NOVEMBER 1992

The Institute of Petroleum

PETROLEUM REVIEW

Advertising

Auction of early examples of advertising designs

Pipelines

The future for the offshore pipeline industry

Fire-fighting

Report on the use of foam against petroleum fires involving lead-free petrol

Argentina

Problems encountered in privatisation of downstream oil industry

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PETROLEUM REVIEW

November 1992 Volume 46 Number 550 £6.00

Subscription (inland) £65.00 (overseas) £80.00

PUBLISHERS

Published Monthly by
INSTITUTE OF PETROLEUM
A charitable company limited by guarantee

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Membership Services Director: *Roger Sparrow*

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London W1M 8AR
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Fax: 071-255 1472
For details of membership, including Petroleum Review at no extra cost, please apply to the Membership Department.

Printed by Eyre & Spottiswoode Ltd, London and Margate.

US MAIL: Petroleum Review (ISSN 0020-3076 USPS 006997) is published monthly for **US $160 per year.** Second class postage paid at Middlesex, New Jersey.
Postmaster: send address changes to C&C Mailers International, PO Box 177, Middlesex, New Jersey 08846, USA.

ABC AUDIT BUREAU OF CIRCULATIONS BUSINESS PRESS

ISSN 0020-3076
MEMBER OF THE AUDIT BUREAU OF CIRCULATIONS

Contents

Cover photo: Shell's posters from the 1930s, auctioned in London. Photo courtesy of auctioneers, Phillips.

. . . news in brief

18 September

Goal Petroleum lifted its half-year pre-tax profits by 7 percent to £3.94 million.

21 September

A Japanese oil tanker and a Hong Kong container ship collided in the Malacca Strait, the shipping corridor that separates Malaysia and the Indonesian island of Sumatra.

22 September

Enron, one of the largest US gas companies, has been thwarted in its attempt to buy a block of North Sea gas production from Chevron — co-venturers British Gas, Phillips Petroleum and Agip have exercised their pre-emption rights.

Opec and BP launched attacks on the European Community's plans to introduce an energy tax.

Indonesia's main island of Java is set to increase its consumption of natural gas by 242 percent to 975m cubic feet a day with the commissioning of three new electric power stations, a urea plant and a gas system for the city of Surabaya in East Java.

Wintershall is to close down 12 out of its 15 domestic oil fields as part of a wide-ranging restructuring programme.

Christian Salvesen, the distribution, manufacturing and specialist hire group, has sold its oilfield technology subsidiary for £28.5m to BJ Services Company of Houston, Texas.

23 September

A new North Sea drilling record has been claimed by semi-submersible rig *Ocean Alliance*. The rig which is jointly owned by BP and Ben Odeco drilled to a depth of 2,000 metres in only five and a half days.

26 September

The Health and Safety Executive's offshore safety division has awarded £8,000 to the business research unit of the Robert Gordon University for a study into health promotion in the offshore oil industry.

29 September

The Russian government is putting out for tender oil and gas fields off the far eastern island of Sakhalin according to the Itar-Tass official news agency.

1 October

Hamilton Brothers Oil and Gas is one of the most efficient operators on the UK Continental Shelf according to a report by the County NatWest WoodMac.

The Chicago Board of Trade announced that it expects to launch pollution futures and options contracts late next year.

China's state-owned oil group China National Petroleum Corporation has obtained rights to explore for oil in Canada and the United States and is in talks to exploit a field in South America.

2 October

Danish Underground Consor-tium has applied to the Ministry of Energy for permission to extend the Tyra gasfield, enabling around 30bn cubic metres of additional gas to be produced over a 15 year period from 1996.

The Indian government is to offer 43 oil and gas fields to private companies for development as part of its privatisation programme.

Pollution taxes are to replace regulations as the central instrument of environmental policy according to the UK environment secretary, Michael Howard.

7 October

OMV, the Austrian oil group, is to seek a foreign partner to take a 20 percent stake in the company in a further step in its privatisation.

Enterprise Oil have completed the pre-drilling of the main production wells in the Nelson field.

8 October

A consortium including Norsk Hydro and British Gas has found a 'promising' oil deposit in the Danish sector of the North Sea.

Clyde Expro, a subsidiary of Clyde Petroleum, has formed a joint venture with OMV UK to carry out exploration and appraisal work in the UK North Sea.

9 October

Ernst and Young, with the DTI and British Gas, is leading a UK energy industry delegation to Kazakhstan in a bid to secure a stake in the development of the republic's oil and gas reserves.

Total and London Electricity have announced the formation of a new joint venture, called London Total Gas, to supply gas to the city.

Sullom Voe oil terminal in Shetland is in the UK's top five ports for tonnage handled according to the Department of Transport's 1991 survey.

10 October

Shareholders in Kelt Energy have agreed to proposals for a reduction in the company's capital and the cancellation and reduction of certain reserves to allow dividend payments to be made.

Indonesia and Australia have awarded 11 production sharing oil and gas contracts in the Timor Gap area which separates the two countries.

12 October

Iraqi oil minister, Usama Abdul-Razzak, said his government will sue banks and institutions using frozen oil assets following the decision to seize £1 billion of Iraqi oil money abroad.

British Petroleum is to merge a key part of its petrochemical business with Enichem, the Italian state-owned company, in a worldwide restructuring of its loss making chemicals operation.

13 October

Sonatrach of Algeria has signed a 20 year contract with the Italian state electricity company ENEI, whereby Sonatrach will deliver 4bn cubic metres of gas a year starting in 1995.

International oil companies will contribute £10m in compensation to the Italian *Haven* incident and £950,000 to the *Volgoneft 263* pollution incidents. The contribution is in the form of a levy to the International Oil Pollution Compensation Fund.

14 October

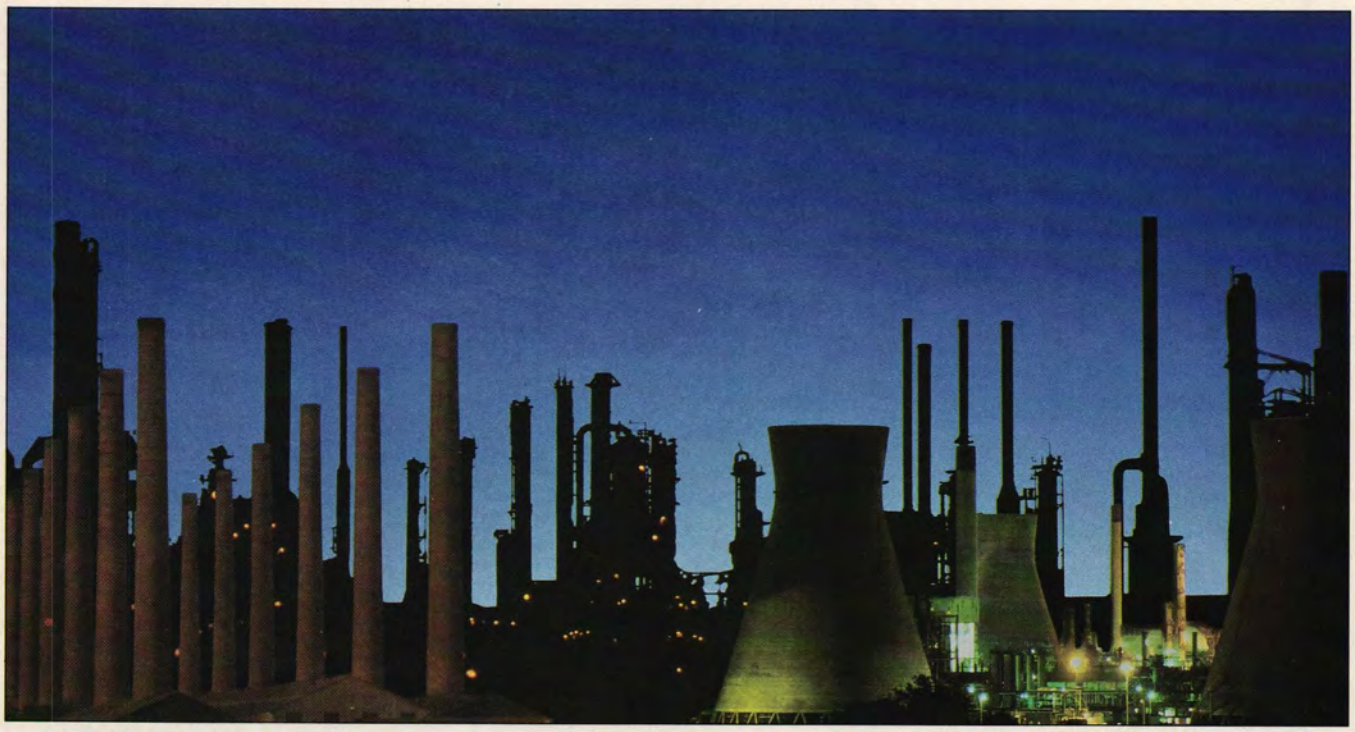
Conoco have released promising preliminary results from exploration well 15/20b-11, 150 miles north-east of Aberdeen. The well produced stabilised flows of 6,350 barrels of light oil, plus 1.9 million cubic feet of gas a day.

15 October

The Alberta government has come to the aid of western Canada's struggling energy industry by substantially cutting royalties levied on oil and gas producers and by simplifying the 20 year old tax system.

Agip is expecting to bring its £500m Tiffany field platform in UK North Sea block 16/17 on stream in mid-1993 through four pre-drilled wells.

SOON EMISSION CONTROLS WILL BE LAW.



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Nest eggs out of Shell

By Joan Brittaine

Brisk bidding at Phillips in London for posters fresh out of the archives of Shell UK has meant an entirely new life for them and they are making as big an impact as they did 60 years ago . . . on the walls of collectors!

Described as a 'pictorial shout', the posters won fame when Jack Beddington livened up the power of advertising and for over 30 years they were some of the best advertisements Britain has ever seen.

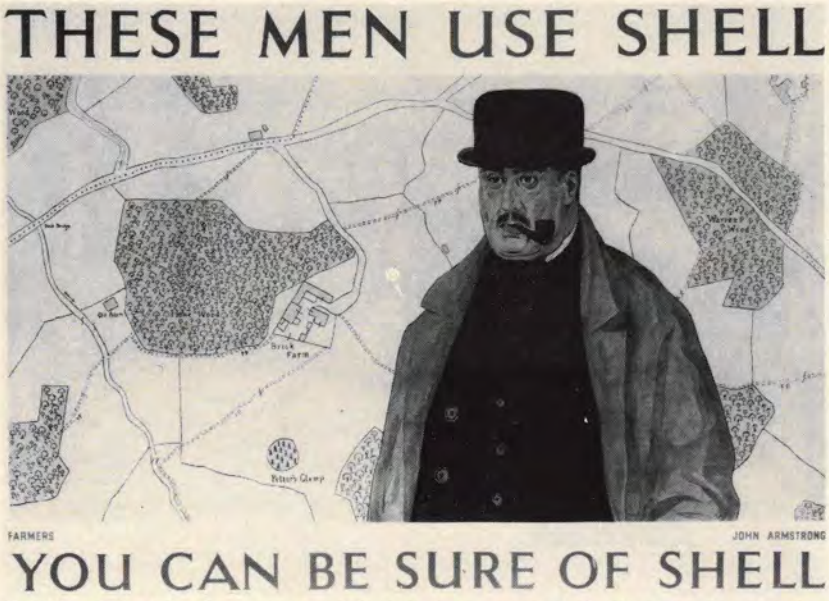
Up to the 1930s, posters advertising Shell products often bordered on the mundane. A few illustrated humour. Many were based on topical issues of the day. And some had the edge of a patriotic theme. But there was no impact in them to make people stop and look. Something was missing. And when Jack Beddington, who was an employee at Shell with no previous advertising experience whatsoever, criticised the posters and suggested they needed pepping up, he found himself in a new job!

When he took over as advertising manager, his flair for publicity and knack of choosing the right artist for the job changed everything. He turned to the young artists of the day, encouraging them in free expression and some whom he recruited are now famous in their own right. Graham Sutherland had his first professional commission from Shell and other artists who worked on the posters included McKnight Kauffer, Paul Nash and John Reynolds. Rex Whistler, who once tricked people into squatting flies he had painted on windows, also worked for Shell. He originated the famous two-headed posters and John Reynolds, who subsequently worked on the series, developed the drawing of a navvy holding his shovel and looking after a car which had disappeared from sight.

Interestingly, this single-headed poster with the slogan 'That's Shell — That Is' evolved into the two-headed man with the caption 'That's Shell — That Was'. This alternative slogan was a brilliant suggestion sent in by a member of the public who superimposed a second head on the drawing looking in the opposite direction. Needless to say this grabbed the imagination of the public and formed the theme for future posters which were to remain popular for many years.

Many of the artists chosen to design the posters opted for humour. This was encouraged by Jack Beddington and readily grasped by the public. Others used subtle themes which gave the observer something to think about. Then there were the surrealist Dali-like posters, or the ones which co-incided with a big event going on at the time like 'Footballers Prefer Shell' when the cup final was coming up — or 'The Winner — SHELL' for horse-racing events. But they all made a dynamic statement people found difficult to ignore or forget.

Jack Beddington gave all the artists absolute freedom to come up with something original. He never issued guidelines and often had no time for an internal meeting to discuss format. He just gave an indication of the subject,



Sold for £715. John Armstrong modelled the farmer on Jack Beddington who commissioned poster designs for Shell during the 1930s.

then let the artists convey that information in an entertaining way to inform the public. So with no constraint whatsoever, the posters had a distinction which became very special.

As it happened, the artwork did not always carry a poster exclusively. The slogans on them also conveyed a message and the statements they made became something of a 'personality' for the company. 'Shell for Go', 'You Can Be Sure of Shell' and 'Shell Is Always First' were all powerful assurances — and would probably be described by some as a display of arrogance! But if nothing else, Jack Beddington now had the public sitting up taking notice. The posters not only advertised petrol and oil but also expressed the joy of motoring with emphasis on physical and psychological power and the freedom this could bring.

With freedom in mind, another point of interest is that conservation figured very much within the company at a time when people felt free to advertise absolutely anywhere — and bill-boards popped up everywhere in the country. Shell never advertised on hoardings at that time and on 11 July 1930 the company received a letter at the Kingsway office from the President of The Design and Industries Association which read:

> 'The Design and Industries Association desires to express its appreciation of Shell's stand against roadside advertising, and also the hope that the more enlightened public that shares our views as to advertising on the landscape is showing its approval of your enlightened lead by giving you its patronage.
>
> We believe too that your good manners are ultimately good business.
>
> We should be glad if you are able to help our progaganda by giving this letter publicity'.

At this time all advertising was only displayed on Shell's delivery lorries — one poster on the tailgate and one on either side of the vehicle. So in order to keep Britain 'green', the company relied entirely on advertising by their startling posters and familar slogans being driven and up and down the country.

Now, with the familiar Shell lorries carrying red cans of petrol having been replaced by tankers roaring along motorways and the power of advertising turned over to the media of television and the press, the need for posters has dwindled quite considerably. This has had the effect of the lorry bills of Jack Beddington's time becoming attractive collectables.

Sold for £460.

Sold for £1,485.

Fortunately, someone at Shell UK had the foresight to keep the originals of the earlier posters in the archives — which in itself is an interesting point to ponder when one considers that these originals were in a way only stepping-stones in the production line. After all, what use would they be when all the prints were ready for pasting up and the next idea was already in the pipeline?

Nevertheless they were saved and with 120 posters up for auction for the first time at Phillips in London, they are not only seen as an indulgence in nostalgia but also a valuable source of sound investment. Many of the posters were in mint condition and the prices fetched were surprising ranging from under £100 to the top price of £2,400, paid for McKnight Kauffer's 'Actors Prefer Shell'. Some posters, particularly those by known artists, fetched prices well above pre-auction estimates.

The wonderfully evocative record of motoring in the 1920s, which Petroleum Review has put on this month's cover, sold for £1,450, while in the 'These Men Use Shell' series, the top price was paid for 'Journalists' — even higher than for 'Film Stars'. What can we deduce from that?

Coinciding with this sale was the launch of *The Shell Poster Book*, published by Hamish Hamilton. This large format glossy contains 92 coloured reproductions of posters in Shell UK's comprehensive collection of original paintings and posters, in itself a vivid and substantial contribution to the art history of the 1920s and 1930s. ■

British Gas plans CNG vehicle network

British Gas has announced that it plans to extend its fleet of 100 Compressed Natural Gas (CNG) vehicles by at least 200 percent by the beginning of 1993 and to set up a nationwide network of gas filling stations in an attempt to stimulate demand and compete with petrol and diesel as a transport fuel.

The plans by British Gas are part of a long-term programme by the company to highlight what it sees as the environmental benefits of the fuel. At present it is lobbying the government and the Department of Transport. However, much uncertainty surrounds the extent of environmental legislation emanating from the European Commission.

Some fuel retailing companies are privately sceptical with at least one stating that the concept had been 'thoroughly explored and rejected'. None of the major retailers has any plans to market the fuel although they are 'aware of the possible development' of the fuel in light of experience in the United States.

CNG vehicles have met limited acceptance around the world, particularly in the United States, Australia, Italy, Canada, Russia and New Zealand where the impetus for the projects has mostly been environmentally-driven legislation or government incentive.

Mr Keith Nelson, British Gas marketing manager for natural gas vehicles (NGV), says that the company is currently spending £2 million a year on NGV development, mostly but not entirely in the United Kingdom, and that the company's future programme depends on several factors including 'government reaction and the degree of interest of vehicle manufacturers'.

'The UK transport market is largely determined by what is happening in the rest of the world,' he adds. 'Other countries are offering incentives such as The Netherlands and Belgium which carry a zero excise duty on NGVs.'

He conceded that it would be necessary to convince consumers of the safety of NGVs after the experience of LPG vehicles but stressed that 'natural gas is not LPG'.

'There needs to be a gradual education process, he added. 'The first step is to set up our own fleet with in-house refuelling depots and then extend that to other fleet users.'

MacDonald's in motorway deal

Fina has announced an agreement with fast food retailer MacDonald's Restaurants as part of its plan for a new service area at junction 11 on the M42 in Leicestershire.

Planning consent has been given for a petrol filling station consisting of six pump islands, a car wash, HGV fuelling, parking facilities and a convenience store in addition to the restaurant.

A statement by Fina said the agreement reflects the food retailers aim of extending their network of roadside restaurants to major trunk routes and motorways.

Construction of what the company hopes to be the first of many such ventures will commence shortly and the site is due to open next summer.

Gas gets going

Commercial generation has commenced at Powergen's 900 megawatt natural-gas fired power station at Killingholme.

Production from the first 450 MW unit of the combined cycle gas turbine power station has been achieved in just over two years after turnkey contractor Siemens began construction. The second module of the scheme will come on stream in early 1993.

The new power station has a thermal efficiency of over 50 percent, will emit virtually no sulphur dioxide, half the carbon dioxide and a quarter of the nitrogen dioxide of a coal-fired plant of equivalent output.

The company has also announced that it will close 1,200MW of uneconomic plant at the end of March 1993, resulting in the loss of 120 jobs. The company expects to avoid compulsory redundancies.

Two gas oil stations, Bulls Bridge (280MW) in Middlesex and Leicester (102MW), will close. Both ran less than five hours in 1991/92 and are the most expensive plant to run in the company's portfolio.

New MTBE plant

Neste Oil of Finland is claiming 10 percent of the world's MTBE market following the opening of a new plant in Edmonton, Canada.

The 530,000 tonne per annum plant is a 50–50 joint venture with Chevron and cost Can$390 million to build.

The plant is the first for the company in North America and follows other joint ventures in Malaysia and Saudi Arabia. The company was also the first to introduce reformulated gasoline in Europe with its two 100 percent owned plants in Finland and Portugal.

World production of MTBE stands at 10 million tonnes per annum.

Azeri partnership to develop fields

Ramco Energy and its partner, Pennzoil Caspian Corporation, have signed an agreement with the government of Azerbaijan and the State Oil Company of Azerbaijan to develop the Guneshli field in the South Caspian Sea.

Current production at the 1.3 billion barrel field is 130,000 barrels per day (b/d) but Pennzoil, which will act as operator estimates that production will increase to 270,000b/d when the field is fully developed.

The company plans to install five new platforms and drill around 170 new wells.

As part of the deal, the companies will spend $9 million to construct and equip a new rehabilitation centre for the United Workers Hospital, $3 million to a trust fund for the education of Azeri students and $3 million to the State Oil Company for management systems and facilities upgrading.

Under the terms of the partnership agreement Pennzoil will fund both its own and Ramco's share of local infrastructure and development costs. Initially Ramco will have a carried interest in 10 percent of the profits until Pennzoil has recovered development costs, after which Ramco has a full participating interest of 17.5 percent.

Premier announces Myanmar production sharing deal

Premier Consolidated Oilfields has announced that its wholly owned subsidiary, Premier Petroleum Myanmar Ltd, and its partners have signed a production sharing contract with national oil company Myanmar Oil and Gas Enterprise.

The deal covers approximately 3·1 million acres of offshore Myanmar in block number M-12 and is the third deal between Premier and its partners and the Myanmar government.

Premier (30 percent), Texaco Exploration Myanmar (50 percent) and Nippon Oil Exploration (Myanmar) (20 percent) had previously signed agreements for Blocks M-13 and M-14 in May 1990.

The first well, Yetagun No 1, located in 350 feet of water, commenced drilling on 8 October by the drillship *ODCC Deepsea Ice* and is expected to reach a total depth of 8,450 feet. The well is 260 miles south of the capital Yangon, formerly Rangoon.

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New North Sea joint venture

Austria's largest company, OMV, has announced that it has subscribed for new shares in a subsidiary of Clyde Petroleum resulting in the formation of a new company, St James's Oil and Gas Limited.

The share holdings in the new company — which holds eight licence interests — is split 55/45 between OMV (UK) and Clyde. OMV will fund the exploration and appraisal expenditure on the licence blocks for the next six years.

Once such expenditure reaches £15 million (index linked) further activity will be funded either by OMV or, at its option, Clyde can contribute its pro-rata share.

Clyde will retain 45 percent of the new company's interest in the first three discoveries to reach development stage in the next six years. If OMV funding is over £15 million, then Clyde's interest in any subsequent developments will be reduced.

OMV will be responsible for the management of St James's and its assets although Clyde will be represented on the board.

Martin David, managing director of OMV (UK) will take up the role of chairman of the new company. Mr David told *Petroleum Review* that the joint company was a way for a newcomer to the North Sea such as OMV to acquire exploration acreage which, following the deal, is 980 square kilometres net to OMV — a 20 percent increase on its previously held acreage.

