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

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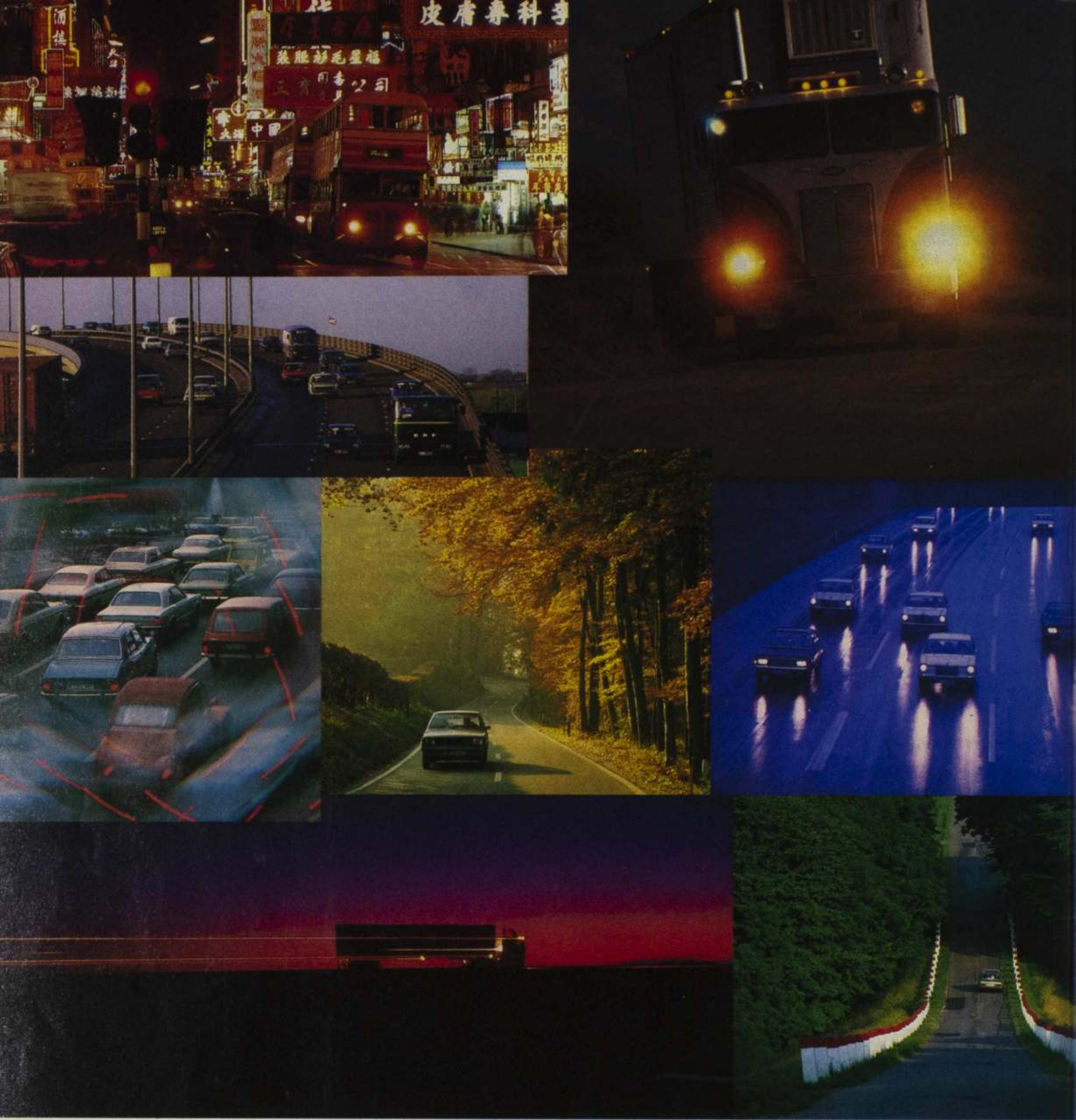


5 August
Muhammed Al-Oteiba Group to build $400m oil refinery at free trade zone in Shen Zhen, China.
Negotiations between Esso and Petronas over participation in $378.85m. Peninsular gas utilisation project reaches final stage.
Union Pacific Corp confirms inviting bids for purchase of its Wilmington oil refinery.
Venezuela and Mexico renew commitments to supply oil on preferential terms to Central America and Caribbean, including Belize, with first time quota of 500 bpd.

8 August
Occidental Petroleum (UK) Ltd drills exploration well 12 miles offshore Poole harbour.
Dept of Transport says UK to delay tougher exhaust emission standards for large cars by three years.
Elf Aquitaine to begin drilling exploratory well at Ivry-sur-Seine, S Paris.

9 August
BP tries idea to bring back attended fill service to garage forecourts, charging £1 for basic checks and cleaning.
Japanese term buyers of LNG ask Indonesia, Malaysia and other oil producers to cut LNG export prices.
Gas leak on Norwegian North Sea oil platform prompts evacuation of 300.
Scallop Petroleum Co to shut down in September 1988 say reports.

10 August
Kuwaiti govt signs undertaking not to increase its 21.7% stake in BP and refrain from influencing company policy.
Iran gives priority to rebuilding and expanding oil, petrochemicals and heavy industries after ceasefire.

11 August
Ecopetrol discovers new oil field containing 15m bls of proven reserves.
Neste raises stake in Sovereign Oil and Gas to 14.9%.
Madagascar seeks foreign partners to build $324m synthetic oil plant.

15 August
Conoco Inc and partners discover oil 160 miles offshore Quito.
Shipowners are targets of new oil frauds emanating from Nigeria.
USSR economic reforms favour future joint ventures with US Oil companies.

16 August
Saudi Arabia agrees to buy 50% stake in Texaco Inc's refining and distribution activities.
French Union of Banks agree to lend Istanbul FrFL.693bn to build natural gas distribution network for home heating.

17 August
BHP announces Montara-One well in Timor Sea flows 35.5° API oil at maximum 5,536 bpd.
Showa Shell Sekiyu Kaihatsu KK acquires 10% stake in oil field on NZ's North Island.
USSR crude oil exports show rise in 1987 of nearly 200,000 bpd to 4m bpd, almost equal to Saudi Arabian output.

18 August
Govt gives financial guarantees to Emerald Field Contractors and Soverign Oil and Gas for conversion of rig for Emerald field development.
Britoil's new oil rig 'Oil Alliance' to be at forefront of deepwater exploration programme costing £300–325m in 1990.
Up to $\frac{1}{10}$ of all US proven oil and gas reserves are for sale as oil industry undergoes mass restructuring.
Major Middle East economies, will be hit by continued weak oil prices over next five years, EIU study concludes.

19 August
Ultramar plc says appraisal well on block 49.5 in North Sea gas basin flowed 18.7m cu ft of natural gas and 150 bls condensate per day.
Husky Oil Ltd leads race for Texaco Canada Inc assets.
China to construct first LPG carrier with 3000 cb m capacity.
Thai Shell Exploration & Production Co Ltd says its new Wat Ten oil field started producing an average 600 bpd.

23 August
Dept Energy directs North Sea oil cos to submit plans for safety modifications to offshore rigs which could cost £100's millions.
Barringer Oil begins search for new fields offshore Scotland using Fluoroscan laser-based technique which detects bubbles from 'gas cap' over oil reserves.
Petroleum Directorate issues most pessimistic forecast for Norwegian oil producing prospects to date.

24 August
Statoil to begin talks with Brit Gas for annual delivery of 5bn cu m of Norwegian gas to UK.
Angola plans to increase crude production to 500,000 bpd from anticipated 450,000 bpd to year end 1988 output.
French govt to ease year old embargo on oil imports from Iran by swapping Iranian oil imports against French exports.

6 September
All 36 wells at Piper Alpha platform are sealed while work advances to restore production at Claymore and Tartan fields.
Oil and gas strike by ONGC off Tamil Nadu coast yields 2,470 bls and 55,868 cu metres per day.
Norwegian Oil and Energy Ministry to allocate 13 offshore blocks in disputed fisheries area of Barents Sea and new Haltenbank oil province in 1989.
Australia and Indonesia agree to develop oil and mineral resources in Timor Gap, with possible reserves of 5bn bls.

7 September
TransCanada Pipelines Ltd file application to build 3.3km pipeline parallel to existing line in Ontario.
Japan agrees to supply technical know-how including gas exploration and petrochemical production to Qatar, investing $6bn to develop North Field.
Taiwan negotiates crude oil purchases from Iraq as domestic demand rises and supplies are diversified.

8 September
Statoil to build natural gas terminal at Zeebrugge and large petrochemical complex in Belgium.
Husky Oil plans to increase international oil investment in next four years from current level of less than 10% of its asset base.

9 September
BHP Petroleum to explore for oil in Congo for first time at 1,300km Kayes B onshore block.
Shell Oil Co cancels high cost drilling contract in Mexican Gulf.
OPEC Secretary General contacts Venezuela and other member states on whether to call extraordinary conference over current slump in world oil prices.

12 September
New co, Associated Gas, headed by Lord Ezra, believes it will break British Gas monopoly, being within months of concluding contracts on gas distribution by early 1991.
Govt seems set to face criticism for failure to actively promote use of unleaded fuel, following publication of rules requiring new cars to run on the fuel from October 1989.
RWE to concentrate oil and gas activities in new energy co, large enough to compete with Veba, Esso, Shell, BP and Mobil.

13 September
Broker Hoare Govett stages "dawn raid" on LASMO shares paying 480p per share, though buyer is not named.
Petroleum Industry Association says bigger financial incentive needed to increase poor sales of unleaded petrol, but Society of Motor Manufacturers and Traders says could encourage people to buy wrong petrol.
President of OPEC warns price of oil could drop to $9 a barrel without members support.

14 September
LASMO sells 29% stake in Enterprise Oil Plc and claims is unrelated to Brit Gas moves.
National Energy Board gives approval to Shell Canada Ltd to build natural gas pipeline to US near Ontario.
Environment Minister says leaded petrol will be banned in Canada from Dec 1 1990.

15 September
Govt authorises Mobil's Camelot gas field, Hamilton Bros' Crawford oilfield and £52m expansion of Amoco's Indefatigable D gas field, first oil and gas projects to be approved since Piper Alpha disaster.
BP Drilling Technology in Aberdeen announces it has developed a universal subsea wellhead, tested on 14 different wells.
Legislation to establish Malta as new offshore insurance, ship registration and finance centre to be introduced by island's govt.
Proven reserves of US crude oil rose greatly in 1987, owing mainly to oil cos upgrading Alaskan reserve estimates.

16 September
Occidental announces Piper Alpha wreckage to be demolished by controlled explosion, and field to be redeveloped.
Indonesian private consortium to build 580km oil pipeline network worth $306.64m across Island of Java.
Pemex informs clients it's suspending all oil exports for 3 days from 14 Sept, no explanation given.

19 September
BP expects to double its N Sea drilling activity in 1989 in effort to comply with exploration commitment with govt.
Oil cos want to abandon showing price of 4 star on signs outside petrol stations and advertise price of unleaded instead, in bid to increase sales.

Conoco takes an optimistic view on the future of Southern Basin gas

John R Kemp, Director and General Manager, Southern Operations, Conoco (UK) Limited in an interview with *Petroleum Review* following the inauguration recently of the Viking gas fields in the southern North Sea said:

● 'We have looked very closely at the overall UK supply and demand picture. We are confident at the present time there are ample indigenous supplies of gas to meet the UK's requirements in both the short and longer term.'

● 'Our gas is for sale to everyone—British Gas and industrial users. We have restructured our gas division specifically to identify opportunities to sell direct to users'.

John R Kemp is Director and General Manager of Conoco's UK southern operations. He joined Conoco 22 years ago after graduating in petroleum and natural gas engineering from Pennsylvania State University. Before moving to London in January this year, Mr Kemp was president and managing director of Conoco's Dutch subsidiary, Continental Netherlands Oil Company, and had earlier held a number of engineering and management positions in the United States.

Geoffrey Mayhew: The Southern Basin has a long history of gas production now. Can you tell me how much gas has been produced from this sector to date?

John Kemp: To the end of 1987, I believe approximately 18.6 trillion cubic feet of gas had been produced from the Southern Basin since production began in 1967.

How does the UK Southern Basin compare with, say, the Dutch sector of the North Sea in terms of number of fields and production volumes?

There are, I think, more developments on the UK side — some 25 to 30 gas fields compared with around half that number offshore the Netherlands. Average daily production is more than twice as high from the UK sector. That does not, of course, include the vast onshore Groningen field, which alone produces almost as much as the entire UK Continental Shelf.

Have there been peaks and troughs of activity in the Southern Basin?

Yes there certainly have. After the initial phase of intensive exploration and development activity in the late sixties and early seventies, there was a downturn that lasted until the beginning of this decade. This was due to market forces: British Gas had secured sufficient supplies from the original large fields to meet their requirements and the price they were offering for additional reserves did not warrant further exploration.

During this period, Conoco and the other major operators turned their attention to the northern North Sea and the development of our oil reserves.

What brought you back to the Southern Basin?

Price. Demand for gas trebled through the seventies and by the end of the decade British Gas were looking for new supplies and offering prices that made it attractive for the explorers to return to the area.

That was in the early eighties?

Yes. And what you are seeing now with the completion of the 'V' fields project and other developments is the result of that sharp upturn in drilling activity at the start of the decade.

How would you describe the future potential of the Southern Basin, assuming acceptable economics?

I think the potential for further discoveries in the area is considerable. We believe there is a good deal of gas still to be found in the Rotliegendes formation, where most of the gas to date has been discovered, but also in the deeper Carboniferous sandstones.

The Rotliegendes has been the primary reservoir rock and is basically in the southern part of the basin. Producing wells in the Rotliegendes are generally very productive. The Carboniferous strata are principally in the northern part of the basin, and while the reservoir characteristics there are not as good as in the Rotliegendes, we believe they contain significant reserves for the future. Conoco is carrying out an aggressive exploration programme in both areas of the Southern Basin.

Is the Carboniferous more difficult to explore and produce from?

I would not say it was more difficult to explore. I think we are now going through the same evolutionary process in the Carboniferous as we did in the Rotliegendes. There is high risk with all exploratory programmes and that applies to both these formations.

Since Carboniferous reservoirs generally appear to be tighter than Rotliegendes, development costs can certainly be expected to be higher as more wells will be needed to exploit a given-sized field.

Are there any Carboniferous fields in production in the Southern Basin so far?

I do not believe so. There have been a number of significant discovery wells drilled but I do not think any Carboniferous reserves are yet being produced.

There is no doubt that Britain will need more gas to meet its needs through the nineties and into the next century. Does Conoco believe this gas can be found within the UK's own waters?

We have looked, and continue to look, very closely at the overall UK supply and demand picture. We are confident at the present time that there are ample indigenous supplies of gas to meet the UK's

continued on p6

Mrs Thatcher inaugurates 'V' gas fields

The Prime Minister, the Rt Hon Mrs Margaret Thatcher, MP, with Conoco (UK) Chairman John Ogren at the inauguration of the Viking Gas Terminal in Lincolnshire recently.

One of the largest gas developments in the UK North Sea for more than a decade, the Conoco-operated 'V' fields project, was formally inaugurated by The Prime Minister, the Rt Hon Mrs Margaret Thatcher, MP, recently.

The four 'V' fields — Vulcan, Vanguard, North Valiant and South Valiant — lie some 70 miles off the Lincolnshire coast and are being developed by Conoco in partnership with Britoil, Arco, Marathon, Occidental, Shell and Esso.

The fields are being developed through a major new gas transporation system known as the Lincolnshire Offshore Gas Gathering System (LOGGS). Jointly owned by Conoco and Britoil, LOGGS will also handle gas from the nearby Phillips-operated Audrey field.

The system has the capacity to serve additional discoveries in the area and will ultimately be able to transport some two billion cubic feet of gas per day, or around 20 per cent of Britain's daily gas requirements. Commercial sales begin this month.

The inauguration of these facilities by the Prime Minister at the Viking Gas Terminal, Theddlethorpe, Lincolnshire, marked the culmination of a four-year development programme that was completed ahead of schedule and below the original project estimate of £760m. The cost is expected to be some £632m.

Tribute

Mrs Thatcher said: 'I want to pay tribute to the tremendous amount that the economy and prosperity of this country owes to those who work in oil and gas.'

The Prime Minister described the highly automated 'V' fields development as 'a landmark in Britain's history of exploration and production.'

'We're here today to see the very latest technology, and the very best health and safety techniques,' she said.

Contribution beyond 2000

John Ogren, Chairman and Managing Director of Conoco (UK) Limited, described the successful completion of the 'V' fields project as highly significant for the 'V' field partners and Britain as a whole. The 'V' fields and LOGGS will be contributing to Britain's gas needs into the next century,' he said.

'The development demonstrates that, given realistic pricing and taxation policies, the UK suppliers can maintain a high level of indigenous gas production for many years to come.'

Production from the 'V' fields is highly automated, with six unmanned wellhead platforms linked by some 35 miles of subsea flowlines to a central gas gathering station consisting of separate, bridge-linked accommodation, production and, later, compression facilities.

After initial treatment and metering at the gas gathering station, the gas and associated liquids are transported via the LOGGS pipeline to the expanded Viking Gas Terminal at Theddlethorpe. From there, the gas is passed to the adjacent British Gas Terminal before entering the national grid, while the liquids are piped to Conoco's Humber Refinery.

The 'V' Gas Gathering Station consists of three platforms: production, accommodation and compression. These are linked by two interconnecting bridges, with a third bridge linking the GGS to the North Valiant 1 wellhead platform.

The GGS has a design capacity of 1,200 million standard cubic feet of gas per day. Gas and condensate from Audrey will be metered separately on the GGS before being mixed with gas from the four 'V' fields and transported ashore. A further 800mmscfd of gas can be taken by the trunkline from additional risers at the GGS, or from injection at the subsea tees.

Production platform

The production platform is an eight leg structure and comprises three deck levels — main, mezzanine and cellar — housing all production equipment and facilities. The main 36 inch diameter trunkline riser and the five field flowline risers are also located on the production platform.

Most of the equipment on the three deck platform is involved directly or indirectly with metering gas arriving from the seven satellite wellhead platforms.

Gas risers from the satellites run into the 'pig' receiving area on the intermediate deck of the production platform. The gas then flows to the separators, also on this level, where the phases are split. Gas rises up to the top deck where it is metered before mingling with other gas flows and either entering the export line or being compressed. Condensate drops from the

continued on p7

continued from p4

requirements in both the short and longer term.

Conoco's estimates are very much in line with the Government's projections in the Brown Book. Taking account of proven, probable and possible reserves within the Central and Northern North Sea as well as the Southern Basin, we believe there is sufficient gas remaining in the UK Continental Shelf to meet projected demand for between 20 and 50 years.

You are confident in spite of the fact that we currently import around 20% of our gas from Norway?

Yes we are. Our current imports come from one field, Frigg, which was always expected to be depleted by the early nineties. British Gas have anticipated this decline and have contracted substantial volumes of UK gas to make good the shortfall.

One indication of the industry's continuing confidence is that there are at present some 48 jack-up rigs at work in the Southern Basin in an effort to find and develop new supplies. That is the highest level of activity for some time. The rig market is very competitive, the industry is out drilling wells and experiencing considerable success in identifying and proving new prospects.

Do you think that exploration in the southern Basin could be stepped up even further?

Not significantly. A major limiting factor is the number of jack-up rigs available. Activity could only be increased by finding more rigs to bring to the area and I think this is unlikely.

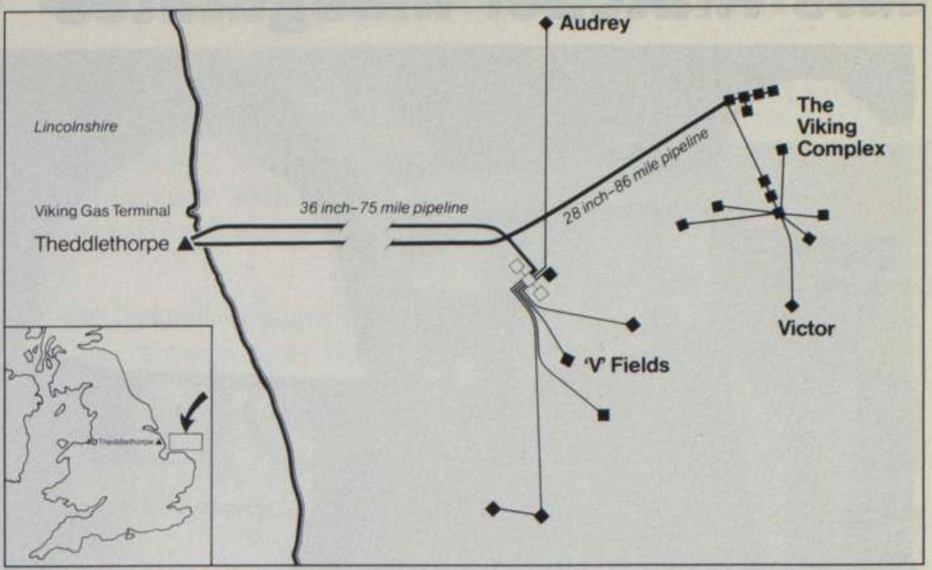
The 'V' fields project is now completed, to add to the existing Conoco-operated Viking and Victor gas fields. Do you have any other prospects in the Southern Basin?

Within the Viking area, we have at least three satellite development prospects. We hope to bring one of these, the Venture field, into production in 1990. We also have interests in several other significant discoveries in the southern part of the basin which should begin to bear fruit by the early nineties.

In the northern Carboniferous area, our discoveries in blocks 44/22 and 44/23 appear to be attractive. We shall be maintaining an aggressive drilling programme next year to give us a better assessment of how this area should be developed.

You identified prices earlier as the determining factor in the pace of activity in the Southern Basin. Does technology play a part in improving the economics of gas developments?

'V' Fields Development Outline, LOGGS* and Viking Complex**



*Lincolnshire Offshore Gas Gathering System
**The Viking field came onstream in 1972, Victor in 1984

It does indeed. As can be seen from the 'V' fields, we believe that the use of unmanned wellhead platforms and a very high degree of automation is extremely important. This technology enables us to develop, operate and control our fields efficiently, safely and more cost-effectively.

Staying on the economic issue, do your future plans include the possibility of direct sales to industry?

Yes. We have a considerable portfolio of gas prospects and our gas is for sale to everyone — British Gas and industrial users. Conoco, like other leading suppliers, has made an initial assessment of the industrial market, and in fact we have recently restructured our gas division specifically to identify opportunities to sell direct to users.

