JULY 1992

The Institute of Petroleum

PETROLEUM REVIEW

New President

CM Smith is elected president of The Institute of Petroleum

Automotive diesel

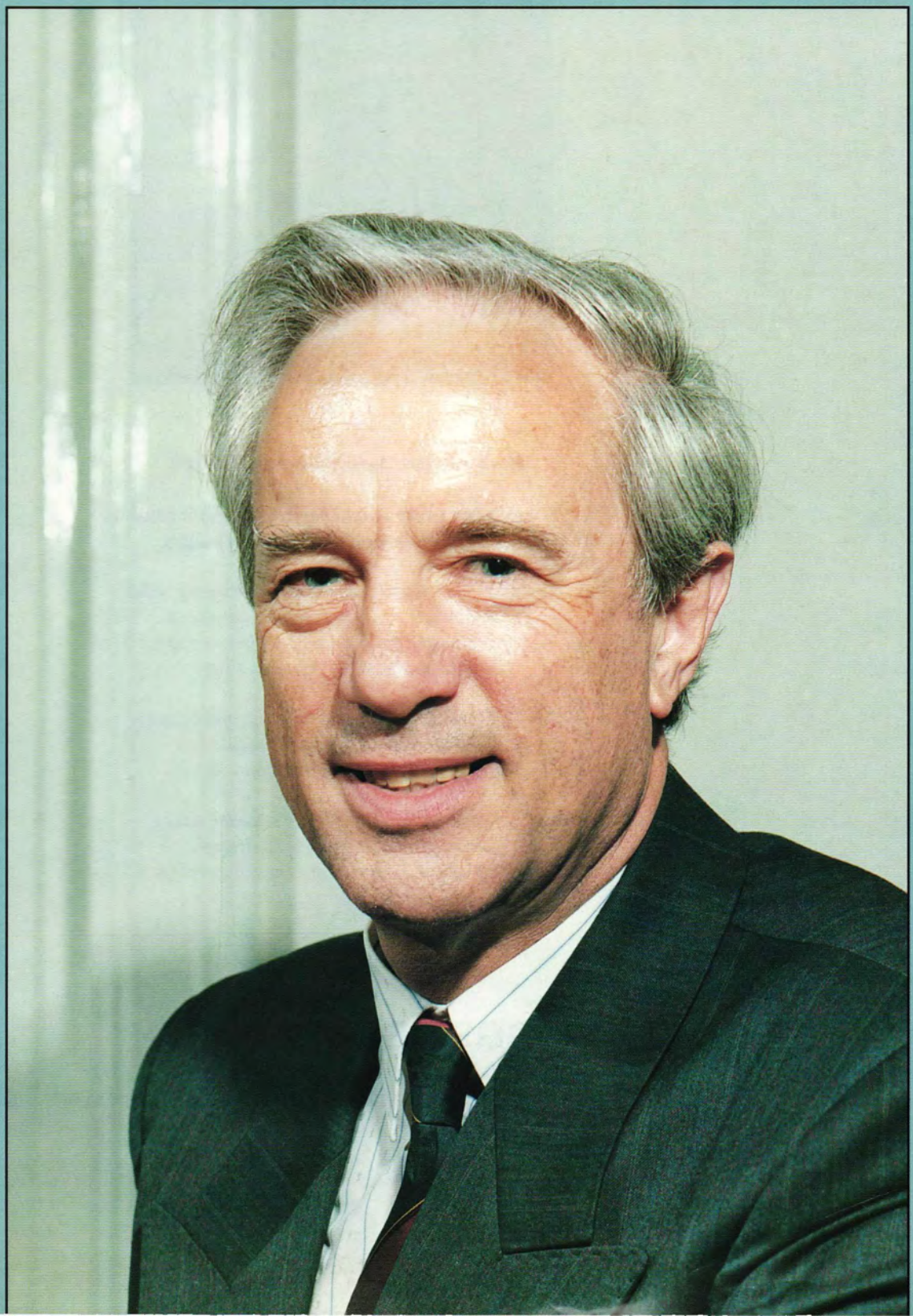
The crucial balance between cost-effectiveness and environmental acceptability

Blending

How one UK refinery upgraded its gasoline blending facilities

Saudi Arabia

Future expansion plans by John Roberts



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Cover photo of C M Smith, Managing Director, Chevron UK Ltd, the new President of the Institute of Petroleum *Photo by Jon Whitbourne*

. . . news in brief

16 May

BP Exploration has awarded an engineering contract for the Forth field oil production facilities to a consortium comprising Technip-Geoproduction and McDermott Engineering (Europe).

An appraisal well has successfully tested the western flank of BP's Mungo field, one of six prospects in the company's eastern trough area project in the UK North Sea.

19 May

Russia will more than double its gas exports to Germany while cutting oil deliveries by a fifth during the next five years according to Georgi Sokolnikov of the Russian Economic Research Institute.

21 May

Two steel catamaran anti-pollution vessels have been delivered to the Milford Haven Port Authority to provide rapid response in containment and removal of pollution.

23 May

Exploration Company of Louisiana has completed negotiations with the Chinese authorities for an offshore concession in the Zhao Dong area, a shallow water portion of Bohai Bay.

Lasmo has announced moves to sell out its Canadian subsidiary in a divestment which could cut debts by a total of C$80m.

26 May

Amoco will start producing gas from the P15/P18 fields, located around 40km northwest of The Hague, by the end of 1993.

27 May

Britain and The Netherlands have signed a deal allowing Lasmo to exploit the Markham gas field that straddles the Anglo-Dutch median line in the North Sea.

The start of production from the Piper field redevelopment in the UK North Sea has been delayed until the final quarter of 1992 because of bad weather and technical problems last winter.

28 May

A £55m management buyout of the UK oil field services group Expro from Flextech has been finalised.

29 May

A Pta25bn ($250m) convertible bond offering by Repsol has been oversubscribed and the corporation will extend the issue to Pta50bn.

Alliance Gas, the joint venture established by BP, Statoil and Norsk Hydro, has drawn up a marketing arrangement with the regional electricity company Manweb.

UK North Sea output has recovered from the sharp dip experienced in March according to the Royal Bank of Scotland's oil index.

Nippon Oil has reported a 5.9 percent fall in pre-tax earnings to Y44.1bn due to rising personnel costs and a decrease in financial income.

The corporation tax staff of BP is to join Price Waterhouse in what the accountancy group claims is the first move of its kind in the United Kingdom.

1 June

Mr Viktor Chernomydrin, Chairman of Gazprom has replaced Mr Vladimir Lopukhin as the Russian energy minister.

2 June

Westland, the helicopter manu-facturer, is in discussions with several oil companies to supply a civil version of its EH101 helicopter for use in the North Sea.

Atlantic Richfield has disclosed plans to auction offshore assets in its Netherlands portfolio as part of an international rationalisation programme.

Norway's Ekofisk oilfield plat-form was back in production less than a week after being shut down following a fire in an air filter on one of its platforms.

South Korean firm Hyundai has won another major offshore platform construction contract from India worth $530m.

3 June

Chevron in the US is to streamline five oil and gas research and technology organisations into one unit — the new unit will be known as Chevron Petroleum Technology.

Statoil has recalculated the reserve base of the UK-Norwegian Statfjord field as 3.56 billion barrels, of which 2.3 billion have been produced since start-up in 1979.

Total Gas Marketing has bought Conoco UK's share of production from the Anglia gas field for an undisclosed sum.

4 June

Exploration activity in Indonesia looks set to remain high during 1992 and 1993 according to consultants Arthur Andersen.

Maxus Energy Corporation, one of the largest US independent oil and gas exploration and production companies, is to raise up to $132m through an international share offer.

5 June

Saga Petroleum and partners have declared that the Midgard gas field on Haltenbanken is commercial.

Lasmo and Japan's C Itoh have won exploration rights to block 04–2 in the Con Son Basin off southern Vietnam.

European Marine Contractors have won a $531m contract covering the installation of a significant part of Norway's new offshore gas infrastructure.

6 June

Lasmo Nova Scotia has achieved the first commercial oil production off Canada from its Cohasset development project 250 kilometres south-east of Halifax.

Mobil reported that the first horizontal development well drilled in the Lancelot gas field in the southern North Sea has produced at a rate some 35 percent higher than the previous best well on the field.

The Spanish cabinet has approved a bill that would liberalise the petrol market, ending the price and distribution monopoly held by Campsa.

9 June

BP Exploration has begun to produce oil from its Miller field.

Occidental Petroleum has bid successfully for the exploration and production rights covering a 1.5m acre block in the Timan Pechora basin in Russia.

10 June

Bristow Helicopters have renewed their contract to service Marathon Oil UK's North Sea operations.

11 June

The French port of Le Havre has been commissioned to work on a feasibility study for the creation of a new Russian oil terminal in the port of Arkangelsk.

Vietnam has opened up four more blocks off its southern coast to exploration by foreign companies according to PetroVietnam.

12 June

Aker Engineering has won a contract worth around £365 million from Norske Shell in connection with the Troll Development in the Norwegian sector of the North Sea.

15 June

British Gas has offered contracts to 32 applicants who applied for gas which will be sold in competition with it to industrial and commercial customers.

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Saudi minister rejects tax moves

Doubt has been expressed on the 'effectiveness of [energy/carbon] taxes in tackling a problem with global dimensions' such as the possibility of climatic change.

The view was expressed by the Saudi Minister of Petroleum and Mineral Resources, His Excellency Hisham Nazer, at a meeting of representatives of the European Commission and the Gulf Cooperation Council.

In the statement, Mr Nazer pointed to the 'excessive petroleum taxation' that currently exists in the EC. 'Taxes per barrel of petroleum products increased from approximately $7 in 1973 to $56 in December 1991, while emissions increased over this period. Petroleum product taxation in the EC was increasing at an annual rate of five percent over this period while per capita emissions were also increasing at an annual rate of one percent.'

Mr Nazer felt that the oil producing and exporting countries' main export commodity was being subjected to further taxes under an 'environment pretext'. Coal's share of the fossil fuel market had increased by five percent since 1973, he maintained, despite it being the highest carbon dioxide emitter. 'This is largely due to excessive petroleum taxation and generous coal subsidies.'

He was concerned that the proposed tax was 'yet another form of excise tax intended to raise government receipts which in some consuming countries are already more than three times the petroleum export revenues of developing oil producing countries'.

Mr Nazer warned that the new taxes could add an element of uncertainty to the oil market which could lead to them being susceptible 'bottlenecks and shortages leading to price surges'.

Efforts to improve the environment should be directed to research and development of 'cleaner and environmentally friendly' petroleum products, he added.

'The point I am trying to make, quite candidly, is to highlight the importance of policies taken by the EC relating to oil, the production and export of which we consider to be the vehicle of our economic growth and future welfare of our people.'

Diverless TLP installation

The 106,500 tonne Snorre field tension leg platform (TLP), the largest of its kind in the world, has been successfully installed in 310 metres of water in a totally diverless operation.

The first tethers were stabbed and latched into their seabed foundations in April in an operation involving the simultaneous deployment of a heavy lift vessel, a fleet of eight tugs and six remotely operated vehicles (ROVs).

The integrated operations enabled the tether deployment control centre, via ROV contact with the bottom of each tether, to move the structure — in steps as small as one metre — into position.

The installation was the culmination of two years' work for underwater contractor Rockwater.

Canada's first offshore oil production

LASMO Nova Scotia Limited has announced the first commercial oil production from its Cohasset development 250 kilometres southeast of Halifax, Nova Scotia.

The development comprises two fields, Cohasset and Panuke, with estimated recoverable reserves of 50 million barrles of high-quality, light oil and is the first commercial production in Canadian waters.

The company, a wholly owned subsidiary of LASMO plc, is project operator and has a 50 percent interest, with the remainder held by Nova Scotia Resources Limited — a provincial crown corporation.

Production has commenced from the Panuke field and is being processed via the combined drilling and production jack-up rig, Rowan Gorilla III before being loaded into an offshore storage tanker. Development drilling of the Cohasset field will begin in 1993 and total production is expected to rise to approximately 40,000 barrels per day.

A third satellite field, Balmoral, may be tied in through a subsea pipeline at a later date.

First UK gas for export

The signing of the Markham Treaty relating to the exploitation of the Markham field which straddles the international boundary between the United Kingdom and the Netherlands has opened the way for the first UK gas exports.

The field has reserves of about 700 billion cubic feet of which approximately 40 percent lies in UK waters. The operator will be LASMO Nederland bv and the project is expected to come onstream in October.

HM The Queen's Birthday Honours

Sir James Richard Samuel Morris, Chairman, Brown and Root Ltd
Sir Alan Cockshaw, Chairman, AMEC
TM Evans CBE, Chairman, The Energy Council
RR Knowland CBE, Managing Director, BP
AC Longden OBE, Managing Director, Croda Hydrocarbons
D McGeachie OBE, Director, Conoco (UK)
VES Thomas OBE, Chief Executive, BP Oil UK

Forecourt association launched

A consortium of building and maintenance contractors specialising in petrol retail outlets have formed a new organisation — the Forecourt Contractors Safety Association (FCSA).

The aim of the FCSA is to establish and promote safe working practices and to provide the constructors with a representative voice. Members will be encouraged to develop uniform and consistent safety strategies, according to the requirements of the Institute of Petroleum's Industry Codes of Safe Practice.

The association intends to work closely with the recently-formed Association of Forecourt System Contractors which represents mechanical and equipment suppliers. Both groups will be represented on the Institute of Petroleum Panel A committee.

While safety is the prime objective of the FCSA, it also intends to focus on environmental and other legislative issues that impact on contractors, operators and members of the public during the construction of service and filling stations.

According to Mr John White, the association's secretary/consultant, the FCSA will be 'totally committed to contribute towards the identification of safety needs, the provision of effective training and the implementation of safe working practices in the automotive fuel retailing environment'.

Troll go-ahead given

The go-ahead has been given for the $2.5 billion Norsk Hydro-operated Troll project by the Norwegian government.

Utilising semi-submersible concrete production platforms and what the company claims is the largest subsea development so far in the North Sea, the company hopes to be able to produce around 350 million barrels of oil. A series of construction contracts will be awarded over the next 12 months although contracts for the detailed engineering and procurement for the platforms deck structure and for the basic engineering for the platform have been let.

Primarily a gas field, there are large volumes of oil in very thin layers ranging from 10–12 metres and 22–26 metres situated below the gas. According to the company, it was previously considered almost impossible to find commercially attractive ways of producing it.

All 17 wells (with the possible development of a further 23) will have horizontal sections of 800 metres and be subsea completed at water depths of between 320–340 metres. No decision has yet been reached on the method for transporting the oil to shore. Production is planned to start in January 1996.

Iraq pipeline may open soon

The oil export pipeline running from the fields around Kirkuk in northern Iraq to the Mediterranean could reopen if talks currently underway allow the resumption of oil exports from Iraq and Turkey agrees to cut its transit tariffs.

The 1.5 million barrels per day pipeline could be reopened under a UN plan to allow Iraq to export $1.6 billion worth of oil over six months, providing the money is spent on food, medical supplies and war reparations.

Turkey, which had demanded a fee of $264 million for the six month operation — a figure far higher than that charged before the Gulf War — has now said that it is willing to negotiate these fees as a 'goodwill' gesture — although the reopening of the Mina al-Bakr terminal in the Gulf may have persuaded it to hold negotiations. Turkey has lost around $500 million in revenues since the pipeline closure in August 1990.

Mexican power project

Integrated Power Corporation is to supply an integrated community hybrid power system for a Mexican village.

The system, consisting of photovoltaic, wind and diesel power sources, will provide power for 100 homes, three schools, three stores, a community centre and church. The system is designed to accept an input from a microhydro generator which will be installed at a later date.

Gas company joint venture

Phillips Petroleum and Southern Electric have announced the formation of a joint company to acquire and market gas.

Landward licences announced

Details of the 26 new landward petroleum exploration licences have been announced by the Department of Trade and Industry.

Following consideration of applications received in the Fifth Landward Round, 18 exploration licences have been awarded to 20 companies and eight licences have been awarded to holders of existing production licences to transfer this acreage to exploration licences.

Energy Minister Tim Eggar said that he was particularly encouraged by the number of licences for exploration for coal-bed methane. 'This is a relatively new venture in Great Britain.'

BP America assets on offer

BP America is seeking a buyer for more than 300 retail outlets and two distribution terminals in the United States.

The company has issued notification of intent to withdraw completely from California and to reduce its assets by between 70 and 80 percent in Florida. The notification is required under US law at least six months prior to withdrawal and the company hopes to complete the sales by the end of this year.

Poor industry conditions and low market share were cited as reasons for the sales though it intends to keep a presence in north and north eastern Florida and the surrounding states.

The company has not put a value on the assets but has distributed details of the offer to over 100 interested parties. It expects to get replies by the end of July.

Production manifold installed

Conoco (UK) Ltd, as operator, has installed the Lyell oilfield subsea production manifold in the UK North Sea block 3/2 in 479 feet of water, 300 miles northeast of Aberdeen.

Development drilling of 13 wells (eight production and five water injection) will begin in September, starting with the recompletion and conversion to production of well 3/2–9 — first drilled in 1988 and used for a long-term production test.

Production is scheduled to begin in October reaching a peak of 18,000 barrels of oil per day in 1993. The oil will be transported to the Chevron-operated Ninian Southern platform where associated gas will be used primarily for fuel.

Lyell, discovered in 1975, is believed to hold some 400 million barrels of which some 30 million barrels will be recovered in the first phase.

IP Annual General Meeting

The IP Annual General Meeting took place on 9 June with the President, Mr B R R Butler OBE, in the Chair. Mr Butler paid tribute to the contribution made to the Institute by Brian Goodland, who had completed the six-year maximum period on Council, the last three as a Vice-President, and Roger O'Neil, also a Vice-President, who had resigned during the year. He also expressed his appreciation of the work done by Members of Council who had retired — David Jamieson, Dr John Price and Ieuan Thomas.

The President also made reference to the recent study of the Institute's future direction which had involved the Council, Management Committee and the senior management of the IP. The review had been completed and a statement of the Institute's Mission, Objectives and Strategies, which provides a directional framework towards the end of the decade, agreed.

The Mission is:— 'To be the most respected independent, European based centre for the advancement of technical knowledge relating to the international oil and gas industry'.

Mr Charles Smith was elected as President for the session 1992–93.

Robin McLean was re-elected as Honorary Treasurer and Ian Fotheringham was re-elected as Honorary Secretary.

The election or re-election of Mrs Elaine Gillatt, Peter Johnson, Anthony Levy and Frans Said as Ordinary Members was approved, as was the election of John Orange and David Varney as Additional Members, all for terms of three years.

Alan Green (Humber Branch) was elected to Council as one of the representatives for the Branches.

The Report of Council was adopted, having been presented by the Director General, Ian Ward.

The Accounts were adopted and Ernst & Young were appointed auditors for the coming year.

Awards of Council were presented to Mrs Jean Etherton, Gordon Forsyth, Dusty Miller and Mike Salter and an Honorary Fellowship was conferred on Ted Williams.

At the close of the meeting, Charles Smith received his badge of office and delivered his Presidential Address, in which he paid tribute to Basil Butler for his leadership during the past two years (see page 312). ■

Mr Charles Smith, right, became President in succession to Mr Basil Butler OBE.

Gordon Forsyth retired as Honorary Treasurer of the Institute in June 1991 after six years' service — the maximum period allowed under the rules of the constitution. During that time, he was instrumental in establishing the IP accounts and financial affairs on a more professional basis. In his role as Honorary Treasurer, he chaired the Finance, Benevolent Fund Trustees and Pension Fund Trustees Committees, as well as serving on Council and Management Committee.

Dusty Miller is a Founder Member of the Irish Branch, serving in turn as Chairman, Honorary Secretary and Treasurer. Ex Total Marine Ireland Ltd, he also served for three years as Branch Representative on Council. His numerous works for the branch since its establishment in the 1970s have included the initiation of the Bryony Berry Award — for students in their final year at school — and the development of strong links with the Irish Department of Energy.

Mike Salter was elected to the IP Engineering Council in 1983 and in 1987 was elected as Chairman. During his four years in office, he oversaw the activities of a number of subsidiary committees, including the Electrical, Refining, Marketing, Safety and Aviation subcommittees. On his retirement from the chairmanship, he undertook a study into the objectives and organisation of the Engineering Committee. His recommendations led to the formation of the Downstream Operations Committee, composed of senior oil industry managers, which has now replaced the former.

Jean Etherton retired last year after 14 years' service as Head of Library and Information Department at the Institute. She was influential in developing a whole new range of services, taking advantage of new technologies. She established the IP Information for Energy Group (IFEG) which has done much to consolidate and enhance the position of the IP as an acknowledged centre of excellence in providing information on energy matters.

Ted Williams received an Honorary Fellowship. He was the first Director General of the Institute, retiring last September after five years in office. Prior to his appointment, he worked for BP for more than 25 years, including lengthy spells with BP Chemicals and BP Far East. Great progress was made in all fields of activities and the professionalism of the IP improved significantly during his stewardship.

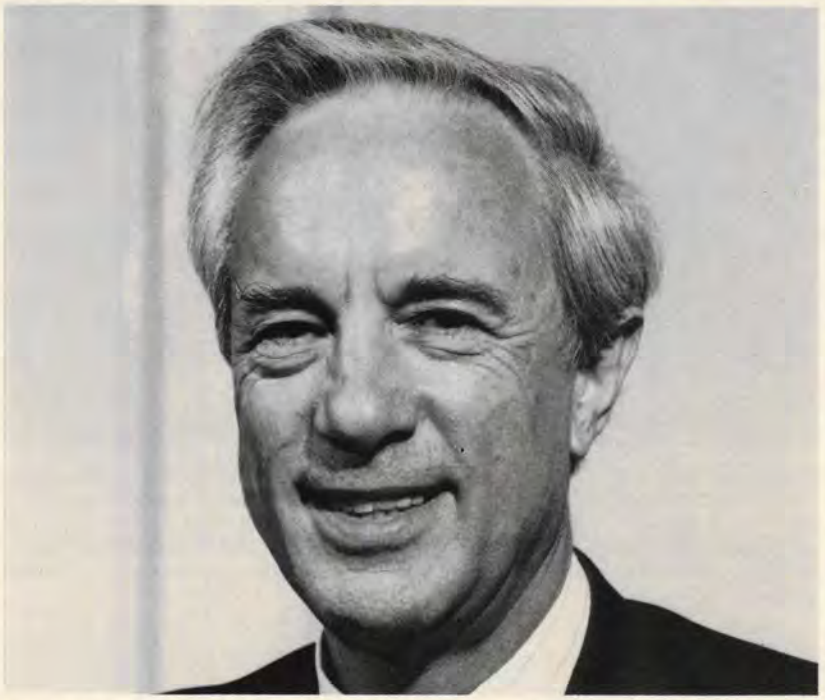
Anthony Levy, above, was elected as an Ordinary Member of Council. He combines being a Senior Lecturer at Thames Business School with an active consultancy in strategic and change management.

John Orange, top left, was elected as an Additional Member of Council. He is Chief Executive, BP Oil UK Ltd.

Frans Said, left, was elected as an Ordinary Member of Council. He is Chief Executive of Medserv and Founder Member of the IP Malta Branch.

Presidential address

By C M Smith, Managing Director, Chevron UK Ltd



Mr Charles Smith gave his inaugural presidential address at the Annual General Meeting of the Institute of Petroleum on 9 June 1992. He said:

I feel greatly honoured to be the new President of the Institute of Petroleum as the Institute approaches its 80th year in existence. I recognise the responsibility the position brings and I will do my utmost to carry on in the tradition set by my predecessors, and in particular the outgoing President Mr Basil Butler, whom I thank warmly on behalf of everyone for his leadership over the past two years.

I have already enjoyed a long and happy association with the Institute and I feel particularly responsible during my period of office, for moving the Institute forwards in what can only be described as very interesting times, both politically and within our own industry, as I am sure all those watching EC affairs will readily agree.

The Institute would not function, of course, without the Director General, Mr Ian Ward, his excellent staff and all those who support our various committees, and I shall be doing everything I can to support their efforts.

For many years the Institute of Petroleum has been one of the principal independent bodies in Europe concerned with the advancement of knowledge in the science, technology and economics of the oil and gas industry. The Institute has recognised, however, that we face a new and challenging environment, with the ever-increasing influence of Europe, the constant importance of safety against a background of rapid technological change and the development of environmental issues into a mainstream political concern.

Over the last six months, some of you will know that the Institute has been considering its future direction, with a view to focusing its activities more sharply. We have set ourselves a Mission — to be the most respected independent, European-based, centre for the advancement of technical knowledge relating to the international oil and gas industry. Specific objectives have been agreed in order to fulfil that Mission.

We have laid the foundations to respond to the changing world and I intend to carry that process forwards during my Presidency by continually checking the focus of the Institute's activities. I am confident that all of us share a clear sense of purpose.

Fiscal policy

These have been difficult times for the industry, with reduced revenues from low oil prices against the background of a deep world recession. Against this difficult background, it is at the same time necessary to invest in measures to maximise the recovery of resources, ensure the safest working conditions and to minimise environmental damage. There is currently concern in the UK upstream industry that the fiscal regime operating in the North Sea is not entirely appropriate in the present circumstances.

As the industry in the North Sea approaches a mature stage of development, research will be vital to increasing the ultimate recovery of resources from mature fields and to permitting the economic development of prospects which are currently uneconomic. In addition, the optimum use of existing facilities should be achieved. This raises the question whether some change to the fiscal regime might be necessary to assist the industry to meet these objectives.

Radical structural change to the North Sea fiscal regime is not being sought, nor do I believe that a regime devoid of discretionary powers would be helpful. What I should like to see is an evolving regime in which the barriers to maximising economic recovery are reduced. It is likely that this issue will be one for debate over the coming months, as the industry strives to achieve both reasonable commercial returns and the wider objectives of government, Europe and the regulatory bodies.

