) Total does not add mainly due to omission of figures for the Rough field now used for storage. (v) Gross production, net figure is 536.2 BCM

SOURCE: Brown Book, 1986, adapted from Table 4.10 and Appendix 7.

An assessment of the Troll gas sales agreements.

The Troll revolution — James Ball, editor of International Gas Report

I remember when I first believed someone who said that Norway's giant Troll gasfield could produce gas at an economic price. And it wasn't when West Troll was declared commercial by Shell in November 1983. No, it was in March 1985 and I believed the estimate because I was assured that the gas could be produced for a price as low as $5.00/MMBtu.

As any of the companies now selling gas from the Statfjord and Heimdal fields can tell you, the price formula finally agreed for Troll would, today, yield an even lower price. They are selling on virtually the Troll formula and they aren't getting even half that $5.00/MMbtu price. So what happened and what is all the fuss about?

What is so special about Troll?

In a word: integration.

This can be, at best, a chain of cooperation, at worst handcuffs. The fate of parties to the agreement is now inextricably linked. *So far Troll has demonstrated the fruits of cooperation.*

The Troll agreements — and there are many so far — showed Norway capable of a fundamentally different approach to price and flexibility; and even its government willing to make a marked shift in policy. It decided to allow a gas development to be a gas development and not force it into the very different mould of an oil project. These elements and a new approach to selling gas on a supply basis rather than on a field-dedicated basis formed the heart of Norway's contribution to the agreements.

On the buyers' side a determination to open a totally new gas relationship with Norway and to take European gas buying a quantum leap into the future, dovetailed with a natural desire to secure a share of what is the largest gas field in Western Europe, after Groningen, the declining Dutch giant.

To be sure, events went the buyers' way in the three years leading up to the Troll settlement. A radical shift in approach was cemented into the new and revised 1984 contracts, settled between Dutch and Soviet producers and their European buyers. And this development paved the way to the Troll deal. But there was more involved than adding Norway to the elite club of Gasunie of the Netherlands and Sojuzgazexport of the Soviet Union.

The buyers laid down their manifesto in public in Stavanger, Norway at the Offshore Northern Seas Conference in August 1984. Delivered by their key negotiator, Burkhard Bergmann of Ruhrgas, it stated that Norway could expect no special treatment; either it sold gas that would compete in the market or it would not sell Troll. That statement remains, in my opinion, one of the most important summaries of the realities of the European gas business. But the Troll agreement hammered out two years later surpassed even that vision.

Long before they signed their contract, in the small hours of June 1, 1986, it was clear that success from the Troll negotiators' deliberations would alter forever — and alter fundamentally — the shape of Western Europe's gas business. When they signed, the Troll Revolution had begun.

The triumph of cooperation over confrontation

The Troll revolution can be summed up thus: **it brings a new level of integration to the European gas business, an integration that stands to grow. And, so far, it demonstrates the triumph of cooperation over confrontation**; it is, if you will, the amicable relations of adult brothers and sisters in the place of sibling rivalry. Those of you who, like myself, are from big families or who have raised them, will understand this analogy in particular. I rather prefer it, myself, to the overworked one of a marriage — too many divorces. You have your family for life and either you get on or you don't — it's just a lot nicer when you do. But only determined effort stops you from slipping back into the backbiting, wimpering and jockeying for favour you engaged in as children.

Since Troll was signed, there have been outbreaks of petulance. On both sides. But if buyer and seller take on board the lesson of a little maxim — which I think best describes the last five or six years of the European gas business — perhaps the spirit of Troll will triumph over the many diversions it will face along the way.

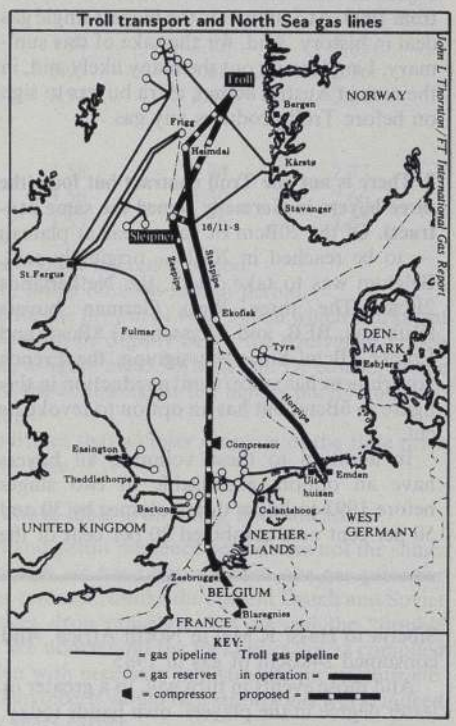
It goes: in the gas business you must be very careful to do a good deal. You must be even more careful not to do *too* good a deal. Too good a deal? Statfjord sprang to the mind of the Italian philosopher who told me that line and you will recall that Italy took none of that gas. And some would say today that amended Statfjord is too good a deal the other way.

Evening out of advantage

Between the settling of the first Statfjord contract in 1980 and now there has been a gradual evening out of advantage. Then the sellers had the upper hand. They retained it in the Algerian negotiations which followed and then the balance shifted back in the Dutch and Soviet negotiations of 1984 and 1985. It would not be unreasonable to expect this seesaw to continue. I believe, however that Troll can break the mould because it is not based on one upper hand or the other asserting itself but, as I said, cooperation taking a quantum leap forward. It is at this stage, however, only an opportunity. The reward of sustaining this spirit will be a bigger European gas market. The price of killing it will be a smaller one; not be a redistribution of spoils, but fewer spoils.

No matter which aspect of the many features of the Troll settlement you care to examine; from price structure to pipeline arrangements; from backup services to producer interrelations; this increased integration and increased opportunity stands out: that is the Troll Revolution.

Now, it is always argued in some forum or other that cooperation has always prevailed — even in Britain — so I know that I have to justify a stand which says this is something new, and that is what I hope I shall do in this paper. But for those of you who are unfamiliar with the settlement, let me just give a barebones summary — as shown on the following page.



The impact of Troll

I wish to return to the evolving Troll story. And that story, as we spent the second half of last year learning, is only just beginning. The immediate impact of Troll has already begun to shape events in the entire West European gas business, a business that stretches from

Mr James Ball presented this paper recently to the Institute of Petroleum's Energy Economics Group.

The barebones of the Troll Settlement

1 First signed on June 1, 1986, and finally approved with a few exceptions last December, the Troll deal involves at least 450Bcm of gas being delivered from Norway to European buyers in four countries over at least 27 years from 1993. At $50bn, it is the biggest single gas deal in history. And, for the sake of this summary, I am leaving out the many likely and, in the case of Austria actual, extra buyers to sign on before Troll produces any gas.

2 There is not one Troll contract but four (the three buyers in Germany signed the same contract). Of the 20Bcm of gas a year at plateau — to be reached in 2002 — originally sold, Belgium was to take 2Bcm; the Netherlands 2Bcm; The three West German buyers (Ruhrgas, BEB, and Thyssengas) 8Bcm; and France 8Bcm. Since the signing, the French government has since 'won' a reduction in this figure to 6Bcm, but has an option to revoke its cut.

In addition to these volumes, all buyers have an option, exercisable in two stages before 1993 to boost their volumes by 30 and 50 per cent or a combined 80 per cent of the original contract figure; a theoretical total of 36Bcm a year.

3 There is not one Troll delivery point, there are four. There is not even one Troll export line, there are, two. Thus, Distrigaz of Belgium will take delivery of its gas at Zeebrugge, the landfall of Zeepipe, a line which will be completed — I think — in 1995. Gaz de France, whose gas will also travel via Zeepipe, will take its gas at its border and the Germans and the Dutch, whose contract delivery point is also at their respective borders, will take gas via Norpipe which lands at Emden.

4 There is not one Troll price formula and one Troll invoice currency, there are four. Price is calculated and payment is made in each country's own currency, and price formulae vary from country to country. Indeed that of France is considered inappropriate in today's low oil price environment, while Germany's has been brushed up and slapped into the existing Statfjord contracts.

5 In short, Troll's sales terms are tailored to the end market: They integrate a high degree of flexibility, with a competitive price subject to regular adjustment negotiations.

- Price is designed to be end-market related not production-cost and high-seller-government-tax related.
- Troll gas is delivered under a 90–110 per cent flexibility swing with a 90 per cent take-or pay flexibility.
- It must be backed-up with at least two weeks maximum delivery capacity in continental Europe.

6 For the producers there is not one field but many. Troll must have the capacity to deliver all of the gas in the contract itself, but up to 25 per cent of the actual gas may come from other fields. Before Troll comes on stream, the Sleipner gamma structure will — from October 1993 — deliver Troll contract gas. Troll begins in 1996. Any other fields that join like Sleipner did however, are not bought by the buyers but by the Troll group, to be sold as Troll gas.

Siberia to Hassi R'Mel in North Africa. And consumed 248Bcm of gas in 1985.

And those events in turn will, to a greater or lesser degree in the players' own hands today, determine what kind of contract and what kind of strategic impact Troll gas really has when it begins flowing.

For, the Troll settlement will not produce first gas until 1993. That is six and a half years from now. Its physical impact will not be felt until planning decisions are hardened up in 1990. Its most immediate impact will be felt on the European re-negotiations between now and 1993. Indeed, so large is the aura of Troll, that it will colour all international gas dealing in Europe from now on.

The degree to which the parties to the deal can institutionalise the Troll model in future gas renegotiations, revisions and new contracts, will determine what the actual Troll settlement looks like on the day its gas begins flowing. A proper understanding of the Troll Revolution, I think, should lead both producers and buyers to protect its gains less they fail to reap the benefits they have sown.

So what are the features of the Troll Revolution?

- First, and foremost, is the concept that gas must be priced to compete in the markets where it is consumed. The French call this 'le netback.' We can include in this category the general price provisions and the agreement to reopen price and escalation clauses for periodic review.

- Second, and related to this, is the flexibility of delivery and the options to expand takes by up to 80 per cent of the originally agreed 20Bcm a year (and now, temporarily 18Bcm) plateaux.

- Third, is the strategic advantage the deal affords Norway: no longer must Norway sell gas only at Emden, Germany for a single consortium of continental European buyers and at St. Fergus to a single British buyer. Now it can sell at a number of points, even within Britain.

- Fourth and stemming from this, the buyer's side of this coin almost, is the novel introduction of delivery terms from Norway. These put Troll more on par with Gasunie of the Netherlands than any of Western Europe's other suppliers. Also — unlike the Dutch Groningen field's sales — the delivery capability will not be just field based, but involve an integrated effort of producers and utilities employing storage and transmission systems.

I should say that this is considered by some as the most revolutionary component of the Troll deal. It is a concept, further, whose failure to grasp, I feel, will make the French government deserve more than a footnote in the history of great governmental gas gaffes.

- Fifth, and related to several of these points, is the realisation that the day of the stand alone producer, the stand alone marketer, the stand alone transporter are over in Europe:

The needs of the market are everyone's concern. As a producer you don't just need to know about your buyer's market so you can belittle an argument about an escalation formula. You might need to work with the producer to expand that market; share ideas.

A maturing European transmission system is a chess board on which all the pieces must be active; come alive and play. Norway cannot abandon all responsibility for its gas at Emden or Zeebrugge, St Fergus or Bacton; everyone else is more deeply involved. The playing of gas swap deals; the control of spot and counter spot deals; the economic use of storage and deliverability; are crucial to the European gas business of the future.

Working together on a solution to Troll, utilities and producers may even spawn a new business: creative transportation.

- Sixth is the Troll aura: the impact of Troll on other aspects of the business. For example, what happens when the Troll bug comes to Britain? You know the North Sea producers and British Gas have been friendly adversaries for a long time. What happens when big friendly Troll comes along with a totally different attitude? What about the Soviets putting in some end of the line storage like the Norwegian producers? Or the Algerians deciding to use the inherently flexible characteristics of LNG to play the Troll game but better?

In short, if Statfjord's seller superiority begat a similar Algerian attitude, begat a buyer resistance, begat the Dutch and Soviet terms of 1984 and 85, what will Troll beget? It stands to do rather better than join this endless tug of war.

On the Norwegian side alone there are other implications, just two of which I wish to highlight.

The provision of 25 per cent of Troll sales supply to come from other fields, with poor, ill-fated Sleipner finally getting a chance to go first. This is most important to Norway as it means that selling Troll does not rule out selling and thus developing (and thus exploring for) other gas.

The organisation of gas sales and gas transport, perhaps even the setting up of Norgas — a Norwegian Gasunie — must be fundamentally reviewed before Sleipner (really Troll's first gas) begins flowing.

To give you an idea of why I have to limit myself to these points for Norway, just consider the fate of gas which cannot join the Troll club. What has happened with Troll has already boosted its chances; just when you would have thought that it was doomed. We shall hear in the future years of many schemes to use and sell this gas, and some will succeed.

The netback concept

I would first like to look at this pricing concept, the netback concept. It is not, as it first

appears, a strict application of mathematical formulae. It is a concept. Let me read you the explanation of Gaz de France's Purchasing Director, Yves Cousin last October at the European Study Conference: Preserving Gas Competitiveness in Europe:

'Market analysis is a complex operation indeed, and a strict net-back calculation is virtually unfeasible...in view of the complexity of our markets, it does not work with an economic computation process that would yield given gas values and purchasing prices in a straightforward fashion. Pricing can in fact result only from negotiation, preferably in the spirit of a common goal, for instance, market expansion and of a driving concept, referring implicitly to netback.'

At the same conference, Shell's Dick De Jong gave the paper 'Europe's Gas Industry — an Insider's Overview.' He makes the same point about the netback concept or, to put it another way, the philosophy of keeping gas competitive in its end market is more important than the mathematical formula.

To illustrate this, **Table 1**, shows my estimates in autumn of 1986 of the notional Troll price

You will see that I have played around with different assumptions of the end market competition. This is what the gas negotiators had to do and I am not claiming that I know what exact price they arrived at. I do know that the aim of 'Le Netback' is to peg price and escalation such that if gas can compete against say electricity, gasoil and fuel oil in France or coal, heavy and gasoil in Germany etc.

But look now at a strict fuel parity table: **Table 2**.

The impact of oil product prices on European gas pricing

Since they are looking at different time periods let us just look at one moment where they overlap: Q3 1986. The lowest Troll price is $2.57/MMBtu, and I am ignoring here the important concept of multiple currencies. The highest parity price with competing oil — last year we just forgot electricity, it was out of the game — that is one weighted heavily by gasoil, is $2.06/MMBtu; taking HSFO alone we tumble to $1.65/MMBtu.

Of course this really just shows a time lag difference in one sense; the low prices are now in place for gas just as oil prices are rising. But they show too that someone in this chain is suffering. The current way out is what I call the double protector, where the market is protected above all else. That is, gas prices fall rapidly when oil does and they rise slowly when oil does. This is because the latter step keeps gas competitive against electricity, the former against oil and each does so at the time when its fuel competitor is most potent. Some would call this a buyer's market phenomenon.

But I ask those who do, to explain what good a dead market is to a producer. Anyone who wishes to see what happens to a gas market where the component links of the gas chain decide to devour each other need look no further than the United States.

I should just add that there is already talk in Europe of what I shall call the multiple pro-

Table 1: Taking a closer look at the Troll price

	1.10.85	1.1.86	1.4.86	1.7.86
REFERENCE ($/Tonne):				
GASOIL Ref (1)	231.00	241.77	230.22	201.89
LSFO REF (2)	146.83	145.00	130.83	94.67
GAS Price ($/MMBtu): (3)				
60/40 GO/LSFO	3.90	3.99	3.72	3.05
50/50 GO/LSFO	3.90	3.97	3.68	2.96
40/60 GO/LSFO	3.90	3.94	3.63	2.87
GAS Price ($/MMBtu): (4)				
60/40 GO/LSFO	3.50	3.58	3.34	2.73
50/50 GO/LSFO	3.50	3.56	3.30	2.66
40/60 GO/LSFO	3.50	3.53	3.26	2.57

(1) Spot Gasoil at Rotterdam taken on a nine month reference period.
(2) Spot Low Sulphur Fuel Oil, at Rotterdam, taken on a six month period.
(3) Statoil announced a "rough" gross revenue for the project of NKr 300bn which works out to $3.88/MMBtu. As the base price is understood to be slightly below the equivalent Dutch price at the time, we have used, as a base case, a figure of $3.90/MMBtu. Of course, as the dollar is not used to calculate or invoice any of the contracts, its use here is purely notional. The price is adjusted quarterly with no time lag.
(4) Further information to emerge on Troll indicates that a closer estimate of the Base price is $3.50/MMBtu, the impact of which is shown here.

A General note: We are not suggesting that the above table is anything but indicative.

The important points to note are: that the fuel oil and gasoil reference periods are not the same; that there is no crude oil in the index; that although we have not adjusted our gas price for inflation, it appears in the indexes at around 20 per cent and, unlike the current Dutch and Soviet contracts does not always fall out when oil prices drop rapidly (what we call the "double protector"; and that the adjustment is quarterly. We understand the fuel prices are as compiled by the West German statistical office at Wiesbaden with necessary adjustments for sulphur etc. Of course, these prices will never appear on a Troll invoice; it would be a strange gas world indeed that left untouched a formula worked out seven years earlier.