When might Conoco begin direct sales?

That will of course depend on many factors, but we would hope to secure our first direct sales agreement by 1990. We are actively pursuing a number of possibilities at present, and potential customers are also calling on us.

Would these potential customers be large users?

Compared with an average Southern Basin reservoir, they tend to be relatively small and that has been our initial difficulty — trying to match the deliverability of a particular reservoir to the requirements of a given industrial user.

Generally speaking, their demands are well below the deliverability of an average field, which might be in the region of 50–100 million cubic feet per day, and therein lies part of the difficulty. On the other hand, a smaller satellite development delivering around 40 million per day could perhaps be more easily matched with the needs of an industrial consumer or group of consumers.

On what basis would such sales be agreed?

We would be looking for long-term contracts covering the productive life of the particular field. Obviously, the price would be negotiated between Conoco and the interested purchaser. That price would have to take account of a tariff rate negotiated with British Gas if we needed to use their transmission system to deliver the gas to the purchaser.

Direct sales is a new area for all of us. like all new areas it will present some complexities, but I do not believe those complexities will prevent direct sales from becoming a significant part of Conoco's and other suppliers' business in due course.

May I ask if Conoco is satisfied about the safety aspects of gas production in the Southern Basin?

Safety is, and must be, of paramount importance in our business of searching for and winning energy resources. In the aftermath of the Piper Alpha disaster, Conoco, like other operators and the Department of Energy, is reviewing every aspect of safety practise and procedure to see if there is anything that can be done to improve them. Conoco's employees in our Southern Basin operations have not lost a single working day through an accident for more than three years and our contractors have exceeded a year without a lost-time accident. We shall do everything possible to keep it that way. ●

continued from p5

separators to the metering systems on the cellar deck which also houses the condensate export pumps and the methanol injection pumps.

A fuel gas system provides fuel to the 3 main power generators, each producing 3.3 megawatts, which are situated on the top deck of the production platform.

The top deck area slso contains the main control room where all activities on the production platform and the wellhead platforms are monitored and controlled.

A dominant feature on this platform is the 57 metre high vent stack, which will be used for emergency venting of gas from the production and compression platforms.

Production metering

LOGGS provides a common transportation system for gas from different fields under different ownership. A total of 13 companies have interests in the initial five fields. All incoming gas and hydrocarbon liquids (condensate) from each field is therefore metered before mixing with other gas and liquids and, in the future, before compression. In addition to meeting UK Government regulations for custody transfer and simply determining ownership of hydrocarbons sold onshore, the metering operation provides basic data for pipeline integrity monitoring.

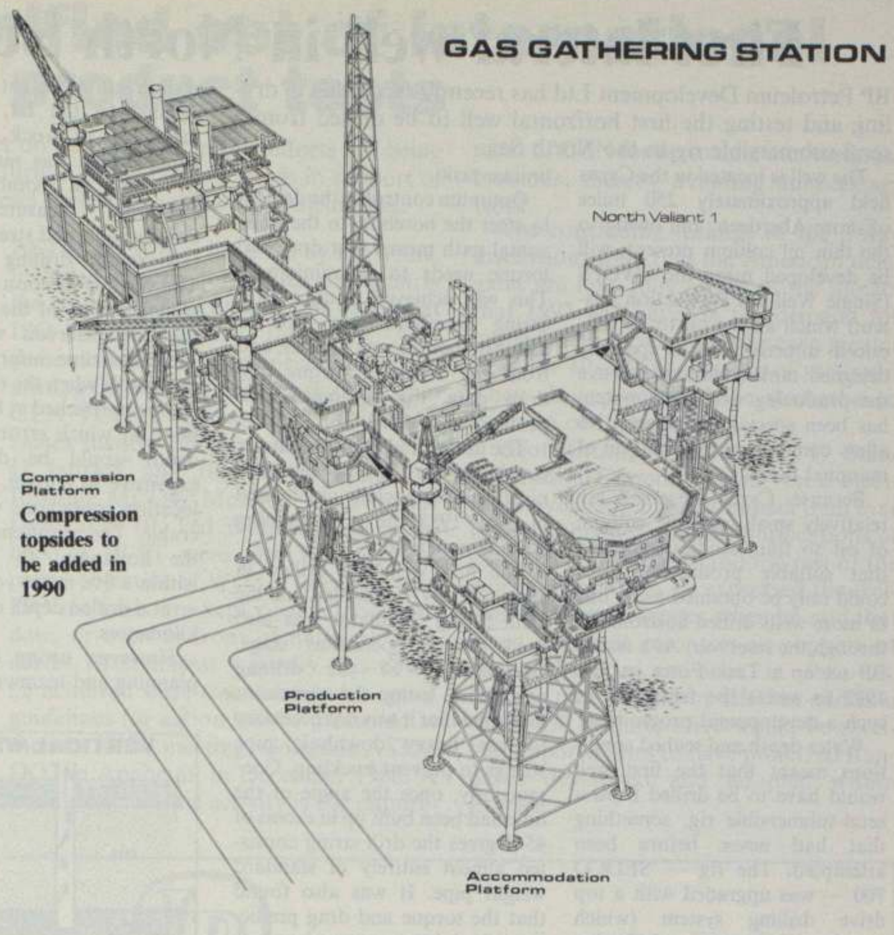
Production control

Control and monitoring of the 'V' fields platforms is achieved by use of a microprocessor-based distributed control system known as CALCAM (Computer Assisted Logic Control And Monitoring). The system was designed and developed by Conoco and has been in operation on the company's Victor and Viking installations since 1984. CALCAM — one of the largest computer control systems in the North Sea — will provide an instant picture of production levels and flow rates and will monitor overall performance and safety. The key combination of control and monitoring, provided by 200 supervisory/monitoring remote terminal units (SMRTUs), represents a major innovation in offshore control systems.

Accommodation platform

The accommodation platform is a four leg structure consisting of five deck levels and an offset cantilevered helideck. As well as providing high quality accommodation and living conditions for the crews who will run the 'V' fields complex, it will also serve as the central communications base for all Conoco's producing gas fields in the southern North Sea, including Viking and Victor.

The platform can accommodate up to 125 people, although the normal operating crew level will be about 42. The extensive facilities include a sauna and gymnasium on the upper deck, and cinema, recreation area and fully equipped sick bay on the main deck. Utilities are located on the cellar deck while the dining area, galley and laundry are situated on the mezzanine deck.



The communications module, containing state of the art equipment, will play a significant central role in Conoco's southern offshore operations. Housed on the roof deck, it contains a meteorological station, helicopter control centre, data, microwave and private radio systems, INMARSAT terminal, telephone, telefax and facsimile facilities and a SOLAS system.

Power on the platform can be provided by two independent 600 kilowatt generators. Normally, however, it will be supplied by the production platform's main generating system.

Compression

The compression deck is scheduled for installation in May 1990, some two years after production start up. It has been designed to accommodate up to four gas turbine compressor trains although only three are to be installed initially.

Safety

Conoco considered the practicalities of a subsea emergency shut off valve on the export line when planning the design of the 'V' system. It was rejected as a conception because of doubts about the ability of maintain such a unit efficiently, the lack of certainty that it could be relied upon to work 100 per cent, and the difficulty and risks that could arise in placing it in the shallow seas where the 'V' gas gathering station is situated.

They were convinced they had the safest possible design through a deliberate separation of activities on the gas gathering station while deciding to carry pipelines between the seabed and the production platform inboard of the jacket for added protection — in addition to the many shut off valves throughout the system.

Nevertheless, in view of the Piper Alpha disaster, Conoco is looking again at the question of a total shut down valve on the seabed. ●

First lateral well in North Sea completed

BP Petroleum Development Ltd has recently succeeded in drilling and testing the first horizontal well to be drilled from a semi-submersible rig in the North Sea.

The well is located in the Cyrus field approximately 250 miles offshore Aberdeen, and owing to the thin oil column present, will be developed using the SWOPS (Single Well Oil Production System) which allows oil to be produced directly into a specially designed tanker stationed above the producing well. This system has been specially engineered to allow commercial exploitation of marginal fields.

Because Cyrus' reserves are relatively small, and the column of oil so thin, studies indicated that suitable production rates could only be obtained using one or more wells drilled horizontally through the reservoir. As a result, BP set up a Task Force in July 1987 to assess the feasibility of such a development programme.

Water depth and seabed conditions meant that the first well would have to be drilled from a semi-submersible rig, something that had never before been attempted. The rig — SEDCO 700 — was upgraded with a top drive drilling system (which greatly improves drillstring versatility and control) and its Oil Based Mud (OBM) system was improved, to cope with this unique task.

Optimum control at the drill bit to steer the borehole to the horizontal path means that drag and torque needs to be minimised. This was achieved using a Drill String Simulator was used to assess numerous well profiles, and from the resulting torque and drag data the optimum well profile was selected.

The design and feasibility study concluded the venture was technically and financially viable, and in May 1988 the programming stage commenced.

The first well was drilled in June and July of this year, and the Drill String Simulator was also used at the operations stage. Optimisation of the drilling assemblies using the simulator indicated that it was not necessary to use heavy downhole pipe strings to prevent buckling. Consequently, once the angle of the hole had been built up in excess of 45 degrees the drill string consisted almost entirely of standard weight pipe. It was also found that the torque and drag predictions had been extremely accurate.

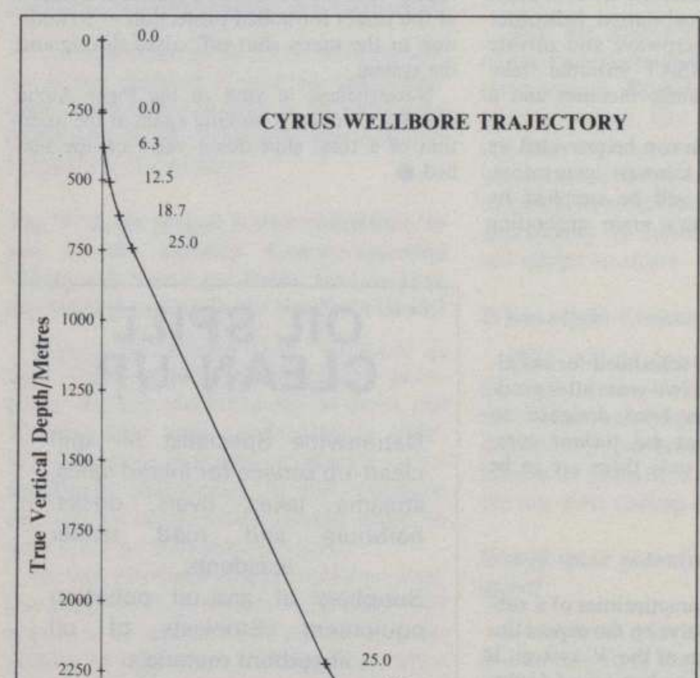
Continuous monitoring and correction of wellbore inclination and direction, weight and torque applied to the bit, and interpretation of rock formations being drilled was made possible by using a combination of electronic measurement-while-drilling tools and steerable downhole motor drilling assemblies. The vertical position of the horizontal section of the wellbore in the thin reservoir was critical. This real time information was invaluable when the reservoir was being approached at 80 degrees, a point at which errors in vertical depth would be difficult and expensive to correct, as wellbore location constraints were considerable. The requirement was for the horizontal to be reached within a five metre vertical target — at a drilled depth of over three kilometres.

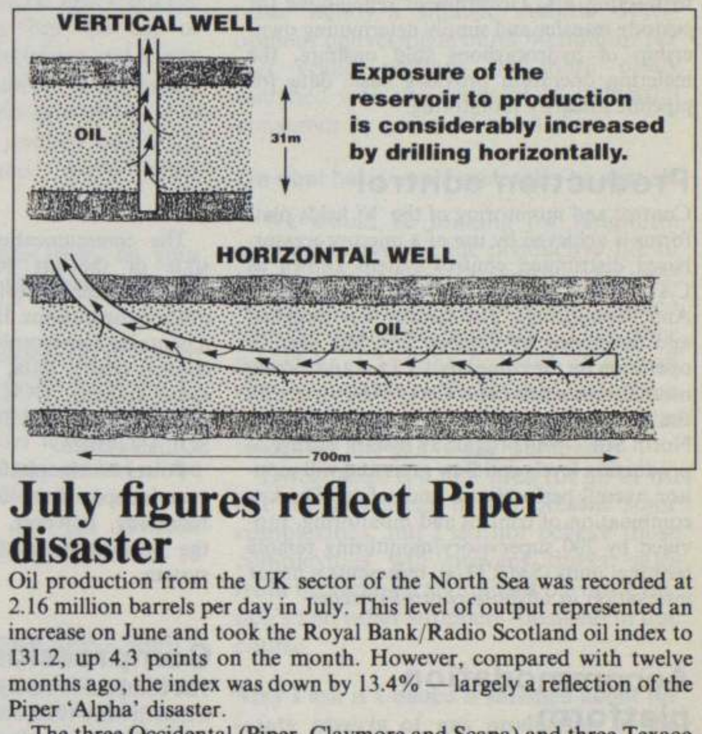
However, owing to extensive planning and teamwork, the predicted profile was followed and the actual well path overlaid the plan almost exactly. A 9⅝" casing was set at the top of the reservoir, and the horizontal section was held between 88.8 and 91.7 degrees within the five metre vertical target.

The first well was completed with a slotted liner in 44 days 11.5 days ahead of schedule, to a total depth of 3724 metres with 770 metres in the reservoir, of which 550 metres were horizontal at a vertical depth of 2568 metres.

The results in flow through a one inch choke on the horizontal well was approximately 6,000 barrels a day, compared with 2,700 barrels a day from a vertical well.

It appears, therefore that, using horizontal drilling techniques, many of the North Sea's marginal fields can now be economically exploited.





July figures reflect Piper disaster

Oil production from the UK sector of the North Sea was recorded at 2.16 million barrels per day in July. This level of output represented an increase on June and took the Royal Bank/Radio Scotland oil index to 131.2, up 4.3 points on the month. However, compared with twelve months ago, the index was down by 13.4% — largely a reflection of the Piper 'Alpha' disaster.

The three Occidental (Piper, Claymore and Scapa) and three Texaco (Tartan, Petronella and Highlander) fields which are tied into the Flotta pipeline system were all shut down after the explosion which occurred on 7 July. Only a fraction of their normal output is included in the July figures. In this respect the August index will be depressed even further because of zero production from the system since the accident.

The July figure, although usually lower than for the early and late months of the year, normally demonstrates a marked recovery in oil output compared with June, the favourite month for maintanenance activity. This July's production is over 200,000 barrels per day down (12.1 index points) because of the Flotta shutdown. This represents a daily loss of revenue in the order of $3m at current prices.

Piper Alpha wells secure

All 36 wells on Piper Alpha have been made secure. The crew working from the *MSV Tharos* left the platform on 4 September having installed the final plug in the last remaining well.

Toward a unified set of international product tests

With 1992 and the single European market on the horizon, urgent efforts are being made within the European Community to furnish unified test methods in support of new specifications for: motor gasolines, diesel fuels and liquefied petroleum gas.

The favoured methods will initially be ISO (International Standards Organisation). Up to the present the methods most acceptable to ISO have been produced by IP/ASTM (American Society for Testing and Materials). However, in future there is a strong likelihood that the new test methods will arise within CEN (Comite Europeen de Normalisation).

During the period 8 to 12 September, a series of meetings were held in the IP, between IP Standardisation Committee (responsible for IP Test Methods) and their opposite numbers in ASTM Do2 (Petroleum Products, Lubricants and Fossil Fuels) to discuss developments/ problems with existing methodology, particularly joint IP/ASDTM methods.

Concurrent with part of the above meetings, a special meeting of a new working group, ISO WG8, in ISO Technical Committee TC/28 was held. The ASTM delegation to IP led by Ed White, included experts for WG8, particularly the convener Paul Strigner, so elected at ISO TC/28 in Tokyo, June 1988. Also present were European specialists, representing CEN, Mr CAF Stapel (Chairman CEN TC/19), representing DIN (Deutsches Institut fur Normalierung) — Dr O Janssen and for British Standards Institute Mr OW Molony. The Director General of IP, Ted Williams, and members of IP-ST were also present. The prime objective of WG8 is to ensure that ISO methods are kept completely up to date, or even in front of national standards. Mechanisms whereby this could be achieved were discussed and a set of guidelines for action will be presented at the next WG8 meeting, alongside ASTM DO2 in Anaheim, in December 1988. A strong spur to this activity is the requirement of CEN for up to date international methods, thereby avoiding unnecessary work.

The concluding feelings of the 3 day discussions were that the American delegates are now fully aware of the impact that 1992 will have on the demand for unified methodology and the even greater need for IP/ASTM jointing of methods. They also appreciated the strengthened position of ISO methods.

Geoff Crump, Chairman of IP Standardisation Committee said: 'these meetings have made a bigger impact than ever before in highlighting the implications of 1992 for both Europe and the rest of the world'. Moreover, he expressed the feelings of many delegates when he said that given sufficient resources in support of standardisation activities in the UK (maybe part funded by EEC in addition to the Oil Majors) there would be excellent opportunities to have preferred standards developed and adopted within Europe.


Pipe stringing on Creech Heath, one of the Sites of Special Scientific Interest on the Wytch Farm pipeline route.

The Wytch Farm pipeline team commended

Geoffrey Mayhew reports

On the desk of Chris London, Pipelines Manager for Wytch Farm oilfield in Dorset, lie some prized letters.

These relate to the current construction of an underground crude oil pipeline 56 miles long and 16 inches in diameter through some of the most environmentally sensitive areas in southern England.


Chris London

The link

The pipeline will link Wytch Farm to an export outlet at BP Hamble Terminal on the east side of Southampton Water. On route the pipeline passes through Esso Fawley Refinery on the west side of Southampton Water. Esso has the option of a connection to the pipeline through a short spur, which they are constructing.

Final stages

October and November will see the final stages in the construction of the pipeline. These will include the crossing of Southampton Water, in which a trench is being dredged for the pipeline.

The commissioning of the line, which is expected to be carried out in 1989, will enable Wytch Farm's production to rise from its current 10,500 barrels to 60,000 barrels a day. It is the largest onshore oil field in Western Europe, with two reservoirs. A much larger discovery was made 5,000 feet beneath the first reservoir, which lies at 3,000 feet below Poole Harbour.

The Wytch Farm pipeline project has consisted of three stages: the 16″ line from the Wytch Farm Gathering Station to BP Hamble Terminal; an 8″ diameter line has been laid from the gas gathering station to Sopley to deliver gas to British Gas; and a multi-line system has been laid between Wareham — where BP discovered a small field in 1964 — and the gas gathering station, from which an LPG pipeline has been laid to Furzebrook Railway Terminal.

Recognition

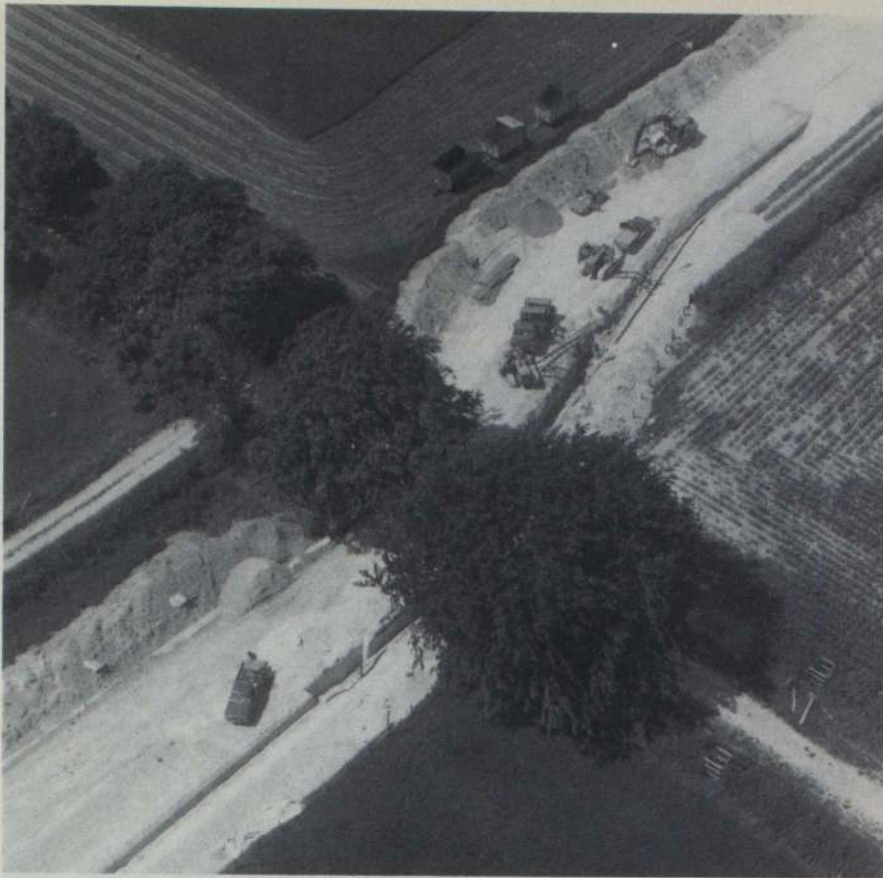
'Very impressed with the way the work has been carried out, and particularly with the reinstatement,' said one letter. 'Most professional,' commented another.

These letters, unsolicited of course, are from landowners through whose land the pipeline has been laid. The BP pipelines team, and their contractors, were delighted to receive them. They are a recognition — not often volunteered by the public — of the care that has to be taken in any pipeline project, and never more than on the Wytch Farm to Southampton Water pipeline.

Most complex

'Except for the crossing of the Beaulieu River there has been nothing technically very difficult about this operation,' said Mr London. 'But it remains one of the most complex pipeline constructions because of the environmentally sensitive nature of the area and the large number of occupiers and statutory and voluntary bodies involved'.

In Dorset and Hampshire and in particular close to the route of the pipeline to Hamble, thousands of people live — many of them retired. BP made a special



On the right: The Purbeck-Southampton pipeline near Kingston Lacey, Wimborne, showing a tree screen uninterrupted on Sweet Briar Drove.

The Beaulieu River Crossing by horizontal drilling in order to avoid passing through the environmentally important banks of the river. The photograph was taken from Gins Farm towards Lower Exbury.

effort to contact local people and had frequent meetings. As a result the time table for laying a number of pipeline sections was changed. They were laid out of sequence for ecological reasons or to avoid disturbance to local activities or industry

This led, for example, to a decision to lay the pipeline one third of a kilometre through a holiday park after their summer visitors had left. Another was to pass the pipeline through a cricket ground 'between fixtures'. When the next game was played, the trench had been refilled and turf laid. It was very difficult to tell where the trench was.