Environment

Fossil fuels have been the subject of recent environmental concern and yet those concerns have to be weighed against increasing demands for energy to assist economic growth. It must be remembered that fossil fuels are, and for the foreseeable future will continue to be, the mainstay of the world's energy supply. Nuclear power has its own environmental but not insuperable problems and renewable sources of energy can realistically only make a small contribution to meeting world energy demand.

The protection of the environment must be addressed in a global context, particularly with reference to concepts such as the recent EC draft proposal for a carbon/energy tax. A House of Lords European Committee Report recently examined the proposal and said that the committee could not support it because 'it is a unilateral response to a global problem'. They also made the point that it would be ineffective because of the relative inelasticity of the energy markets.

It should also be remembered that research is continuing into the scientific basis of many environmental claims. At this stage, there are sensible measures which can be taken to protect the environment, such as the banning of CFCs, whilst scientific research continues. In my view, the best ways forward are for government and industry to promote energy efficiency, ensure that research is undertaken into the technological development of environmentally 'friendly' methods of exploiting as well as utilising our fossil fuel resources, encourage conservation of our finite resources, and foster development of renewable sources of energy.

Pollution is another major environmental issue for the industry. The IP has an important role to promote the adoption of standards in dealing with pollution incidents and to research the results of marine oil spills and the long-term environmental effects, ensuring that information gained from such incidents is disseminated so that it can assist with any future operation.

There is scope for more work on the monitoring and appraisal of the remedial actions taken by the industry and my aim will be to ensure that the Institute's work and the industry's achievements receive the widest coverage. A former Environment Minister told the IP a few years ago that the oil industry had a very good record on pollution control and did not make enough of it — and he was right.

Health and safety

It is also important that research is undertaken to establish the extent of any health risks associated with working in the industry. A recent updated report on the epidemiological studies of workers employed in refining and distribution between 1950 and 1975 gave reassuring results, showing a healthy worker effect and a deficit of deaths from all non-cancerous causes and from all cancers. It is important that this work continues and deeper study and analysis in this area is planned by the Institute.

Of course, the Institute's most prestigious area of work is undoubtedly its Codes and Standards, relating to both the downstream and increasingly the upstream sectors of the industry. Although these Codes and Standards are internationally recognised and often adopted elsewhere, we now intend to build further on our excellent reputation and increase our influence on the development of European and International Standards.

The Institute intends to continue focusing on the upstream as well as the downstream industry. The ongoing implementation of Lord Cullen's recommendations is a constant reminder of the lessons learned from Piper Alpha. We can contribute both in terms of establishing good industry practice and in providing a forum, through our conferences, which are an opportunity for the industry to discuss the way forward on offshore safety.

Research

I have referred to elements of the Institute's research programme. The Institute is capable of conducting and managing a larger programme of research than we have at present. It is my intention that the Institute's role in research should expand, by identifying worthwhile projects in consultation not only with members, but with government, Europe and the various regulatory authorities.

IP Committees

The industry's support is vital to the Institute in its Mission to be the European-based centre for the advancement of technical knowledge on the oil and gas industry. Much of the work carried out is undertaken by people who are members of the technical committees. The continuing support of those individuals concerned and their companies is essential. I should like to thank both the individuals concerned for their time and efforts and pay tribute to their companies. I know that at a time when the numbers employed in the oil sector have declined, there are increasing pressures on those who support the committees' work.

Codes and standards produced by the Institute, rather than imposed by the regulatory authorities, are to the advantage of everyone in the industry and must be the most effective option. We have a good track record of self-regulation and continued support from the industry is essential.

Communications

We must take every opportunity to communicate with a wider audience, from policy-makers and governments to the European Community and international organisations. We already have the means to do this, through our Committees, publications and conferences, but there are still many people in the outside world who could be made more aware of its activities and expertise.

The Institute intends to develop a European branch network, with a view to becoming more influential in Europe. We should also continue to build our links with other representative bodies in the oil and gas industries, such as UKOOA, E&P Forum, UKPIA and API, taking a lead on issues where the high reputation of the IP as an impartial, technical body will most effectively convey the views of the breadth of the industry and where increased co-operation will prevent waste of precious resources. Any opportunity to play a strong expert role in the formulation of legislation must be taken.

It is also important to increase the Institute's influence in the upstream sector. We must foster a more influential role with government and regulatory bodies such as the HSE in particular. There are new opportunities in the upstream, particularly with reference to environmental and safety matters, to bring together the different interest groups in this field with a view to reaching a consensus.

The Institute has an important general and technical information resource and dissemination of knowledge is one of the key services to members. However, I believe that this resource is not exploited to the full and it is my intention that we should communicate its potential to a wider audience. Our current individual membership of around 7,000 is a relatively small number compared with those working in the industry and in associated fields; there is clearly scope for a significant increase. Improved communications and customer focus are essential to ensure that our aims, achievements and range of services are fully understood.

In looking to wider membership, we must address attracting new entrants. The IP is working particularly to reach those in secondary education, with a view to promoting the study of subjects which will enable them to go on to a career in the industry. It is crucial to attract good candidates to a career in the industry and the IP is well placed to convey the importance and interest of the energy sector as a career choice.

Conclusion

I have three main objectives to achieve in the course of my Presidency:

- To support the implementation of the objectives and strategies recently agreed by the Institute, in order to progress the achievement of our Mission.
- To achieve greater recognition of the IP in the upstream where there are new opportunities.
- To play a more influential role in Europe, developing a European branch network and building links with other representative bodies. ■

Saudi ambitions

By John Roberts, Editor, Middle East Monitor

Saudi Arabia is currently engaged on what is quite possibly the most expensive oil expansion programme in history. Since the project is open-ended, its costs cannot be adequately quantified. One estimate of the total value of every single project considered for either replacing, expanding or initiating new oilfields, totals no less than $44,492 million in capital costs, with a further $60,067 million in non-capital costs. The US Embassy in Riyadh believes Saudi Aramco will spend $25 billion over the next 10 years. Saudi financial sources assert that Aramco will spend around $17 billion by the end of 1995 to raise capacity to 10 million barrels per day (mb/d).

However, sufficient projects have been unveiled, and detailed contracts awarded, for the programme for the next two or three years to be ascertained. In essence, there will be an initial focus on restoring capacity at Ghawar, the world's biggest oilfield, while new sources of light crude in the interior will be brought on stream and offshore oilfields producing Arab Medium will have their capacity increased.

The current oilfield expansion programme is focused primarily on three sectors: Ghawar and the related southern fields, the offshore fields in the north, and the Central Field development at Hawtah. The latter is not the most important but it is the most interesting. Three years ago, Saudi Aramco, responding to official suggestions that it start drilling outside its traditional Retained Area No 1, drilled a series of successful wells in an area of Nejd to the south of Riyadh. These disclosed substantial reserves of very high quality light (44°–49° API), low-sulphur crude of a kind Saudi Arabia did not previously produce. At a time when incremental Saudi exports have to come from the heavy end of the barrel, thus reducing their value, the knowledge that by 1996 Saudi Aramco could be producing an extra 170,000 b/d of extremely light crude is most welcome.

Hawtah is still being assessed but it could hold as much as 5 billion barrels in recoverable reserves. John Brown, in partnership with a UK-Saudi concern, King-Wilkinson, has the contract for supervising overall development of the field; in April two major contracts were awarded. ABB Lummus Crest is to build a $130 million gas/oil separation plant (GOSP) and Stone & Webster will build a $110 million stabilising plant. Output will be piped northwards to intersect the main east-west Petroline. The east-west pipeline is itself to have its capacity upgraded from 3.2mb/d to 5.0mb/d through provision of extra pumps at its existing pumping stations.

Two US companies have meanwhile been charged with overseeing expansion of existing fields. Ralph M Parsons is in charge of developing the southern region, notably the giant Ghawar oilfield. Initial efforts to increase production capacity have naturally been focused on Ghawar, where production capacity fell from a level of 6.0mb/d in the early 1980s to just 4.0mb/d by the end of 1990. With the completion of various projects later this summer, Southern Ghawar and nearby fields should be able to produce an extra 520,000b/d of 34 API° Arab Light. At Hawiyah, near the centre of the 150-mile long field, a new 300,000b/d gas/oil separation plant is being built, while two existing GOSPs are also being expanded. Further development is also being carried out at two other southern fields, Harmaliyah and Khurais.

Fluor Daniel is supervising development of the offshore Zuluf, Marjan and Safaniyah fields. The aim is to maintain rather than increase production of Safaniyah at the existing level of 1.5mb/d of Arab Heavy, whilst raising output at Zuluf and Marjan, which both produce Arab Medium. However, to the south of Safaniyah, the heavy crude producing field of Manifa is being upgraded, so that its capacity should rise from around 100,000b/d to 300,000b/d by 1995.

Two GOSPs, originally built in the 1980s but never commissioned, are currently being overhauled as part of a $300 million development programme for Marjan. Various onshore facilities previously constructed but not brought into service are also being brought on stream. At Zuluf a new $400 million handling facility is to be built, together with a $300 million improved gas compression plant. Overall capacity at Zuluf is likely to rise from 500,000b/d in 1991 to 900,000b/d in 1995, whilst Marjan's capacity should likewise increase from 100,000b/d to 400,000 b/d.

The northern onshore fields are not being neglected. Five new GOSPs were commissioned in 1990 and new onshore GOSPs inaugurated to serve the Khursaniyah, Qatif and Abu Hadriyah fields under a project supervised by ABB Lummus Crest. This work will continue with the aim of effecting an overall capacity increase of at least 100,000b/d by 1995.

Further expansion

While the Saudis are certainly studying longer-term possibilities that could take the production up to 12 million b/d or even 15 million b/d on a sustainable basis, financial considerations mean they will take no firm decision on pursuing the necessary projects for several years to come. For it is not just oil output expansion that needs to be financed but also the Kingdom's capacity to refine, process and export both crude oil and product. Samarec, the Kingdom's principal refining and

The Saudi-Yemeni dispute

In recent months Saudi Arabia has despatched at least two sets of letters to western oil companies in Yemen asserting that they are drilling in territories claimed by Saudi Arabia. It appears that the Saudis are moving to revive seriously a series of claims which, in effect, cover the northern half of the Hadhramaut and a substantial section of territory generally acknowledged to have belonged to the former state of North Yemen.

The Saudis underscored the seriousness of their claim by despatching the letters concerning American companies not to the companies concerned, but to the US State Department. The letters informed various US, UK, French and Canadian companies that their 'activity constitutes a trespass on the Kingdom of Saudi Arabia and that the Kingdom reserves its right to take what measures it sees fit to safeguard its rights.' In the second letter the Saudis took a line that was paradoxically both more conciliatory and more belligerent. The letter declared the companies had secured concessions in 'disputed lands between the Kingdom of Saudi Arabia and the Yemen Republic' — a comment acknowledging the issue is at least debatable, whilst yet asserting that the Kingdom 'considers this an intransigence and will take any necessary action to protect the sanctity of its borders.'

Only one stretch of the roughly 900-mile border between Saudi Arabia and Yemen has been formally agreed and demarcated. Most of the remainder of the border, from a Yemeni perspective, consists of lines laid down by the British colonial authorities on behalf of the Crown Colony at Aden and its various protectorates. Riyadh has never accepted these lines and in 1935 and 1955 proposed the border should lie much further to the south. For much of the disputed area, the fact that first Britain, and then South Yemen patrolled regularly up to the claimed lines would constitute a major element in any defence of the status quo by the Yemeni authorities. But in the northeastern sector, north of the Hadhramaut, patrolling by both Britain and the Yemenis was far more erratic. Of course, any Saudi presence in this area has also been highly erratic. At the most it means the territory is debatable. It does not mean it is Saudi. Saudi military maps acquired by the allies during the Kuwait crisis show a Saudi claim line extending south along the 17th parallel, effectively annexing a large swathe to the north of the Hadhramaut. The Saudi claim lines definitely cover the Block 11 concession, Sirr Hazir, awarded by Yemen to Elf Petroland, a Dutch subsidiary of Elf Aquitaine. It also covers Block 12, North Sanau, held by Ireland's Tullow Oil, the UAE's Bin Ham and the local Coplex. The Saudi claim lines also affect at least part of an onshore concession, Block 7, Barqa, awarded to BP and the Gibraltar based Furnet, which two companies also hold Block 8, Asakir. BP has also received a letter in connection with its offshore concession at Antufash, Block 23. The Yemenis here appear to be claiming that the northern limit of the Antufash concession is based on the equidistant median line favoured by the UN Law of the Sea Convention in assessing maritime boundaries. But while Yemen is a signatory to the Law of the Sea Convention, Saudi Arabia is not and would appear to be arguing for a simple maritime extension of the adjacent land boundary.

Although the dispute is commonly interpreted as being about oil, in essence, its main thrust is almost certainly political. There are more indigenous Yemenis than Saudis and they are committed to an essentially pluralist form of political and economic development. While President Saleh of Yemen officially espouses democracy, King Fahd argues that democracy is not suitable for the peninsula. The dispute thus has major implications for the region, although it is the western oil companies in Yemen that are likely to suffer initially.

BP has already announced that it is opting out of an active role in Yemeni oil development in favour of Amoco. Although this move almost certainly relates to BP's policy of consolidating in key areas and pulling out of many peripheral projects, its actions have nonetheless caused considerable concern in Yemeni government circles.

The Yemeni government has said it favours a comprehensive settlement of the border issue, while Saudi Arabia's attitude appears to be to make indirect claims while letting the issue remain open. The Yemenis are sufficiently nervous about the whole issue that they say they cannot make any kind of decision on where the borders should be in advance of elections planned for this autumn. The feeling is that no government, but only an elected parliament, can take such a momentous decision, particularly since it would involve final confirmation of a 1934 treaty between Saudi Arabia and the former Imamate of Yemen under which three provinces ruled by Yemen in the 17th century were formally ceded.

The difficulty of ascertaining even the claim lines of the various sides is epitomised by the question of whether there is, in the heart of the disputed territory, a patch of land currently and formally unclaimed by either Saudi Arabia or Yemen. British officials who drew up various claim lines of relevance to the dispute, argue that there is no unclaimed territory. However, it would appear that in rejecting certain British proposals and in basing their own claims on more precise lines now than they did in the past, such a parcel of territory does exist in an area some 40–50 miles to the northwest of Yemen's Shabwa oilfield.

marketing organisation, and Sabic, which runs most of its petrochemical plants, often in joint venture with foreign companies, are expected to spend at least $8 billion in the next four or five years.

Samarec has already appointed Foster-Wheeler to be project manager for a major programme which aims initially to upgrade the refineries at Yanbu, Riyadh and Jeddah. Yanbu is to be debottlenecked so that effective capacity rises from 170,000b/d to 240,000b/d, while a 90,000b/d methyl tertiary butyl ether (MTBE) unit is to be added. Capacity at Riyadh is to rise from 135,000b/d to 150,000b/d. All three refineries are run by Samarec and

there is a separate programme for overhauling the giant Saudi Aramco refinery at Ras Tanura. Last year Brown and Root was given a six-year contract to upgrade and overhaul the complex, which has a nominal capacity of 530,000b/d but which has been operating at around 300,000b/d following a fire during the Kuwait crisis.

The Kingdom is also studying proposals for a string of new joint venture refineries with Japan, and for extensive storage facilities with Korea. It is also buying up storage facilities in the Caribbean in pursuit of its policy to be able to take swift advantage of upturns in US demand.

Resources

The resource base for such development is certainly there. The Kingdom's oil reserves are officially estimated at 260 billion barrels and both local and western analysts consider this may well be a gross under-estimate with the true level of reserves possibly being as high as 400 billion barrels. Although the Kingdom is almost certainly right in arguing that there will be a market in the mid- to late-1990s for increased volumes of Saudi crude, there are still considerable doubts over how the expansion programmes for both the production and refining sectors are to be financed.

Saudi officials have firmly rejected ideas put forward by the former Saudi Oil Minister, Sheikh Ahmed Zaki Yamani, that a new accommodation should be reached between producer nations, consumer nations and international oil companies which would enable oil multinationals to invest directly in such expansion programmes as Saudi Arabia's. It was partly in order to stress that Saudi oil would be produced entirely by Saudi concerns (with the exception of the former Neutral Zone in the north), that the Kingdom let it be known last autumn that Saudi Aramco would not borrow to finance expansion plans. The Saudi comments came after extensive talks between Saudi Aramco and JP Morgan which, earlier in the year, had raised the Kingdom's first modern sovereign loan, for $4.5 billion.

Financial realities quickly showed that the Kingdom could not afford such a policy. So far this year, Saudi Aramco has raised $2 billion to finance its expansion programme and a further $900 million to help purchase tankers. Saudi sources are already saying that Aramco will likely borrow a further $2 billion to finance purchase of more tankers for its Vela subsidiary.

'The Kingdom is proud to be the world's oil supplier of last resort'

Further borrowing is to be expected because of the continuing strain on government finances caused by the Kuwait crisis. In brief, by the end of 1992, the government is likely to have paid out close to $60 billion in crisis-related costs. Of course, much of this has been covered by increased revenues stemming from both increased oil output and generally higher oil prices than those prevailing between 1986 and August 1990.

But although the government can reasonably expect to secure oil export earnings in the region of $43–44 billion this year, and a similar level next year, in comparison to pre-crisis oil export earnings of around $20–24 billion, the net gain is not nearly as great as it first seems. There are loans to be repaid; there will be reduced income as a result of the liquidation of external assets and the consequences of modest inflation. In reality, the Kingdom should benefit by about $10 billion a year from the Kuwait crisis, but with much of this going on defence and with a considerable need to dispense largesse following the traumas of the 1980s, the government will not have the extra income necessary to finance all the expansion plans of Saudi Aramco, Samarec and Sabic single-handed. Indeed, under IMF tutelage it may well encourage privatisation of key sectors of Sabic in order to raise funds for other government spending.

Its programmes to increase oil output capacity, refining throughput and internal and overseas storage will all put pressure on its finances. Moreover, whereas in the past it sometimes turned to the giant state-owned corporations, notably Saudi Aramco, for extra funds to help cover budget shortfalls, it will now have to help these corporations to fund their expansion projects.

The Kingdom is proud to be the world's oil supplier of last resort and its expansion programme means it will be able to retain such a role for the rest of the decade. But the world will also have to help pay for the Kingdom to retain this role, in the form of loans to fund oilfield development, while it will also have to contribute investment capital for the various downstream ventures designed to enable the Kingdom to maximise the value of its oil production. ■

John Roberts has just completed an extensive business report on Saudi Arabia which is available from Business Monitor International, London.

Optimised gasoline blending at Lindsey oil refinery

By J White, Process Control Manager, Lindsey Oil Refinery and
HVD Kemp, Senior Systems Engineer, Foxboro (Netherlands) Ltd

Lindsey Oil Refinery Limited (LOR), located in South Humberside, England, has recently installed and successfully commissioned a major upgrade to its gasoline blending facilities. Replacement of a conventional blending system has been enhanced by the installation of Foxboro's Blend Optimisation and Supervisory System (BOSS), implemented with an Intelligent Automation (I/A) Series system. This article gives an impression of the blending system, project execution, advantages and financial justification of the blend optimisation and an indication of the initial results and experience gained in the first six months of operation.

Lindsey Oil Refinery Ltd is jointly owned by Fina plc and Total Oil (Great Britain) Ltd. The modernisation of its gasoline blending facilities is part of the Offsites Modernisation Project (OMP), which was started in the late 1980s. Optimisation of the gasoline and gasoil blending are expected to provide the credits to finance the complete project, which also includes an upgrade of the tank gauging system, automation of rail load facilities and movement monitoring

Gasoline blending facilities

In order to be able to apply blend optimisation techniques, a number of subsystems have to be integrated. These are described below:

- **Intelligent automation system**
  The I/A system is a DCS (Distributed Control System) which provides an interface between the operators and the field equipment. It consists of processing modules connected via a nodebus. Control functions are executed in Control Processors (CP) which interface to the field equipment. The operator interface is provided by Workstation Processors (WP). These drive CRTs equipped with keyboards and a trackball. The I/A system includes the capability of running software packages in Application Processors (AP). For LOR two nodes are connected via a LAN. Installation of the BOSS package within the DCS system (rather than within a host computer) guarantees a high reliability and availability of the optimisation software.
- **Digital blender**
  The digital blender is a modern replacement of the old panel mounted blender. It provides ratio and batch size control of blends using standard control software and displays resident in the I/A system.
- **Blend optimisation and supervisory system**
  The Blend Optimisation and Supervisory System (BOSS) is a sophisticated software package capable of controlling and optimising blends by manipulating the setpoints of the digital blender making use of on-line analyser measurements.
- **Tank inventory system**
  The Tank Inventory System (TIS) collects tank levels and temperatures from a Whessoe tank gauging system. TIS provides component availabilities used by BOSS in its optimised blend calculations. Other inventory related data, like net tonnes, are also calculated. Temperatures are used for temperature compensation of blend flows.
- **Refinery information system**
  The I/A System is connected to the refinery network to allow for exchange of tank inventory, quality data and process rundown flows (used for component availability calculations).
- **On-line analysers**
  On-line analysers are used for Research Octane (RON), Motor Octane (MON), Reid vapour pressure (RVP) and several distillation points. BOSS employs validation techniques before using any measurements for quality integration and feedback control.
- **Fast sample loop**
  The fast sample loop consists of a pump, piping and valves to provide the on-line analysers with a representative sample of the blended product. Manipulation of the fast sample loop is controlled by the BOSS package.

Project history

In June 1989 LOR awarded Foxboro, a Siebe company, the contract for the optimisation of the gasoline blending at LOR. After an intensive process study and specification phase of approximately three months, the optimal way of applying the BOSS package was jointly determined.

Prior to the start of commissioning in August 1990 operator training was carried out using the 'training mode' of the BOSS package on simulation equipment. The operators found that the system was very user friendly; throughout the setting up and operation of an optimised blend, appropriate guidance and advice messages were given by the system. The quality of training proved to be a key element in the successful introduction of the package. Commissioning of the digital

blender took place on schedule 12 months after contract award. The old blender was disconnected from the existing field equipment and the I/A system connected to it over a three-day period. Blending was then resumed using the I/A system digital blender. Six weeks later, optimised blending was the norm.

The BOSS package

Obviously the goal of blending is to make saleable products out of the component streams produced by the process units and any imported components. Making saleable products means respecting product quality specifications. To operate successfully, pump capacities, flow meter ranges and short-term component availability constraints must be obeyed, whilst long-term optimal overall plant schedules have to be taken into account. This multiple constraint problem is solved by the BOSS package using linear programming (LP) techniques which are extremely suitable for solving multi-variable constraint control problems in the most economic way. Controlling qualities against their target constraints (ie for the qualities for which the giveaway is minimised) is a natural outcome of the LP's drive to maximise profit.

The most recent process information on qualities and availabilities is used for the calculations. This ensures that conflicts with the refinery schedule, due to the inherent stochastic nature of refinery operations, are recognised in advance. For this purpose the strategy includes facilities for the blend operator to override limits set by the refinery schedule. The system will provide clues to the operator that guide him towards a feasible solution.

The blend model is updated using on-line analyser measurements. As a result blend predictions will be more accurate whilst a blend proceeds. During the blend the quality of the finished product tank is integrated, using on-line analyser measurements, normally at a higher frequency than the optimisation frequency. Regularly the blend recipe is recalculated by an on-line LP to control the integrated quality of the blend to specification, in the cheapest way possible. The optimisation frequency can be fixed (eg 8 minutes) or be synchronised to the slowest analyser (at LOR).

Other approaches that 'trim' the initial start recipe using (multi-) analyser trim techniques do not guarantee that the recipe is adapted in the most economically attractive manner at any time during a blend.

In order to minimise the gap between the scheduling department and the operators it is very important that both the off-line optimiser/scheduling package and the on-line optimiser use exactly the same calculation methods and both use actual data.

The key characteristic of the BOSS package is the ability to control *all* relevant qualities simultaneously. As a result the quality giveaways that are most expensive are minimised, whenever sufficient degrees of freedom are available. This is the case when the available pool of components allows for minimising giveaways and equipment or availability constraints do not prevent the objectives to be reached. At all times the BOSS package will control a blend in the cheapest way.

Filtering of the analyser measurements before using them for feedback control and the manner of product quality integration results in very stable control.

Accuracy

The accuracy of the integrated qualities based upon on-line analysers can best be judged by comparing the predicted tank qualities with the qualities measured in the laboratory. The difference between laboratory and predicted tank qualities should be compared to the reproducibility of the analysis method. The reproducibility compares results obtained by different operators, using different equipment on the same sample. It is determined statistically with a 95 percent confidence limit. In the table below the results found during the first six months of operation for the key qualities are listed; comparing laboratory results for tank samples (T) with predicted results from on-line analyser (A):

John White of Lindsey Oil Refinery

distribution of the absolute differences conforms to the statistical prediction. Approximately 95 percent are within the reproducibility, even though based on different samples. The results presented include all blends performed with the BOSS package. Excluding the blends for which the analyser availability was not 100 percent, or blends with incorrect heel qualities, would give even better results.

Conclusion

The most important reason for installing the system was economic. Return of investment for blending optimisers is normally expected of product quality giveaway reduction, particularly octane and vapour pressure. For the latter the related vapour lock index (VLI) is the specification of importance at LOR.

However, considering octane prior to the installation of the system it was always LOR's policy to avoid octane giveaways of greater than 0.1 MON. This was always achievable given enough reblend time and tank ullage. Therefore there was no major economic advantage, at least not at LOR, from installing a system to reduce octane giveaway.

Quality Controlled	Reproducibility of Test Method	Average (1) T-A	Average (2) T-A
RON	0.7	0.06	0.31
MON	1.0	−0·04	0.25
RVP (Bar)	0.05	−0.007	0.026
VLI	0.06	−0.007	0.026

Average (1) indicates the average difference between the on-line and laboratory methods. Average (2) is the average absolute difference, regardless of sign, and is indicative of the range of difference between the two techniques.