Source: International Gas Report & Petrospot News *Prices are indicative and estimates our own*

Table 2: The impact of oil product prices on European gas pricing

	Q3 1986		
	Sept	August	July
Gasoil			
$/tonne	126	121	86
£/therm	0.196	0.186	0.131
HSFO			
$/tonne	89	57	41
£/therm	0.147	0.093	0.066
$/£	1.48	1.496	1.507
Gas price (High HSFO)			
pence/therm		11.03	
$ per MMBtu		$1.65 (4)	
Gas price (high gasoil)			
pence/therm		13.8	
$ per MMBtu		$2.06 (5)	

Notes:

(1) Based on the now-abandoned sale of Irish gas to Northern Ireland, a deal which attempted to price gas at heavy fuel oil parity, with a gasoil adjustor. Both product prices are measured at Rotterdam. Most contracts in Europe now use a larger gasoil mix and tend to favour LSFO. None are on the parity basis shown here, and Rotterdam quotes have been largely discarded for buyer nation references. The illustrative value of this formula is the way in which it illustrates the impact of oil price changes on gas pricing. The gas price indicated by the original HSFO-directed formula is shown first.
(2) To better illustrate the effect of gasoil price changes we have included a second price much more heavily weighted to gasoil.
(3) Sterling quotes are used for consistency. The full version of this table appeared in International Gas Report 069 p. 5.
(4) The corresponding prices for the previous three quarters (Q2, Q1 1986 and Q4, 1985, the starting point for the Troll price,) are: $1.56, $2.68 and $3.75.
(5) Over the same periods as note 4, these prices are: $2.33, $3.44, $4.74.

Source: International Gas Report & Petrospot News *Prices are indicative and estimates our own*

tector, where buyer and seller take steps to minimise the pain of the seller during ultra low oil prices and of the buyer when prices should be very high. There are problems with this concept in tight markets, but again it shows the spirit of cooperation.

Integration of the links of the gas chain

The other concept I wish to look at a bit more closely follows closely on from this point. In the paper I just mentioned by Dick de Jong, he shows how gas should have a premium value over fuel oil and remarks that this is seldom the case in reality. And he laments that industrial users are not encouraged to rely on cheaper, single firing gas boilers but rather to invest in dual firing capacity. And he says:

'The gas industry should emphasise that it can provide security and price flexibility. Supply security is ensured by its diversification of supply sources, the long term nature of gas supply contracts, the reputation and track record of the suppliers and the creation of strategic stocks in the market place. The commitment to reliability was recently underlined by the preparedness of the Troll sellers to provide stand-by capacity.'

At first he can be lecturing the distribution companies. But he links in the Troll deal. It is a point which I feel is one of the least understood but most important aspects of Troll: All of this integration, Statoil and Shell looking for storage in Europe to back up the gas supply — and to deliver some fancy seasonality too I think; complicated price formulae geared to specific energy markets; annual and seasonal delivery flexibility and the like are all part of the same thing: integration, or cooperation.

The producers are not dumping gas at the buyers' door step and saying 'here's a load of dirt cheap gas which we are really suffering to produce for this abysmal price so get out and sell it.' Or if that is what they are saying they are missing the point. They are sharing with the utilities buying the gas an effort to expand the market they both need in order to make money.

This integration in turn will create a saleable commodity: the reliability and goodwill De Jong was talking about. And this is what will give gas its inherent premium. So far, I should add, however, the record is not too hot in Europe. Customers who cannot fuel switch are often treated worse than those who can. This hardly encourages the installation of gas only equipment.

Leaving aside the industrial market, there is a bigger fish to catch: the residential market. The records set in gas sendouts last week demonstrated the growing importance of this sector. Meeting its needs is a job for the entire system, from production to transmission to storage to pricing.

The Troll producers do not have the luxury of Groningen. Their big flexibility must be created closer to the market than to the field. And this is a business they can create together with the utilities or not. I would argue that it is in the interests of both sides to work it out together, rather than to fight for one controller. The very possibility of a mutual approach shows again the importance of Troll.

'Troll is a good deal — but not inviolable. It is a matter of solving problems together'

Extra customers

Troll can be delivered at either St Fergus or at Bacton at a marginal cost to the producers. That means that it is not going to be expensive compared to a lot of UK gas, especially more difficult to produce high pressure, high temperature, deep gas/condensate field gas. Nor is it going to be as unreliable as associated gas. That means that it will be attractive to British Gas and I would be surprised if BG were not already discussing the possibility with Statoil and its partners.

There is no use UK producers moaning about this. It is in their power to do what the Troll producers did and sell gas now for delivery many a year down the road. To look at the market in detail and not just from a pipeline flange at Bacton. Likewise it is up to British Gas not to take UK producers for granted while it signs up a healthy tranche of Troll gas.

Perhaps I am saying you can't beat Troll, so you might as well join.

This is what Austria has done, even though I should be most surprised if Austria actually takes many Norwegian gas molecules. But let us remember that in buying Troll, and making the necessary swap deals with Ruhrgas, Austria's OMV is applying the Troll principle: it is playing with what it's got, an important slice of European transmission, in its case delivering Soviet gas.

Other buyers will join too. And when they do they will be looking to extend the privileges of Troll to other contracts.

Norway

I remember back in March 1985 that I also believed that Troll could be sold because some heretics in Norway were beginning to talk about selling gas on a supply-dedicated basis rather than on a field-dedicated basis —as had been the case for all previous North Sea gas sales.

The Troll sales talks did not begin on this basis. Indeed up to the eleventh hour the most remarkable concretisation of this feature of the deal — the inclusion of the Sleipner field — was only vaguely conceived. But this once minority view, came alive in the negotiations, and I think came alive even more when Norway rallied 'round to outplay the French government's attempt to squeeze extra concessions out of Norway in return for approving Troll.

The trouble with the good idea of selling gas from many a small field to the Troll partners to onsell to their buyers is that the system is not in place to allow this. Norway has always sold gas from field producers to buyers and has tended to let the various groups of sellers fight their own battles. There was certainly an appalling lack of solidarity with the poor Ekofisk gas sellers when they had to curtail sales in an attempt to stop field subsidence. Yet it was the unreliability of Ekofisk sales which Burgmann cited when he told Norway to sell gas competitively or not at all.

Lately, there has been very uneven suffering on the part of some producers selling through Statpipe (Statfjord, Gullfaks and Heimdal field producers). There are two solutions: a rationalisation of transport policy, which the NPD is currently working on, and there is the possibility of a Norwegian gas transmission and export company taking over gas purchase and sale.

The Norgas idea has been around for a long time, but it is receiving more play now. I feel that the Troll group has already begun to play this role and if the policy decision were to create a Norgas along the lines of Gasunie — that is as a state/private oil company joint venture — the gas department of Statoil and maybe other Norwegian producers could make such a company fly.

But I do not think it will happen for some time — if at all. More likely is a policy guided increase in cooperation and sharing existing facilities. It's a shame, however, I think. Europe has hardly done badly as a result of the efforts of Gasunie. As Troll takes over Groningen's model, it could be useful to have a gas company looking after its market welfare.

Conclusion

In the next few years, Gaz de France; Belgium's Distrigaz; Snam of Italy; the German utilities Ruhrgas, Thyssengas and BEB and others will renegotiate, or to use Yves Cousin's preferred term 'adjust' their price, escalation and flexibility terms. They will review their storage requirements. They will settle terms with the Soviets and the Dutch and the Algerians. And all the while Troll will be coming closer to market, Frigg will be declining, and new customers will knock on Troll's door.

The oil price will go up and down.

The balance of power will shift between buyer and seller of gas and next year's Dutch contract terms will have as much impact as last year's Troll terms...or will they?

The buyers and the sellers have achieved a platform for cooperation with Troll. They will not become king of any mountain by pushing one another off. They would do well over those years up to 1993 to try to bring others into their new club: they can wipe spot gas out of Europe; they can expand market share for gas or they can return to the vicious cycle of the Spierenburg mission and the cancellation of Algeria's LNG-3. Of an unreviewable Statfjord contract at too high a price, of stretching Sleipner till it snaps and starting all over again.

Or they can cooperate and try to make the plateau of Troll gas 36Bcm not 90 per cent of 20Bcm.

The core of the Troll Revolution is solving problems together, much more than it is any of the details now on paper. It is a good deal. But it is not inviolable.●

New contracts are developing Far East use of LNG

Michael Cooper, Chief Executive Shipping and Associates, Burmah Oil, discusses the market for Liquefied Natural Gas, in which his company is the major maritime transporter.

He believes there will be greater use of LNG in Europe in the 21st century.

A Burmah LNG carrier at sea.

Geoffrey Mayhew: It was a long time ago that liquefied natural gas was used in the United Kingdom?

Michael Cooper: Yes. It was used in the British Gas and Shell project at Canvey Island, importing LNG from Algeria, in the early sixties. There were two vessels used, both of which are now laid up. The requirement for LNG in the UK was made obsolete by the discovery and development of gas from the North Sea.

What has happened to the world's LNG supply situation?

It is in considerable surplus. In the recent past, the last thing companies have wanted to discover, other than in certain privileged locations, has been gas. Finding gas in the North Sea, or near to consuming areas where facilities exist, is desirable, but in other areas the problems of distribution can be so immense and so expensive that finding gas is a major disappointment. Summarising, gas supplies are in actual and potential surplus and will remain so for a good time to come — well into the next century.

Is that why the Far East is the biggest area for the use or consumption of liquefied natural gas?

When one talks of the Far East, one is talking essentially about Japan, which effectively has no indigenous energy resources other than some rathe important hydroelectric facilities. It has to import all its energy, and for a variety of reasons LNG has been a rather significant contributor in Japan. I can perhaps summarise those reasons by pointing two factors: the desire of the Japanese to diversify their sources of energy, both as to type of energy and geographical location from which it comes, and the fact that LNG is clean and very acceptable environmentally for the generation of electricity. The other areas in the Far East that are actual or potential consumers of LNG are: Korea, which started a year ago; Taiwan, which will start in 1990, and other anticipated developments, whether it be the Philippines, or, ultimately, mainland China. Japan is overwhelmingly important.

Where does the LNG which they are using — or will use — come from?

The Japanese first imported LNG from Alaska, and that project still continues — in rather modest volumes. The Japanese then did the same through Shell from Brunei, which again has been very successful and continues to this day. Following that came Indonesia, with a project with which my own company is involved — and that remains the biggest single LNG project in the world. That was followed up by a second contract with Indonesia, with the result that Indonesia now provides over half of Japan's LNG requirements. Since then we have seen Malaysia begin to supply product. In 1989 the Australian northwest shelf will become a supplier. Abu Dhabi is also a supplier of LNG to Japan. Therefore, they have diversified their sources very successfully, although Indonesia is overwhelmingly the most important.

Michael Cooper

The transportation of LNG is carried out by the type of fleet that Burmah possesses?

If you find natural gas near an area which consumes it — whether it be for industrial use, power generation or domestic use — it can be put straight into a pipeline. In remoter parts of the world — where it has tended to be found — the only economic method of getting it to the consumers is to send it by pipeline to a position near a loading port where the gas can be liquefied. This process requires the temperature to be reduced to −160° C, the science of cryogenics. It is then loaded into tankers which are designed to carry the liquefied gas. Clearly, it does not need to be emphasised that these will be vessels with special containment facilities, and therefore highly expensive. When the vessel reaches its destination the liquefied gas, after its discharge, is turned into gas before it can be redistributed. This is now a well-established technology, but when the idea was developed it was very special indeed, and the plants were immensely expensive to construct.

(Continued overleaf)

Are there any in Britain?

There are no liquefaction plants because when it is near to population centres, gas can be supplied by pipeline. It does not need to be liquefied. For example, North Sea gas goes by pipeline to the British coastline and then into a grid. That grid is one of the great successes in terms of the general infrastructure in this country. In Europe, one has a situation where the vast majority of the gas is distributed (unliquefied) by pipeline, including the very long pipeline coming from east of the Urals which supplies gas right through to France. But significant quantities, although a minority of the total, do come in a liquefied form: the main consumers being Italy, France and Spain; and suppliers being Algeria and Libya.

Given the expensive nature of the fuel, how can they afford it?

Your assumption that it is an expensive fuel is incorrect. It is relatively cheap to produce. What is expensive is its distribution. Essentially, the price of natural gas has been geared to the price of competitive fuels — primarily oil, so with the rises in the oil price from 1973 onwards it became very profitable to sell gas even given the costs I have been describing.

We might see more LNG in parts of Europe?

I think we will. But, I think it is quite a way off, because the North Sea supplies, particularly those remaining untapped in the Norwegian sector, are very important — plus the enormous reserves enjoyed by the Soviet Union. So there is a prospect of gas being supplied to meet Western European needs by conventional pipeline rather than in liquefied form. Having said that, I think we will see an increase in supplies most particularly from Algeria. I am talking rather long term — I am talking of a time well into the twenty-first century. We may expect it to be a more important source of energy at that time.

Is one of the reasons the fact that the use of the liquefied natural gas carrier has proved to be a safe operation?

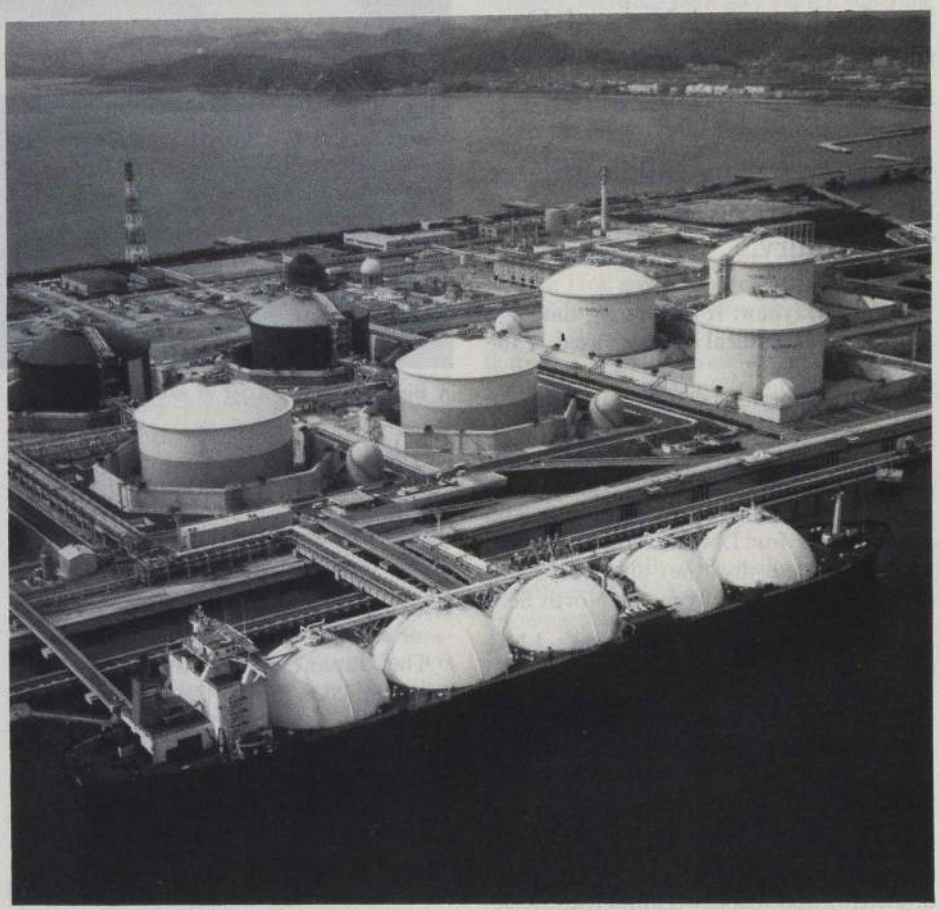
Yes, indeed. This form of carriage has had a remarkable record. There have been no really serious incidents. There have been a number of minor ones. The safety record of these vessels compared with that of other forms of shipping, not least conventional tankers, is outstanding. We have had no significant incidents and no fatalities in 10 years of operation and over 1200 cargoes, to take our own experience — so some of the more evocative phrases which have been used, such as 'floating bombs', have been shown by experience to be entirely inappropriate. The safety record compares very favourably with other forms of transportation and other products. Having said that, it is a highly flammable product and the highest standards in safety are required. What is most reassuring is that the methods of containment of the LNG have been so successful and have been shown to be extremely safe. Just to give an example of what we do — in my own company we have recently completed an operational safety audit of our fleet of eight 125,000 m^3 LNG carriers, with one of our own people and an outside marine consultant sailing with the vessels, checking their equipment, practices, procedures and safety exercises to verify to our satisfaction that the safety standards are satisfactory. Of course there are some areas where we want to see one or two improvements introduced, but the result of the exercise has been very reassuring.

We have a safety officer who is a permanent member of the establishment doing this type of work all the time, while an outside, comprehensive and objective look is not something we do on a routine basis. We do that on a one-off basis, but it is an important source of reassurance.

How does your fleet compare with others?

Just to give you an example, the second of the Indonesia/Japan gas sales contracts required a fleet of seven vessels of the same size compared with our eight. That is the second largest in the world. Next must be the Brunei project, served by seven vessels — but they are smaller than ours. That is the Shell/Mitsubishi project. The Malaysian project has five vessels. We are talking here of ships that cost about $150 m each to build. A big investment. **(Continued p.30)**

'Methods of containment of LNG have been shown to be extremely safe'



A Burmah LNG carrier discharging at Himeji, Japan. Photograph by courtesy of Osaka Gas.

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Burmah was far-sighted in establishing these vessels?

I think that if you go back to the days when this project was first mooted — the very early seventies — astonishing imagination and innovation was shown. Now you see projects which have developed elsewhere and it all seems perhaps reasonably routine, not counting the immense investment which has been put together. Yes, in those days there was a lot of flair involved and a lot of risk-taking.

The operation of the fleet is profitable for Burmah?

It is profitable, but the profits are not really very satisfactory. Profitability is not entirely commensurate with the level of financial commitment required.