'We spent two years in close consultation with all the interests concerned in planning the route, and that consultation continues,' said Mr London.

In this planning operation BP consulted some 270 individuals and representative bodies. They included landowners, land agents, occupiers, different types of councils, farmers, environmentalists. The Nature Conservancy Council participated in the examination of each area of ecological sensitivity.

The perambulation

The pipeline does not pass through the New Forest itself but through its 'perambulation'. That distance is less than three-and-a-half miles.

'As we expected, this particular section has been by far the easiest part of the whole line,' said Mr London. 'It is mostly fields and by next summer the ground above it will be back in use as in the past.

'More difficult were the areas of numerous paddocks and small holdings. As elsewhere, we had to make sure every owner and occupier fully understood how carefully the work would be done and that the reinstatement would be carried out efficiently.'

On the way to Southampton Water the pipeline has crossed 10 A roads, including three dual carriageways, 10 B roads and a large number of minor roads. In most cases, traffic was not held up.

Six main rivers, several minor rivers and four railway lines were also crossed, again with very little inconvenience. This is because special techniques to lay the pipe were used when traffic hold ups might otherwise be the case.

On main roads, and on minor roads where the pipe route arrived at a difficult bend in the road, for example, the thrust bore technique was used. This involved digging a pit at a short distance from the crossing to take the thrust borer equipment. The pipeline was then pushed through the hole the equipment made while the road traffic continued overhead. It was used on each rail crossing.

Dorset County Council helped the pipeline operation in an interesting manner in the crossing of the very busy Ferndown by pass (A31). This road, which opened recently, was built before it was possible to know whether the building of the pipeline would be finally approved.

Nevertheless the council decided to insert two concrete pipes beneath it during their construction so that the Wytch Farm pipeline could be passed through this with the least convenience if approval was forthcoming. In the event this happened, and BP paid for the work that Dorset County Council had done.

The Beaulieu River crossing

With the exception of the Beaulieu River, trenches were dredged in rivers and the pipe was then pulled across by cable.

The banks of the Beaulieu River are designated Sites of Special Scientific Interest. There are important bird sanctuaries. The river bed is ecologically important and the river is used for leisure pursuits.

By using horizontal drilling, the pipeline constructors avoided working through the banks, did not disturb the river bed and, as with main road and rail crossings, the use of the river went on unaffected.

The horizontal drilling rig was placed on the east side and a small diameter drill driven 10 metres below the river bed to surface 750 metres beyond the far bank. The span of the horizontal drilling operation was more than half a mile.

Much special treatment

More than 95 per cent of the route of the Wytch Farm pipeline passes through agricultural land, forestry or already disturbed land but no Grade 1 agricultural land is involved. However, pieces of land which required special treatment because of their environmental importance are present. These were highlighted in the detailed Environmental Impact Assessment document (*the summary of which is in adjoining columns*), which included a field by field map of hedgerows and drainage systems in large scale for the 56 miles long route.

The preservation of heathland along the route of the pipeline was one of the prime conservation issues. Construction and restoration methods were tailored to the specific conditions, and were agreed with the Nature Conservancy Council before construction started. For example, restricted working widths, the use of temporary protective roads and time restraints were necessary in several cases when crossing lowland heaths. Heather was lifted as turves, stored on a geotextile membrane, looked after and relaid immediately backfilling was completed.

Eight sites were selected for the harvesting of seeds of wild flowers, meadow grasses, herbs and marsh plants. Ecologists took the view that the seeds should be taken from these sites because they often display local genetic adaptations. BP will be monitoring these sites for up to five years to ensure that the species have reestablished themselves.

Mr London has a full time Environmental Officer, who has Environmental Inspectors, who reports directly to him. There is a full time Drainage Inspector with the team, and also an archaeologist with two assistants who have been working ahead of the pipeliners.

The BP archaeologists have made discoveries which add important information on Dorset's ancient history. This points to the possible remains of a deserted medieval village, an iron age fort, and ancient industry in the form of mining and smelting. What is believed to be some Roman timbering has been carefully stored in the right humidity.

Crossing Southampton Water

Before it reaches the water's edge on the western side of Southampton Water, the Wytch Farm pipeline passes through Esso Fawley Refinery. Esso has taken responsibility for building that section, which is above ground. Esso will also construct the short spur towards tankage from the main line.

Part of Esso's land alongside Southampton Water is being used to store and prepare the pipeline sections which will be laid across the sea to BP Hamble Terminal this month.

The dredging of the seabed is in hand and at BP Hamble Terminal a substantial redevelopment is being carried out for the reception, storage and export of Wytch Farm crude oil, including the removal of the old jetty and the building of another.

Epoxy coating of pipe joints on the Wytch Farm pipeline to BP Hamble Terminal on Southampton Water.

The pipeline will be pulled by cable across Southampton Water by a 100 tons winch which has been installed at Hamble. The procedure is a common one and although the preparation on both sides of the water for the operation have been over several weeks, the final operation of pulling and laying is expected to take no more than two days.

The cable from the Hamble winch will be attached to the first section of pipe which has been assembled and coated at Fawley. This start to the operation will be carried out in daylight and in liasion with the harbour and shipping authorities and at specific times.

Stretching 1.2kms across the water, the cable will slowly pull most of the first section into the prepared trench. Then the operation will stop to allow the second section of pipe to be welded to the first. That job will take a very short time, but it has to be followed by Xray tests of the welding. This done, the pulling operation — in liason with the port — will continue.

Once substantial progress has been achieved, the pipeline laying operation will be continued at night when shipping movements are fewer and the cable distance much shorter.

'This year will see the pipeline completed and reinstated throughout its length,' said Mr London. 'Next year we will be dealing with remedial problems, which are expected to be few and of a minor type but which we will put right. It will not be long before the signs of the construction work will have gone. The pipeline from Wytch Farm to Hamble will be invisible.' ●

Extract from the Wytch Farm Pipeline Project Environmental Impact Assessment Document

1.3 SUMMARY

The proposed Purbeck-Southampton Pipeline route has been selected to avoid as far as possible impact on all notified sites of human and environmental interest. Further detailed assessment has been undertaken in order to minimise impact on non-notified natural and built features of local interest. Where such sites have proven unavoidable then detailed routing, construction and restoration specifications have been prepared in order to minimise construction impacts and ensure the highest possible standards of restoration.

The following summarises the most significant environmental aspects of the proposed scheme:

(i) The pipelines will be installed within one construction season avoiding the winter period, and will be buried with a minimum 0.9m (3ft) depth of cover throughout their length. There will be no requirement for intermediate pumping stations. Once installed, pipelines will be silent, with only marker posts and unobtrusive intermediate valve stations above ground.

(ii) Over 95% of the proposed route

lies in agricultural, commercial forestry or already disturbed ground. There is no grade I agricultural land on the route. Over 80% of agricultural land on the proposed route is graded 3 or below.

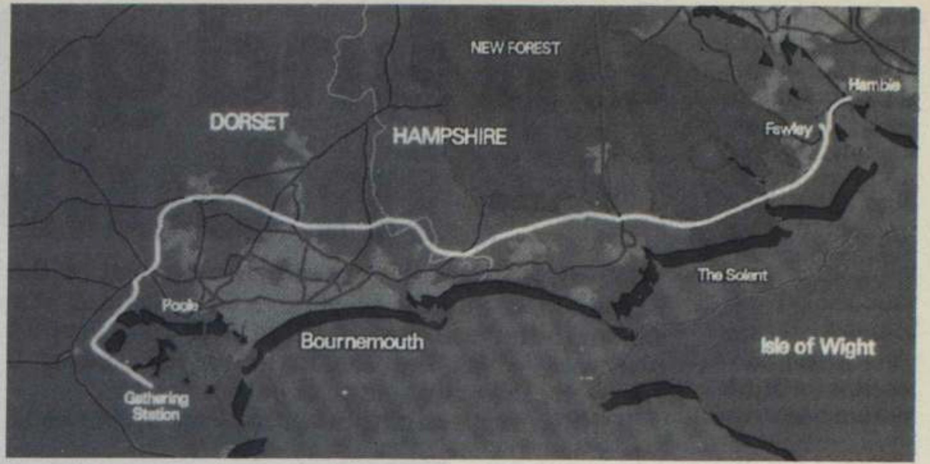
(iii) Construction and restoration techniques for agricultural areas have been discussed with national and local farming organisations. Construction techniques will take full account of local soil conditions and land use practises.

(iv) The pipeline route lies partially within designated Areas of Outstanding Natural Beauty (AONB) where hedgerows can make an important contribution to the landscape. In this respect impact on hedgerows has been minimised throughout the length of the pipeline. It may be possible to make further detailed re-alignment prior to construction. During construction hedge clearance will be kept to a minimum, compatible with pipeline installation and the passage of construction traffic. Mature standard trees will be avoided where possible and all hedges will be replanted, using species compatible with the existing hedgerow, and maintained until established.

(v) Route selection has tried to avoid, as a priority, all areas of human or environmental interest. In this respect the pipeline will not affect the Crown Lands of the New Forest containing a Grade I site of international conservation importance. Instead the pipeline route crosses private agricultural land, south of the Crown Lands, but within the New Forest Perambulation and Heritage Area.

(vi) However the pipeline route crosses parts of five SSSI's for a total length of 4.25km. Where SSSI's have to be crossed the shortest possible crossing points, combined with the least sensitive habitats, have been identified for pipeline alignment.

(vii) Of the 4.25km of SSSI's crossed, the habitats of significant conservation interest amount to 0.95km (23%), and comprise Stoborough and Creech Heathlands (840m), Moors River crossing (50m) and Avon River crossing (60m). Detailed construction and restoration specifications have been prepared to minimise the habitat loss from the sites. Environmental impact will be of temporary duration. Based on previous experience satisfactory heathland restoration should occur at Stoborough and Creech Heaths within five growing seasons, whilst river bed restoration at the Moors and Avon River Crossings should occur naturally within 6–12 months of construction.



(viii) The remaining of 3.3km (77%) of SSSI's crossed will not result in disturbance to habitats of conservation importance. These areas comprise 2.8km of improved grassland or recent woodland, for which rapid restoration techniques are available. The remaining 0.5km constitutes the Beaulieu Estuary where the pipeline will be installed by horizontal directional drilling beneath the saltmarsh and estuary, thus completely avoiding disturbance to these sensitive habitats.

(ix) The proposed route will pass between a group of Scheduled Ancient Monuments at Worgret Heath. These monuments comprise a complex of earthworks suspected to originate from the Romano-British era. The proposed alignment avoids the Scheduled areas but passes within the site as a whole providing an opportunity for further archaeological investigation. Elsewhere on the route no other Scheduled Ancient Monuments occur within 100m of the proposed alignment.

(x) The proposed route has been selected to avoid, where possible, village conservation areas and English Heritage Parks and Gardens. However, the route agreed with the National Trust at Kingston Lacy will involve a 30m crossing within Pamphill village conservation area in order to avoid the beech tree avenue along the B3082.

(xi) No residential property is affected by the proposed route. One building of architectural interest lies within 30m of the proposed route and will not be affected by construction. Elsewhere no listed buildings or buildings of architectural interest lie within 50m of the proposed route.

(xii) There will be no permanent loss of recreation facilities along the proposed pipeline route.

(xiii) No water abstraction boreholes occur within 50m. The proposed route has been selected to avoid the recharge area for major borehold water abstraction points.

(xiv) Access routes for construction traffic together with possible locations for the main base and lay down areas have been discussed with the County Surveyors Departments. Traffic movements will be co-ordinated outside peak periods to minimise disturbance to road users.

(xv) Notwithstanding the remoteness of the risk of an oil spillage contingency plans will be prepared. ●

UK onshore: the emergence of the next generation of oil companies

by Paul Foulsham, Director, Capital Petroleum Services Ltd, scouting and reference service for UK onshore oil and gas

Over the past four years, UK onshore has become a major province for the oil exploration and production industry. Interest in exploring onshore gained momentum in the early 1980s and prompted the introduction of a new onshore licensing system in 1984 with formal licensing rounds like those already used offshore, where applications for exploration acreage have to be submitted to the Department of Energy on specified dates. Since December 1985, a considerable number of new exploration licences (EXLs) have been awarded in two full Rounds, as well as in a two-phase Conversion Round which has allowed companies to convert old-style licences to new-style EXL's.

There are currently 349 licences in issue for UK onshore covering a total of 56,000 square kilometres. These licences are held by over 100 companies who cover a very broad spectrum, ranging from one-man companies all the way up to the majors like BP and Shell. UK onshore is attractive because many areas of the country have large potential and have only been sparsely explored to date. The smaller companies are particularly attracted to UK onshore because of the lower costs involved in comparison to the North Sea. Some of the larger companies have systematically built up substantial acreage positions with the strategy of running a cost-effective operation at a high level of activity to justify the use of the latest techniques. However, it is generally amongst the medium sized and smaller companies that the growth has been most remarkable. The Wytch farm field, with recoverable reserves of well over 200 million barrels, is viewed as exceptional, but the recent discovery at West Firsby, with recoverable reserves approaching 10 million barrels, is indicative of achievable rewards from UK onshore.

The structure of the UK onshore industry has been affected by the wave of merger and acquisition activity in the oil industry. Corporate transactions which have had a significant impact on UK onshore include: BP's purchase of part of Trafalgar House's onshore holdings; Atlantic Richfield's acquisition of Tricentrol; Teredo Oil's merger with Marinex; British Gas' acquisition of the newly formed Acre Oil; Elf's purchase of RTZ Oil and Gas (and RTZ's prior purchase of Sun's onshore interests); Kelt's purchase of Taylor Woodrow Oil and Gas; Cairn Energy's asset swap for Conoco's onshore interests; Total's purchase of CSX Oil and Gas (and hence the UK subsidiary Industrial Scotland Energy); Amerada Hess' purchase of Whitehall Petroleum from Pearson; and Ultramar's recent purchase of Blackfriars Oil and Gas from Associated Newspapers. This merger and acquisition activity has resulted in some major changes in company land holdings.

The prominence of large corporate transactions should not be allowed to obscure what is happening lower down the scale of UK onshore land holdings. While the big companies are putting in place long term global strategies and adjusting their acreage portfolios through acquisitions and disposals accordingly, a new generation of oil companies are emerging and concentrating on UK onshore. The table shows land holdings of all the companies involved in UK onshore exploration. Companies which have chosen to devote a major part of their energies to onshore include: Sandpiper Oil and Gas, Cairn Energy, Marinex Petroleum, Blackland Park Exploration, Pict Petroleum, Pentex Oil, Edinburgh Oil and Gas, Floyd Energy, Pendle Petroleum, Harlech Petroleum and Croft Exploration. There are also some fairly recently incorporated companies, such as Brabant Petroleum, Stag Petroleum and Trans World Oil and Gas. The financial backing for the new generation of onshore companies is varied; some already have share quotes; others are backed by institutions or wealthy private investors who are hoping to see their companies grow into significant publicly traded oil companies in due course; and there is a noticeable interest growing from North American independents as the US production outlook worsens.

Land holdings of all companies involved in UK onshore oil and gas

Company	Total net area sq km	Of which EXLs sq km
Aberdeen American Petroleum Company plc	100.0	100.0
Adobe Resources Corp	109.5	109.5
Alfred McAlpine plc	185.6	185.6
Amerada Hess Corporation	595.3	537.1
Amoco Corporation	2595.8	2309.0
Anglo European Minerals Ltd	135.8	135.8
Aran Energy plc	384.9	384.9
Atlantic Richfield Company	1622.5	1075.6
Bannerman Seafoods Ltd	5.7	5.7
Bayford & Co Ltd	50.7	6.7
Bearcat Explorations (UK) Ltd	280.0	40.0
Belvoir Petroleum Corporation	110.0	110.0
Blackland Park Exploration Ltd	1044.2	597.8
Bow Valley Industries Ltd	266.7	266.7
Brabant Petroleum Ltd	207.7	207.7
British Gas plc	2525.5	1322.5
The British Petroleum Co PLC	5431.4	2118.7
WF Brown Exploration Ltd	128.1	0.0
Bula Resources (Holdings) plc	444.8	332.5
Cairn Energy plc	1489.7	556.4
Carless plc	528.7	152.8
Charterhall plc	507.5	267.3
Chatsworth Estates Company	13.0	0.0
Chevron Corporation	137.5	137.5
Cluff Resources Plc	145.2	145.2
Clyde Petroleum Plc	1088.6	804.0
Coalite Group plc	294.8	294.8
Coho Resources Ltd	80.0	80.0
Conroy Petroleum & Natural Resources plc	102.0	0.0
Consolidated Oil & Gas, Inc	120.5	0.0
Croft Exploration Ltd	296.1	262.1
NV DSM	16.5	7.3
Deepwood Mining Co Ltd	570.0	255.0
El Du Pont De Nemours & Co	308.9	308.9
Dual Energy Ltd	144.9	144.9
Edinburgh Oil And Gas plc	765.7	685.3
Societe Nationale Elf-Aquitaine	1082.9	580.1
Ennex International plc	343.3	224.3
Ente Nazionale Idrocarburi	404.7	404.7
Enterprise Oil plc	1823.1	1245.5
Eurafrep SA	148.3	99.7
Eurocan Ventures Ltd	654.0	654.0
Finance and Investment International Ltd	78.4	6.9
James Finlay plc	243.5	59.4
Floyd Energy plc	489.2	93.5
Global Natural Resources Inc	46.3	0.0
Goal Petroleum plc	47.6	32.5
Graig Exploration Ltd	83.6	0.0
Graig Shipping plc	88.1	88.1
Hamilton Oil Corporation	391.8	205.0
Harlech Petroleum Ltd	530.7	341.0
Highwood Resources Ltd	30.0	30.0
Holland Sea Search Holding NV	264.3	264.3
Honey Bear Petroleum Ltd	20.3	20.3
Hunt Oil Company	134.6	134.6
International Thomson Organisation Ltd	234.8	234.8
Kelt Energy plc	526.1	229.2
Kuwait Petroleum Corporation	128.0	44.4
London & Scottish Marine Oil plc	420.1	338.7
London and Aberdeen Oil and Gas Ltd	100.0	100.0
Marinex Petroleum plc	1421.6	706.0
Maxus Energy Corporation	667.8	667.8
Moage Ltd	300.9	300.9
Mobil Corporation	362.1	362.1
Montana Power Inc	103.0	103.0
Monument Oil and Gas plc	143.7	110.0
Moseley Petroleum Corporation	320.2	320.2
Royal Nedlloyd Group NV	357.1	240.2
Norsk Hydro AS	17.7	17.7
Peko Oil Ltd	672.3	462.5
Pendle Petroleum Ltd	436.0	436.0
Pentex Oil Ltd	790.2	740.4
Petrofina SA	2449.9	917.9
Petrogen Petroleum Inc	80.0	80.0
Phillips Petroleum Co	448.9	281.6
Pict Petroleum plc	924.4	486.4
Placer Dome Inc	30.0	30.0
Premier Consolidated Oilfields plc	493.9	246.5
Banger Oil Ltd	846.8	549.8
I.N. Rankin Oil Ltd	520.7	520.7
Renown Energy Ltd	265.7	242.3
Christian Salvesen plc	31.1	0.0
Sandpiper Oil and Gas Ltd	1474.5	1054.0
Royal Dutch/Shell Group	5107.4	3550.9
Sovereign Oil & Gas plc	593.5	582.7
Stag Petroleum Co Ltd	200.1	184.7
TR Energy plc	20.8	0.0
Tanqueray Resources Ltd	196.3	129.5
Texaco Inc	44.6	44.6
Total Compagnie Francaise Des Petroles	547.7	377.6
Trafalgar House Plc	1625.9	533.2
Trans World Oil & Gas/Oil Products	91.2	91.2
Triton Europe plc	205.3	205.3
Tuskar Resources plc	168.7	168.7
Ultramar plc	671.7	197.7
Union Jack Oil plc	48.3	48.3
Union Texas Petroleum Holdings, Inc	1145.6	907.7
Wagner and Brown	136.7	136.7
World Homes Ltd	201.7	81.2
Yates Group	136.7	136.7

Three decades of fuelling aircraft: a personal view

By TWW O'Keeffe, C. Eng., F.I.Mech.E

Figure 1(a) Constellation Venezuala

Terry O'Keeffe has retired recently from Shell International where he was Technical Manager in International Aviation for many years. He was also the Chairman of the Institute of Petroleum's Aviation Liaison Sub-Committee.

My first involvement in aviation was in 1957. I had returned to London following a two year spell as project engineer in Tobruk, Libya, and I was told that my next job was as development engineer on aircraft fuelling equipment. I didn't argue as I had a soft spot for aeroplanes which started from making models of Spitfires during the war and the job sounded interesting. In 1957 there was little point in arguing with Personnel Department anyway.

Upon reflection, I suddenly realised that although I had flown several times in piston engined aircraft, I knew very little about fuelling aircraft; where, for example, was the fuel stored, how was it put on board the aircraft, what was so special about aviation fuel, etc.? I then started on a learning curve that has continued unabated until the present day.

In the late 1950s, the aircraft industry was dominated by large piston engined aircraft such as the Boeing Stratocruiser, Lockheed Constellation and Douglas DC7. These aircraft consumed large quantities of high octane aviation gasoline and lubricating oil, all of which was filled into the tanks in the aircraft wings by gravity or 'overwing'. Fuel was delivered by tank trucks (fuellers) a typical capacity being 13,500 litres and often a trailer of equal capacity was towed to increase the volume available at the aircraft. Lubricating oil was delivered by smaller vehicles in much the same way. **Figures 1**

At a number of airports hydrant systems were built in which fuel was pumped underground from remote storage tanks with the pipeline terminating in a special hydrant valve at the aircraft parking stand. A hydrant dispenser, usually a small hand-towed trolley containing meters, filters and hoses was connected to the hydrant and allowed fuel to be pumped directly into the aircraft. **Figure 2**

Several grades of Aviation Fuel were required by different aircraft such as Avgas 91/96, 100/130, 108/135, 115/145, so many hydrants were required particularly if several oil companies were involved in selling fuel at the airport.

The oil industry and their suppliers had developed some ingenious equipment to cope with the technical requirements. The fuelling equipment could deliver at high pumping speeds, sensitive flow control valves were introduced, meters which were accurate over a wide rate of flow evolved and microfilters with excellent dirt holding capacity, fine filtration, coupled with high reliability were developed. With so many grades of fuel being used, grade selectivity was a problem and selective couplings were developed to help solve this although gross contamination is still a concern today.

