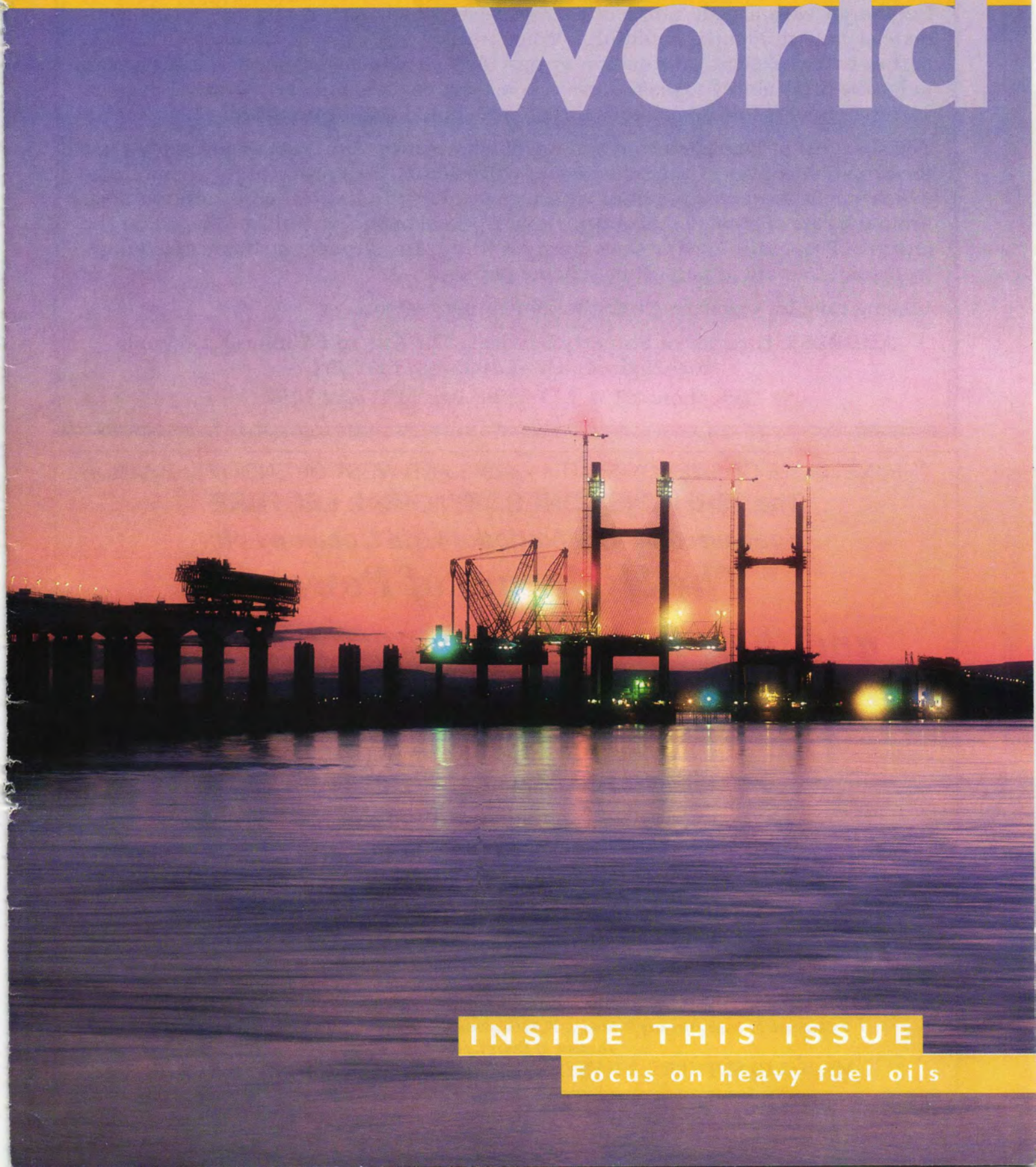
THE MAGAZINE OF THE INSTITUTE OF ENERGY

energy world

the institute of energy

No.235 January 1996



INSIDE THIS ISSUE

Focus on heavy fuel oils

CENTRAL EDINBURGH:
COMBINED HEAT AND POWER/DISTRICT HEATING SCHEME

Energy Companies are invited to register their interest to be shortlisted in the development of a Combined Heat and Power/District Heating System for Central Edinburgh with a wide range of energy needs which includes institutional, commercial and residential buildings. When registering interest Companies should ensure that sufficient information is provided on which the Local Authority can judge the firm's ability to plan, finance, construct, market and operate a CHP System. Turnover figures for the previous three years should also be provided.