Given that there have been some recent new consumers — for example, Korea — is the market for LNG going to expand in the eastern areas of the world?

I think the prospects for expansion in the Far East in the foreseeable future — up to the mid-1990s and the turn of the century — are modest. I would be surprised if we did not see further sales to both Korea and Taiwan. In the case of Japan, there is already an expansion in consumption because of trade with the Australian project due to come on stream in 1989. That is all under way. The plant is under construction and some of the vessels have been ordered.

Beyond that, there is a capability for an expansion of LNG trade from existing facilities, including Indonesia, and I would expect that to be taken up.

The inhibition is really two-fold. Here one has to assess essentially Japan's propensity to consume increasing quantities of energy — because the first inhibition is related to the simple demand for energy. Japan has been economising on the consumption of energy and there has been substitution of energy source—which has reduced its demand for oil and indeed gas. In addition, Japan's current economic performance is having a similar effect, although that may be short term.

The second factor is the one already mentioned, in that the Japanese are determined to maintain a balance between sources of energy both as to type and geographical location. Therefore, I suggest, they will want to keep LNG in its place along with hydroelectric power, oil, coal, nuclear etc, and that will, continue to be a significant constraint.

The possibility of great pipelines in the east is not so great as it is in Europe?

A fairly reasonable assumption, but the obvious exception to that — just to speculate — is China. With such a large and widely spread population, China does have the basic requirements for the sort of network and much bigger scale of pipeline that one finds in Europe and in this country. Nevertheless, LNG is a fuel of the future. It has a lot of very considerable advantages, perhaps the most significant one of which, given modern thinking and pressures, is its cleanliness. It compares extremely favourably with oil and coal in that respect. Its applications can spread beyond simply the generation of electricity and distribution for domestic and other purposes into major industrial uses, for example, as a feedstock for the petro-chemical industry. It has a very firm future — but it will, by its nature, always be expensive to develop and distribute. ●

Esso helps Britain to be beautiful

Near Esso's Fawley refinery, children find their way along the bat walk at the Woodland Centre, Beaulieu, run by the Countryside Education Trust

European Year of the Environment was launched on 18 March by HRH The Prince of Wales, who is patron for EYE in the UK. Speaking at Cargo Fleet, an area of reclaimed land beside the River Tees in Cleveland, the Prince, an Honorary Fellow of the Institute of Petroleum, emphasised the need to translate concern for protecting the environment into direct and effective action.

The Prince said he hoped EYE would 'enthuse the business and industrial community who are increasingly recognising that a good environment makes economic as well as visual good sense. The EYE campaign can give new meaning to the word "awareness", not just in terms of the environmental effects of industrial activity but awareness also of the vital regenerative and

Northern Ireland has the fewest trees of any country in the European Economic Community and is the second least wooded area in the whole of Europe. The reason is not some mysterious malevolence on the part of mother nature but just the usual, mundane shortsightedness of mankind. The felling of trees began in earnest around the sixteenth century when people living off the land quite simply cleared more and more woods for the sake of agriculture. And so it continued.

People clearly had to be enticed into planting and preserving trees. Towards the end of 1986 Esso decided to help the *Trees for Ireland* campaign and joined the British Trust for Conservation Volunteers (BTCV) and the Northern Ireland Department of the Environment in their efforts: it funded the delivery of a leaflet to 120,000 homes urging people in Northern Ireland to plant trees.

Such practical schemes should be proliferating all over Europe this year as 21st March was the start of European Year of the Environment. Its aim is twofold; to heighten awareness of the need to protect and improve the environment and to carry out practical improvements in the course of 1987/88.

The participation of Esso in projects like *Trees for Ireland* forms part of its long standing efforts to help preserve and enhance the British environment and is over and above the statutory conservation requirements which govern all oil company operations. John Gooderham, Manager, Contributions, explained why Esso gives time and money to environmental projects: 'We are operators throughout the UK and as such all of our operations impinge on the environment. Secondly, we are a major contributor to UK industrial activity and we believe that a company of our size and nature should be involved in the concerns of the community. It's in our role as a corporate citizen that we have become involved in environmental concerns and we tend to work through voluntary bodies.'

Given that Esso is approached by all kinds of organisations with their own preoccupations, it has to select certain criteria which are used in deciding which applicants will receive financial help. One obvious criterion is that if Esso is connected in some way either by location or by the nature of the activity, it becomes particularly relevant. This could mean anything from Fawley Refinery and North Sea operations to the recently built Midline pipeline or their marine operations.

If the presence of Esso in certain parts of the country does not provide a link, it is happy to consider environmental bodies which are concerned with the overall or nationwide protection of, say, birds or woodlands — features which affect the whole country. A recent example was Esso's agreement to sponsor a series of Countryside Conservation Awards under the auspices of the Royal Society for the Protection of Birds (RSPB).

The awards, which will go to outstanding achievements in the field of conservation, are divided into categories which include industry, the media and individuals. 'We need to heighten awareness among people so that they think about the environment,' said Mr Gooderham. 'It's every citizen's responsibility, including every corporate citizen.'

The overall winner, judged to have made the most positive contribution, will receive a £2,000 cash award from Esso. A wide range of entries is expected and will probably include habitat creation, the fight against pollution and the protection of rare species. The awards are different from other schemes in that groups and the media, as well as individuals, will be recognised for their contributions.

An important consideration which Esso also tries to bear in mind when it decides which particular project to support, is education. 'We've seen that unless you get to them young, it might be a little too late.'

At Fawley near Southampton, Esso has provided funds for an educational officer to be employed by the Countryside Education Trust. He goes round the local schools giving talks and trying to draw children into environmental interests — by, for example, creating a

'Environmental awareness'

restorative role industry needs to play.

'This is already happening with ideas like the One Per Cent Club and Business in the Community but the value of the EYE campaign, amongst other things, might be to focus on the areas and schemes where this business advice and support is most needed.

'Success will, however, depend on the actions of a multitude of individuals and small groups, public, private and voluntary, who share my concern with the quality of the environment, particularly that part of it they see every day.'

Teaching children to care for the environment is one of the most important aims of EYE and an environmental education pack will be distributed to schools throughout the country in 1987.

garden in the school or teaching them about wildlife.

Still in the field of education and training, Esso, along with the Nature Conservancy Council and the BTCV, is providing training courses for instructors who will then play a part in UK 2000, which was announced by the Government in July, 1986 and is chaired by entrepreneur Richard Branson. The newly trained instructors will help to expand the courses which are already run by the BTCV at its training centre in Doncaster.

UK 2000 has a similar purpose to that of European Year of the Environment. It will arrange a whole variety of environmental campaigns and provide high quality training for community programme schemes. It currently has over 100 projects planned for the future. For example, as part of the national Environment Week (25 April to 4 May), UK 2000 held a 'Forest of London' campaign to plant thousands of trees throughout London and give advice on how to keep them alive.

UK 2000 is also currently involved in the North East with the renovation of Tynemouth railway station and its conversion into workshop space for the community. 'As part of our participation we have seconded a senior manager to get UK 2000 launched in Scotland. He'll be there for two years. It's a way of making sure that Scotland is covered by the campaign,' said Mr Gooderham.

'Another of our general concerns is inner cities. As part of this, we are backing several organisations who are trying to improve the environment in the inner cities where we may have very little presence other than service stations and customers. So we link in with organisations like the BTCV and the Groundwork Trust.' The latter is a fairly recent initiative using local resources to improve the urban environment. It started in the north west of England but is now spreading further afield and an Esso manager has been seconded full time to the Trust to help achieve this.

BTCV volunteers working on a conservation-in-practice garden at the Stoke garden festival

Esso does not, of course, specify which particular area should be cleaned up. It would simply give backing and support to an organisation like Groundwork which would then arrange how to do the work and liaise with local authorities and residents.

A project which was completed quite recently was the transformation of an area of wasteland in Trafford Park industrial estate, into an ecological park. The land was adjacent to the Esso distribution terminal at Manchester and the company made it over to the local authority who then set about creating a haven of flora and fauna.

In fact, Esso showed an interest in directly protecting the face of the countryside in the '40s when, during the expansion of Fawley refinery it was decided to build a screen of trees. Although you clearly can't hide a refinery completely, the tree screen, now mature, provides a good ecological habitat.

'Similarly, when Esso and Shell developed the chemical complex at Mossmorran in Fife the companies were very careful to blend the tankage within the hills so that it would have the least impact on the landscape.'

One of Esso's recent involvements has been with something that concerns the whole country and not just a specific area connected with business activity. It is funding an NCC project on the 'Ancient Woodlands' which will list all the ancient woodlands in the UK.

The whole project will take three to four years to complete. 'We believe it will be of lasting value. We're talking about something in the environment which has taken hundreds, perhaps thousands of years to build up and which can disappear unless there is wide recognition that these habitats are important and need active management', said Mr Gooderham.

'Attention to the environment is carried right through to the design of service stations. Wherever possible Esso tries to ensure that the corporate design of their forecourts blends with the surrounding landscape. Working with local planners at Bath, for example, Esso used local Bath stone for the surround to a Service Station in the city.'

Esso recently inaugurated the Midline pipeline. At a cost of £37m it links Fawley refinery with the Midlands and north west and passes through areas of outstanding natural beauty — Salisbury Plain, the Marlborough Downs, the Cotswolds and the Vale of Evesham. These areas are also of considerable archaeological interest.

From the start Esso took full account of the environmental aspects of the project, including doing a full environmental impact assessment. It is now virtually impossible for the untrained eye to see where the pipeline runs. In addition to this, however, Esso engaged a team of archaeologists as consultants to the construction team so that whenever ancient relics were discovered, nothing went unrecorded or lost. The Wessex Archaeological Trust, in association with Esso, have since produced a booklet on the discoveries that were made.

The archaeological work on the Midline pipeline highlights the interest Esso has always maintained in the environment. 'We are pleased to recognise designation of 1987 as European Year of the Environment, which we are supporting', said John Gooderham. 'But that support will not stop with the end of the year. Our policy of commitment to environmental issues will continue.'●

Amrit Pandya

The Conversion Refinery: The Catalytic Magic Wand

● A cat cracker is a cat cracker? And is it so for cat reforming — the refinery basic workhorse? Don't believe it! It is too simple to take the progression to today's conversion refinery, the whitening of the oil barrel and factors like the reduction in lead content just for granted. The progression didn't happen like that; and even in long utilised processes such as the above the technology has had to change critically to suit.

● Peter Jones, whose earlier papers took a general view at unleaded gasoline,[1] and charted the expected continuing shift in product pattern away from heavy fuel,[2] examines how just one or two of these crucial process changes have helped the refiner to balance his commitments.

You didn't attend the IP Economics of Refining Conference on the 11th November 1986? Pity! Perhaps you thought it was only for the specialists. While this was mainly true, you still can purchase and enjoy perusing the published conference proceedings.[3] The writer did just that one bleak weekend and, not entirely unselectively, from its many attractive papers, has chosen just two illustrations from one of these[4] that, even for the non-specialist provide insight into how well the research and development into catalyst improvements have provided ever more effective tools for the refiner.

The first such extract — on Fluid Cat Cracking — presents, in the tabulation below a concise picture of how catalyst change has served to sharpen the ability of this key process to increase conversion yield to gasoline (33 to 53 per cent in the example), with little change in the production of cat cracked middle distillate (Light Cycle Oil, and blendable into heating or diesel fuel), and a welcome reduction in the residual heavy material (Heavy cycle oil/slurry) that has to be disposed to heavy fuel oils.

The limitation to the refiner, had catalyst development stopped short at the low or high alumina stages of the 50's/60's can be well imagined. For those with an eye to the minutiae of yield structure, that conversion loss to 'coke' — which has to be burnt off non-usefully in the catalyst regenerator recycle step — is reduced and largely offsets the extra one per cent on process fuel consumption, may perhaps be seen in mitigation of that old generality 'that there is no such thing as the free lunch'.

There is one aspect where not even modern cracker catalysis can live up to the old alchemists dream of the perfect 'Philosophers stone of perfect transmutation to gold.' This may be seen from the table, wherein despite the change in yield, there is no accompanying change in octane quality of the cracker gasoline — and thus no compensation for the octane loss due to lead reduction, for which the refiner has to look elsewhere, not only for the production of the current low lead (0.15 g Pb/litre four star 97 RON gasoline), but likewise for the 95 RON/85 MON debut of the unleaded gasoline era of the EEC Directive.

Such a topic is well beyond the scope of this paper (and equally beyond the indulgence as to space that would be granted by the Editor), but leads to the second tabulation, illustrative for a chosen quality naphtha, and two chosen octane target points (95 and 100 RON, unleaded), the effect of catalytic reformer catalyst development in the period 1965–75–85.

The squeeze between cat reformate (i.e. C5+) yield and octane quality requirement, even with the catalyst development shown will be fully apparent, particularly when it has been predicted[5] that, with the phase down of lead and in order to achieve a satisfactory future octane level for refinery gasoline blending, the severity of cat reforming will need to rise from a current 93–94 RON level to the future range of 98 to 100 RON.

The rather limiting octane quality of cat cracker gasoline mentioned already is also envisaged to require at least portions to be separately fractionated and further upgraded by inclusion in the reformer feed input. To meet such increased duties, a major investment in refineries lies in the upgrading of reformers — in some cases by adaption of existing reformers to the newer reforming catalysts and severities of operation, but in many cases by the replacement of the older units.

Development History of Catalysts

FLUID CAT CRACKING

Catalyst Type	Low Alumina	High Alumina	General Purpose Zeolitic	Catalysts
Year	50's	60's	70's	80's
Yields				
% wt on feed				
C1–C2	4	3	3	2
C3–C4	6	10	12	13
Gasoline	33	35	45	53
Light Cycle Oil	22	21	20	21
Heavy Cycle Oil/Slurry	28	24	14	5
Coke	7	7	6	6
RON Gasoline	93	93	91	92
Fuel Consumption				
% on feed	6·9	7·2	7·5	7·9
Cat. Consumption				
t/1000 t feed	1.6	1.4	0·7	0.65
Cat. Costs				
(Europe 1986) $/tonne	1000	1000	1000	1000
Cat. Costs $/tonne feed	1.60	1.4	0.70	0.65

CATALYTIC REFORMING

Catalyst Type	Mono-metallic	Bimetallic Low Density	Bimetallic High Density
Year	1965	1975	1985
Rel. Stability, Stream-days	1	2	4
Cat. replacement cost, $/tonne feed	0.157	0.160	0.281
RON 95			
C5+ yield, %wt on feed	83.6	85.5	86.5
RON 100			
C5+ yield, %wt on feed	—	78.8	81.5

Conclusion

For those wishing to further explore these and other related developments the Conference proceedings may be commended, and it is hoped that these brief outlines may serve to whet the appetite. For those who have found the individual chapters on conversion processes in the IP 'Modern Petroleum Technology (5th Edition) 1984' reference book[6] of basic value, these proceedings could well deserve an accompanying place on the bookshelf. Six references to read you say? yes, and all within the coverage of the state of the art provided by the IP for its membership. ●

References

1 *The Introduction of Unleaded Gasoline into Europe. Petroleum Review December 1984.*

2 *The Efficient Use of Energy; Appropriate Use of Energy Sources, Particularly Oil Fractions. The Institute of Petroleum Quarterly Journal of Technical Papers. January–March 1986.*

3 *Institute of Petroleum. Economics of Refining. Papers presented at an Energy Economics Group Conference on 11th November 1986.*

4 *Ibid. Economics of Catalysts on Refining Economics. M. M. van Kessell and R. H. van Dongen.*

5 *Institute of Petroleum 'Modern Petroleum Technology (5th Edition) 1984, published by John Wiley and Sons Ltd.*

6 *The Outlook for the Economics of Refining R. C. M. Langley. The Economics of Refining: Papers presented at the Energy Economics Group Symposium, Institute of Petroleum 25 October 1984.*

Refinery facilities

The diverse re-shaping of refineries is indicated in the tables below and in the following page (p.36). They were provided by Shell International and relate to its own operations.

PLANNED COMMISSIONING OF FACILITIES UNDER CONSTRUCTION AT REFINERIES OUTSIDE NORTH AMERICA
Position as at 1st January 1987

Country	*Company*	*Refinery Location*	*Shell financial share (%)*	*Project*	*Capacity 000 b/cd*	*Planned Commissioning date*
France	Shell Francaise	Berre	98.41	Fluid Cat. Cracking Unit (relocation from Pauillac)	19	4th quarter 1987
Netherlands	Shell Nederland Raffinaderij B.V.	Pernis	100	Hycon complex (Hydrocatalytic residue conversion)	22	3rd quarter 1988
United Kingdom	Shell U.K. Oil Ltd	Stanlow	100	Fluid Cat. Cracking Unit (long residue)	59	End 1987
Japan	Toa Oil Company Ltd.	Kawasaki	17.64	Fluid Cat. Cracking Unit	18.1	Mid '87
				Polymerisation Unit	3.85	Mid '87
Malaysia	Shell Refining Company (Federation of Malaya) Berhad	Port Dickson	75	CDU, revamp	to 66	4th quarter 1987
				Cat. Reformer, conversion for Cont. Cat. Regeneration	to 14	4th quarter 1987
				Hydrotreater, revamp	to 23	4th quarter 1987
				Vacuum Distillation Unit	8.5	4th quarter 1987
				Bitumen Blowing Unit	2.3	4th quarter 1987
Thailand	Thai Oil Company Ltd	Sriracha	15	Cat. Hydrocracking Unit (distillate)	15.4	End 1988
				Vacuum Distillation Unit	29.8	End 1988
				Hydrogen (SMR)	28 mmcfd	End 1988
				Revamp of:		
				CDU	by 12.6	End 1988
				Visbreaking Unit	by 7.4	End 1988
				Cat. Reforming Unit (semireg, bimet.)	by 2.3	End 1988

LEGEND for Capacity Data for Refineries outside North America (on opposite page)

1) D — Distillation; C — Cracking; L — Luboil; A — Asphalt; W — Wax

2) Intake capacity, all figures are per calendar day representing the annual capacity, divided by 365, accounting for inspection and maintenance shutdown time.