Generally the average predicted tank qualities are in agreement with the laboratory results. Only for RVP and VLI a small offset is measured due to the inevitable loss of light components. The average absolute differences between laboratory and predicted qualities are well within reproducibility of the analysis method. The

With respect to vapour pressure, a significant reduction in VLI giveaway has been achieved during the first four months of operation with BOSS, ie when the price of butane was favourable, the average butane content in a blend was increased by over one percent.

Even if no giveaway reduction was being achieved, a major economic benefit from the system, for which a financial return can easily be calculated, has been revealed at LOR by a detailed analysis of blend composition before and after installation.

This showed for a given octane giveaway, that there is a marked difference in blend composition for those blends produced by the BOSS system. Although it may be obvious that it should be the case, when using an LP based optimiser, practical results have shown this to be so blend after blend. There is significantly higher percentage utilisation of cheap components, such as cat cracked spirits (CCSs) and corresponding reductions in the use of expensive components such as reformate. This CSS/reformate swing alone provides a one and a half year payback. (This is for an investment which provides other than just optimised blending, eg tank gauging functions). For those refiners who are not able, because of time constraints for example, to guarantee 0.1 octane giveaway, using traditional methods, installation of the BOSS package will produce a much bigger benefit, since with BOSS 0.1 giveaway is generally achieved *without* reblending.

Assuming that during 50 percent of a year the price of butane is between 50 and 60 percent of the finished gasoline price, the payback time reduces to well below one year.

The reduction in reblends — down to better than one in ten, compared with one in two, prior to BOSS installation — has other spin-offs. The risk of running out of product or not being able to meet an export cargo are much reduced when blends are on specification first time. Less reblends also means that less inside and outside operator effort and laboratory testing are required. Laboratory testing was further reduced within six months of commissioning when enough confidence in the system had been obtained to issue product certificates of quality based on the results from the on-line analysers and related quality integration software. This was done at a time when LOR was preparing procedures in preparation for application for registration to the British Standard for Quality Systems: BS 5750, Part 2 (equivalent to ISO 9002, EN 29002 and NATO standard AQAP-4).

Against the reductions in workload resulting from this system, it should be borne in mind that additional on-line analyser maintenance is required as a result of installing the system and effort is needed to maintain the system itself. However, the requirement for system maintenance has proved to be minimal; it is proving to be very reliable and the software is robust and requires little attention. The benefits from optimised blending are much more easily won, compared with for example, advanced controls or process unit optimisation. Both these generally require significant continual specialist support to maintain financial benefits. This is not the case with blending optimisation.

The reduction in reblends and the realisation that any required tend to need much less tank correction space has allowed LOR to increase the stop level in each product tank. This has provided the equivalent of a new tank at zero cost! ■

Automotive diesel fuel: the balance between cost-effectiveness and environmental acceptability

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Supply and demand scenarios to the year 2010 suggest that transportation fuels will continue to rise as a proportion of total world oil demand.

Diesel fuel forms a significant part of today's oil demand, but it must compete with other oil products for the available crude. Namely, oil needed for:

- Other gas oils, such as heating oil;
- Aviation fuels or kerosenes, consuming the 'lighter' hydrocarbons;
- Gasolines, of which the heavier hydrocarbons could find an alternative use in gas oils or aviation fuels/kerosenes;
- Upgrading feedstocks in cracking plants, converting the 'heavier' hydrocarbons into smaller, lighter molecules.

These hydrocarbons originate from either the distillation of crude oil, known as 'straight-run' components, or from cracking plants that upgrade surplus heavy hydrocarbons — such as residual fuel — into gas oils, kerosenes and gasolines.

An imbalance is expected between the type of crude oil available and the products needed. Balancing these factors will be a considerable challenge for those involved in the manufacture and supply of fuels.

There is a need for substantial investment in refineries, not only so that conversion plants can alter the structure of the hydrocarbons to meet demand, but also for plants seeking quality improvements in oil products, notably for diesel fuel. In this article we concentrate on the aspects of diesel fuel quality which relate to its environmental performance. In particular the impact of diesel exhaust emissions on local and global air quality.

In principle, the manufacturing technologies needed to meet future oil product demand, in terms of both quantity and quality, are already available and include new technologies to reduce the sulphur content and/or aromatics content of gas oils by hydrogenation. However, their commercial viability in the absence of tax incentives has not yet been established.

This article considers these trends in demand and supply in more detail and describes our current views regarding the influence of diesel fuel quality on exhaust emissions, especially particulates. The development and application of exhaust gas treatment devices (catalysts) for diesel vehicles is also considered as an alternative, more cost-effective, way of controlling diesel engine emissions than major changes in fuel composition.

Whatever route is chosen we consider it essential that the diesel engine retains its position as one of the most efficient and 'clean' modes of road transport.

Demand trends

About 85 percent of the oil we use today is converted into energy. During conversion, water and carbon dioxide (CO_2) are formed. The carbon dioxide raises particular concerns in relation to global warming. Also, conversion into diesel motive power gives rise to emissions of nitrogen oxides (NO_x), sulphur dioxide (SO_2), hydrocarbons (HC) and particulates. NO_x and HC contribute to photochemical smog, whilst SO_2 contributes to acid rain. Particulate emissions are believed to be a health hazard, although the evidence is often conflicting.

Among the many elements in the evolving market for oil products, the environmental factors are of growing importance. Both the demand for energy and oil and the energy mix are determined by a complex set of factors. Energy demand is governed by demographic factors, by the level of economic activity and by available technologies. The energy mix, by contrast, is often influenced by the availability of indigenous supplies and by government policies.

Within those constraints, oil will continue to compete with other fuels in the domestic, industrial and power generating sectors. In the transport sector it is under pressure in areas with severe air pollution. However, there are long lead times to investment in large scale substitution of oil for transport.

Automotive diesel fuel demand has been growing strongly in most regions in recent years (**figure 1**), and its share in the transportation market has grown substantially due to the stimulus of economic activity and dieselisation of the passenger fleet. Although, as **figure 1** shows, this dieselisation varies considerably from area to area.

Several key factors influence medium term demand for diesel fuels in the transportation sector. Local taxation on both new vehicles and the fuel itself primarily influences passenger car diesel fuel demand but in the comercial road transport (CRT) sector the better fuel economy, lower maintenance costs and longer life of diesel powered vehicles mean that gasoline is unlikely to compete with diesel fuel. Furthermore demand in the CRT sector is fairly insensitive to diesel fuel price, although demand is sensitive to economic growth. In addition the current environmental debate could have an influence on the market penetration of diesel fuelled vehicles depending on whether the diesel vehicle is perceived to be 'green' and whether its undoubted lower impact on enhanced global warming is endorsed by governments through the introduction of favoured vehicle purchase tax, fuel tax incentives or other means.

The above considerations have been taken into account in predicting diesel fuel demand over the next five years (see **figure 1**). The projected increase in demand is particularly apparent for the Less Developed Countries (LDCs) where economic growth is the dominant factor. In Europe demand for diesel fuel is expected to be stimulated by economic liberalisation in the East.

In the longer term transportation fuels are expected to account for an increasingly large proportion of oil demand. In the case of road transport, the importance of the CRT segment will increase substantially, with diesel fuel usage increasing at the expense of gasoline. This is because fuel demand for CRT is GDP driven and the diesel fuel/engine combination is the most cost-effective approach.

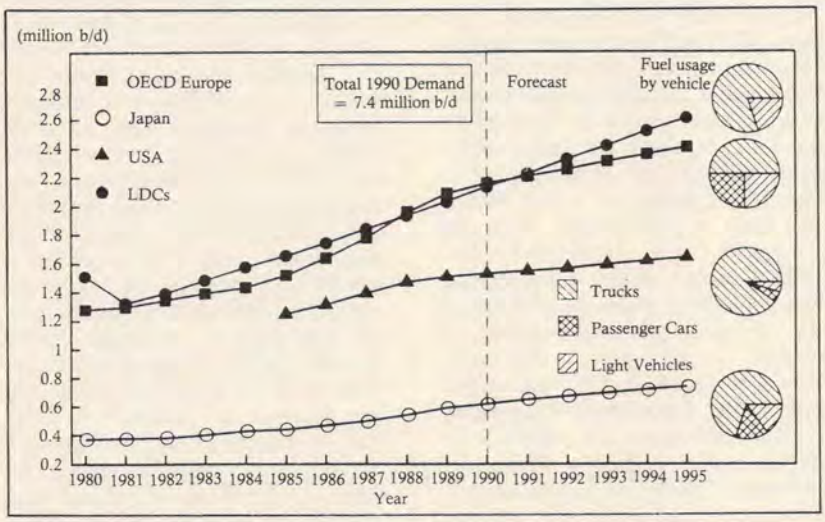

Figure 1: Forecast diesel fuel demand and usage in main areas

Supply considerations

The developments that influence demand for oil differ from region to region. European oil requirements are expected to remain more or less constant, with a further reduction in industrial fuel oil demand. Within Europe, there are considerable differences in the relative demands for gasolines and gas oils. To complicate matters further, the ratio of diesel fuel to heating oil within the total gas oil pool also varies considerably from country to country. The hydrocarbon supply and the appropriate technology, needed to match differences in supply and demand is available. The problem is getting the technology operational within the right time scales.

To obtain a reasonable balance between gas oil and gasoline demands would be an advantage. A relatively high gasoline demand, as found in the United States, favours catalytic cracking as an upgrading/conversion process. This results in high proportions of low-quality cycle oils in the gas oil pool. Alternatively, a relatively high demand for gas oil favours the hydrocracking process and yields better quality gas oil components but the gasoline components obtained by this route are of low octane quality. Increasing demand for jet fuel will also pose a problem for the refiner. Cold flow properties of diesel fuel and higher volatility requirements will be difficult to meet if the lighter boiling range fractions are unavailable.

These imbalances in product demand, and choice between manufacturing routes, will have to be optimised in each supply envelope, and are one of the reasons why diesel fuel quality varies from region to region. In addition the quality of crude oil has a major impact on diesel fuel quality. North West Europe has enjoyed the advantage of North Sea crude oils, which produce gas oils low in sulphur and with good cetane and density characteristics. However, current expectations suggest that the proportion of high-sulphur Middle East crude oils used in Europe will increase. This would have a significant impact on the facilities for upgrading residues and gas oil hydrotreating.

Synthetic gas oils, such as those produced from the Shell Middle Distillate Synthesis process, are not expected to have a major quantitative impact on the supply position. They could feature, however, in high-quality products for premium diesel engines if such engines are shown to benefit cost-

effectively from a high quality fuel. As synthetic fuels may be produced close to gas fields, such as in Malaysia, the Middle East and North Africa, any European demand is expected to be satisfied by importation.

For the 1990s, trends in supply and demand, together with an increased focus on the environment, will continue to stretch the refining industry. Future products must not only satisfy demand and quality requirements, but investment will be needed to satisfy environmental performance.

Exhaust emissions and diesel fuel quality

The compression ignition engine has an excellent reputation for reliability, long life and low maintenance cost. These factors, together with the favourable pricing structure for automotive diesel fuel compared to gasoline in many countries, have made diesel engined vehicles the first choice for the movement of goods by road. In addition diesel engined passenger cars and light trucks have, with the notable exception of North America, become increasingly popular with private owners and fleet operators.

Over the years the diesel engines used in the above vehicles have become increasingly more sophisticated, nevertheless they have retained their reputation for reliability and in addition have shown themselves relatively tolerant of variations in diesel fuel quality providing that a certain minimum fuel quality level is used.

Traditionally minimum diesel fuel quality has been defined in terms of cetane number, distillation range, density range and low temperature properties. In this article we consider the impact of diesel fuel quality on the latest challenge facing the diesel engine manufacturer, exhaust emissions control.

Historically exhaust emissions came under scrutiny because of concerns over poor local air quality such as smog formation and high local carbon monoxide concentrations. This led to the control of CO, NO_x and gaseous HC emissions from both diesel and gasoline engined vehicles and exhaust smoke from diesel engine vehicles. More recently further local air quality concerns have led some countries to regulate the emission of particulate matter.

All of the exhaust emissions described above have an impact on *local* air quality but concerns about enhanced *global* warming have also led to calls, and in some cases government commitments, to reduce emissions of one of the major constituents of all vehicle exhaust gases, carbon dioxide.

Before considering the role that diesel fuel quality can play in influencing emissions from diesel engines it is worth remembering that the diesel engine has many advantages over the gasoline engine in terms of its impact on both local and global air quality.[1] For example emissions of CO, NO_x, and HC from diesel engines are up to 95 percent less than those from gasoline engines of similar performance (exhaust catalysts are required before gasoline engine emissions match those of the diesel engine). In addition CO_2 emissions from diesels are up to 25 percent less than those from their gasoline counterparts.

However, the diesel engine does have one major drawback compared to the gasoline engine: particulate emissions.

The main reason for wishing to control particulate emissions is the concern over their impact on local air quality and thus public health and in particular the possible carcinogenic nature of certain particulate species. Excessive particulate emissions are apparent as black smoke from diesel engine exhausts but in modern well-maintained vehicles particulate emissions are better controlled and are usually invisible (gasoline engines emit very low levels of particulate). Nevertheless there is still concern that even at low levels, particulate emission can be damaging to health and hence stringent legislation to control exhaust particulate emissions from both light and heavy duty diesel engines has been or will be introduced.

Particulate composition varies considerably from engine to engine but is made up of several basic components. 'Dry' carbonaceous soot, a fuel and lubricant derived soluble organic fraction (SOF) and an inorganic fraction made up of ash and sulphate and bound water. (A fixed amount of bound water is associated with the sulphate particulate). Total particulate emissions and the ratio of the main constituents depends on many factors including engine design, operating conditions, oil consumption etc. Indeed engine design and operating conditions have the major influence on the amount and composition of exhaust particulate emissions. However, recent studies have shown that, as the overall diesel engine particulate emissions are reduced by improvements in engine design, the influence of diesel fuel quality on total particulate emissions may become greater in percentage terms.

This observation has led to increasing pressure on the oil industry from diesel engine manufacturers and government bodies to improve diesel fuel quality. Improvements in a wide variety of diesel fuel properties have been called for including narrower distillation and density ranges and lower aromatics and sulphur levels. Below we have used the results of our own exhaust particulate emissions studies to consider the technical merits for an improvement of each of the fuel properties in turn.

The impact of diesel fuel quality on gaseous exhaust emissions is not discussed in this article because, with the exception of NO_x, the modern diesel engine has no major difficulty in meeting the required levels. Several authors have shown that variations in diesel fuel composition (eg ignition quality) can influence NO_x emissions but this topic is outside the scope of this article.

In recent years much has been written on the influence of diesel fuel quality and individual fuel properties on particulate emissions. However, in our view some of the data may have been misinterpreted because of the inter-correlation of diesel fuel properties. For example a reduction in particulate emissions ascribed to a reduction in aromatics content could equally well have been ascribed to a reduction in fuel density or an increase in cetane number. Further details on the importance of designing a fuel matrix to break these inter-correlations are described elsewhere.[2]

Our own findings from experiments carried out in a variety of vehicles using sets of fuels designed to avoid these pitfalls are described below.

Sulphur content

The contribution of sulphur to particulate emissions has been extensively investigated in the United States and in Europe, and there seems little doubt that sulphate and bound water particulate is a problem once stringent emissions standards (eg US 1994 limits) are introduced. Our studies have shown that the percentage of fuel sulphur emitted as sulphate particulate is independent of fuel sulphur concentration and chemical structure and is largely independent of engine type and operating conditions. We have termed this percentage the 'sulphate conversion factor (SCF).' Typical SCF values range from 1 to 2 percent (the remaining sulphur is emitted as SO_2). Therefore as the total particulate emissions of the engine are reduced by design changes the percentage contribution of the sulphate and bound water particulate fraction will increase,

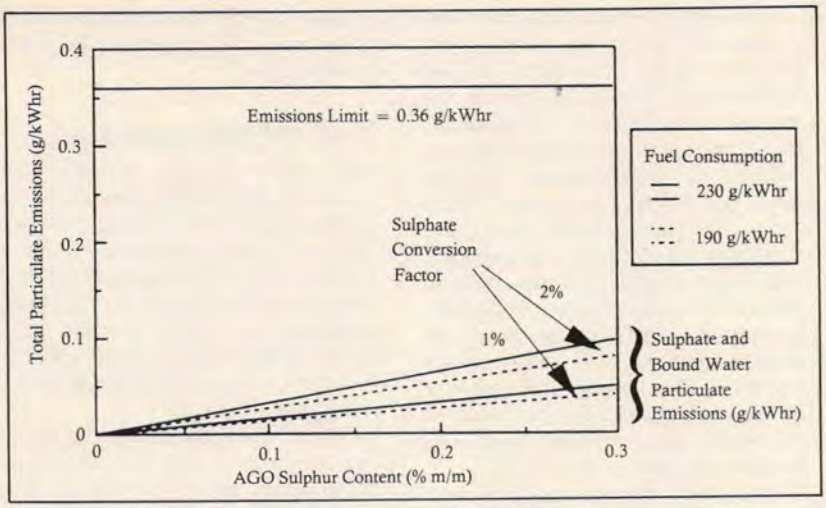

Figure 2: Calculated contribution of AGO sulphur content to particulate emissions from heavy duty engines

since it is only dependent on the amount of diesel fuel sulphur burnt in the engine.

Thus an engine running over the ECE 49 test cycle for heavy duty vehicles, burning a 0.3 percent m/m sulphur diesel fuel, with an SCF of 1.5 percent and a fuel consumption of 210g/kWhr, produces 0.067g/kWhr of sulphate and bound water particulate which is just less than 20 percent of the level allowed by the proposed 1992 European emissions limits for heavy duty vehicles (0.36g/kWhr). In contrast a 0.05 percent m/m sulphur diesel fuel is calculated to produce only about 0.011g/kWhr of sulphate and bound water particulates or about 3 percent of the proposed particulate emission limit, **figure 2.** Thus it could be argued that switching to a diesel fuel with a low (0.05 percent m/m) sulphur content in an engine that exceeded the emissions requirement by 15 percent when using a 0.3 percent m/m sulphur diesel fuel could enable that engine to meet the emissions requirement.

Similarly light duty diesel engine vehicles, designed to meet the 0.14g/km particulate limit for the combined ECE 15 plus EUDC driving cycle, would typically exhibit a 9 percent reduction in total particulates when sulphur is reduced from 0.3 to 0.05 percent m/m.

Therefore we conclude that a reduction in fuel sulphur to 0.05 percent m/m will assist engine designers in the most stringent future emissions standards. It would also reduce street-level SO_2 emissions if applied to the whole vehicle fleet. In addition the high cost of sulphur removal in terms of investment, lost volume and CO_2 emissions, discussed in the next section of this article, must be taken into consideration before deciding to reduce fuel sulphur levels.

Density

Density is an important fuel characteristic in the emissions debate. Traditionally it is the fuel density range that has concerned OEMs. However, our more recent work has shown that in the US transient emissions test (and to a lesser extent the European 13 mode steady state test) for heavy duty vehicles, the actual fuel density as well as its range has an important influence on total particulate emissions.

Indeed a re-investigation of the literature has shown that many of the papers which ascribe a reduction in total particulate emissions to a reduction in fuel aromatics content could more consistently ascribe this change to a lowering of fuel density.

The details of this work will be described in a forthcoming SAE paper but in essence the correlation of particulate emissions with density appears to arise because, during rapid changes in engine operating conditions, the engine is subject to momentary over-fuelling. The higher the diesel fuel density the greater the over-fuelling and hence emission of particulates. We have found that reducing diesel fuel density from 845kg/m^3 to 835kg/m^3 can reduce exhaust particulates from 'clean heavy duty engines' by up to 0.01g/bhphr or 10 percent of the US 1994 emissions limit for heavy duty enginers tested over the US federal transient test cycle. In light duty engines we have not observed a major influence of density on particulate emissions because the fuel injection system is designed differently and the engine rarely operates at 'full-rack' during the test cycle.

Whilst variations in fuel density can influence particulate emissions from current engine technology, it is conceivable that future fuel injection systems could be designed to minimise over-fuelling hence reduce the influence of fuel density on particulate emissions.

Cetane number

Many workers have shown that ignition quality, as measured by cetane number, influences the formation of both gaseous and particulate emissions — higher cetane numbers giving lower emissions. Our work on light duty vehicles tested over both the US and European emissions test cycles has confirmed this observation. Whilst the reduction in particulate emissions vary from vehicle to vehicle, typically we found that increasing cetane number from 49 to 52 can reduce particulate emissions by up to 0.01g/km or 10 percent of the future emissions standards.

However our studies in heavy duty engines operating under transient and steady state conditions have shown that an increase in cetane does not necessarily lead to a reduction in particulate emissions, probably because any influence of cetane number on particulate emissions is masked by the density effect described above.

The costs of improving ignition quality are discussed elsewhere in this article. It would, however, be appropriate to mention here some of the implications of high cetane number. Such fuels are, by their very nature, paraffinic. This means that they exhibit relatively high cloud points and may be problematic in terms of cold weather operability. In addition, many cetane rich paraffinic crudes are high in sulphur content and will require more severe hydro-treatment if they are to meet either current or predicted sulphur limits.

Distillation range

Other papers have suggested that back-end volatility influences particulate emissions. However, it is often impossible to determine which part of the boiling range influences a specific emission, simply because volatility characteristics are probably the most inter-correlated of all the fuel properties.

Our recent work in light duty vehicles supports this view and suggests that several parts of the boiling range may have a small influence on particulate emissions. Further work is

required before a definitive view on how volatility influences particulate emissions can be established. In our heavy duty engine studies there are indications that high end point fuels may give high SOF particulate emissions but further work is required to quantify this observation.

Aromatics

When discussing the influence of 'aromatics content' on diesel engine emissions it is important to understand exactly what is meant by the term 'aromatics' when applied to diesel fuel. Our own views on this issue are described elsewhere,[2] where we conclude that simply referring to a fuel's 'aromatic content' is an inadequate description of its chemical composition.

In heavy duty engines our results regarding the influence of diesel fuel on particulate emissions can be explained by a combination of sulphur and density effects without needing to include an 'aromatics term'. Indeed many of the heavy duty engine studies which purport to shown an aromatics effect could equally well be explained by density changes (see above). In light duty vehicles some very recent Shell research work indicates that a reduction in diesel fuel polyaromatic content may bring about a greater reduction in particulate emissions than would be expected from the small resultant increase in cetane number. However, further work in a wider range of vehicles is required to quantify this observation.

To sum up, work in this area must continue to establish whether 'aromatics' really do influence emissions, but to specify fuel compositional changes without a greater understanding of how 'aromatics' composition is related to emissions performance would be premature.

Exhaust catalysts

Finally in this section we should perhaps say a little on exhaust after-treatment devices. A number of motor manufacturers have stated that in order to meet the most stringent exhaust emissions limits they will need to use exhaust after-treatment devices. At the moment the most popular choice seems to be oxidation catalysts which can decrease CO, HC, and SOF particulate emissions. However catalysts have no influence on carbonaceous particulate emissions and in addition can increase the emissions of sulphate and bound water particulate emissions through further oxidation of SO_2 to SO_3.

This observation has led to increased pressure for low sulphur diesel fuels. However in our view diesel catalyst technology is still in its infancy and catalyst manufacturers are optimistic that improved, more sulphur tolerant, catalysts can be developed. We also note the views of some North American manufacturers who have stated that a 0.05 percent m/m sulphur fuel is low enough to enable them to make effective use of exhaust catalysts. In short we consider that the use of exhaust catalysts adds weight to the argument that diesel fuel sulphur should be reduced to 0.05 percent m/m maximum but as yet there is no justification for lower sulphur levels.

The use of exhaust catalysts may also have implications for other diesel fuel properties. We have described aboe that a number of diesel fuel properties can influence total particulate emissions. However all these studies were carried out on vehicles without after-treatment devices and it could well be that the fitting of exhaust catalysts could reduce the impact of fuel quality on exhaust emissions. Clearly further urgent work in this area is required because if exhaust catalysts do reduce the impact of fuel quality on particulate emissions a good deal of costly refinery investment could be avoided.

To conclude this section it would be appropriate to reiterate a few comments:

As engines become 'cleaner' the influence of fuel properties on emissions performance may become more significant.

Our own work has shown that for heavy duty engines, the observed response of diesel engine particulate emissions to changes in fuel quality can be ascribed to variations in diesel fuel sulphur content and density. For any engine designed to produce very low particulate emissions (eg meeting US 1994 limits), fuel quality variations (other than sulphur content) can influence particulate emissions performance by as much as 10 percent.

For light duty vehicles, clear influences of diesel fuel cetane number and sulphur content have been established. However further light duty vehicle testing is required to quantify the possible influence of diesel fuel distillation range and polyaromatic content on particulate emissions.

Despite the above observations it should be remembered that the evolution of diesel engine design concepts have had a much greater influence on diesel engine emissions than changes in fuel properties. In short, advances in engine and catalyst technology will continue to offer the best opportunity for emissions improvement for some time to come.

The refinery challenge

The above results suggest that demands for higher-quality diesel fuel in terms of, for example, sulphur content and cetane number are likely to increase. At the same time, supply and demand developments are exerting downward pressures on the future quality of the refinery's diesel fuel pool. So what are the refining options to meet this quality challenge?

So far, the reduction in European sulphur levels to 0.2 and 0.3 percent m/m has been met by use of spare hydrodesulphurisation (HDS) capacity and by switching to higher proportions of low sulphur crudes. However, these options will not suffice if sulphur content is to be reduced further. Additional HDS capacity will be required. New units will have to be of at least 60 bar reactor pressure because of the necessity to desulphurise deeper. The approximate manufacturing costs of meeting a reduced limit of 0.05 percent m/m have been calculated by various parties and are shown in **Table 1** (from[2]).