Outside of North America the oil industry had set up a wide network of aviation fuelling depots as the aviation industry expanded its routes to the Far East and Africa.

The Institute of Petroleum Aviation Liaison Sub-Committee, **from left to right: PW Gent, Petrofina (UK) Ltd; AJ Rowe, Chevron International Oil Co Ltd; RL Hook, Conoco Ltd; TJ Synnott, Air BP International; DM Watson, Elf Oil (GB) Ltd; RA Simpson, Aviation Fuel Services Ltd (representing Total Oil (GB) Ltd); PR Carpenter, Mobil Oil Co Ltd; TWW O'Keefe (Chairman), Shell International Trading Co Ltd; SJ Shimmin (Chairman Elect), Shell International Trading Co Ltd; DC Frantz, Exxon Company International; PE Berriman, Texaco Ltd; EJ Whitford, IP; AF Rowlands, Caltex (UK) Ltd; PF Jordan, Kuwait Petroleum International.**

These depots were owned by the oil industry and their staff operated and maintained them and fuelled the aircraft. Conversely in the USA many airlines carried out their own fuelling, or it was handled by agencies and generally the oil industry was not involved in investment and development at the airport.

Fuelling the large piston engined aircraft was labour intensive and upon reflection hazardous. Climbing onto the top of aircraft wings in wet, windy or icy conditions was not easy particularly when wrestling with a fuelling hose. One of my jobs at this time was to develop a powered hydrant dispenser with a built in hydraulic ladder to gain access to the aircraft wing. The dispenser would approach the aircraft with the ladder raised, an electronic device would sense the aircraft wing and automatically apply the brakes so the aircraft could not be damaged. Electronics were not very sophisticated in 1957 and by the time the device was snag free the Constellations and Stratocruisers had been superseded by jet aircraft.

Jet aircraft were starting to have an impact upon fuelling at the end of the 1950s. Two further grades of fuel were being introduced, ie Jet A-1

Figure 1(b) DC3 Rio De Janeiro

Figure 2 Constellation Bombay

(kerosine) and Jet-B (wide cut) to further complicate matters and aircraft such as the Viscount, Comet etc were fuelled underwing by a pressure fuelling connection. The pressure at the aircraft coupling had to be accurately controlled over a wide range of fuelling speeds but because the aircraft was connected directly to the fuelling equipment any surge pressures generated in the system could damage the aircraft, if not controlled carefully.

A great deal of research work was undertaken on both understanding the problem, calculating the probable result of various operations and designing valves that could cope. A typical valve was the early 'Prematic' pressure control valve **(Figure 3)** which was used with a compensating venturi device. This valve was very advanced for its time but like all valves of this type the friction of the seals, the inertia of the moving parts and the position of the equipment was such that it was difficult to meet the aircraft manufacturers pressure control requirements. Very few aircraft were damaged due to over pressurisation so there must have been a high factor of safety built in by somebody, somewhere.

Water is the great enemy of aircraft engines and although it is easy to separate water from gasoline, it is more difficult with kerosene. Traditionally water separation had been undertaken by allowing water to settle in storage tanks but this is a much longer process with kerosene and frequently emulsions are formed which are often very stable. New equipment had to be developed to handle these and the modern filter/separator was born.

Perhaps the most dramatic change that took place with the introduction of jet aircraft capable of flying the Atlantic non-stop was the fuel quantity and fuelling speed required. **Table 1**

Aviation had now become a high growth industry, the volumes of fuel required had become substantial, and many suppliers could produce Jet A-1 and entered the aviation fuel market. Conversely aviation gasolines sales started their long decline. **Figure 4b**

This led to a radical rethink of the design of both aircraft fuelling facilities and fuelling equipment. To cope with future growth, hydrant mains were becoming larger, airport authorities did not wish to see many pipes under the parking aprons, nor for the aprons to be excavated to permit any new fuel marketer to construct his own facility. The joint hydrant system concept was born where one hydrant is built and constructed by a consortium of oil companies with each owner using it to supply his individual customers.

The simple towed hydrant dispenser was unable to cope and it was an exciting time designing fuelling equipment that could dispense 4,500 litres/min of fuel onto B707s and DC8s and meet all the technical requirements. Hands on experience was impossible because the equipment was needed as soon as the aircraft entered service at a large number of airports worldwide, lead times were long and shipping opportunities few and far between.

New ways of handling hoses in order to reach the aircraft couplings and methods of reducing pressure losses in order to achieve high flow rates and adequate pressure control together with ensuring product quality became an absorbing task. Solving these problems introduced another. Pumping very clean kerosine at high velocities can build up a charge of static electricity in the fuel which leads to incendive sparks being induced in storage, equipment and aircraft tanks which could result in disastrous fires. Various solutions were proposed ranging from relaxation tanks, control of pumping speed and in line static charge dissipators. An alternative idea was to dope the fuel with a static dissipator additive which increases the conductivity of the fuel, allows any charge to relax almost immediately and prevents an incendiary spark occurring.

Table 1

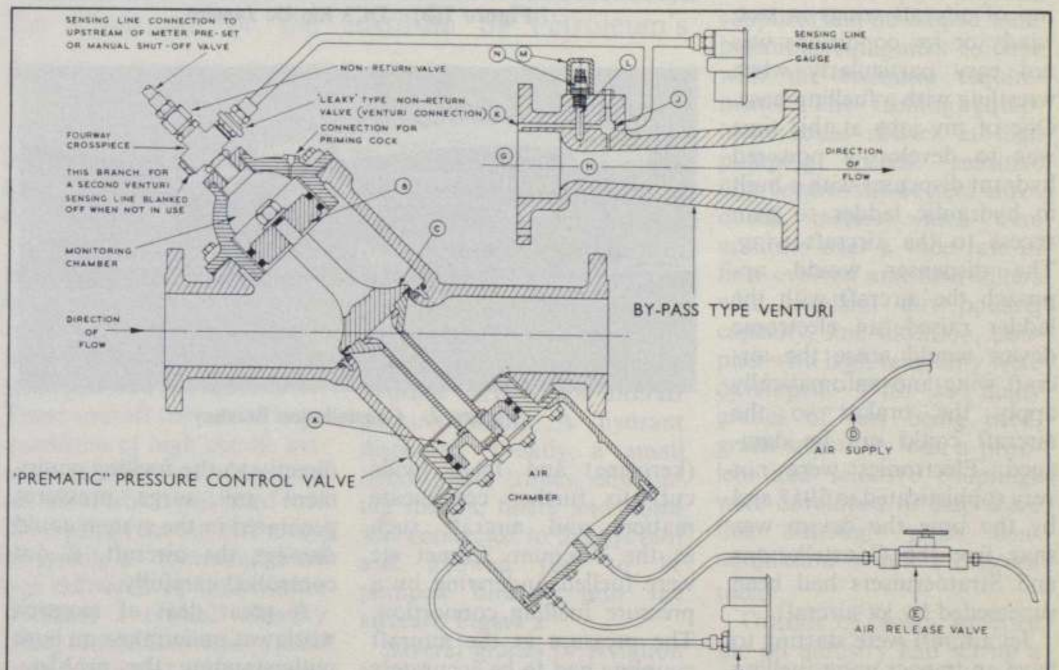
Aircraft	Tank Capacity Litres	Fuelling Speed Required Litres/min.
DC3	3,200	450
DC7	21,000	1,400
Constellation	22,100	1,400
Stratocruiser	29,500	1,400
Viscount	8,900	1,400
Comet	35,400	1,800
B707	65,800	4,500
DC8	66,500	4,500
VC10	81,500	4,500
B747	211,800	9,000

Introducing an additive into aviation fuel is not welcomed because of the side effects it can have on the aircraft engine and the ground handling equipment. Many trials had to be completed over a whole range of engines, aircraft and ground handling equipment before approval was obtained from the specification writing authorities and general acceptance given. This work took many years, millions of pounds were involved but the additive solution is now used virtually worldwide and has been a major contribution to safety.

The next major step forward at the end of the 1960s was the introduction of the 'Jumbo Jet' led by the now familiar B747. Parking and handling these aircraft on aprons designed for much smaller aircraft was a difficult task. Luckily the oil industry, the airlines and the aircraft manufacturers were able to agree on a sensible positioning of aircraft fuelling couplings and the IP through the Aviation Liaison Subcommittee (Engl3) did an excellent job in putting forward the oil industries views.

With the decline of Avgas many hydrant systems at older airports were combined and converted to jet fuel and the joint hydrant system concept was developed further. Agreement was reached on the positioning of hydrant pits relative to the aircraft parking position so that hydrant dispensers could tuck away unobtrusively and mechanical handling devices could lift men, fuelling hoses and couplings to the aircraft fuel connections which were 5.2 metres above the apron. Hydrant dispensers had evolved dramatically from the simple towed units and the equipment had to be carried on small truck chassis and contained sophisticated hydraulic, pneumatic and electrical control devices. Large fuellers were still needed at airports where no hydrant systems had been built. **Figures 5**

The high flow rates demanded by the B747 added to the surge problem in the aircraft and much development effort was channelled to overcome this. Eventually lightweight control valves positioned at the hose end were produced which had an extremely rapid response and could control the surge pressure in the aircraft and time has endorsed their reliability. **Figure 6.** Secondary control valves which gave pressure control backup and permitted



GENERAL ARRANGEMENT OF PRESSURE CONTROL EQUIPMENT

Figure 3 Prematic pressure control valve

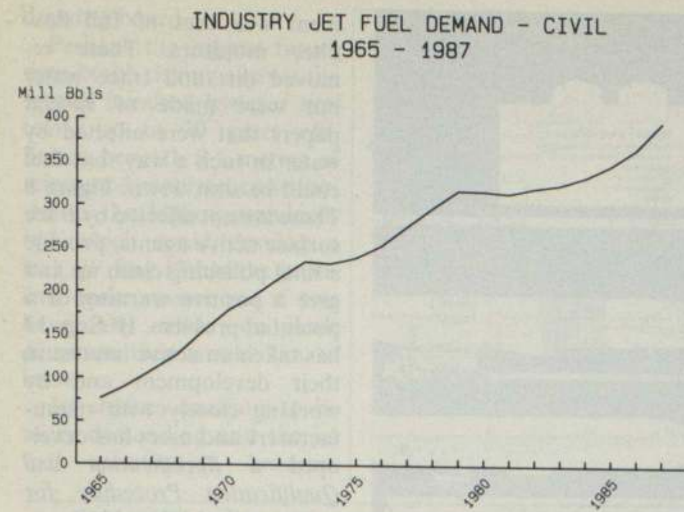
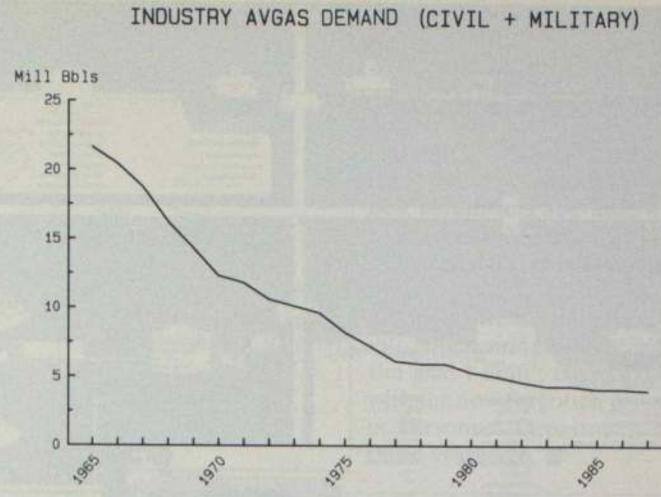


Figure 4a Jet Fuel World outside Communist areas



(b) Avgas and North America

a 'deadman' type operating system were mounted on the fuelling equipment and this dual system has been very successful.

As joint systems were developed at new airports agreement had to be reached by the oil industry owners on the mechanics of the layout of the system. It was certainly true at this time that if you put 10 oil companies' engineers in a room to design a piece of equipment to be jointly owned, they came out with at least 20 differing proposals.

IP Eng 13 performed a tremendous task in collating views and agreeing compromises and coordinating these with USA based organisations, IATA, ATA, etc. Through this work the API 1581, *Specification and Qualification Procedures for Aviation Jet Fuel Filter/Separators* was produced and via its regular updates has become a worldwide accepted specification. General agreement was reached on the layout of hydrant pits and the *IP Specification for Aviation Pit Valve Systems* has become an international standard and is the system used at many of the world's airports.

Figure 6 Hose End Pressure Control Valve and Coupling. (Avery Hardoll 3000 Series)

A number of unique planning tools had been developed to design hydrant systems and aviation fuel depots. Many airports were seeing 15% annual increases in jet fuel throughputs and as hydrants systems were difficult to dig up and replace they had to be sized for the future. Two grades of jet fuel were still thought necessary with one grade being reserved for a special fuel for SST aircraft. The simple 4 inch hydrant line had grown and at some airports underground pipelines were being positioned 32 inches in diameter and several kilometres in length and the backup fuel supply facilities being indistinguishable from a large installation.

Nineteen seventy-three changed many views and the oil crisis caused the first drop in aviation fuel demand. Supersonic transport aircraft were hit both by the increase in jet fuel price which dramatically changed the economics and the political and environmental lobbies. The original forecasts that 400 SST aircraft would be in service by the late 1970s was revised downwards to the actual figure of 16 Concordes. All things change and aviation fuel demand bounced back and growth — albeit modest, is with us again. **Figure 4a**

Figure 5a Shell 'Hart' 3800 litre/min hydrant dispenser fuelling B747 at Hong Kong

The complications of the world supply scene had a major impact on the handling and quality aspects of jet fuel. Previously at many airports jet fuel came from a single crude, processed at one refinery and handled through a dedicated marketing distribution channel. In the late 1970s we saw refineries handling many crudes, considerable exchanges and co-mingling of jet fuel occurring. Trying to ensure that jet fuel was delivered to aircraft meeting the specification and 'suitable for use' which is the catch-all requirement, became more demanding. The industry developed a standard specification called *Aviation*

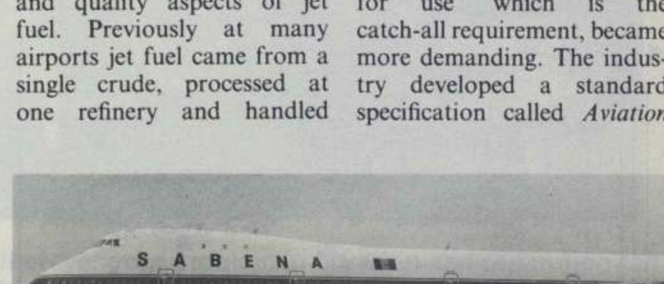


Figure 5(b) B747, Brussels low profile 65,000 Litre fueller

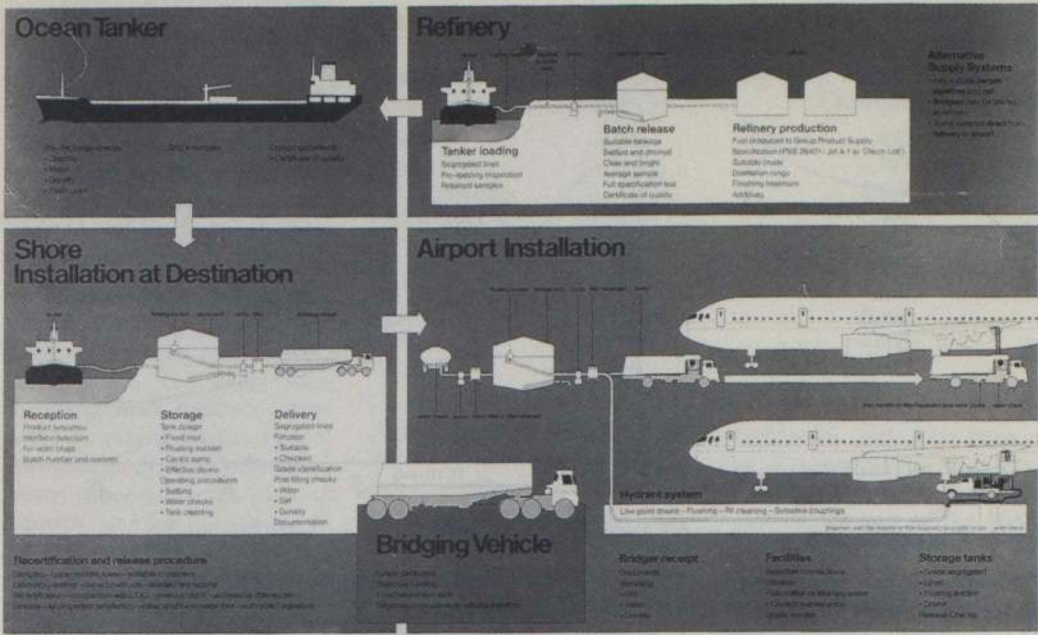


Figure 7 QC System

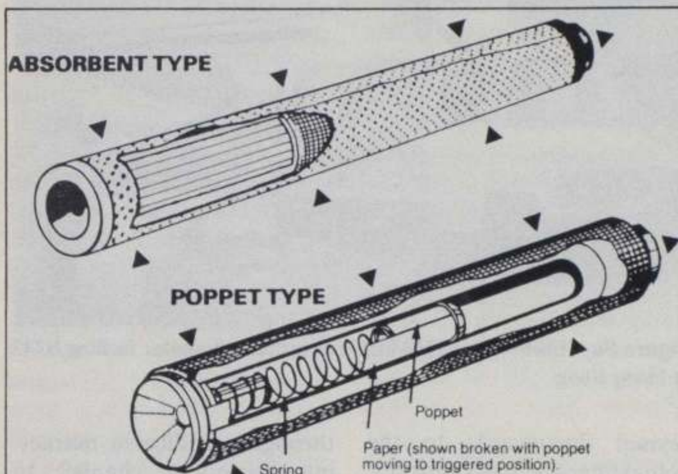


Figure 8

Fuel Quality Requirements for Jointly Operated Systems (often called *Checklist*) to police such operations and detailed quality control systems were implemented to prevent accidents. **Figure 7**

Possibly the most critical quality aspects of jet fuel at the end of the distribution chain is the need to remove dirt and water as these have an immediate deleterious impact on aircraft performance. Filtration equipment is affected drastically by surface active agents which can enter the jet fuel system particularly if fuel is handled through multi-product pipelines or non-dedicated systems. If a water haze is developed it is very difficult to remove and can be the trigger to start microbiological growths which can contaminate aircraft fuel systems.

Much thought was given over this period to methods of monitoring the fuel to ensure product quality and a number of full flow and side stream electrical monitors were developed with various results. They all suffered from the drawback that they were expensive, sophisticated, difficult to maintain and set up and added nothing to the task of cleaning the product.

An alternative development was that of full flow filter monitors. These removed dirt and trace water but were made of special papers that were affected by water in such a way that fuel could be shut down. **Figure 8** These are not affected by trace surface active agents, provide a final polishing clean up and give a positive warning of a potential problem. IP Eng. 13 has taken an active interest in their development and by working closely with manufacturers and users has developed a *Specification and Qualification Procedure for Aviation Fuel Filter Monitors*, which has become an international standard.

The technical advance of electronics and microcomputers in the 1980s has progressed them to a stage of reliability where they can be used with confidence in the rugged environment of the fuelling apron. Electronic meters are now in use with consistent accuracy over wide flow rates and these can be programmed to record weight of fuel delivered even if the density varies during a delivery. The Shell *AD ASTRA* system can extract data from the fuelling vehicle and collect information from many airports thousands of miles apart, issue bulk invoices, collate, match and sort data in any format required without the need for any written document or manual copying of data. The usefulness of such a system opens a way to endless possibilities that have unlimited benefits. **Figure 9**

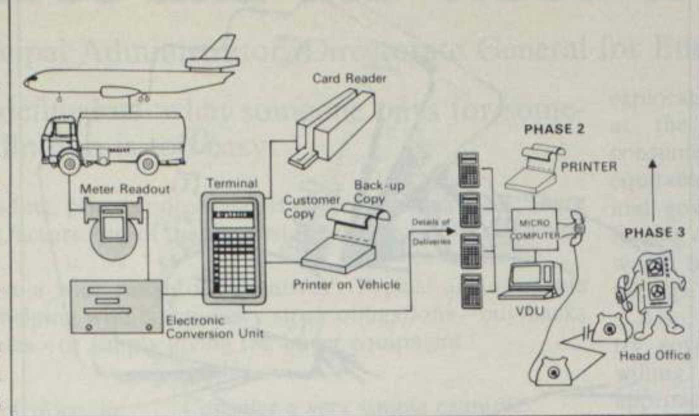
Aviation is an activity that has always attracted the innovator and aviation fuelling has been a business that has developed intense commercial and technical competition. Involvement in joint operations has meant that some of these technical rivalries have had to be channelled to the common good and IP Eng 13 has been the European forum for this. Current work has concentrated on the preparation of an *Airports Safety Code*, general areas of safety, development of hoses for fuelling aircraft, and how to fuel the aircraft now on the drawing board.

Perhaps the biggest future time-bomb ticking away is the several hundred hydrant systems, up to 30 years old, buried beneath 0.5 metres of reinforced concrete, constructed to the highest standards but which could develop a leak. IP Eng 13 has the problem under review but if you have any ideas on leak detection they would like to know.

Jet engines continue to be more demanding and the jet fuel specification becomes more stringent. Engines run at higher temperatures and pressure ratios which in time will mean that present combustion and thermal stability limits in the specification will no longer be satisfactory and new parameters and tests will have to be invented.

Aviation is an area that will never sit still. It has provided me with a tremendous insight into engineering and people. I'm glad I didn't try to argue with the now forgotten person in Personnel Department all those years ago. ●

Figure 9 Shell Ad Astra



13–14 October London
The Ninth Herald Tribune Oil and Money Conference. *Details*: The International Herald Tribune, 62 Long Acre, London WX2E 9JH. Tel: 01 379 4302. TX: 262009.

17–19 October London
EUROPEC '88. The European Petroleum Conference: Building on Expertise — The New Momentum. *Details*: Dr Ken Winckle, BP Exploration Company Ltd, Britannic House, Moor Lane, London EC2Y 9BU.

18 October London
One day introductory course on 'Drilling for Engineers'. *Details*: The Society for Underwater Technology, 1 Birdcage Walk, London SW1H 9JJ. Tel: 01 222 8658. Tx: 917944.