CRACKING
THERMAL PROCESSES
a) Thermal Cracking
b) Visbreaking
c) Delayed coking
d) Other (Flexicoking)

CATALYTIC CRACKING
Fluid

CATALYTIC HYDROCRACKING
a) Distillate upgrading

CATALYTIC REFORMING
Semiregenerative:
a) Conventional catalyst
b) Bimetallic catalyst

Cyclic:
c) Conventional catalyst
d) Bimetallic catalyst

Other:
e) Bimetallic catalyst

CATALYTIC HYDROREFINING
a) Residual desulphurisation
b) Gas oil desulphurisation
c) Cat-cracker feed pretreatment
d) Other

CATALYTIC HYDROTREATING
a) Pretreating cat-reformer feeds
b) Naphtha desulphurisation
c) Naphtha olefin or aromatics saturation
d) Straight run distillate
e) Lube-oil polishing
f) Other

ALKYLATION
a) Sulphuric acid
b) HF

AROMATICS/ISOMERISATION
a) BTX
b) Hydrodealkylation
c) C5–C6 feed

HYDROGEN MANUFACTURE
a) Steam methane reforming

(Continued p.36)

CAPACITY DATA FOR REFINERIES OUTSIDE NORTH AMERICA (Shell operations)
Position as at 1st January 1987 (Revised issue, March 1987)

Country	*Company*	*Refinery Location*	*Shell financial share (%)*	*Refinery (type 1)*	*Capacities in thousand barrels per calendar day 2)* Distillation *Atm.*	*Vacuum*	Cracking *Thermal*	*Fluid Cat.*	*Hydro Cat.*	*Cat. Reform.*	*Hydro-refining*	*Hydro-treating*	*Alkylation Poly**	*Aromatics Isom.*	*Lubes*	*Asphalt*	*Hydrogen MMs cfd a)*
Denmark	A/S Dansk Shell	Fredericia	100	D/C	55		22 a)			12 b)	10 b)	19 b)		3.4 c)			
France	Shell Francaise	Berre l'Etang	98.41	D/C/A	128	60	23 b)	19		15 b)	35 b)	33 b)					
		Petit-Couronne	98.41	D/C/L/A	217	113	10 b)	19		42 b)	33 b)	48 b)			7.5	8	
	Compagnie Rhenane de Raffinage	Reichstett-Vendenheim	63.97	D/C/A	85	36	16 ab	14		13 b)	12 b)	21 b)					
Germany, West	Deutsche Shell A.G.	Godorf	100	D/C/A	170	73	29 a) 7 b)		19 a)	17 b) 21 e)	32 b)	52 b) 34 c) 12 d)		14 a) 3 b) 6 c)		12	
		Harburg	100	D/C/L/A	86	45	14 b)	15		16 e)	14 b) 6 d)	31 b) 2 c)			6.1	7	
Netherlands	Shell Nederland Raffinaderij B.V.	Pernis	100	D/C/L/A/W	348	148	45 b)	78		17 b) 35 e)	77 b)	138 b) 8 c) 0.3 e)	6.8 b)		7.1	5.5	
Norway	A/S Norske Shell	Sola	100	D/C	60		26 a)			10 b)		16 a) 9 d)					
Sweden	Shell Raffinaderi AB	Gothenburg	100	D/C	80	17	27 a)			16 b)	16 b)	22 b) 5 d)		4 c)			
Switzerland	Raffinerie de Cressier S.A.	Cressier	100	D/C/A	60	24	11 a) 9 b)			16 b)	8 b)	27 a) 5.5 d)		3.6 c)		5.2	
United Kingdom	Shell U.K. Oil Ltd	Shell Haven	100	D/C/A	92	30			21 a)	34 e)		34 a) 29 d)				3	
		Stanlow	100	D/C/L/A/W	262	90		54		29 b) 27 e)	41 b)	56 a) 14 b)		9 a) 5 b)	4.5	8	
Cameroon	Societe Nationale de Raffinage	Pointe Limboh	8	D	43					6.5	10	10					
Gabon	Societe Gabonaise de Raffinage	Port Gentil	14.14	D/C	16		7.2			1.4		4.5					
Ivory Coast	Societe Ivoirienne de Raffinage	Abidjan	5.15	D/C	59	34.5			11.5 a)	16.6	11.5	21					
Kenya	Kenya Petroleum Refineries Ltd	Mombasa	12.75	D/A	95	1.6				4.3 a) 4.6 b)		30 bd				0.8	
Senegal	Societe Africaine de Raffinage	Dakar	23.6	D	24					2.6		2.6					
Sierra Leone	The Sierra Leone Petroleum Refining Company Ltd	Freetown	28.5	D	10												
South Africa	Shell and BP South African Petroleum Refineries (Pty) Ltd	Durban	50	D/C/L/A	200		43	27		26	55	57					
Sudan	Port Sudan Refinery Ltd	Port Sudan	50	D	24					2.1 a)		9 d)					
Zimbabwe	Central African Petroleum Refineries (Private) Ltd	Mutare (inactive)	20.75	D/C/A	20		6 c)	7		3	2	8					
Saudi Arabia	Petromin Shell Refinery Company	Al Jubail	50	D/C	250	68	27 b)		34 a)	15 e)	39 b)	15 a) 56 b) 47 d)		7 a) 4.4 b)			90
Turkey	Anadolu Tasfiyehanesi A.S. (ATAS)	Mersin	27	D	90					10		20 b) 11 d)					
Brunei	Brunei Shell Petroleum Company Sdn Bhd	Seria	50	D	10												
Japan	Seibu Oil Company Ltd	Yamaguchi	12.1	D/A	137.7	42.2		18.1		12.9 b)	40.1 a) 24.9 b)	48.3 b) 24.5 d)					42.4
	Showa Shell Sekiyu K.K.	Kawasaki	50	D	136.8	27.5				19.1 b)	7.6 b) 14.2 d)	30.3 b) 18.7 d)		5.5 c)			
	Toa Oil Company Ltd	Kawasaki	17.64	D/C	59.7	48.6	17.8 d)			9.8 b)	51.6 b)	18.3 b) 8.9 d)					32.8
	Showa Shell Sekiyu K.K.	Niigata	50	D	27.5					4.3 b)		11.6 b) 2 d)					
	Showa Yokkaichi Sekiyu Company Ltd	Yokkaichi	37.5	D/C/L/A	215.7	106.5		22.6		38.1 b)	37 b) 35.6 d)	61.4 b) 39.2 d)		7.6 a) 5 c)	5.5	6.3	28.3
Malaysia	Sarawak Shell Berhad	Lutong	100	D	45												
	Shell Refining Co. (Federation of Malaya) Berhad	Port Dickson	75	D/A	90	2.4				4 a) 10 b)		28 b) 5 d)				1.7	
Pakistan	Pakistan Refinery Limited	Karachi	15	D	46.3					2.7		18.1					
Philippines	Pilipinas Shell Petroleum Corporation	Tabangao	50	D	68					8.3 a)	5.5 b)	15.5 bd					
	Philippine Petroleum Corporation	Pililla	56.78	L		20.5									3.4		
Singapore	Shell Eastern Petroleum (Pte) Ltd	Pulau Bukom	100	D/C/L/A	300	85.6	64.7 a)		21.6 a)	20.7 be	44.6	107 bd			5.8	4.3	40
Thailand	Thai Oil Company Ltd	Sriracha	15	D/C/A	63.9	18.8	9.6 b)	9.3		2.8 a) 5.3 b)	10 b)	32 d)				1.1	
Australia	Shell Refining (Australia) Pty Ltd	Clyde	100	D/C/A	75	21		31		13.3 b)	7 a)	37 d)	5 b) 3 *				
		Geelong	100	D/C/L/A/W	110	10		25		8 b) 20 e)	4 b) 11 c) 3.5 d)	55 d)	6 b) 1.5 *	8 c)	2.5	2.5	
New Zealand	The New Zealand Refining Co. Ltd	Whangarei	17.14	D/C/A	81.7	38.7			20.1 a)	21.7 b)	6 b)	32.1 a) 10.1 b)				2.1	45
Argentina	Shell Compania Argentina de Petroleo SA	Buenos Aires	100	D/C/L/A	121.7	54	27 b)	21.7		10.8 a)		14.9 b) 7.5 d)	1.7 b) 0.5 *		1.4	4.2	
Dominican Republic	Refineria Dominicana de Petroleo SA	Haina	50	D	32.5					7.9 a)		15 d)					
El Salvador	Refineria Petrolera Acajutla SA	Acajutla	35	D/A	16.3	1.9				2.8 a)		5.6 b) 6.5 d)					
Martinique	SA de la Raffinerie des Antilles	Fort de France	23.94	D	12					3		4.85 a) 3.5 d)					

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Alcohol as a future motor fuel: prospects

by the Swedish National Energy Administration

The Swedish National Energy Administration has responsibility for the working programme concerned with the introduction of alternative motor fuels, initiated by the Swedish Parliament in 1983.

Under this programme the Administration is required to review the experience so far obtained and to put forward proposals for continued work. It is for this reason that the Administration has produced the report *'Motoralkoholer i Sverige'*.

It describes the present world markets for methanol and ethanol, together with the prospects for increased Swedish output of alcohols for use as motor fuels.

It also describes experience in Sweden and other countries of the use of alcohols as motor fuels.

***'Motoralkohol i Sverige'*, discusses the feasibility of, and the factors associated with, a large-scale replacement of present-day gasoline and diesel motor fuels by alcohol fuels. Both technical and economic aspects are considered. It analyses the world markets for methanol and ethanol as a background to a discussion of the factors governing the production of alcohol fuels in Sweden.**

Methanol production

In 1985 world consumption of methanol amounted to about 13 million tonnes. Of this, about 70 per cent was used for the manufacture of formaldehyde, and considerable quantities were used for the manufacture of acetic acid and MTBE.

Total world methanol production capacity in plants in use today is probably between 17 and 20 million tonnes a year, with an extra 2–3 million tonnes a year from plants currently under construction. Actual production is about 13 million tonnes a year, ie a capacity utilisation of only 70 per cent. Natural gas is the main raw material, as it provides cheaper and simpler process paths for manufacture than solid raw materials do.

The price of methanol on the spot market at the end of 1985 was about US$130 per tonne (approx SEK 0.77 per litre). During the spring of 1986, the price trend has been affected by the falling price of oil: in the middle of April, spot market prices CIF Western Europe were about US$95 — 120 per tonne (approx SEK 0.57 — 0.71 per litre).

In the longer term, the price of methanol will be governed primarily by demand. If, as hitherto, demand is influenced mainly by the use of methanol as a feedstock for the chemical industry, it is likely that significant quantities (about 5 million tonnes a year) will be available on the spot market at prices not in excess of US$140 per tonne (approx SEK 0.84 per litre).

If, on the other hand, demand should increase by some millions of tonnes a year through establishment of a market for the admixture of alcohol in gasoline, the price could be expected to rise to about US$180 per tonne (approx SEK 1.07 per litre). At this level, further capacity based on manufacture from natural gas would become viable.

If methanol were to be introduced on a large scale as a motor fuel or component thereof, prices might rise further, bringing them above the level at which coal-based methanol production processes could become competitive. At such a stage, the price could be expected to have reached about US$250 per tonne (approx SEK 1.50 per litre).

As far as the use of ethanol for technical purposes is concerned, two essentially different production processes are in use. The most common method involves fermentation of biomass, followed by distillation. The second method starts from oil or natural gas, producing ethene as an intermediate stage in the production of synthetic ethanol. Total world production of ethanol in 1984 amounted to about 11 million tonnes, of which the fermentation process accounted for about 85–90 per cent.

The price of the raw material input largely determines the cost of the final product, ethanol. The most widely known examples of manufacture of ethanol by fermentation of biomass are production in Brazil and in the USA. With the more favourable conditions for biomass production in Brazil, ethanol can be manufactured there from sugar cane at a lower cost than is possible from agricultural-based production in Europe or in the USA.

Brazilian production costs in the spring of 1985 were stated as being equivalent to about SEK 2.00 per litre for ethanol containing 5 per cent water. This represents a gasoline-energy-content equivalent price of a little over SEK 3.00 per litre. Production in 1984 amounted to about 7.3 million tonnes.

Research

Research and development work aimed at investigating the feasibility of producing fuel-grade alcohol from indigenous raw materials has been in progress since the middle of the 1970s, concentrating on the production of synthesis gas for subsequent synthesis of methanol.

Work and planning have focused on verifying technology and economics on a pilot scale until 1985, verification on a prototype scale until the end of the decade, followed by possible demonstration-scale production in the middle of the 1990s. Raw materials that have been tried out are biomass, peat and oil shale. Swedish work on gasification of these raw materials ranks among the foremost in the world.

Theoretical production costs for the production of methanol from indigenous raw materials, verified by pilot-scale processes, are in the range of SEK 1500–1800 per tonne, equivalent to 1.20–1.45 per litre of methanol (equivalent gasoline price SEK 2.40–2.85 per litre).

In recent years Swedish production of ethanol, aimed at the motor fuels market, has also been considered, in spite of the fact that ethanol must be regarded as a more expensive alternative than methanol.

A trial plant for production of ethanol from agricultural raw materials is in operation. It has a capacity of about 5000 tonnes a year of ethanol, and has been financed partly by funds from the national energy research programme. The plants use a new continuous fermentation method. According to information from the project, the cost of ethanol from the process is about SEK 3.77 per litre after allowing credit for saleable byproducts (equivalent gasoline price SEK 5.53 per litre).

Costing

The method of costing is based partly on the use of subsidised raw materials. In the opinion of the Swedish National Energy Administration, production cost using raw materials at current prices would be about SEK 5.30 per litre of ethanol (equivalent gasoline price SEK 7.78 per litre), if the input raw material was not subsidised. The expected cost of ethanol from a full-scale plant, having a production capacity of 50,000 tonnes a year and using non-subsided input raw materials, is calculated as being about SEK 4.20 per litre (equivalent gasoline price SEK 6.16 per litre).

The production of ethanol from forest raw materials has also been the subject of an investigation, which has indicated that joint location of such a production unit with a pulp mill could give a cost advantage over production from agricultural-based products.

The Swedish National Energy Administration does not at present have sufficient information to enable it to assess a process proposal which has been put forward from the forest industry. A preliminary cost estimate indicates a possible production cost, under favourable conditions, of about SEK 3.00 per litre of ethanol with 5 per cent water, giving an equivalent gasoline price of SEK 4.60 per litre.

Price relationships between the various alternative fuels, expressed as gasoline equivalent prices, are shown in the table below. The prices shown allow for the different energy contents of the fuels.

Considerable experience of operation of vehicles fitted with otto engines and running on blended fuel has been accumulated from the M15 project, in which about 1000 vehicles participated. About 20 vehicles are at present running on 100 per cent methanol fuel within the current M100 project.

Although experience so far from the M100 trials is still not sufficient to allow any com-

Table of Gasoline-energy-content equivalent prices, SEK per litre

Methanol, max 0.15 per cent water:	
—imported	1.20–1.50
—indigenous production from peat	2.70–3.00
Ethanol, max 5 per cent water:	
—imported	3.50–4.00
—indigenous production, forest raw materials	Approx 4.60
Ethanol, max 0.5 per cent water:	
—imported	4.00–4.70
—indigenous production, agricultural materials	Approx 6.20*)
Gasoline, premium or unleaded 95 octane:	
—imported	0.70–1.10

**Raw materials cost based on Swedish-grown wheat.*

prehensive assessment to be made, the project (which was due for conclusion during 1986) will generate important information.

Field trials of two Volvo buses, fitted with two-fuel compression-ignition (diesel) engines, have been carried out.

Within the national programme of work, trials are also in progress with E95 fuel (ethanol with about 5 per cent water and certain performance additives) for use as a substitute for diesel fuel in heavy vehicles.

The critical problems associated with the use of alcohol fuels in otto engines must now be regarded as well documented. On the other hand, the use of alcohols as fuel in diesel engines involves different and more complex technical problems, which have not been equally satisfactorily identified.

Results from the work carried out so far on alternative fuels indicate that the higher production costs of such fuels prevent them from competing unconditionally with gasoline and diesel fuel. Present and expected future developments on the world oil market have further underlined the cost disadvantages of alcohols.

In the short and medium term, production costs for the production of methanol and ethanol from indigenous raw materials are expected to be considerably higher than the cost of importation from the world market.

An IEA investigation has emphasised that the main problem in the way of large-scale introduction of alternative motor fuels is to be found in the major economic risks associated with any larger change in the motor fuels or transport sectors. This will mean that political agreements will probably be required between many countries, as well as agreements between the political instances and industries affected in order to facilitate a new fuel market. The Swedish government and Swedish authorities should do what they can to encourage international cooperation in this area.

The use of alcohols is felt to have a number of environmental benefits, although these are not as great for otto engines as was previously thought. As far as the use of alcohols in diesel-engined vehicles is concerned, there are indications that there may be somewhat greater environmental benefits. However, experience so far of diesel vehicles using alcohol fuels is not as extensive as that of vehicles fitted with otto engines. For this reason, priority should be given to development work on diesel engines.