	U.S.A.	Canada	EC-12
Capital costs (Million $)	3000	820	4300
Unit costs ($ per tonne of diesel)	17	25	18

Table 1: Desulphurisation costs for diesel fuel

In the case of the EC-12, the additional HDS capacity required will be approximately 30 to 46 million tonnes a year, depending on diesel demand and availability of low sulphur crude. This is equivalent to some 81 new HDS units of 1000 and 2000 tonnes per calendar day capacity.

The additional energy required for desulphurisation should also be considered because energy consumption equates to CO_2 emission. The environment balance needs to be carefully considered because reducing the sulphur content in diesel fuel from 0.25 to 0.05 percent m/m would lead to an increase in refinery CO_2 emissions which is 10 times greater than the reduction in exhaust SO_2/SO_3 emssions.

To meet future cetane requirements and aromatics/density limitations, gas oil components will have to be upgraded by hydrogenation. Basically, aromatics are saturated into higher cetane and lower density hydrocarbons. The processing units are

essentially an extension of the HDS units, but with a specific catalyst to effect the hydrogenation. The level of hydrogen partial pressure to be applied will depend on the hydrogenation required and the quality of the feedstock.[2]

The specific catalyst required to bring about the hydrogenation and for example a reduction in 'aromatics', is the subject of considerable development. Tolerance for nitrogen, sulphur and hydrogen pressure requirements are variables to be optimised. Recent developments in Shell laboratories[3] have led to the commercialisation of catalyst and process technology with considerably improved cost effectiveness.

However, as we have shown, there are doubts whether an indiscriminate reduction of 'aromatics' in gas oil is necessary to improve diesel exhaust emissions. For example it may be that only polyaromatics contribute to diesel particulates and that monoaromatics do not contribute. If so more cost-effective solutions in catalyst and process technology should emerge; which in turn should have less of an impact on refinery CO_2 emissions.

Conclusions

Between now and the end of the century growth in oil product demand is expected. In particular, in the short to medium term, we have seen that diesel fuel demand for commercial road transport will grow steadily. Indeed diesel fuel will continue to be the cost-effective fuel to support growing economic activity.

For the 1990s, trends in supply and demand, together with an increased focus on the environment, will continue to stretch the refining industry. Future products must not only satisfy demand and quality requirements, but investment will be needed to satisfy environmental performance.

The greatest challenge facing the diesel engine fuel supplier and diesel engine manufacturer is to provide low cost fuels and engines with low emissions.

We believe that advances in engine technology will continue to offer the best opportunity for emissions improvements for some time to come. However, as engines become 'cleaner' the relatively minor influence of fuel properties on emissions performance may become more significant.

Indeed we have shown that a number of fuel properties can significantly influence particulate emissions from 'clean' diesel engines. However, the role of fuel characteristics in diesel engine emissions performance is still not fully understood and further work, in collaboration with the motor manufacturers, is required. In addition the combination of a low sulphur diesel fuel and exhaust catalysts could be a more cost-effective way to control emissions from diesel vehicles than major changes in fuel composition.

Refinery technology is available to meet future demands in terms of both quantity and quality. This also applies to aromatic reduction by hydrogenation, for which proprietory catalyst and process technology has been developed by Shell. However, considerable investment will be required and fuel cost will inevitably rise. There is also the substantial increase in CO_2 emissions to be considered. The implications of such changes and their cost effectiveness need careful study between oil and motor industries.

Governments may well play an important role in those studies as diesel fuel cost relates so closely to the cost of goods and services.

The implications of diesel fuel quality improvements thus go beyond the arena of technical feasibility and a balance has to be struck between the desire for environmental improvement and the cost of that improvement, i.e. the social balance. ■

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Contractors set for facilities upgrade

By Robert McLeod

World over-supply in the refining sector means that, for the next five years at least, there will be very few new refineries built. The sector is not dormant, however, as billions of pounds will be spent on refinery upgrades in response to commercial and environmental demands.

Industry sources estimate that there could be hundreds of projects within the £10–60 million range around the world in 1992–97 as operators seek to produce fuels and additives to meet modern specifications and maintain market share.

Environmental concerns and new legislation, for instance, have meant that many refineries have installed new systems for octane enhancement, such as isomerisation and methyl tertiary butyl ether (MTBE) units as the demand pattern for products changes. While refineries in the United Kingdom — where continued improvements over the last five years have been mostly environmentally driven — and United States utilise the latest technology, elsewhere there is enormous scope for development.

Despite the advanced state of facilities, approximately £8 billion is estimated as earmarked for expenditure in North America, the world's largest market. Expenditure in the Far East could top £7 billion; Western Europe, £6.5 billion; and Latin America, £4 billion. As much as £5.5 billion is expected to be spent in the Middle East, Central Europe and Africa over the same period.

It is particularly in the United States, where from 1 November a total of 39 cities will be designated carbon monoxide control areas, that demand for reformulated fuels has been greatest and work on refinery upgrades and enhancements has proceeded at a hectic pace.

In an attempt to meet a shortfall in supply of MTBE for oxygenated gasolines — currently estimated at 224,000 b/d — 28 MTBE plants have been constructed in North America since the early 1980s, 60 are under construction and studies are proceeding on a further 37.

A total of 52 such plants have been built since the mid-1980s throughout the rest of the world and 65 are under construction or study.

In Central and Eastern Europe the need for refinery upgrading is urgent but the funding is a serious problem. Most work at present is concentrating on specific projects around the £5–10 million mark, designed to give sufficient added value to end-products to generate funds to enable further work to be carried out. In the Commonwealth of Independent States each of the countries is looking to become self-sufficient rather than relying on central suppliers; here, smaller units which may not be economical in Western Europe, for example, may be better suited to their needs.

In Western Europe additional MTBE capacity is required because of increased octane demand and, to a lesser extent, for reformulated fuels. MTBE production currently stands at around 60,000 tonnes per annum but plans are in place to increase this to 500,000 tonnes. Nerefco is working on one of Europe's major projects at its Europoort site with a grassroots 65,000 tonnes pa MTBE unit and FCCU revamp.

Reducing sulphur content in fuels is also a prime concern with large companies vying to be amongst the first to meet new legislative requirements.

Light ends handling unit constructed using 63 PAUs with a combined weight of 6,000 tonnes. ***Photos: AMEC Engineering***

Investment will be triggered by the need to meet the new specifications for low sulphur diesel and gasoil which come into effect in 1995–96. The environmental aspects of both the end-product and the production operations need to be considered by refiners.

Some areas of Europe have lagged behind in refinery upgrading and enhancement including France, where a quarter of all investment in European refinery upgrades and enhancements is expected to take place over the next five years.

Refineries in the Middle East are, according to one industry source, in 'desperate need' of upgrading to US and UK standards as the investment has not been made in the past. Contracts have also been awarded to British companies to make assessment valuations for three war-damaged Kuwaiti oil refineries.

New refinery construction is particularly active in the Far East. The strong influence of Japanese and US companies in these projects, particularly in Thailand, Malaysia and China. Mobil Oil Singapore recently contracted Tokyo Engineering of Japan to build a £49 million catalytic hydrosulphuriser plant at its 235,000 b/d refinery.

Niche markets

With the overwhelming majority of projects being in refinery upgrades and enhancements, companies whose core businesses involve petroleum engineering work need to establish themselves in these niche markets.

Mr Maurice Bell, Managing Director of AMEC Engineering, believes that the need to establish a reputation based on work carried out in the United Kingdom and respond to local requirements is of paramount importance.

'By developing systems of work, such as pre-assembled units (PAUs) and total project management that were developed originally in the North Sea and since extended onshore, companies can put themselves into a position to win the customer's confidence,' says Mr Bell.

Companies that are involved in this type of engineering work can now carry out sophisticated operations at only a fraction of the shut-down time. By working with the company from the feasibility study stage right through to fabrication and installation they can keep the entire facility under control and ensure the project comes through within budget and provides a reasonable rate of return.

'As far as our structure is concerned,' added Mr Bell, 'we have set up a Hydrocarbon Technology Group that can provide these services and can work on developing partnerships overseas.'

Deisohexaniser column being installed at Elf/Murco refinery in Milford Haven.

A project being carried out for the Elf refinery in Milford Haven involving an isomerisation unit, naphtha hydrotreater and modifications to outside battery limits was fabricated using PAUs made in Sunderland and assembled on-site in a matter of days. Similar scale projects have been completed for the Pembroke Cracking Company and Conoco's Humberside refinery. The company has also been carrying out refinery shutdowns for BP for the last seven years. It now intends to market this expertise overseas in the face of shrinking domestic demand.

Mr Bell readily concedes that despite the existence of a world economy and the development of international standards each country has developed its petroleum industry in its own way. While the common objective is to 'get more out of the barrel', each refinery may be at a different level or starting point and be serving different national needs.

'To enter into the international markets you need to have some local expertise. For that reason we have set up a joint company with a French organisation that will be called AMEC Serate Energie and Process.'

This company could also facilitate access for AMEC into the Far East — where the company is 'actively looking' at projects in several countries — and West African markets.

A similar strategy has been adopted in the United States where companies are in the process of expanding to tap into the Latin American market; in Abu Dhabi and Saudi Arabia as a Middle East base; and in South Africa to service the Sub-Sahara.

'One of the greatest problems is the Export Credit Guarantee Department which must be more flexible about arrangements for financing. At present it is encouraging projects in more secure areas rather than the areas where the business actually is.' ■

Tax subsidy encourages US coalbed methane industry growth

By Judith Gurney

The economic production of natural gas from coal seams is a new industry. Many coal deposits are reservoirs for considerable amounts of coalbed gas, which is predominantly methane and has a heating value of approximately 1,000 BTU/cuft. Coal deposits are ranked in terms of so-called 'coalification' stages, from peat, the lowest rank, through lignite, sub-bituminous coal, bituminous coal and anthracite, up to graphite, the highest rank. The largest amounts of methane are generated as coal 'matures' from high-volatile to low-volatile bituminous rank.

Extraction technology

The production of coalbed methane differs from the production of so-called town gas, once widely used in industries, residences and street lighting. Town gas is produced, along with coke, by heating mined coal in sealed retorts. Coalbed methane, which is naturally occurring methane maintained by pressure within coal seams, is produced directly from the mine.

Until recently, coalbed methane technology was focused on trying to eliminate methane in coal mines, as it can cause serious breathing problems for miners. It is also explosive in a narrow bank of concentration. In the late 1970s and 1980s, however, coalbed methane came to be viewed as an unconventional source of natural gas, and technology began to emerge for the purpose of producing it.

Coal mines pose difficulties as natural gas reservoirs. In the first place, it is difficult to evaluate reserves. Whereas natural gas in conventional reservoirs is free gas, except for a small amount of free gas occasionally found in the cleat system of a coal seam, coalbed methane exists as a layer adsorbed on the surface of coal and held there by pressure. Adsorbed methane is not found in all coal seams and the amount of methane in a coalgas-bearing seam is a function of the coal's adsorptive capacity, its thermal maturity or rank and the depth of the deposit. The deeper the coal seam is buried — and therefore the greater the pressure exerted on the coal — and the higher the coal rank, the greater its likelihood and capacity to hold methane.

The production of coalbed methane is difficult and costly. Drilling must take into account that coal and coal structures are easily damaged. Most production techniques are designed to release absorbed methane by lowering the reservoir pressure, which generally involves removing the water present in the coal seam, thereby lowering the hydrostatic pressure. Some form of artificial stimulation is required to achieve favourable rates of gas flow, such as hydraulic stimulation using gels or foam and sand. Because coal is a naturally fractured, somewhat plastic and readily crushable material, its stimulation requires great care. Experimental technologies, now being tested, involve desorbing methane from coal through chemical processes, such as by injecting nitrogen to release methane by sorption displacement.

Once methane is freed from its attachment to coal, it will diffuse through the coal seam matrix until it reaches a coal cleat, the natural fracture network in coal. A production wellbore must be strategically situated in order to harvest this free-flowing methane. Production rates are usually low, with ultimate recovery historically limited to less than 50 percent.

Once it reaches the wellhead, coalbed methane can be transported through pipelines used for conventional natural gas as long as it is pipeline quality. In some instances, especially in the case of methane produced from mines used for the production of coal, air must be removed; this is not a problem in methane produced from virgin coal. In other instances, CO_2 must be removed.

The economics of coalbed methane production from a coal seam depends on production costs, the existence of a convenient pipeline system for its distribution and the price of competitive fuels.

US production tax credit

The incentive for the US coalbed methane industry is a tax credit for producers of so-called unconventional fuels, which includes shale and tar sands oil as well as coalbed methane. This tax credit was established by the Crude Oil Windfall Profit Act of 1980, with minor modifications in subsequent legislation. It is only applicable for production from new wells on new property, as defined by the act, and these wells must have been drilled after 31 December 1979 and before 1 January 1993. The act does not provide a definition of what is meant by 'drilled'; it is generally assumed that it is the same as with other oil and gas drilling operations where spudding by a certain date is the equivalent of drilling. The formula for the tax credit is complicated, as shown in the **Table**. The benefits of the credit are apportioned among producers according 'to their respective interests in the gross sales.'

The tax credit, which is linked to the price of oil, was intended to encourage production of unconventional fuels in periods when oil prices were too low to allow them to compete successfully in the marketplace. When it was first enacted in 1980, oil prices were high and credits were not available until 1982, when oil prices had declined. By 1991, tax credits were assured since oil prices were nowhere near the linked ceiling price of $49.35 a barrel. The tax credit is a very significant element in the economic analysis of coalbed methane projects. At current low natural gas prices, allowing for the costs of production, the coalbed methane producer nets more income from the tax credit than from the sale of the methane. Under these circumstances, coalbed methane is threatening if not displacing conventional natural gas in some geographic markets and with some customers. The electric power generating industry, for instance, is showing interest in coalbed methane because of its low cost and long-term supply potential.

US reserves

There is an estimated 400 trillion cubic feet (tcf) of coalbed methane in the lower 48 states, of which 90tcf are considered recoverable under current technology. US coal basins are commonly grouped into the eastern and western basins because of their geologic similarity. Some 72 percent of this coalbed methane, about 290 tcf, is found in the Cretaceous coals or early Tertiary coal seams of the western coal basin, primarily in the San Juan Basin of southwest Colorado and northwest New Mexico, in thick individual or multiple-seam deposits with little continuity, often as deep as 10,000 feet. An additional 110 tcf of US coalbed methane reserves are found in the Pennsylvanian-aged coals of the eastern basin, in thin, multiple seams with extensive lateral continuity. Eastern coal seams are generally less than 4,000 feet deep and are normally pressured or underpressured.

Within the San Juan Basin, the so-called Fruitland Formation, covering 7,500 square miles with some 50 tcf coalbed methane reserves, boasts the most well-developed coal seams. It has been extensively assessed and is presently the primary target for coalbed methane development in the area. About 34 tcf of reserves are believed to exist in the Menefee Formation, covering 12,000 square miles, as well as in other smaller formations within the basin. The Piceance Basin, to the north of San Juan Basin, is said to contain 84 tcf of reserves. To date, activity there has been primarily in exploration and testing.

The Black Warrior Basin in east-central Alabama and east-central Mississippi covers 18,000 square miles and is said to contain 20 tcf of coal bed methane reserves. The focus there is on the Mary Lee and Blue Creek seams where there is a well-established coalbed methane industry. The northern Appalachian Basin covers Pennsylvania, Maryland, West Virginia, Ohio and Kentucky, an area of about 43,000 square miles. It is considered to have a potential of 61 tcf of reserves but has undergone only limited exploration.

Exploratory drilling

A number of major oil companies, including Amoco, ARCO, Chevron, Conoco, Marathon, Mobil, Phillips and Texaco, have been involved in coalbed methane projects at various times, along with smaller, independent and more specialised companies. Approximately 6,000 coalbed methane wells were reported as having been drilled by mid-1991, mostly in the San Juan and Warrior basins, with about half of these drilled in 1990 in order to beat the 1 January 1992 tax credit deadline. Although the drilling deadline to qualify for the tax credit was extended to 1 January 1993, drilling activity in 1991 was less than in 1990, as operators took time off to plan drilling programmes, to evaluate completion techniques and to develop markets. During 1991, the emphasis was on well completions and the installation of production equipment in order to begin gas production. The San Juan and Black Warrior basins account for more than 90 percent of exploration activity; the rest of the current drilling is occurring primarily in the Appalachian area, the Raton Mesa in Colorado and Powder River Basin in Montana.

Production

The pace of exploration in the late 1980s and especially in 1990 put a strain on the coalbed methane industry's infrastructure; less than half of its wells are currently producing. Production at the end of 1990 was 490 million cubic feet a day (MMcfd) in San Juan, 110 MMcfd in Black Warrior and 23.5 MMcfd elsewhere, giving a total of 623.5 MMcfd. Total production during 1991 has been estimated at 310,000 MMcf, slightly less than 1,000 MMcfd, which was approximately 2 percent of the total natural gas production in the United States. If all wells reach their potential, a total peak production of 2,000–2,795 MMcfd has been projected.

Commercial production is concentrated in the San Juan and the Black Warrior basins. In the long term, with the development of new technology, production is expected to increase in other areas, especially in the Appalachian Basin in West Virginia and Virginia, and in Utah. One problem which producers face in developing Appalachian coalbed methane wells, however, is the difficulty of acquiring large lease holdings as there are currently numerous small leaseholders in this area, many involved in coal mining. Problems have also arisen over the issue of water disposal.

There were a handful of producing wells in the early 1980s in San Juan. By 1989 there were 500 producing wells and by the end of 1991, some 3,000. Production is primarily in the north-central portion of the basin and highly diverse reservoir conditions result in varying production rates. Average well

US TAX CREDIT FORMULA

The US tax credit formula for coalbed methane can be expressed in algebraic form as follows:

$$TC = (\$3 \div BOE) \times IAF \times PH$$

where:

TC = Tax credit in $/MMBTU (million BTU)
BOE = Barrel of oil equivalent, 5.8 MMBTU
IAF = Inflation adjustment factor (based on GNP implicit price deflator)
PH = Phaseout factor (PH < 1)

PH is based on domestic crude oil prices at the wellhead, as follows:

$$PH = 1 - (\text{Domestic oil price} - \$23.50/\text{barrel} \times IAF) \div (\$6/\text{barrel} \times IAF)$$

The value of the tax credit for a given year cannot be calculated until March or April of the following year. At that time the Internal Revenue Service presents values for the IAF and the reference domestic oil price.

production is about 500 Mcfd. San Juan methane is distributed through the existing natural gas pipeline system and a new pipeline is planned to move gas to southern California.

In Black Warrior, there were also only a handful of producing wells in the early 1980s. By 1989 there were 900 producing wells. The count rose to 1,800 in 1990, and 3,000 by the end of 1991. It has been estimated that Black Warrior will produce 300 bcf coalbed methane in the next decade. If the tax credit did not exist, however, production would probably not be feasible in this basin. Using a projected 1991 value of the tax credit of $0.90/MMBTU, Black Warrior production will be eligible for $270 million in tax credits over the next decade, assuming its coalbed methane has nominal heating value of 1,000 BTU/cuft.

In San Juan, however, several mines are so productive that it probably would be economical to produce them even without the advantage of the tax credit. In geologically favourable basin areas, the so-called 'sweet spots', coalbed methane development is economic at relatively low natural gas wellhead gas prices. San Juan sweet spots, however, are limited and already largely developed.

Overseas

There is considerable coalbed methane activity outside the United States. Australia has developed several fields, although it lacks an existing pipeline infrastructure and is therefore concentrating on supplying industries located near coalbed methane wells. China has several different projects and Poland has had extensive talks with resource developers but has not yet embarked on production. France and Spain have also expressed interest. In Britain, Kirkland Resources (Holdings) plc, in partnership with other companies, and Evergreen Resources (UK) Ltd were recently awarded licences to explore for coalbed methane as part of the fourth onshore licensing round. Kirkland received a 610 square kilometre area that includes most of the South Wales coal field, and Evergreen received seven licences in South Wales, Yorkshire, the West Midlands, Cheshire, Merseyside and North Wales. These licences cover exploration for all hydrocarbons, not just coalbed methane. The industry is in an early stage in Britain and has still to work out protocols for exploration and taxation. It needs proprietary data from British Coal to conduct evaluation.

Companies in the coalbed industry in Europe apparently believe that production will be economic despite the lack of government tax credits. Presumably they are counting on an increased European push for gas as the primary fuel and perhaps also on the enactment of a European Community carbon tax which will favour natural gas. ■

FORTHCOMING EVENTS

July

6th–7th
London: Conference on 'North Sea Oil and Gas'. Details: Financial Times Conference Organisation, 126 Jermyn Street, London SW1Y 4UJ. Tel: (071) 925 2323. Fax: (071) 925 2125.

6th–7th
London: Conference on 'Biotechnology in the Petroleum Industry'. Details: Lucy Lloyd, Henry Stewart Conference Studies, 2–3 Cornwall Terrace, Regent's Park, London NW1 4QP. Tel: (071) 935 2382. Fax: (071) 486 7083.

7th
Leeds: Course on 'Engine Emissions Measurement'. Details: Hansa Patel, Department of Continuing Professional Education, Continuing Education Building, Springfield Mount, Leeds LS2 9NG. Tel: (0532) 333235. Fax: (0532) 333240.

7th–10th
London: Conference on 'The Behaviour of Offshore Structures'. Details: Robert Gibbins, Boss 92 Secretariat, 2 Tavistock Place, London WC1H 9RA. Tel: (071) 837 6362. Fax: (071) 837 0822.

13th
London: Conference on 'The Business Implications of the New Government's Environmental Priorities'. Details: Mr A Wilkes, Managing Director, Environmental Policy Consultants. Tel: (071) 624 2728.

13th–16th
Aberdeen: Course 'Well Control (Supervisor)'. Details: The Drilling and Production Training Centre. Tel: (0224) 895504. Fax: (0224) 895770.

13th–17th
Oxford: Course on 'Health, Safety and the Environment in the Downstream Oil and Petrochemical Business'. Details: The Registrar, The College of Petroleum and Energy Studies, Sun Alliance House, New Inn Hall Street, Oxford OX1 2QD. Tel: (0865) 250521. Fax: (0865) 791474.

13th–14th
Aberdeen: Conference on 'Successful Quality Management Systems for Offshore Contractors and Suppliers'. Details: IIR Industrial Ltd, 28th Floor, Centre Point, 103 New Oxford Street, London WC1A 1DD. Tel: (071) 412 0141. Fax: (071) 412 0145.

15th–16th
Cranfield: Course on 'Managing Safety in the Offshore Oil and Gas Industries'. Details: Cranfield School of Management, Cranfield, Bedford MK43 0AL. Tel: (0234) 751122. Fax: (0234) 750835.

15th–16th
London: Conference on 'Refurbishment of Bulk Liquid Storage Tanks'. Details: IIR Industrial Ltd, 28th Floor, Centre Point, 103 New Oxford Street, London WC1A 1DD. Tel: (071) 412 0141. Fax: (071) 412 0145.

Call for Papers

The conference 'Offshore Iberica' is to be held in Lisbon between 21 and 23 October 1992 and papers are requested on the following subject areas:

- ★ **Subsea operations**
- ★ **FPSO technology**
- ★ **Storage units**
- ★ **Deepwater solutions**
- ★ **Field economics**
- ★ **Drilling**
- ★ **Multi-phase production**
- ★ **Safety and the environment**
- ★ **Tension leg platforms**
- ★ **Topside facilities design**
- ★ **Conversions**
- ★ **Certification**
- ★ **Financing**
- ★ **Maintenance**
- ★ **Yard facilities**
- ★ **Repair facilities**

To register a paper for the conference send brief details to: Conference Officer, OCS, 34–36 Apsley End Road, Shillington, Hitchin, Herts. SG5 3LX. Tel: (0462) 712049. Fax: (0462) 711889.

August

19th–20th
Aberdeen: Course 'Subsea Well Control & Refresher'. Details: The Drilling and Production Centre. Tel: (0224) 895504. Fax: (0224) 895770.

25th–28th
Stavanger: 'Offshore Northern Seas' Conference. Details: Conference Secretariat, PO Box 175, N-4001 Stavanger, Norway. Tel: +47 4 55 8100. Fax: +47 4 55 2270.

September

1st–3rd
Houston, Texas: 'The 6th Congress and Exposition — Gas Turbines in Cogeneration and Utility, Industrial and Independent Power Generation'. Details: The American Society of Mechanical Engineers, 6085 Barfield Road, Suite 207, Atlanta, Georgia 30328, USA. Tel: (404) 847 0072. Fax: (404) 847 0151.

7th–9th
Birmingham: 'Distillation and Absorption '92'. Details: IChemE Conference Section, 165–171 Railway Terrace, Rugby CV21 3HQ. Tel: (0788) 578214. Fax: (0788) 577182.

9th–11th
London: Course on 'Offshore Pipeline Engineering'. Details: Nadia Ellis, IBC Technical Services, 57–67 Mortimer Street, London W1N 7TD. Tel: (071) 637 4383. Fax: (071) 631 3214.