18–20 October Rotterdam
CoalTrans '88. *Details*: Conference Manager, CS Publications Ltd, McMillan House, 54 Cheam Common Road, Worcester Park, Surrey KT4 8RJ. Tel: 01 330 3911. Tx: 8953141 Carsys G.

19–20 October Houston
Conference on 'Gas Futures Trading'. *Details*: Spencer Publishing, PO Box 27717, Houston, Texas 77227–7717. Tel: 0101 713 880 0983.

24–28 October Bedford
Intensive short course on an 'Introduction to Fluid Dynamics'. *Details*: Mrs Judy Whitham, Department of Fluid Engineering & Instrumentation, Cranfield Institute of Technology, Bedford MK43 0AL. Tel: 0234 752766. Tx: 825072.

31 October–4 November Oxford
A five day course on Petrochemical Markets and Economics — the impact of feedstocks and costs on competitiveness and business strategy. *Details*: The College of Petroleum Studies, Sun Alliance House, New Inn Hall Street, Oxford OX1 2QD. Tel: 0865 250521. Tx: 838950 COLPET-G.

31 October–5 November China
SPE International Petroleum Equipment and Technology Exhibition. *Details*: Society of Petroleum Engineers, PO Box 833836, Richardson, Texas 75083–3836. Tel: 0101 214 669 3377. Tx: 730989 SPEDAL.

15–17 November Edinburgh
EFTPoS & Home Services '88. ***Details*: SETG, 1 Lady Margaret Drive, Troon, Ayrshire KA10 7AL.**

3–4 November London
Conference on Oil and Gas Production — Recent Technological Developments. *Details*: IBC Technical Services Ltd, IBC House, Canada Road, Byfleet, Surrey KT14 7JL. Tel: 01 236 4080.

7 November London
One-day tutorial on 'Gas monitoring for industrial environmental safety'. *Details*: Conference Office, Sira Ltd, South Hill, Chislehurst Kent BR7 5EH. Tel: 01 467 2636. Tx: 896649.

8–11 November Argentina
Oil & Gas '88, Investment Opportunities in Argentina. *Details*: CIIE, Paraná 768, Pisco 8, (1017) Buenos Aires, República Argentina. Tel: 41 6873 or 42 9334. Tx: 18117 CIIADI AR.

9–11 November Glasgow
Wescon '88. Global Prospects Offshore. A three day seminar aimed at everyone with an interest in offshore oil and gas and the implications for its future in the Scottish economy. *Details*: Ewan Marwick, Secretary, Glasgow Chamber of Commerce, 30 George Square, Glasgow G2 1EQ. Tel: 041 204 2121.

14–17 November Bedford
Intensive short course on 'Instrumentation Systems for Engineering in the Process Industries. *Details*: Mrs Judy Whitham, Department of Fluid Engineering and Instrumentation, Cranfield Institute of Technology, Bedford MK43 0AL. Tel: 0234 752766. Tx: 825072.

14–18 November Aberdeen
Subsea Production Technology Course. Details: Lothian Oil Ltd, Gardeners House, 34b Haddington Place, Edinburgh EH7 4AG. Tel: 0620 843333 or 031 557 5255.

17 November London
Seminar on the Cost Effective Reliability in Mechanical Engineering. *Details*: The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London SW1H 9JJ. Tx: 917944.

22–24 November London
The Fourth International Conference on Electrical Safety in Hazardous Areas. *Details*: The Institution of Electrical Engineers, Savoy Place, London WC2R 0BL. Tel: 01 240 1871. Tx: 2261176 IEELDN.

23–24 November Milan
Third Annual European Gas Seminar on The Challenge of Keeping and Expanding European Gas Markets. *Details*: European Study Conferences Ltd, Douglas House, Queen's Square, Corby, Northants NN17 1PL. Tel: 0536 204224. Tx: 347260 KM G.

28–30 November Chester
Course on Project Planning and Cost Control Techniques. *Details*: The Conference Section, The Institution of Chemical Engineers, 165–171 Railway Terrace, Rugby CV21 3HQ. Tel: 0788 78214. Tx:311780.

30 November–1 December London
Two day intensive course on oil Loss control. *Details*: IBC Technical Services Ltd, Bath House (3rd Floor), 56 Holborn Viaduct, London EC1A 2EX. Tel: 01 236 4080.

1–2 December London
Second Annual Conference on Offshore Drilling Technology. *Details:* IBC Technical Services Ltd, Bath House (3rd floor), 56 Holborn Viaduct, London EC1A 2EX. Tel: 01 236 4080. Tx: 888870.

4–7 December Watford
Short course on Management of Offshore Projects. *Details*: The Institution of Chemical Engineers, 165–171 Railway Terrace, Rugby CV21 3HQ. Tel: 0788 78214. Tx: 311780.

5–6 December London
Third International Energy Conference, sponsored by RIIA, BIEE and IAEE. *Details*: Terry Lockhart, IEC Conference Organiser, RIIA, Chatham House, 10 St James's Square, London SW1Y 4LE. Tel: 01 930 2233 (ext 249).

1989

21–22 February London
Two day course on Strategic and Business Planning for Exploration and Development. *Details*: DCA Consultant Ltd, Main Road, Aberuthven, Perthshire PH3 1HB. Tel: 0764 63936.

Evening Meetings

20 October Chatham House
BIEE AGM at 1750 hours, followed by Sir John Hill on Problems Facing the Nuclear Industry. Details: Mary Scanlan. Tel: 01 997 3707.

24 October Grosvenor House
SPE meeting starting 1600 hours. Panel on Extended Reach Drilling, chaired by Mike Hazell (BP). Details: SPE, Doug Field. Tel: 01 499 9555.

15 December Chatham House
BIEE meeting commencing at 1800 hours. Norwegian Oil Policy by His Excellency Arne Øien, Norwegian Energy Minister. Details: Mary Scanlan. Tel: 01 997 3707.

Oil prices and the 'Need to Know'

By John Bishop, Principal Administrator, Directorate General for Energy, EEC*

A price can be easily defined as 'what someone pays for something'—but such a definition is too easy.

In the real world of supply trading, price is only one part of a commercial deal. There can be a large variety of other factors: one of the simplest involves credit terms, which are very much part of price.

Customer services can involve a wide range of 'incentives'. Typical arrangements could include: free storage—helping with compulsory stock obligations—buy-backs against crude or feedstock sales—or simply giving the buyer equipment.

All these gimmicks are part of price, in the fuller meaning of the word.

For an active trader the important factor is the *net acquisition cost*, of which price is only one part, an important part, but only a part.

Active traders have to think on their feet and know the interplay of all these factors. Maybe it is because of this knowledge that they scoff at the very concept of price transparency. They consider the concept to be meaningless and unnecessary, since all those buying and selling oil know exactly what going market prices are from moment to moment. Those that don't soon go out of business.

So one can conclude (from the trader's point of view) that those who need to know prices already know them. Whether they pass on accurate information to others is another question.

Apart from its place in the trading activity itself, price is also crucial in determining profit and consequently taxation. Tax, in fact, is a very important issue, as is the morality of different attitudes towards the *tax man*.

It is interesting to note that there is a unique moral attitude towards tax. From the days when heads were turned away as 'the gentlemen rode by' to the present, the tax man is virtually in a category of his own. The most honest, god fearing, church going citizens, the sort of people who, when finding a shilling on the floor, would hold it up and ask who owns it, rather than pocket it, these same people see nothing wrong in doing down the tax man. They will go to great lengths and indeed boast to their friends about how they have deprived the tax man of the revenue he is entitled to.

But what is he entitled to? If a tax payer can, within the law, take actions that reduce the tax man's entitlement, there isn't even any cheating involved. In fact as long as measures taken do not stray over into tax evasion, all measures for tax avoidance constitute good cost cutting management principles.

Consider a very simple example:

- a multinational company has the following affiliates:
- a crude production company A, which is subject to a very high rate of tax, and ad valorem royalties;

  an offshore tax haven registered international trading company B, that pays no tax; and

  a refining/marketing company C subject to moderate tax rates on real profits.
- in deciding where to draw its profit lines the group should aim towards low priced sales by company A to company B to give income that would only just cover company A costs. Then company B would sell to company C at inflated prices that would just allow company C to break even. This puts all profits into the tax haven company B and eliminates almost all tax payments.

Clearly those governments that would lose tax revenue must seek to ensure that action of this sort wouldn't be 'allowed'. In other words law would intervene and companies would only be allowed to follow this tax minimization pattern to the extent permitted by law.

This leads inevitably to consideration of the law. Not just one law. Clearly the situation is going to be complex. There are several legal entities involved and a number of different jurisdictional areas. Whose law are we therefore talking about? In practice, both historically and today we have to consider a series of separate laws, each with its own validity and no sensitivity to, or interface with, any of the others.

Economic rent

In a perfect world, it could be argued that the total economic rent stemming from the overall activity—starting at exploration and production and ending at the point of delivery to final consumers—should be shared on an equitable basis between all companies and governments concerned. However, finding a universally acceptable formula would not be one of the easiest undertakings.

Also, historically, no consumer country government would ever have been willing even to contemplate such an approach. There were many reasons for this earlier unwillingness.

A major factor was that consuming country governments, especially in Europe, used oil as a tax collecting mechanism. For the most part a mechanism was all it was.

The tax was levied on the population and the economy as a whole. While some tax proceeds were certainly spent on building and maintaining the infrastructure associated, in part, with a society structured around the use of oil, the taxes themselves were not intrinsically on oil.

This, however, was not the way producing countries saw it. They considered only that a disproportionately large share of overall economic rent was being stripped off by the consuming country governments.

Whatever the rights or wrongs associated with past and present shares of the economic rent, they have been arrived at without international cooperation and thus we have the series of insular regimes, each standing on its own.

The problem with this situation is that each individual regime cannot take due account of the true costs that are incurred outside the jurisdiction of the regime itself. It has to start with costs at the point of entry into the regime. To a large extent this means if invoices for imported cargoes. Such invoices are often raised by international trading companies operating out of tax havens. And this is where the problem lies. Governments are never sure whether they are being disadvantaged by companies drawing their profit lines in the way described in the earlier illustration of companies A, B and C.

Governments know that to avoid this problem their laws must protect them. But the strictly legal possibilities are severely limited. All that can be done is to establish a maximum supply price that can be deducted for tax purposes. In doing this governments must be reasonable. They know from the past experiences that some countries have had, that too low a legislated price can lead to

***The views expressed are those of the author and do not necessarily reflect the opinions of the Commission of the European Communities.**

supply shortages, especially in times of tight supply and hardening prices.

In short it is terribly important for government to get it right. This therefore is the second crucial aspect of price reporting and transparency.

Current values

To recapitulate: those active in the buying and selling of oil know current market values/prices on a minute by minute basis—they have to, to stay in business; and governments also need to know at least periodic averages of 'proper', 'fair', 'going' 'commercial' prices. Call them what you will, governments need to have access to the *right* prices.

While the main reason is the prevention of tax avoidance, there are other important aspects of the national economy that need to be safeguarded, not least the balance of payments.

Government price information needs to be flexible so as to reflect changes in real supply cost but it need not reflect minute by minute changes. In fact, it should avoid the high level of price volatility that would reflect the extremes of change in the marginal area of the spot market and concentrate rather on the more stable overall supply costs.

Where can governments get the sort of price they need? This is not a new question. It is, in fact, a very old question to which we now need a new answer. In this quest, it is useful, at this point, to examine the answers of the past.

Postal prices

In the early days following World War II, Western European prices were based on two criteria, both of which employed *posted prices*:

- Products, many of which were imported from the US, were priced on US Gulf refinery postings plus freight. This gave the famous 'Channel Parity' which remained a satisfactory basis for European product pricing for a long time.
- Crude prices were also posted at most loading ports.

This combination of posted prices gave a satisfactory degree of transparency of main stream market values. However, even during those days of real posted prices, governments were not completely happy.

While, for the most part, accepting the true nature of the postings at that time, they cast doubt on the freight rates used to arrive at landed European prices.

The line of the argument was that, when oil companies use their own ships to move oil, they should add in only the variable and fixed costs of operating the ships, to arrive at landed cost, rather than a commercial freight rate including a profit element. This was contested in a series of tax cases at the start of the 60s, notably involving Shell and Mobil in Australia.

In effect, the Taxation Board of review ruled that a local affiliate should be viewed as 'an independent enterprise and its dealings with the other enterprise (parent company or tanker company) were dealings at arm's length'. In other words, oil companies should be allowed to make the same profits on the running of their owned ships, as were made by shipping companies with no other related business.

These judgements were later reinforced in tax cases against Shell and Esso in Norway and thus effectively sanctified AFRA (The London Tanker Brokers Panel Average Freight Rate Assessment), which, albeit with some disputes from time to time, serves and has been accepted as a 'proper' shipping cost for many years.

The freight story, while peripheral to the main price issue, is illustrative of the degree of government concern over 'proper' pricing. It is strange, therefore, against this historical and logical background of government concern, that reaction was not faster, when transparency disappeared from the world market.

This followed mainly from US action taken in March 1958, to severely restrict imports of 'cheap' foreign crudes. These were the 'new crudes' found by hitherto US domestic companies, which had, for some years, extended their exploration programmes to North and West Africa, tempted by better prospects/lower costs than they could expect at home in the US.

When most of this lower cost oil was backed out of the internal US market, by the quota system, prices there hardened to stabilize at slightly more than \$3/bbl for most of the '60s.

At the same time, the locked out oil gave rise to surpluses in the rest of the world and, outside the US, prices fell to as low as \$1.30/bbl. With this sort of differential, a two-tier price structure developed. Thus US Gulf refinery postings based on internal US crude costs, while remaining true commercial numbers for the US domestic market, became irrelevant to the 'international' scene. From then on 'channel parity' had no more meaning for Western Europe.

Developments were also taking place in the Arabian Gulf, as world crude prices weakened. Producing country governments progressively opposed cuts in posted prices because of their affects on royalty and tax revenue. The main battle started in August 1960 when postings fell to \$1.76/bbl and by the end of September companies agreed to put postings back to \$1.80/bbl while selling at discounts. Although still called 'Posted Prices', at this stage they had, in reality, already become what later became known as 'tax reference prices'. So crude oil postings in the Arabian Gulf were now artificial and too high to be of any use in the determination of the right prices.

Are prices low enough?

In fact, \$1.80 remained the official number until 1970, over a period in which real sale prices were in the range of \$1.50 to \$1.30/bbl. Probably the main reason for governments not reacting immediately was that, relative to the old points of reference, prices actually being paid were falling all the time. It was however only a matter of time before the new lack of transparency caused new concern and raised the inevitable question 'Prices are lower, but are they low enough?'.

To meet Government concern at this time *Platt's* started to publish assessments of spot market prices in North West Europe. These were adopted by governments and grudgingly later by the industry for all price formation and control purposes. Industry reluctance was based on the view that spot trading is only a thin balancing exercise on the margin of the market and that prices generated there reflect the volatile characteristic of that market and not the costs or prices for main stream supply.

This view, although not accepted at that time, has been corroborated by subsequent price crises in which the whole of world supply has been ratcheted up in line with prices paid for very small volumes by panic buyers and speculators in the spot market.

While spot prices continue to occupy their present place in price formation procedures, we all remain vulnerable to a repetition of the ratchet affect.

However concern now needs to extend beyond this already important vulnerability, because the nature and sources of spot prices themselves are no longer clear.

Volume

Observers today often say that the volume of spot market trade has increased dramatically. They imply that a lot of main stream supply goes through the spot market. If this is true, it opens up some interesting prospects that will be dealt with later. However, it is more likely to be a misinterpretation of the current situation.

No one doubts that a lot of oil is sold at spot or spot related prices. The question is whether or not this is spot market trade.

There is a world of difference between buyers and sellers negotiating a price for a once-off prompt deal, with one party in a last resort situation where the parties are *creating* a spot price, and the situation where buyers and sellers agree to *use* a spot price (mean of Platt's date of loading) as a price formula.

There can be no doubt that many people USE published spot prices for transactions in what used to be called 'the Cargo Market'. In fact, today spot prices are *used* for quite a lot of normal trade extending from once-off single cargoes through consecs to significant term deal contracts. Indeed, because of broad government acceptance of published spot prices, even multinationals use them for inter-affiliate transactions.

None of these are MAKING spot prices they are only USING them and the transactions involved are not therefore genuine spot transactions. Consequently, it is important not to be persuaded that the spot prices we see, are generated by the large trade volumes sometimes attributed to them by this incorrect definition of spot trade.

The interesting question is 'How much volume is making the spot prices everyone else uses? This is not easy to determine. Between June 1979 and May 1980 the EEC Commission ran an exercise (its second) to investigate the spot market. This exercise—COMMA—indicated that some 5% of supply was traded through the spot market, but in terms of making rather than using spot prices, this figure could be too high.

If further progress along this line of argument leads to the discrediting of spot market assessments, something else will need to be found to take their place. There will be those involved in the exchanges NYMEX and IPE, who may push for futures prices to be used. This suggestion raises a whole barrage of questions.

Certainly futures prices are real in that they are openly traded and reported. The fact, however, that they are real *futures prices* does not necessarily mean that they are real *oil supply prices*. Also, in terms of potential volatility in times of tension they could be more destructive than spot prices if they are used for overall price formation.

Channel parity

So much for destructive criticism of the past and present situations and some potential alternatives. Is there also a constructive side to such analysis? The answer must be yes, but there are no easy options. One simple solution could be to reintroduce US based 'channel parity', now that the US is a free and open market, in line with the rest of the world, as far as products are concerned. This however would be open to substantial criticism on the grounds that:

- the structure of oil markets and world supply has changed dramatically;
- US Gulf postings today are not as truly representative of world oil market values as they were in the 50s;
- the restrictions on crude oil exports from the US have an effect on the global validity of US product prices, particularly in the context of the Atlantic Basin;
- Europe does not import from the US Gulf, in fact the trend is now in the opposite direction; and
- available product freight rates (clean) would be unrealistic today if related to trans-atlantic movements that do not take place.

So resurrecting that past solution may not be the answer today.

To get improvement, it looks as if we may have to find, or establish something new. Easier said than done. However, we have some advantages over the past. The world has had a lot more experience with reporting systems of all kinds. Modern electronic information networks, spreading out from the stock exchanges/bourses of the world, now encompass vast areas of both paper and commodity trading.

In this context, it is interesting to recall that in the late 70s, concern over spot prices and the spot market prompted the French Government to suggest that consideration should be given to the possibility of oil being traded in a regulated open exchange or Bourse.

The EEC Commission undertook this task and in April 1980 published the *Report of the Bourse study group*. This indicated that, while establishing an oil bourse would be technically possible, there would be insufficient interest in using it, to justify its existence or cover its costs.

One of the main factors leading to this conclusion was the high percentage of supply covered by inter-affiliate trade within integrated companies.

In discussion within the group, one independent surprised everybody by saying that he would be very much in favour of a bourse. He went on to say that he would only be in favour if it meant that the international supply companies of the multinational majors put up their supplies in the open market, and left it to their affiliates to compete with the independents for their supplies. In other words all suppliers would openly auction oil to all potential buyers. This was, of course, said as a joke, because such an idea was completely unthinkable at that time.

New freedom

Today the world has changed. Tax spinning crude trades in the North Sea to prove price veracity followed very much that approach, with companies deliberately selling to third parties in preference to their own affiliates. Also, in general terms it is clear that, today, most affiliate refiners and marketers have much greater freedom to purchase where they will. They are no longer tied to supplies from the parent company. This is, in effect, why there is so much of the so called spot trade referred to earlier.

In this context it does not matter what it is called: what matters is whether or not it is reasonably arms length. If a lot of supply now comes from arms length trading, could it not be handled as an open floor activity with open transaction price reporting? It would not be on its own any more, even in the oil sector. It would stand beside NYMEX and IPE and, more importantly, it would be very close in nature to the new *regulated* Brent Market, all of which will be reporting their prices. If Brent can be openly traded in a regulated exchange type situation, why not products also? The need for proper price information is as great in both cases—for products perhaps even greater.

Investigation of price, rather than open trade reporting—an on-going COMMA approach, could also be considered, as could the setting up of an industry panel to make price assessments—an idea already aired in the US. Such investigative approaches might need to be given greater credulity by combining them with the adoption of a code of conduct for traders which would govern both the mechanics of spot trade and price reporting systems.

An Oil Bourse

In today's electronic communications age open price trading could increase trading efficiency and speed. It could be popular today with those very traders that spurned the idea in the past. And, of course, if an Oil Bourse did develop and handle sufficient volumes it could be used to generate a lot of transaction price information which could be rapidly distributed electronically. Any reporting system embracing spot transactions with their known price volatility, would also need to encompass sufficient additional mainstream oil to allow it to become the source of price information of the type relevant to main stream supply. In other words, the sort of price information everyone is looking for. •

Biocide oil/water partition coefficients: an important consideration when choosing an effective antimicrobial treatment for stored fuel

by Andrew Coutts, Rohm and Haas (UK) Ltd

Introduction

In the past the choice of biocide for stored middle distillate fuels has often been made without due regard to its solubility in both fuel and water (its partition coefficient). Many preservative failures have resulted from the misappropriate use of biocides which are soluble in only one of these. By choosing a biocide which concentrates in both phases a highly cost effective preventative policy against microbial contamination of stored fuel can be constructed.

The problem

Water is synonymous with microbiological growth in fuel, the biodeterioration of fuel and its deleterious effects on fuel quality and storage tank integrity have already been well documented. In theory, the exclusion of water from storage systems by good housekeeping should prevent microbiological problems from occurring, but, this is more difficult in practice.

Fuels contain certain amounts of dissolved water. In warmer temperatures this can lead to the condensation of water droplets on tank cold spots. Water vapour can also enter through tank breather vents and some delivery systems require purging with fresh, salt or brackish water for ballast.

All of the above can be compounded by poor tank design and inadequate water bottom drainage facilities.

Use of Biocides

More often than not, the microbiological contamination of fuel will manifest itself as a fuel flow problem, either as the plugging of jets or the blockage of filters by fungal hyphae, or bacterial slime. Under these circumstances biocides have been used as one off curative treatments to clean up fuel storage tanks. Unfortunately, this often misappropriate use of a biocide can lead to further problems. A blocked filter may be the result of a microbiological contamination of a storage tank, many points further back in the distribution system. Failure to treat at source will result in quick recontamination. Microbial debris resulting from curative dosing can also cause as many problems as live biomass resulting in manual clean-up after biocide treatment. This type of treatment is also associated with the handling of large amounts of biocide and requires them to have a disinfecting and not preserving action.

Preventative rather than curative treatment where the preserving rather than disinfecting action of a biocide is utilised, is the most cost effective dosing strategy.