Any benefits of Swedish production of motor alcohols from a contingency planning viewpoint must be assessed against the effect of other measures intended to provide a similar degree of contingency preparedness. The costs for contingency storage of gasoline are at present about SEK 0.015 per litre for the acutal storage and about SEK 0.13 per litre interest charge. These costs are far below the additional cost of indigenous production of motor alcohols, which means that contingency preparedness based on such production cannot be regarded as cost-effective.

Monitor

Against the background of the experience and assessments now available from the working programme for alternative fuels, the Swedish National Energy Administration suggests that the working programme on supply aspects should be concentrated on monitoring continued development of the world markets for alcohols. No specific activities for drafting import agreements need to be undertaken.

As far as the emphasis of the programme on more widespread activities with larger fleets of vehicles is concerned, the Administration suggests instead that limited fleet trials should be conducted. Bearing in mind general development trends on the motor fuels market, it would not seem possible today to say exactly when large-scale fleet trials might be justified. The possible date for large-scale introduction of motor alcohols must depend on international developments.

The administration feels that the Swedish M100 trial, which is now in progress, should be terminated and its results be assessed. Work on continued, wide fleet trials is not justified for vehicles with otto engines.

The Administration also suggests that the emphasis of the work programme should be clearly concentrated on vehicles fitted with diesel engines, mainly for environmental reasons.

As far as engine technology is concerned, it is immaterial whether the fuel is methanol or ethanol, as the two alcohols are essentially interchangeable. However, the Administration feels that methanol is preferable from a cost viewpoint.

Fleet trials on a smaller scale, eg with a small number of buses, could suitably be started during the 1987–1990 period. These fleet trials should possibly be linked to the IEA work being carried out within the transport sector, thus facilitating a practical exchange of information and experience with countries such as Canada, the USA and Japan.

Over and above this, it is important, as with the situation for otto engines, to maintain a high level of competence within the motor fuels programme in order to be able to monitor international developments and to consider possible joint working projects.

As far as indigenous production of alcohols for use as motor fuels is concerned, the Administration feels that any such production would result in higher costs for fuels than if the corresponding quantities were purchased on the open market. This, in any case, is expected to be the case during any introductory phase, which would also include large scale introduction in several neighbouring countries.

In view of this, the Administration feels that there is no longer any justification for carrying out the earlier plans intended to verify prototype-scale processes of methanol production from synthesis gas produced from wood and peat. This change of emphasis means that the possibility of production of methanol from synthesis gas is now postponed until beyond the turn of the century.

As far as indigenous production of ethanol from agricultural products is concerned, the Administration feels that it is now clear that the use of this fuel would be more expensive than the use of methanol. The demonstration production plant, which has been partly financed by the energy research programme, has demonstrated that the actual process works as intended. It is not felt that there is any need to continue with a larger production unit for further verification of process technology.

Complementing the thoughts on production of ethanol from agricultural products, suggestions have also been put forward for production of ethanol based on total hydrogenation of forest raw materials. The Administration does not consider that this process path can result in the production of ethanol at a sufficiently low price to justify the construction of a production plant.

However, the Administration feels that if any decisive knowledge benefits concerning the process can be achieved through further experimental work on a small scale, then there is justification for providing support for such development work within the framework of the energy research programme.

Research into production of ethanol from lignocellulose using enzymatic processes should continue under the auspices of the energy research programme. This particular line of development is still at a more basic stage. These processes are thought to be environmentally benign, and can have considerable potential in the long term.

Summary

Summarising, the Administration considers that the Swedish working programme for introduction of alternative motor fuels can continue to be promoted, but in a more long-term perspective and with reduced input. The Administration feels that development work should be continued only within certain sectors, and has made suggestions for work to be carried out during the 1987–1990 programme period.

On the whole, the Administration's proposals are intended to maintain a high level of competence within the sector. The Administration would particularly like to emphasise the importance of actively monitoring and also influencing international development, as any large-scale introduction of motor alcohols would require broad international cooperation. ●

SPOT, FORWARD AND FUTURES MARKETS

Who Uses Them and Why? Are They Efficient?

Thursday 11th June 1987

To be held at
The Institute of Petroleum

These will be the themes of a Conference being organised by The Institute of Petroleum's Energy Economics Group

The Role of the Spot Markets in the West and the East
(Joe Roeber, Joe Roeber & Associates)

The Forward Markets in Brent Crude Oil and Russian Gas Oil
(Robert Mabro, Director, Oxford Institute for Energy Studies)

A Trading View of the Forward Markets
(Nigel Graham, Managing Director, Neste Petroleum (Products) Ltd)

The Activities of a Wall Street Refiner
(David Salomon, Vice-President, Oil Division, J. Aron, New York)

The Use of the Markets by a Major Oil Company
(Russell Seal, General Manager, Oil Trade and Supply, BP Oil International)

The Futures Markets
(Rosemary McFadden, President, New York Mercantile Exchange)

Forward or Futures?
(Meg Annesley, Consultant to the International Petroleum Exchange)

The Conference will be chaired a.m., by **Mr. Silvan Robinson**, President, Shell International Trading Company, and p.m., by **Mr. Walter Greaves**.

For a copy of the registration form, please contact **Caroline Little**, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Telephone: 01-636 1004. Telex: 264380.

Automation leads to the forecourt's own show

Martin Derrick discusses an important equipment exhibition which is taking place at the time of another retail event in London — the Institute of Petroleum's conference on *Petroleum Retailing: Europe and the UK, 20–21 May*

Petrol forecourts are to get their own mini 'Motor Show'. The Forecourt Marketing and Equipment Show opens at London's Alexandra Palace between May 20–22, when petrol retailers and the suppliers of products, services and equipment will be brought together for the first time under one roof.

No direct oil company involvement

Pelcom, the organisers of the show, by the beginning of April had already sold most of the 180 stands and have contacted every one of Britain's 21,000 service stations inviting their proprietors to attend. Unusually for a major event that is directly aimed at increasing forecourt profitability, there is no direct oil company involvement; the show has come about because Pelcom and the trade itself recognised that forecourts, properly developed and marketed, offer enormous potential profit opportunities.

Motorists now make up to 16 million visits to UK forecourts every week and the amount they are spending is increasing all the time. Forecourt turnover is going up by about 15% a year and that trend looks like continuing, hence the opportunity for both petrol stations and their suppliers to cash in on a rapidly growing market.

Exhibitors at the show fall into two main categories: those producing the latest forecourt equipment that is necessary to make a modern service station efficient, but which also constitutes the leading edge of an electronic revolution; and those offering goods and services for retail sale on the forecourt, eager not to miss out on what some observers see as a retailing revolution.

As far as high-tech electronics goes, it is clear that the suppliers of the equipment aimed at closing the electronic loop are now targetting their sales efforts not at the major oil companies — which are already convinced of the necessity to automate forecourts as soon as possible — but at the smaller independents.

A glance at just some of the suppliers with stands at the show already booked, shows how keen they are to get their message across to the proprietors and managing directors of forecourts of all sizes. Ambitron, Avery Hardoll, Dresser Wayne, Dunclaire Dispensers, Edacom Data, Ferranti, Fortronic, Micrelec, Nixdorf, Normond and Veeder-Root will all be there.

All gain from automation

According to the suppliers, just about everyone gains from forecourt automation. Oil companies are automatically informed of wet stock levels so deliveries can be made at the optimum time; operators benefit from far greater efficiency and management control which ought to translate into lower overall running costs and increased profitability; and customers will find the average forecourt transaction taking no longer than three minutes instead of today's average six or six and a half minutes.

With high levels of credit card sales on forecourts, it is the EFT/POS part of the electronic link that is the key element. Swiping cards through an electronic reader rather than filling out time-consuming and inefficient credit card dockets is not only far quicker; it virtually eliminates operator error, it guarantees that any floor limit is checked each sale, it provides an up-to-the-minute blacklist of stolen cards and it greatly reduces administration costs. It can also save petrol retailers money because the rebates currently offered by credit card companies for automated transactions can outweigh the cost of acquiring an EFT/POS system.

Significantly, it is not necessary to invest in a fully integrated electronic forecourt system in order to reap the benefits of EFT/POS. Aimed specifically at the smaller independents is Fortronic's F75 stand-alone credit card reader costing under £1,000 and able to store up to 300 transactions before transmitting them down the telephone line to a mainframe processing bureau. The question is not so much *will* petrol retailers of all sizes join the electronic age, but *when*.

The shop

The second area of dramatic change in service stations lies in the rapidly-increasing importance of the forecourt shop. Partly the shop has become more important because as margins on petrol sales have been squeezed, so it has become that much more important to find profits elsewhere. But at the same time an increasing number of retailers have recognised the potential of the forecourt shop as a convenience store in its own right, open long hours and serving both the local community and the passing motorists.

Estimates of current forecourt shop sales vary between £300 and £500 million a year, but all observers agree on one thing — that the market is growing very rapidly, both in overall size and in scope. In 1985 there were 34 convenience stores on forecourts, in 1986 some 250, with the biggest outlets enjoying a turnover of over £500,000.

Virtually any sort of products can successfully be marketed in forecourt shops, but groceries, soft drinks and snack foods are one of the fastest-growing areas. Small wonder that amongst the Forecourt Marketing and Equipment Show's 180 stands are some of the biggest names in foodstuff retailing: Birds Eye Walls, Cadburys, Coca-Cola, Express Dairies, Golden Wonder, Lyons Maid, Rowntree Mackintosh and United Biscuits.

Many profit opportunities

Other profit opportunities are offered by suppliers of videos, cassettes, electrical goods, car accessories, security systems, toys, gifts, tobacco, photographic products, flowers and garden products. British Telecom has booked a stand to promote the potential of payphones and particularly of phonecard sales on the forecourt and Odarc are promoting their new trading stamps.

'The object of the Forecourt Marketing and Equipment Show is to give petrol station proprietors an opportunity to see how they can make and save more money,' said Pelcom's Sales Director Nigel Nathan. 'It's a unique opportunity for them to assess forecourt equipment that could make their business more efficient and to see the goods and services that could generate that vital extra profit.'

Entry fee

Entry to the Show is free and tickets can be obtained via Pelcom's free Linkline telephone booking service on 0800 282828. Opening times are 10am–6pm on May 20 and 21, and 10am–4pm on May 22.●

Saudi Arabia diversifies its economy

Ibrahim A Salamah, Vice Chairman and Managing Director, Saudi Basic Industries Corporation, describes for *Petroleum Review* how Saudi Arabia is developing a wider industrial base.

The recent shift of Saudi Arabia's oil-pricing policy has put the Kingdom on the front pages of newspapers and magazines throughout the United States and Europe.

● This sudden intensification of interest in Saudi Arabia is understandable because any major change in OPEC policy will eventually have a strong impact on the industrial economies of the West.

● Regrettably, however, one searches the newspaper articles and TV stories in vain for any new information or perspectives about the land that Westerners are so fond of calling the *Desert Kingdom*.

Having ignored all developments unrelated to oil or Middle East politics for the past 15 years, the media seem content to go on forever portraying Saudi Arabia as nothing more than an endless expanse of desert punctuated only by oil rigs pumping light crude.

The reality is quite different. Saudi Arabia is no longer a one-product country. We are a developing nation whose rapid pace and comprehensive scope of industrialisation constitutes one of the economic miracles of the 20th century.

Some 15 years ago, when oil accounted for 70 per cent of Saudi Arabia's gross national product and 99 per cent of its exports, the Government realised that no nation with an economy based on a single, depletable resource can hope to enjoy a secure and prosperous future. In a world where rapidly changing technology reigns supreme, the key to survival for developing nations is industrialisation and diversification.

In 1970, therefore, the Saudi Government adopted an ambitious strategy that called for a broad-based industrial and agricultural revolution to be financed by revenues derived from oil production. This vast undertaking was scheduled to be completed, moreover, within a single generation.

The obstacles were truly formidable. Although the size of the United States east of the Mississippi, Saudi Arabia had a population of only around seven million in 1970, and very few of these people had the education and skills necessary to operate an industrial economy. Nor did the rudiments of a modern infrastructure exist; it would have to be created literally from nothing before industrialisation could proceed.

And so it was. Contracting with engineers, technicians and skilled workers from advanced, industrialised nations and manual workers from developing countries — their entry into the Kingdom ultimately amounting to a mass migration of some 2 million people — Saudi Arabia spent $547 billion building roads, bridges, ports, telecommunications, power transmission and distribution networks, airports, schools and hospitals. Within 10 years a modern infrastructure capable of servicing a nascent industrial society was in place and functioning. This infrastructure was the primary goal of Saudi Arabia's First Five Year Plan (1970–75). With the adoption of the Second Five Year Plan (1975–80), emphasis shifted to developing a world-class petrochemical industry.

Petrochemicals are the hub around which Saudi industrialisation has developed. Capital intensive, highly automated and requiring limited amounts of manpower and water, the petrochemical industry adds value to the Kingdom's abundant supply (an estimated 100 trillion cubic feet) of natural gas.

With the completion of the Master Gas System (MGS), the natural gas produced in association with petroleum drilling and formerly flared or burned off, became available for industry, power generation, water desalination or export in liquid form. Once collected, the two natural gases basic to Saudi Arabia's petrochemical plants — methane and ethane — are converted into chemicals that form the raw materials for a wide range of industrial and consumer products, such as fertilisers, plastics, paints and polyester fibres.

SABIC's formation

The development of petrochemicals and related industries was entrusted to the Saudi Basic Industries Corporation (SABIC) in 1976. Established with an initial capitalisation of $2.75 billion, SABIC was wholly owned by the Saudi Arabian Government, although provisions were made for the future sale of 75 per cent of its equity to Saudi nationals and other citizens of the Gulf Co-operation Council (GCC) countries. Today 30 per cent of the joint stock company is owned by private investors.

Besides developing the petrochemical, fertiliser and other hydrocarbon-based industries, SABIC was made responsible for creating the iron, steel and aluminium industries, as well as any other basic industry which the private sector might be unable or unwilling to undertake. At its beginning, SABIC lacked the technical and managerial expertise to carry out such a huge and complex undertaking and had to seek assistance from international companies with long experience in the field of oil, gas and petrochemical production.

SABIC planners rejected the turnkey approach that so often had proved disastrous for developing nations, opting instead to build the corporation's first generation of petrochemical facilities in joint-venture partnership with reputable multi-nationals, such as Mitsubishi, Mobil, Exxon, Shell, Celanese and Texas Eastern. Additional joint-venture partnerships to produce a second generation of petrochemical and plastics plants were later formed with Lucky Group (South Korea), Neste Oy (Finland), ENICHEM (Italy) and APICORP (an Arab investment company).

Although ownership of the first generation plants was usually on a 50:50 basis, SABIC and its joint-venture partners were each required to provide only 15 per cent of the equity investment. Another 60 per cent came from the Saudi Government's Public Investment Fund in the form of low interest (3–6 per cent) loans. Commercial banks furnished the remaining 10 per cent. More generous investment terms were scarcely to be found anywhere.

SABIC's master plan called for construction of no less than seven major petrochemical complexes between 1980 and

1986, six in the new industrial city of Al Jubail on the Arabian Gulf, and one in the twin city of Yanbu on the Red Sea. Two of the facilities — SADAF (Saudi Petrochemical Co) and IBN-SINA (National Methanol Co.) — were intended to rank among the largest production complexes for ethylene and methanol in the world.

The challenge of building state-of-the art petrochemical plants in a desert was almost as daunting as building the infrastructure of Al-Jubail and Yanbu. Many sceptics believe construction of the giant plants would bog down in the sand. For two of the largest installations — SADAF (Saudi Petrochemical Co) and KEMYA (Al-Jubail Petrochemical Co) — SABIC and its joint-venture partners chose the novel approach of importing modular plants. The modules were built in Japan and South Korea and transported to Al-Jubail on specially modified ships. In port, modules were hoisted by crane and placed on huge, self-powered overland-transporters, which drove them on specially constructed roads to the plant sites. Here they were bolted together.

Ultimately, every one of SABIC's petrochemical plants was completed ahead of schedule and under budget, thereby enabling Saudi Arabia to enter the international petrochemical market in 1983. To date, 16 out of 18 first generation projects are operational, and SABIC is progressing steadily towards its objective: a 5 per cent share of the world's chemical market by the end of the 1980s and perhaps a 15 per cent share by the end of the next decade.

The first phase of SABIC's mission has been completed. By building and operating basic industries (petrochemical, metallurgical, fertiliser) that convert the Kingdom's hydrocarbon and mineral resources into industrial products for domestic and international consumption, and by helping to develop a Saudi workforce and managerial class capable of assimilating advanced technology, SABIC has laid the keystone for Saudi Arabia's long term industrial future.

SABIC's primary objective for the next Five Year Plan (1985–1990) is the completion of 14 second generation enterprises, most of them downstream from the first generation facilities. As they are vertically integrated into the country, these projects will expand the nation's industrial base and provide a training ground for more Saudi youth to learn how to run a modern plant.

Efforts will also be made to provide new investment opportunities for the private sector, and to maintain the growth of other non-oil related industries that contributed to the development and diversification of the Saudi economy during the last fifteen years: electric power; water desalination; cement and construction; food and beverages; paper products; fabricated metal; wood products; textiles and apparel.

But, once again, as SABIC and other enterprises sets their sights on a bright and prosperous future, the sceptics cast doubts. Fifteen years ago, they dismissed Saudi Arabia's massive development programme as an unrealistic fantasy. Today, they insist that the galloping pace set during the previous three Five Year Plans cannot possibly be sustained during the fourth. They may be right, but they miss the point.