The short list of interested companies will be provided with a document setting out the broad objectives of the scheme and will identify the Local Authority buildings which might be served together with recent fuel and electrical consumption data. From the date of issue of this information, a period of 56 days will be allowed for the return of Proposals. The Local Authority is willing to consider any financial arrangements put forward as part of the scheme proposal.

Closing Date for registering interest: 29 February 1996.

ADDRESS: Director of Property Services, The City of Edinburgh Council, 329 High St., UK–Edinburgh EH1 1YJ.

Telephone 0131 225 2424 Fax 0131 220 1494

THE INSTITUTE OF ENERGY SOUTH WALES AND WEST OF ENGLAND BRANCH

The 23rd IDRIS JONES MEMORIAL LECTURE

Sponsored by The National Grid Company plc

The Highways of Power and their Role in the Energy Markets

by David G Jefferies CBE FEng

President of The Institute of Energy
Chairman of The National Grid Company plc

on Friday 22nd March, 1996 at 11.00 am

(coffee & reception at 10.30 am)

at

CARDIFF CASTLE

to be followed by the BRANCH ANNUAL LUNCHEON at 12.00 for 1.00 pm

Admission to the lecture is free, but those wishing to attend should apply for lecture tickets. Tickets for the luncheon should also be applied for, these will cost £8 per head, inclusive of coffee, pre-lunch drinks and wine with the meal.

Tickets will be issued in early February. Ticket applications in writing, with cheques made out to Institute of Energy, please, to:

MR DAVID SUTHERS, 2 DANYBRYN CLOSE, RADYR, CARDIFF CF4 8DJ

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COVER

This month's cover picture shows the second Severn crossing. The South Wales electricity company, SWALEC, recently completed a two-year project to link an 11 000 volt underground cable to the new bridge, due to be opened this year.

The high voltage line cost £67 000, and as part of the project SWALEC subsidiary Celtic Exterior Lighting also installed new lighting for the toll plaza.

The magazine of The Institute of Energy

Published by H Howland Associates, The Martins, East Street, Harrietsham, Kent ME17 1HH, on behalf of The Institute of Energy, 18 Devonshire Street, London W1N 2AU.
Editorial: 01622 850100
fax: 01622 850977
Administration: 0171-580 7124
Membership, Education and Journal subscriptions: 0171-580 0077 fax: 0171-580 4420

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Printed by Headley Brothers Ltd
The Invicta Press, Ashford, Kent

THE INSTITUTE OF ENERGY

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ISSN 0307-7942

With the recommissioning of the last of a total of 22 turbines, Sulzer Hydro recently completed its largest renovation contract in South -East Asia. It entailed the renovation of seven hydropower plants on the island of Java, Indonesia, and was valued at 25 million CHF. As a consequence of the renovation, Sulzer was able to increase the output of the turbines, which in some cases were up to 60 years old, by 10 to 20%, and to ensure the economics and safety of the plants for a further 25 years. The project supports the go-ahead industry, inasmuch that it fulfils its requirement for reasonably priced energy. The picture shows Jelok, one of the seven hydropower plants.

Developing safe disposal of Orimulsion ash

A EUROPEAN collaboration under a Brite-Euram CEC award, headed by EA Technology, will help the power plant industry comply with stringent EU requirements on the control of effluents.

The Chester-based research and development company has joined forces with a UK power station constructor, a chemicals producer in Germany and a research institute in Portugal. The resulting consortium has developed a new process to facilitate the recovery of the toxic but valuable chemicals nickel and vanadium, which are produced in ash form during the combustion of the fuel Orimulsion.

The first of two different solutions to the problem is a 'fast track' recovery route involving the relatively simple synthesis of vanadium and nickel salts. The process has been tested at 20 kg and on a scale of tens of tonnes, producing fly ash feed which can be in the form of dust, slurry, extrudite or granulated material, all of which have been handled very successfully.

The great advantage in using a synthesis process is that alternative nickel and vanadium products can to a large extent be tailored to meet local requirements. For instance in a location where a power station is adjacent to an ammonium plant, it makes logical and economic sense to recover the vanadium as an ammonium vanadate compound.

A solvent extraction route was developed in the second approach, and it enabled the recovery of vanadium, nickel, iron and magnesium after a prior vanadium recovery as a precipitate or even following the initial leaching step. It is more complicated and costly to install than the first process, but has the advantage of producing lower effluent volumes than the fast track process.