The deal will effectively tie-up OMV (UK)'s exploration funds for the next two years although the company is willing to examine similar proposals from other companies in the future. OMV's exploration budget is set at around £11–12 million per annum.

The UK Continental Shelf is an international core area for the 70 percent state-owned company. Interests purchased in the Beryl and Dunlin fields in 1990 make up almost half of the company's 26,000 barrels of oil per day international production.

Photo courtesy of BP

The British pavilion at Expo 92 in Seville, which incorporates a solar-powered water curtain, has been awarded two commendations at the British Construction Industry awards. The application of BP solar technology pumps water to the top of a five-storey edifice from where it cascades down the eastern face.

Floating production for Gryphon field

Kerr-McGee Oil has signed a Memorandum of Agreement for the purchase of a floating production vessel as part of its development plan for the 90 million barrel Gryphon oil and gas field.

Planning for production drilling and installation of the subsea systems is also progressing and the company, on behalf of the joint venture, is confident that production will commence in the fourth quarter of 1993.

Discussions with the Departent of Trade and Industry on the Annex B development plan approval are well advanced and approval is expected in 'the very near future'.

The Tentech 850C ship-shaped floating production vessel is currently nearing completion by Astilleros Espanoles at El Ferrol in Spain. Fitting out the vessel and engineering design of the process facilities is continuing with the intention of installing the vessel on block 9/18b over the Gryphon field, first discovered in July 1987.

Partners in the field are: Kerr-McGee Oil (UK) PLC (operator) 25 percent; Clyde Expro PLC, 25 percent; Santa Fe Exploration (UK) Ltd, 25 percent; Aran Energy Exploration Ltd, 15 percent; and, Clyde Petroleum (North Sea) Ltd, 10 percent.

US gas prices recover

US natural gas prices have risen dramatically over the last eight months. Last month spot prices rose to $2.57 per million cubic feet, up 140 percent from February levels and reached their highest level since June 1985.

Prices began drifting upward in the early summer, due partly to an abnormally cool spring, rising demand and below normal volumes in storage. Undoubtedly another cause was the decision taken by Texas, Louisiana and Oklahoma, states that account for 75 percent of US marketed gas production, to adopt proration rules to limit output.

Prices surged upwards after Hurricane Andrew swept across the Gulf of Mexico on 25 August, just as many gas-burning utilities and manufacturers were building stocks for the winter. It was estimated that 2,000 of the Gulf's 3,852 oil and gas platforms sustained 164 mile-per-hour hurricane force winds which caused considerable damage. At least 241 oil and gas platforms and satellite structures were damaged, toppled or blown away. Several pipelines were badly battered.

Gulf wells account for 12.5 billion to 13 billion cubic feet of gas production a day, one-quarter of total US gas production. Early in September, Scott Sewell, Director of the US Minerals & Management Services, described a reduction in Gulf gas production of 2 to 2.5 billion cubic feet a day. Estimates of repair time varied; two major gas pipelines were expected to be out of service until sometime in November.

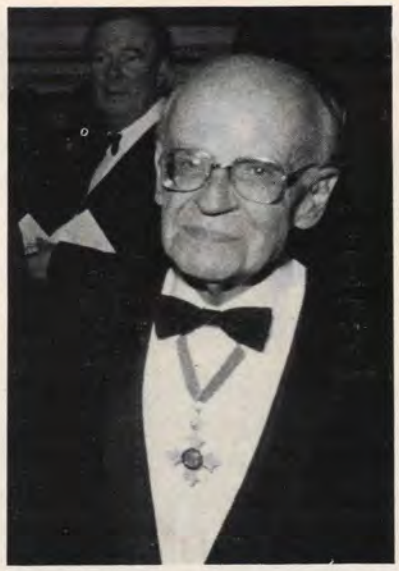
Fears of delayed production starts fuelled the upward price spiral. Prices are not expected to rise much further, however, as the current price ceiling — the price for an equivalent amount of energy from fuel oil — is $2.75. It is estimated that some 55 percent of utilities and manufacturers that burn natural gas can use coal or oil if need be.

Onshore field start-up

Pentex Oil has been given Annex B consent to develop the small East Glentworth onshore oilfield in Lincolnshire.

The field, discovered in 1987, has predicted minimum recoverable reserves from the first phase of the development of 135,000 barrels over 10 years. Production start-up is likely to be immediate.

Obituary



Paul Herzberg Frankel CBE (1903–92)

With the death of Paul Frankel on 21 October, we lose the most distinguished oil consultant of our time. He was also the most loved, as the generations who learnt from him — particularly the younger members — will testify. While never suffering fools gladly, Frankel had all the generosity of the good teacher which was his salient role in his long career.

In a world of institutions, which the oil industry essentially is, Frankel stood out as an individual. There are of course many distinguished people in the oil industry. But while they have helped to create and shape the organisations for which they work, their views are inevitably tempered, influenced, perhaps in some cases dominated by the companies and interests they serve.

Paul built on two foundations, his intellect and his character, to pursue a path unique in the industry.

His articulation of the economic essentials of one of the world's greatest industries was the base from which all else sprang. To observe that oil is a liquid — as indeed he did — might appear a truism. To spell out the economic implications of this observable fact — the importance of fixed and variable costs, the menace of the marginal barrel, the absence of self-adjustment and thus the inherent instability of the industry — was to illuminate for oil men and women the conceptual framework in which they lived their working lives.

A pointed tongue and pen, always tempered by an unfailing sense of humour, were part of his armoury. But without them, I doubt if he could have so faithfully adhered to the independent path he set himself, could have avoided working for the major companies, could have transformed himself from someone who in his early days was regarded as no more than an irritant gadfly to the most distinguished oil consultant in the world.

Paul's tangible memorial may well be considered to be Petroleum Economics Limited. If I say that he succeeded there without really trying, I may be misunderstood. What I would wish to say is that this immensely successful and prosperous organisation that he created — and which will live on after him — was the natural corollary to the successful application of his personal convictions — a belief in the objectivity of analysis, a delight in the force of reason, in absolute independence, and in the encouragement of younger people.

The award of the IP Cadman Medal gave him particular pleasure, putting him as it did among the leaders of the great oil companies who constituted its ritual recipients.

His adopted country was slower to honour him than those on the Continent which more early recognised his contributions. But his CBE, when it came, could not have been more richly deserved.

We are fortunate that Paul Frankel was of our generation. He witnessed and commented with consistent objectivity on the influences underlying the most radical changes of structure and ownership that the oil industry is ever likely to see. He recognised the essential interdependence of its component functions; he saw, with a clarity denied to most, that the lack of any inherent self-adjustment required some institutional ballast, whether this was the major companies, OPEC or something else. He was interested in observing analytically, not in judging emotionally.

Paul Frankel will be enormously missed by a multitude of people and will long remain in their affections.

Sir Geoffrey Chandler OBE

Paul Frankel was born and educated in Vienna, leaving university with a doctorate in political economy. He entered the oil industry in 1925, holding executive posts in Austria, Poland and Danzig. He came to Britain in 1938 and after working in oil broking, for Raven Oil and as director of Manchester Oil Refinery Ltd, he set up his own consultancy business, Petroleum Economics Ltd, and, as Life President, dedicated the remainder of his long career to running a highly regarded firm of consultants.

From the beginning of his career he was a prolific writer of articles and books. He is best known for *Essentials of Petroleum* published in 1946.

He joined the Institute of Petroleum in 1943 and became a fellow in 1947. He was awarded the prestigious Cadman Medal in 1973. When the IP held its 75th Anniversary lunch in October 1988, Paul Frankel was principal guest of honour, celebrating his 85th birthday.

Subsequently, generous donations made possible the Paul Frankel Award. In 1991 its first recipient was Miss Christina Caffara, who is studying at the Oxford Institute for Energy Studies.

Contaminated gas oil disrupts the market

By Robert McLeod

Contaminated gas oil is entering the European market. The problem, a recurring one, has been dealt with in the past with surprisingly little upset. This summer, however, has seen what some are describing as 'hysteria' and amid claim and counter-claim a long, hot winter of litigation could be on the way.

Over the summer months, oil traders reported numerous cases of micro-biologically contaminated gas oil entering the market. Suspicion has fallen on rail cargoes exported from the former Soviet Union through the Ventspils Terminal, although traders acknowledge that suspect cargoes have also emerged from other sources. Some companies are warning of a potential 'epidemic'; others remain sceptical, while acknowledging 'unusual' levels of contamination.

Microbiological contamination of middle distillates such as gas oil and aviation fuel is not a new problem. Given the ubiquitous nature of the organisms involved, their presence in small concentrations is hardly surprising and every year, particularly in the summer, contamination is detected.

The chief culprits appear to be aerobic bacteria and filamentous fungi which are living organisms and in the right conditions their populations can multiply rapidly. Their capability to degrade middle distillates, particularly C_6-C_{18} hydrocarbons, is well established and in time the bacteria can cause the breakdown and degradation of the fuels forming corrosive carboxylic acid and carbon dioxide. Some organisms can also cause emulsions as part of the breaking-down process which can affect viscosity and water separation.

The chief conditions which need to be present for the micro-organisms to flourish are a water/product interface in the storage tank (or pipeline, railcar, etc), time, air and warmth.

According to Dr David Leak, a specialist in microbial physiology and biotransformations from the Centre for Biotechnology at Imperial College, London, before this degradation could become severe enough to affect, for example, engine performance, the contamination would have had to have been present for some time. 'A certain amount of contamination can be tolerated. In the normal cycle of events, particularly in Western economies, there is not sufficient time for the contamination to become severe. It would take years of storage under normal conditions.'

It is understood that there has only been one major problem in Western Europe over the years with relation to contaminated gas oil. In what became known as the 'Champignon Case' some 10 years ago, a whole tank of gas oil was so badly contaminated it had to be incinerated.

Outside of certain strategic stocks (which, in any event, consist primarily of unrefined crude oil), the storage time for gas oil in most modern refineries producing an average of 25,000–40,000 barrels a day of gas oil is about 7–10 days. Refining margins, particularly in the current economic climate, are tight and longer storage times are not required. The fuel is then piped, shipped or railed to either a marketing terminal or an end-user.

Gas oil imports

If, as suspected, the contaminated gas oil is coming from the former Soviet Union and the degradation is sufficient to warrant treatment — a hotly contested point — then the implications for the European Community could be serious.

In 1991, EC imports from the former Soviet Union totalled 11.7 million tonnes (**Table 1**) making it the leading non-EC source of gas oil imports (in OECD Europe the figure is nearer 13.5 million tonnes). The total amount imported has increased dramatically since 1989.

In the same period the United Kingdom imported just 490,000 tonnes, while in the first quarter of 1992 the figure was only 69,000 tonnes. There are some suggestions, however, that future imports of gas oil could increase if independent companies require supplies that cannot be sourced locally now that the UK refineries rarely produce major surpluses.

Concern also exists over practices at

Gas oil imports from former Soviet Union ('000 tonnes)

Year	*European Community*	*United Kingdom*
1991	11,682	490
1990	9,462	574
1989	7,725	613

Table 1

MICROBIOLOGY WORKSHOP

CURRENT PROBLEMS OF MICROBIAL SPOILAGE OF BULK DISTILLATE FUELS

Thursday 3 December 1992 (p.m.)
To be held at The Institute of Petroleum

There is currently a high incidence of microbiological contamination of distillate fuels that is causing some concern to the trading community. The pattern of contamination does not appear to be limited to any one particular source but would seem to be in part due to the recent release of some strategic stocks of fuel oils. The Institute of Petroleum's Microbiology Committee has previously reviewed the problems of microbiological contamination through its Fuel Contamination Task Force. Although more directed at problems for end users and distribution terminals, the same general principles still apply. This afternoon workshop will review the general problems and issues arising from the current crisis and it is hoped that some guidance and comfort will be given to traders who are currently facing expensive claims for treatment and restoration of contaminated stock and facilities.

The Workshop will be chaired by **Mr T J Berryman, Chairman, The Institute of Petroleum Test Method Standardisation Committee**

Papers will be presented on the following topics, followed by discussion:—

Review of Current Problems Dr J Koenig, Erdolbevorrantungsverhand, Germany
Sampling, Testing and Standards Dr B N Herbert, Shell Biosciences Laboratory, Sittingbourne Research Centre
Treatment Methods Mr E C Hill, ECHA Microbiology Ltd
and
House Keeping Mr S Taylor, NEREFCO

For a copy of the registration form, please contact
Caroline Little,
The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR, UK.
Telephone: 071 636 1004. Fax: 071 255 1472

certain tank farms that include washing storage tanks with heavily polluted river water — as is the case in Rotterdam — which could also lead to microbial contamination.

Petroleum Review spoke to some traders who questioned the extent of the problem. One trader, who asked not to be identified, maintained that the problem 'had been blown out of all proportion' and that some companies were 'quite happy' with that situation.

'There have been suspect cargoes where some degree of contamination has been detected but, besides these, the quality of the Russian gas oil is very good.'

Martin Schenker, Operations Manager with Vanol International, is less circumspect about the problem.

The 'hysteria of the summer months' is starting, he says, to go quiet and he is indignant at some of the claims that have been made against the company. In one case, Vanol was presented with a bill for $60 per tonne for cleaning a quantity of product and a tanker. In another, his company received a report on bacterial contamination from a shipment of gas oil that indicated contamination at 10^5–10^6 fibres per millilitre. Two weeks later they received a report on the same shipment which showed contamination of 10^4 per litre.

'Claims have been based on such tests, biocides have been added on the results of such tests', said Mr Schenker, 'yet some of these reports are inaccurate and irresponsible'.

'Some inspection companies', he claimed 'are giving certificates which are misleading and not scientifically sound.'

Clean-up cost

A cost variously estimated at between $3–4 and $6–10 per tonne is being charged to clean the gas oil and cash is being held back by some traders to cover the cost of cleaning the fuel by either filtration or the use of biocides.

Instances of contamination in the United Kingdom are rare. A contaminated shipment of aviation fuel from one UK refinery three years ago was not detected in time and resulted in damage to a storage tank and suction fittings which required the installation of a new floor. Statutory requirements mean that aviation storage tanks must be cleaned and inspected once every three years and the problem has not recurred.

Mr Jim Rowson of the Federation of Petroleum Suppliers states that he has not come across any cases of contaminated fuel reported by his members.

Gas oil consumption ('000 tonnes)

Year	*European Community*		*United Kingdom*	
	consumption	*stocks*	*consumption*	*stocks*
1991	186,407	33,576	74,294	8,999
1990	175,626	31,486	73,945	8,353
1989	174,138	32,028	73,026	8,870

Table 2

Because of the nature of the contamination, 'good housekeeping' is stressed as the best method of preventing degradation. Tanks and product/water interfaces should be tested regularly, particularly where the stagnant product at the base of the tank below the suction pumps has not been removed over several shipments.

Badly affected fuels can be treated and made usable through the use of biocides, filtration or centrifuging.

Biocides, while common, are finding less favour as they can have unpleasant side-effects, have environmental implications and can kill useful micro-organisms, thereby creating further potential problems.

This is particularly relevant where stock is delivered into Germany where it is a criminal offence both to dispose of biocide-contaminated water other than through chemical incineration and to market biocide-treated fuel.

Traders sense a move towards filtration 'particularly in recent weeks', although at least one major storage company has decided to drain away the water bottoms and is relying on long-term settling in the base of the tank.

Although there are no international standards on the levels of contamination to assess the degree of degradation, a simple test has been in use since the early 1960s, when it was originally proposed at an Institute of Petroleum conference on microbial spoilage, that indicated whether the sample was contaminated.

Visual examination

Much valuable information can be gained from a visual examination of the fuel and water bottom. Particular attention should be given to: whether the sample is bright, hazy or viscous and containing suspended matter; the interface is clean, emulsified or slimy; and the water bottom's turbidity, sludge deposits and smell.

Mr John Minton of the independent laboratory, Minton Treharne Davies, said that in the past, people have made subjective judgements as to whether there was no problem/a slight problem/a cause for concern when inspecting gas oil.

'This year, for the first time, there has been a controversy over what the actual level of contamination should be. Nobody has been looking at a tight specification for gas oil in the past, just whether it passed the normal quality criteria.'

Mr Minton added that tests that take up to five days to establish the presence of viable colonies are likely to be unacceptable to traders. In particular, long delays at a terminal such as Ventspils where there is a high turnover of stocks through relatively small tanks in what he described as an 'uncontrolled' operation means that matching the tested sample with delivered stock could prove difficult. Up to 15 tanks could be used at Ventspils for a 30,000 tonne shipment.

He also expects there will be a 'long period of litigation for tank cleaning costs' arising particularly from the cleaning of ships. 'Some companies were carrying out specialised cleaning operations when, in reality, industrial Domestos would have sufficed.'

A set of guidelines has been proposed by the inspection company SGS Redwood which suggest a limit of 1,000 micro-organisms per litre. Although this level was not rejected when put before traders at a seminar run by the company, some traders maintain that 5,000 micro-organisms per litre is satisfactory so long as the fuel is not put into long-term storage.

The situation is further complicated by the status of fibres or organisms counted. Although a count can assess the number of fibres present, it does not assess whether these are viable organisms or are dead. If the organisms are dead and the sources of contamination removed, no further contamination or degradation should occur, although filter blockage in fuel systems could still present a problem.

With good 'working practices and housekeeping', however, contamination of middle distillates should not present a problem in the first place. ■

IMPLICATIONS OF BIOCIDE USE WITHIN THE PETROLEUM INDUSTRY

12 November 1992

To be held at

The Institute of Petroleum, London

Chairman: Mr PJ Ruane, Castrol Technology Centre

Presentations will include:

Overview — Biocides Boon or Bane?
Mr EC Hill, ECHA Microbiology Ltd

Industrial Applications
Dr BN Herbert, Shell Biosciences Laboratory, Sittingbourne Research Centre

Three manufacturers will give papers on the use of their products:

Mr W Siegert, Schulke and Mayr GmbH
Dr M Wooder, Rohm and Haas UK Ltd
Dr B Backhouse, SHE Department, ICI Specialty Chemicals

Biofilms
Ms S Kinniment, School of Pure and Applied Biology, University of Wales

Environmental Impact of Biocides
Dr M G Ford, School of Biological Sciences, University of Portsmouth

Toxicology of Biocides and Regulations
Dr A Saleem, Pesticides Registration Section, Health and Safety Executive

For further information, and a copy of the registration form, please contact **Caroline Little,** The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR, UK. Telephone: 071-636 1004. Telex: 264380. Fax: 071 255 1472.

The Institute of Petroleum

IP WEEK
15–18 FEBRUARY 1993

The programme of events will be available shortly.

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

The effect of different membrane types on a fuel's filterability when using IP 385 test method

The IP 385 test method, based on methodology used in several UK laboratories, necessitates filtering fuel through a sterile membrane, washing fuel from the membrane with a non-toxic detergent followed by saline and then transferring the membrane to a solid nutrient agar medium. Nutrients from the agar diffuse through the membrane to microbes on or near the surface and after a suitable incubation period, colonies of microbial growth can be counted.

At the time of the publication of the code in 1988, it was not possible to nominate the type of membrane to be used. After problems were subsequently encountered in running tests, sometimes because of difficulties in passaging the fuel but more often because of problems associated with passaging the aqueous washes, the Institute of Petroleum commissioned Dr Neil Smith and Mr Michael Wright of University of Hertfordshire to investigate a number of permutations of fuel and membrane types in order to make a recommendation for inclusion in IP 385. Their report has now been received and is available in full on request.

Research tests

Membranes differ in their chemical composition (and hence fuel compatibility), thickness and structure; some are essentially depth filters in which microbes became trapped and some are traversed by defined parallel-sided pores which restrict the retained microbes to the surface.

The researchers selected the following membrane types for testing:

- Nucleopore Membra-Fil (mixed esters of cellulose)
- Millipore MF Mixed (mixed esters of cellulose)
- Millipore Duropore (polyvinylidene difluoride)
- Sartorius Cellulose acetate
- Sartorius Sartolon (nylon 66)
- Sartorius Regenerated cellulose
- Whatman Cellulose acetate

The fuels tested were:

- Straight run medium gas oil
- 30% HIACID/70% MGO
- Commercial Derv
- Commercial Automotive
- KLSA 87/5106
- KLSA 85/9208
- KLSA 85/9209
- KLSA 87/5107
- Jet A1
- Jet A1 + ASA3.

There were three timed filtration processes, each basically according to IP 385:

A. 750 ml of product was filtered at 0.6–0.68 Barr. Times recorded were 0–100, 600–700 and 0–700 ml. This was followed by filtering 10 ml of 0.1 percent aqueous Corexit and the time to filter this was also recorded.

B. The procedure was the same as A but the filtrate from A was passed through the same membrane.

C. The procedure was the same as A but filtrate was passed through a new membrane.

It was argued that if all particulates had been removed in A, a slower consistent filtration time should be obtained in B and would be an indication of membrane blockage. If a slow filtration time was recorded in C, it could be argued that this was due to membrane incompatibility and not membrane blockage.

It is interesting to speculate as a sideline that a timed filtration test could be the basis for a 'fitness for use' test and in fact has already found its way into methodology as MIL-S-53021 — a test designed to assess particulates in diesel fuel after biocide addition.

It was noted by the contractors that membranes sterilised in-house by autoclaving could retain sufficient water to impede subsequent fuel passage and hence pre-sterilised filters should be used.

One fuel blend, KLSA 85/9209, was not amenable to membrane filtration. Others yielded a variety of results with the various membranes. These results are summarised below:

Summary of the results of filtering 750 ml volumes of fuel samples through seven different filters followed by 10 ml of 0.1 percent Corexit.

FILTER TYPE	*FILTRATION TIME (SECONDS)*			
	OIL		*COREXIT*	
	Range	Mean	Range	Mean
Nucleopore membra fil	69–404	229	3–162	26.6
Sartorius regenerated cellulose	80–447	313	2–71	11.6
Millipore duropore	97–565	332	3–177	28.1
Sartorius cellulose acetate	110–620	357	3–325	65.9
Whatman cellulose nitrate	89–443	290	7-Blockage	
Millipore mixed esters	111–613	352	9-Blockage	
Sartorius sartolon (nylon N66)	203–613	459	11-Blockage	

Conclusion

The research indicated that as a practical compromise membranes should be chosen according to their ranking in the above table and this information used in conjunction with IP 385.