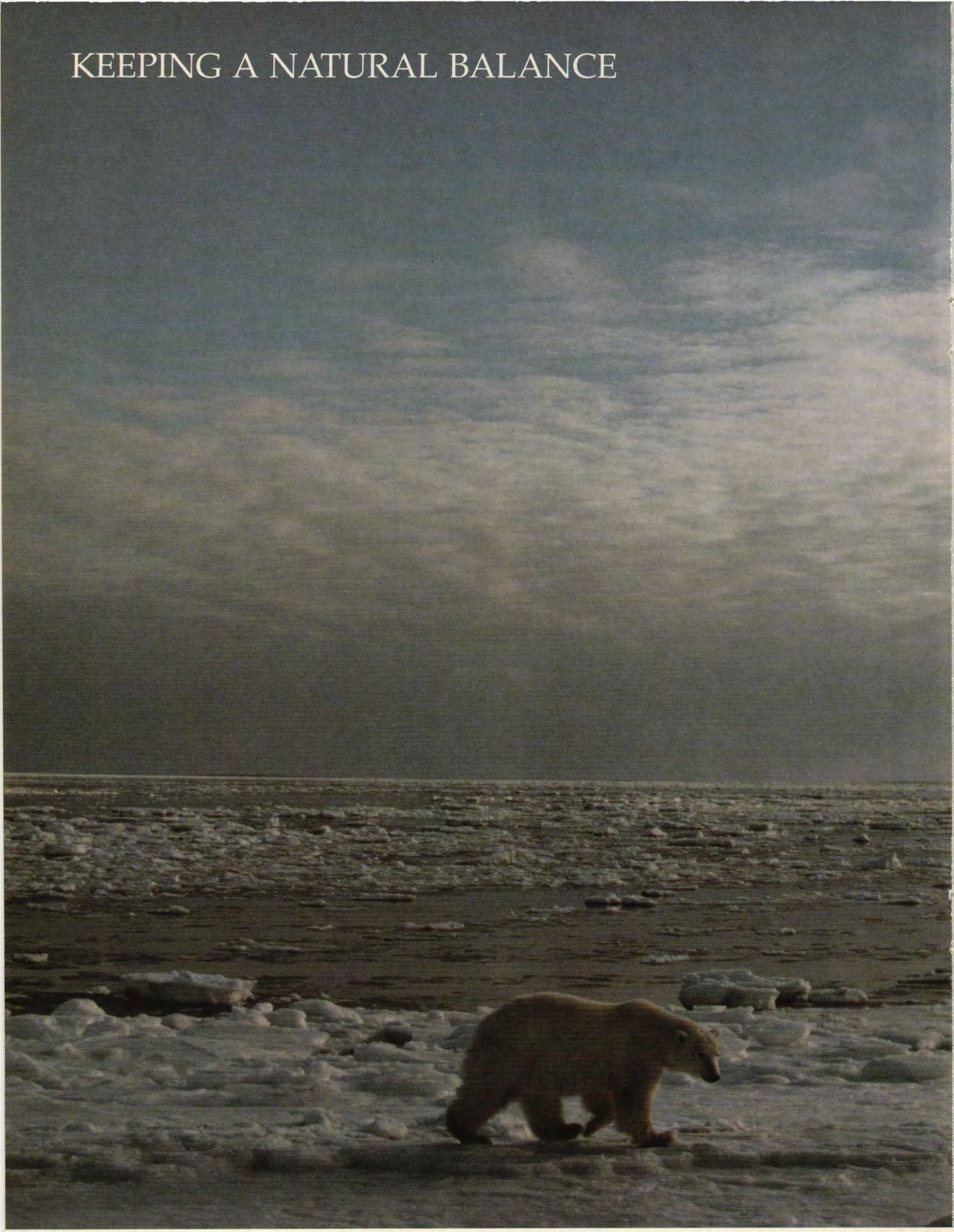
13th–25th
France: 'International Petroleum Executive Seminar'. Details: Dr RL Gale, Seminar Manager, Petroleum Economics Limited, Piercy House, 7 Copthall Avenue, London EC2R 7BU. Tel: (071) 638 3758. Fax: (071) 638 3708.

15th–17th
Maastricht, The Netherlands: 'Energy Economy 1992'. Details: Energy Economy 1992, RAI Gebouw bv, Europaplein, 1078 GZ Amsterdam, Netherlands. Tel: 31 (0) 205491212. Fax: 31 (0) 206464469.

16th–18th
Brussels: Conference on 'Lubricants of the Future and Environment'. Details: BfB Consultant, DPT Congress, 23 Rue Haigneaux, 5300 Nameche, Belgium. Tel: 32 (0) 81581177. Fax: 32 (0)81581179.

20th
Moreton-in-Marsh: Course on 'Handling of Emergencies in the Petroleum Industry'. Details Mr R Cameron, Marketing Manager, The Fire Service

KEEPING A NATURAL BALANCE



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21st–22nd
Aberdeen: Conference on 'Practical Approaches to Implementing Successful Quality Management Systems for Offshore Contractors and Suppliers'. Details: IIR Industrial Ltd, 28th Floor, Centre Point, 103 New Oxford Street, London WC1A 1DD. Tel: (071) 412 0141. Fax: (071) 412 0145.

21st–23rd
Cambridge: 'Oil and Gas Tariffing Workshop'. Details: Langham Oil Conferences Ltd, 37 Main Street, Queniborough, Leicester LE7 8DB. Tel: (0664) 424776. Fax: (0664) 424832.

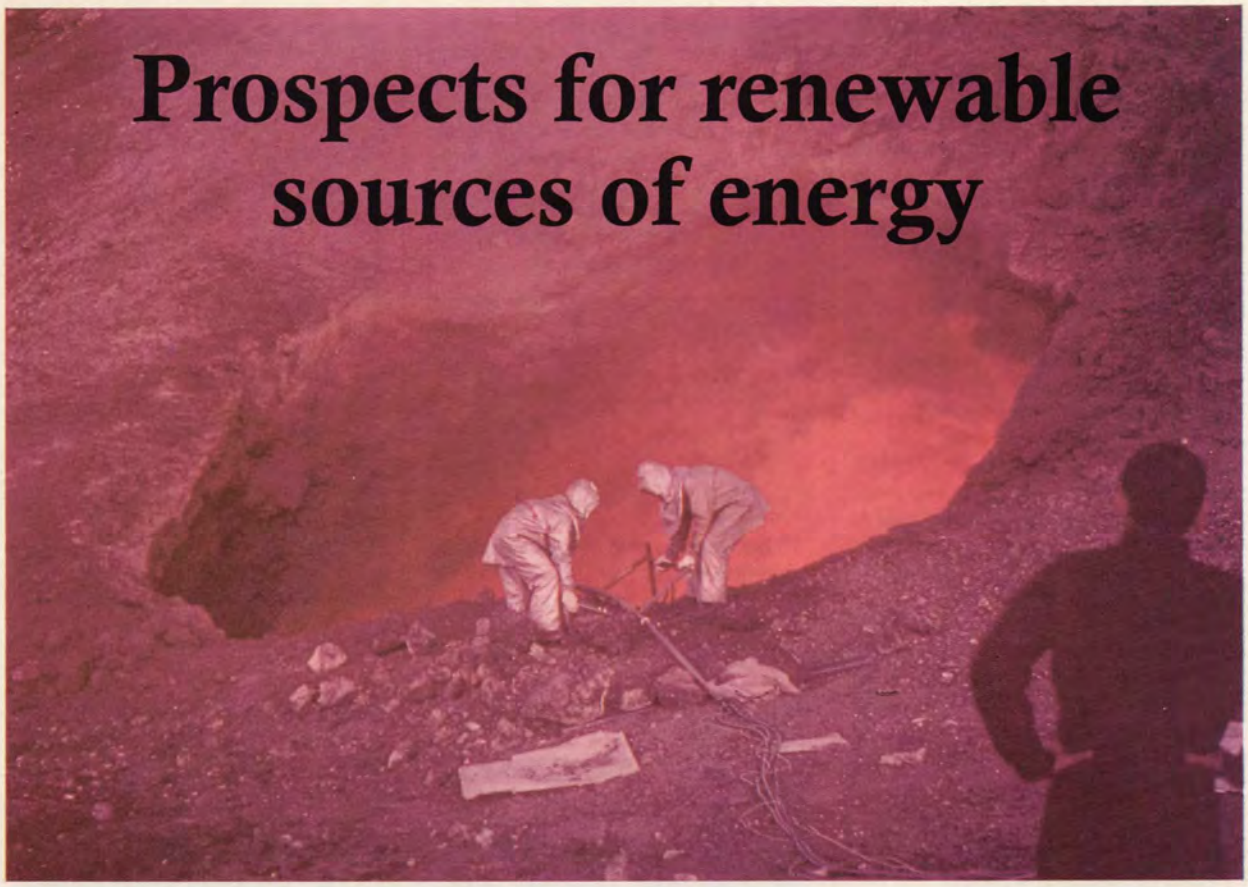
22nd–24th
London: Conference on 'Offshore Site Investigation and Foundation Behaviour'. Details: Society for Underwater Technology, PSTI House, Exploration Drive, Bridge of Don, Aberdeen AB23 8GX. Tel: (0224) 823637. Fax: (0224) 820236.

23rd
Leeds: Meeting on 'Fundamentals of Combustion in Reciprocating Engines'. Details: Professor D Bradley, Department of Mechanical Engineering, The University, Leeds LS2 9JT. Tel: (0532) 332117. Fax: (0532) 424611.

23rd–25th
Southampton: '4th International Conference on Hydrocyclones'. Details: Mrs K Stones, Conference Organiser, Hydrocyclones, Cranfield, Bedford MK43 0AJ. Tel: (0234) 750422. Fax: (0234) 750074.

27th–29th
Course on 'Introduction to Petroleum Exploration for Non-Geologists'. Details: The Administrative Secretary, JAPEC, c/o The Geological Society, Burlington House, Piccadilly, London W1V 0JU. Tel: (071) 434 9944. Fax: (071) 439 8975.

Prospects for renewable sources of energy



By Professor DT Swift-Hook, Visiting Professor, Kings College, London and Chairman, Swift-Hook Associates

The upsurge of interest in renewable energy was undoubtedly due to petroleum. Oil crises have happened fairly regularly over the years with various outcomes. The 1973 crisis led people to believe that the world was running out of oil and that endless supplies of energy were essential. The International Energy Agency was formed to ensure that all sources of energy were developed. Major research programmes were established to develop the limitless supplies of energy represented by renewable sources.

Since that time, the world's reserves of oil have increased in almost every single year, demonstrating that oil is not running out after all, at least not in the foreseeable future. Also the apparently unstoppable exponential growth of energy consumption faltered. The link between economic advance and energy consumption was broken. The search for limitless sources of energy lost its sense of urgency and by the early 1980s the need for renewable resources seemed to recede.

But dedicated enthusiasts are a hardy breed in any field and the field of renewable energy is hardier than most. Research on the renewables managed to keep going.

Relative costs of energy

Wind farms	6.9
Gas turbine combined cycle	7.1
Recommissioning disused plant	7.2
Plant life extension	8.0
Geothermal (230MW flash boiler)	8.1
Fuel cell (molten carbonate)	9.3
Coal (pulverised fuel combustion)	9.3
Gas turbine	9.6
Solar (parabolic trough)	10.4
Pumped air storage	12.9
Solar (central receiver)	14.4
Photovoltaics (with concentration)	18.0

Source: California Energy Commission Report ER-92.
The technologies shown are a representative sample and the figures are estimated costs levelled in nominal 1989 US cents per kWh.

Non-polluting energy

Just in time (for the renewables), another global catastrophe reared its head in the 1980s — environmental pollution. Sulphur dioxide brought the spectre of acid rain for coal as well as oil. Chernobyl came along to cast a blight upon the nuclear option. Finally, in case flue gas desulphurisation or catalytic converters proved too successful, carbon dioxide was found to be melting the ice-caps. The need was no longer for limitless energy but for clean energy and oil was once more being blamed, rightly or wrongly, for causing most of the problems.

It was found that the renewables were all very clean indeed. The work that had been done to establish them as modern technologies had not been wasted and it only remained to establish their economic viability.

This was proceeding steadily, with price reductions and several renewable sources able to claim that they were becoming competitive, when the world seemed to discover that it was running out of capital and that interest rates must be increased.

Capital-intensive renewable energy

A feature of power generation from the renewables is that the energy is regarded as free and there are no fuel costs. This means that they are capital intensive and so high interest rates were very bad news. Low-capital-cost generating plant was required and the cheapest of all was the gas turbine. The realisation that there was rather a lot of natural gas, and that it could be burnt in gas turbines, was enough to set back plans for all other types of power plant, including the renewables. By the end of the 1980s the rush for gas had started.

The capital-intensive nuclear industry would have collapsed in the United Kingdom without government protection. It proved impossible to privatise and a nuclear tax was decided upon. The renewables lobby appealed for protection at just the right time. With hardly a thought that the clean renewables made strange bed-fellows with their nuclear opponents, they were herded together under the inelegant title of non-fossil methods of generation. The Non-Fossil Fuel Obligation (NoFFO) was introduced in England and Wales.

Government support for renewable energy

This method of subsidising renewable sources of power generation is proving highly successful. In 1990, 75 NoFFO projects were ready to sign contracts with more than 100MW of generating capacity. In November 1991 further contracts were announced. The target of 1,000MW by the end of the century was declared by the Minister to be 'past history' and 20 percent of electricity generation from renewables by the year 2025 was being quoted.

NOVEMBER 1991 NoFFO CONTRACTS

Technology	Projects	MW
Landfill/Sewage Gas	47	75
Waste	14	290
Wind	49	190
Mini-Hydro	12	10

The sudden surge of gas turbines in combined cycles has shown everyone how easily it is for a new technology to

take over when the economics are right. But the recent escalation in gas prices has shown that oil is not the only fuel to experience dramatic price fluctuations as supply and demand take turns to outstrip each other. As gas prices rise, wind power is poised to move into prominence.

The latest figures from California show that wind farms are back at the top of the economic league table. They are ahead of gas turbine combined cycle and other cheap options such as repowering disused plant and extending the life of old equipment. The prospects for wind power are good.

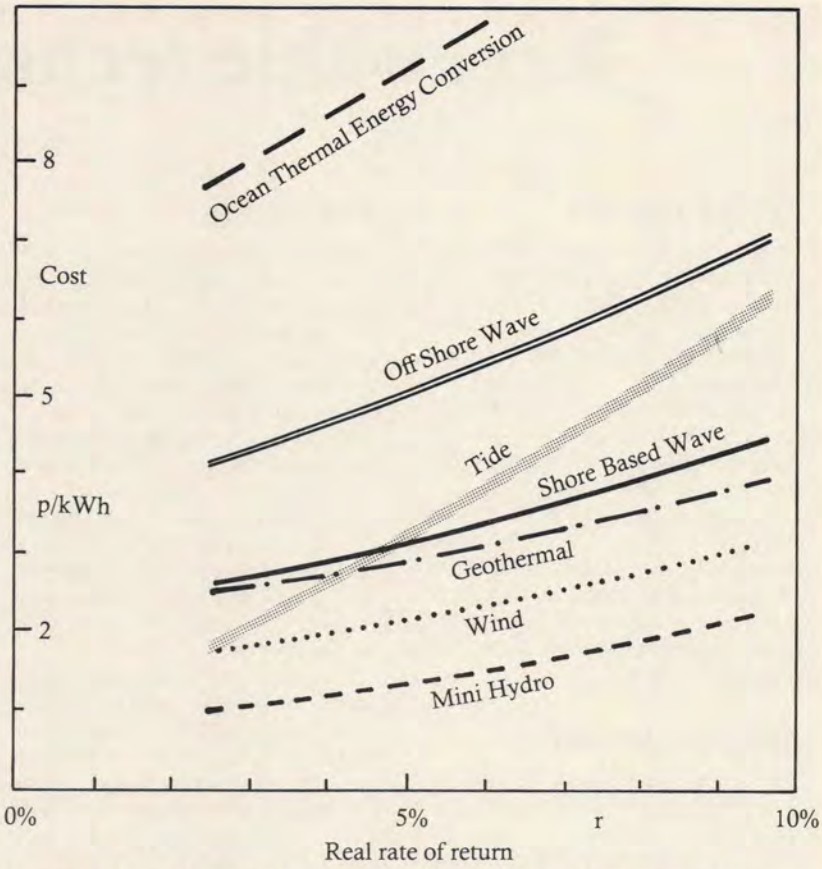
In the United Kingdom where the costs of waste disposal are very high, methods of generation which use refuse and sewage look particularly attractive. The fuel can be cheaper than free when people have to pay for it to be taken away. Every town could have its own small scheme. The total resource is not enormous but it could provide a modest fraction of the country's power.

Mini-hydro schemes, typically generating a fraction of a megawatt, have similarly attractive economics but represent a rather small resource probably amounting to only a few hundred megawatts in the whole of the United Kingdom.

Offshore prospects: wind power

The best windy sites in the country tend to be on high open land which is regarded as outstandingly beautiful. Difficulties are often encountered in obtaining planning consent in these listed Areas of Outstanding Natural Beauty. In the same way, not everyone wants a land-fill rubbish tip or waste incinerator in their backyard. It is interesting to look at the offshore options.

Anyone associated with the oil industry knows that the wind blows much harder offshore than on land. Detailed studies of offshore wind power have been carried out by the International Energy Agency. Individual demonstration projects were planned in England, Germany and Sweden but last year an offshore wind farm was built in the Great Belt of water which lies between the major islands of Denmark. The offshore industry faces a new prospect. When oil and gas experience their next down-turn, there will be an exciting opportunity to develop offshore wind farms. ■



Comparing costs of renewable technologies: Generating costs from all capital-intensive power plant such as nuclear and the renewables are sensitive to the cost of capital, as reflected in interest rates. Real interest rates, the difference between bank interest and inflation, are normally around five percent, although private companies may have to pay several percentage points more to cover their extra risks. It is found that variations in interest rate do not affect the relative costs of the different renewable sources (levelised over plant life-times), apart from tidal schemes which are particularly long-lived.
Source: **Report No 22 of Watt Committee for Energy: Renewable Energy Sources (Laughton, MA, ed) Elsevier, London: 1990.**

Renewable technologies

Solar power

Solar cells use the photovoltaic effect to convert light energy from the sun directly into electricity. BP has been particularly active in this field. Although thin films of silicon are not expensive in themselves, a considerable amount of mechanical and civil engineering work is needed to protect solar cells against the wind, the rain and the force of gravity.

A less direct approach is for heliostat mirrors to focus the sun's rays upon a central boiler at the top of a power-tower. Simpler and more economical technology can be used when absorbing tubes are used with focusing mirrors.

Water power

In many developed countries, hydroelectricity is the main source of power, to such an extent that most major resources have been used up. Remaining possibilities are for small run-of-river schemes using novel, low-head techniques.

The tides rise and fall every 12 hours or so, driven by the sun and the moon. A barrage across the Rance estuary in Brittany has been generating 240MW of electrical power since 1966. Several similar schemes are being considered around the coasts of Britain and elsewhere.

Waves are created by the wind. In the middle of the Atlantic, they rise and fall every ten seconds or so with an averge wave height of four metres. It has been shown experimentally that this energy can be tapped with efficiencies as high as 90 percent by many different devices including a 'nodding duck', a hinged raft, a flexible tube and oscillating water columns. Costs of deep sea mooring, offshore maintenance and power transmission are prohibitive but shore-based systems have achieved some success.

Ocean Thermal Energy Conversion (OTEC) aims to use small differences between sea surface temperatures (22°C or more) and those below the thermocline (4°C) in a reduced pressure steam cycle or one using a refrigerant fluid. Costs appear to be very high.

Bio-fuels

Biofuels represent a form of solar power with sunlight providing the energy needed for photosynthesis, the process by which water and atmospheric carbon dioxide are combined to form carbohydrates and other organic compounds.

Biofuels are regarded differently from fossil fuels since their use does not increase the burden of greenhouse gases. The carbon dioxide which they release must have been absorbed very recently from the atmosphere and would be returned there in due course by biodegradation.

Firewood, cattle dung and camel dung are major fuels in many developing countries. Cultivation of plants is possible in equatorial forests but all advanced economies have industrial and commercial residues such as wood chips and food processing wastes as well as agricultural and domestic wastes including straw, livestock manure and sewage sludge.

The simplest approach is to use such wastes as combustible fuels. More sophisticated and cleaner fuels can be produced by pyrolysis or gasification. Fermentaton or anaerobic digestion can produce alcohol or methane; such processes occur naturally at refuse land-fill sites and sewage plants and can be enhanced when conditions are properly controlled. Avoiding the high costs of waste disposal can be of considerable economic benefit.

Geothermal

The same underground heat that is responsible for volcanoes can produce hot aquifers under suitable conditions, and these can be tapped to provide hot water or steam. Many countries with histories of volcanic action, such as Iceland, Italy and New Zealand, generate power from such 'wet' geothermal sources. Hot dry rocks can be found beneath every part of the earth's surface and the heat can be mined if holes are drilled deeply enough.

Many techniques established by the oil industry are being developed to improve heat extraction. A pair of holes can be drilled close together so that cold water pumped down one will collect heat from a fractured volume of rock and will return as steam out of the other. Methods of fracturing that are being developed include hydraulic pumping and underground explosions. Thermal fracturing takes place to extend the fracture zone as the rocks are cooled.

Wind power

Old style windmills with four blades were widely used for land drainage and irrigation in past centuries. Modern designs of wind turbine use two or three (or occasionally one) tapered blades with advanced aerofoil cross-sections made from fatigue-resistant materials.

A 30-metre diameter rotor will generate a fraction of a megawatt, so many machines are needed to generate significant amounts of power. Wind farms with numbers of machines spaced about 10 diameters apart operate in the United States, Denmark, the Netherlands, United Kingdom and elsewhere.

Intermittent sources

Many of the renewable and environmentally-friendly sources of power are intermittent, notably wind, wave, tidal and solar. This means that they cannot be used on their own to provide a steady and reliable power supply. Battery and other storage systems can be used to improve the availability of energy but the only fully effective way to ensure a really reliable supply is to have a diverse system of independent generating units capable of working together with spare capacity, in fact a power system.

If a moderate amount of any intermittent source of energy, up to 10 percent or 20 percent of total capacity, is connected to a power system, reliability is improved by this extra spare capacity on the system. The intermittent source can contribute its energy or its average power to the system capacity without the need for any other provisions such as storage or extra control.

Fuel cells get policy boost

By Robert McLeod

The technology that has powered space flight since the 1960s is now coming off the assembly line for commercial and industrial use. Just how advanced is fuel cell technology and can it compete in the market-place? Its protagonists believe its time is coming but advances will owe more to government policy than technological revolution.

Although the first fuel cell was demonstrated by William Grove in 1839, the modern 'father' of fuel cell technology is generally held to be the eminent British scientist, Dr Francis Bacon*, who demonstrated the first alkaline fuel cell in 1959. The first phosphoric acid cell, the type in most common use at the moment and likely to be the most functional unit at least until 2000, was tested in 1977.

Fuel cells (FCs) produce electricity from the electrochemical reaction of hydrogen and oxygen combining to make water. For most types of FC the oxygen can be extracted directly from the air and the hydrogen from a wide variety of fuels including natural gas, alcohols, land-fill gas, biogas, naphtha, oil or coal gas.

The efficiency of FCs is affected by the type and quality of fuels used without reforming. In a report to the Second Grove Fuel Cell Symposium in September 1991, AJ Appleby of the Center for Elecrochemical Systems and Hydrogen Research in Texas, stated: 'For wide use in the present fuel economy, a fuel cell system must operate on common clean fuels, particularly natural gas'.

The 430kW project built by Solar-Wasserstoff-Bayern in southern Germany is developing a system of using high pressure electrolysers to produce hydrogen from water which is then fed through the FC.

The latest solar powered photovoltaic cells in use in this project have only recently come onto the market for this application and are prohibitively expensive. According to Mr Karl Beckmann of Air Products Ltd, the cost of producing this hydrogen is DM6.99 per cubic Nanometre (Nm). The cost of producing hydrogen from steam reforming of natural gas is around DM0.15 per Nm^3.

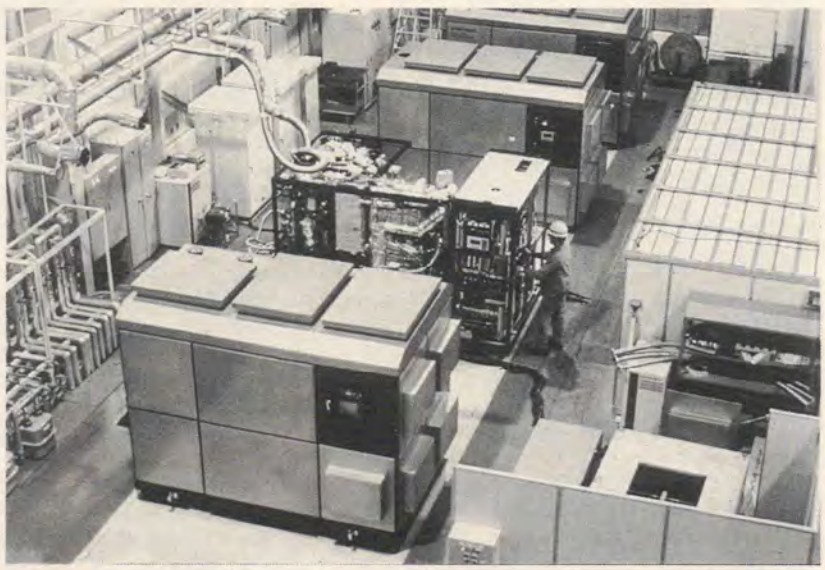
The flexibility in fuel sources is seen as a major advantage in the technology as any source of hydrogen can be reformed to provide an appropriate fuel although the choice will have a bearing on emissions.

The experimental or demonstration nature of many of the projects (excluding military or space use) has meant that the technology has been trapped in an economic circle. The price will not come down until demand increases and demand will not increase until the price falls to levels approaching conventional facilities. There is considerable expectation that this situation is about to change.

The Japanese Ministry of International Trade and Industry set a target in 1990 for installed FC generating capacity in Japan of 2,250MW by the end of the century, thereby stimulating demand for the technology and providing the market to cover initial production set-up costs. Three companies — International Fuel Cells (IFC) (formerly Pratt and Whitney) in the United States, Fuji and Toshiba in Japan — have set up facilities to produce phosphoric acid fuel cells (PAFC) in commercial quantities and a fourth company, Mitsubishi, plans to begin production in 1996.

Markets have been identified mainly for the on-site generation of heat and power, research institutes and gas companies although several large-scale projects are under development including an 11MW plant built by IFC for Tokyo Electric and a 5MW fuel cell being developed by Fuji in a project supported by the Japanese government and power companies.