Bitor Europe, who market Orimulsion, have recently announced a contract with SK Power of Denmark to supply 7.5 million tonnes to Asnæs power station on the island of Zeeland. The power station's 700 MWe unit five began using Orimulsion in February 1995. The new contract for additional supplies from 1997 will enable the power station to use more than 1 million tonnes a year into the next century. The fuel is shipped from Venezuela in double-hulled tankers in cargoes of 100 000 tonnes.

Asnæs unit five is the biggest generating unit in Scandinavia, and has FGD. The ash produced will be processed in a new plant, operated by Orbit Metallurgical Ltd. to recover metals.

CFB plant gets THERMIE support

AN international project called *Provence Clean Energy,* which utilises circulating fluidised bed (CFB) technology, is receiving 20 MECU through THERMIE, the EC programme for the demonstration and promotion of innovative, clean and efficient energy technologies.

The 250 MWe unit at the Province power station, at Gardanne-Meyreuil, near Marseilles in France, was connected to the EdF grid at the end of last year. The CFB boiler (LURGI process) is the world's most powerful single furnace boiler using this technology. The operator of the project is the Société Provençale de Lit Fluidisé — a joint venture between EdF, ENDESA, the Spanish power company, Société Nationale d'Electricité et de Thermique, a subsidiary of Charbonnages de France, GEC ALSTHOM, Stein Industrie and LURGI, the French and German manufacturers of the boiler.

The CFB technology allows the clean combustion of fuels with a high sulphur content, meeting the highest standards of environmental protection and without the need for complex auxiliary pollution control equipment.

The market for power stations of 250 to 300 MWe using this type of technology is substantial, particularly in countries with abundant resources of poor quality coal. It also paves the way for units of 500 to 600 MWe.

Chernobyl memorandum signed

THE Memorandum of Understanding on the closure of Chernobyl nuclear power plant by the year 2000 has been welcomed by UK junior energy minister, Richard Page. The Ukrainian Minister for Environmental Protection and Nuclear Safety, Mr Yuriy Ivanovych Kostenko and Canadian Deputy Prime Minister, Sheila Copps, acting on behalf of the leaders of the Group of Seven (G7) countries, signed the Memorandum in Ottawa on 20 December 1995.

This is the outcome of discussions on an action plant to close the remaining reactors by 2000 subject to agreement on Western assistance. It looks at the closure of Chernobyl in the context of wider energy sector reform, and includes short term upgrades, and decommissioning preparation.

Obituary:

John Collier

Numerous tributes were made from around the globe, following the untimely death of John Collier, Chairman of Nuclear Electric, on 18 November, aged 60.

John Collier obtained a first class degree in chemical engineering from University College, London, embarking upon his highly successful career in 1957, in the chemical engineering division at Harwell in Oxfordshire. Here he worked in the nuclear safety areas of heat transfer and two-phase flow. By 1975 he was head of the division. In 1977 he became head of the central technical policy team at AEA.

As well as providing evidence for the Sizewell B inquiry, he also worked on developing joint arrangements between the CEGB and NNC for the PWR design and construction.

In 1982 Mr Collier became director of the UKAEA's safety and reliability directorate, and in

John Collier

1983, director general of the CEGB's generation development and construction division. In 1987 he was appointed chairman and chief executive of the UKAEA. When the nuclear element was removed from electricity privatisation in November 1989, he was invited by John Wakeham to be chairman of Nuclear Electric, since when he has brought the company to the point where it can now be privatised.

A man of immense talent and vision, he will be greatly missed by all those who knew and worked with him.

Round Table reports

THE UK Round Table on Sustainable Development published its first three reports in January: *Domestic energy markets: 1998 and beyond; Freight transport;* and *Environmental management and audit.*

These topics were considered initially by subgroups which included outside experts as well as Round Table members, but the reports reflect the views of the Round Table itself. Each report includes recommendations designed to help achieve sustainable development in the area studied.

Comments are invited by 23 February, and will be taken into consideration in finalising the annual report, to which the Government will respond formally. Copies are available from the Round Table Secretariat, Room P1/021, 2 Marsham Street, London SW1P 3EB.

Continued growth in wind energy

AN assessment by the British Wind Energy Association shows the continued steady growth in the wind energy industry.

At the turn of the year there were 29 wind farms in operation in England, Wales, Scotland and Northern Ireland, of which seven came into operation during 1995, raising capacity by over a quarter. A further 13 are either under construction or awaiting construction, adding a further 60% capacity. This total represents a doubling of investment, from approximately £140 million to £280 million, all of it private capital.

There are further indications of growth: BWEA has itself grown to 90 corporate members, and a recent survey of employment within the industry found that it employs 1300, with a 32% increase between 1993 and 1995.