'Saudi development,' to quote a former Government official, 'is a child from the cradle of Saudi mores, customs and traditions.' So regardless of downswings caused by weak oil prices or other economic adversity, Saudi Arabia's march into the future will continue — it will continue until the child becomes a man and the skills and potentialities of the Saudi people are developed to the maximum.●

Investment in training continues to pay

David Trippier, RD, JP, MP, Under Secretary of State for Employment, stressed at an Offshore Petroleum Industry Training Board conference recently that while the oil industry was going through a difficult period of change and contraction as a result of the fall in the price of oil, investment in training continued to be essential. He said, in part:

'At times like the present training can seem like just one more overhead cost. Making the right long-term decisions about training become particularly difficult and exhortation from Government to train more because it will pay off in the long run sounds implausible.

In a high risk, high tech industry, there is no alternative to investment in the highly skilled human resources needed to manage the industry, maintain essential technical and safety standards and run the rigs and platforms. High standards and quality work remain the keynotes of the industry. And despite fluctuations in its fortunes, I think it is important to remember that offshore petroleum still remains a major British industry.

More than that, however, training is necessary now to cope with the changes the industry is going through: new technology in the production process means training staff to handle that new technology. Change in the industry requires effective management of that change and thus more effective management training, and new technology and change coinciding with cuts in production mean that many staff will need training in multiple skills and new working patterns.

Above all, our competitors, whether they are affected by the downturn or not, will still be there. They will not give up training and developing their human resources. Nor must we. We must match their every move: not to do so will certainly cost the industry dear.

Many schemes

The Government recognises that it has a major role to play in making the training market work better and helping industry to help itself. We are helping with a wide range of schemes. For example:

● We are improving information at national and local level through the MSC's new skills unit, through computerised labour market information in local MSC offices, and through the pilot training access points which enable employers and individuals to tap into a computer in their local bank, shop or post office which will tell them what training courses are available and where.

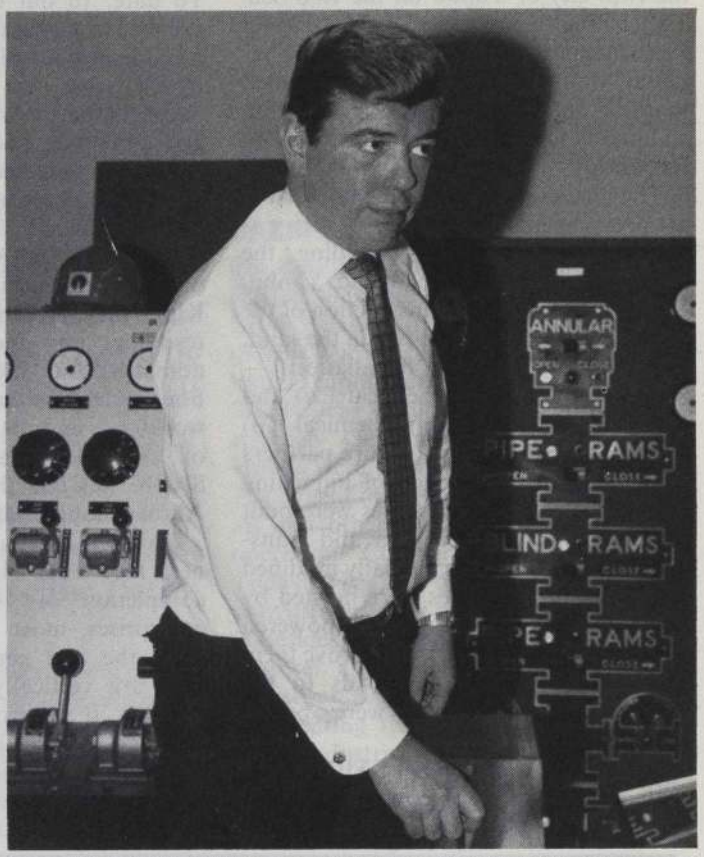
● We are bringing employers together with each other, and with training providers, to identify training needs and ensure that appropriate courses are laid on.

● We are piloting a new Career Development Loans Scheme in four areas of the country, including Aberdeen. These loans are designed to enable individuals, who might not otherwise have the opportunity to acquire the skills industry is looking for, to invest through training, in themselves, in their own job prospects, in their future. The results so far in Aberdeen are certainly proving that training pays.

Open learning

Perhaps most importantly for this industry in particular, we are helping to speed up the development of new and more cost-effective training methods, especially open and distance learning which enables people to train at a time and place convenient to them. The Open Tech programme has proved highly successful in developing flexible training provision for supervisors and technicians. We hope to build on the pioneering work of Open Tech with a new programme aimed at embedding open learning at all skill levels throughout industry and education.

But perhaps our most exciting innovation yet in this field is the Open College, which we hope to see commence operations later this year. The College will aim to promote a large scale increase in the open learning opportunities for industry and individuals by linking the communication potential of radio and television to existing open and distance learning facilities. It will have regular broadcast slots on national and local television and radio programmes to ensure as wide an audience as possible. We hope it could help up to one million trainees in its first five years.



On a visit to the OPITB centre at Aberdeen, David Trippier operates the brake on the drill floor simulator.

Offshore need

The offshore petroleum industry cannot survive without appropriately skilled personnel. There can be no doubt then of the need for training. The question is whether, even with all the Government help available, training as an investment can continue to pay for you, now, individually.

Like all investors, you have difficult choices to make about where you put your money. You need to be sure that you will get the most out of your investment.

Like all investors, you have difficult choices to make about where you put your money. You need to be sure that you will get the most out of your investment, particularly at a time when you are trying to cut costs all round.

Some of you may have doubts about the benefits to your particular company of training using new methods such as new technology. There are circumstances and skills where traditional classroom and textbook training methods will always be appropriate. The cost of courses using new technology may at first seem high.

Open learning methods enable individuals to train during or after working hours, at a pace which suits them. The individual user-centred approach of new technology in training can generate a degree of commitment and enthusiasm which is rarely found in standard training courses. Of course the various training associations in the industry have all played an active part in such developments. But the Offshore Petroleum Industry Training Board has had a particularly important role.

The high standards and quality work, which are what this industry is all about, can only be achieved if training remains a priority that you as employers are prepared to value.

Conclusion

There is no doubt in my mind that the most successful companies — and the most profitable — are those that invest in their human resources at all levels, from the boardroom downwards. Because if we expect the workforce to be prepared to train and retrain, the managers should be prepared to do no less. And that commitment to training at all levels in an organisation will only come if we believe that investment in training pays. ●

Industry initiatives on open learning

With increasing pressures on the time of management and personnel in the oil business, there is a growing interest in the subject of Open Learning, which allows people to develop their skills in their own time.

On 22nd January 1987, some 60 participants met at the Institute of Petroleum to attend a Workshop on 'Open Learning' organised by the IP Education and Training Committee.

The aim was to examine the oil industry's experience of Open Learning to date and to try to define some of the areas which needed covering more effectively.

The Workshop was chaired by Mr EI Williamson of The College of Petroleum Studies, who is a member of the IP Education and Training Committee.

The keynote speaker was Mr Michael Freshwater, acting-director of the Open Learning Unit, Manpower Services Commission. The MSC has had a major programme running since 1982 to encourage training and educational organisations to enter the Open Learning field. A total of 140 projects received funding and the work to produce these essentially ran from 1982 to 1985.

Since the middle of 1985, a large number of training packages have been made available for sale and, according to the MSC, some 6,000 packages are now available.

High costs

The second presentation came from Mrs Judy Oliver of BP plc, who discussed her company's 'official' network approach to Open Learning, which involves company training advisers, public affairs personnel, video production staff and subject specialists. BP had recognised the very high front-end costs involved in producing Open Learning materials and was, therefore, organising itself to maximise the use of internal resources.

Although the emphasis on production costs was often raised during the Workshop, Chris Morris of Texaco showed what could be achieved by adopting a more pragmatic approach. Texaco had organised 'ASSET' (Acquire Skills by Self-Education at Texaco), by forming a Computer Controlled Resource Centre. This Resource Centre contains many books, as well as training packages, videos and audio tapes.

Texaco has not gone for the high technology approach. The key to Texaco's success has been the production of a loose-leaf booklet, listing the resources available and emphasising management's encouragement to those who wish to take advantage of the facilities. They currently have 875 users, which is more than 50% of the total staff and there are 400 'active items' out on training.

Back-up

Mr Tim Ward, head of group finance training for Shell International, discussed the Shell/Henley experience in producing a modified Henley package for financial managers. Once the specialised package was produced, it was made available throughout the group and more than 100 packages have gone out to African affiliates of Shell. Because of the geographic spread of the distribution, monitoring had been difficult and so had provision of local support to individuals taking the course.

Shell is now considering changes to improve the effectiveness of what, it was agreed, was an excellent training resource.

Mr Paul Chapman gave a presentation on behalf of ICI which reviewed the company's experiences in operator training using Open Learning. Some £3m had been spent on this project. ICI emphasised the value of using high-quality learning packages, providing support for the individual learner and managing the learning arrangements.

At ICI they have operators who study at night or at lunchtime and easy accessibility had been a key issue.

Mr John Singer of Britoil discussed experiences in Open learning for offshore use. Britoil has developed Distance Learning courses for technicians, already skilled in maintenance of pneumatic and analogue electronic control systems, to enable them to maintain micro-processor and computer-based systems.

The key benefit to Britoil has been the large number of people who have been trained, over and above what would have been possible using conventional methods. Britoil has also adopted the CAVIS system from SCICON, based on interactive video, to provide specific platform production systems knowledge to individual recruits or transferees.

The final presentation of the Workshop was given jointly by Mr Frank McCaughey, company secretary to BACIE and a former training manager with BP Chemicals, and Mr David Geary, project manager of the Open Tech Unit, Humberside College of Higher Education (HCHE). They discussed the BTEC National Certificate Programme, which has been run by Humberside College for personnel from BP Chemicals in Hull. A total of 60 personnel are currently enrolled on the Programme.

In conclusion, the chairman summed up the main points arising from the group discussions:

- The most successful open learning schemes had all first obtained the commitment of top company management.
- The way that the Open Learning projects were organised and paid for was important. There was considerable scope for different approaches as the wide cost differences between the Texaco and ICI experiences showed.
- The scope of joint ventures should not be missed. For example, the Shell/Henley Financial Package and the BP Chemicals/Humberside College of Higher Education experiments had both been very valuable.
- Effective internal communications were vital.
- Back-up support to individual learners was important.
- In order to keep employees motivated when undertaking Open Learning, it was considered important to provide them with some worthwhile 'target'. The Humberside and Britoil examples were interesting, since they led to qualifications recognised outside the company.

The oil business on video

Those contemplating a career in the oil business and those concerned with career advice in the industry will be interested to learn of a new video programme on the subject recently released by the Edman Communications Group as part of 'Careers in Focus'.

'The Oil Business', sponsored by Shell UK Ltd, is a 20 minute programme aimed at giving young people a clearer insight into the oil industry and its career opportunities.

It uses a lively case study approach, portraying people with a variety of qualifications talking about their work, how they started, their likes and dislikes and what makes them right for the job and the job right for them.

On the exploration side we see a geophysicist using the latest technology of computerised mapping and a petrophysicist who, as a petroleum engineer, has a vital role to play in 'log' evaluation.

Offshore is covered by an oil installation manager in the North Sea. It eavesdrops on a marketing meeting where a forecaster, a computer analyst, a graduate on the distribution side and a marketing colleague discussing product pricing.

There is something in this video for everyone, whether the interest lies in exploration, research and development, engineering or marketing.

The programme is available on VHS or Betamax, price £15.53 (incl. VAT), from Careers in Focus, 94 Hagley Road, Edgbaston, Birmingham B16 8LU.

Publications

Planning for change — training your workforce: The MSC's Local Training Grants to Employers Scheme can offer financial assistance to employers seeking to improve the efficiency of their companies by introducing or developing training and retraining for their employees or for new adult recruits. Leaflet available from the Manpower Services Commission, Moorfoot, Sheffield.

National vocational qualifications — an information guide: This booklet, produced by the CBI with assistance from the MSC, is intended to help employers make a full contribution to the development of national vocational qualifications. Availabele from CBI, Centre Point, London.

ILO Petroleum Committee Reports: Three of relevance to oil companies recently published — General Report; Occupational Safety and Health and The Working Environment in the Petroleum Industry; Manpower Planning and Development in the Petroleum Industry. Available from International Labour Office, 4 route de Morillons, CH-1211 Geneva 22, Switzerland.

A national research spearhead

Mr George Innes, Technical Director, Shell UK Exploration and Production, pinpointed the objectives of North Sea offshore research recently. He called for a series of integrated R&D exercises on a national scale. He said, in part, to the Offshore Research & Development Conference:

'The big question is: when the global price of oil falls significantly, should R&D in the UK also be allowed to slide into decline? The answer is a very emphatic NO. The very survival of oil producing areas like the North Sea depends on research and development.

The costs of oil and gas production in some areas of the world are so low, and look like remaining that way, that local operators and host governments have little or no motivation towards improving the economics of exploration and production.

However, where exploration and production costs are high, the motivation towards R&D is very much greater — or at least it should be. The UK is a prime example. Exploration and production is, as a matter of course, much more expensive in places like the North Sea than areas like the Middle East. Couple this with the fact that future prospects involve marginal fields where costs are potentially higher still, and the case for maintaining R&D becomes essential — or at least, again, it should be.

The end result

Unless the challenge — the end result — is clearly identified, a research and development initiative, if it takes off at all, can be insufficient, and very rapidly disappear up blind alleys taking vast quantities of money with it without ever arriving at the desired objective. I classify R&D under two headings context:— the development and refinement of existing technology; the identification of truly innovative ideas and their development through to practical application.

Both aspects have the same thing in common — they must be driven by business needs on the part of the ultimate users. Equally, every research and development project must also ultimately fulfil attractive prospects for business advantage in order to motivate manufacturers and suppliers to become involved.

We need to find appropriate manufacturing organisations, or consortiums, to manage the total R&D effort and the eventual exploitation in each business-need area. This managing contractor also has to provide sufficient motivation to encourage people to commit themselves to what, in many cases, may be a high risk area in competition with other more commercially attractive ventures.

What we in the UK — operators, manufacturers, fabricators, suppliers and researchers — have to do is develop philosophies into a series of major integrated R&D exercises aimed at achieving objectives that are best addressed on a national scale: objectives that are in the national interest rather than just that of offshore operators.

Reducing costs

There are two major topics we must look at:— the need to find ways of dramatically reducing the development and operating costs of offshore installations in the 1990s; the need to drastically reduce the cost of decommissioning and removing unwanted offshore installations compared with current predictions.

Are we prepared for the eventuality of a substantial find in the deep waters west of the Shetlands? What if it is gas? How do we evacuate it? There is no doubt such problems could be solved by using current technology, but the cost would be so enormous that it would become totally impractical.

Within the next decade or so we are probably going to have to start removing some of the North Sea installations. If we look at the large concrete structures, leaving aside the requirements that may eventually be laid down by the Government, there are many technical questions to be answered. These include the feasibility of such things as concrete platform refloatation. In the case of steel platforms, the use of explosives is of interest, and Shell is sponsoring a two year study into their use. An alternative to explosives is remotely controlled cutting devices.

Who can properly identify spearheads of this nature in the UK, and then bring together and manage the vast amount of work that will be needed to find and execute the solutions? That, I believe, is the real challenge for the offshore research and development industry.'

Thames complex augurs well

A North Sea gas-gathering project was inaugurated recently by Mr Alick Buchanan-Smith, Minister of State for Energy, bringing the number of UK offshore gas fields in production to 16.

Speaking at the inauguration of ARCO's Thames complex, he congratulated ARCO and the other companies concerned in bringing the Thames project forward ahead of schedule and below budget.

The 'Thames Complex' is located in the Southern North Sea, some 50 miles off the Norfolk coast. The Complex comprises three gas fields — Thames, Yare and Bure — with total recoverable reserves of some 460 billion cubic feet. The life of the complex is estimated to be 11 years.

'This is a unique development. For the first time in the UK sector of the North Sea, stainless steel clad pipe has been used for the construction of flowlines and, I know, other operators will take a keen interest in this development to see whether the innovative ideas used by ARCO and their partners can be applied to their own marginal field developments,' the Minister said.

Esso success

Esso has announced an after tax profit of £527m for 1986. Chairman and chief executive, Archie Forster, said that despite the upheaval brought about by the fall in oil prices in the early part of 1986 'it was a very creditable outcome in a very difficult year', although it was down by more than £100m on the 1985 figure.

Capital and exploration expenditure in 1986 was £472m compared with the all time high of £591m in 1985, the main reason for the reduction being that 1985 was a peak expenditure year for a number of projects in the refining and distribution side of the business, which reached completion and start-up in 1986.

Offshore production of crude oil and natural gas liquids in 1986 were at a record 421 thousand barrels a day and sales of natural gas rose to their highest levels at 615 million cubic feet per day.

Commenting on the refining and marketing side of the business Mr Forster said that 1986 had seen a welcome improvement in margins in the downstream and lower prices had also led to a rise in demand for transportation fuels.

Resin agreement

An aggreement between Ciba-Geigy and Phillips Petroleum to co-operate in the European polyphenylene sulphide resins and compounds field has recently been completed.

To begin with, Ciba-Geigy will manufacture PPS compounds, using Phillips' resins. The parties hope to establish a joint venture company for the manufacture of PPS compounds and resins at a later date. These products will be marketed under the trade-marks, Craston and Ryton.

PPS is an engineering thermoplastic that is capable of withstanding high temperatures, and can resist corrosive chemicals. It's inherently flame resistant and can be moulded to exact tolerances. It is also used in producing advanced composite materials that can replace metals in many applications when reinforced with long carbon or glass fibre rods.