Dr Gary Acres, Director (technical and planning) with Johnson Matthey, estimates that the subsidy in Japan stands at around 30 percent for the units and is crucial for the develop-



Fuji PAFC production lines

ment of first generation FCs. 'The utility companies and other customers are unfamiliar with the technology,' he said.

'The fuel cell itself is simple but the systems around it to provide hydrogen-rich gas, including a reformer unit, are not established technologies in this application. The size of each unit is a critical factor as there are technological challenges to be met with the integration and control systems.'

Although a number of companies in Europe — most notably in Italy where Ansaldo SpA has established a joint company with IFC to sell and service FC units — are beginning to enter the research and development of this technology, Dr Acres believes the European Community still lags some eight to 10 years behind the Japanese and Americans and is only slowly catching up.

The joint company, CLC srl, markets a 200kW on-site cogeneration plant which it hopes, eventually, to manufacture in Europe.

Economic viability

'The decision in Germany to obtain five percent of its energy requirements from renewable resources by 2000 is obviously a spur to development,' added Dr Acres. 'Although most people would say that while technologically feasible, fuel cells are still economically impractical, in countries where energy is expensive or that do not have hydrocarbon feedstocks there is a great deal of potential three to five years down the line.' Johnson Matthey supply a major part of the world's platinum group metals, demand for which could rise substantially with increased FC use as the metals are used as a catalyst on the electrodes, although alternatives and substitutes are also being developed.

The current generation of fuel cells are, at $2,500 per kW for a 200kW plant, too expensive for most applications. However, energy consultants Arthur D Little predict that the price will fall dramatically as demand improves and the comparative price of competing technologies, such as Combined Cycle Gas Turbines, increases in the face of more stringent environmental legislation planned, for example, in California.

Fuel cells, they note, are also vastly more competitive in terms of transmission and distribution costs as both the higher efficiency of smaller units (below 100MW) and the fact that they can be sited close to demand reduces the need for overhead transmission lines which they estimate can result in power losses of up to eighty percent.

The next generation of FC currently under development and testing will use proton exchange membrane (PEM), molten carbonate (MCFC) or solid oxide (SOFC) electrolytes which, in the case of MCFCs and SOFCs, will be able to operate at much higher temperatures ($\sim$1,000 celsius compared to 200 celsius for PAFCs) suitable for large-scale combined heat and power generation. Such units have already achieved up to 54 percent operating efficiency and rates as high as 80 percent are expected. PEMs are being tested at an operating temperature of 85 celsius and are approaching suitable size and performance requirements for transport applications.

***Dr Francis (Tom) Bacon studied at Eton and Trinity College, Cambridge and worked closely with the inventor of the modern steam engine, Sir Charles Parsons. He went to Kings College, London to continue work on fuel cells before moving into anti-submarine warfare in World War II. He resumed his work on fuel cells in the 1950s. In addition to an Order of the British Empire, Fellowship of the Royal Society and a Doctorate of Science, Dr Bacon was awarded the first Grove Medal (made of five ounces of platinum) in 1991. He passed away on 24 May 1992.**

Zero emission vehicles at test stage

California has introduced stringent new exhaust emission standards including a requirement for two percent of all vehicles to be zero emission vehicles (ZEVs) by 1998. Work is under way on a number of projects and the first feasible prototypes are being tested.

One of the most advanced projects in the world is the ZEV transport bus, dubbed the 'Cordless Trolley', being built in Vancouver by Ballard Power Systems and SAIC Canada. The impetus for the project, part funded by British Gas venture capital as well as the local, state and Canadian governments, is the emission legislation being implemented by California and 13 other US states. The requirement for two percent of vehicles to be ZEVs by 1998 will rise incrementally to 10 percent by 2005.

The prototype bus has been built to meet the design and performance specifications of existing diesel-powered vehicles and, according to Mr Paul Howard of Ballard Power Systems, the vehicle has met and exceeded these requirements.

'The current project is designed to prove the feasibility of the system and the results have been very positive. We deliberately aimed to better the standards required of existing vehicles and given the superior torque characteristics of electric motors this has been achieved.'

At present the cost of the vehicle would be around $1 million and the company has set a target of six years for its commercialisation programme. It predicts that the eventual unit price will be around $250,000–300,000 compared with the equivalent diesel price of $200,000–225,000.

'There are other economic considerations to be taken into account,' added Mr Howard, 'which will make the costs quite comparative. We believe that diesel and other non-ZEV units will be charged a premium relating to emissions; perhaps on a per tonne of NO_X or SO_X emitted basis.'

The prototype bus is powered by Proton Exchange Membrane Fuel Cells (PEMFCs) and will be delivered to British Columbia Transit later this year.

Ballard set up a steering committee to ensure the development programme was driven by commercial rather than technical targets. The preference in the market was found to be the use of stored hydrogen as a fuel rather than on-board hydrocarbon sources such as methanol, as transport regulators saw this as the only reasonable option for eliminating CO_2 emissions and avoiding the capital cost, weight and main-

tenance expense of having an on-board reformer for each bus.

The power system is based on 21 nominal 5kW stacks which will ultimately deliver 75kW to the wheels.

Passenger cars

There are also projects being carried out around the world — most notably by Siemens, Daimler/Benz and BMW in Germany and General Motors in the United States — on the development of FC powered passenger cars and smaller vehicles.

At Loughborough University a simulation project has been underway for four years and researchers are hoping that, with increased funding, they will be able to build a fuel cell to test in a standard vehicle. At present funds are received from the Ministry of Defence, the Research Council, British Gas and to a smaller extent, the motor industry.

Professor Paul Adcock, who works on the project, believes that there are two systems that presently seem most viable. The first involves reforming units sited at retail outlets which would deliver hydrogen directly to the consumer. The second system encompasses an on-board reforming unit using methanol as a base fuel.

'It will probably be at least 10 years,' he says 'before such vehicles, powered by a 5–10kW fuel cell, are available to the general public. There are still problems to be overcome including getting the price down, fuel storage and system size and weight.'

At present most of the work is centred on the development of hybrid vehicles which use a combination of FC and battery power. A number of different fuel types are being investigated but, at present, only natural gas or bio-gas appear to be feasible alternatives as there currently exists no technology to store the quantity of hydrogen needed to give comparative performance characteristics to internal combustion vehicles using conventional fuels.

Most developers agree that in the short to medium term the most likely applications for FC powered transport is in delivery and service vehicles. ■

Ballard's fuel cell-powered prototype bus

IP advice regarding radio telephones in cabs

By KS Millington,
Chairman of the IP Electrical Engineering Committee

The Electrical Engineering Committee DOC-1 has produced a specification DOC-1.92.1 designed to allow operators to achieve a high level of safety in their use of radio telephone equipment in the cabs of petroleum carrying vehicles. The Specification is particularly directed towards the avoidance of radio frequency induced sparking in fittings or equipment that may be close to or mounted on the vehicle. It is based on the Electrical Research Association Report 90-0481 which was prepared by the ERA on behalf of the IP.

Operators wishing to benefit from this specification are advised to instruct their radio telephone system suppliers/installers to comply with each of the following clauses (*a*) to (*e*).

(*a*) Supply and install equipment in accordance with the IP Specification DOC-1.92.1.

(*b*) Having completed and commissioned a new installation in accordance with DOC-1.92.1 or similarly inspected/modified/serviced an existing installation and found it to be in order the supplier shall issue to the operator a certificate stating that the installation does comply with the said specification. One certificate will be required for each combined transceiver and convertor installed. The certificates will be retained throughout the life of the transceivers/convertors by the operator. During subsequent servicing

THE CERTIFICATE

The certificate shall take the following form and shall contain at least all of the information detailed herein. Suppliers may add further wording relevant to their own organisation provided that the general format remains as depicted herein.

CERTIFICATE OF COMPLIANCE WITH
THE INSTITUTE OF PETROLEUM
SPECIFICATION DOC-1.92.1

I certify that the transceiver and convertor to which this certificate applies, and the method and standard of the complete installation, meet all the requirements of the Institute of Petroleum Specification DOC-1.92.1 and that the following details accurately describe the installation:

Vehicle Registration No .....

RF output of transmitter ..... Watts

Transmitter frequency ..... MHz

Make of transceiver .....

Model No of transceiver .....

Serial No of transceiver .....

Is antenna mounted at least 2m away from front end compartment man lid } YES/NO .....

If 'NO' does installation meet one of the safety conditions 12.1 to 12.6 } YES/NO .....

State which condition is met .....

The person certifying the installation shall complete all of the missing details hereon and shall sign below:

SIGNATURE ..... Name (Printed) .....

ID No (or name) of installer .....

Date of installation .....

SERVICE HISTORY

of the installation details of the work done may be entered on the certificate by the authorised radio telephone servicing agent. In the event that a radio telephone or convertor has to be changed a new certificate should be issued. At all times the certificate should bear the registration number of the relevant vehicle. If the equipment is transferred to another vehicle then a new certificate should be issued and the old one be cancelled.

(*c*) Permanently attach to the transceiver a label coloured green and bearing the message —

THIS RADIO TELEPHONE INSTALLATION MEETS THE REQUIREMENTS OF THE INSTITUTE OF PETROLEUM SPECIFICATION DOC-1.92.1

Date of installation .....
Installed in vehicle registration No .....
Serial No of Transceiver .....
Name of installer .....

The dimensions of this label should not exceed 30 × 90mm. The installer/supplier shall enter the relevant data on the label.

(*d*) Permanently attach to the associated 24 to 12 volts convertor a label coloured green bearing the message described at (*c*) above.

(*e*) In addition to the above mentioned information bearing labels operators and/or installers may choose to make use of an 'Installation Seal.' This would be similar to the label described at (*c*) but bearing the message —

'Name of Installer' INSTALLATION SEAL
CERTIFICATION VOID IF SEAL IS BROKEN

It should be fixed between the transceiver and its mounting board by the installer at the time of the initial installation. Should the seal subsequently be found to be broken, operators could assume that interference had taken place and hence require that the installation be re-examined and recertified.

The above mentioned labels and seal should be of a type that will disintegrate if attempts are made to remove them. Only the installer should be allowed to affix them and it is essential that he should certify that the equipment does meet the said specification by completing and signing the certificate referred to at (*b*) above.

By means of these labels and certificate, operators should be able to carry out the necessary check on a radio telephone installation to determine whether or not it is safe for a vehicle so fitted to be used within a loading terminal or retail forecourt.

The IP Safe Loading Pass Scheme will be modified to take account of this new specification and of the procedure outlined in this article.

For further information see the July 1991 issue of *Petroleum Review*, page 337. ■

INSTITUTE OF PETROLEUM SPECIFICATION DOC-1.92.1

1. The vehicle mounted radio telephone system and its mode of installation shall meet the requirements of both the DTI licence and the DTI installation code of practice MPT 1362.
2. The transceiver, its antenna and associated equipment and wiring shall be permanently mounted in or on the vehicle.
3. The transceiver shall be energised from the dead side of the vehicle master switch via appropriate protective devices and via a suitably rated 24 to 12 volt convertor. Additional DP isolators may be incorporated if so desired.
4. The convertor shall provide galvanic isolation between the 24 volt input and the 12 volt output, between the 24 volt input and chassis and between the 12 volt output and chassis. The convertor shall have a voltage withstand level exceeding 400 volts between input and output, input and chassis and between output and chassis.
5. The transceiver and the convertor shall be mounted on an insulating board but shall have their chassis or cases permanently connected to the vehicle chassis via a 1k ohm resistor. In the case of installation in a vehicle having a non-metallic cab the connection to vehicle chassis may be made via the metallic frame of the cab. If this resistor is built into the unit circuitry it shall be of the metal film type rated at 0.5 or 1 watt. If it is to be mounted external to the RTU or convertor it shall be of the aluminium housed ceramic core wire wound type rated at 10 watts (such as those meeting spec. MIL-R-18546C or CECC 40203.001).
6. The RF output of the transmitter shall not exceed 25 watts.
7. The antenna shall be (*a*) fully encapsulated or sheathed in insulating material and (*b*) arranged so as not to cause direct current path from transceiver to vehicle chassis.
8. The operating frequency of the transmitter shall not be less than 165 MHz. (But see also clause 12.)
9. The antenna shall be positioned as far as possible away from the nearest vehicle compartment man lid and shall be at least two metres from it. (But see also clause 12.)
10. No component or surface of any part of the installation shall exceed a temperature of 200 Celsius when the equipment is in normal operation in an ambient temperature of 40 Celsius.
11. Only high quality materials shall be used throughout the installation, conductors and all terminations and terminals shall be suitable to carry rated current continuously in an ambient temperature of 40 Celsius, all current carrying conductors, terminations and terminals shall be fully insulated or shrouded. Wire ends shall be terminated in crimped connectors.
12. Where the requirement(s) of clause 8 and/or clause 9 cannot be met one of the following six alternative safety conditions 12.1 to 12.6 shall be complied with.

Safety condition clause number	Frequency of transmitter (MHz)	Gain of antenna relative to a ¼ wave whip (Decibel)	Minimum permissible distance between antenna and first compartment man lid for gas group IIA (Metre)
12.1	41 to 68	0.0	2·0
12.2	71 to 87	0.0 to 2.5	2.0
12.3	105 to 141	0.0 to 3.0	2.0
12.4	153 to 220	0.0 to 3.0	1·5
12.5	425 to 462	0.0 to 3.0	1.0
12.6	860 to 960	0.0 to 3.0	0.5

Oil discovery brings Uzbekistan closer to independence

By Laura Le Cornu from Tashkent

For many in the former Soviet republic of Uzbekistan, a major oil blowout last March brings the sleepy Central Asian nation closer to achieving full independence and prosperity. 'March 2, 1992 is a happy day for independent Uzbekistan,' read *The Voice of Uzbekistan* 'the oil discovery has introduced our great country to the world.'

Uzbekneft, the state-run oil concern, struck oil at 5,237 metres depth in March after drilling for two years in Mingbulak, which means 'one-thousand springs' in Uzbek. Subsequently, 13,500 tonnes of crude poured daily out of the uncontrolled well, before it was finally capped two months later.

'This is a world-class blow-out. These people may become rich,' said Robert Evans, a Texas petroleum engineer, working with the Oklahoma-based well control firm Cudd.

Oil was first discovered in Mingbulak, situated about 700km east of Tashkent in the fertile Ferghana valley, over a century ago and carried out of the region in copper pitchers.

'The oil spill has caused little damage to the environment,' said Vladimir Konjukhov, assistant deputy of the Uzbekistan Environmental Protection Committee. He said, according to results of a joint investigation conducted with the US Environmental Protection Agency (EPA) around 60 hectares of cotton farmland were damaged.

The Uzbek government has signed a deal with Stan Cornelius, a US firm based in Seattle, to jointly develop the field on a 50-50 production sharing basis.

The new venture plans to drill five more wells at 6,000 metres depth at Mingbulak. The field is estimated to have reserves of at least 35 million tonnes.

Uzbekistan produced less than 3 million tonnes of crude oil in 1991 and imports around 10 million tonnes annually of mostly Siberian crude. The republic has two refineries with combined throughput capacity of about 8 million tonnes.

'Our aim is to export crude oil approximately five years from now,' said Rashidov Hakimovich, deputy head of Uzbekneft. Presenting a stack of business cards from western oil companies, he said foreign interest in Uzbekistan is high.

Uzbekistan, situated in the southeastern part of the former Soviet Union, is the largest and most populous of the Central Asian republics. Under Russian domination since the 19th century, a cotton monoculture was established that has deprived the republic of food and basic industries. It is also a major producer of natural gas and supplied nearly one-third of all gold production of the ex-Soviet Union.

'But we are still dependent on Russia. There are no car plants and metal industries here,' said Mr Hakimovich, echoing other Uzbek officials who maintain the republic is still closely linked with Russia. 'More than half of our technology is 50 years old. Since the collapse of the Union we have had difficulty obtaining spare parts and equipment,' he complained.

Uzbekistan has recently signed preliminary agreements with several oil firms including Lasmo.

Uzbekistan President Islam Karimov, an economist who was elected leader in 1991 in the country's first popular election, is keen to attract western investments to develop the country's backward industrial base. Under new legislation introduced last year, foreign investors are entitled to a two-year tax holiday and free repatriation of hard currency profits. ■

Oil and gas outlook in Turkmenistan

By Juliette Rossant

Located at the southern most end of the former Soviet Union, Turkmenistan is potentially the wealthiest of the emerging ex-Soviet republics as a result of its vast oil and natural gas reserves. Foreign companies have been put off exploring Turkmenistan because of the lack of laws protecting investment, financial instability of the republic and the absence of pipelines other than those which go through Russia and the Ukraine. However, in the long term, Turkmenistan promises to be as good a prospect as Kazakhstan has proved to be.

Natural gas production, primarily from eastern Turkmenistan, reached 84 million cubic metres in 1991, two million of which was produced from western fields. Ten percent of production is consumed locally and the rest is exported through pipelines to the Commonwealth of Independent States (CIS). Of the 112 million cubic metres of gas exported by Russia in 1991, approximately 10 million cubic metres originated in Turkmenistan. Specific information on new fields is difficult to obtain from Turkmen authorities who insist that there are too many active fields to count. However, there are new discoveries at Amudarinsky and Pravobereje and increased exploration in the southwest.

The problems facing the natural gas sector are not related to production but to price and transportation. The CIS agreed to a price of 800 roubles per 1,000 cubic metres plus transportation fees last year up from 30 roubles in 1990 but well below the world market price for natural gas. The Ukraine, reportedly, balked at the price and the gas pipeline to the Ukraine was eventually closed. The Ukraine meanwhile is charging close to world market prices for its own agricultural produce.

The other republics, although urging lower price for natural gas, have acquiesced and are buying gas on a clearing house basis. However, in a bid to keep prices from rising higher, to world market prices next year, Russia froze $2.2 billion in Turkmenistan's accounts in its export bank, Veneshekonom.

In a meeting of the Central Asian republics this April, pressure was put on President Sapamurat Niyazov to guarantee lower rates for the Turkic-speaking republics. So far, the Turkmen president has declined to lower rates preferentially; however, he is under continuing pressure to do so. Turkmenistan relies on pipelines that pass through Russia and the Ukraine to export its natural gas. Although the republic has signed an agreement with Iran to build a pipeline which would carry gas to Turkey and Europe, the project is by no means definite — funding is still a problem and the pipeline would take at least five years to construct. Meanwhile Turkmenistan is dependent on the Central Bank of Russia to provide roubles and on the other republics to honour agreements for the supply of consumer products.

The government is planning to accept new bids in the second half of the year after important legislation on the protection of foreign investments and 100 per cent foreign-owned companies is approved. A new draft constitution, to be approved mid-year, is being studied by different groups. What is currently missing are regulations on investments, privatisation and customs. Many governmental decisions are being made through presidential decree which can mean delays and confusion.

Turkmenistan is, however, politically relatively stable compared with its neighbours. The small population of 3.5 million of which only 2.5 million are ethnic Turkmen has meant the government has had an easy time of supplying consumer needs without loosening the reins of power. There are virtually no opposition parties and most of the structures of government dating back to the Soviet period are intact.

President Niyazov and his cabinet,

'President Niyazov and his cabinet are extremely concerned about abrupt change and a too radical shift to free market policies'

Crude oil deposits are located predominantly in the west of the country in the Iranian-Azerbaijan belt up to the north to the huge Enghiz oil deposits discovered recently in Kazakhstan.

Turkmenistan produces 5.4 million tons of oil annually, with reserves estimated at 213 million tons. There are two refineries which process crude oil in Turkmenistan. One at Krasnavosk which processes 5.5 million tons and one at Charchov which processes 7 million tons and is used primarily to process imported crude from Russia.

The Argentinian company Bridis established a joint venture with the petroleum ministry to explore for oil for one year after winning a tender offer. Turkmen officials say other foreign companies were interested in bidding as well but failed to meet criterion or dropped out for unknown reasons.

mainly holdovers from communist rule, are extremely concerned about abrupt change and a too radical shift to free market policies. Relations with Iran are warm, as Iran represents the only non-CIS neighbouring country and transportation links through Iran would provide Turkmenistan not only with access to the Gulf but also to Turkey and Europe through train and pipeline links. There are currently four border crossings with Iran. At the same time, the Turkmen government identifies itself closely with Turkey and has so far rejected any lean to an Islamic fundamentalist state.

Turkmenistan's obvious potential is, however, severely limited by its geographic position and current reliance on transportation through the CIS. The severe squeeze on finance cause by Russia's refusal to release roubles and foreign currency means that Turkmenistan seems ripe for foreign investors who have a long-term view. ■

Fresh welcome to Canada for foreign companies

By Carol Reader

Earlier this year the Canadian government decided to make a radical policy change in order to stimulate the petroleum industry — henceforth there is no longer a requirement to ensure Canadian ownership of 50 percent of the upstream oil and gas industry through the Oil and Gas Acquisitions Policy. Announcing the change, Jake Epp, Minister of Energy, Mines and Resources, said 'With these changes, oil and gas will be treated exactly the same under the Investment Canada review process as any other sector.'

The earlier Canadianisation policy dates back to the 1960s when there was a very nationalistic atmosphere in Canada and it was felt that the natural resources, particularly the profitable oil and gas resources, should be reserved for the benefit of Canadians. As a result a national energy policy was created aimed at 50 percent Canadian ownership of oil reserves. While there were fairly strict limits, the problem was that at the outset Canadian ownership did not amount to 50 percent — but only some 30 percent.

One way of reaching this target was to exclude all the smaller companies which were owned by foreign companies. This gave a chance for Canadians to become players in the business. A lot of Americans from Texas and other places moved up to Canada and became Canadian citizens or Canadian residents to develop these assets. But the share never reached 50 percent — about 49 percent was the maximum.

Subsequently, although the government acted to reduce intervention in industry and promote free trade, it retained the goal of 50 percent Canadian ownership in the upstream sector of the oil and gas business. This meant that acquisitions by foreign investors of healthy Canadian controlled companies or properties were not allowed, although the acquisition of Canadian-controlled producers in financial difficulty, or of foreign controlled producers, was allowed subject to conditions which included commitments on increased Canadian ownership and investment spending.

The 50 percent Canadian ownership goal was virtually achieved but at a cost. Recently criticism of this policy has been increasing, particularly since the ability of Canadian-controlled companies to sell and to rationalise their holdings of oil assets was restricted, causing problems in obtaining financing.

It was therefore decided to make a radical turnabout and open up the upstream oil sector to further foreign investment, by allowing foreign interests to own the smaller companies.

However, the government will still continue to review foreign direct acquisitions over Can$5 million and indirect acquisitions over Can$50 million, except for US buyers whose threshold will be Can$150 million (under the Free Trade Act). These are the same review thresholds that currently apply to other sectors of the economy.

Speaking to *Petroleum Review* in London, Mr EA Walker, Special Adviser (Investments), Canadian High Commission, said 'This latest move allows foreign companies to invest in Canadian oil exploration development and production on a controlled basis. I think it is a very good thing for the industry.'

'It is hoped that the policy change will bring new funds into the smaller companies which at present make up only 10 percent of the total investment in the oil business in Canada,' he added.

'The prime aim is to stimulate the exploration momentum by attracting extra investment funds. Over the last two years the Canadian oil and gas industry has made a poor showing, compared with other sectors of the economy. This was caused by the lower than expected prices for both oil and gas during and after the Gulf War. Moreover, some 9,000 jobs have been lost and the trend seemed likely to continue, unless some stimulus was given.

'Over the same period there have been a number of company changes, including several mergers. Chinese interests came in, while BP plc floated BP Canada on a public issue and then Husky went off to a Hong Kong interest. A few companies have pulled out and a few new companies have come to Canada,' Mr Walker said that he was confident that a fresh wave of companies would now show an interest in the Canadian upstream. He told *Petroleum Review* that he had already canvassed 80 companies in Britain and at least eight had showed a definite interest in doing business in Canada. 'So it is a positive step,' he added.

The Scottish oil and gas service and supply industry companies are already being encouraged to 'go international' and look to Canada, where it is felt that their technological expertise and experience of working in harsh environments could be of benefit. In January Scottish Enterprise carried out an in-depth analysis of market opportunities in Offshore Newfoundland and particularly in the Hibernia project. It indicated the huge potential of the frontier offshore areas of Canada, many parts of which are as yet relatively unexplored. This contrasts with the mature oil and gas producing area concentrated mainly in Alberta, where the likelihood of finding new large finds are not high.

First oil flowed from the Panuke field in June.

Hibernia

Developments of the large offshore discovery at Hibernia (estimated reserves of 525 million barrels) was finally going ahead, with the topsides engineering, procurement contract and the project services contracts already awarded (see *Petroleum Review*, January 1992). However, all activity on this Newfoundland development has now been stopped after one of the partners in the consortium, Gulf Canada Resources, pulled out of the Can$5.2 billion project in March.

The other partners in Hibernia Management & Development Company — Petro-Canada, Mobil Canada and Chevron Canada — halted work on the project and postponed the start-up date by a year to late 1997. However, their search for a new partner or new funds seems so far to have been unsuccessful.

Gulf's pull-out came as a big blow, particularly since massive public funding had already invested on the related infrastructure, training and technology transfer allowances etc.

While there is widespread dismay at the current fate of the huge Hibernia project, other offshore projects are making progress. The Cohasset and Panuke oil discoveries offshore Nova Scotia are now being developed (see page 308). These are operated by a joint venture between Lasmo and Nova Scotia Resources Ltd and are expected to produce some 38,000 barrels per day.

Meanwhile, the Canadian authorities are keen to attract new foreign companies to Canada. Two or three smaller companies in western Canada are coming up for sale for one reason or another and it is hoped that there will be some UK players in future offerings. The Canadians believe that this is an excellent time for UK companies to step into Canada for the first time because by buying an oil and gas company with adequate assets one is buying oil cheaper than if one speculates on finding it.