The Institute will be reconvening its Fuels Task Force later this year and part of its remit will be to consider new microbiological tests for distillate fuels and a revision of the IP 385 test method. ■

The future of the offshore pipeline industry

By NJ Smith, Managing Director, Smith Rea Energy Associates

Historically the offshore pipeline industry, or more correctly construction industry, has experienced marked fluctuations in activity. For instance, activity peaks in 1975/76, 1983/84 and 1991/92 have been separated by periods of low activity **(Figure 1).** This chart is in fact SREA's forecast of North West European Continental Shelf (NWECS) activity from 1990. As with most forecasts it has proved a little too tidy, and Europipe is likely to raise the figures in 1994 and 1995, but it reflects reality well enough to show the fluctuations.

Lay-barge capacity

The critical element in the offshore pipeline industry is the lay-barge. Given the limited number of lay-barges and the long lead times involved in their construction, it is their capacity which determines in the short-run the amount of offshore pipeline construction work which can be undertaken.

Since the large-scale development of the northern North Sea Basin began in the early 1970s, it has been the main theatre of operations for advanced (or third generation) lay-barges. Indeed with the exception of 'Castoro Sei', where the needs of the original Trans-Mediterranean Pipeline were of paramount importance, it would be true to claim that it was the northern North Sea's combination of difficult sea conditions, large fluid volume transportation requirements and significant mean water depths, which brought the third generation of pipelay vessels into being — vessels whose original performance has been considerably upgraded and which rarely operate outside the North Sea and Mediterranean areas.

As is illustrated in **Figure 2**, there are currently five third-generation 'North Sea' vessels, with a combined annual pipelaying capacity under 'normal' North Sea conditions of the order of 2000 kilometres (kms).

By way of comparison, steel tube mill capacity would be at least four times as great, and tube can also be stocked. The vessels have been concentrated into the hands of three operating companies, which probably represents the minimum which the oil companies would regard as providing an acceptable level of competition. Capacity is of course heavily concentrated in the hands of two of the three contractors, EMC and ETPM McDermott, aggregations which came into being following the 1986 oil-price collapse.

The five vessels have all been specially constructed or modified to work in the North West European Continental Shelf area. They are able to work over a lay-season normally from April to October (mid-March to mid-November in more the sheltered southerly waters) without the need to lay-down and pick-up pipe every time bad weather intervenes.

It is worth noting that most of the vessels could probably continue operating through the winter months if the work-load demanded it, although cost and other penalities would be involved. Allowances for weather downtime would increase the overall cost of laying the line and the more frequent requirement to lay-down and pick-up pipe as a result of bad weather conditions would be likely to cause additional stresses in the pipe itself.

Capacity can always be further increased by mobilising in the area some of the secondary capacity which exists in pipelay vessels mainly of an earlier generation and in modified heavy lift crane vessels.

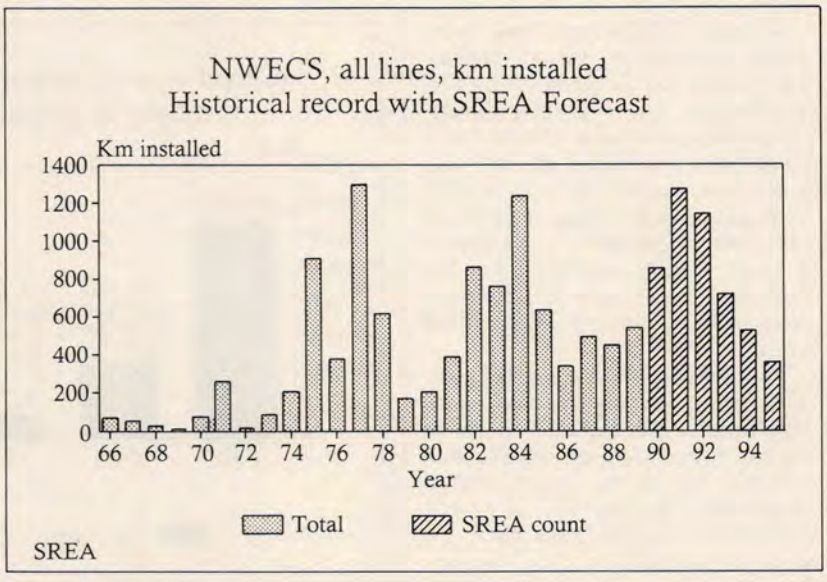


Figure 1

The offshore pipeline construction programme 1993–97

Figure 3 illustrates SREA's current information on the likely construction rate of transportation/transmission lines (ie lines greater than 16 inches in diameter) in the 'tough' areas over the period to 1997.

In **Figure 4**, SREA has assigned a probability rating to each line, based on published reports and its own assessment, as follows:

- Committed — approved/in progress (100 percent certain)
- Probable — preliminary engineering or planning in progress (85 percent probability)
- Possible — economic/technical assessment in progress, best estimate of timing (50 percent probability).

By way of comparison, the estimated figures for 1992 are also included. In 1992 the total of something approaching 1,300 kms arises from five major projects, Bruce to Forties (242 km), further work on the CATS (gas) system (c200 kms), the remainder of Zeepipe Phase I (225 km of condensate line and 185 km of gas line), some of Nogat in The Netherlands and the Tunisia to Sicily stretch of the Transmediterranean System enhancement.

In 1993, there are four significant projects in sight — the Irish-UK gas interconnector (193 kms), the Murdoch/Caister system gas line (167 kms), the 80 kms Harald to Tyra gas. Although we have included as a possible a Finland-Sweden link of approximately 200 kms, this possibility seems to be receding into an indeterminate future.

Whereas 1993/94 seem likely to be poorer years for the pipelay contractors, despite the inclusion of the 630 km Europipe line to Emden (though this could be delayed to 1994/5), and a North Africa to Spain gas line (84 kms), there could be a recovery in 1995 with the Zeepipe Phase II lines as fairly secure projects. An additional if more remote possibility for the same year would be a line from the Norwegian west coast to Sweden (300 kms).

For 1996 and 1997 we are obviously into fairly speculative territory. The Haltenpipe from Heidrun to shore (about 245 km) is committed, and will probably fall in this period. Other possibilities, the last two of which could be mutually exclusive, are:

- a third reinforcement of the TMPC (160 kms)

Annual pipelaying capacity

Vessel	Operator	Kms/pa
McDermott LB 200	McDermott-EPTM	433
DLB 1601	McDermott-EPTM	433
Semac	EMC	375
Castoro Sei	EMC	375
Lorelay	Allseas	308
Total		1,924

SREA indicative only

Figure 2

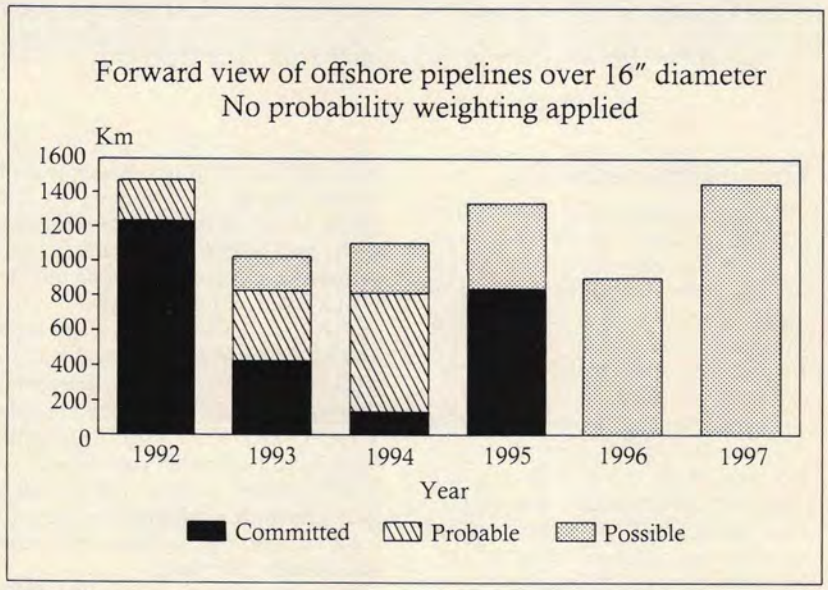


Figure 3

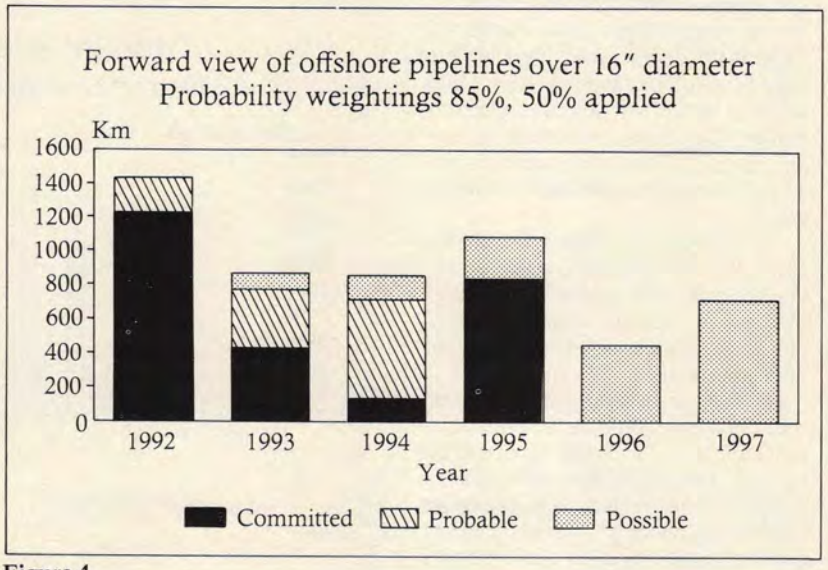


Figure 4

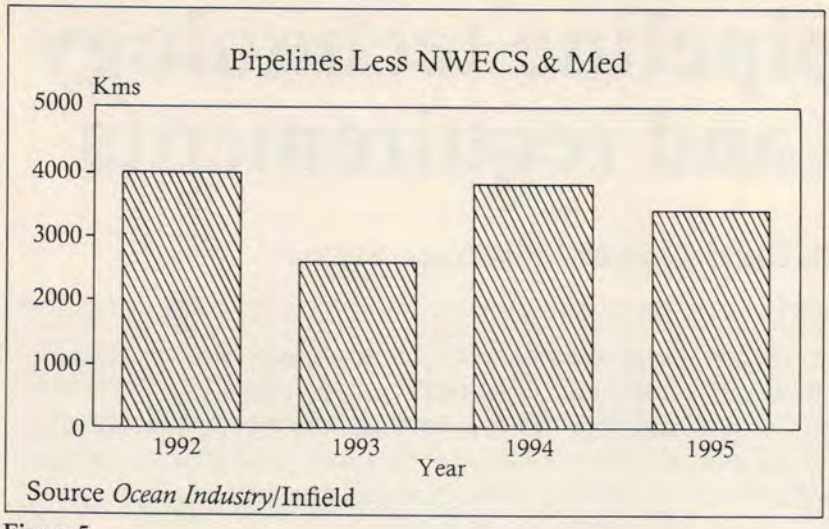


Figure 5

- export line(s) from the Britannia field (maximum 60 kms)
- a Bacton-Zeepipe link (maximum 120 kms)
- a gas link across the English Channel (250 kms).

One thing which stands out from the above data is the almost exclusive future dependence of the pipelay industry on the development of the international gas transportation business. Another is that adequate lay-barge capacity exists in every year, with the theoretical exception of 1995. The term theoretical is employed because it is likely that looking that far ahead the potential contracting parties would have considerable flexibility.

The question of how far the pattern of adequate capacity might be effected by events outside the North West European Continental Shelf and the Mediterranean is an interesting one. As a generalisation the connection between this and the other offshore areas is a fairly weak one as they are mainly benign regions serviced by a distinct earlier generation of pipelay vessels. However, it is always possible that some 'mega' project such as the proposed ASEAN or Iran-Pakistan gas lines might justify the mobilisation of one of the five key third generation vessels.

Strangely enough to judge from information from the Infield Data Base published in *Ocean Industry* for February 1992, it would appear that 1995 might well be a capacity pressure point on a global scale (**Figure 5**). It would also appear that 1993 might well be a low capacity utilisation point on the global scale. It should be noted that the Infield and SREA data are not directly comparable.

Economic trends

Earlier research suggested (**Figure 6**) that costs of pipelining fell significantly during the 1980s. The reasons for this were various but included long periods of excess capacity and consequential intense competition, technical progress and most importantly the move to fixed price contracts as opposed to day rates, which provided a real incentive to lay faster. It seems unlikely that prices will fall in the same manner in the 1990s. However, it is possible that the recent conclusion of a supposedly NOK 3.5 bn contract between Statoil and EMC, to extend on a negotiated basis the present Zeepipe contract into the next stage of Norwegian trunk line construction reflects a current oil company view that further economies can be achieved by changing 'traditional' commercial ground rules.

By the end of the decade the average age of the five key assets will be about 25 years and the question of whether their replacement can be economically justified will be coming on to the agenda.

Finally, it is perhaps worth noting that oil companies are now sufficiently flexible in their thinking and sufficiently aware of the third-party tariff income potential of their pipelines as to include speculative 'Tees' in their new construction.

Conclusion

The offshore pipeline industry would appear to have an exciting and generally active five years ahead of it in the European/Mediterranean area. Nevertheless, I should end on a note of caution. Given the volatility of the international hydrocarbons industry, any forecast, particularly one extending beyond two years, must be treated with considerable scepticism. ■

This paper examines the outlook for the period to 1997. It confines itself to transportation/transmission lines with a diameter of 16 inches or over, and excludes infield lines. It is based on information available in June 1992. It was first presented at ONS 92 in Stavanger.

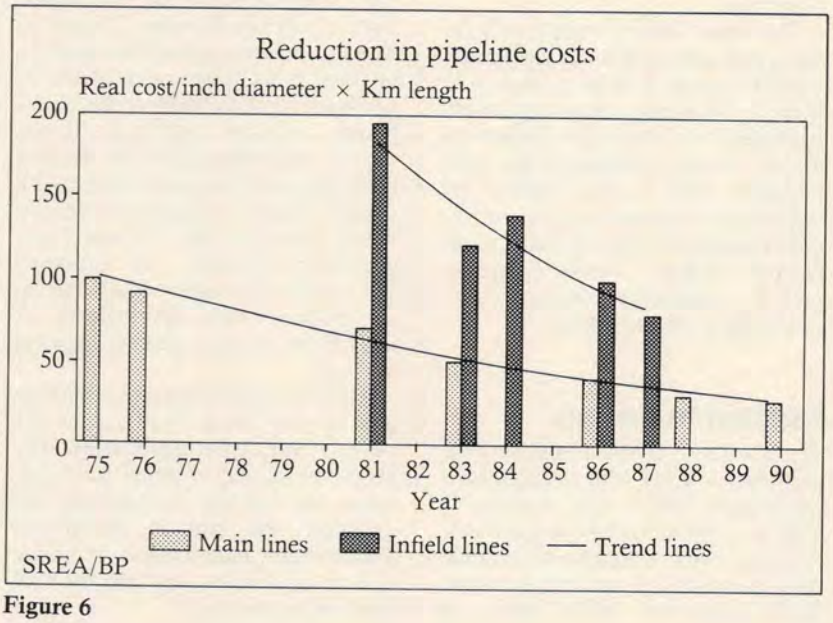


Figure 6

Offshore pipeline technology — status and requirements

By S Lund, Chief Engineer Pipelines, Statoil

Offshore pipeline technology comprises a spectrum of technologies within seabed mapping, design materials, construction, inspection and maintenance. Basic methods for design and installation have not changed significantly over the last few decades. However, gradual improvements of methods and procedures have taken place, and special design and construction solutions have been introduced to serve particular project needs.

On a North Sea map, the large pipeline systems, mainly for gas, are easily recognised. In addition there are numerous pipelines not directly shown on a North Sea map, such as flow lines between platforms and intra-field lines.

At present, pipelines installed on and from the Norwegian continental shelf represent very much the status of the technology considering pipe size (up to 40 inch), water depths (down to 350–400 metres), distance between pigging stations (up to 800 kilometres), landfall solutions and seabed intervention. Projects in other parts of the world have involved larger diameters and deeper waters respectively, but not in the diameter/depth combinations, with the same extent of rough seabed topography and under the same hostile environmental conditions as in the North Sea.

This paper deals primarily with the status and requirements for technology needed for gas transmission lines on or from the Norwegian continental shelf. Although it may seem straightforward to use existing technology for most problems, there is still potential for considerable development, in order to improve pipeline capacity, reduce cost of new projects, improve environmental consequences, or even create new business opportunities.

Seabed mapping

There has been an increasing need for pipelines in areas with rough seabed topography, where route planning as well as pipeline design require very accurate maps. A significant development of mapping technology has taken place during the 1980s, based on advanced multi-beam echo-sounders, large capacity data processors and automated map drawing.

Statoil has recently completed the route survey for Haltenpipe, with equipment which allowed processing of data and drawing of route maps onboard the survey vessel in parallel to the survey operation. The seabed is extremely rough due to iceberg ploughmarks and the parallel production of maps has allowed the engineers to perform onboard evaluation of the mapped area with respect to suitability for pipelaying. The plans for the survey have been adjusted during the operation in accordance with the findings of this evaluation.

The accuracy of mapping based on echo-sounding from a surface vessel is reduced with increasing water depth. The areas close to the Norwegian coast, inside the Norwegian fjords, as well as in several areas on the continental shelf have large water depths in combination with rough seabed topography. Accurate maps are a fundamental requirement for the detailed route planning and intervention work design. There is therefore a need for survey systems with a lesser depth-dependent accuracy, for example, using a ROV as equipment-carrier, in combination with development of underwater survey and positioning systems.

Sand waves, present in the southern part of the North Sea, are in the shallow end of the depth scale. The ability to identify whether the sand-waves are moving, in particular the direction and rate of movement, impose heavy requirements on survey system capabilities and precision of positioning systems.

Design

The primary function of the pipeline as a structure is to withstand the pressure acting on the inside wall from the medium transported in the pipe. Given the pipe diameter, the wall thickness and the strength characteristics of the pipe material are the main parameters considered in the structural design.

There is a simple relationship between the pressure in the pipe and hoop stress in the pipe wall:

$$p * D = 2 * \sigma * t$$

p = pressure

D = pipeline diameter

σ = hoop stress

t = wall thickness.

All pipeline design codes, onshore and offshore, have requirements to the wall thickness based on the principle reflected in this formula. However, smaller and larger differences are apparent in the various codes, related both to the further definition of the parameters entering into the formula and to the definition of allowable stresses.

As to the differences in parameters, the pressure may be the inside pressure only or inside minus outside pressure; the pipeline diameter may be inside, mean or outside; and the wall thickness may be the nominal wall or the nominal wall minus the negative fabrication tolerance. Onshore pipelines have no outside pressure and usually relatively low operating pressures, which result in a high D/t ratio. The different definitions of the parameters have therefore little effect on the resulting design of onshore pipelines.

For modern offshore pipelines, most often with much higher operating pressures and correspondingly low D/t ratios, these differences are more significant and are becoming particularly apparent for pipelines crossing several national sectors, where different codes are employed.

The maximum allowable stress is in many codes expressed by a design factor, which is the ratio between the maximum allowable stress and the yield stress of the pipe material. Alternatively a safety factor is given, which is the inverse of the design factor. Most codes have design factors or safety factors resulting in approximately the same stress levels for comparable design situations, however differences may be significant on a detailed level.

Many codes relate the design factor to a classification of the area the pipeline is passing through. A lower design factor 'higher safety' is used in more densely populated areas, i.e. in areas with increased consequences of pipeline failure and increased exposure to accidental forces from third party activities. A similar practice is also used for offshore pipelines, i.e. reduced design factor for platform areas, risers and landfall zones.

Norwegian and other design codes stipulate a design factor for hoop stress of 0.72 for normal pipeline design, and 0.60 in platform areas, etc. The DnV-81 code stipulates a design factor of 0.5 in platform areas. The factors have apparently been adapted from codes of the same origin, probably American. The numerical values appear to be empirically developed.

Experience has shown very good safety records for pipelines, indicating that the additional strength between the maximum allowable hoop stress and yield stress, or in reality between the maximum operating hoop stresses and the ultimate strength, has been sufficient for the other functional, environmental and accidental loads acting on the pipeline in addition to the inside pressure and to take care of imperfections in the pipeline wall, such as material and welding defects and corrosion.

However, it is possible that present design criteria result in a more than sufficient additional strength, depending on the design situation.

The quality standards of pipeline design, fabrication, installation, inspection and maintenance have steadily improved, reducing the possibilities and significance of undetected material and construction defects. However, this has so far not been followed by changes in design factors.

With increasing diameter and design pressure, the relative part of the wall thickness which may be considered as a reserve for other loads and material imperfections remain unchanged, however, the absolute value is increasing. It is therefore recognised that a modern large diameter, high pressure pipeline may be more resistant to, for example, external impact or corrosion attack before failure than a smaller diameter, lower pressure line. The design factor may therefore possibly be increased somewhat for large diameter, high pressure lines, without a significant impact on the safety level.

A revision of the design principles for pipelines should be based on the limit state design approach. By this method all foreseeable failure mechanisms are analysed by probabilistic methods, finding for each failure mode the probability for the load carrying capacity to be smaller than the actual load. These probabilities are then related to acceptance values for the various failure modes. The approach could be used directly in design situations or to calibrate new design factors.

Considering the wide use of present hoop stress criteria, it is believed that the introduction of new criteria for pipeline design would need a joint effort by the industry. Some work has recently been started in this direction. The SUPERB project, being performed by SINTEF in cooperation with Snamprogetti and sponsored by several international offshore pipeline operators and authority agencies aims to develop a submarine pipeline reliability based design code.

Requirements for hydrotesting are closely related to the traditional pipeline design criteria. The codes specify hydrotesting of the installed pipeline to a pressure 25 percent above the design pressure and require the pressure to be stable over an extended period, for example, 24 hours. Hydrotesting requires costly and time consuming operations, with the necessity for flooding and subsequent dewatering and drying of the line. Dewatering is also an environmental concern, due to the use of inhibitors in the flooding water. The value of the hydrotest as a strength test relative to construction of the pipeline can be argued, since the rest exposes the girth welds to low stresses only. Therefore, research into modern design criteria for pipelines should also include requirements to hydrotesting.

Much R&D work has over past years been devoted to special aspects of offshore pipeline design, such as on bottom stability and free spans. The knowledge and ability to perform an adequate design within these areas are in general quite advanced, however, some research is still ongoing, mostly to transform R&D results into practical design tools and criteria. Methods to predict span development in shallow water sand wave areas and in scour sensitive areas require improvement.