Biocide Requirements

A biocide is a chemical which kills and prevents the subsequent regrowth of bacterial (bacteriacide) and fungi (fungicide) at the same time. Before applying a biocide to a fuel/water system the source and type of microbiological contamination should be determined as should the activity spectrum of the biocide against the contaminants.

As microbial growth occurs most readily at the fuel/water interface, the most significant performance characteristic required of a biocide is that it must kill and prevent the regrowth of bacteria and fungi in both the fuel and aqueous phases.

Finally fuel containing a biocide should be shown to have no toxic properties and furthermore have no deleterious effects on fuel quality or engine performance.

Utilisation of a Biocides Partition Coefficient

The partition coefficient of a substance (K) is a measure of the relative solubility of a substrate between two immiscible liquid phases.

For a fuel/water system:

a $$K = \frac{Cf}{Cw}$$

Cf = Concentration in fuel phase

Cw = Concentration in water phase

The dosage of any substance into a fuel/water mixture is by definition.

b $$\text{Dose} = \frac{(CfVf + CwVw)}{(Vf + Vw)}$$

Vf = Volume of fuel phase

Vw = Volume of water phase

By the substitution of equation (a) into equation (b), the relative theoretical concentrations of an active ingredient in both the fuel and aqueous phases can be determined, provided the overall volume and fuel to water ratio of the system studied is known.

c $$Cw = \frac{\text{Dose}\,(Vf + Vw)}{K\,(Vf + Vw)}$$

The following theoretical calculations show that a sound knowledge of the partition coefficients of biocides will enable one to choose an effective treatment to prevent microbial fouling of stored fuel.

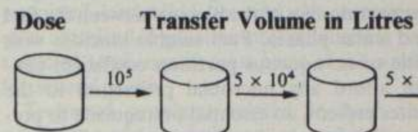
A theoretical fuel distribution system involving four storage tanks in which the tank volume and approximate fuel to water ratios are known is shown in **Table 1.**

Table 1 Theoretical Storage System

Tank	Volume (litres)	Fuel/Water Ratio
1	10^6	1000 : 1
2	10^5	500 : 1
3	5×10^4	250 : 1
4	5×10^4	100 : 1

Transfer volumes in litres from tanks 1 to 4 has been assumed and is shown in **figure 1.**

Figure 1



In the calculation we consider the fate and distribution of a biocide in this system when dosed into the fuel in Tank 1 and the transfer volumes in **figure 1** are assumed. For comparison we consider two biocides of equal biological activity with partition coefficient of 0·176 and 0·95 respectively. This illustrates the difference between a fuel/water soluble biocide and an almost solely fuel soluble biocide respectively.

Biocide Requirements for Distribution Systems

For the purposes of this calculation we can assume that laboratory studies indicate that a concentration of 4 ppm active ingredient is required to kill and prevent the regrowth of a bacterial/fungal contamination in the distribution system. The distribution and fate of a 3 ppm dose of active ingredient into Tank 1 is considered below.

Table 3 shows the theoretical fuel and water concentrations of the biocide throughout the distribution system for biocides with partition coefficients 0·176 (**Table 3a**) and 0·95 (**Table 3b**) if the theoretical transfers of fuel in **figure 1**, were carried out.

Table 3 Biocide Distribution in Storage System

	(*a*) (K = 0.176)		(*b*) (K = 0.95)	
Tank	**Cw**	**Cf**	**Cw**	**Cf**
1	16.9	2.9	3.15	3.00
2	16.1	2.8	3.14	2.98
3	15.6	2.7	3.13	2.98
4	14.6	2.6	3.13	2.98

Cf = Concentration in fuel phase

Cw = Concentration in water phase

Table 3(a) illustrates that the dosing of 3 ppm a.i. into storage Tank 1 with a biocide partition coefficient 0.176 results in water concentrations of approximately four times that required to kill and prevent regrowth in all four tanks from one single dose, indeed partition of the biocide and effective prevention of microbiological contamination will continue for many more consecutive transfer of fuel.

Table 3(b) reveals that the dosing of a biocide with similar activity to that in 3(a) but with a partition coefficient of 0.95, indicative of a solely fuel soluble biocide will at no point in the distribution system impart the 4 ppm active ingredient required to prevent and kill the microorganisms in the aqueous phase.

Conclusion

The successful preservation of stored middle distillate fuels is very much dependent on the partition coefficient of the biocide used. Failures to prevent microbial growth in fuel is often due to an incomplete understanding of the partitioning of the biocide between the fuel and water phases. Fuel soluble biocides with little or no aqueous partition coefficient cannot afford any microbial protection to the water present, an essential prerequisite to prevent the growth of microorganisms. Similarly biocides with no solubility in the fuel phase cannot impart any measure of down stream protection. The addition of a biocide occurring refinery storage, which concentrates at effective levels in both the fuel and water phases, will provide antimicrobial protection during its subsequent distribution to an end-user.

Reference

1 Genner C, and Hill EC, Fuels and Oils in Economic Microbiology, Vol 6 (Rose AH Editor) pp 259–306 (1981) Academic Press, New York.

Oil spillage

Cork granules provided the answer to a difficult oil pollution problem dealt with recently by clean up specialists Alba O.P.D. Limited, when heavy fuel oil spillage penetrated into cracks between rocks. Previously used primarily on the familiar, unsightly, but environmentally fairly harmless rainbow sheen that usually follows a spillage, cork granules in this case virtually eliminated the problem within forty eight hours.

The spillage, caused by a valve malfunction while a tanker was discharging, had contaminated approximately 200 metres of rocky foreshore, part of which at low tide exposed a shingle beach. As a Scottish salmon river flowed into the estuary where the spillage occurred, the use of dispersants or other chemicals was precluded on ecological grounds.

After the area had been boomed off, the contaminated rocks were cleaned with hot water pressure washers, the floating oil trapped by the booms and disposed of by vacuum tanker. The problem that remained was the oil deep in the cracks between the rocks. Each tide washed more oil out so that, after five days, oil was still flowing into the river.

Several radical solutions were rejected, so cork granules were applied to a small stretch as a trial. It was found that the cork sealed the oil into the cracks, removed the black shine from the surface of the rocks and mopped up the sheen where oil had been washed into the water.

As a result, the whole 200 metre long polluted stretch was treated with a layer of cork granules. The first tide showed the treatment to have been a complete success. The oil was sealed in, further flow into the river prevented and only surplus cork was washed off where it was held by the containment booms for later removal by vacuum tanker.

Helicopter guidance aid for North Sea installations

A new form of visual guidance aid designed to assist helicopter pilots landing on North Sea oil and gas installations has been developed by Leech (Rochester) Limited in association with British International Helicopters and with the support of Total Oil Marine.

The landing aid assists the pilot through the final phase of the approach to a heli-deck and visually indicates a recommended flight-path from whatever direction the helicopter may be approaching.

A need for visual aid of this kind was recognised by the International Civil Aviation Organisation (I.C.A.O.) in June 1987 and development work has taken less than a year to complete. The development has been undertaken with the co-operation and assistance of the Civil Aviation Authority and the Royal Aircraft Establishment (RAE) at Bedford.

The aid, known as ODAPI (Omni Directional Approach Path Indicator) stands 2ft high and weighs approximately 200lbs. It uses a unique method of combining the ICAO signal format with true omni directional capability.

Testing of the new system took place on land in January 1988. These trials demonstrated the unique capability of guiding both tangential and curved approaches. The reports stated that the unit gave both clear and unambiguous signals throughout.

Offshore trials were then carried out in March on Total Oil Marine's MCP-01 platform. These were flown by pilots from the CAA and the Air Accident Investigation Branch and a regular normal North Sea operational pilot. This trial highlighted the problems of the rig lighting environment and the positioning of ODAPI on the deck for it to be used to best advantage. For this trial it operated only on a 210 degree arc.

The CAA now say that ODAPI is operationally acceptable for introduction into services and ready for pilot evaluation and reporting. A spokesman for the CAA said: 'User experience is now essential. In our opinion the sooner a number of units are deployed for operational use the better.'

Petrol and Diesel Additives

By TJ Russell, Associated Octel Company Limited, Engine Laboratory

1 Introduction

Additives play a key role in the formulation of gasoline and diesel fuels. They provide a rapid, economic and easy means of improving a fuel's performance properties and controlling its quality during production and distribution.

Within Europe the future quality of gasoline and diesel fuels are being affected by a range of factors which include:

- changing demand patterns for petroleum fuels
- increasing attention to the effects of fuel quality on vehicle emissions
- growing customer awareness of fuel quality and its effects on vehicle performance.

The potential role of additives in this changing situation is reviewed in this paper.

2 Gasoline additives

2.1 Future gasoline requirements

Most projections of future gasoline demand within Europe suggest a slight reduction in total gasoline requirement throughout the 1990s. As illustrated in **Figure 1,** however, an increasing proportion of unleaded gasoline will be used. **(1, 2)**

It is expected that in most European countries only two grades of gasoline will be available by the mid-1990s. These will include a leaded premium grade product retained for use in high octane requirement vehicles of current design and the premium unleaded 'Euro-Super' grade produced for vehicles of newer design.

A summary of current leaded gasoline and expected future unleaded gasoline specifications is give in **Figure 2. (3)** The possible move to a more co-ordinated gasoline specification within Europe will minimise some of the significant variations which now exist, particularly in terms of Motor octane number and hydrocarbon composition.

Seasonal and regional variations in volatility will continue to exist, but, it is possible that future legislation on vehicle evaporative emissions could result in more generally restrictive specifications. This would be of particular impact in the United Kingdom where current volatility requirements are the least restrictive in Europe. **(4)**

2.2 Types of additives available

A summary of the principal types of gasoline additives used is given in **Figure 3.** These include additives which are used to give functional benefits within the refinery and also additives used to improve the performance of gasoline during use.

Antiknocks and antioxidants are considered functional additives. Their use within refineries enables specification requirements for octane quality and stability to be met at a cost significantly lower than additional refinery processing. Use of these types of additives offer refiners significant economic benefits and also the flexibility to react to specific blending situations.

The remaining additive types are essentially considered performance additives. In the main their use improves the performance of the gasoline in the engine. Benefits in terms of improved vehicle operation, reduced fuel consumption and reduced exhaust emissions are typically claimed. Additive use enables Oil Companies to enhance the reputation of their gasoline by offering these and other benefits to the discerning customer.

2.3 Additive properties and performance

2.3.1 Antiknock additives

Antiknock additives, almost exclusively the lead alkyl antiknocks tetraethyl lead and tetramethyl lead, represent the largest market for a single type of additive currently used in gasoline production. Despite reductions in permitted lead alkyl use and the increasing sales of unleaded gasolines this situation is not expected to change in most parts of the world for several years.

Technical problems related to both the production of unleaded gasolines and their use in existing vehicles will only allow phased changes in gasoline grades to be made. The potential problems of valve seat sinkage in a wide variety of engine types and the high octane requirement of vehicles designed for use with leaded premium gasolines cannot be ignored. **(5)**

Despite extensive research over many years no direct replacement for lead alkyl antiknocks exists. Antiknock activity is associated with a range of chemical elements and organometallic compounds have typically shown greatest activity. Various compounds have been considered and these include the products shown in **Figure 4.** As indicated, however, most of these alternatives have normally at least one serious disadvantage.

The two metals which have received most attention are manganese and iron and products based on these elements have been commercialised.

The manganese additive, methyl cyclopentadienyl manganese tricarbonyl (MMT), was introduced as an antiknock and supplement to lead alkyls in the United States during the late 1950s. **(6)** Since that time the development of MMT has been limited by various factors. These include:

- the high cost of the product
- the very low concentration at which the additive can be usefully employed. Problems due to fuel instability, deposit build-

Mr TJ Russell's paper was first presented at The Institute of Petroleum Conference, Petroleum Retailing into the 1990s in May.

Figure 1: European Gasoline Demand 1987–2000

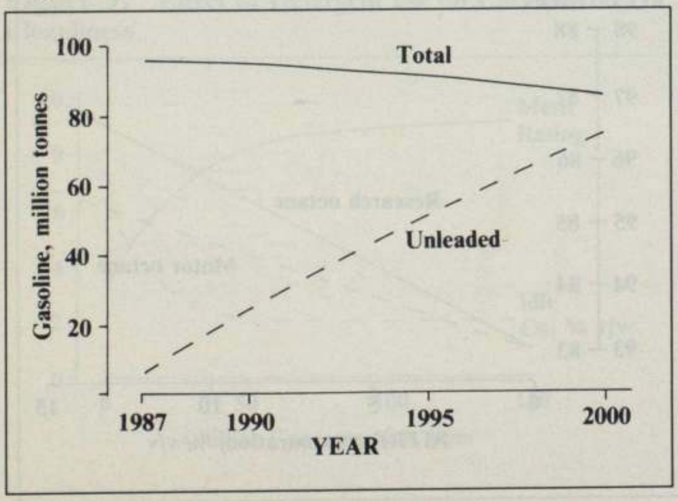


Figure 2: European Gasoline Specifications

PROPERTY	CURRENT LEADED	FUTURE UNLEADED
Research Octane Number	97/98 min	95.0 min
Motor Octane Number	85/88 min	85.0 min
Lead Content, g/litre	0.15/0.40 max	0.013 max
Sulphur Content, % m/m	0.10/0.20 max	0.10 max
Existent Gum, mg/100ml	5/10 max	5 max
Copper Corrosion, 3hr at 50°C	1 max	1 max
Density at 15°C	0.720–0.780	Limits 0.725–0.786
Volatility	Significant Variation	Range 0.050
Oxidation stability, minutes	240 min	To be specified by individual countries

up in engines and rapidly reducing response are evident at concentrations above the recommended maximum addition of 0.0165 g Mn/litre

- the Clean Air Act Amendments of 1977 banning the use of MMT in unleaded gasoline. The required EPA waiver being denied on the basis that MMT increased hydrocarbon emissions and could, under some circumstances, cause plugging of exhaust catalysts
- restrictions on the use of organo-metallic compounds as gasoline additives in many parts of the world.

Use of MMT does exist in both the United States and Canada. MMT is often used as a co-antiknock with lead alkyls in the very low lead gasolines produced in the USA, while in Canada use of MMT in unleaded gasoline is permitted. The potential of MMT in other parts of the world remains in doubt.

Iron based antiknocks were also used commercially in both Europe and the USA during the 1930's. The most well-known compound was iron pentacarbonyl and it was an extremely cost effective additive for use in the low octane paraffinic fuels of that time. The iron compounds, however, cause very significant engine wear and problems related to spark plug operation.

Organic, ashless, antiknocks have also generated much interest and the work of Shell in this area is probably most informative. (7) This class of antiknocks is of less effectiveness and treatment rates of up to 5% are often necessary to produce the required improvement in octane number. The two groups of organic compounds which typically exhibit most activity are:

- aromatic compounds containing nitrogen
- aromatic compounds containing oxygen.

Information on the performance of various different organic compounds are given in **Figure 5**. The data show response relative to N-methyl aniline which at the chosen test concentration of 0.025 mole/litre gave an antiknock benefit of 0.84 RON.

In the absence of alternative antiknocks to lead alkyls it would appear therefore that future gasoline octane numbers will be achieved principally by refinery processing and not additive use. Non-refinery components such as MTBE will play a part but, as indicated in **Figure 6**, these should be considered as high octane blend stocks and not antiknock compounds.

Figure 3: Major Gasoline Additives

ANTIKNOCKS
ANTIOXIDANTS
ANTI ICERS
DYES
CORROSION INHIBITORS
DETERGENTS
COMBUSTION IMPROVERS

2.3.2 Antioxidants

Existent gum and oxidation stability requirements are present in most gasoline specifications. In practice, however, most Oil Companies produce gasolines to their individual requirements and oxidation stability significantly better than the specification requirement is usually achieved. Routine use of antioxidants together with associated metal deactivators enables the required gasoline stability to be maintained and also allows for the possible effects of changes in process unit operations.

The oxidative degradation of gasoline is believed to proceed via a free radical chain mechanism which involves peroxide radicals. Antioxidants, such as alkyl phenols or phenylene diamines, inhibit this chain reaction by reacting with the peroxide radical. Greatest antioxidant activity is achieved by on-stream use of the additives in more unstable components such as FCC gasoline.

As shown in **Figure 7** the phenylene diamine antioxidants are more effective than the alkyl phenol type. This is particularly evident in fuels containing olefinic blending components and despite their higher price phenylenediamine antioxidants are often more cost effective in today's gasolines.

Figure 5: Antiknock Effectiveness on a Relative Weight Basis for Various Ashless Antiknocks

COMPOUND	RELATIVE EFFECTIVENESS
N-methyl aniline	1.0
'Best' amine	1.1
'Best' hydrazine	0.9
'Best' n-nitrosamine	1.5
'Best' phenol	0.5
'Best' formate	0.5
'Best' oxalate	0.4
Iodine	1.1
'Best' selenium compound	2.8

2.3.3 Anti-icers

Ice formation in carburettors remains a problem even with many cars of current design. Under conditions of high humidity and relatively low ambient temperatures moisture from the inlet air can freeze within the carburettor. This results in rough engine running and even stalling particularly during engine warm-up.

As shown in **Figure 8** fuel volatility has a marked effect on the tendency for carburettor icing to occur. Control of icing by the use of additives, however, presents a more practical and economic alternative than varying gasoline composition.

Two principal forms of anti-icing additives exist; they are cryoscopic additives and surface active additives. The cryoscopic additives function by lowering the freezing point of condensed water and preventing it turning into ice. Alcohols such as iso-propanol can be used but glycols such as dipropylene glycol or glycol ethers such as ethylene glycol mono methyl ether are more effective.

The alternative additives are surface active compounds which function by forming a hydrophobic film over the critical surfaces of the carburettor and prevent ice adhering to them. Many chemical compounds can be considered as surface active anti-icers and these often include the compounds used as carbu-

Figure 4: Potential Organometallic Antiknocks

METAL	COMPOUND	LIMITATION
Manganese	Methyl cyclopentadienyl tricarbonyl	Economics range of application
Iron	Pentacarbonyl	Engine durability
Copper	Methylamino methyleneacetone	Gasoline stability
Thallium	Naphthenate	Economics
Cerium	Tetramethyl heptanedionate	Economics
Nickel	Carbonyl	Economics stability engine durability
Tin	Tetraethyl	Economics engine durability

Figure 6: The Effect of MTBE Addition on Gasoline Octane Quality

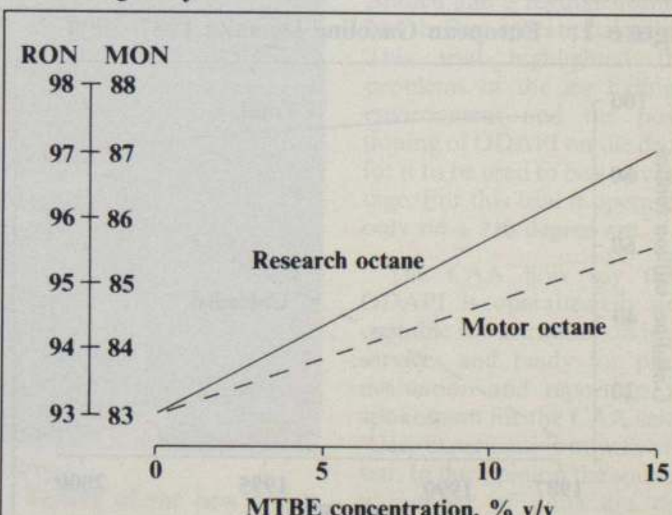


Figure 7: **Effect of Fuel Composition on Antioxidant Effectiveness**

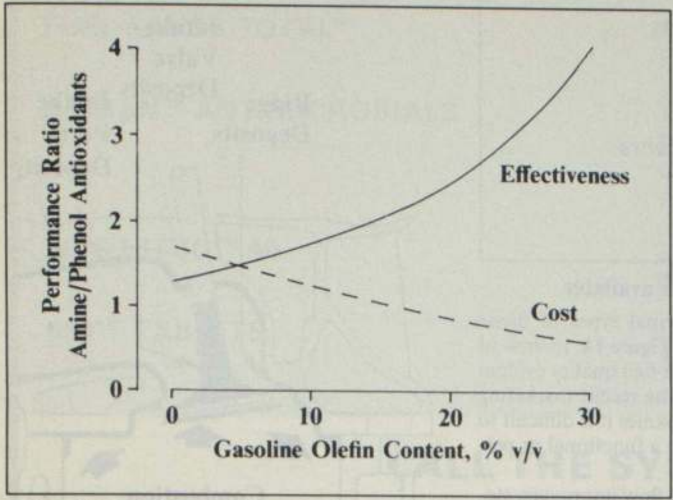
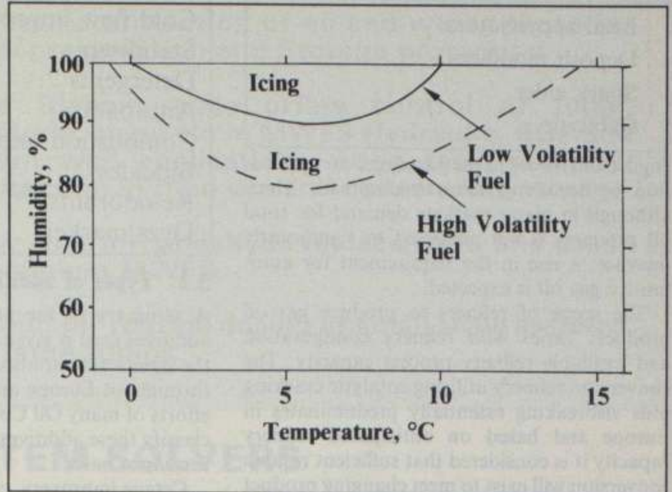


Figure 8: **Effect of Ambient Temperature and Humidity on Carburettor Icing**



rettor detergents or engine cleanliness additives which are discussed later.

2.3.4 Detergents

The control of deposit build-up in carburettors, fuel injection equipment and inlet systems can offer significant performance benefits. These include:

- reduced exhaust emissions
- improved fuel economy
- improved vehicle driveability
- reduced maintenance costs.

Changes in engine design such as the recycling of crankcase gases and extended use of exhaust gas recirculation are expected to increase deposit problems. Additives are again seen as the likely solution.

Experience has shown that use of low levels of carburettor detergents typically amides, fatty amines and imidazolines can give good control of carburettor deposits. These reductions in deposits are associated with improvements in engine driveability, fuel economy and reduced exhaust emissions. Additive use also results in anti-icing protection and some corrosion protection.