Texaco Inc files for bankruptcy

Texaco Inc and two of its finance subsidiaries in the United States have filed for protection under chapter 11 of the bankruptcy code as part of the long running legal battle between Texaco Inc and Pennzoil over the acquisition of Getty Oil.

However, the bankruptcy filing concerns only Texaco Inc, Texaco Capital Inc and Texaco Capital NV. None of Texaco's subsidiaries around the world, including Texaco UK, is affected by the decision.

Praise for innovation

The innovative engineering produced by UK contractors on North Sea Sun Oil's Balmoral offshore oilfield was praised by the Rt Hon Alick Buchanan-Smith MP, Minister of State for Energy, at the recent inauguration.

'Through the Offshore Supplies Office, Sun Oil are giving UK companies access to information on their world-wide activities: this provides a real opportunity for UK industry and I hope it will be maintained,' he said.

IPE gas record

On 2 April the International Petroleum Exchange announced that a record 98,885 lots were traded on the Exchange's Gas Oil contract during March, surpassing the previous best of 96,046, recorded in January.

Southern councils seek greater control over Channel exploration

Policies aimed at controlling the impact of offshore exploration for new oil and gas reserves in the English Channel are being co-ordinated by local authorities along the South Coast.

The County Councils of Dorset, Hampshire, Isle of Wight and West Sussex, together with city, borough and district councils have established the Standing Conference on Oil and Gas Exploration in the English Channel.

The Conference, made up of elected members with an advisory group of council officers, has been formally recognised by the Secretary of State for Energy as representing the views of the coastal local authorities on all aspects of oil and gas exploration in the Channel.

They report that their agreed policy is that in general the Conference will support offshore exploration — but only if strict safeguards are included in licence agreements with oil companies to protect the coastal environment, the local economy including tourism, fisheries and shipping, and the interests of residents.

The Conference also wants to see sensitive areas — which would normally include all areas within three miles of the coastline — identified and given extra protection.

A large area of the English Channel from Dorset to West Sussex has already been licensed for oil exploration by the Department of Energy, with international oil companies including BP, Esso, and Texaco, as well as the British Gas Corporation, involved.

A licence has also been granted by the Department covering the Solent. This, however, is treated as an onshore rather than an offshore exploration area and the Department has said that new, stronger consultation arrangements are being made with oil companies required to assess and report on safeguards needed, in co-operation with councils, environmental groups, fishing and local interests.

One of the aims of the Standing Conference is to persuade the Department of Energy to extend these more stringent consultation requirements to offshore oil exploration in the English Channel.

The coastal local authorities want to be told about any plans for exploration or appraisal drilling as soon as possible and not less than one month before work starts. They want early discussions with oil companies on oil spill contingency plans, safety and environmental issues, as soon as possible after a drilling licence has been awarded by the Department of Energy.

This will give the Standing Conference time to consult widely and to put its views to the Department so that appropriate safeguards can be applied. Extra requirements would need to be met if and when oil companies moved to exploit oil reserves, including environmental impact assessment and full restoration of any areas affected by development.

A document setting out the policies of the Standing Conference has recently been published. Copies can be obtained by writing to the Conference Secretary, Mr RA Leyland, County Secretary, Hampshire County Council, The Castle, Winchester, Hants.

Letter to the Editor — Cathodic Protection

Sir,

I read with interest the article 'An alternative to mild steel in underground storage' by Geoffrey Ashton in the *Petroleum Review*, March 1987 issue.

I feel some clarification is required concerning the section headed 'Cathodic Protection' as follows:

a Electrochemical corrosion on the external surface of underground tanks is generally due to potential differences between anodic and cathodic areas on the same metal surface and not necessarily due to contact with a dissimilar metal. There are other reasons as well such as 'differential oxygen cells' and/or sulphate reducing bacteria which can contribute to the corrosion.[1]

b Cathodic protection is a well proven method for corrosion control provided the design, installation and management are carried out in a professional manner. The mechanism for protection is due to the application of a current to the structure to be protected using either sacrificial (or galvanic), anodes or an impressed current system. Application of the current should render all anodic areas on the metal surface cathodes, thus converting the entire surface of the metal into a single cathode.[2]

The above comments do not alter the overall tenet of the article, ie, the replacement of a constructional material subject to corrosion by a non-corroding material. There is a caveat relating to design, fabrication and mechanical properties of non-metallics.[3] Evidently, the US experience has shown that any difficulties arising can be overcome.

Yours faithfully,

CF Britton, Corrosion Monitoring Consultancy, St Pirans, Denchworth Road, Wantage, Oxfordshire.

References:

[1] *Guide to Practice in Corrosion Control, Dept. of Industry, No 10, Corrosion Control in Buried Pipelines.*

[2] *Ibid, No 9, Cathodic Protection.*

[3] *How to Select Materials, GN Kirby, Chemical Engineering (NY) 3 November 1980.*

Business centre for Aberdeen

The business community in Aberdeen is now able to enjoy the facilities of a new communications centre — the Aberdeen Network Business Centre.

Mr Ian Lang MP, Parliamentary Under Secretary of State for Scotland, officially opened the centre which claims to be the most technologically advanced business facility of its kind in Europe.

The centre has been used largely by companies supplying services to the oil industry who can ill afford, in these lean times, to take on expensive and prestigious offices in the city. Likewise, companies who are finding it increasingly difficult to maintain the offices they took on when the industry was booming, are turning to the centre and its amenities.

So too are oil company executives who are trying to set up their own businesses after having been made redundant. In return for a £1,000 p.a. membership fee, the centre offers them personalised telephone, telex and fax numbers to use for their businesses.

Opinions vary on sales of unleaded

How will the Budget tax reduction on unleaded petrol effect its sales? Hardly at all, in Shell's view.

A much bigger cut in the tax would have had a definite effect they say — but at the same time they are convinced that the Chancellor of the Exchequer was wise not to make a larger favourable move in unleaded petrol's direction.

A cut of, say, twice the amount would have precipitated a rush which the market is not able to take.

The West Germans followed this cautious course when they pioneered large reductions in lead in petrol. Eventually the tax reductions reached the equivalent of a 13 ppg in tax advantage for unleaded against leaded petrol and sales then jumped. Tax adjustments in the UK, not necessarily happening only at Budget time, could achieve a comparable result in two or three years — but it is still early days in the market for unleaded petrol and opinions vary.

But the tax cut for unleaded petrol has been followed by a decision from Texaco to extend its sales in the expectation that demand will increase. It will also continue the 'Texaco Lead-Free Phone', a free telephone service which motorists can call for information on whether or not their car can use unleaded petrol.

The service has recently been updated to include new makes and models of cars.

Chinese hint?

The possibility of life being made easier for joint venture companies in China, which will help China technologically and earn it foreign currency, was hinted in a joint briefing in London recently at AT Kearney Ltd, management consultants, and the International Trade Research Institute of the People's Republic of China. Will this help the UK's supply industry to sell their services in China? Energy, it was said, has one of the highest priorities.

Dr Jochen H. Mohnfeld, who wrote an Energy Economics Paper on *Consumer reactions to lower oil prices* in *Petroleum Review*, April 1987, is a member on the staff of the Federal Economics Ministry in Bonn and responsible for energy market affairs and inter fuel competition. The article presents his own views.

Shell's costs for Tern and Eider reduced by 30–35%

Shell Expro made significant inroads into the capital costs of the Tern and Eider North Sea developments in 1986 which are expected to be reflected in the costs of the marginal Kittiwake and Osprey fields when these are submitted to the Department of Energy later this year.

Cuts of between 30 per cent and 35 per cent were made in Tern and Eider through reducing the money required for contingencies — 10 per cent, competitive bidding from hard pressed yards — 10 per cent, and through innovative engineering by Shell staff and contractors — 15 per cent.

Kittiwake costs will benefit from a lighter platform than had been proposed. Osprey's production unit has been simplified.

Despite the 1986 price collapse, the Shell-Esso joint venture in the North Sea produced more oil than ever before. It reached what will probably be seen as its peak.

These assessments were given at a Shell UK briefing on 1986 results recently. It was earlier investment that helped to achieve record production.

Interestingly, the average price Shell paid for crude oil in 1986 was between $14 and $15 a barrel, although it was down to $9 at one point. Their 'feel' for the summer price in 1987 — the traditional low spot — is between $15 and $18 a barrel.

Shell, which in the most difficult days of 1986's price falls, took a calm, long sighted view of the situation, is inclined to believe that OPEC has managed to keep its lower production strategy together. Importantly, the market is seen to have a perception of what the price of oil should be — at about its current level — and this is a very important stabilizing factor which was not present during 1986.

The general view in the oil industry is that it will be the remarkable reductions which have been achieved in the front end costs of offshore projects — as indicated by Shell — which will keep the North Sea alive, rather than the 10 per cent Petroleum Revenue Tax cut of the Budget — one of the reasons being that Corporation Tax can absorb much of the saving.

Martin Lovegrove, Head of Petroleum Services, James Capel and Company, echoed this in detail when he talked to the IP Energy Economics group on Budget effects recently.

He considered whether 19 projected North Sea fields would be accelerated as a result of the cut in PRT. His assessment of the chances of these fields coming on earlier than proposed was: good — Don and Kittiwake; medium — Columba, Ettrick, Gannet, Lyell and Marnock; low — Alba, Andrew, East Brae, Bruce, Emerald and J Black; and no chance — Arbroath, Miller, Ness, Osprey, Tiffany and Toni, and Thema.

The PRT change was a step in the right direction, but the best approach, in his opinion, would be to restore the first year allowances against Corporation Tax for offshore projects.

George Band, Director General of the UK Offshore Operators Association, also told a Commons energy select committee that the tax changes were seen as a positive step in the right direction, rather than a great leap forward.

Technology expansion for BP

The Bexon Laboratory at BP's main research centre at Sunbury-on-Thames, named after Roger Bexon, a former Deputy Chairman of BP and now Chairman of Laporte Industries, is the first of three major new laboratories to be completed in a building development programme costing £20 million.

The largest single investment made at Sunbury, it demonstrates the importance BP places in technology for its current and future business needs.

BP's expenditure on research and development in 1986 was £170 million, up from £145 million in 1985. Sunbury accounts for about 45 per cent of the group's research spending.

Much of the research centre's work is at the frontiers of scientific knowledge which requires a continuing and growing link with university research.

The new building provides office and laboratory accommodation for about 100 scientists and technicians working both on projects supporting BP's traditional oil exploration and production business and on other areas of research such as chemicals, nutrition, coal, minerals and advanced technology.

Carless grows

Oil distributors Torch Petroleum and Bulldog Petroleum recently underwent structural changes when they were merged and incorporated into Carless Petroleum.

The two companies had been bought by Carless some years previously but had continued to operate separately.

Green Shield

Last month Mobil became the first oil company in the eighties to re-introduce Green Shield stamps to most of its retail outlets.

Mobil's retailing general manager, Geoff Fisher said: 'Trading stamps are once again to become a key element in retailing. A recent Gallup survey revealed that 59 percent of UK households would collect Green Shield stamps again.'

Three stamps will be given with every £1 spent on fuel, motor oil and motoring accessories. These can be redeemed against a wide range of different products available in the Green Shield catalogue.

The promotion will be run in conjunction with the Save the Children Fund who will be putting collection boxes on-site for customers who wish to donate some or all of their stamps to help the charity.

Mobil's Booker

Mobil's playwriting competition was ranked for quality with the Booker Prize for novelists by Ronald Harwood, himself a playwright, at the recent launch of the second competition. James Maxwell, the actor, said that the competition had changed the climate for writing in the UK. With others, they complimented Mobil on its support for the arts when this was declining elsewhere.

The competition is open to entries from anywhere in the world. They must be original, full-length plays, written in English, and not previously produced or offered. The closing date is 16 January, 1988. There were 2,000 entries from 14 countries last time. The £33,000 of prizes include a first prize of £10,000, with second and third of £5,000 and £3,000.

'I am confident that it will prove even more successful than the previous competition in attracting vivid, fresh, playwriting talent,' said John Lowein, Mobil's Chairman.

The competition is held for the Royal Exchange Theatre in Manchester, the area where Mobil began 102 years ago. It is one of the most remarkable theatres-in-the-round in the world and was built to 'free the imagination of dramatist, actor and audience'.

Six hose pump

Gilbarco is unveiling a six hose pump, a major breakthrough — they report — in retailing efficiency.

North Sea research gains momentum

Research for the North Sea oil industry is moving apace with the setting up of a test centre in Orkney for water processing equipment and the agreement by ten oil companies to finance a project which aims to cut the cost of developing fields.

The research and development centre is to be established with the help of a £1.5 m grant from Conoco (UK) Limited and will be located within the Flotta oil terminal in Orkney. Its purpose is to improve the efficiency and environmental standards of equipment used to process water.

It will be set up by Heriot-Watt University's Institute of Offshore Engineering and is due to open in 1988 at a cost of over £2 m.

The research project which ten oil majors have agreed to finance is by Weir Pumps, who hope to develop a subsea multiphase system to pump reservoir fluids to remote platforms or to the shore without separating gas, liquids and solids. This will overcome the present need to have so many production platforms located at or near the well-heads.

A cash injection by Arco British Limited enabled the second stage of the project to start five months ahead of schedule. This work includes the building of two prototypes for extensive endurance tests in a multiphase hydrocarbon test loop and detailed design work on a complete subsea installation.

Arco, BP, Britoil, Chevron, Elf, Fina, Shell Expro (on behalf of Shell and Esso), Statoil, Mobil North Sea and Texaco are now financing the project. The experimental work will be shared between Weir Pumps' Alloa Research Laboratory and BP's Sunbury Research Centre.

QUARTERLY JOURNAL OF TECHNICAL PAPERS

The first issue of the 1987 **Quarterly Journal of Technical Papers** is now available. This publication contains the following technical papers:

Additive solutions to diesel combustion problems
RD Cole, MG Taylor, F Rossi, Esso Chemical Ltd.

The Macroeconomic implications of Government oil revenues
DC Austen, Portsmouth Polytechnic

Development of a novel gasoline additive package — laboratory test work
DR Blackmore, LB Graiff, GA Harrow, JM Jones, GT Kalghatgi, R Miles, Shell Research Ltd.

The following technical papers which have appeared in Petroleum Review are also in this issue:

Offshore helicopter firefighting and rescue training
G Allen, OPITB

Past, present and future exploration in NW Europe
(An overview of the 3rd Conference on Petroleum Geology of NW Europe)
J Brooks, K Glennie, Conference Organising Committee

An alternative to mild steel in underground storage
G Ashton, Ferranti Resin Ltd.

Copies of the first issue of the 1987 **Quarterly Journal of Technical Papers** are available **at a cost of £10.00 VAT zero rated.** A copy of each of the three papers **which have not appeared in Petroleum Review** are available free of charge to **IP members.** Copies to non-members cost £3.50 per paper.

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What price the Paper Barrel?

People talk about the effect of the oil price — but is there really *an* oil price? And how can we be sure that we know what it is? Judith Mirzoeff, of Hollobone Hibbert & Associates, reports on a half-day conference on *Oil Price Information* held at the Institute of Petroleum during IP Week, 1987

The conference was chaired by **Meg Annesley,** for some years an oil trader and now an oil consultant, who compared oil price information to an elephant riding a bicycle. It began with a critical overview of published sources of oil price information presented by Irene Himona, an analyst with Hoare Govett.

She pointed out that there are two main types of oil price, official prices and market or 'spot' prices, and several different grades of crude. Official prices are varied infrequently, although individual countries have on occasion added premiums or offered discounts. The considerable oil price reporting network has grown up in response to traders' need for instant information about fluctuations in the spot market. A number of specialist publications have arisen to meet this need, including some which deal chiefly with regional markets.

Oil price reports can be divided into daily, or more frequent, reports used for trading and historic reports used by financial institutions for medium term analysis.

About 40 per cent of the volume of oil trading takes place on the spot market, and a similar proportion is related to the spot price, either through futures deals or daisy chains, where a cargo is sold many times in transit. Consequently the published oil prices for the spot market are widely used, so it is useful to know how they are obtained. The daily price reports include *Platt's Oilgram, Petroleum Argus, Petroflash* and *Reuters Pipeline,* while *London Oil Reports* come out twice a day. In the absence of an established trading floor, they are all based on market survey.

Their accuracy will depend on a certain transparency in the market, and even more on a degree of subjectivity in assessment. It is unlikely that busy market traders will spare the time to talk to reporters for a twice-daily report.

On the other hand, rarely traded types of oil may be reported on the basis of out-of-date deals which have been overtaken by considerable price movements. The highest degree of accuracy is obtainable with hindsight, and a weekly such as *Petroleum Intelligence Weekly* is able to synthesise the information in the daily reports into price movements and averages.

Dr Himona compared the prices reported by *Platt's* and *Argus* for gasoline and No 2 heating oil over a critical period in 1986. Although the broad trends were the same, daily variations could be quite large. *Argus* is based on a higher number of reported deals, but it is impossible to assess the subjective element. Efforts have been made recently to improve the accuracy of spot price reporting, with the most successful being prompted by the evolution of the futures (paper barrels) markets. Futures prices have become essential to any spot deal and they are available almost instantaneously. Other attempts to set up a better system have not improved on the one we have, which contains the risk that the sources may help to make the price that they report.

Hoare Govett has published the above paper, which gives much solid information.

Peter Lymbery, also a consultant, discussed the provision of electronic or on-line sources of information. He began with a comment on the age old problem of gathering information on market deals, that those who talk don't know and those who know don't talk. Commodity and futures brokers make their money from price fluctuations and have a vested interest in volatility. The advent of on-line price information has helped to make reporting more open and less subjective, although published information will remain important for historical analysis.