The above described SUPERB project based on limit state methods will also address other aspects of offshore pipeline design and may necessitate further consideration of stability and free span design criteria but will take advantage of the considerable recent research within this area.

Comprehensive work including model and full scale tests have been performed on interaction between fishing gear (bottom trawl) and pipelines. The behaviour of trawl boards during passage, as well as the forces acting, are in general well understood for various pipe sizes and a range of configurations between trenched and free spanning pipe.

Deepwater pipelines are exposed to a high net external pressure during construction and possibly also later during their lifetime. Extensive research has been performed into buckle and collapse resistance of pipe exposed to combined external pressure, bending and axial force. This area is in general well understood. Large safety margins are often used due to the huge consequences of failure. However, in this area, a common industry approach to criteria is still lacking.

Collapse and buckle resistance of a pipe depend to a large extent on the compressive properties of the pipe material. Material properties, such as the stress-strain curve, are by convenience usually measured in tension, and symmetrical properties in compression are assumed. However, the mechanical strength may be lower in compression than in tension, depending on the fabrication method for the line-pipe. This may result in lower than expected collapse resistance if not properly taken into account.

Materials

The technology for manufacturing, joining and corrosion control of pipelines has steadily improved and is in itself a huge area for research. Modern micro-alloyed carbon steels are well suited for sweet and sour gas pipeline operations, with excellent welding properties. Several pipe mills can supply line pipe in the diameters, thicknesses, grades and within the tolerances required for offshore deepwater operations.

The efficiency of pipelaying has con-

siderably improved in recent years, mostly due to the development of advanced automatic welding methods and equipment, producing consistent high quality welds. The joining principle is based on simultaneous work on several welding stations along the work deck, where the pipe string is assembled from double joints prefabricated elsewhere on the deck of the lay vessel. Alternative single station welding methods have been proposed, such as flash butt welding, induction heat welding, etc. Such methods were previously believed to be the path to follow for improved laying speeds. However, relative to present automatic welding, single station methods appear now to have a reduced potential for speed improvements.

Traditional corrosion protective coating materials, such as asphalt enamel, have shown excellent long term properties and are still in use on new, large projects. Experience records are now also available for the more modern coating materials, such as the three layer epoxy/polypropene system, which are used in several smaller projects and for special applications.

A significant research effort is going into materials for multi-phase pipelines, transporting wellstream with components which may be very aggressive with respect to corrosion. The challenge is to find materials and inhibition schemes which make offshore field development based on long distance multi-phase transportation economically attractive and sufficiently reliable. Stainless steel or cladded carbon steel may be used, or alternatively, carbon steel in combination with injection of chemicals in the pipeline.

Pipeline installation

The traditional S-lay method is without competition for laying of larger diameter trunklines. This method is also extensively used for smaller lines, intra field lines and flowlines, but other methods such as reeling and towing are also in use for such lines.

The 'third generation' lay barges of semi-submersible type, although commissioned in the 1970s, have undergone significant upgrading, and have proven well suited for todays' most advanced projects, such as the Zeepipe and the Europipe projects. The requirements of the Zeepipe Phase II project, involving installation of a 40 inch pipeline across the Norwegian Trench at a maximum depth of 365 m, represent a new challenge, which may necessitate some further extension of lay vessel capabilities.

The nominal capabilities of a lay vessel are usually expressed in terms of tension capacity and stinger characteristics. There is a need for a margin between the nominal tension capacity of the vessel and the required lay tension to take into account continuous tensioner operation and for tension deadband setting.

For laying in shallow water, the submerged weight of the pipe is usually limited by the tension required to maintain acceptable stresses/strains in the sagbend. For laying in deep water, the capability of the stinger to support the pipe in the overbend to a sufficiently steep angle may limit the diameters and submerged weights which can be laid. Tension requirements are reduced with steeper angles.

J-lay, i.e. laying from a lay vessel with a ramp which is inclined to angle the pipe will naturally take if not bent over a stinger, has been proposed and also used for deepwater pipeline installation. The inclination of the ramp allows one welding station only, making the method slow and hardly competitive with S-lay if S-lay can be used.

The depth capabilities of S-lay vessels may be extended if a smaller stinger radius could be used. In addition to the static strain caused by overall bending of the pipe to the stinger radius, the pipe is strained as a result of tension in the pipe and local bending of the pipe over the roller supports. Additional strains may be introduced locally if the pipe has uneven stiffness distribution, i.e. in field joint areas without the stiffness contribution of the concrete coating, and at integral ring buckle arrestors. Dynamic strain effects are also present in the pipe, caused by wave movement of the lay vessel and environmental forces acting on the suspended pipe string.

While the strains caused by overall bending of the pipe to the stinger radius are deformation controlled, the additional strains are load controlled and may depend on the extent to which the elastic strain capacity of the pipe is used for overall bending.

Strains in the overbend are normally limited to stay within, or approximately within linear behaviour of the material. Typical strain limits may be 0.20 percent for static loads and 0.25 percent for static and dynamic loads. Higher strains may increase cumulative fatigue during laying, and give a residual curvature in the pipe, which may result in torsional instability of the pipe string in the sagbend, complicate recovery operations, and cause 'spiralling' and free spans of the 'as laid' pipe on a flat seabed.

A reduction of roller spacing will reduce the local bending strain. This effect may be significant for smaller pipe, leaving a larger part of the allowable strain available for the overall stinger radius. Some slight increase in allowable strains may also be possible, provided it can be satisfactorily demonstrated that this will not cause undesirable effects for the laying operation and the subsequent operational life of the pipeline.

Most lay vessels are using an anchoring system for station keeping. Dynamic positioning may provide some operational advantages, e.g. for laying in deep water and in congested areas such as close to platforms and in skerry zones.

Areas of rough seabed topography are particularly challenging for pipeline installation. Typical features are sandwaves in the southern North Sea, pockmarks in the Norwegian Trench, iceberg ploughmarks in the eastern slope of the Norwegian Trench, at Haltenbanken and in the Barents Sea, and mountainous subsea landscapes in the nearshore area and inside the fjords along the Norwegian coast.

Intervention works are performed along the routes in these areas in order to provide acceptable support conditions for the pipe. Firstly, pipeline routes are sought which minimise the amount of intervention work. Then installation solutions are sought which avoid interventions prior to pipe laying. In the most rough terrain, also prelay intervention may be required to establish acceptable support conditions for pipeline installation.

The most common intervention methods are trenching and gravel dumping. Trenching may be used to lower the pipe at span shoulders in softer sediments. Present equipment is limited to post-lay work. Mechanical cutters have been used in the past for such operations in deep water. Ploughs would be another possibility, and may also have a potential for allowing prelay levelling of the seabed at expected span shoulders.

Gravel may be dumped in heaps or sleepers before and/or after pipelaying, and may also be used for continuous cover of the pipe for protection purposes. Large gravel heaps may become unstable on a very soft seabed and in steep slopes.

Grout bags and mechanical supports are other methods which have been used to reduce free spans. Pre-lay dredging has been used in sandwave areas in the southern part of the North Sea where more significant lowering of the pipeline has been required.

The very rough and rocky subsea landscape close to the Norwegian coast is particularly challenging for pipeline landfalls. For Statpipe, a 600 metre subsea bridge was installed to support and protect the two pipelines at the landfall. Subsequent projects have been based on the use of subsea-floor tunnels underneath the most difficult terrain. Drilling of an inclined shaft by directional drilling methods may represent an alternative to conventional tunnels.

The amount of seabed intervention is normally designed to allow installation and operation of the pipeline with bending limited to the elastic range and to prevent significant cumulative fatigue due to current and wave effects on the pipe span. Interaction with bottom trawl is also a consideration relative to free spans and protection methods in fishing areas.

Laying with reduced lay tension will result in a reduced residual tension in the pipe on the seabed, allowing the pipe to flex more into the span and thereby reduce intervention requirements. For S-lay, an increase in allowable overbend strain, to permit a steeper exit angle from the stinger, may therefore be beneficial considering intervention requirements. The J-lay and reel methods allow pipeline installation with a minimum of residual tension.

Methods have been proposed to bend the pipe into the plastic range at the span shoulders, in order to significantly reduce free spans. Such bending may be difficult to achieve after the pipe is installed, since catenary effects prevent the axial displacements required for deepening of the pipe curvature into the span. Plastic bending at shoulders may be performed during laying by special procedures involving additional weight on the pipe in the span.

Installation methods for offshore pipelines in areas with rough seabed topography as described above are generally based on adjusting the seabed profile to provide supporting conditions which are suitable for an initially straight pipeline. In similar terrain onshore, the pipe profile is often designed to follow the terrain by welding of pre-bent pipe sections into the pipe string. The idea has been launched to consider pre-bent pipe sections offshore as well, either by prefabrication, towing and lowering of long pipe strings formed in accordance with the seabed profile, or by installing pre-bent pipe joints into the pipe string on a conventional S-lay vessel.

At present, new ideas, as well as extension of conventional methods are being explored for the presently optional routing possibility of Halten-pipe through Ramsoyfjorden to the landfall at Tjeldbergodden. This pipeline will land associated gas from Heidrun and other Haltenbanken fields to mid-Norway. Ramsoyfjorden has very rough seabed conditions, and conventional installation solutions have so far appeared unfeasible or very costly.

Subsea connections

The trunkline system for Norwegian gas will allow transportation from new fields when existing fields are depleted. The system will probably be considerably modified and extended to increase the capacity and to connect new fields. Production platforms on depleted fields may have a future as riser or compressor platforms and for tie-in of new fields. However, operating such platforms for transportation purposes only may prove costly and subsea tie-in solutions for new fields therefore seem attractive.

It is desirable to have technology for subsea tie-ins to existing pipelines which minimise or avoid water ingress in the existing line during construction and commissioning of the new pipeline, and which minimise downtime for the existing line. Key aspects of such technology would be hot-tapping, inside tools for sealing, gel plugs, Y-connections, dual diameter pigging and remote control of subsea valves.

In designing upstream extensions of existing transportation systems it will be desirable to use a higher design pressure for the upstream pipeline, in order to maintain the transportation capacity without intermediate compression. If the connection is made via a platform, conventional systems for pressure protection of the downstream line can be used. A subsea connection will result in a subsea code break, and the pressure connection would then require unconventional methods, such as controlling the downstream and upstream pressures to ensure that the shut in pressure at any point in time will not exceed the lowest design pressure.

Inspection and maintenance

Pipeline inspections are normally performed on a regular basis, to check the external and internal conditions along the pipeline, and in particular to detect changes relative to previous inspections.

External inspections are carried out at intervals by ROV equipped with video equipment and a sensor package for registration of support conditions (free spans and burial status), anode conditions, foreign objects. The ability to detect and follow a completely buried pipeline needs improvement.

Internal inspections are performed, for example, every fourth year by inspection pigs. The purpose is to detect possible structural changes to the pipe (ovalisation), and corrosion metal loss. Modern inspection pigs have the ability to detect and locate localised corrosion which is far less than the acceptance limits. Recent development has extended gas pipeline pigging distances considerably. Pigs are available for inspection of the Zeepipe 40 inch pipeline, with a distance of more than 800 kilometres between pigging stations.

Maintenance work for an offshore pipeline is normally rather limited. Some changes in span conditions may appear as a consequence of the natural self-burial process for the pipeline, however, special interventions by means of rockdumping, groutbagging, etc, are required in exceptional situations only. More significant inspection and maintenance work may be required in connection with special installations, such as subsea T and Y installations.

The pipeline operator will always have to be prepared for a possible repair situation. The probability of damage to the pipeline is, in general, low and reduced with increasing water depth. However, it has to be foreseen at any point along the pipeline, at all actual depths.

The PRS mechanical hyperbaric welding system has been developed to minimise repair times for possible damage to the Statpipe and Oseberg transportation systems and is also available for other pipelines. Arrangements have been made to allow quick mobilisation of a repair spread with this equipment. The equipment will be used for construction tie-ins in new systems (Zeepipe, Europipe), which also will be covered by the same repair spread once the systems are in operation.

One objective with PRS has been to minimise diver time in performing the repair. Diver independent repair systems for smaller pipelines without concrete coating do exist. The development of diverless repair equipment for larger concrete coated pipelines is now being planned. ■

This paper was presented at ONS, Stavanger, in August.

Biofilms in metalworking fluids

In 1988 the Institute of Petroleum agreed to sponsor a two-year research project into the study of biofilms in water-based metalworking fluids. The project was based at the University of Wales, College of Cardiff, and was undertaken by Miss Sarah Kinniment under the supervision of Dr Julian Wimpenny.

A brief report on the initial findings of the work was published in *Petroleum Review* in February 1991. The progress made by the end of the second year was sufficient to persuade the Institute to extend its financial support for a further year.

Miss Kinniment has now produced a final report detailing all the work carried out over the three years of the project. The report begins with a thorough review of the problems which can result from biofilm formation in water-based metalworking fluids and a discussion on biofilm structure and composition. There is also a detailed analysis of why metalworking fluids support biofilms and how microorganisms which have developed in these fluids develop resistance to antimicrobial agents. The use of a model system to facilitate the study of biofilms is then discussed.

Once a stable biofilm was developed, this was used to establish the efficacy of treatments with three different types of antimicrobial agent, namely formaldehyde, chlorocresol and an isothiazolinone mixture. In addition, significant differences were also demonstrated in their efficacy towards the same microorganisms when these were freely suspended in the test medium.

In the final part of the report, Miss Kinniment examines the organisation of the biofilm and undertakes an investigation into the physiological behaviour of the organisms within its structure. A general discussion of results, some recommendations for further work and a very detailed reference survey complete the text.

Copies of the finished report, which runs to 313 pages with 97 photographs and numerous line figures and diagrams, can be viewed in the Institute's library.

Miss Kinniment will present a paper on selected aspects of her project at the forthcoming conference on the 'Implications of Biocide Use within the Petroleum Industry' on 12 November.

Russian expert to address congress in Amsterdam

Professor Youri A Yershov, Deputy Director of the all-Russian institute for the studies of external affairs, ministry of economics of the Russian Federation, will address the IRO-Holland Offshore Congress in Amsterdam, on 3 November.

Mr Yershov will be speaking about the problems of the oil and gas industry in the Russian Federation on behalf of the Russian government. He is an expert on the legal aspects of the oil and gas industry. Furthermore Mr Yershov is the leader of the delegation which negotiates the basic agreement of the European Energy Charter.

IRO, the Dutch Association of Suppliers in the Oil and Gas Industry, has organised the IRO-Holland Offshore Congress in co-operation with the Dutch Ministry of Economic Affairs, the Netherlands Oil and Gas Exploration and Production Association (Nogepa) and the RAI Congress Centre.

The Dutch Minister of Economic Affairs, Dr J E Andriessen will officially open the congress, 'Europe Tomorrow: Risks & Rewards'. He will officially inaugurate the new Nogat pipeline.

IRO was founded in November 1991 and now has some 270 members. The organisation is a co-founder of EUGOES, the European Group of Equipment and Services Suppliers in the Energy Sector. This group lobbies in Brussels on behalf of the European associations of suppliers in the energy sector.

New developments

Several major oil and gas projects are being developed on the Dutch continental shelf. Technical, safety and environmental aspects of these developments will be highlighted during the third day of the IRO-Holland Offshore Congress. The new developments include:

Amoco's P15/18 development — Amoco Netherlands Petroleum Company, operator of the Rijn oilfield off the coast near Europoort, submitted a plan at the beginning of 1991 to develop a group of gas fields in the same environs in blocks P15 and P18. It involved constructing a central production platform and four satellites. Total investment, including the drilling work and the necessary pipelines, amounted to more than $500 million. The first gas will be produced next year. The average production level will be approximately 13.4 million cubic metres per day.

LASMO's Markham development — LASMO Nederland is developing the gas reserves in block J6, the so-called Markham-East field on the boundary of the Dutch and British shelf. This is the first joint British-Dutch development and, moreover, was the first export of British gas to the continent. Total investments amount to a billion Dutch guilders. The total gas reserves in Markham East are estimated at 19 billion cubic metres.

The Nogat project — Work on the 260-kilometre pipeline between Den Helder and NAM's F3 field to the north has been steadily progressing since 1991. The pipeline itself has been positioned, including a spectacular dune-crossing which took place above Callantsoog. Furthermore, NAM installed the gas production platforms L2–FA–1 and L5–FA–1 as well as the gravity base stucture for the F3 gas and oil production platform.

With its total investment of 2.1 billion guilders, Nogat is far and away the largest offshore project currently being carried out on the Dutch shelf.

The F3 field consists of condensates, oil and gas. After extraction, these condensates and oil can be stored in the 32 square compartments on the concrete base structure on which the F3 platform rests. This structure has a base measuring 80 by 70 metres and the legs are more than 60 metres high. The over-capacity of the pipeline allows the builders to keep an eye on future possibilities.

Legislative changes for French crude imports

The French government is to modify a 1928 act relating to imports of crude oil in order to make it more amenable to the workings of the Single Market. A reform bill is to be read in Parliament during the autumn session before taking effect from 1 January 1993.

The 1928 act has been the cornerstone of state policy to ensure self-sufficiency in oil supplies especially during times of crisis. It obliges importers to use French-registered vessels to supply the equivalent of two-thirds the volume necessary to meet domestic market requirements for refined products. The government is proposing to reduce this proportion to a maximum of 5 percent. This would mean an importer handling 10 million tonnes of crude a year would need to ensure that 400,000 tonnes of crude traffic was sailing under the French flag.

Refinery groups were hoping that the amendment to the act would abolish such obligations altogether because of the high operating costs attached to home vessels (FFr26/tonne). 'There is not a precedent or equivalent in another Community country,' complained Bernard Calvet, President of Union Française de l'Industrie Pétrolière, UFIP, 'French refiners have to bear an additional cost which is a handicap in competing with importers of refined products and refinery groups in other EC countries,' he added.

The UFIP is considering appealing to the European Court of Justice on the grounds that the French legislation breaches fair competition regulations. The stipulation that strategic oil stocks, the equivalent of 90 days' demand, viewed as yet another operational constraint on firms in the sector, is retained by the reform bill, probably as a consequence of the Gulf war. 'The government's intention in reforming the 1928 act is to make it more compatible to the spirit of the Single European Market but the bill it proposes is complex, interventionist, disparate and in certain aspects, useless,' said Mr Calvet. French minister Charles Josselin has sought to counter industry criticism by arguing that without an obligation to use home vessels, 'France's tanker fleet would transfer to another flag.'

The government has offered a 'halfway house' concession by allowing tankers to register under a second national flag, Kerguélen, a French territorial zone in Antarctica. Under Kerguélen, up to 65 percent of crews can be of foreign nationality, while employers' social security contributions for the French seamen aboard are significantly lower than those incurred under the main national flag. Tanker operators would enjoy savings of around $1 million per ship each year enabling them to close the gap on operational costs with international flags. 'For the moment, such a move is merely a possibility. Nothing has been signed to bring it about,' a UFIP source confirmed.

Transferring the 14-strong French deep-sea, tanker fleet to Kerguélen is likely to entail heavy job cuts among the 1,400 seamen (600 officers) employed on crude oil carriers. The UFIP estimates between 200 to 300 redundancies while unions representing crews say 400 posts are threatened and are considering strike action in protest. The government has said that authorisation to transfer vessels to Kerguélen would only be given if adequate redundancy programmes were offered, a position shared by French refinery groups.

The UFIP also questions government plans to reform the system of securing stock reserves. According to the bill, the system would be placed under the responsibility of an industry committee. The UFIP claims this would multiply administrative costs 10-fold. It has also voiced its opposition to a section of the reform bill which refers to a government 'right of veto' not only when refinery groups decide to shut down/dismantle or sell off installations, [which is widely accepted], but also on acquisitions, new construction and redevelopment. 'This means the state is trying to "manage" affairs in the sector which could lead to it favouring one firm as opposed to another. This could have a very negative impact on refinery groups investing in France,' Mr Calvet warned.

The UFIP are hoping that a number of amendments will be made to the bill during its passage through both the Senate and the Assembly this autumn. 'We are waiting to see what happens and if the objections we have raised are not incorporated in the final text we could well decide on taking our case to the European Court,' a UFIP source concluded. ■

Stuart Todd

Petrol products tax to increase

A French finance bill is proposing a double increase in 1993 in the consumption tax imposed on petroleum products. The first increase is scheduled for 15 January and will add 4.5 centimes to the fiscal duty (before VAT) on a litre of leaded petrol. The same measure will be applied to diesel and, for the first time, to unleaded petrol. A second increase is to follow on 15 April, after French parliamentary elections and will add a further 2.3 centimes, taking the fiscal duty on a litre of leaded petrol to around FFr4 (before VAT). These measures will generate an extra FFr1.5 billion to the state's revenues from taxes. News of the double increase co-incided with a UFIP announcement that French refinery groups made losses of FFr42 million in the first half of 1992, compared with profits of FFr5.36 billion for the equivalent period last year. The UFIP calculates the poor performance as a loss of FFr0.8/tonne in marked contrast to a profit of FFr105.4/tonne tabled in 1991. The UFIP forecasts little improvement for the second half of the current year.

Russian domestic crude price doubled

By Toby Latta

Boris Yeltsin's 18 September decree doubling the price of Russian crude on the domestic market did not come as a surprise. Last year, producers were still turning in a tonne of oil at 70 roubles, which at the time was equivalent to $1–2. In January, when the government launched its ambitious reform programme, prices stood at 500 roubles. In May, they were increased to 1,800 roubles (then around $9). but the knock-on inflationary effect undid much of the benefit producers might otherwise have gained.

The new price of 4,000 roubles ($12) will still not cover the running costs of most producers in the Russian Federation. A senior official at the Russian oil producers association, Rosneftegas, recently estimated that with current domestic prices a tonne of oil should cost at least 8,000 roubles in order to break even. However, the cautious approach adopted by the Gaidar government proves its sensitivity to pressure from inefficient industrial enterprises left over from the Soviet era, whose managers are protesting against any dramatic price increases which could have a devastating effect on their fragile existence. The government is also wary of dealing another blow to a population weary of soaring prices, at a time when discontent with plunging living standards could spill out onto the streets.

Fortunately for the Russians, the International Monetary Fund has dropped its demand that oil prices be freed immediately as a condition for the country receiving the $24 billion in credit it so desperately needs. Mr Yeltsin's assurances that prices will reach world levels by the end of 1993 are probably optimistic and aimed at world economic opinion. Mr Yegor Gaidar has emphasized prices can only be freed if 'the state of the economy allows.' For the time being, Russian oil producers can only continue to expect gradual administrative increases of the type seen this year. New fuel and energy ministry policy reflects this approach.