The data in **Figure 9** illustrate the results of carburettor detergency tests undertaken using the Renault R-5 procedure. **(8)** With no additive idle CO had increased to 6% from the original 2% and the engine visual rating which is based on cleanliness had deteriorated to 3. Additive treatment rates of only 40 ppm were sufficient to improve the visual merit rating from 3 to 9 and reduce idle CO after the 12 hour test to almost the original 2% v/v set point.

As shown in **Figure 10**, however, deposit build-up is possible throughout the inlet system and also within the combustion chamber. Current interest is, therefore, directed at additives which, in addition to carburettor cleanliness, give control of deposit build-up in these areas. Polymeric dispersant additives, such as polyalkylene succinimides and polyether amines, in correctly formulated additive packages have been shown to be effective in this role. **(9)**

Test procedures such as the Opel Kadett and the Mercedes 102E exist for screening additive performance and concentrate mainly on control of inlet valve deposits. **(10, 11)** The future importance of combustion chamber deposits and their possible effects on engine octane requirement increase (ORI) must not be underestimated. ORI has not generally been considered a major problem in the small high compression ratio engines typically used in Europe. Recent test results, as shown in **Figure 11**, **(12)** show significant ORI can however occur with European type vehicles operated on unleaded gasolines.

2.3.5 Combustion Improvers

In closing this section on gasoline additives illustrations of historic approaches to combustion improvement are necessary. As illustrated in **Figure 12** a range of additives have been used. These include:

- lead appreciators such as tertiary butyl acetate which were effective at extending the antiknock effectiveness of lead alkyls at high additive concentrations
- deposit modifiers such as the phosphorus and boron compounds extensively used to increase the glow point of engine deposits
- the spark aider approach recently considered
- the catalytic approach where the catalyst is added to the fuel which appears to be increasingly considered.

Additions to this list are expected in the future.

3. Diesel Additives

3.1 Future diesel requirements

The good fuel economy of the diesel engine, together with its durability and reliability, is steadily increasing its importance as a vehicle power unit. Commercial transportation in Europe is already dominated by the diesel

Figure 9: **Effect of Detergent use on Carburettor Cleanliness**

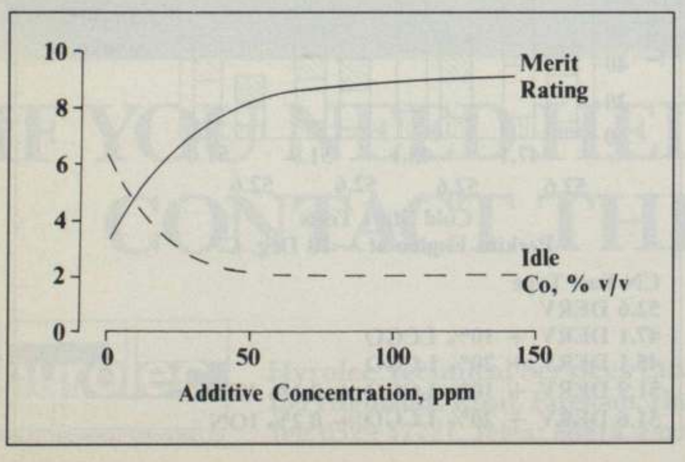


Figure 11: **The Effect of Mileage Accumulation on Engine Octane Requirement**

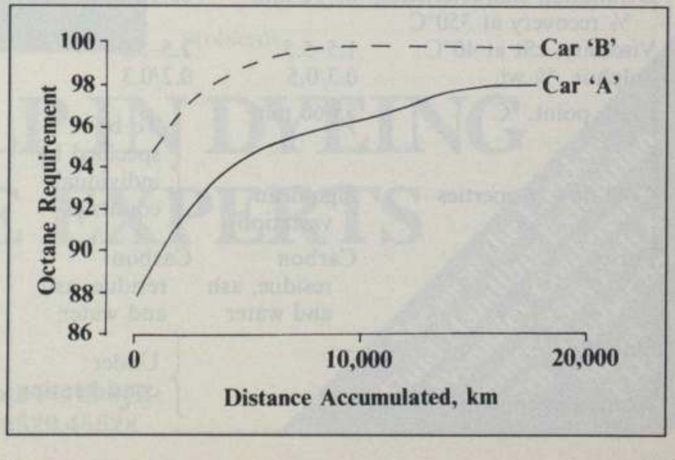


Figure 12: Historic Approaches to Combustion Improvement in Gasoline

Lead appreciators
Deposit modifiers
Spark aider
Catalytic

engine and its use in the passenger car application is becoming more widespread. Thus, although in many markets demand for total oil products is not predicted to significantly increase, a rise in the requirement for automotive gas oil is expected.

The scope of refiners to produce gas oil products varies with refinery configuration and available refinery process capacity. The conversion refinery utilising catalytic cracking plus visbreaking essentially predominates in Europe and based on anticipated refinery capacity it is considered that sufficient residue conversion will exist to meet changing product requirements throughout the 1990s. The proportion of cracked components within the automotive gas oil blending pool will, increase. This will lead to higher density, lower stability and lower ignition quality products; the situation that currently exists in certain parts of the USA being an extreme example of this trend.

Concern, however, already exists over the quality of automotive gas oil within Europe and the very significant variations which occur both within and between individual markets. Consumer organisations and engine manufacturers are calling for more consistency in the quality of fuels. They contend that optimum performance of the diesel engine with respect to power, fuel consumption, exhaust emissions and noise can only be achieved with good quality fuels.

A reassessment of specification requirements is expected in the near future and as with gasoline a more co-ordinated approach is likely. A review of current and possible future specifications are given in **Figure 13**. Control on fuel stability and aromatic content may feature in these future requirements.

Figure 14: Major Diesel Additives

Cetane Improvers
Cold flow improvers
Stabilisers
Detergents
Antifoams
Combustion improvers
Biocides
Re-odorants
Dyes/marker

3.2 Types of additives available

A summary of the principal types of diesel additives used is given in **Figure 14**. In view of the significant variation in fuel quality evident throughout Europe and the recent marketing efforts of many Oil Companies it is difficult to classify these additives on a functional or performance basis.

Cetane improvers, cold flow improvers, stabilisers and dyes/markers are considered to be principally functional additives. Although their role as performance additives, for instance in the formulation of 'Premium diesel fuels', cannot be overlooked.

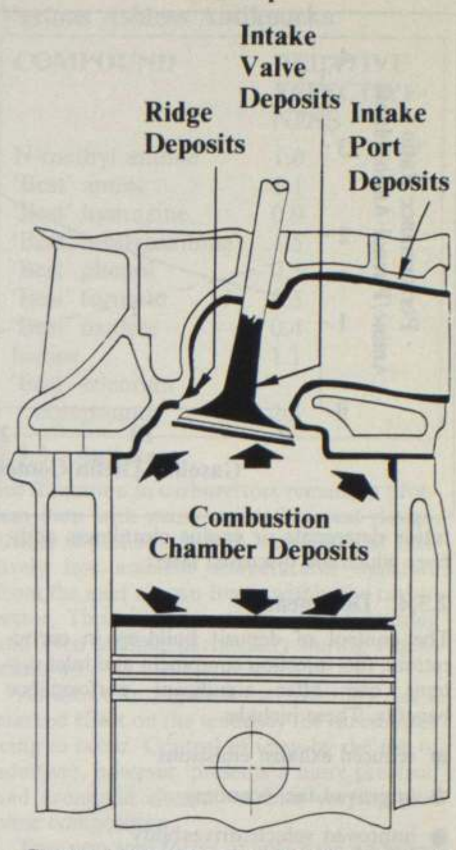
The remaining additives are currently used essentially to improve the performance of the fuel during distribution and use.

3.3 Additive properties and performance

3.3.1 Cetane improvers

Cetane improvers are compounds which readily decompose to give free radicals and enhance the rate of chain initiation for hydrocarbon oxidation in diesel combustion. They promote fast oxidation of fuels and thus improve their ignition characteristics. Chemical compounds with thermally sensitive nitrate groups are known to be effective cetane improvers and various alkyl nitrates, ether nitrates and ethylene glycol nitrates have been used. In practice iso-octyl nitrate is considered the most effective additive for normal applications.

Figure 10: Typical Engine Deposit Build-Up



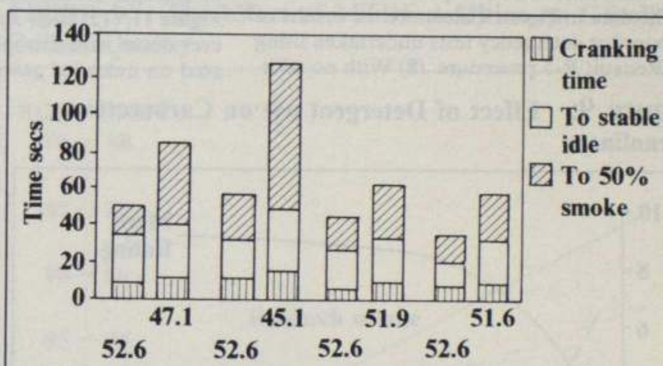
Cetane improvers provide refineries and blenders with a simple and effective means of achieving operational flexibility on a day-to-day basis. They are typically used to:

- upgrade automotive gas oil quality to meet specification requirements in conversion refineries where economic benefits from the use of cracked components in automotive gas oil production exists
- give the flexibility required to process

Figure 13: European Diesel Specifications

PROPERTY	CURRENT	POSSIBLE FUTURE
Density at 15°C	0.810–0.890	0.835–0.865
Ignition quality, Cetane number	45/50 min	48 min
Distillation characteristics, % recovery at 350°C	85/90 min	85/90 min
Viscosity, cSt at 40°C	1.5–5.5	2.5–5.0
Sulphur, % wt.	0.3/0.5	0.2/0.3
Flash point, °C	55/60 min	To be specified by individual countries
Cold flow properties	Significant variation	To be specified by individual countries
Purity	Carbon residue, ash and water	Carbon residue, ash and water
Stability	—	Under consideration
Aromatics content	—	Under consideration

Figure 15: The Effect of Cetane Improver on Cold Start Characteristics



Cold Start Tests
Perkins Engine at −10 Deg. C.

CN Fuel Type
52.6 DERV
47.1 DERV + 10% LCGO
45.1 DERV + 20% LCGO
51.9 DERV + 10% LCGO + 0.1% ION
51.6 DERV + 20% LCGO + 0.2% ION

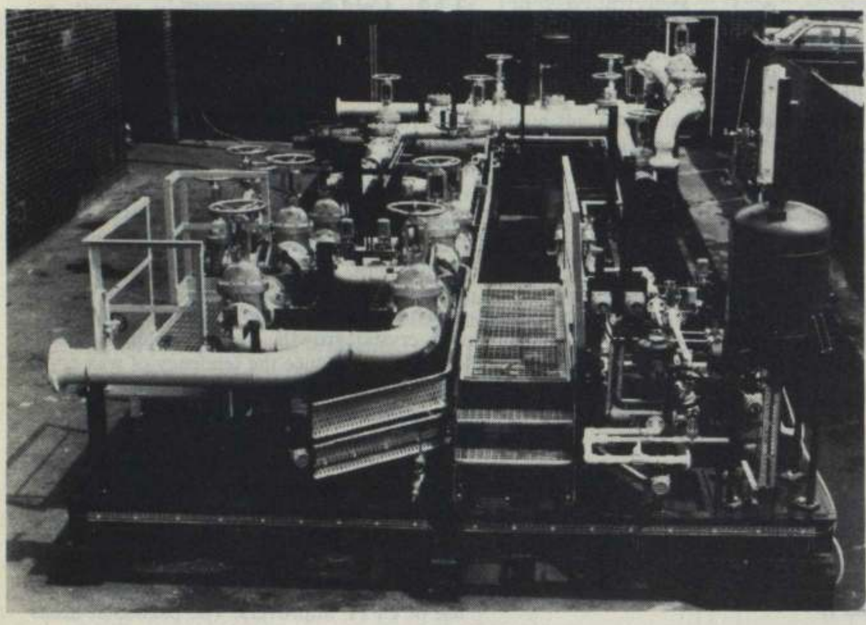
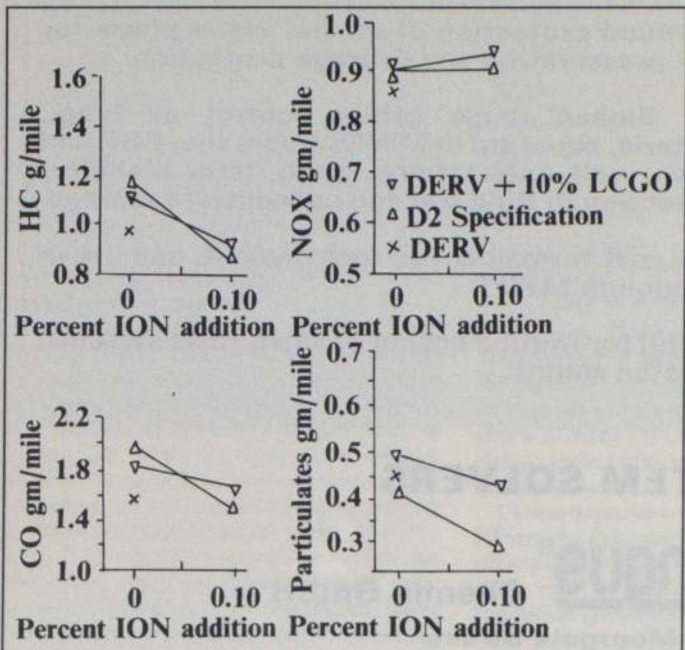


Figure 16: The Effect of Cetane Improver on Exhaust Emissions



UK DERV	51.8
UK DERV + 10% LCGO	47.2
UK DERV + 10% LCGO + 0.1% ION ...	53.0

Figure 17: CFPP as a Measure of Vehicle Cold Temperature Operating Limit

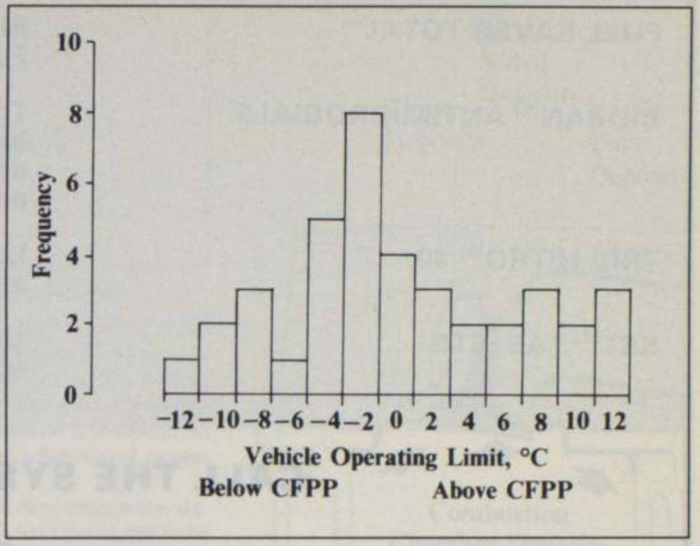


Figure 19: Mechanism of Cloud Point Depressant Action

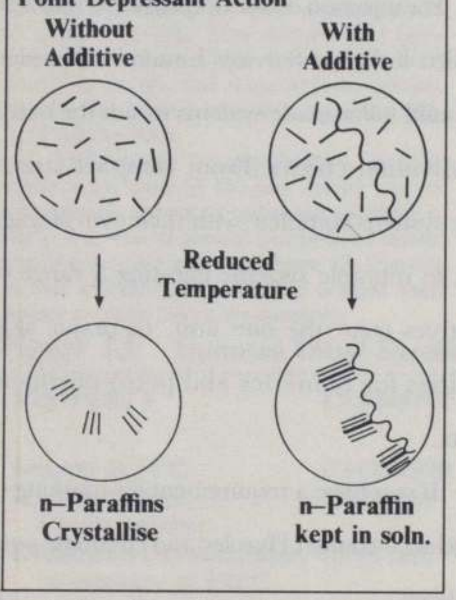
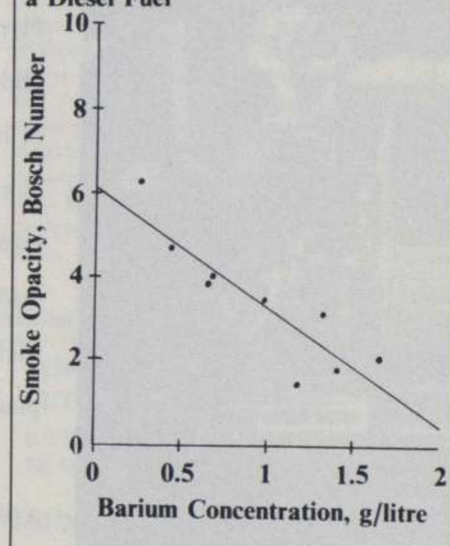


Figure 23: Relationship of Smoke Reduction to Barium Concentration in a Diesel Fuel



significant quantities of low cetane naphthenic crude when geographic or economic conditions dictate this

- upgrade automotive gas oil quality to give the premium grade products required in certain European markets.

The effects of cetane improver use on the performance of vehicles have been widely considered. The cetane number of a diesel fuel reflects the ease with which it undergoes compression ignition and is an indicator of performance related properties which include:

- cold starting
- smoke emissions during warm-up
- noise
- power
- exhaust emissions
- fuel consumption
- engine durability

Extensive testing has shown a strong correlation between cetane number and combustion ignition delay exists for hydrocarbon fuels in commercial engines. These correlations have been confirmed for fuels containing cetane improvers. **(13)**

The benefits cetane improvers offer in terms of improving vehicle starting from cold are shown in **Figure 15**. The results of tests undertaken in a direct injection engine at −10°C illustrate the potential benefits of iso-octyl nitrate to improve the performance of low cetane number basefuels.

Reduced exhaust emissions have also been shown to result from cetane improver use. The potential of iso-octyl nitrate to reduce emissions of hydrocarbons, carbon monoxide and particulates is clearly evident from the test data in **Figure 16**. **(14)**

3.3.2 Cold flow improvers

The use of additives to improve the cold filter plugging point (CFPP) of middle distillate products is extensively practised in Europe. Additive use, together with correct product formulation, is essential to the production of acceptable automotive gas oils.

The additives typically used are complex mixtures of varying molecular weight ethylene/vinyl acetate (EVA) copolymers in conjunction with other polymeric material. They function in the solid state by mechanisms which include nucleation and modification of wax crystal growth. These combined effects significantly reduce the tendency of wax crystals to interlock and gel and give marked improvements in the flow properties of correctly formulated gas oils.

The general relationships between CFPP values and minimum vehicle operability limits were established in work completed during the early 1970s. Problems under recent extreme winter conditions have, however, refocused attention on the CFPP test procedure and the use of CFPP improvers. The particular areas of concern have included:

- National specifications which do not allow for the lowest expected winter temperatures
- the reliability of the CFPP test as a measure of low temperature operability in fuels where a large differential between CFPP and cloud point exists
- the significance of wax settling during extended storage at low temperatures.

The results of recent test work are summarised in **Figure 17** and show the significant variations which can exist between vehicle operating limits and fuel CFPP values. Many of these variations can be linked to vehicle design but fuel cloud point is known to have an influence. Operability indices based on cloud point and pour point values often give a better correlation with vehicle operating limits than CFPP alone.

Information on the response of a typical CFPP improver is given in **Figure 18**. Very significant improvement in CFPP values are seen at low additive levels in the medium and high final boiling point products for which the additive was designed. The effectiveness of the additive was much less in the low FBP fuel. No improvement in the cloud point values of the gas oils were, obtained or expected from this type of product.

Additives which control cloud point have been developed and are being used in certain parts of Europe. **(15)** As illustrated in **Figure 19** the additives work in the liquid phase and function by solubilising the low proportion of very high molecular weight paraffins which crystallise at the gas oil cloud point. A reduction in cloud point of 3°C to 5°C can be achieved at acceptable additive levels and significant economic benefits result from their use.

Other approaches which are being increasingly used to improve the low temperature properties of diesel fuels are the use of:

- cold flow improvers which enable acceptable operability to be achieved at large CFPP and cloud point differentials
- further additives to prevent wax settling during storage at or near a fuels cloud point

3.3.3 Stabilisers/detergents

In view of the changes which are occurring in the composition of automotive gas oil increasing attention is also being given to fuel stability. Concern over the stability of automotive gas oils exists both with respect to their ability to withstand oxidation during storage and also their tendency to form deposits prior to combustion. Particular attention is being attached to the dual role of antioxidants and detergents in solving these problems.

Figure 20: Causes of Diesel Fuel Instability

Acid-base reactions to form sediment
Oxidation reactions to form gum
Esterification reactions to form sediment

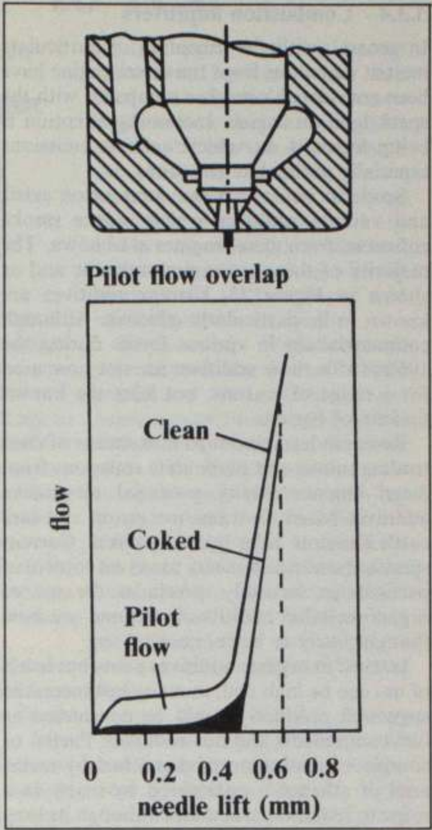
Additive use is one of the alternative means of improving gas oil storage stability and this approach will become more important as increasing quantities of less stable components go into the gas oil pool. As illustrated in **Figure 20** diesel fuel instability is caused by various reactions. Additives have been shown to control both gum and sediment formation, although at this time the problem of fuel darkening is not fully resolved.

Consideration is also being given to the effects of fuel composition and stability on injector nozzle fouling with diesel engines. Significant importance is being attached to this problem in view of the increasing proportion of diesel cars in many European countries.