British Gas, for instance, is already in Bow Valley and the expectation is that now the regulations have changed that they will take an even greater interest in Canada.

Offshore potential

While virtually all exploration in Canada until recent times has been onshore, the great potential now is considered to lie in the frontier areas, largely offshore. However, as Mr Walker pointed out, the oil price in fact needs to be $28–30 a barrel so that while prices are down at $18–22 a barrel, the development of some offshore discoveries are not economic with the result that most companies are holding back until prices recover.

The same argument also applies to the vast reserves of unconventional oil sources — principally the tar sands, concentrated at Athabasca, where the present rate of production could be maintained for 400 years but expansion awaits a sufficiently high oil price — say $27–28.

Now that the Ottawa government has opened up the oil industry to new foreign investment, fresh funding should now be pumped into both conventional and unconventional oil and the latest technology to exploit those resources. As Mr Epp said, 'These changes open the way for increased industry activity and competitiveness and boost future hopes for prosperity throughout Canada'. ■

Uncertainties and challenges for the oil industry: a commercial banker's view

By Herman Mulder, Senior Vice President, ABN AMRO Bank

A new world

The recent changes in geo-politics are profound and offer hopes and expectations for the 1990s: the issue now is to keep the initial momentum by delivering adequate ways and means for the fulfilment. Will there indeed be a more stable and peaceful Middle East, will the transition from communist, centrally planned economies into more market oriented economies be relatively smooth and will the Uruguay Round on international trade be successful, ie stimulating global free and fair trade, rather than a new wave of protectionism which would be particularly at the expense of the developing countries?

The agenda for the 1990s is heavy: cleaning up and reconstructing Central/Eastern Europe, constructing new capacities in the Middle East, while some of the old debris has still not been removed: a high level of public sector (internal) debt in most of the OECD-countries and a still sizeable external (hard currency) debt load for quite a number of countries in Latin America, Asia and Africa. Dealing with this agenda requires a high degree of realism, prioritising, internal discipline, goodwill and also a constructive attitude of governments towards creating an acceptable climate for domestic and international private investment.

Enormous call on capital

The financing of the agenda in developing countries and in the countries 'in transition' in Eastern Europe may be a major bottleneck, as a result of which priorities, timing and funding sources must be carefully evaluated and planned. As far as the private sector is concerned, equity and credits will only be following the opportunities with the best risk/reward balance.

The political desirability of programmes, as perceived by the local governments and/or the international community, does not play a role herein, hence political priority projects must be enhanced by official investment/credit protection.

Against this background certain types of projects qualify better for foreign investment/credits because of their nature or because of their economic/legal environment:

a. rates of return (ROE 25 + %), credit-margins (125 + basis points) should reflect commercial and political risks;
b. countries with a positive and reliable political/legal infrastructure towards business (including free convertibility/-transferability of income);
c. a developed domestic capital market and banking system, enabling the mobilisation of international and regional funds;
d. independent/de-coupled state-owned companies as partner, client or borrower, rather than government agencies;
e. credit insurance-, investment protection-programmes and co-financing with multilateral institutions;
f. a balanced mix of export-projects and purely domestic or import substitution projects: the relation between hard currency funding (by way of equity and/or credit) and project cash (in-) flows should be a sound one.

The relevancy of each of these issues is, of course, also a function of the strategic interest and the staying power of the foreign investor.

Financing the oil industry

The oil (and natural gas) sector is one of the sectors which offers some of the greatest opportunities for the governments in developing countries and countries 'in transition' (in Eastern Europe), to attract private investment. The countries often have the natural resources but lack the technology, management expertise and the capital. Oil is an international commodity (although suffering from a political liability) and the relevant players are typically strong companies with an international reach, and therefore with appreciation of working in technical and political frontier areas.

By its nature, ie apart from the political risk in the countries where the operations occur, the oil industry is faced with a significant capital and operating risk: capital expenditures have a high fixed cost component, are heavily front-end loaded and are lead-time sensitive. In our view, the oil industry, cyclical as it is, is currently entering into a 'post-contraction pre-expansion phase', which may put strains on the supply of adequate staff, services and goods. In itself it is comforting that after a period of contraction of four to five years, capital expenditures worldwide seem to be bottoming out, despite high real interest rates and continuing uncertainty about future oil-prices.

Recent analyses made by us on the minimum required capital expenditures in production, transportation and marketing of oil and natural gas for only maintaining present capacities (ie a reserve replacement rate of 1.0, with a minimum remaining reserve life of 10 years and applying the same mix of capital expenditures as during the previous expansion-cycle 1973–1982), are globally around $200 billion per annum.

The top 25 integrated oil companies should be able to finance $50–80 billion (or 25–40 percent) by way of their cashflow, equity raising ability and borrowing capacity. The balance must be financed by the state-owned companies, other private (oil) companies, governments, multilateral institutions and commercial banks. This is not impossible provided that the structures and the risk/reward balances are right, which means a pro-business attitude from the host governments.

An issue is also whether the pace of

capital expenditures in the oil industry is currently sufficiently high to ensure a longer-term stable, balanced energy development. It may not be the case. In this context we are of the opinion that reliance on foreign (mostly OECD sourced) financing for domestic projects or for the local cost component of export projects in developing countries should be reduced — regional capital markets must play a more important role.

Global capital is not scarce *per se* but it is highly dislocated from a significant portion of possible applications, notably in developing countries and in the 'economies in transition'. Also, in an uncertain world capital has a short-term focus. For the energy industry, with its long-term nature, this may be a handicap.

European Energy Charter

One of the most challenging opportunities to create momentum in Europe is the European Energy Charter to strengthen the European house by matching (1) Western management, technology and capital for increased (nuclear), environmental protection, safety and energy conservation in Central and East Europe, with (2) natural gas and oil imports. There is, generally, consensus that West and Central Europe will need to import (much) more natural gas from the C.I.S. beginning at the turn of the century.

With project leadtimes of eight to ten years, preparation should start now rather than later. It seems, however, that there is currently more political momentum for such a plan than there is in the oil industry.

The challenge appears to be how to convert such a political European Energy Charter, with 45 countries involved, into a framework for business action: designing and striving for an ideal world is necessary but, during the transition period, there must be sufficient catalysts in place, offered by all governments involved, to induce industry to invest and operate in the countries concerned on a sufficiently large scale to accelerate the realisation of a better world.

Beware of complacency

Lack of today's investments to diversify the oil supply base will be putting increasing pressure on tomorrow's world and on the Middle East, Saudi Arabia in particular. For this and for environmental reasons, continued emphasis must be put on energy conservation. Also, developing higher cost reserves to broaden the diversity of supply, implies paying an acceptable insurance premium. The surpluses of oil during the 1980s should not be taken for granted during the 1990s; energy today may have become cheaper than we can afford in the long run! ■

Conference report

Western Australian premier seeks second LNG project

Western Australian Premier Ms Carmen Lawrence told delegates at the Australian Petroleum Exploration Association (APEA) annual conference in Perth that evidence to date suggested the industry was reluctant to develop another greenfield LNG project in the state.

She accused the industry of dragging its feet on the development of Australia's offshore gas reserves.

The existing North-West Shelf project had frequently been suggested as being adequate to meet future market needs but new markets were emerging, particularly in Korea and Taiwan. This suggested there was room for new projects. 'I cannot but wonder whether the national interest is best served by continuing to rely on one market only for LNG [Japan], rather than spreading our customers more broadly,' the Premier said.

She suggested the public could be better informed on the issue if the outcome of next year's price renegotiation of the North-West Shelf contracts with Japanese buyers were made public. To date the LNG pricing formulas have remained confidential.

Her views were at loggerheads with those expressed in the same week by Mr Charles Allen, managing director of the North-West Shelf project's operator, Woodside Petroleum Ltd.

Mr Allen told an international conference in Kuala Lumpur that although potential demand would outstrip supply in the next two decades the equations needed for new greenfield LNG projects were not adding up under current economic conditions.

'Pricing is a key factor, so too are relations between suppliers and buyers and, in particular, the sharing of "rents" of returns between the parties and the timing of cash flows,' he said.

To make a project attractive, he added, sellers required a sufficient flow of funds to support initial investments, replace reserves and generate an appropriate return on funds for investors.

'Unless these needs are met to an acceptable extent we cannot continue to have an industry.'

Ms Lawrence told the conference that the WA Government had banned oil and mineral exploration drilling in WA marine parks, marine nature reserves and in all proposed parks and reserves.

She said two existing permits, issued after a marine park was announced but before the policy on drilling was finalised, would allow drilling.

The sea bed to a depth of 100m was also protected under the new guidelines. However, pipelines and other marine structures might be allowed to be built in marine parks in the future provided they meet environmental guidelines.

Ms Lawrence also noted that a directional well could be drilled beneath a marine park from outside the park boundaries provided the drilling rig did not encroach on the protected area. In addition, seismic surveys may be permitted in marine parks to assist in determining prospects which lie adjacent to existing reserves.

Petroleum companies tended to under-estimate the role the WA Government has played in promoting the industry in Western Australia, she added. 'For many years the people of this State have been told that without the WA Government's take-or-pay domestic gas contract there would be no LNG project on the North-West Shelf.'

'If this is true then perhaps there should be greater recognition by the partners in the NWS project of the impact the domestic gas contract has had on the people of Western Australia.'

She said to argue, as some of the NWS partners had, that the WA Government had no right to be concerned about the price to be paid for domestic gas was to completely misunderstand the role of Government.

The current domestic gas contract between the NWS partners and the WA Government is under review. According to Ms Lawrence the current contract was disadvantageous to commercial, industrial and domestic gas consumers.

Choice of platforms

In recent weeks industry debate has raged over the use of floating offshore production systems following a claim by the Federal Government's Bureau of Mineral Resources (BMR) that $A15 billion of oil reserves could be left in the ground if floating production systems were used to develop new discoveries off Western Australia instead of fixed offshore platforms.

The oil industry has rejected the BMR arguments that floating systems are less efficient than fixed platforms saying that when circumstances demand, floating systems can often be the best solution for oil and gas production.

In an address to the conference, Senator Peter Cook, speaking on behalf of Federal Resources Minister, Mr Alan Griffiths, said the Government did not seek to impose a 'preferred' approach to oil developments.

Mr Cook said the government did not 'want to assume the role that falls properly within the province of the private sector'. He also stressed that if any government instrumentality, such as the BMR raised 'an issue of national significance, the merits or otherwise of the case put forward must be rigorously examined'.

He added that scrutiny by government instrumentalities of technical proposals planned by oil companies for a development project would give due consideration to all relevant matters.

The government, however, assured the oil industry that any matter raised by such an organisation would be dealt with promptly and rigorously.

'It is clearly essential that companies proposing investments of hundreds of millions of dollars in resource development projects are not subjected to any protracted delay and uncertainty.'

Floating production systems are clearly the first choice of developers off the WA coast. One is proposed for the Cossack project operated by Woodside Petroleum; another for the $A660 million Griffin project, just announced by BHP as a development which will

use a floating production and storage system; and a further system is likely for the development of the Wandoo field by Ampolex Ltd following success in the Coogong – 1 Wildcat 20kms north of Wandoo.

The Bureau of Mineral Resources, through its chief petroleum engineer, Mr Dennis Wright, continued its attack on the use of subsea oil well completion technology and floating oil field production facilities in a technical paper delivered at the conference.

The use of such technology was strongly defended by BHP Petroleum's group general manager (production), Mr Brian McCammon.

In the paper Mr Wright explained his theory on how large volumes of hydrocarbon reserves could be left under-developed through the use of subsea completions. He claimed it was common in the oil industry to achieve substantial growth in the known volume of reserves in a field once production had begun.

The knowledge acquired through actual production performance of wells and subsequent follow-up drilling in extensions of the fields and by reworking existing production wells had often resulted in sharply higher production.

When a field is developed using a fixed platform from which follow-up drilling can be performed the cost of later wells is low, thus encouraging additional drilling.

Mr Wright said the cost of working over wells completed as subsea facilities was extremely high and discouraged companies from carrying out follow-up work. In addition the use of floating production facilities, which are unable to carry a drilling rig, might result in no further follow-up drilling. If additional drilling was to be done it had to be carried out by manoeuvring a separate drilling rig close to the production facility at very high cost.

The extra costs of follow-up work on a field developed using a floating production facility and sub-sea wells was a big disincentive, Mr Wright maintained.

In a strong rebuttal of these claims Mr McCammon cited BHP's experience with the Jabiru field in the Timor Sea. Jabiru was developed using a floating production facility and was initially developed on the basis of 11 million barrels of proven recoverable reserves.

Only one well was initially completed as a production well although the production vessel was built with the capacity to take up to four wells. Major upgrades to the Jabiru floating facility since its construction have seen three more production wells drilled and tied to the facility. New oil and gas-handling technology has been built into the production facility in that time.

Mr McCammon said that to date production from Jabiru had totalled 69 million barrels and proven reserves estimates had risen to 100 million barrels. Modifications to the field were made as information about the hydrocarbon reservoir became available through production data. The maximising of production from oil reservoirs was the primary objective. The major benefit of the floating production facility technology was its flexibility, he said.

Maintenance of access

Esso Australia Ltd added its voice to those calling for the maintenance of access to land and sea acreage for oil exploration.

In the keynote environmental speech Esso's chairman and managing director, Mr John Schubert, said the industry needed continued access to prospective acreage and approval to develop discoveries.

His call followed the announcement by the WA Government that it had banned drilling in marine parks within coastal waters.

'We must ensure that at the time of commitment and approval of exploration expenditure, companies have a reasonable certainty of being able to develop any commercial discoveries,' Mr Schubert said.

'An important component of dialogue with government has to be the principle of multiple land and marine use. Failure to address these issues could threaten the industry's ability to compete for international exploration and development capital.'

Mr Schubert added that because Australia's oil industry was such a big player in the country's economy it was important to ensure the industry remained strong.

'If uncertainty surrounding environmental regulation continues to increase, or if government resolves the issues in ways which affect our industry's access to acreage, land and marine tenure or the efficiency of operations, the balance may be tipped further against investment in Australia and towards prospective areas available overseas.' ■

William Scholes

Alternative ethanol production research

Scientists working at the Imperial College of Science have developed a method of producing ethanol from agricultural waste that is normally burnt as stubble. A pilot plant is currently being developed.

The use of alcohols, particularly ethanol, as an alternative to petrol as a fuel is well established though the decision to use it has been based less on efficiency as a fuel or price than on strategic considerations.

In Brazil, for instance, where 33 percent of vehicles run on ethanol, the decision to utilise the cane-growing areas for production of ethanol for transportation was made in 1975 and was designed to reduce reliance on imported crude. The move was accomplished with only limited success and with the benefit of high subsidy levels.

In the United States ethanol is added to some unleaded fuels at a rate approaching 10 percent and is seen by some as a way to meet the tough air quality laws. Some analysts estimate that the number of alcohol-fuelled vehicles on US roads will total one million by 1997.

The major drawbacks of the fuel are the production cost from non-petroleum sources — which can be up to three times that of petrol — and its low calorific value. Research being carried out in Britain, however, may have come up with a novel process that could sharply reduce variable production costs and make ethanol a viable on-site energy source.

Most ethanol for industrial use is at present made from oil. Potable alcohol is obtained from the conversion of sugar cane bagasse. Plausible costs for fermentation and ethanol recovery using established technology have been calculated by the Centre for Biotechnology at Imperial College, London, at $0.43–$0.50 per litre.

Most of what farmers grow is wasted. Cereal straws contain about 45 percent cellulose, 35 percent hemicellulose and 10 percent lignin. Soft straws such as rapestraw contain even more hemicellulose and pulps such as sugar beet and citrus pulp are mostly pectins.

Cellulose is difficult to convert to its constituent sugars because the fibres are designed by nature to be non-degradable, being semi-crystalline and waterproofed by lignin glued in place by hemicelluloses. By contrast, hemicelluloses and pectins are easy to hydrolyse but have been ignored because yeasts cannot ferment the resulting sugars.

Efforts to degrade cellulose to sugars are misplaced as it is a useful natural fibre. Chemical paper pulping of wood hydrolyses the hemicellulose glue and makes the lignin water soluble so that cellulose fibres remain after simple water washing. But the wash contains over half of the dry weight that is uselessly incinerated at considerable fuel cost during chemicals recovery.

However alternative paper-pulping processes are now at hand, using high pressure steam to hydrolyse the hemicellulose 'glue', which is washed away. The lignin can then be extracted with organic solvents such as ethanol. The Canadian 'ALLCELL' process uses hot aqueous ethanol to combine both steps; the ethanol is recovered by distillation, leaving soluble hemicellulose and undegraded lignin.

Since yeasts cannot efficiently utilise the major sugars derived from hemicellulose or pectins, research has been directed to engineering an organism that can do so. Scientists selected a thermophilic *Bacillus* that utilises them anaerobically very rapidly at 70°C, probably because its natural home is high-temperature compost heaps. It did not make much ethanol but with CEC support they have constructed a mutant by a combination of genetic and physiological manipulation that makes ethanol from pentoses in yields approaching that of yeasts on starch-based sugars, but much more rapidly.

Since non-growing cells give maximum ethanol yields, a novel continuous two-stage 'Closed System' is being developed that maximises ethanol production from a wide range of mixed sugars. Hemicellulose sugars are fed to non-growing cells at 70°C retained in an anaerobic reactor by membrane filtration. Most of the ethanol is removed in the vapour by N_2 sparging or mild vacuum; this allows use of high sugar feeds without ethanol toxicity. Ethanol is stripped from the filtrate by distillation or membrane separation and the stillage is passed to an aerobic fermenter in which the unused sugars and by-products are converted to fresh thermophile cells. These are then concentrated by membrane filtration and passed to the catalytic anaerobic reactor to compensate for the death rate of the cells therein.

This Closed System has many advantages. It is self-optimising for ethanol production; if the catalytic rate in the anaerobic reactor declines, more sugars pass to the aerobic stage and so the catalytic rate is restored by the increased flux of fresh cells. It is also automated via CO_2 sensors, since the rate of ethanol production equals the rate of anaerobic CO_2 production and the aerobic CO_2 production reflects the amount of waste sugar and by-products. Hence maximising anaerobic CO_2 production maximises ethanol yield.

The system is being developed to pilot plant stage under an EC ECLAIR contract by a consortium of Imperial College (strain improvement and system development), École Centrale de Paris (automation and membrane ethanol separations), Institut Français du Pétrole (studies of wood and wheat straw hemicelluloses from their steam-explosion pilot plant) and University College Galway (studies on sugar beet pulp). The next stage will be to construct a pilot plant to assess a variety of feedstocks derived from agricultural wastes.

Preliminary estimates of ethanol costs are below $0.50/litre for total conversion of sugar-cane bagasse to ethanol and below $0.25/litre for utilisation of ALCELL paper pulping wastes, excluding fixed costs. In the latter case, it is relevant that self-contained and non-polluting pulping plus ethanol plants could be built in remote forest locations. It is only a small step from this technology to making paper plus liquid fuels from straw. In cases where wastes are factory generated — eg sugar beet plants or citrus juice plants — similar ethanol costs may be possible.

Petroleum Review **acknowledges the assistance of Professor BS Hartley FRS in the preparation of this article.**

. . . people

Mr David Smith, above, has been appointed Customer Service Director of Edacom Data Systems. Mr Smith is a founder member of the company and has previously served as Technical Director.

Great Lakes (Europe) Limited has appointed **Dr Richard Elsmore** to the position of Technical Manager. Dr Elsmore has worked in the speciality biocide industry for both Coalite Chemicals and the Boots Company. He will be responsible for the European technical development of the company's biocide business.

Mr Ron Goodfellow, below, has joined Mott MacDonald's Maritime Division. Mr Goodfellow has many years experience in offshore and subsea engineering, docks and harbours. He has assisted in the development of a number of North Sea oil and gas fields and advised on projects in North America, the Middle and Far East.

Mr John Duncan has been appointed a Director of Addison and Baxter Ltd, UK. He has been with the company for a year as Projects Manager and was previously with seismic contractors Simon Horizon for 10 years.

Mr Patrick Clark has joined Intercat Inc, the manufacturer of specialty FCC additives for the petroleum industry, as a Senior Technical Service Engineer.

Fina plc have appointed **Mr Bernard Claude** to the Board as Executive Director, Exploration and Production with responsibilities for Fina's UK Exploration and Production activities. This follows Mr Claude's recent promotion to General Manager, Exploration and Production.

Brown Fintube Company has promoted **Mr Nick Spinks**, above, to the position of Vice President of Sales and Marketing. Mr Spinks has 25 years of design engineering and sales experience in the field of heat transfer and has specialised in applications technology in the hydrocarbon process, petroleum and power industries.

Wilcomatic have appointed **Miss Susan Jones** as Sales and Marketing Co-Ordinator.

Bandera Engineering Inc has appointed **Mr Fred Dorst** as Project Manager of the Consolidated Oil Ltd, Offshore Nigeria project. Mr Dorst has many years of diversified project management experience in the design and installation of offshore oil and gas production facilities.

Mr Roger King, former Member of Parliament for Birmingham Northfield, is to be the new Head of External Affairs at the Society of Motor Manufacturers and Traders.

British Gas has appointed **Mr Tom Hendy** as Head of Industrial and Commercial Contracts. His responsibilities will include the implementation and development of contract price schedules and the co-ordination of industrial and commercial marketing policy.

RJ Brown and Associates have promted **Mr Vural Dolen** to the position of Vice President of RJ Brown and Associates (Far East) Pte Ltd. Mr Dolen joined the company in 1973 when he served as Senior Project Engineer. He has been in Singapore since 1988 as the Engineering Manager.

Mr Alex Carter, above, has been appointed Manager of Construction at Foster Wheeler Petroleum Development Limited. He has 16 years experience in the offshore oil and gas industry, mainly with Brown and Root, where he was the Construction Manager on several major projects in the North Sea.

Mr David Whittle has joined the Computer Management Group as a senior consultant from Price Waterhouse Management Consultancy Services. Mr Whittle was involved in a number of key consulting assignments with major oil companies whilst with Price Waterhouse and has also worked in-house for Mobil and Texaco.

Former Venezuelan education minister **Mr Gustavo Roosen** has been appointed President of Petroleos de Venezuela.

Mr Graeme Donald, above, has been appointed to the new post of General Manager at Engelhard's Petroleum Catalyst Group for the Middle East and Africa.

Mr Ian Mackrell has been appointed UK Director of the Corporate Banking Group of Barclays Bank. Mr Mackrell was formerly Banking Director for the energy, mining and chemicals team within the Corporate Banking Group. Replacing Mr Mackrell is **Mr Robert Skinner** who returns to London after serving as Managing Director of Barclays Bank Swaziland Ltd.

Dr Gerry Orbell, below, has been appointed Director of Exploration at Premier Consolidated Oilfields plc as well as a main board Director. He was previously General Manager and Director of Exploration and Production for Fina Exploration Ltd.

Institute News

New Collective Member

MOL Tankship Management Ltd

6th Floor, Dexter House, Royal Mint Court, London EC3N 4JR. Tel: 071 702 3762. IP Nominated Representative: Capt MB Smith, General Manager.

MOL Tankship Management Ltd is a subsidiary of Mitsui (OSK) Lines Ltd (MOL), formed in 1964 with the merger of the Mitsui Steamship Company and the OSK Line. The business is built around a fleet of high-speed vessels, including containerships, tankers and specialised carriers for a range of products and commodities, and includes a 'total logistics' service of sea, land and air transportation, as well as global distribution and warehousing, ship brokering, ship agency, insurance and port and harbour transportation.

Deaths

It is with regret that we have been notified of the following deaths:

	Elected
Denis R Bailey, Wantage, Oxon	1948
RD Briggs, Texas, USA	1977
GPR Esdale, Hampstead, London	1956
GH Harries, Sale, Cheshire	1944
Douglas R Harvey, Langwathby, Cumbria	1979
Capt Alec Haines Little, Eastleigh, Hants	1964
DAD Munro, Stone, Staffs	1977
GG Pennie, Drymen, Glasgow	1983
AG Shaw, Camberley, Surrey	1977

Around the Branches

Irish

24 September: Seminar on Gas Pipeline
29 September: Golf Outing

Shetland

15 September: 'Ladies Night'
13 October: 'Training for a Changing World', Bob Edmondson, Institute of Petroleum.

South Wales

22 September: 'Virtual Reality — A vision of the future', Mr J Huff, Virtual Presence Limited.
20 October: 'Removal of Sub Surface Hydrocarbon Pollution', Mr G Licence, Miller Environmental.

Captain George Buckenham receives his Institute of Petroleum Award of Council in Aberdeen on 12 May 1992. Left to right: Alan Higgins, Chairman of the Institute of Petroleum Aberdeen Branch; Mrs Pat Buckenham; Captain George Buckenham and Mr Ramsay Spence OBE, immediate past Chairman of Aberdeen Branch.

Netherlands Branch

The Interim Committee is busy with formalities relating to the legal establishment of the new branch. All IP members in the Netherlands will be sent full details of the first meeting in September. For further information please contact the secretary: Mr Chris Fisher (010) 31 4798600.