After Vladimir Lopukhin, the former minister for fuel and energy, was deposed in a government reshuffle in June, the industry waited in expectation of pronouncements by his successor, Viktor Chernomyrdin. Anxiety was caused in liberal circles as he is not seen as a reformer, his roots lying firmly in the Soviet system of centralised planning and the command economy. His previous handling of the state gas monopoly, Gasprom – though most admitted, sometimes reluctantly, that it was rather successful – bore witness to this. There was little inclination on his part to break with the centralised system.

It soon became clear that Mr Chernomyrdin's approach would not be radical, in harmony with the increasing domination in Mr Gaidar's cabinet of conservative 'industrialists' who represent old Soviet state enterprises. Indeed his initial instinct has led him to attempt to restore order in the oil industry through a partial re-centralisation, clearing up the rather messy devolution of control to the country's regions and local production associations.

But the step-by-step approach — including the matter of price rises – is generally being greeted positively by producers and economists. Nerves are on edge as Russia's production tumbles closer to the critical 300 million tonnes per year mark, beyond which the country could become a net importer of oil, to say nothing of the fact that its main source of hard currency income would completely dry up. Output for 1992 is expected to be 390 million tonnes, down from 460 million tonnes in 1991. Economy minister Andrei Nechayev has described a 'worst case scenario' under which production for 1993 would dip to 310 million tonnes. But Mr Chernomyrdin is more optimistic and insists that exports can be maintained at stable levels of around 58 million tonnes, thanks to reduced domestic consumption and the halving of exports to other Commonwealth of Independent States countries.

The stated aim of the price rises is, in Mr Chernomyrdin's words, 'to stabilize the industry, increase its effectiveness', and to begin clearing up its debts. 'If we continue to operate like this (with the old prices) we will lose 170 billion roubles by the end of the year.' Quite how the measure will increase the industry's effectiveness has yet to be seen, though the price rises must be seen as part of a larger complex of measures. The debts of the industry have been growing dramatically as price liberalisation this year has sent the cost of food, equipment, pipelines, construction materials and other goods soaring. The fundamental aim is to bring in some capital, relieve the burden on the government and to give production associations some room for manoeuvre.

Though the exact mechanism attached to the price rises and new progressive taxes on oil producers has still not been clarified, it is forecast that producers will raise their prices to around 5,200 roubles ($16) a tonne. Mr Yeltsin's decree stated that producers charging more than the new 4,000 rouble ceiling would face punitive taxes. It has been reported that profits of oil producing enterprises would be limited to between 10 and 20 percent of production costs.

Inflationary pressure

It is still too early to say whether the price rise will have a positive effect. After the May increases, prices across the board increased by an average of 35 percent during the following month and at least another 30 percent over the next two months. Mr Gaidar predicted in late September that the effects of the latest rise would entail 'relatively moderate' inflation. However, there was panic at the currency markets immediately after the announcement, causing the rouble to plunge from 250 to the dollar to a recent all time low of 345 roubles. The net result of inflationary pressure on the economy caused by the rise in oil prices could leave the producers in an equally unfavourable position, unless the government can take measures to resist such pressure.

A government session just before the price rise approved a complex of measures proposed by Mr Chernomyrdin for the energy sector. The new policy, he said, would be oriented towards establishing 'reasonable energy requirements and a rational use of national resources.' Extensive development will be dropped in favour of an attempt to halt a further slide in production, giving priority to meeting domestic supply requirements, workovers and the introduction of 'a series of fuel-saving measures' which are 'top priority in the programme.'

Oil — a priority

On the other hand, the government has pinpointed the oil industry, along with five or six others, as 'priority' areas for 1993. This means that government investent financing of the sector will be resumed, probably with generous credits, now that Mr Gaidar's strict monetary policies have all but vanished into thin air. Although Mr Gaidar understands this spells disaster for the budget deficit, he realizes there is little choice. The government concept also calls for accelerated conversion of fuel and energy enterprises into joint stock companies. Latest proposals envisage the creation of up to 12 vertically integrated companies to run everything from well-head to petrol pump. Few details have yet been made available but there are doubts as to whether the proposed units would be able to establish effective control.

While producers are divided as to the benefits of such undertakings, they are undoubtedly united in opposition against the latest proposals by Mr Yeltsin which would make it compulsory for all enterprises earning hard currency to sell their dollars to the state in exchange for roubles. So far, many production associations have been taking advantage of their freedom to sell independently up to 20 percent of their production; much of it has gone abroad, bringing significant hard currency incomes. Compulsory exchange of currency, which would give Mr Chernomyrdin greater manoeuvre to centralise and invest hard currency where he feels necessary, is likely to cause rebellions throughout Siberia. Producers naturally feel they are better placed to decide where that investment should go. Mr Chernomyrdin's moves to centralize exports through the state company, Rosneftetrans, have already caused angry reactions in the region.

Ironically, the best way of solving the problem of exports — export quotas and licences, centralized export, hard currency incomes from export — would be to bring Russian prices up to world levels. Until then, producers will obviously strive to sell their oil on the lucrative world market. Measures such as the compulsory sale of currency will only serve to encourage dishonest operators keen on keeping profits in private bank accounts abroad.

Effect elsewhere

The price increases in Russia have caused storms in other CIS countries, heavily dependent on cheap Russian oil. Within hours of the announcement, government officials in Ukraine said the move would spell disaster for the Ukrainian economy. The republic's Lisischansk refinery (Europe's largest) is running at 15 percent capacity as a result. The effect on Ukraine and especially the Donestsk coal basin where the refinery is located could well be catastrophic. But little sympathy is given to Ukraine which insists on charging other CIS countries world prices for its own goods, including agricultural produce, a highly sensitive matter in Russia itself.

In Belarus, the price of crude could rise to 24,000 roubles per tonne, from 3,000 as a result of the Russian rise. Experts have forecast that about 50 percent of oil in Belarus will be traded at deregulated prices in the first quarter of 1993. Other former Soviet republics are in a similar position.

CIS countries are also being faced by an increasingly tough stance by Russia on the matter of debts. Mr Chernomyrdin has warned that oil supplies could be cut off completely to countries which fail to clear their debts and that henceforth deliveries would be made on a prepayment basis. The total debt to Russia amounts to some 530 billion roubles, well over the debts owed by the Russian oil industry itself. This uncompromising approach with regard to its neighbours indicates that Russia is unwilling to give up its dominant role in the Commonwealth but also adds a note of desperation in the bid to put its own house in order.

At the last CIS summit meeting in Bishkek in mid-October, six of the former Soviet republics pledged to stay in the 'rouble zone.' The other countries have stated their intention of introducing their own currencies. While the republics which stay in the rouble zone are likely to have to tolerate a certain dictation of economic policy from Moscow, they will probably benefit from cheaper oil prices in the meantime as a reward for staying in the rouble zone. Meanwhile, the 'rebels' will have to pay world prices, a fate which is already coming close to crippling the economies of the independent Baltic states. ■

The use of foam against large-scale petroleum fires involving lead-free petrol

By JA Foster, Home Office, Fire Experimental Unit

As a result of public concern, the Fire Experimental Unit (FEU) was asked to evaluate the performance of portable foam extinguishers on fires of various traditional and unleaded petrol formulations. The tests, carried out in 1989, revealed that the foams tested suffered no significant loss of fire extinguishing capability when used on small scale unleaded petrol fires. The report concluded that there appeared to be no need to change fire extinguisher requirements for garage forecourts or comparable situations.

In order to establish whether lead-free petrol, conforming with current standards, would present any problems to the fire service using their standard low expansion foam equipment and techniques, large-scale trials were carried out by FEU in September 1991.

Discussions were held between the Home Office and the petroleum industry during the planning of the trials. The industry co-operated fully and assisted with the specification, mixing and delivery of fuel. The fuel for the main tests was donated by Shell, Esso and BP with the Home Office paying for the duty and VAT charges.

The choice of fuel

Lead as lead tetra-ethyl and/or lead tetra-methyl has been used for about 60 years to improve the performance (octane rating) of the hydrocarbon mixtures which constitute petrol, but health and environmental concerns have resulted in the progressive reduction in amounts of lead in petrol from 1974 onwards. The reduction of the lead content has led to the use of oxygenates, for example ethers and alcohols, as alternative octane improvers. Oxygenates are only used in either leaded or unleaded fuels when the octane rating cannot be achieved cost effectively by refinery processes.

The choice of fuel was made after advice from the petroleum industry on the most suitable combinations to represent blends towards the upper limits of oxygenate concentrations which could potentially be present in the United Kingdom. The three fuel types agreed for testing were:

Figure 1 Foam being applied to fire

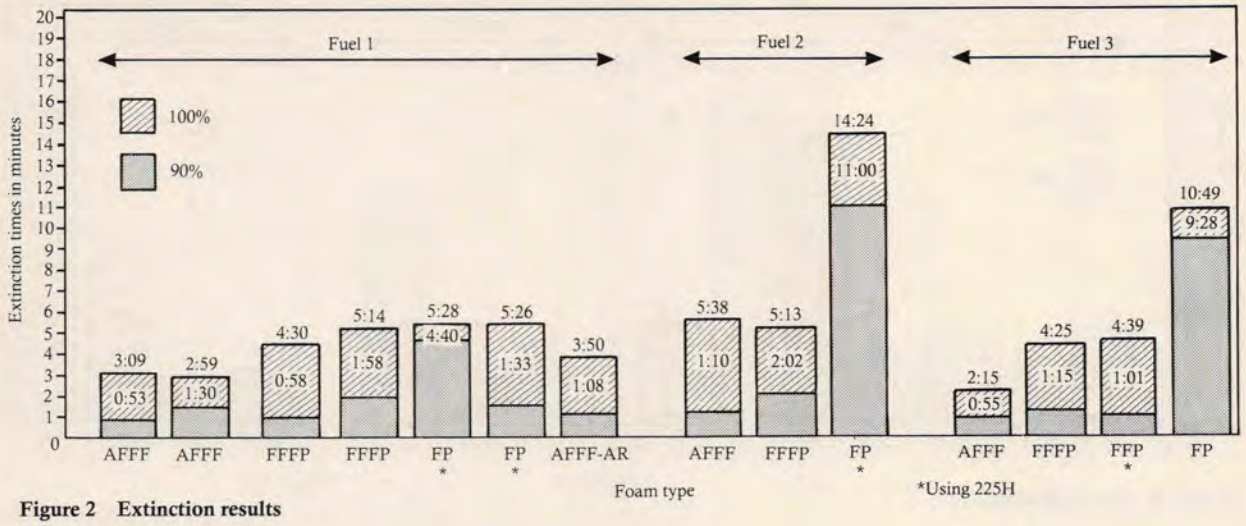


Figure 2 Extinction results

- *Fuel 1* — Unleaded petrol with no oxygenates. This was 95 octane premium unleaded petrol.
- *Fuel 2* — Unleaded petrol with a moderate oxygenate level, using an alcohol component of three percent methanol and two percent tertiary butyl alcohol (TBA). This gives a total oxygen content of 1.93 percent which approaches the UK maximum of 2.5 percent.
- *Fuel 3* — Unleaded petrol with 15 percent methyl tertiary butyl ether (MTBE). This is the maximum allowed under EEC Directive and is greater than that allowed in the British Standard for use in the United Kingdom.

The choice of foam additives

The additives tested were fluoroprotein foam (FP), aqueous film forming foam (AFFF) and film forming fluoroprotein foam (FFFP). These were chosen because they were the foam types most commonly used in the fire service.

One test with alcohol resistant AFFF (AFFF-AR) was included because of current interest from some brigades in using a 'universal' concentrate.

All the additives were used at three percent concentration. The application rates used for the main tests were four litres per minute per square metre (lpm/m^2) for AFFF, FFFP and AFFF-AR and five lpm/m^2 for FP. These were the minimum rates currently recommended to the fire service for the selected foam types.

How the tests were carried out

The tests were performed in a purpose-built 56m^2 circular tray on the Fire Service College fireground. The tray had a concrete base and metal circular rim. For each test, 3000 litres of fuel were dispensed from a tanker into the tray. The fuel was ignited and allowed a one minute preburn before the foam stream was applied to the upwind side of the tray.

The branchman, an experienced fire officer, applied primary aspirated foam to the tray surface, attempting to cause minimum disturbance to the fuel (**Figure 1**). Two different branch pipes were used during the test programme.

Five minutes after the fire was extinguished, a burnback test was performed to assess the resistance of the foam blanket to flame.

Throughout the tests, observers noted the progress of the fire fighting, the times to 90 percent control and extinction, and the times to 25 percent and 100 percent burnback. Radiometers were used to measure heat radiation and all tests were recorded on colour video equipment.

Results for Fuel 1

The results of the extinction tests for all the fuels are given in **Figure 2** which records the 90 percent and 100 percent extinction times in minutes and seconds. The burnback test results are given in **Figure 3** which records the times to 25 percent and 100 percent burnback.

AFFF and FFFP gave convincing extinction at four lpm/m^2 using the Chubb FB5X MkII branch pipe. FP gave satisfactory extinction when used at five lpm/m^2 with the Angus 225H but not with the FB5X MkII. The single test with AFFF-AR gave results similar to those of AFFF and FFFP.

The burnback tests using AFFF, FFFP and AFFF-AR produced similar results, with small flames developing over the foam surface and tray rim shortly after the burnback flame was applied. The foam blanket did resist a major burnback for several minutes before the flames quickly spread to the whole tray area. The performance of FP was much better with 25 percent burnback times in excess of 12 minutes.

Results for Fuel 2 and Fuel 3

With Fuels 2 and 3, both AFFF and FFFP at four lpm/m^2 gave convincing control and extinction with a Chubb FB5X MkII Branch. FP at five lpm/m^2 with the Angus 225H Branch did not achieve 90 percent control until 11 minutes with Fuel 2 and 15 minutes with Fuel 3. The fire was only eventually extinguished when the firefighter directed the foam stream to hit the ground outside the tray and flow over the bund wall and gently on to the fuel surface. This tactic is referred to as indirect application. The burnback test results were similar to Fuel 1 with little resistance from AFFF and FFFP; FP showed superior performance.

A single test was carried out with Fuel 3 using FFFP and the Angus 225H Branch at four lpm/m^2. This did not show a significant change in the extinction performance but it did give improved burnback times. The significant change in the measured foam properties was that FFFP had a longer drainage time when used with the Angus Branch.

Implications for firefighters

The trials have shown that, using AFFF and FFFP through a Chubb FB5X MkII branchpipe at four lpm/m^2, there was no difficulty in extinguishing all the fuels tested. No dif-

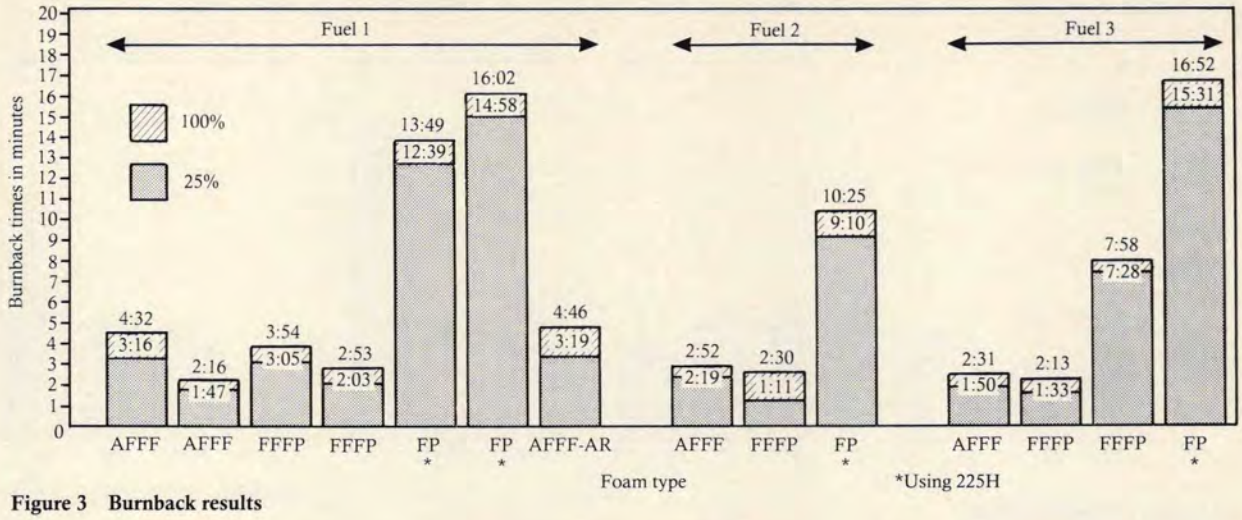


Figure 3 Burnback results

ficulty is expected with petrol formulations to the current standards using the Chubb FB5X MkII or Angus 225H branchpipes under these conditions.

FP only achieved extinction with the unleaded fuel with no oxygenates when used at the minimum recommended application rate of five lpm/m^2 and with an Angus 225H branchpipe. Extinction was not achieved with the other two fuels without using indirect application. This gave gentler application as would be achieved with a backplate, frontplate or other objects which could be used to serve the same purpose. Gentle application is advocated by the fire service wherever possible.

The burnback performance of FP was better than that of AFFF and FFFP.

The tests have shown that foams applied with the Angus 225H have superior performance than when applied with the Chubb FB5X MkII.

In selecting foam additives, brigades should consider the relative importance of extinguishing and burnback performance. FP has the better burnback performance. AFFF and FFFP have significantly better extinguishing performance.

Providing that brigades follow the guidance in the Manual of Firemanship, as amended by Home Office guidance, no problems would be expected when using good quality AFFF or FFFP against petrol formulations permitted by current and likely future standards. ■

The full report of these trials 'The use of foam against large-scale petroleum fires involving lead-free petrol' is lodged in the IP Library. Queries may be addressed to the Fire Experimental Unit. Telephone: 0608 50004. A video of the trials is also available from the IP Library.

Multi-pronged approach to Argentina's downstream privatisation

By John Cranfield

The upstream sector of Argentina's sprawling oil industry is now well on its way to full-scale privatisation (see *Petroleum Review*, August 1992). The downstream side, however, poses far more problems. Partly, the difficulties are similar to those upstream: massive overstaffing within the state oil firm Yacimientos Petroliferos Fiscales (YPF), the consequent zero profitability in turn making new investment almost impossible. But YPF is not the only state body involved: Gas del Estado (GdE) handles all gas distribution throughout the country, as well as trunk-line transmission from the fields. Of the 10 refineries, YPF owns six and thus has a powerful grip on most oil-products retailing. Then, over the years of military rule, the Defence Ministry became a major shareholder in downstream plants. Most are in the petrochemical sector, producing what were presumably seen as strategic materials. The result is a mish-mash of miscellaneous stage holdings (GdE and YPF also have sizeable interests in many petrochemical plants), usually today balanced by minority shareholders from the private sector.

To unravel this spaghetti bowl of state interests, the government is making a three-pronged attack. The Defence Ministry, which is now seen as having no justifiable interest in industry, is selling off its stakes, usually to its private partners, some Argentine, some foreign. GdE has been split into a number of regional companies and each is being privatised, though the government will retain varying minority stakes in each company. YPF will be partially privatised initially, with full transfer to the private sector at a later stage.

Just how much will be raised for the state is open to question. YPF was originally valued at some $8 billion but, after a long hard look at generally inefficient operating methods and the need for modernisation, the government now accepts $4 billion as more realistic. The Defence Ministry's petrochemical interests are very difficult to value, given that this sector has been going through extremely hard times of late. Some interests may end up simply being given away. GdE is on the privatisation block right now and seems likely to prove to be the jewel in the crown. Although suffering from the common malaise of overstaffing and bureaucratic management, the company is far more automated, has lower manning and is profitable. When transferred to the private sector in January 1993, GdE is expected to bring around $2.3 billion to the state coffer.

Worldwide gas interest

Bids for varying stakes in the 10 companies derived from the break up of GdE were called for in July. A pre-qualifying round of bids began on 1 September and ended on 30 October. At this stage, bidders had to set out their plans and show their ability to carry them through. Those chosen to go forward will next have to make firm financial offers, and flesh out the details in development plans. This stage occupies November. Winners, and the consequent transfer of the Argentine gas industry to the private sector, will be announced in January if all go to plan.

The 10 companies established through the break up of GdE, and the percentage stakes available to the private sector, are:

	percent on offer
• Transportadora de Gas del Sur SA	70
• Transportadora de Gas del Norte SA	70
• Distribuidora de Gas Metropolitana SA	70
• Distribuidora de Gas Buenos Aires Norte SA	70
• Distribuidora de Gas Noroeste SA	90
• Distribuidora de Gas del Centro SA	90
• Distribuidora de Gas del Litoral SA	90
• Distribuidora de Gas Cuyana SA	60
• Distribuidora de Gas Pampeana SA	70
• Distribuidora de Gas del Sur SA	90

So far, firm interest has been shown by major utilities such as British Gas, Gaz de France, Electricité de France, various members of the ENI group, Catalana de Gas and a number of large

Argentine conglomerates, such as Perez Companc. Interestingly, already partly-privatised firms such as electricity utility Eseba are now spreading their wings and bidding for interests far removed from their traditional areas and sectors of operation. And a number of joint ventures are being set up, with names new to the industry but with backers long established. Bridas, for example, has set up Rio Colorado as a bidder, and is seeking foreign partners from the United States and Italy.

Of the 10 new firms, two are transmission businesses, the rest distributors. Bidders will not be allowed to take on more than one trunk-line company, nor more than two distributors. And whoever takes over the transmission companies will be ruled out from bidding for any distributor. In addition, the three most significant distributors — Metropolitana, Buenos Aires Norte, and Pampeana — must go to separate bidders. On top of that, gas producers will not be allowed to hold majority stakes in either transmission or distribution companies. In other words, the government aims to get away entirely from a gas monopoly, whether state-owned or private.

Another condition concerns prices, which the government will set for at least two years after privatisation. Domestic prices will rise some 7.5 percent from January, to $2.50/MMBtu, while industry will pay around 15 percent less than at present, at just over $2.00/MMBtu. Further provision against exploitation of local monopoly will stem from the retained state equity interest, though in the case of Cuyana, this interest is being transferred to the provincial government, an arrangement that could be followed elsewhere.