In service experience and vehicle tests have shown that a substantial amount of injector nozzle fouling occurs particularly with the prechamber pintle type of injector which is used in passenger car applications. The deposits formed reduce the pilot fuel discharge which occurs during the overlap period in the early stages of needle lift. This part of injector operation is important because it produces a finely atomised fuel spray in order to promote early ignition. This prevents the excessive rise of cylinder pressure which results if too much fuel is released during the initial combustion phase. Heavy deposits can essentially eliminate the pilot discharge and result in noisy engine operation, increased exhaust emissions and more smoke emissions. These effects are particularly evident under the low temperature conditions where ignition delay is greater.

The flow characteristics of a diesel injector can be determined using an air flow technique. This allows the curve of flow through the injector versus needle lift to be plotted. An illustration of this curve for an injector nozzle when clean and after a period of use is given in **Figure 21**. The pilot phase of injection has essentially been eliminated by the accumulation of deposits.

Figure 21: Pintle Nozzle Fouling



Reported information suggests that injector nozzle deposit formation appears to be greater when the engine is run at medium to high load. The effects of deposit build-up on vehicle performance are, however, most noticeable at light load where the fuel injection system is required to provide low levels of fuel flow. The effects of injector nozzle deposits on vehicle exhaust emissions and engine noise have been extensively reported. **(16)**

Correctly formulated additive packages have been shown to be effective in controlling injector nozzle fouling. The data in **Figure 22** show how these benefits can be realised in reduced emissions after comparative testing of

Figure 22: Effect of Detergent use on Vehicle ECE15 Exhaust Emissions, after 1000km Operation

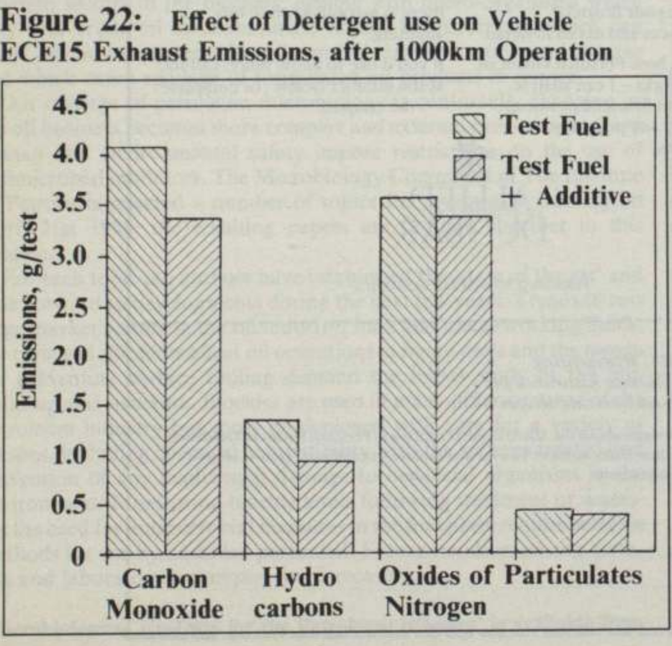
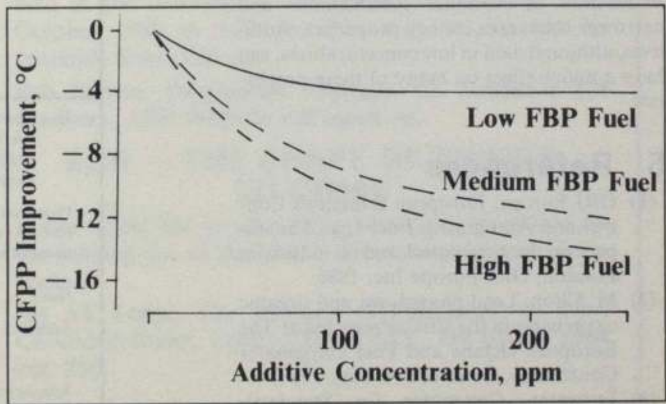


Figure 18: The Effect of Fuel Composition on CFPP Additive Performance



treated and untreated fuels.

3.3.4 Combustion improvers

In general, with the exception of particulate matter, emissions from the diesel engine have been considered low when compared with the spark ignition engine. Increasing attention is being focussed on vehicle exhaust emissions especially particulate emissions.

Scope to improve diesel combustion exists and various additives which reduce smoke emissions from diesel engines are known. The majority of these are organo-metallic and as shown in **Figure 23,** barium additives are known to be particularly effective. Although commercialised in various forms during the 1960s/1970s these additives are not now used for a range of reasons; not least the known toxicity of barium.

Research has continued into means of controlling smoke and particulate emissions from diesel engines. Many potential alternative additives based on transition group and rare earth elements have been identified. Current specification requirements based on control of particulates, basically, precludes the use of organo-metallic additives and none are now thought likely to be commercialised.

Interest in organic additives exists but levels of use can be high and, in many instances, the suggested products should be considered as fuel components and not additives. Partial or complete substitution of diesel fuel by methanol or ethanol is considered by many as a route to reduced particulates although its long term efficacy is yet to be established. In other areas short term objectives are being met by changes in fuel quality to lower sulphur and aromatic contents of the available diesel fuels. More generally, however, widespread use of exhaust treatment devices, such as particulate traps, are expected to be required to meet future stringent particulate requirements.

4 Closure

Gasoline and diesel fuel quality is currently a topic of significant debate in Europe. Concern exists over future trends in the production of these fuels and the effects these trends will have on vehicle performance. In this paper the role of additives in both improving the economic production of gasoline and diesel fuels and also enhancing their performance in vehicles have been considered.

It is expected that increased attention will be focussed on the quality of gasoline and diesel fuels. Consumer groups and engine manufacturers have stated the need for more harmonisation of National specifications and narrower tolerances on key properties. Additives, although used in low concentrations, can have a major effect on many of these properties.

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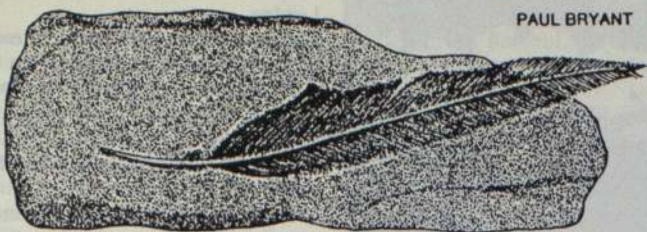
Fossil feathers lay 'forgery' to rest

The archaeopteryx is portrayed on the crest of the Institute of Petroleum, granted by the College of Heralds in 1949. The following article, printed in *The Times* on 25th June 1988, will be of interest to members.



PAUL BRYANT

The discovery of another fossil specimen of the earliest known bird *Archaeopteryx*, adding to the five already known, will lay to rest the contention that the beautiful impressions of feathers in other specimens were the result of an elaborate Victorian forgery.

Treatment of the new specimen has revealed clear impressions of quills, unsuspected by the amateur collector who thought he had found a specimen of the small dinosaur *Compsognathus* until the Bavarian palaeontologist, Peter Wellnhofer, came across it last November. The impressions were buried in the rock, making any kind of forgery impossible. Wellnhofer describes the new specimen in the June 24 issue of the US journal *Science*.

The suggestion of fraud was first made in 1986, in a book by the astronomers, Sir Fred Hoyle and Chandra Wickramasingh. They said that the fossils preserved in museum collections did not represent the earliest birds, but were *Compsognathus* skeletons to which the impressions of feathers had been added later.

Such practices were common enough in Victorian curio collections, and Hoyle and Wickramasingh contended that curators at the time were ignorant of the fraud, or turned a blind eye to it, because the feathered fossils supported ideas about how birds evolved from reptiles.

Charges of forgery were hotly denied by researchers at the Natural History Museum in London in uncharacteristically strongly-worded statements and, later, in scientific journals. Reprints of an article entitled "*Archaeopteryx* is not a forgery" were even handed out to every delegate at a subsequent palaeontology meeting in Belfast.

Detailed examination of the particularly fine *Archaeopteryx* specimen in London showed that forgery was impossible, at least in that case. Delicate veins of minerals, impossible to manufacture, ran through the feather impressions, and there were no traces of glue or cement in the specimen.

That the complete and detailed impressions of feathers are preserved at all in limestone 100 million years old owes everything to the exceptionally fine grain of the particular limestone at the quarry at Solnhofen in Bavaria at which all six *Archaeopteryx* fossils have been found. Lithographers used to prize Solnhofen limestone for its quality and evenness (whence the full zoological name *Archaeopteryx lithographica)*.

The limestones were laid down in the Jurassic period, and have produced many other fossils besides *Archaeopteryx* in the course of decades of commercial excavation. The fossils include specimens of *Compsognathus*, which looks very much like *Archaeopteryx* except for the lack of feathers.

The new *Archaeopteryx* fossil is virtually complete, except for most of the head. Preserved on a slab 52 by 39 cm in area, it is by far the largest of the six known specimens, 10 per cent larger than the London specimen (the largest until the new find came to light) and double the size of the smallest, kept at Eichstatt. Some researchers think that the large size range is indicative of not one but two species of primordial bird at Solnhofen, to go along with the many kinds of Pterodactyl and other reptiles from the site.

Hoyle and Wickramasingh were nevertheless correct in their contention that *Archaeopteryx* bears a more than passing resemblance to a small bipedal dinosaur. The feathers apart, it has many donosaur features such as a long bony tail and a mouthful of short pointed teeth. It also lacks the bony keel on the breastbone that anchors the strong flight muscles in modern birds, making it unlikely that *Archaeopteryx* was capable of sustained flapping flight.

But even though *Archaeopteryx* shares many features with contemporary reptiles, the presence of feathers leave no room for doubt in the minds of most researchers that *Archaeopteryx* is indeed a bird. The latest discovery will confirm that view. ●

Henry Gee

Microbiological up-date for the Petroleum Industry

Proceedings of a Conference held on 21 April 1988

Microbiologists in the petroleum industry are involved in many different sectors of the business, dealing with micro-organisms which may sour crude oil or contaminate refined hydrocarbons, which can block or corrode systems for oil winning, transportation and storage and which cause spoilage of formulated oil products in service.

Our concept of petroleum microbiology is continually changing as the oil business becomes more complex and external pressures to guard human and environmental safety impose restrictions on the use of antimicrobial inhibitors. The Microbiology Committee of The Institute of Petroleum selected a number of topics for review at a meeting on April 21st 1988: the resulting papers are brought together in this volume.

For each topic the authors have established the 'state of the art' and look forward to developments during the next few years. Trends in two large market sectors in the oil industry, fuels and metal-working fluids, are reviewed. Biofilms affect oil operations in many ways and the means for preventing surface fouling demand the initial study of the film build-up and structure. Biocides are used in many different areas of the petroleum industry but must be deployed with care for a variety of reasons, including chemical compatibility with the systems treated and prevention of any inadvertent damage to beneficial organisms in the environment. Monitoring biocide levels following treatment or assessing the need for antimicrobial measures in the first place require suitable methods for use by unskilled personnel. Future trends in on-site methods and laboratory techniques are forecasted.

'Microbiological Up-Date for the Petroleum Industry' is available from The Institute of Petroleum. Price: £10.00 (UK and Europe); £14.00 (Overseas). The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR, UK. Tel: 01-636 1004. Telex: 264380. Fax: 01-255 1472.

EXPLORATION AND PRODUCTION DISCUSSION GROUP

The next meeting of the E & P Discussion Group will be held at the Institute of Petroleum on Thursday, 13th October 1988 at 5.30 pm. Tea and biscuits will be available from 5.00 pm.

Bob Hawes, Programme Manager for Enhanced Oil Recovery, AEE Winfrith will speak on:

EOR — THE SHAPE OF THINGS TO COME

If you would like to attend this meeting or be placed on the mailing list of the E & P Discussion Group please contact:

Mr AE Lodge, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. **Tel: 01-636 1004 ext. 236.**

Mrs Mary McNaughton presenting the Blyth McNaughton trophy to Ted Ferguson, captain of the victorious East of Scotland team on the occasion of the inaugural inter-branch golf match played between the Institute's Edinburgh and South East Scotland; West of Scotland and Aberdeen branches.

The match which took place at Crieff on 9 August, is hoped to become an annual fixture in Scotland.

Edinburgh and South East Scotland team comprised left to right: R Nicol, D Low, E Ferguson, D Colquhon, M Patel and A Bell.

The trophy is named in honour of the late Professor Blyth McNaughton who was Deputy Principal of Robert Gordons Institute of Technology, Aberdeen and particularly associated with founding the college's Offshore Survival Centre. Professor McNaughton was an active member of the Aberdeen Branch.

Around the Branches

Aberdeen

11 Oct: 'Handling H2s Offshore', by Bill Cochrane, Chevron Petroleum (UK) Ltd.

3 Nov: Annual Dinner. Guest speakers: Sir Archibald Forster, The Hon Peter Morrison and Jan Whgeerlings, Netherlands Ministry of Economic Affairs.

Edinburgh and South-east Scotland

3 Oct: 'Downhole Analysis' (speaker to be confirmed).

3 Nov: 'Peat and Lignite as Power Station Fuels', by a speaker from BP Coal.

22 Nov: IP/Phillips Student Lecture: 'Elevating Six Platforms 6.5 metres — only an Intermezzo in the 70–80 Year Lifespan of Ekofisk', by R Wiborg, Engineering Manager, Phillips Petroleum Co, Norway.

Essex

The details of the branch which appeared in the September issue of Petroleum Review were misprinted. They are as follows:

Chairman: Alan Davison, Mobil Oil Company Ltd, Research and Technical Service Laboratory, Manor Way, Coryton, Stanford-le-Hope, Essex. Tel: 0375 646224.

12 Oct: 'Petrol Retailing — A Forward View', by a speaker from Kuwait Petroleum (GB) Ltd.

9 Nov: Ladies Evening: 'Changing Fashions in Wallpaper', by Mrs L Brown, Interior Designer, Shell Chemicals UK Ltd.

Humber

6 Oct: 'Wind Power', by Dr David Lindley, General Manager, Wind Energy Group, Taylor Woodrow/British Aerospace/GEC.

28 Oct: Annual Dinner Dance.

24 Nov: 'Refinery Construction and Maintenance', by a speaker to be announced.

Irish

20 Oct: 'Review of the Irish Offshore Exploration Basins in Comparison with Exploration Basins Worldwide', by Dr Pat Shannon and Dr Dave Naylor.

17 Nov: Annual Dinner Dance. Main speaker Ray Burke, TD, Minister for Energy. Venue: Burlington Hotel, Dublin.

London

19 Oct: Talk by C Neilson, Petrofina is now cancelled.

23 Nov: 'Novel Use of a Sub-sea Completion Assists Appraisal of the Strathspey Field', by CT Hooper and NJ Browne, Texaco.

Midlands

19 Oct: 'Biodegradation of Oil', by Dr G Morton, Lancashire Polytechnic.

16 Nov: 'Total Quality Management', by PD Claxton, BP.

Northern

18 Oct: 'Onshore Exploration', by P Clark, Carless Explorations.

15 Nov: Energy & Nuclear Power', by a speaker from British Nuclear Fuels.

25 Nov: Annual Dinner Dance.

Shetland

4 Nov: Annual Dinner.

22 Nov: 'Ten Years of Brent and Ninian Operations in Shetland'.

Southern

20 Oct: 'SASOL — The Unique Oil From Coal Process', by CD Jones, Esso Petroleum.

1 Nov: Address to Southern Branch by Sir Archibald Forster, President of the IP.

South Wales

14–16 Oct: Visit to Channel Tunnel Project.

10 Nov: Seminar 'Computers and Safety in Process Industries'. Joint HSE, Wintech, IMechE, IEE, IP seminar.

24 Nov: 'The Cyclar Process for Production of Aromatics from LPG', by Tony Hall, BP Research Centre, Sunbury. BP Oil Llandarcy Refinery.

Stanlow

27 Oct: 'Money and the Oil Industry', by J Walker, Royal Bank.

25 Nov: Dinner Dance.

West of Scotland

9 Oct: Celebrity Lecture; 'Energy for Scotland', by Basil Butler, Managing Director, BP.

17 Nov: Dinner and Lecture; 'A Gas Strategy for the UK', by James Allcock, British Gas plc.

Yorkshire

11 Oct: 'Laboratory Engine Testing', by John Maycock, Manager, Mechanical Testing Lab, Lubrizol Int.

8 Nov: 'Oil Distribution Safety Legislation — Today and the Future', by RJ Dingham, Shell Oil UK Ltd.

New Fellows

Mr Nadzru bin Azhari, Executive Director, Protek Engineers Sdn Bhd, Kuala Lumpur, an affiliate of Protech International BV, Holland, has been elected to Fellowship of the Institute of Petroleum.

Graduating with a BSc in Chemical Engineering from UMIST in 1976, Mr Azhari joined Petronas, the National Oil Corporation of Malaysia, as a cadet engineer. The following year he was chosen to attend a postgraduate course in Petroleum Refining and Petrochemical industry at the Institute of Oil and Gas, Ploiesti, Rumania. In 1980, Mr Azhari formed his own project management company which, in 1982, developed a joint venture with Protech International BV, an international engineering company majoring in the oil/gas industry.

In 1983 he became a founding director of Protek Engineers, handling the initial development and operations of the company, which provides engineering and construction management services to the oil and gas industry. In 1985, Mr Azhari left the company to serve as local executive director of Mothercat Ltd, an international electromechanical construction company, but returned to Protek Engineers in 1987 where, as well as serving as executive director, he also assists in the process design of a reformer project for a refinery.

Mr RK Hewstone, Consultant. Recently retired from position of International Environmental Affairs Adviser, Exxon Chemical Ltd, has been elected to Fellowship of the Institute of Petroleum.

Mr Hewstone graduated from the University of London, with a BSc Special in Chemistry, Class I, and joined the Exxon Group in 1956, as Development Chemist at Fawley Refinery. During a long career with the group, he served as Manufacturing Adviser, Essochem Europe Inc, Engineering Associate and then Research Associate, Exxon Chemical Company, USA, Environmental Affairs Manager, Essochem Europe Inc and International Environmental Affairs Adviser, Exxon Chemical Ltd. After retiring this year, he became an environmental consultant, specialising in international regulatory affairs.

Mr Hewstone represented the IP on BSI Environment and Pollution Standards Committee in 1987/88 and has 12 publications to his name. He is a Chartered Chemist and Fellow of the Royal Society of Chemistry and served as President of the International Professional Association for Environmental Affairs, from 1982–1985.

New Members

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Students

Watson, Stephen J, 24 Grestoke Close, Berkhamsted, Hertfordshire HP4 3JJ.

Deliveries into Consumption

UK deliveries into inland consumption of major petroleum products — Tonnes

Products	*July 1987*	*July 1988**	*Jan–July 1987†*	*Jan–July 1988**	*% change*
Naphtha/LDF	299,420	219,120	1,849,860	1,866,640	+ 0.9
ATF—Kerosine	606,030	626,440	3,290,390	3,493,490	+ 6.2
Motor Spirit	2,021,420	1,963,000	12,706,860	13,280,030	+ 4.5
Burning Oil	104,050	103,480	1,166,660	1,096,050	− 6.1
Derv Fuel	730,660	780,570	4,843,850	5,352,690	+10.5
Gas/Diesel Oil	558,640	541,350	5,103,370	4,873,190	− 4.5
Fuel Oil	756,080	651,690	5,274,120	6,070,890	+15.1
Lubricating Oil	72,230	70,860	483,000	506,000	+ 4.8
Other Products	588,490	569,240	3,741,690	4,085,210	+ 9.2
Total above	5,737,020	5,525,750	38,459,800	40,624,190	+ 5.6
Refinery Consumption	434,040	418,840	2,991,190	3,140,900	+ 5.0
Total all products	6,171,060	5,944,590	41,450,990	43,765,090	+ 5.6

†Revised *Preliminary

The Institute of Petroleum

THE THIRD OIL LOSS CONTROL CONFERENCE

PRODUCT HANDLING AND DISTRIBUTION

17th and 18th November 1988

to be held at
The Cavendish Conference Centre, London

PROGRAMME AND SCOPE OF PAPERS

Thursday 17th November 1988

Introductory Overview Paper
An overview and appraisal of the product handling and distribution loss scene
J. W. Bannister, BP Oil International Ltd

Stock Accountability
A review of loss objectives and nature of measurement and physical losses
D. R. Brown, HBH International Consultants Inc

Review of Losses in Coaster Distribution
Examination of inter-terminal losses involving multigrade parcels
M. Longman, Esso Petroleum Co. Ltd

Review of Losses in Pipeline Systems & Networks
Mass/volume balances and reconciliation with white oils and shared pipelines
M. R. Davies, British Pipeline Agency Ltd

Effect of Automation on Loss Control and Security
Examination of influence on losses of new measuring systems, computerised stock control within the supply terminal
J. Little, Mobil Oil Co. Ltd

The View of an Independent Storage Company
Influence on losses and product accountability of product handling, segregation, co-mingling, contractual requirements
R. Kellaway, Unitank Storage Company

Measurement at the Loading Gantry
A review of gantry metering systems, measurement tolerances, mechanical and electronic meter calibration techniques and proving methods
A. Butcher, Consultant to Flow Measurement & Automation Ltd

Friday 18th November 1988

Review of Losses from Gantry Meter to Forecourt
Assessment of general influences and implication of errors due to measurement and physical loss at each stage of the distribution system
J. R. Morgan, Esso Petroleum Co. Ltd

Road Tanker Losses
Recent developments in vehicle measurement systems, vapour capture and on-board computers. Comparison of top and bottom loading
B. Veale, BP Oil Ltd

Service Station — Equipment
An evaluation of current and new measuring equipment
P. B. Whitehead, Micrelec Group plc

Service Station — Monitoring
Methods for establishing losses across the forecourt, data capture and automation systems
P. A. M. Jelffs/P. Harrison, Moore Barrett & Redwood Ltd

Trading Standards View Point
Areas of activities, objectives, methods employed in field operations, etc.
S. Cunningham, Trading Standards Officer

Joint Session
'The Way Ahead into the 1990s'

If you are interested in displaying literature at the Conference, on the afternoon of the 17th November, for which there will be a small charge, please contact **Caroline Little**.

Registration Fees to cover both days will be **£175.00 (plus 15% VAT)** for Individual IP Members and the nominated representative of Collective Members, and **£195.00 (plus 15% VAT)** for non-members.

The registration fee will allow the delegate to attend both days, or another delegate to attend in his place on either the first or second day, although only one set of Preprints of the Conference papers will be available per registration.

For a copy of the registration form, which includes the detailed programme, please contact **Caroline Little**, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Telephone: **01-636 1004**. Telex: **264380**. Fax: **01-255 1472**.