New Members

Mr A Abubakar, 9 Elms Court, Sudbury, Wembley, Middx HA0 2RT
Mr E Agulefo, Marine Technical Services International (Nigeria) Ltd, 34 Wharf Road, PO Box 118, Apapa, Lagos, Nigeria
Mr AR Ali, Emirates General Petroleum Corporation, PO Box 9400, Dubai, UAE
Ms L Allen, British Gas plc, London Research Station, Michael Road, London SW6 2AD
Mr R Al Shamsi, Emirates General Petroleum Corporation, PO Box 9400, Dubai, UAE
Mr CF Ash, Power Display Signs Ltd, Blashworth House, 14A Cranborne Industrial Estate, Cranborne Road, Potters Bar, Herts EN6 3JF
Ms S Ashton, 4 Ravensroost, Beulah Hill, London SE19 3LN
Mr M Azmudeh, Inter-Oil (UK) Ltd, 50 Hans Crescent, London SW1X 0NB
Mr C Bryan, 18 Pembridge Place, Bayswater, London W2 4XB
Mr AY Butler, Jr, Esso Exploration & Production UK Ltd, Mailpoint 509, Esso House, Victoria Street, London SW1E 5JW
Mr MS Butt, 6 Birchgrave Close, Courthouse Green, Charters Field, Coventry CV6 7NQ
Mr C Caley, Caixa Postal No 3266, Luanda, Angola
Mr LS Chauhan, Pencol Engineering Consultants, Darpen House, Citadel Place, Tinworth Street, London SE11 5EH
Mr B Cheyne, 9 Vistavird, Brae, Shetland ZE2 9SL
Mr DJ Cline, Paribas Ltd, 33 Wigmore Street, London W1H 0BN
Mr PH Cochrane, Century Oils Ltd, Unit 8, Rathenraw Industrial Estate, Antrim, Northern Ireland BT41 2SJ
Mr PG Coolen, British Gas Exploration & Production, 100 Thames Valley Park Drive, Reading, Berkshire RG6 1PT
Mr JM Cooper, Mars & Co, 12–18 Grosvenor Gardens, London SW1W 0DH
Dr AFC Coppin, 8 Warfield Avenue, Waterlooville, Portsmouth, Hants PO7 7JJ
Mr T Dada, 25 Martynside House, Grahame Park, Colindale, London NW9 5UT
Mr S Darby, Yamaichi International (Europe), Finsbury Court, 111–117 Finsbury Pavement, London EC2A 1EQ
Mr JB Dawes, Association of United Kingdom Oil Independents, 8 The Limes, 35 Highbury Grove, London N5 1HJ
Mr M Denham, 16 Underwood Drive, Whitby, South Wirral L65 9BJ
Dr N Diab, Unifert Group SA, (Centre de Coordination), 44 Avenue des Arts, 1040 Brussels, Belgium
Mr J Dingwall, SFO Engineering, The Coach House, Rope Hill, Boldre, Lymington, Hants SO41 8NE
Mr RW Duke, Kerr-McGee Oil (UK) plc, 75 Davies Street, London W1Y 1FA
Mr D Edwards, 19 Bowers Road, Benfleet, Essex SS7 5PZ
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Mr NW Francis, Nick Francis & Associates Ltd, 1 Torwood Close, Berkhamstead, Herts HP4 3NU
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Mr AJ Furber, Western Geophysical, PO Box 18, 455 London Road, Isleworth, Middx TW7 5AB
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Mr JR Gray, 2 Stacey Court, Albury Road, Merstham, Redhill, Surrey RH1 3LS
Mr JW Gray, 2 Queens Court, Hillview Road, Woking, Surrey GU22 7NE
Mr HMJ Groenendijk, Reevwijk, Tormentil 14, 2811 RV, Netherlands
Mrs CH Hatcher, Clyde & Co, 51 Eastcheap, London EC3M 1JP

Institute News

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Mr KCJW Hunter, BP Africa Ltd, Britannic Tower (SW–05), Moor Lane, London EC2Y 9BU
Mr JE Irwin, 4 Mount Eden Park, Malone Road, Belfast, Northern Ireland BT9 6RA
Mr P Joyce, Thomas Howell Kiewit, Trinity Court, 42 Trinity Square, London EC3N 4TH
Mr SM Kearney, 72 Meade Hill Road, Crumpsall, Manchester M8 6LS
Mr DR Krahn, European Offshore Affairs, IADC, 17 Grosvenor Hill, London W1X 9HG
Mr B Lakshminarayanan, Emirates General Petroleum Corporation, PO Box 9400, Dubai, UAE
Mr HM Lam, Government Laboratory, 12 Oil Street, North Point, Hong Kong
Mr JD Lauderdale, 27 Market Place, Houghton-le-Spring, Tyne & Wear, DH5 8AH
Mr AM Leatherbarrow, Fire-Tech Ltd, Old Railway Road, Birkirkargh, Malta
Mr JA McMahon, 90 Brynn Street, St Helens, Merseyside WA10 1JA
Mr O Marashian, Platt's Oilgram News, McGraw Hill Inc, Communication Information Services, 1221 Avenue of Americas, NY 10020, USA
Mr TJ Martindale, Tim Martindale Associates Ltd, 1 Avro Court, Ermine Business Park, Ermine Street, Huntingdon, Cambs PE18 6XS
Mr D Matukutuku, Zambia Consolidated Copper Mines, Technical Services, PO Box 260071, Kalulushi, Zambia
Mr MW Maudsley, Elephant's Nest, 2 Barons Way, Langdon Hills, Basildon, Essex SS16 6BN
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Mr SJ Pritchard, Ysgoldy, Bryncroes, Pwllheli, Gwynedd LL53 8EB
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Mr D Ruddock, Geochem Group Ltd, Chester Street, Chester CH4 8RD
Mr JD Rudge, 7 Duneside, Fairfield, Stockton-on-Tees, Cleveland TS19 0TX
Mr K Sandison, SAS Institute, Tara House, 46 Bath Street, Glasgow G2 1AG
Mr BA Scriven, Willcox Hose Ltd, 236–237 Record Street, London SE15 1TL
Mr S Sharma,SAS Institute, Whittington House, Henley Road, Marlow, Bucks SL7 2EB
Dr S Sokolovic, Faculty of Technology, B.Avnoj-a 1, 21 000 Hovi Sad, Yugoslavia
Miss SC Steele, Finneys Drift, Annandale Drive, Beccles, Suffolk NR34 7BG
Mr RH Summers, Byggwik-Telford Ltd, 30 St Mary's Street, Bridgnorth, Salop WV16 4DW
Mr WA Thomas, Windsor Thomas Ltd, Cherry Orchards, Cholesbury Common, Tring, Herts HP23 6ND
Mr SW Warr, Willis Faber & Dumas Ltd, Ten Trinity Square, London EC3P 3AX
Mr EBB Wright, International Petroleum Industry Environmental Conservation Association, Monmouth House, 87 Westbourne Grove, London W2 4UL

Student Prize Winner

Mr TM Goodall, Department of Petroleum Geology, Meston Building, King's College, Aberdeen AB9 2UE

Students

Mr MH Dusabe, University of Dundee, Centre for Petroleum & Mineral Law & Policy, Park Place, Dundee DD1 4HN
Mr SRM Graham, Riverside House, Coast Road, West Mersea, Colchester, Essex CO5 8PA
Mr D McGoldrick, RGIT, Kepplestone House, Viewfield Road, Aberdeen AB9 2PW
Mr DD Peng, 13a Carnegie Tower, Dundee DD3 7EA
Ms GM Slaven, 65 Hardgate, Aberdeen AB1 2UX

UK Deliveries into Consumption

April 1992 — Tonnes

Products	*Apr 1991†*	*Apr 1992**	*Jan–Apr 1991†*	*Jan–Apr 1992**	*% change*
Naphtha/LDF	235,700	310,092	1,222,696	1,171,917	−4.2
ATF—Kerosine	427,502	518,323	1,684,733	1,977,770	17.4
Motor Spirit	2,011,107	2,044,614	7,680,718	7,790,113	1.4
of which unleaded	809, 773	937,342	2,999,038	3,495,456	16.6
Super unleaded	94,470	120,307	347,021	434,908	25.3
Premium unleaded	715,303	817,035	2,652,017	3,060,548	15.4
Burning Oil	196,957	213,661	964,474	1,003,289	4.0
Derv Fuel	895,535	917,621	3,491,418	3,597,218	3.0
Gas/Diesel Oil	694,540	657,482	3,014,429	2,855,903	−5.3
Fuel Oil	920,516	1,016,160	4,071,095	4,167,670	2.4
Lubricating Oil	65,158	63,359	248,894	264,937	6.4
Other Products	638,047	562,966	2,208,071	2,281,547	3.3
Total above	6,085,062	6,304,278	24,586,528	25,110,364	2.1
Refinery Consumption	495,443	495,947	1,971,418	1,979,219	0.4
Total all products	6,580,505	6,800,225	26,557,946	27,089,583	2.0

†Revised with adjustments *Preliminary

Parallel computing network

Geophysical contractor Ensign Geophysics has converted to parallel computers for mainstream seismic processing. During the second half of 1991 a network of four systems was installed providing an impressive combined computer capacity of over 2.5 Gigaflops.

Ensign's Processing Director, Pete Northmore, explained the significance; 'The arrival of the new systems has increased our available processing capacity by several factors. The use of a parallel architecture means that all steps in a processing scheme, including data reading, writing and sorting, execute concurrently. This results in turnaround times being unaffected by the complexity of processing. Several sophisticated processing schemes used for recent surveys would previously have been considered impractical.'

The beneficial effect is also felt by Marketing Manager, Terry Quinn; 'The new developments allow us the confidence to respond very positively to the exploration industry's demands for reduced costs and faster turnarounds, particularly regarding 3D projects.'

Ensign have been developing parallel algorithms since 1986, latterly with the sponsorship of Shell UK Exploration and Production and the UK Department of Energy. The end result is a system referred to as the *BatchStation* — a versatile software architecture executing at supercomputer speeds on low cost computer equipment.

The hardware platform is based around an expandable heterogeneous array of processors supplied by computer manufacturer, Meiko Ltd. Intel i860 processors are used for computation, whilst Sparc processors handle input/output tasks and allow the integration of a large range of standard software products. Specific nodes on the network are configured with additional memory to allow data sorting to take place in parallel with computation.

Ensign has now made its parallel *BatchStation* software available for purchase.

Seabed sampling tool

Alluvial Mining has streamlined its SeaSam sampling tool for high penetration drilling in hard seabed conditions during marine soil investigations.

The remotely-operated tool has been specially-developed for rapid surveys in regions where seabed soil characteristics can vary markedly.

Applications include marine site investigation, pre-dredging studies, surveys in dredging channels, pipeline route surveys, and rig site surveys.

The manufacturers claim that the modifications, together with updates to its control systems and hydraulics, have given the SeaSam greater penetration, plus an impressive core recovery record. It can core using barrels up to 150mm in diameter, achieving 6m penetration into most rock types.

SeaSam has recently completed, to a tight timescale, a 10km geotechnical survey along proposed new shipping channels in the Middle East. During this survey, over highly variable ground conditions, Alluvial Mining achieved core recoveries of 100 percent, no less, all to 6m depth into the seabed at over 100 locations.

Biomedical technology helps combat corrosion problem

Industries involved in aqueous processes have fought sulphate-reducing bacteria (SRBs) since the turn of the century when it was recognised that SRBs cause a multitude of corrosion problems. The sulphide produced by SRBs causes corrosion, odour and iron sulphide plugging problems. Once SRBs are detected in large numbers, biofouling and other bacterial cleanliness problems are not far behind.

In the 1980s, biomedical research identified a specific enzyme — adenosine-5'-phosphosulphate (APS) reductase — common to all strains of SRBs. This discovery led to a more accurate and immediate method of detecting and quantifying SRBs using an antibody which DuPont Research and Conoco Production Research developed.

A patented SRB detection test introduced by Conoco Specialty Products in 1988 is now marketed under the tradename RapidChek and is distributed in the North Sea by Oilfield Microbiology Services. The company's new test kit, the RapidChek II, simplifies test methodology, but it employs the same immunoassay technology.

The RapidChek II test enables operators to identify and quantify SRB populations on site. In contrast with conventional culture methods, RapidChek II offers several advantages:

- Immediate, accurate detection of SRBs;
- Results which are not compromised by chemical or salinity interferences;
- Detection of strains that are difficult to grow in culture;
- Field interpretation without laboratory equipment; and
- Adjustable detection limits.

Traditional culture tests take days or weeks to show results and often underestimate SRB counts because of growth-limiting factors. The RapidChek II method produces accurate results within 20 minutes and detects most SRB strains present in system waters.

Crude oil inspection

The need for a service to complement the loadport surveys has been apparent for some time. This need has been researched and fully studied. The result of this research is the 'Docksider'.

The 'Petrak Docksider' is a multi-function unit to carry out crude oil inspections; the facilities have been custom-built on a 7.5 ton chassis to provide both office and laboratory facilities. Each unit will be manned by two qualified and experienced cargo surveyors, who will be constantly updating clients from the office on the events happening during operations.

The facilities include full communications, phone, fax and telex through a Satcom C unit. The computer on-board includes the Petrak database, word processing and report generating abilities.

The laboratory unit has been designed to handle crude oil. It is equipped to handle the following tests: density by hydrometer, density by DMA PAAR, water by distillation, water by Karl Fischer, sediments by extraction and pour point.

Miniature multichannel video transmission

In a major new development from the world of fibre optics, UK firm COE has developed a multichannel video transmission system that is 90 percent smaller than any of its predecessors.

Designed primarily for use on remotely operated vehicles and submersibles, the Series 500 transmission unit has a volume of approximately 0.6 litres compared with the 5.6 litre volume of existing modules.

COE's system is capable of multiplexing up to five channels of video on a single optical fibre, together with four channels of duplex audio and data. It can therefore be used for hydrophones as well as monitoring and surveillance.

Because of its size, the miniature unit can now be housed within much smaller containers.

For rig installations, and other situations where fibre optic cabling is preferable to copper for safety reasons, the module can be enclosed in a flameproof BASEFA housing.

The system is powered by a single rail 12v supply and can be used with either single or multimode fibre.

The RX module at the monitoring end of the system is standard Eurocard format.

Solar powered valve control

Masoneilan Division Dresser UK Limited has recently supplied 12 high pressure control valves to the Middle East for use on offshore gas modules. The control device employed to supply a 4–20mA control signal is powered by storage batteries charged by solar energy.

The specially modified 21000 series Globe valves are directly actuated by hydraulic power which is provided by a ring main system operating at a pressure of 380 bar produced by pumps driven by the well gas. The maximum working pressure of the valve actuator and associated control gear is 210 bar, so the ring main pressure is first reduced via a self-contained regulator.

The 4-20mA positioning control signal to the valves is fed to an intrinsically safe electronic control unit which, in turn, controls an hydraulic servo valve used to feed a double acting hydraulic valve actuator. A servo device has been used in preference to the more conventional poppet valves in this application in order to minimise the demand on the 24 volt electrical supply provided by the solar energised batteries.

The system ensures that a constant electrical supply is maintained throughout periods of cloud and/or darkness.

Tank level gauging systems

A new generation of easily installed tank gauging systems for use in refineries, tank farms and chemical plants has been introduced by Saab Tank Control.

The TankRadar L/2 features a new modular design with stand-alone gauges offering improved system flexibility and a greater degree of accuracy than most other systems on the market today, providing the user with output tolerances as fine as one millimetre.

The components of the L/2 system are smaller and ligher than their equivalents in the previous system, making installation easier. Its distributed computing power means stand-alone transmitters and lower installed cost. The new system, distributed in the United Kingdom by FMA Ltd, has even greater accuracy and repeatability than its predecessor.

New pressure calibrator

Druck Ltd has launched a new portable pressure calibrator, an improved version of the previous DPI 601 model which dates back to 1987.

The new model, DPI 605, features a number of enhancements to meet an expanding range of application requirements. The latest addition to the company's range of digital pressure calibrators, first introduced in 1981, includes various interfacing capabilities and the ability to read temperatures. The latest version is more accurate and shows dual readings — both pressure and current. An optional extra is a temperature probe.

The new instrument has been given the means to store test programme results and the ability to transfer them (with the necessary software) to a host computer for analysis and storage. Series of calibration results can be stored in the instrument's memory or printed out with an optional printer.

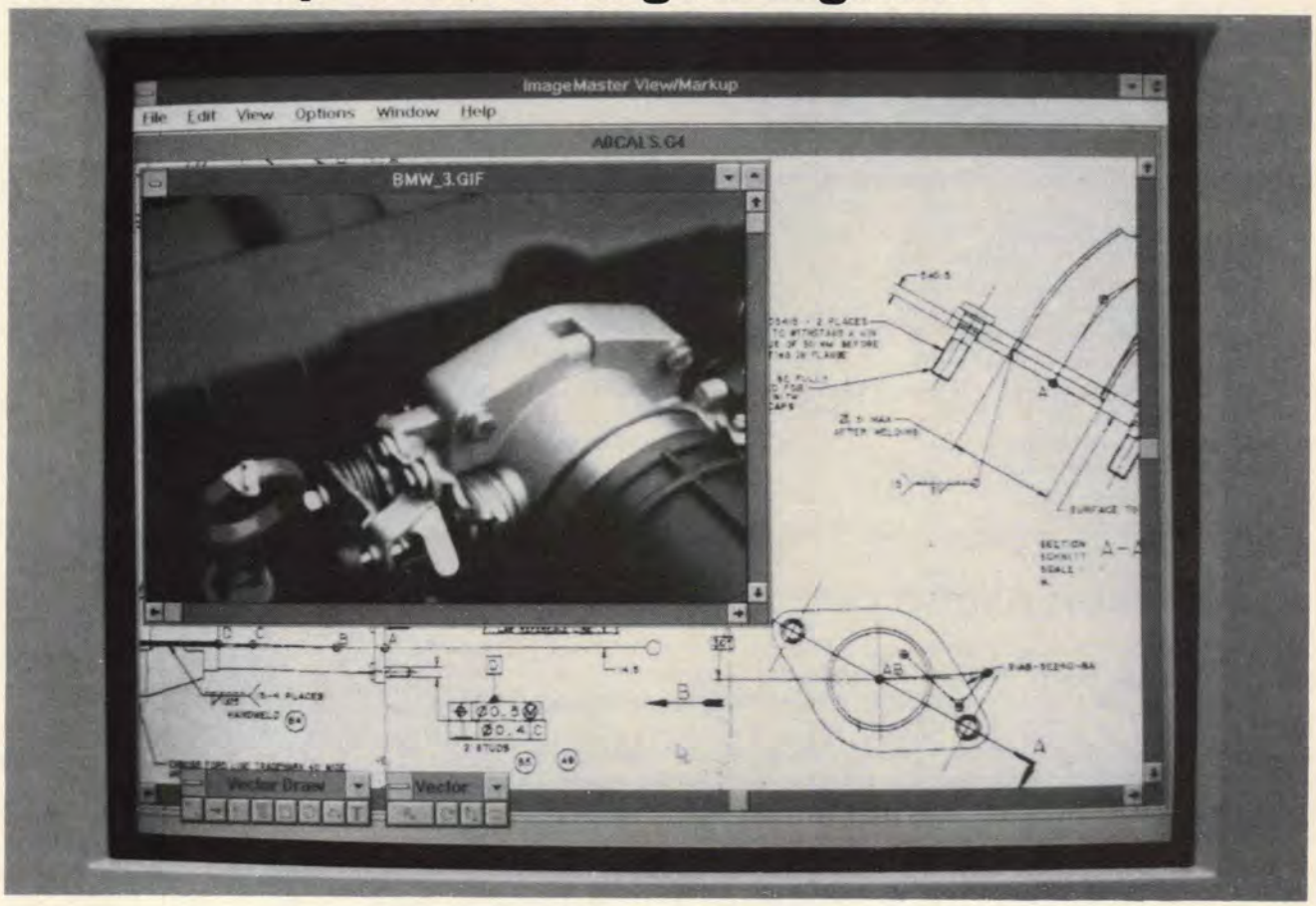
The new instrument is sturdily built; it is enclosed in a tough, sealed weatherproof casing so that it is capable of long-term precision under difficult operating conditions.

Digital viscometer

A digital instrument, with clear, easy to read display, the DVI Plus Viscometer can be used in centipoise or percentage scale with a choice of 18 rotational speeds.

Unlike some other instruments which take intermittant measurements and are inherently less accurate at low speeds, the DVI Plus provides continuous sensing — ensuring an accuracy of within one percent of range across the complete range of speeds. It also allows direct output to chart recorder.

Multi-media problem solving for engineers



Cimage International has brought the engineering community one step further into the multi-media world with, for the first time, video cameras which can link into a technical document image management system (TDIMS) via a PC.

The new video products are seen as a key step forward in engineering problem solving and decision making.

'If you imagine that you are on a North Sea oil platform and you spot a problem, for example with corrosion, having video camera input means you can take a picture of the problem, download it on a PC on the platform and electronically distribute it to engineers at other remote sites who need to see the problem to be able to solve it,' said Cimage International's industry marketing manager, Ewan Botterill. 'In the "bad old days", such a problem would have been handled by endless pieces of paper, telephone calls and visits to the oil platform, all meaning costly delays and reduced safety.'

Companies can benefit from the ability to download and view photographs on a PC. Users can then index the photographs into Cimage International's Document Manager (a powerful networked TDIMS) for distribution via wide area network, modem or fax. The images can be retrieved and viewed by any user on the network using Cimage International's ImageMaster suite of products. ImageMaster also allows users to mark-up images (overlay graphics and textual comments), as well as to manage the mark-up approval cycle across a company.

Cimage International offers two types of photographic image input — a digital still camera and a still video camera. The Digital Still Camera is a very simple, 256-level grayscale, battery-powered digital camera which can store up to 32 images in memory. The images are downloaded via high-speed RS-232C/RS-423 serial link to the PC for viewing and distribution.

Cimage's still video camera offers a more comprehensive set of features than its digital still counterpart. Based on PAL format video technology, the camera can store up to 50 images, either colour or grayscale, on a removeable 2" floppy disc.

Contact List

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Cimage International	0344 860055
Control Transducers	0234 217704
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Masoneilan	0895 258161
Brookfield Viscometers	081 502 4220
Ensign	0932 857433
COE	0532 370054
Petrak	(44) 737 222270
Druck	0533 314314

Load washer

Control Transducers of Bedford have developed a temperature compensated low-cost load washer for measuring bolt stresses, monitoring overloads and ensuring clamping forces.

The Model LW is available from 100 kilos to 100,000 kilos rated capacity. It varies in size from 25mm dia × 9mm thick to 76mm dia × 32mm and is supplied with a domed load button and load base. Spherical washers to correct for misalignment or uneven surfaces can be supplied optionally.

Temperature range is −10 Deg °C to 65 Deg °C with good temperature stability of span and zero. A high temperature option up to 200 Deg °C is also made. Repeatability is 0.15 percent FS, non-linearity 0.15 percent FS and hysteresis 0·15 percent FS.

. . . appointments

Safety awareness for top executives

Directors and senior managers from Texaco have been participating in a series of specialist seminars on health and safety in order to enhance the management of safety within the company. Texaco put 16–20 executives on each of the four one-day courses.

Each of the Senior Management Health and Safety Awareness Seminars, held at the Institute of Petroleum and run in conjunction with the Robens Institute, focused on the importance of the personal commitment of senior executives to health and safety.

The programme has been designed to run for one day so as to optimise the time available for senior management to introduce such courses into their schedule and this was reflected in the calibre of the speakers.

The delegates to the seminar examined the legal requirements under present UK and EC legislation for all aspects of occupational health and safety in a presentation by Professor Peter Waterhouse. In it he pointed out the consequences of senior management consent, connivance or negligence and the powers available to Magistrates and Crown courts to impose terms of imprisonment and punitive fines on the guilty parties.

Mr John Eberlein, ex-Chairman of the Environment, Health and Safety Management Committee of UKPIA, drew on examples of recent disasters to illustrate the consequences of management system failures. The group broke into syndicates to work through scenarios which were then reviewed by other members of the team.

Attitudes to safety and perception of risk within the workforce were examined by Professor Terry Lee. 'There is often an alarming disparity between the subjective perceptions of risk and carefully quantified assessments made by "expert" scientists and engineers,' said Professor Lee. 'The former cannot be dismissed as "irrational" or due to ignorance. There are particular attributes that influence the evaluation of hazards by the layman, such as voluntariness, familiarity, immediacy and the trade-off between personal risk and reward.'

It was necessary to understand these factors in order to anticipate and prevent accidents.

The relationship between a fully implemented, adequately resourced safety management programme and profitable companies was demonstrated by Professor David Elliott, the Shell Professorial Research Fellow at the Robens Institute.

Using a statistical model, Professor Elliott demonstrated how a company with a workforce of 10,000 might suffer annual losses due to unsafe acts and ill-health of:

- 8 employee-years due to Lost Time Incidents;
- 12 deaths in service per annum;
- 30 medical retirements per annum; and,
- More than 200 employee-years due to sickness absence.

Manager — Upstream

The Institute of Petroleum wishes to appoint a Technical Manager whose prime responsibility and activity will be in the oil exploration and production areas.

The person will be the focal point at the Institute for all upstream matters, including coordinator of the recently formed Upstream Operations Committee and the Exploration and Production Discussion Group in London.

Applicants who must be self-starters should have direct experience in oil exploration and/or production and have the ability to develop the Institute's role in the upstream area in co-ordination with other upstream organisations, government departments, and European and international committees. The work will include co-ordination of standards and procedures development and the monitoring of a small research activity.

The Technical Department is a small group which covers a wide range of oil industry activities and the person appointed may also have to undertake responsibilities in other areas, consistent with his/her experience.

The working environment is good and is located in central London close to Oxford Street.

Salary will be dependent on experience and qualifications. There is a contributory pension fund.

Applications marked 'personal' and enclosing CV should be sent to:

Mr J Hayes,
Technical Director,
Institute of Petroleum,
61 New Cavendish Street,
London W1M 8AR.

The Institute of Petroleum

DEVELOPMENTS IN AIRCRAFT FUELLING

Thursday, 19 November 1992

A one-day Conference to be held at
The Cavendish Conference Centre, London

This conference, organised by the IP Aviation Liaison Committee, will explore the latest developments in aircraft fuelling. There will also be an exhibition by major equipment manufacturers.

Topics to be covered include:

Developments in Aircraft Fuelling Systems ★ Developments in Fuelling Equipment ★ Hydrant System Integrity Monitoring ★ Extended Services – Operational and Liability Aspects

For further information, and a copy of the registration form which will be available shortly, please contact

Caroline Little, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Telephone: 071 636 1004. Telex: 264380. Fax: 071 255 1472

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