Downstream oil quandaries

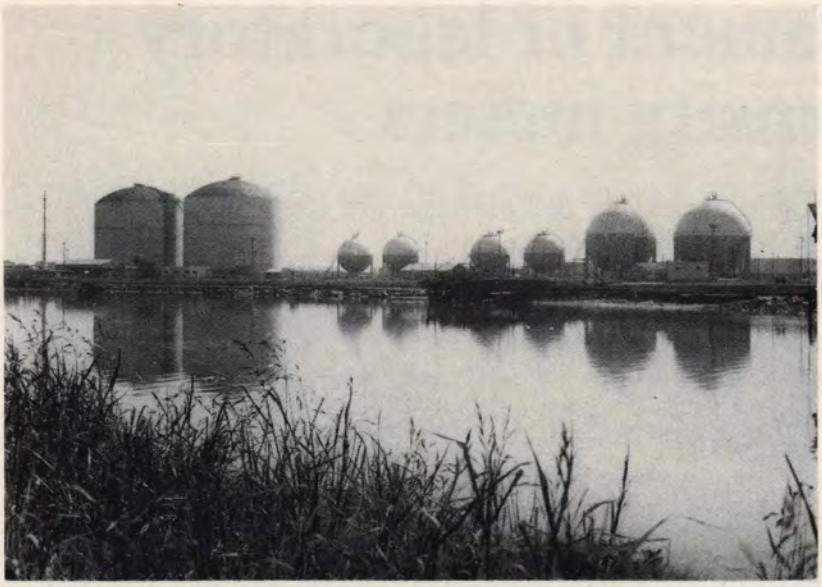
The situation with regard to YPF is very different, in that it does not operate simply in one clear-cut sector like GdE. Ultimately, the government's aim is the creation of an integrated, private-sector, oil company much on the lines of the international majors. To that end, much of the uneconomic and/or capital-intensive upstream operations have been hived off, and the same can now be expected downstream. As yet, however, no clear-cut plan has been developed, except that YPF has already been reconstituted such that 51 percent of its shares are now held by the federal government, 39 percent by provincial governments and 10 percent by employees. Starting next January, tranches of shares will be offered to the public, both locally and abroad. Ultimately 51 percent of current holdings will be sold off but the plan still awaits parliamentary approval.

Gas processing plant at Pico Truncado, Santa Cruz Province.

Assets likely to be sold out of YPF control include its tanker fleet and stakes in many of its pipelines. And much of the filling-station network will be hived off, by franchising. In May, the government chose financial advisers Infupa, Price Waterhouse and Entrepreneurs SA to devise the best way to handle this. Retail sales total some $3 billion/year, just 37.5 percent of the sales target for the new streamlined YPF of $8 billion/year.

It is the refining sector that, currently, remains most hazy. So far, plans exist only for the sale of Campo Duran refinery, way up in Salta Province near the Bolivian border. Stakes in YPF's oilfields in the area have been offered to the private sector, with downstream interests included since this area is remote from most Argentine operations. It operates in effect as a mini-integrated unit. So, besides the 30,000-b/d refinery, the sale will include the NGL-extraction plants, handling 600 MMcfd, and a 1,000-km products pipeline network. Whether YPF remains as operator is yet to be decided.

Last year it was estimated, by private operator Astra, that YPF had 62 percent of the downstream market, followed by Shell with 15 percent and Esso with 13 percent. Local firms Isaura, Puma and Astra shared the remaining 9 percent. By yearend, spurred by deregulation and a lot of investment, Shell reckoned its share was climbing with 20 percent of the gasoline market and 29 percent of Argentina's lubes business. Having its own refinery, Shell is in a better position than most but is not resting on its laurels. A $27-million investment in new harbour facilities was completed



Dock Sud storage complex in Buenos Aires province.

in Buenos Aires late in 1991, while $30 million/year have been earmarked over the next five years for upgrading the retail network. A further $30 million will go on a new lubes-blending plant.

Piecemeal disposal

How much more the foreign majors, and local minnows, can penetrate YPF's hold on the retail market depends partly on whether other YPF refineries are sold. Plans do exist for some disposals but these are mixed in with the privatisation of other huge chunks of Argentine industry. Parliament has yet to pronounce on the matter but just setting out a timetable will be hard work. If too fast a pace is set, both local and international financial markets could suffer from severe indigestion.

So, refining sell-offs are more likely to follow the pattern set for petrochemicals. There, most plants started out as joint ventures, with state interests dominating. Gradually, the state's share has been sold to existing or new partners, thus avoiding financing problems. This route also extends goodwill, since YPF or GdE have of necessity continued as feedstock suppliers. Clearly, however much of YPF is sold, the company will long remain the dominant force in Argentina. So, until newcomers operate all the way from wellhead to gasoline pump, YPF will have to be called upon at some stage. That suggests that a smooth transition to a multi-company private-sector oil and gas industry is virtually certain: it really would not help anybody if hostilities broke out. ■

An assessment of laboratory density meters

By H and D Fitzgerald, H & D Fitzgerald Ltd,
and G Jones, SGS Redwood Ltd.

Many thousands of liquid density determinations are made worldwide every day and substantial sums of money depend upon the outcome. Although at one time, a wide variety of methods were employed, most laboratories now use either hydrometers or density meters.

Hydrometry has been used for many years and the uncertainties associated with it are reasonably well understood, if often appreciably underestimated. Laboratory density meters have been developed from the work of Stabinger et al. [1967] and use a miniature U shaped tube of glass as a measurement cell. The oscillating period of the cell is a function of the density of the liquid injected into it. About 20,000 bench top and 10,000 portable instruments are installed worldwide and since the majority of these are manufactured by Anton Paar K.G. of Austria, it is their machines which have been assessed.

Several papers have already been published on the effect of viscosity on the Paar instruments but unfortunately, most used aqueous sugar or glycerol solutions, giving a very tight correlation of density to viscosity, and as far as is known, few if any had access to a hydrostatic weighing system, and so needed to determine the density of viscous liquids by pyknometry, no easy task. No previous publications have been identified covering cell linearity or calibration.

H & D Fitzgerald Ltd developed a hydrostatic weighing system with an uncertainty of ± 0.01 kg m^{-3} at the 95 percent confidence level for which they hold NAMAS accreditation from NPL. Liquids calibrated by this system were used to assess three of the most popular instruments in the current Paar range, the DMA 48 which indicates density to 0.1 kg m^{-3} the DMA 58 (0.01 kg m^{-3}), and the portable DMA 35 (1 kg m^{-3}). In addition, a DMA 55 (0.01 kg m^{-3}), a type no longer manufactured, was tested since its cell temperature is controlled by use of an external water bath, and it uses the same cell design as the instruments used by National Bureau of Standards (now NIST) Whetstone et al [1978] to gather the experimental data upon which the current Petroleum Measurement Tables are based.

All viscosities were measured by SGS Redwood Ltd, a NAMAS accredited testing laboratory, using IP 71 with an uncertainty of ± 0.4 percent of quoted viscosity at the 95 percent level.

Cell temperature

Table 1 shows $\delta\rho/\delta t$, the change in density per degree at 20°C, and $\delta t/\delta\rho$, the temperature change causing a density shift of 0·1 kg m^{-3} for a number of liquids. If density is to be determined with an uncertainty of ± 0.1 kg m^{-3}, cell temperature must be known with an uncertainty no greater than about half the $\delta t/\delta\rho$ figure, to allow for a contribution from cell calibration errors. For a typical oil or product this equates to about ± 70 mK.

In all the bench top instruments, the oscillating tube is inside a low pressure hydrogen jacket. In most early models, including the DMA 55, cell temperature was maintained by surrounding this with an outer jacket through which water could be pumped, in newer instruments such as the DMA 48 and 58, the hydrogen jacket is surrounded by a metal block equipped with an internal Peltier temperature control system. The oscillator feeds 50 to 100 mW continuously into the cell, most of which appears as heat in the cell walls and the 0.7 ml of sample. The hydrogen therefore also serves to maintain sample temperature in equilibrium with the water jacket or Peltier block.

The classic method of measuring cell temperature is to insert a thermometer into the cell thermowell. The difference between the average of the inlet and outlet water temperatures in a DMA 55 and that indicated by a miniature 25Ω platinum resistance thermometer in the thermowell is shown in **Table 2**.

When a four-wire miniature platinum resistance thermometer was

	A $\delta\rho/\delta\tau$ kg $m^{-3}K^{-1}$	B $\delta\tau/\delta\rho$ K (0.1 kg m^{-3})$^{-1}$
Water	0.21	0.48
2,2,4 trimethylpentane	0.82	0.12
Petrol	0.92	0.11
Kerosine	0.74	0.14
Crude oil (840 kg/m^3)	0.73	0.14
Lube oil (110 cSt @40°C)	0.62	0.16
40% aqueous ethanol	0.70	0.14
Trichlorotrifluoroethane	2.33	0.04

Table 1: Typical coefficients of thermal expansion

Average water temperature °C	*Thermowell temperature* °C	*Best fit temp using liquids* °C	*Liquids s.d. of residuals* kg m^{-3}
14.95	14.95	14.95	0.002
14.97	14.96	14.97	0.009
20.03	20.02	20.00	0.003
50.29	50.00	50.27	0.009

Table 2: DMA 55 cell temperatures

inserted into the cell bore using a light oil to provide thermal continuity with the cell wall, indicated temperature was somewhat lower when the oil in the cell was pumped by syringe very slowly past the probe and out of the cell, and it therefore seemed possible that indicated temperature was being influenced by heat transfer along the probe leads from outside the instrument. Smaller changes were seen when the test was repeated using a two wire thermistor sensor coupled to a Paar DT 100 thermometer and since the four leads on the platinum resistance thermometer had a much greater cross section area than the two on the thermistor probe, this appeared a reasonable supposition. As a further check, the end of the cell was insulated and the probe cable heated; indicated cell temperature rose appreciably within a short time. Tests using a very small thermistor probe suggested that temperature gradients normally exist in the cell both from front to back and from the open end to the closed end.

Since knowledge of the liquid temperature is all important when measuring density, a technique was therefore developed in which a variety of liquids for which the density/temperature relationship had already been determined by hydrostatic weighing, were injected into the instrument and cell oscillation period, τ, noted, along with average water temperature. In theory, density is proportional to τ^2, and a computer routine was developed to determine at what temperature τ^2 best represented the hydrostatic weighing densities. This method appears to work well, and has an estimated 95 percent uncertainty of $\pm$10 mK.

Table 2 shows the results for a DMA 55; **Table 3** for a DMA 58, and **Table 4** for a DMA 48.

The DMA 58 displays cell temperature with a readability of 10 mK, using a thermistor probe in a cell thermowell. The probe can be removed for calibration and the one checked in this exercise was found to have a maximum error between 10 and 70°C of only 10 mK, with an average error of about 5 mK. Although the probe is not used to control cell temperature, it suggests that the quality of the control system is good, since the maximum observed differential between set point and indicated temperature was no greater than 10 mK over the range of 10 to 50°C.

Although cell block temperature is displayed on the front panel of the DMA 48, the design unfortunately makes no provision for its direct measurement. A resistance thermometer inserted into the cell bore of a DMA 48 indicated that when the cell light was on, cell temperature increased by about 50 mK. Although the instrument manual stresses that the light should be off before the density is read, the 48 and 58 have a relatively narrow angle for viewing the cell, and it is therefore felt desirable that the design be modified so that, as in the older 55, the displayed density flashes if the light has been inadvertently left on.

The repeatability and stability of cell temperature in two DMA 48s at a set point of 20°C was examined. The cell was filled with trichlorotrifluoroethane (Freon TF), and after the period had stabilised the set point was briefly changed to mimic the injection of a hot or cold sample and then reset to 20°C. The period was noted once it had restabilised and cell temperature changes calculated from changes in the indicated density of the Freon. Over three to four hours variations of about $\pm$25 mK were seen for one machine and $\pm$35 mK for the other. Over several days, the variations were $\pm$65 mK for the latter instrument. Freon was used since it has an exceptionally high value for $\delta\rho/\delta t$ at 2.34 kg m^{-3} K^{-1}.

A DMA 58 was found to take several days to temperature stabilise after first being switched on; it is recommended that if possible instruments are left running continuously. Glass cells take some time to settle after the set temperature has been changed. Once the instrument is indicating that the cell is at its new set-point, a DMA 48 takes a minimum of two minutes per degree of change, before the cell is properly equilibrated at the new temperature, and a DMA 58 fifteen minutes per degree.

The DMA 35 has a built-in thermometer displaying to $\pm$100 mK. Several of these were tested, by passing water of a known temperature through the cell and noting the displayed temperature. In the range from 10 to 35°C the maximum error in indicated temperature was 0·2°C, although this increased to 0.3°C if the instrument was held in the hand for an extended period. Since the density is only displayed to the nearest 1 kg m^{-3}, this error is insignificant.

The assessment was carried out in an air conditioned laboratory held at 20°C $\pm$ 0·6°. The miniature resistance thermometers used were calibrated against a 25Ω platinum resistance thermometer which had previously been certified by NPL. Once errors due to self-heating had been accounted for, they had an estimated uncertainty of $\pm$4mK (0.004°C).

Linearity

As mentioned above, a technique was developed to determine cell temperature using liquids which had been calibrated in the hydrostatic weighing system and then determining mathematically the temperature at which the calibrated densities gave the best fit to τ^2. Five liquids were normally used, 2,2,4-trimethylpentane 692 kg m^{-3}, cyclohexane 780 kg m^{-3}, water, dichloromethane 1323 kg m^{-3} and Freon TF 1575 kg m^{-3}. These liquids were chosen since they covered the density range of interest to most

laboratories, were of low viscosity and had a wide range of thermal expansion coefficients from 0·22 kg $m^{-3}K^{-1}$ for water to 2.3 kg $m^{-3}K^{-1}$ for Freon.

Tables 2 to 4 show that once viscosity corrections had been applied, the standard deviation of the residuals after fitting to τ^2 was typically <0.01 kg m^{-3}, even for a DMA 48. For none of the instruments tested was advantage normally found in fitting to any function other than τ^2, and the residual standard deviations for the shorter density range of cyclohexane to dichloromethane were normally no improvement over those for the full range. Fitting τ^2 to the densities at the nominal cell temperature gave worse residual standard deviations than at the best fit temperature, without apparently introducing any pattern into the residuals. This is taken to indicate that τ^2 is a linear function of density over the range 690 to 1575 kg m^{-3} and that the cell is almost certainly operating at the best fit rather than the nominal temperature. It also suggests that it should be possible reliably to establish both the cell constants and the cell temperature by use of water and a minimum of two calibration liquids, preferably of densities about 1000 kg m^{-3} apart.

Viscosity effects

Almost every vibrating tube density meter is sensitive to sample viscosity to some extent and the Paar range are no exception. In the earlier instruments such as the DMA 55, the viscosity dependent error is a relatively simple function of sample viscosity (see **Figure 1**), while in the later DMA 48 and 58, a facility exists to switch *viscosity compensation* on or off. When this is turned off, the error curve is similar in form to that of the DMA 55, with it on however, the curve becomes more complex. **Figure 2** shows both curves for a DMA 48. We understand from the manufacturer that the intention was to modify the cell response so that the viscosity error for liquids of less than 100 mPa-s was no greater than the specified precision of the cell when used with low viscosity liquids. The price to be paid, would be a steeper error curve above 100 mPa-s. In practice, possibly due to incorrect adjustment, most of the instruments studied had a minimum in the correction curve at about 15 mPa-s which could be down to -0.3 kg m^{-3} in a DMA 48 and $-0{\cdot}12$ kg m^{-3} in a DMA 58.

Irrespective of whether viscosity compensation was switched on or off, or of instrument model, the error for liquids between 800 and 4000 mPa-s appears to change little with viscosity.

Machine id ♯	*Indicated temperature °C*	*Best fit temp using liquids °C*	*Liquids s.d. of residuals kg m^{-3}*
18	15.00	14.98	0.007
18	20.00	20.01	0.003
12	15.00	15.02	0.002
12	20.00	20.01	0.003
14	15.00	15.02	0.006
14	20.00	20.02	0.0003
16	15.00	15.02	0.003
16	20.00	20.04	0.003

Table 3: DMA 58 cell temperatures

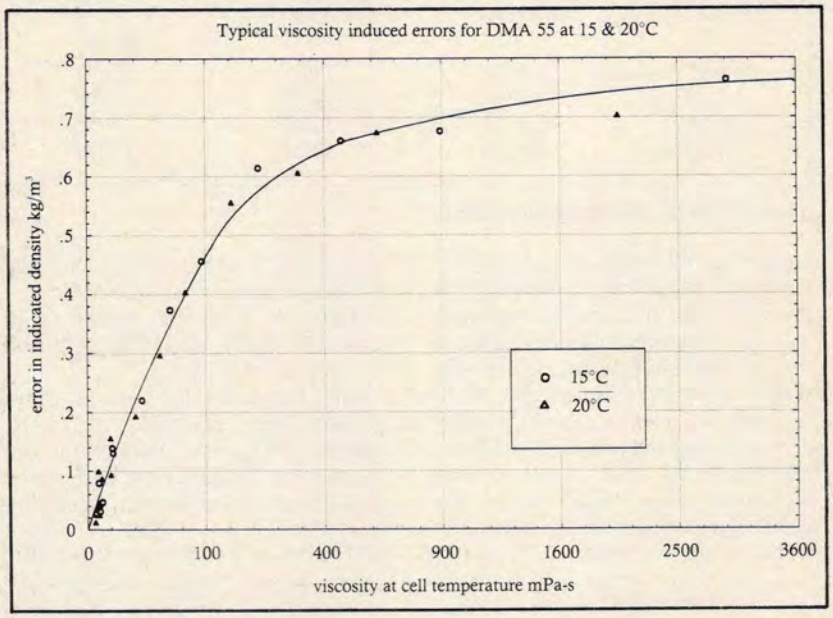


Figure 1

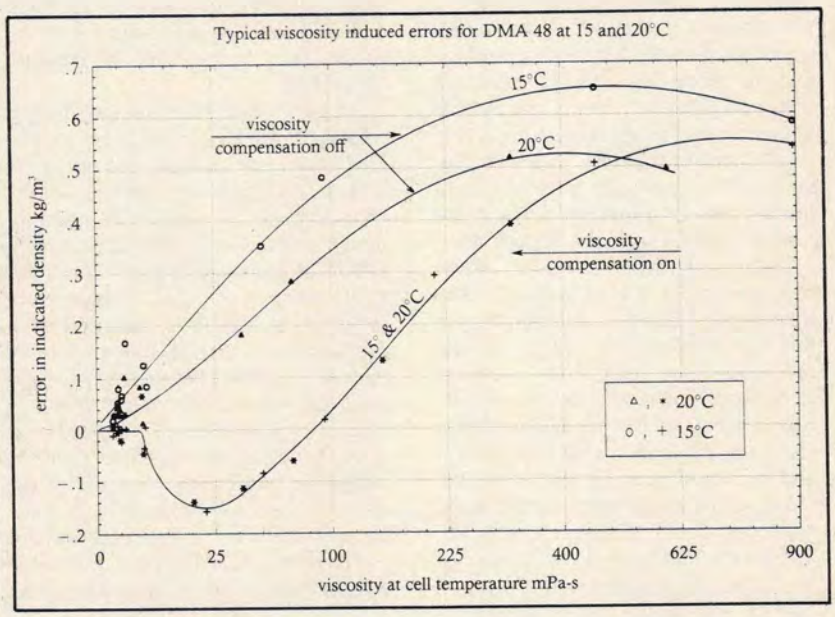


Figure 2

Machine id #	*Indicated temperature °C*	*Best fit temp using liquids °C*	*Liquids s.d. of residuals kg m^{-3}*
3	15.00	14.99	0.017
3	20.00	19.95	0.011
3	20.20	20.14	0.002
9	15.00	15.34	0.0004
9	20.00	20.33	0.002

Table 4: DMA 48 cell temperatures

Some of the experimental data suggested that viscosity dependent errors for certain low viscosity liquids might not lie quite on the normal error/viscosity curve, but there is at present insufficient data to assert this with any confidence.

Dr H Stabinger, one of the original patent holders for this type of cell, has suggested in discussion that over the normal working temperature range, the viscosity effects should depend purely on the sample viscosity at cell temperature. Although this appears to be the case for the DMA 55 and 58, it is probably not quite so for the DMA 48, where for several instruments the errors for a given viscosity are smaller at 20°C than at 15°C. The reason for this is not clear, but may be due to the characteristics of the glass cell wall changing with temperature.

Figure 3 shows the combined 15°C and 20°C curves for a DMA 58 for both viscosity compensation on and off.

Table 5 shows the viscosity correction terms for the instruments tested, where $\delta\rho$ is the error in kg m^{-3} by which a meter will overestimate density due to sample viscosity. It should therefore be subtracted from the indicated density to find the true density. The corrections for different instruments of the same model were effectively identical and appeared to be independent of cell ageing. Provided that the corrections given in **Table 5** are applied, it is estimated that the residual viscosity induced error in the corrected reading is unlikely to be more than twice the standard deviation quoted in the table.

In all models which have it, the viscosity compensation facility is switched on before the instrument leaves the factory and can only be altered as the machine is reset. Unfortunately, only the very latest instruments have a (undocumented) software facility to establish the current setting through keyboard interrogation, and this is felt to be unacceptable in a machine used for

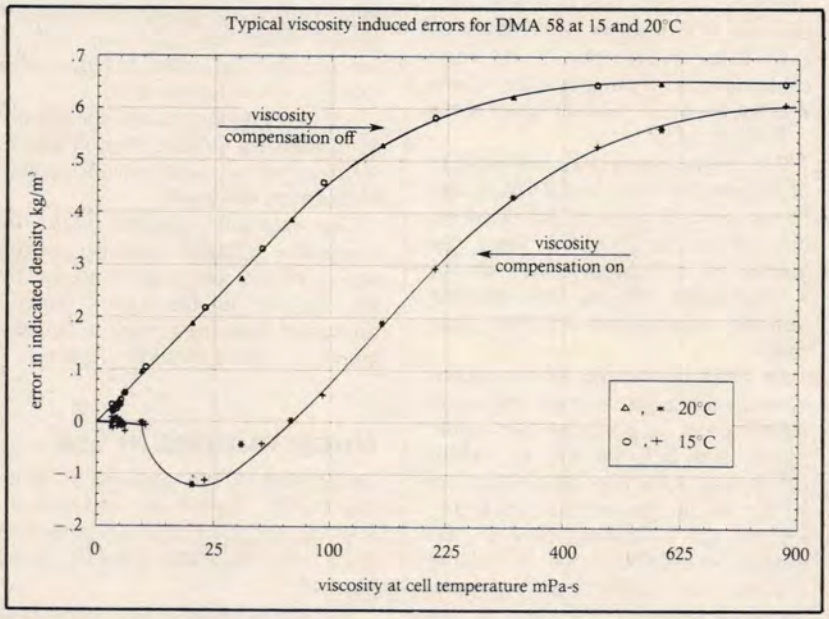


Figure 3

$\delta\rho$ is the amount in kg m^{-3} by which a meter will overestimate density due to sample viscosity. It should therefore be subtracted from the indicated density to find the true liquid density.