The provision of electronic price information is bound up with the rising importance of the futures market, in particular NYMEX, the New York Merchantile Exchange. In the UK we have IPE, the International Petroleum Exchange, which deals in paper barrels of Brent crude. Mr Lymbery considered that futures reporting now determined spot prices and the significance of real cargoes tended to disappear in the scrummage of paper deals. However price-triggered automatic computer dealing was unlikely to enter the oil business, because there will always be unreported deals.

Electronic sources are up-dated as often as six times a day, which comes close to real-time reporting, for frequently traded Brent and WTI marker crudes. More means worse however for rarer categories, as daily reporting does not help to determine the price of a product last traded two weeks earlier. Everyone has to guess what the price would be if you bought some today. Rumour has a greater effect because of the futures market, but never a permanent one. Ultimately oil trading will always depend on market-related factors.

John Bishop of the European Commission made the point from the floor that the screen was now a lot faster than the post, and also believed that commoditisation improved transparency.

Oil company use

An oil company slant was then put on price information by **Michael Jefferson,** head of oil price analysis for Shell International in London. He began with a reflection on earlier papers, that wet barrels and electronic barrels represented two different worlds in collision. An international company was able to organise its deals so as to minimise tax, which could be a more imperative influence than reported price. In any case he considered that price norm boards manipulated price reporting.

The main thrust of his presentation was to show how Shell used price information in 1985–6 to indicate oil price prospects, for the supply and marketing department. The price analysis section has developed its own software for forecasting. A number of problem areas have to be considered in regard to raw price information, ranging from estimates of the accuracy, currency and objectivity of the data to cost benefit analysis of the supply, storage and retrieval of the data itself.

Mr Jefferson ran through the complex inputs to the forecasting model, from political influences in supply countries to price-led variations in demand. He then showed how forecasts had evolved from Jan 1985 to Nov 1986 as a consequence of the dramatic movements in the market.

The worst case scenario was a downward spiral as the price structure collapsed and OPEC lost control. An alternative possibility was a steadier step-wise fall in price. These forecasts are widely used in the company for short and medium term planning of trading, marketing, exploration and production. There were considered to be two possible price extremes over a five year period. Successful pressure on OPEC to restrain production would give a ceiling of $20 a barrel.

Alternatively if the United States managed to cutback on demand and purchasing, there could be a drop to $5. The most probable development was a hybrid between these two extremes.

By March 1986, the forecast to the end of that year was highly dependent on an OPEC agreement, which would probably be reached by July. The probabilities discussed here are subjective rather than statistical. Mr Jefferson warned against ignoring cases with low probability, because these are the ones that would have the greatest effect. He showed a slide of an accurate prediction of the present position, which was made in 1976 but disregarded at that time because it was so unlikely.

His department had not expected the OPEC production agreement to be reached when it was, in June 1986, and did not expect its full cuts to be achieved until 1988. OPEC needs to constrain supply right through to 1991 to keep the price high enough to balance its own books. The main risk to the agreement is that individual producers within OPEC may exceed their quotas to obtain extra income. Consequently an assessment of the probable management of OPEC is an important input to the forecasting model.

Delegates hoping for a free Shell assessment of the short-term futures prices were, not surprisingly, disappointed. The conference showed that whether you want the oil price five minutes ago, the price in three months' time or the price in 1990, the information may be costly. ●

People

Four St Albans schoolgirls have won the opportunity to 'shadow' a Texaco employee in a work area of their choice. The pupils, all from St Albans School for Girls, took part in a civil engineering competition organised by the University of Manchester Institute of Science and Technology (UMIST) and sponsored by Texaco and other industrial companies. The girls are pictured with the crane they designed to show their knowledge of civil engineering. From left to right: Jane Etheridge (17), Samantha Jones (16), Penny Brown (16) and Sarah Newman (16).

Chris Kirk, (*above*) formerly managing director of Worthington Pumps Singapore, has been appointed UK sales director for Worthington Simpson, the Nottingham-based manufacturers of industrial pumps.

Paul Rawson has been appointed financial controller of Lloyd's Register, succeeding **Frank Vickers** who remained in a consultant capacity until April, when he retired after 36 years' service with LR.

At Drilling Tools Inc. in Houston, Texas, **Pat Anderson** has become vice president, sales, for the corporation.

Jean Gaulin has been appointed a director of Ultramar. He is president of Ultramar Canada, a position which he has held since rejoining the Ultramar group in March 1985.

The Teeside Area Office of Control and Applications Ltd, which provides services to the onshore, offshore and marine sectors of industry, has a new area manager — **John Andrews.**

Ron Rogers, who recently retired from the post of senior transformer engineer with the CEGB transmission division, has joined Buchanan Oils of Renfrew as a consultant.

Alan Kershaw, formerly deputy controller of personnel, has been appointed marine marketing manager for Lloyd's Register.

The Cockett Group of Marine Oil Bunker Companies has made the following appointments: **Trevor Allum** as assistant director and senior broker for Cockett Marine Oil (Hellas) Ltd and Europe areas; **Max Carnegie-Jones** as broker UK/Continent; and **Tony Newman** as marketing manager and special consultant to Cockett Computer Services.

The Society for Underwater Technology has recently started a series of annual awards for individual or groups achievements in the development of underwater technology, ocean science and offshore engineering.

The President's Award went to **John Houlder** CBE, in recognition of his contribution to underwater technology, especially in the concept and design of Diving Support Vessels.

The three other awards went to **Michael Tucker** and **David Carter** of the Institute of Oceanographic Sciences for their paper on Uncertainties in Environmental Design Criteria; to **Bill Norton** of Norske Shell for his management of the deep diving project in connection with laying the Statoil pipeline and preparations for the Troll field, and to **Dr Stuart Rusby** and **Michael Somers** of the Institute of Oceanographic Sciences for their work in the conception, design, development and geophysical exploitation of the long range sonar system GLORIA.

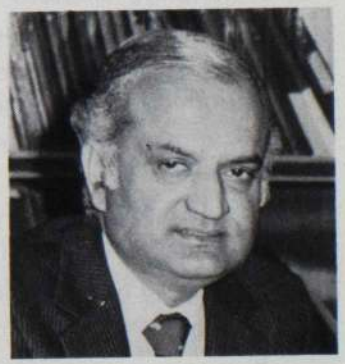
Texaco Limited has reorganised its marketing sales department which has led to the following appointments: **Stewart Cusden** (*above*) is manager, Star Service Stations Ltd. He was previously general manager, public affairs. **Neil Lambert** is manager, marketing development. He was previously national field sales manager. **Tony Price** is manager, retail sales. He was previously manager, Star Service Stations Ltd. **Lawson Roberts** is assistant to the general manager, marketing sales. He was previously manager, commercial sales. **Alan Tucker** is manager, lubricants division and **Owen Jenkins,** director and general manager, marketing sales, continues to head the department.

The highest international award in the field of Tribology has been awarded to **Professor Ward Otis Winer** (*above*) of the Georgia Institute of Technology. The Institution of Mechanical Engineers gave him the gold medal for 'his outstanding and sustained contribution to the science and technology of Tribology, especially in the fields of Surface Temperature and Rheology and of technical transfer in Tribology'.

Arthur D Little, international consultants to the oil and gas industries, have appointed **Stuart M Saint** to their staff. Mr Saint is responsible for upstream energy consulting services in Europe, North Africa and the Middle East.

The Board of Shell has announced that it will recommend to the AGM, to be held later this year, that **John S Jennings** be elected director. Subject to such election, the Board intends to appoint Mr Jennings as managing director of the company.

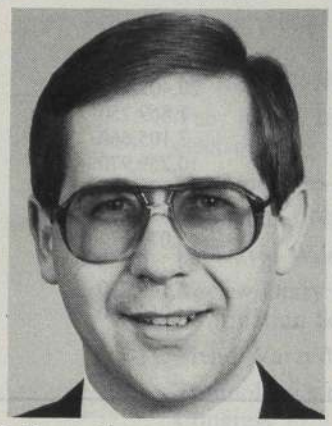
Honeywell Control Systems have appointed **Ken Urquhart** as director of manufacturing automation. He had previously been director of avionic and offshore systems.



Mr KSB Sanyal, (*above*) a Fellow of the Institute of Petroleum, has been appointed Sheriff of Calcutta. He is the chairman and managing director of Andrew Yule and Co. Ltd. in Calcutta.

New Fellows

Richard Morris, Head of Special Industrial Projects at the Scottish Development Agency, Glasgow, has been elected a Fellow of the Institute of Petroleum. Having qualified from Strathclyde University in Chemical Engineering, he joined the Research & Development Department of Courtaulds Ltd. Prior to joining the SDA, he was Chief Engineer of Weir Westgarth Ltd, Glasgow. Responsibilities in his present position are for identifying and implementing large high tech projects in Scotland. He is a Director of the recently established National Hyperbaric Centre, Aberdeen, which he played a key role in setting up. He is also Vice Chairman of the West of Scotland Branch of the Institute.



Richard Pearson, Business Development Manager of Unitank Storage Company, a division of Tate & Lyle plc, has been elected a Fellow of the Institute of Petroleum. He obtained a BSc in Chemistry with Economics and subsequently joined Esso Petroleum. Later, after five years in Finland with Oulu Oy, he joined Unitank where he was Sales Manager before being appointed Business Development Manager in 1984.

New Collective Member

Oeltrans Befrachtungsgesellschaft mbH & Co has been elected a collective member of the Institute of Petroleum. This company acts as cargo broker, charterer and agent for large mineral oil and chemical industries, food manufacturers, trading companies and mineral oil products dealers. Oeltrans operates 35 chartered inland waterways tankers with a freight capacity of minimum 440 tons, with constant expansion in the cargo market and tonnage. In addition, the company manages inland waterways tankers.

There are currently over 270 collective (company) members of the Institute of Petroleum. Membership is open to all companies/organisations with an interest (direct or indirect) in petroleum. For details of collective membership, please contact the Membership Secretary, Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR.

New members elected by Council

Fellows

Morris, Richard M, Scottish Development Agency, 120 Bothwell Street, Glasgow, Scotland G2 7JP.

Pearson, Richard, 40 Pound Lane, Marlow, Bucks SL7 2AY.

Members

Albaz, Afdhal M, Emirates Bunkering & Bitumen Co (Pvt) Ltd, PO Box 5589, Dubai, UAE.

Au, Kam N, Ewing House, Pollock Halls, 18 Holyrood Park Road, Edinburgh, Scotland EH16 5AR.

Bell, Graham G, 28 Bruce Crescent, Ellon, Grampian, Scotland AB4 9BF.

Boult, Stanley R, Spear Oils, 512 London Road, West Thurrock, Essex RM6 1AR.

Bowyer, Richard, 72 Park End Road, Marshalls Park, Romford, Essex RM1 4AU.

Brockett, Peter J, 220 Goring Road, Goring-by-Sea, West Sussex BN12 4PG.

Dixson, Mark, 46 Christmas Lane, High Halstow, Rochester, Kent ME3 8SN.

Dobson, Paul K, 2 Butsfield Gardens, Tunstall, Sunderland, Tyne & Wear SR3 1PN.

Endacott, John A, 99 Maryland Way, Sunbury-on-Thames, Middx TW16 6NP.

Faulkner, Andrew J, 23 Kingston Road, Leatherhead, Surrey KT22 7SL.

Francisci, Jean M, Société Générale, 60 Gracechurch Street, London EC3V 0HD.

Fremond, Olivier PR, Flat 4, 11 Belsize Avenue, London NW3 4BL.

Griffiths, John G, Castrol Ltd, Burmah House, Pipers Way, Swindon, Wilts SN3 1RE.

Hickam, Edward E, 'Westwood', Icklingham Road, Cobham, Surrey KT11 2NG.

Hippolyte, Jacques M, Gable Manor, Shrubbs Hill Lane, Sunningdale, Berks SL5 0LD.

Hodges, Michael J, 3 Bush Elms Road, Hornchurch, Essex RN11 1LR.

Lavin, Paul M, 1 Capton Close, Bramhall, Stockport, Cheshire SK7 3DE.

Lilienberg, Ove, FMV, 11588 Stockholm, Sweden.

Liness, David B, 37 Hornbeam, Newport Pagnell, Bucks MK16 0LD.

Moore, Dean F, Société Générale, 60 Gracechurch Street, London EC3V 0HD.

Palmer, Malcolm, 36 Penerley Road, Rainham, Essex RM13 9HD.

Pearson, Iain NA, 24 St James's Square, Bath, Avon BA1 2TT.

Pedret, Benjamin G, Top Flat, 30 Hillhead Street, Glasgow, Scotland G12 8PZ.

Percival, Robert, 10 The Paddocks, Worksop, Notts S81 0UP.

Price, Christopher J, Petroleum Times, Earl House, 27 Earl Street, Maidstone, Kent ME14 1PE.

Price, Gerard F, 11 Love Lane, Aveley, South Ockendon, Essex RM15 4JA.

Quamruzzaman, Mohammed, 31/1 Kalabagan 1st Lane, Dhaka, Bangladesh.

Sogunro, Adenike A, Nigerian National Petroleum Corporation, Crude Oil Marketing Dept, PMB 12701, Falomo, Lagos, Nigeria.

Stinton, Horace C, Calvert Stinton & Associates, 118 Offington Avenue, Worthing, West Sussex BN14 9PR.

Thomas, Brynley, Uniguard Security, 799 London Road, West Thurrock, Grays, Essex RM16 1LR.

Thompson, Phillip M, 94 Thistle Drive, Portlethen, Aberdeen, Scotland AB1 4QU.

Watling, Anthony D, 8 Bannerman Road, Petersfield, Hants GU32 2HQ.

Watts, David, High Trees House, Holly Bank Road, Hook Heath, Woking, Surrey GU22 0JN.

Zervoglos, George N, 'Morland', The Drive, Eaton Park Road, Cobham, Surrey KT11 2JQ.

Students

Agunbiade, Michael O, 191 Northwood Tower, Marlowe Road, Walthamstow, London E17 3HL.

Akinpelumi, Felix O, 58 Stepney Green, London E1 3JJ.

Badawi, Bashir MK, 408 Mearns Hall, 25 Mearns Street, Aberdeen, Scotland AB1 2AT.

Ghogomu, Peter N, Governor's Office Bamenda, Northwest Province, Republic of Cameroon, West Africa.

The IP Library will be CLOSED on 20 and 21 May and also on 11 June.

Around the Branches

Aberdeen

12 May: 'Offshore Weight Reduction', by A Sim, McDermott, Aberdeen.

London

14 May: 'LPG — the UK Scene', R Holder, Manager, Gas Branch, BP Oil Ltd.

June: Summer visit — to be announced.

Southern
June 19: Summer Social Event. Venue: Beaulieu Barbecue Site, 5.30pm.

South Wales
21 May: Visit to Sony Factory, Bridgend.

Yorkshire
June 17: Annual Golf Match, Wetherby Golf Club.

OBITUARY

The death of George Beeby Thompson, by drowning while trying to save the lives of others, was reported in the March issue of *Petroleum Review*. He was 81. We are glad to take this opportunity of paying tribute to one who had such boundless energy and zest for living.

As a Sales and Service Engineer with Lidgerwood Ltd., he worked in the UK, Venezuela and Colombia, and in the late 20s he joined C Tennant & Sons in Trinidad where he stayed until the outbreak of the second world war, working for Alstons Limited and Contractors Limited.

During the second war, he was appointed to the Office of the British Representative, in Washington, as officer in charge of the material requirements section. The OBPR worked closely with the Petroleum Association for War in handling the requirements of nearly 30 companies operating in the "British areas".

After the war, he went to Bahrain as Government Petroleum Inspector, becoming Chairman of Gulf Aviation, now Gulf Air. In association with Hunting Aerosurveys, he was involved in air photography of Bahrain, resulting in the publication of the official, inch to the mile, government map. A beach on the island is now known officially as Thompson's Beach.

In 1961, he returned to Trinidad, with Trinidad Canadian Oil, but his direct association with the oil industry ended soon after. However, he remained an active member of the Trinidad branch of the Institute of Petroleum until it closed down in the mid 70s. The branch commissioned a history of Trinidad oil, still to be published, for which notes, maintained by George, proved invaluable.

In Trinidad he was much involved in charitable work and received the Humming Bird Silver Medal from the Trinidad government. He was a Fellow of the Institute of Petroleum.

He is survived by his wife Marjorie and a son and two daughters by his first marriage.

Deliveries into Consumption

UK deliveries into inland consumption of major petroleum products — Tonnes

Products	*Dec 1985*	*Dec 1986*	*Jan–Dec 1985†*	*Jan–Dec 1986**	*% change*
Naphtha/LDF	293,440	278,300	3,264,300	3,715,770	+ 13.8
ATF — Kerosine	353,980	393,700	5,006,630	5,496,600	+ 9.8
Motor Spirit	1,702,360	1,898,720	20,402,790	21,469,690	+ 5.2
Burning Oil	187,090	216,400	1,869,750	2,020,330	+ 8.1
Derv Fuel	553,190	663,390	7,105,660	7,865,540	+ 10.7
Gas/Diesel Oil	798,810	766,510	10,259,970	9,320,190	− 9.2
Fuel Oil	813,910	937,690	15,978,780	12,358,280	− 22.7
Lubricating Oil	56,500	58,970	816,190	803,270	− 1.6
Other Products	317,140	493,520	5,076,610	5,927,380	+ 16.8
Total above	5,076,420	5,707,200	69,780,680	68,977,050	− 1.2
Refinery Consumption	459,000	471,770	5,179,270	5,403,960	+ 4.3
Total all products	5,535,420	6,178,970	74,959,950	74,381,010	− 0.8

†Revised *Preliminary