DMA 58 at 15 and 20°C,		
$0 > \eta < 100$ mPa-s	$\delta\rho = -0.007 + 0.048\sqrt{\eta}$	residual s.d. 0.010 kg m^{-3}
$0 > \eta < 1000$ mPa-s	$\delta\rho = -0.018 + 0.058\sqrt{\eta} - 0.001\,24\eta$	residual s.d. 0.014 kg m^{-3}
DMA 48 at 15°C,		
$0 > \eta < 100$ mPa-s	$\delta\rho = -0.003 + 0.05\sqrt{\eta}$	residual s.d. 0.01 kg m^{-3}
$0 > \eta < 1000$ mPa-s	$\delta\rho = -0.01 + 0.063\sqrt{\eta} - 0.001\,43\eta$	residual s.d. 0.01 kg m^{-3}
DMA 48 at 20°C,		
$0 > \eta < 100$ mPa-s	$\delta\rho = -0.01 + 0.033\sqrt{\eta}$	residual s.d. 0.02 kg m^{-3}
$0 > \eta < 1000$ mPa-s	$\delta\rho = -0.02 + 0.044\sqrt{\eta} - 0.000\,92\eta$	residual s.d. 0.03 kg m^{-3}
DMA 55 at 15 and 20°C,		
$0 > \eta < 100$ mPa-s	$\delta\rho = -0.008 + 0.050\sqrt{\eta}$	residual s.d. 0.014 kg m^{-3}
$0 > \eta < 1000$ mPa-s	$\delta\rho = -0.016 + 0.060\sqrt{\eta} - 0.001\,26\eta$	residual s.d. 0.020 kg m^{-3}

Table 5: Viscosity correction terms

fiscal puposes. Twice during these trials, being unaware of the interrogation facility, it only became obvious that the correction facility in a DMA 58 had not switched correctly when the data from a series of standards was plotted.

Calibration

Although all models other than the DMA 35 have a facility to allow them to be calibrated with two liquids, the manufacturer recommends that the instruments be calibrated with air and water, the resultant errors in displayed density are shown in **Table 6**. The only comparable value identified in the literature can be calculated from data given in Whetstone et al. [1978] in an early Paar, where using air and water calibration the error shown for xylene $\rho \approx 867$ kg m^{-3} would have been $+0.05$ kg m^{-3}.

The errors appear to be independent of temperature for the DMA 48 and 58, at normal working temperatures but not for the DMA 55. They also appear to be characteristic of the machine type, varying little between different instruments of the same model.

In addition to the errors shown above, calibrating with air and water places great reliance on the water figure, and little on the air, whilst calibrating with two liquids, one of which would presumably be water, spreads the weighting more or less evenly between the two. It is also possible, by calibrating with two liquids of similar viscosity to the samples normally tested, to cancel out the viscosity dependent errors in the instrument during the calibration.

In view of the uncertainties introduced by using only air and water, it is very doubtful that a machine so calibrated could be regarded as traceably calibrated for fiscal purposes.

The DMA 35 which can only be calibrated by the user with one liquid, normally water, displayed the correct density ± 1 kg m^{-3} over the entire density range. With sample viscosities below ≈ 350 mPa-s, no viscosity dependent errors were seen, above that, the maximum error appeared to be 1 kg m^{-3}.

Additional tests

The density calculation algorithms in the DMA 48 and DMA 58 appear to be correct, as do the internal tables of air and water density.

Reducing the supply voltage by 6 percent appeared to have no effect on machine performance.

model	*at 650 kg m^{-3}*	*at 1600 kg m^{-3}*
DMA 48	-0.1 kg m^{-3}	$+0.2$ kg m^{-3}
DMA 58	$+0.05$ kg m^{-3}	-0.08 kg m^{-3}
DMA 55 @ 15°C	$+0.08$ kg m^{-3}	-0.14 kg m^{-3}
DMA 55 @ 20°C	-0.11 kg m^{-3}	$+0.11$ kg m^{-3}

Table 6: Errors due to calibrating with air and water

If a DMA 48 or 58 is tilted, the displayed period starts to change at 3° and the density at 4.5°. It is therefore important that a densitometer installed in a mobile laboratory be calibrated immediately prior to use.

In a DMA 48, variation in atmospheric pressure between 920 and 1050 mbar caused no change in displayed period when the cell was full of air, beyond that commensurate with changes in the density of air.

Although no tests aimed specifically at looking for surface tension effects were carried out, no errors attributable to this were observed.

The manuals supplied with the machines probably contain all the necessary data likely to be needed by the operator but the layout, illustrations, and indexing are felt to be poor and the manuals should be rewritten.

Uncertainties in use

In the light of this assessment, what uncertainty should be attached to densities determined at a nominal 15 or 20°C by a laboratory following good practice?

The repeatability of the instruments is normally excellent, although duplicate injections should always be made to check for inconsistency due to the presence of bubbles in the cell.

Assuming that:—

a The cell is clean and cleanliness is monitored by checking the air period.
b Syringes, autosampler lines and other sample handling equipment are clean.
c Cell temperature is stable.
d The cell has been traceably calibrated using two liquids with densities known to 0.01 kg m^{-3}, which bracket the sample density. Calibrations should be carried out:—
   After disturbing the cell by maintenance,
   After disturbing the cell by inserting or removing a thermometer in the thermowell,
   After resiting a machine if there is any possibility of it being at a different angle to the horizontal,
   If calibration has not been carried out at this temperature within the last month,
   After changing cell temperature (0.01 kg m^{-3} instruments)
e Sample viscosity is below 1000 mPa-s and is known to $\pm 25\%$ for a 0.1 kg m^{-3} instrument or $\pm 10\%$ for a 0.01 kg m^{-3} instrument.

The density determined by a DMA 48 after applying the viscosity correction given in **Table 5** will probably be within ± 0.25 kg m^{-3} of the true value and by a DMA 58 within ± 0.05 kg m^{-3}. These figures can both be substantially improved upon if sample viscosities are known with greater precision, actual cell temperature has been determined using calibration liquids and the viscosity error curve has been determined for that particular instrument.

For comparison, if the IP 160 hydrometer method is followed using a traceably calibrated L50, and no losses of light components occur from the sample:—

a Hydrometer calibration 0.15 kg m^{-3}
b Surface tension known to ± 5 mN m^{-1} 0.15 kg m^{-3}
c Temperature known to ± 250 mK (0.25°C) 0.20 kg m^{-3}
d Repeatability of reading the hydrometer 0.15 kg m^{-3}

The total uncertainty in hydrometer density will be about ± 0.6 kg m^{-3}. When handling volatile samples such as road fuels or crude oils, an uncertainty of ± 1.1 kg m^{-3} is probably the best which can be achieved using this type of hydrometer.

Conclusions

It is suggested that the DMA 48 is operated with viscosity compensation switched on and a correction applied for samples of more than 100 mPa-s. The operator of the DMA 58, who is presumed to use it because of the need for higher precision densities, has a more difficult choice to make, since small viscosity changes can lead to relatively substantial errors. Even a low viscosity sample such as Derv of 4 mPa-s has an error of 0.09 kg m^{-3}. The difference in displayed densities with viscosity compensation on and off

will actually be slightly larger, since when it is on, the error in displayed density will be negative at this viscosity.

If a DMA 58 is to be used for fiscal or high precision purposes, it is recommended that the compensation be turned off and a standard correction applied to the displayed density using one of the terms in **Table 5**. For all fiscal work or measurement requiring proven traceability, four and five place machines should be calibrated using two liquids rather than with one liquid and air, and, if the internal cell temperature indicator is being relied upon, it should be independently checked annually. The air period should be monitored regularly and used as an indicator of cell cleanliness. ■

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Acknowledgements

The authors would like to thank Dr H Stabinger, Paar Scientific Ltd, Mrs S Lewis, Dr K Sommer and Mr J R Whetstone for their help. The work was financially assisted in part by a grant from the Institute of Petroleum.

IP Information Service News

Desk research

Do you need to research a subject related to the petroleum industry? For instance, has your boss just asked you how much petrol was sold in each EEC country over the last 10 years? Or the pump price of petrol in Birmingham each month for the last five years? Or a breakdown of the energy consumption of Luxembourg since 1980? Or do you want to know what is happening to the upstream oil industry in Indonesia?

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IFEG

The annual AGM and Wine and Cheese Party will be held on 10 December. We invite all members and potential members to attend. To commence the evening Dr Stewart Brown, Director of Geoscience at the Petroleum Science and Technology Centre, Edinburgh, will give a talk about the work of the centre.

Invitations will be sent to all IFEG members but if you would like to reserve a place or require further information about this event or IFEG in general, please contact Catherine Cosgrove, IFEG Secretary, on 071-636 1004 x210.

Selected additions to Library stock

Directories and bibliographies

North Sea Oil and Gas Directory 1992/93. Tonbridge, Benn Business Information Services Ltd, 1992.

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The Institute of Petroleum

OIL SUPPLY AND PRICE SCENARIOS FOR 1993

Wednesday 18 November 1992

To be held at

The Cavendish Conference Centre, London

The oil industry faces a further period of considerable economic and political uncertainty in 1993. Economic recovery is likely to be weak and may be jeopardised by problems in the structure of the international banking and economic system. Political events worldwide will add to the uncertainty.

The Institute of Petroleum has organised this Conference to provide management and their planning advisers with an opportunity to hear a range of informed views on some of the economic and political factors which will influence the oil market and oil prices in 1993.

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8 December: 'Pipe Freezing Techniques', M Jepp, CCT.

Essex
11 November: Ladies evening 'Bread and cake making', J Scott, Bakery Manager, ASDA Stores Ltd.
1993
13 January: 'The safety consultant — a necessary evil or an evil necessity', R Turner, Consultant, RT (Health and Safety) Associates.

Humber
26 November: 'Installation of the living quarters on Conoco's BA platform', J Tonge, Conoco UK Limited.
1993
21 January: 'The Killingholme Powergen CCGT Powerstation', G Miles, General Manager, Powergen.

Irish
12 November: Annual Dinner

London
10 November: 'I am/was a graduate', P Gaffney, Gaffney Cline and Associates.
1993
19 January: 'European unity — a time for change and challenge', J Dean, Shell UK Downstream Oil.

Midlands
11 November: 'Background and Implementation of BS7750 Environmental Standard', presentation by BSI.
9 December: Social Event.

North-East
2 December: Presentation by Halliburton Ltd.
1993
26 January: 'Cleveland County Emergency Plan', P Taylor, County Emergency Planning Officer.

Shetland
13 November: Annual Dinner.
1993
9 February: AGM.

South Wales
19 November: 'Explosives awareness', K Callaghan, Ministry of Defence.
1993
19 January: 'Lube oil developments in the future', T Stribley, BP.

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10 November: 'Environmentally Friendly Lubricants', RJC Biggin and AR Barber, Lubrizol Ltd.
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Mr SM Mitchell, Indeva Energy Consultants Ltd, Hill Samuel House, 2 Thames Avenue, Windsor, Berks SL4 3RY.
Mr WJ Morgan, Graham Miller & Co Ltd, 228/9 Shoreditch High Street, London E1 6PJ.
Mr AS Mu'azu, NNPC Pipelines & Product Marketing Co, PMB 2293, Kachia Road, Kaduna, Nigeria.

Institute News

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Mrs NG Nwokedi, NNPC/NAPIMS, 1637 Adetokinboh Ademola, Victoria Island, Lagos, Nigeria.
Mr KJ O'Brien, Corporate Services, Electricity Supply Board, Lower Fitzwilliam St, Dublin 2, Ireland.
Miss N Ogba, NNPC, 7 Kofo Abayomi Street, Victoria Island, Lagos, Nigeria.
Mr A Ogunbiya, NNPC, 7 Kofo Abayomi Street, PMB 12701, Victoria Island, Lagos, Nigeria.
Mr GC Okonkwo, Nigerian National Petroleum Corporation, Carrier House 1–9 Warwick Row, London SW1E 5ER.
Mr JO Olabisi, NNPC, 7 Kofo Abayomi Street, PMB 12701, Lagos, Nigeria.
Mr SO Otitoola, NNPC-NPDC, NPDC Ltd, PMB 1262, Benin City, Nigeria.
Mr SS Otusemade, NNPC, 7 Kofoabayomi Street, Victoria Island, Lagos, Nigeria.
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Mr RM Powrie, Teasels, The Ridge, Winchelsea Beach, Winchelsea, East Sussex TN36 4LT.
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Captain UB Raj, SGS India Private Ltd, 304–305 Anna Salai, Madras 600 018, India.
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Mr M Rigas, 2 Kendrick Place, London SW7 3HF.
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Mr ADR Roberts, National Eng & Tech Co Ltd, NNPC/Bechtel Overseas, Stallion House, PO Box 74173, Lagos Nigeria.
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Mr RG Winter, Fluor Daniel Ltd, Watchmoor Park, Riverside Way, Camberley, Surrey GU15 3AQ.
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Student Prize Winner

Mr A Caruana, St Martha, Old Railway Track, Attard, Malta

Students

Mr E Ajaj, 25 Marston Ferry Court, Summertown, Oxford OX2 7XH.
Mr I Al Ajlan, 20 Bishop Court, John Garne Way, Oxford OX3 0TU.
Mr S Alkhayyal, 5 Woodmen Court, Cross Street, St Clements, Oxford OX4 1BZ.
Mr A Al Sabti, 12 Dunstan Road, Old Headington, Oxford OX9 3BY.
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Mr H Jamalal-Lail, College of Petroleum Studies, Sun Alliance House, New Inn Hall Street, Oxford OX1 2QD.
Mr I Karboji, 85 Green Road, Risinghurst, Headington, Oxford OX3 8LD.
Mr SP McGinnis, 39 Cupar Road, Newport on Tay, Dundee DD6 8DF.
Mr M-S Sarawak, 69 Green Ridges, Headington, Oxford OX3 9PL.
Mr E Takrouni, 2 Bishop Court, John Garne Way, Oxford OX3 0TU.

UK Deliveries into Consumption

August 1992 — Tonnes

Products	*Aug 1991†*	*Aug 1992**	*Jan–Aug 1991†*	*Jan–Aug 1992**	*% change*
Naphtha/LDF	207,919	271,871	2,241,670	2,179,496	−3
ATF—Kerosine	636,490	685,127	4,039,126	4,512,389	12
Motor Spirit	2,099,999	1,949,144	15,985,325	15,866,791	−1
of which unleaded	871,396	921,193	6,419,399	7,278,841	13
Super unleaded	104,381	118,547	754,399	917,733	22
Premium unleaded	767,015	802,646	5,665,000	6,361,108	12
Burning Oil	130,879	134,366	1,501,362	1,494,996	0
Derv Fuel	867,849	858,474	7,046,513	7,238,481	3
Gas/Diesel Oil	605,504	542,840	5,338,703	5,101,407	−4
Fuel Oil	1,073,005	796,718	8,261,367	7,425,767	−10
Lubricating Oil	58,405	60,645	506,794	532,098	5
Other Products	669,764	518,694	4,791,328	4,521,544	−6
Total above	6,349,814	5,817,879	49,712,188	48,872,969	−2
Refinery Consumption	525,304	529,412	4,027,631	4,014,718	0
Total all products	6,875,118	6,347,291	53,739,819	52,887,687	−2

†Revised with adjustments *Preliminary n/a Not Available

. . . publications

General

The Art of the Long View. P Schwartz (Century Business, 1992). ISBN 0 7126 9831 0, pp258, £16.99.

Peter Schwartz, a leading futurologist, describes the new techniques, originally developed within Royal Dutch/Shell, for building scenarios. These have become increasingly powerful tools for developing strategic vision within businesses and helping individuals select their own paths into the future. The book explains how companies can think creatively and systematically about the future business environment and reduce their vulnerability to the shocks and surprises that can overwhelm their plans.

The Golden Century of Oil 1950–2050 — The Depletion of a Resource. C J Campbell (Kluwer Academic Publishers, 1991). ISBN 0 7923 1442 5, pp345.

The majority of the oil found in recent times has been in a small number of giant fields. The pool of giants has all but dried up, according to Mr Campbell, and production must soon decline as the resources are depleted. His book is an opinion on the situation, discussing exploration, in non-technical terms, resource definition, the data-base, as well as political and other pressures. It contains information on all producing countries and on analysis of trends and methodology.

Pipelines

Performance of oil industry cross-country pipelines in western Europe 1990. (CONCAWE Report Number 4/91, 1991), pp16.

This report is the latest in a series of annual reports issued by CONCAWE reviewing the performance of oil industry cross-country pipelines in western Europe. It covers an oil pipeline network of 19,350 km and analyses reported spillage incidents by cause and effectiveness of clean-up.

Pipeline Pigging Technology. 2nd Edition edited by J N H Tiratsoo (Scientific Surveys Ltd and Gulf Publishing Inc, 1991). ISBN 0 901360 24 4, pp459, £58.50.

The book brings together 33 technical papers from recent conferences in the United States and Europe, which provide answers to many of the most frequently asked questions on problems associated with the pigging and pipeline inspection technology applied to oil, gas and products pipelines, both on- and offshore.

Oil Recovery

The Mathematics of Oil Recovery. Edited by P R King (Clarendon Press, 1992). ISBN 0 19 853645 3, pp836, £95.

The conference on which this book is based was the first in a series of European meetings on the mathematical aspects of oil recovery problems. It concentrated on three main themes: the statistical description of porous media and geological environments at various length scales; the derivation of appropriate, spatially averaged equations for multiphase displacement processes; the solution of the resulting equations by numerical methods.

Taxation

UK oil taxation: abandonment supplement. (Arthur Andersen, 1992), pp11.

The 1990 edition of *UK oil taxation* described oil industry concerns over the adequacy of existing reliefs for abandonment costs. This supplement outlines the Government response to those concerns, by way of legislation in Finance Acts 1990 and 1991. It should be read in conjunction with the original guide.

Guide to European oil taxation. (Arthur Andersen, 1992), pp30.

A guide to oil taxation in Denmark, France, Germany, Ireland, Italy, The Netherlands, Norway, Portugal, Spain and the United Kingdom.

Geology

Carbonate reservoir characterisation: a geologic-engineering analysis, part 1. G V Chilingarian, S J Mazzullo and H H Rieke (Elsevier Science Publishers, 1992). ISBN 0 444 88849 7, pp639, $179.50.

This book integrates those critical geologic aspects of reservoir formation and occurrence with engineering aspects of reservoirs, and presents a comprehensive treatment of the geometry, porosity and permeability evolution and producing characteristics of carbonate reservoirs.

Thermal Properties and Temperature-Related Behaviour of Rock/Fluid Systems. W H Somerton (Elsevier Science Publishers, 1992). ISBN 0 444 89001 7, pp257, $125.50.

The book brings together the results of research on the thermal properties and temperature-related behaviour of rocks with their contained fluids, under subsurface environmental conditions. These data are of increasing importance with increased application of underground processes involving high temperature and, in some cases, low temperature environments. Some of the important processes are described in which thermal data are needed.

Petroleum Related Rock Mechanics. E Fjaer, R M Holt, P Horsrud, A M Raaen and R Risnes (Elsevier Science Publishers, 1992). ISBN 0 444 88913 2, pp352, $110.50.

This book explores the fundamental concepts of rock mechanics along with various petroleum related applications. Emphasis is placed on the weak sedimentary rocks which normally fall between traditional rock mechanics and soil mechanics. Elasticity, failure mechanics, acoustic wave propagation and geological aspects of rock materials are all detailed.

Refining

Refining and Reformulation: The challenge of green motor fuels. A Seymour (Oxford Institute for Energy Studies, 1992). ISBN 0 948061 68 5, pp95, £14.

This study focuses on the question of the future impact of reformulated motor car fuels mandated in the 1990 amendments to the Clean Air Act on the US refining industry. Areas covered include the uncertainties surrounding the legislation and investment decisions; the costs of greening motor fuels; the impact on refinery structure, oil companies' behaviour and the motor fuels trade and the environmental impact of road transport emissions.

Cleaning up Motor Car Pollution — New Fuels and Technology. C Cragg (Financial Times Management Reports, 1992). ISBN 185334 158 4, £221.

The report examines both the traditional car fuels — diesel and gasoline — and investigates the alternatives — methanol, ethanol, rapeseed oil, natural gas and electricity. It puts into perspective the emissions problems of the new fuels as well as the old. The report also explores the progress that is being made in fuel efficiency and examines some of the dilemmas of 'going green'.

Flexible joints for Snorre platform

Metalastik of Leicester has designed and manufactured unique flexible joints to allow movement in the new Saga Snorre platform in the Norwegian North Sea, the world's largest tension leg platform (TLP) to date.

Metalastik's 'flexelements' consist of large rings of interleaved steel plates and rubber fitted at either end of the 16 giant steel tubes which tether the TLP to the seabed. They allow the platform to move horizontally under the strain of violent storms and heavy tidal flow, without imposing excessive bending loads on the tethers.

The design is fail-safe, capable of withstanding the varying tension forces in the tether for up to 30 years and will accept a 30 percent tension overload for more than a year. In addition, all the materials used have been specially selected to resist the adverse affects of seawater.

Over a two-year development programme different materials, sizes and designs were evaluated using a variety of techniques including three-dimensional finite element analysis modelling, before the first, one-third scale prototypes were ready for testing in a specially built rig.

Optimum process and inspection procedures were defined to ensure a uniform cure, bond integrity and interleaf position throughout the flexelement. The final design was based on a deproteinised natural rubber incorporating 18 steel interleaves in a part spherical shape. Each weighed 3 tonnes and 41 were produced, including nine spares.

Metalastik's flexelements are located in the cross load bearings at the top of each tether and in the anchor latches which connect the bottom of each tether to their anchors. The tethers are made up of special thick-walled pipes, each 17 metres long with a diameter of 812mm. In April, the platform was successfully tethered to the seabed in a diverless installation procedure involving a fleet of tugs and a giant semi-submersible crane.

Flow straightener introduced

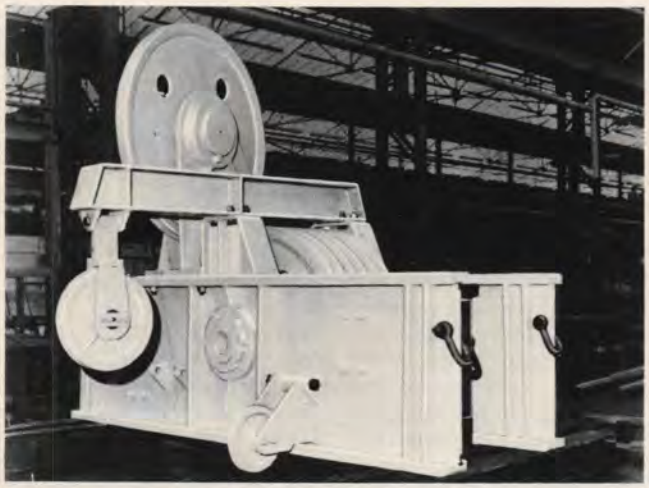
An in-line solution to flow irregularities caused by elbows, valves, pumps and similar fittings in pipelines is now available from Allison Engineering Ltd.

This is the FCI Vortab Flow Conditioner, which rapidly limits swirls and velocity profile distortions to enable accurate and repeatable flow-metering to be performed with greatly reduced installation requirements. Conditioning is achieved with a minimum of pressure loss on liquids, gases, slurries, steam and two-phase flows.

Designed and manufactured in consultation with leading meter makers, the FCI Vortab combines proven swirl removal technology with a patented mixing process to achieve flow conditioning. Short section swirl tabs remove any swirl in the flow, while up to three arrays of mixing tabs provide rapid cross-section mixing to eliminate velocity profile distortions.

Flow conditioning is achieved within a short distance, the standard length of the flow conditioner assembly being just three times the pipe diameter with a settling distance of four times pipe diameter being recommended downstream of the flowmeter. Pressure drop is less than half that of a flow straightener/conditioner.

Hooked on load cells



The introduction of computer-based drilling instrumentation, primarily on offshore installations, has resulted in the upgrading of sensors to monitor weight on hook/weight on bit.

The derrick operator needs to control the 'weight-on-bit' to keep the long pipeline in tension, relieving it from cyclic torsional and bending stresses. Various methods of measuring the weight have been developed with varying degrees of success. Hydraulic load cells fitted at the anchor share disadvantages with other systems that are installed on the deadline. The multiple sheaves and levers introduce friction errors into the measurement. In addition, the hydraulic circuit often needs regular bleeding to retain the circuit hardness. Wire tension dynamometers are also fitted on the deadline, and also need regular re-calibration and maintenance.

To solve these problems, Nobel Systems has applied its KOSD shear force load cells to the measurement of weight on hook in the drilling derricks of offshore oil and gas rigs. The system allows existing installation to be upgraded as well as 'new-builds' with the minimum of structural interference. It complies with hazardous area certification, DNV and API requirements for the largest rotary-drilling installations.

These systems are now employed in a number of North Sea projects, using the KOSD 115 double shear force load cell, which retain complete attachment integrity between the water table beams of the drilling derrick and the crown block assembly. By these means four 200 ton range load cells and their mountings sense the entire suspended weight of the travelling block and all that is suspended from its hook.

The design, construction, and hence maintenance of the crown-block frame, sheaves, bearings, etc., do not have to be modified to meet this measuring arrangement and therefore retrofits to existing derrick masts are not complex. The high measuring ranges available in the KOSD series enable the largest rigs to be accommodated. Hazardous area requirements are satisfied by BASEEFA Intrinsic-Safety Certification to EExiallc T4 which covers all zones and all gases. The sensors have a long offshore pedigree in rugged exposed location offshore application with over 1000 units installed on anchor handling, towing and mooring winches world-wide.

Vapour recovery pump

Pumptronics vapour recovery version of the Series 200 range of fuel pumps is now approved by National Weights and Measures for use on the forecourt.

The certificated pump uses the assisted method to retrieve vapour. The Series 200 pump, which was launched into the UK market about a year ago, was designed from the outset to enable vapour recovery to be fitted should customers require it. Although the pump retains its small footprint size, the incorporation of the nozzle put-downs into the main body of the pump allows the additional room required for the vapour recovery mechanism.

Subsea pipeline installation

SpanSet's new ratchet securing strap to secure ballast control to pipelines is being used by Rockwater of Aberdeen. The strap, designed and manufactured by SpanSet, secures chains to pipelines being installed offshore using the controlled depth tow method installation technique.

Rockwater selected the SpanSet straps over other options for a number of reasons; a main advantage cited was the cost-effectiveness of SpanSet's straps, in comparison to traditional steel clamps, wire ropes and stainless shackles. The straps are also easy to apply and can be tensioned by hand.

Each strap incorporates a safety seam, which would release the ballast control chain in the event of it snagging on the sea bed, avoiding damage to the pipeline. Each polyester webbing strap is secured by stainless steel buckles. Both straps and buckles are highly resistant to the damaging effects of sea water.

Plugging pipe costs

To eliminate the need to weld flanges onto the ends of pipework fabrications for pressure testing, a new range of high pressure testing plugs is available, from Huntingdon Fusion Techniques Limited.

The costly welding of test flanges and subsequent cutting off and re-bevelling of the pipe end is prevented due to the Argweld range of high pressure test plugs.

Argweld plugs are simply placed in the pipe end and a nut opens out a toothed ring which retains the plug in the pipe. A cone shaped plastic cup retains the pressure medium and the higher the pressure, the more the plastic cut seals against the wall, while the toothed ring prevents the plug from moving.

Suitable for inside pipe diameters from 25–450 mm the Argweld plugs can be fitted and removed in seconds. There is a removable threaded insert in the end of the plugs to allow connection of pressure testing lines or drain lines as required.

Contact List

Pumptronics Ltd **0692 500640**
SpanSet Limited, c/o IAS Marketing & Communication **0625 34343**
Allison Engineering Ltd **0268 526161**
Angus Flexible Pipelines Division **084 421 4545**
Huntingdon Fusion Techniques Limited **0480 412432**
Metalastik Vibration Control Systems **0533 730281**
Nobel Systems Ltd **0234 49241**

Mechanised pipelaying

A system for laying and retrieving long-range pipelines at speed with minimal labour has been introduced by Angus Flexible Pipelines. 'Flexline' combines purpose-made flexible pipe with powered deployment and retrieval from a moving vehicle.

It originates from techniques developed using Angus pipelines in the Middle East, where in one application a six-man crew regularly laid 4000 metres of flexible 6 inch diameter pipeline across desert in a day. With the rigid pipeline used previously, twelve men rarely exceeded 1000 metres of 4 inch diameter per day.

The company believes 'Flexline' will be particularly useful in onshore oil and gas exploration, mining, quarrying and wherever water supplies must be provided quickly and economically, or to remote locations.

Speed is not the only benefit. 'Flexline' also improves overall cost-efficiency by enabling heavy and unwieldy rigid pipes to be replaced by tough flexible pipelines that are easier to handle, store, transport, assemble and maintain. Flexible pipelines also give excellent hydraulic performance and, with their built-in resistance to corrosion, scaling, abrasion, ozone and ultra-violet attack, achieve long working lives.

Suitable for both deployment and retrieval, 'Flexline can be used for constructing pipelines of any length over difficult terrain in almost any climatic environment. It centres on a hydraulically powered reeling mechanism mounted on a vehicle. As the lorry travels, pipeline is reeled out or in under automatic control.

Provided in layflat form in 200-metre capacity reels — for ease of handling, transportation and storage — the synthetic-rubber pipe is connected by quick-action couplings as each 200-metre length is laid. There is no need for special skills or tools.

The lorry carries at least three reels of pipe. A support vehicle — the only other transport required — provides further supplies of 200-metre coils.

Other features include pinch rollers — to evacuate residual fluids — and brushes to clean the pipe during retrieval. When not in use, the system can be easily folded down for transportation to a new site. It can also be demounted rapidly and easily from the lorry to free the vehicle for other tasks.

. . . people

Mr Stuart Carlyle, above, has been appointed Business Manager for the oil and marine industry sector of Kemira Polymers. Mr Carlyle was previously Business Development Manager for adhesives, surface-coating resins and nitro-cellulose solutions.

The Health and Safety Executive has appointed two senior Offshore Safety Division (OSD) inspectors to the new posts of Operations Manager based in Aberdeen. **Mr David Bainbridge,** currently OSD's Head of Inspections (Scottish Waters) and **Mr Tony Powell,** Head of Well Operations, have both now taken responsibility for the management of multi-disciplinary inspection teams assigned to a number of oil companies and drilling rig operators. These teams will deal with the assessment of safety cases, audit and inspection of offshore platforms and rigs, investigation of accidents and enforcement matters.

In addition to the above duties, Mr Bainbridge also has special responsibilities for engineering and construction activities and Mr Powell for engineering and oil production activities.

Mr Don Hynek has been appointed General Manager of Texaco Ltd's upstream asset development. He replaces **Mr Don Bennett** who was recently appointed Managing Director, exploration and production. Mr Hynek moves from Louisiana where he has been Assistant Division Manager of Offshore Producing.

Also in asset development, **Mr Ron Sanderson** is to become Manager, Business Development. He replaces **Mr Alan Neil** who has been appointed Managing Director, Texaco Exploration Thailand.

Mr Jean-Pierre Daine has been appointed commercial manager of Total Oil Marine's engineering and construction division. He succeeds **Mr Jean-François Remy** who has returned to Paris. Mr Daine has worked on various Total projects since coming to the United Kingdom nine years ago. He was site representative during the jacket fabrication and offshore hook-up of the Alwyn North drilling and accommodation platform, then engineering manager of the St Fergus phase 3 plant and was most recently project manager for the Miller receiving facilities at St Fergus terminal.

Mr Struan Robertson, Chief Executive, International Trading of BP Oil International Ltd has been elected to serve a term as Vice Chairman of the International Petroleum Exchange Board of Directors.

Mr David Weston, below, has been appointed Managing Director of Shell Bitumen UK. He was formerly business manager within Shell Bitumen and succeeds **Mr John Hastie,** who takes over responsibility for a portfolio of Shell businesses, including bitumen.

Tuskar Resources Plc have appointed **Mr Duncan McGregor** as Chairman. Mr McGregor is a consultant to Hamilton Oil, where he was formerly Managing Director of Hamilton's subsidiary, International Petroleum Refining Company. Tuskar have also co-opted **Mr Emmet Brown,** Managing Director of Upstream Energy Services, an energy consultancy service, to the Board. Mr Brown, who is a geologist, is a former Managing Director of Atlantic Resources and has spent many years in the oil industry, including holding a number of senior technical positions with Marathon.

The United Kingdom Offshore Operators Association has appointed **Dr John McKinnell** as the new Director of its Aberdeen office. Dr McKinnell has worked for Shell for over 30 years in the United Kingdom and the Netherlands. He has had very wide experience in the management of chemical operations in the downstream sector. Since 1985 he has occupied senior posts in the upstream sector, with Shell Exploration and Production in Aberdeen, as Engineering Manager and then Technical Manager and General Manager of Gas Plants and Systems. Immediately before his recent retirement from Shell he managed Shell Expro's academic liaison activities throughout the United Kingdom.

Mr Damir Skerl, below, has been appointed President of Atlas Wireline Services in Houston. He has been Vice President of Western Geophysical for Europe/Africa/Middle East; Senior Vice-President of Western Geophysical and Managing Director of Western Research and Senior Vice-President for International Operations, where he continued to be responsible for research and software development.

Mr Ross Smith, above, has been appointed Exploration and Ventures General Manager of a newly formed strategic business unit (SBU) for Chevron. The Western Europe SBU has been expanded to cover all Europe and the Middle East. It is known as Chevron Europe and Middle East, the business unit, of which **Mr Charles Smith** will remain Managing Director. Prior to his current posting, Ross Smith, was Managing Director of Chevron's South East Europe/Middle East strategic business unit.

Flow metering specialists Surrey Instruments has appointed **Mr Peter Mitchell** to the Board of Directors. Mr Mitchell joins the company with extensive knowledge of flow metering and microprocessor control requirements throughout the United Kingdom.

OMV has appointed **Dr Richard Schenz** as Chairman. Dr Schenz has been Deputy Chairman since 1990 and has been acting Chairman since July this year. On first joining the Board in 1988 his responsibilities included downstream activities including supply and trading, refining, marketing and petrochemicals.

LONDON BRANCH

'I am/was a graduate'

by Mr P D Gaffney, Cline & Associates

will be held on Tuesday, 10 November 1992, at the Royal School of Mines, Imperial College, Prince Consort Road (near the Royal Albert Hall) at 17.30 hours.

Peter Gaffney will address some of the challenges and opportunities facing graduates and those who already work in the industry.

The meeting is preceded by tea and biscuits at 17.00 hours and is followed by light refreshments.

Enquiries to Mrs E Walker, Hon Secretary, London Branch, Tel: 0926–404257.

FORTHCOMING EVENTS

November

9th–10th
London: Conference on 'World Electricity'. Details: Financial Times Conference Organisation, 102–108 Clerkenwell Road, London EC1M 5SA. Tel: (071) 251 9321. Fax: (071) 251 4686.

9th–13th
Singapore: Course on 'The Global LPG Business — Supply, Markets and International Trading'. Details: The College of Petroleum Studies, Sun Alliance House, New Inn Hall Street, Oxford OX1 2QD. Tel: (0865) 791474. Fax: (0865) 250521.

10th
London: Seminar on 'Engineering Documentation '92'. Details: Allen Brobyn, Institute of Scientific and Technical Communicators, Kings Court, 2/16 Goodge Street, London W1P 1FF. Tel: (071) 436 4425. Fax: (071) 580 0747.

10th–11th
London: 'Marinflex 92 — flexible pipes, umbilicals and marine cables conference'. Details: Mr Bob Gibbins, Marinflex 92 Conference Secretariat, 2 Tavistock Place, London WC1H 9RA. Tel: (071) 837 6362. Fax: (071) 837 0822.

11th–12th
Moscow: Conference on 'Doing Business with Russia'. Details: Caroline Hurley, Financial Times Conference Organisation, 102–108 Clerkenwell Road, London EC1M 5SA. Tel: (071) 251 9321. Fax: (071) 251 4686.

11th–12th
London: Conference 'Deadline 1993 — Will your safety management system be ready?'. Details: Sarah Peace, IBC Technical Services Ltd, 57–61 Mortimer Street, London W1N 7TD. Tel: (071) 637 4383. Fax: (071) 631 3214.

12th
Sheffield: Course on 'Safe Storage of Hazardous Substances'. Details: Miss Maria Elliott, Division of Adult Continuing Education, The University of Sheffield, 65 Wilkinson Street, Sheffield S10 2GJ. Tel and Fax: (0742) 768653.

12th
London: Conference on 'Implications of Biocide Use within the Petroleum Industry'. Details: Miss C Little, The Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR. Tel: (071) 636 1004. Fax: (071) 255 1472.

12th
London: Conference on 'Resolving Problems in Seismic Data Management and Storage'. Details: Mr A McBarnet, Conference Director, Themedia Ltd, PO Box 2, Chipping Norton, Oxon OX7 5QX. Tel: (060884) 700. Fax: (060884) 796.

14th–15th
London: Conference on 'Developments in the isolation of microbial products'. Details: Society of Chemical Industry, 14/15 Belgrave Square, London SW1X 8PS. Tel: (071) 235 3681. Fax: (071) 823 1698.

16th–17th
London: 'Oil and Money: Planning for Chaos'. Details: Brenda Hagerty, International Herald Tribune, 63 Long Acre, London WC2E 9JH. Tel: (071) 836 4802. Fax: (071) 836 0717.

16th–18th
Perth, Western Australia: Conference on 'Trade and Investment Opportunities in Services to the Mining, Oil and Gas Industries in Asia/Pacific'. Details: Century House Information Ltd, Century House, 22 Towcester Road, Old Stratford, Milton Keynes MK19 6AQ. Tel: (0908) 560555. Fax: (0908) 560470.

18th
London: Conference on 'Oil Supply and Price'. Details: Miss C Little, The Institute of Petroleum.

18th
London: Conference on 'Treatment and disposal of liquid wastes'. Details: Society of Chemical Industry, 14/15 Belgrave Square, London SW1X 8PS. Tel: (071) 235 3681. Fax: (071) 823 1698.

19th
London: Conference on 'Developments in Hydrocarbon Recovery: Making the most of the North Sea'. Details: Mr C Peacock, Chem Systems Ltd, 28 St James Square, London SW1Y 4JH. Tel: (071) 839 4652. Fax: (071) 930 1504.

19th
London: Conference on 'Developments in Aircraft Fuelling. Details: Miss C Little, The Institute of Petroleum.

23rd–27th
Cranfield: Course on 'Management of Offshore Accident Investigations'. Details: Short Course Manager, Cranfield Institute of Technology, Cranfield, Bedford MK43 0AL. Tel: (0234) 752776. Fax: (0234) 751206.

24th–25th
London: 'Cost Effective Corrosion Protection of Offshore Pipelines'. Details: IIR Ltd, 28th Floor, Centre Point, 103 New Oxford Street, London WC1A 1DD. Tel: (071) 379 8040. Fax: (071) 412 0143.

24th–25th
Aberdeen: Conference on 'Achieving Optimum Offshore Safety'. Details: IIR Ltd, 28th Floor, Centre Point, 103 New Oxford Street, London WC1A 1DD. Tel: (071) 379 8040. Fax: (071) 412 0143.

25th
London: Accounting seminar on 'Raising Finance'. Details: Mrs P Ashby, The Institute of Petroleum.

25th
London: Conference on 'Successful Contract Negotiations in the UK Gas Market'. Details: Christine Rickards, IBC Legal Studies and Services Ltd, Gilmoora House, 57–61 Mortimer Street, London W1N 7TD. Tel: (071) 637 4383. Fax: (071) 631 3214.

25th–26th
Aberdeen: Conference on 'Offshore Drilling Technology'. Details: Nadia Ellis, IBC Technical Services Ltd, Gilmoora House, 57–61 Mortimer Street, London W1N 7TD. Tel: (071) 637 4383. Fax: (071) 631 3214.

25th–27th
London: 'Petex '92 — Applying New Technologies'. Details: Karen Whitehead, PETEX Ltd, Burlington House, Piccadilly, London W1V 9AG. Tel: (071) 287 2782. Fax: (071) 734 0921.

26th
London: Conference on 'Life Cycle Analysis and Eco Labelling for the Oil Industry'. Details: Miss C Little, The Institute of Petroleum.

FORTHCOMING EVENTS

26th–27th
London: Two day course on 'North Sea Risk Analysis'. Details: DCA Consultants Ltd, Haughend Farm, Bridge of Earn Road, By Dunning, Perthshire PH2 9BX. Tel: (0764) 84664. Fax: (0764) 84665.

26th–27th
London: Conference on 'Maintenance and Repair of Petrochemical Storage Tanks'. Details: Business Seminars International Ltd, 56–60 St John Street, London EC1M 4DT. Tel: (071) 490 3774. Fax: (071) 490 2296.

26th–27th
Prague: Conference on 'Oil and Gas in Czechoslovakia'. Details: Birgit Tollner, Enerfinance, 69 rue d'Hautville, 75010 Paris, France. Tel: (1) 47 70 29 00. Fax: (1) 47 70 27 37.

30th–1st December
London: Second Annual Conference on UK and European Gas — price, supply and demand'. Details: Monique Quant, IBC Financial Focus Ltd, 57/61 Mortimer Street, London W1N 7TD. Tel: (071) 637 4383. Fax: (071) 323 4298.

29th–2nd December
Kuala Lumpur: 'Symposium on Tectonic Framework and Energy Resources of the Western Margin of the Pacific Basin'. Details: The Symposium Secretary, c/o Geological Society of Malaysia, Dept of Geology, University of Malaysia, 59100 Kuala Lumpur, Malaysia. Tel: 03-7577036. Fax: 06-7563900.

December

1st
London: Conference on 'World Class Competences in Practice for the Oil Industry'. Details: Miss C Little, The Institute of Petroleum.

1st–2nd
Aberdeen: Conference on 'Minimum Facilities for Offshore Oil and Gas Production'. Details: Sarah Peace, IBC Technical Services Ltd, Gilmoora House, 57/61 Mortimer Street, London W1N 7TD. Tel: (071) 637 4383. Fax: (071) 631 3214.

2nd
London: Accounting seminar on 'Accounting and taxation issues'. Details: Mrs P Ashby, The Institute of Petroleum.

2nd–3rd
London: Conference on 'Future Developments in Regulation and Competition in Electricity Supply'. Details: IIR Industrial Ltd, 28th Floor, Centre Point, 103 New Oxford Street, London WC1A 1DD. Tel: (071) 412 0141. Fax: (071) 412 0145.

3rd
London: 'Microbiology Workshop — Current problems of microbial spoilage of bulk distillate fuels'. Details: Miss C Little, The Institute of Petroleum.

7th–8th
London: Conference on 'World Energy Demand: Is Growth Inevitable'. Details: The Energy Conference, The Conference Department, Chatham House, 10 St James's Square, London SW1Y 4LE. Tel: (071) 957 5700. Fax: (071) 957 5710.

8th–9th
London: Conference 'Subsea 92'. Details: Themedia Ltd, PO Box 2, Chipping Norton, Oxon OX7 5QX. Tel: (0608) 84888. Fax: (0608) 84796.

8th–10th
Stratford-upon-Avon: Conference on 'Profitable Condition Monitoring'. Details: Miss T Peters, Conference Organiser, BHR Group Ltd, Cranfield, Bedford MK43 0AJ. Tel: (0234) 750422. Fax: (0234) 750074.

10th–11th
London: Conference on 'Floating Production Systems'. Details: Sarah Peace, IBC Technical Services Ltd, Gilmoora House, 57–61 Mortimer Street, London W1N 7TD. Tel: (071) 637 4383. Fax: (071) 631 3214.

10th–11th
London: Conference on 'Oil and Gas Economics in the North Sea'. Details: IIR Industrial Ltd, 28th Floor, Centre Point, 103 New Oxford Street, London WC1A 1DD. Tel: (071) 412 0141. Fax: (071) 412 0145.

15th
London: Forum for discussion on 'Preparation of an Offshore Safety Case'. Details: Society for Underwater Technology, PSTI House, Exploration Drive, Offshore Technology Park, Bridge of Don, Aberdeen AB23 8GZ. Tel: (0224) 823637. Fax: (0224) 820236.

16th–18th
London: Course on 'Safety analysis and techniques required for formal safety assessments in the shipping and offshore industries'. Details: Ms Rhian Bufton, The Institute of Marine Engineers, 76 Mark Lane, London EC3R 7JN. Tel: (071) 481 8493. Fax: (071) 488 1854.

The Institute of Petroleum

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