Consumer councils call for utilities

THE NATIONAL Consumer Council (NCC) has called for the creation of three specialist consumer councils, with adequate funding, independence and 'clout' to protect the interests of water, electricity and telecoms consumers.

In a report published in January, *Consumer representation in the public utilities,* NCC suggests that these councils would be modelled on the Gas Consumers' Council, currently the only independent representative body for utilities consumers.

Acknowledging the valuable work done by existing consumer committees, NCC's research finds that their scope for independent action is limited, because they are attached to and funded by the regulators. Both Ofwat and Offer's consumer committees have felt the need to set up additional national consumer panels, pointing to inadequacies in the current regulatory set-up. "Until there is full competition ... consumers will remain in a precarious position," says NCC chairman.

UK: solar capital of Europe

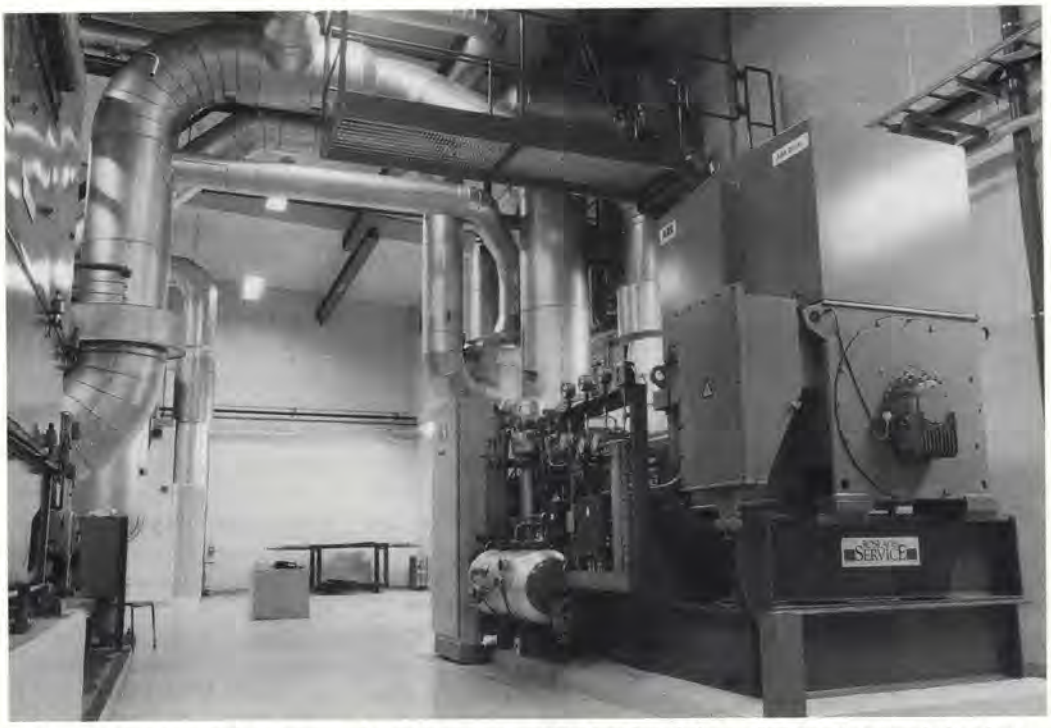
A MAJOR plan to help establish the UK as the solar energy enterprise capital of Europe will proceed to the next round of the Government's Technology Foresight Challenge. Part of the programme involves the installation of systems in hundreds of schools and colleges in the UK to educate future generations in photovoltaics (pv).

The project would collate data into a central database and connect sites via the Internet, undertake strategic research and provide hands-on demonstrations of pv. It would also help to raise public awareness of this promising renewable technology.

The consortium includes all the major players in the UK pv industry, as well as companies interested in applications of the technology. These include, BRE, Beacon Energy, Colt Group, Crest (Loughborough), Dulas Ltd, EA Technology, EETS (Cardiff), ERA Technology, IT Power, Open University, Ove Arup, Pilkington Technology, Sollatek, Southampton University, and Wavedriver.

A joint venture company, Seabank Power Ltd, is to build a 755 MW gas-fired power station at Avonmouth, near Bristol (artist's impression pictured above). Seabank Power will be owned 50:50 by British Gas and Hydro-Electric. The latter has contracted to take the full electricity output of the station and will provide gas from its own portfolio. Under a separate arrangement, British Gas Supply is supplying a substantial volume of gas to Hydro-Electric.

The construction contract has been awarded to Siemens plc. Construction, which is on an old gas works site, will create over 500 jobs from mid 1996, with commercial operation scheduled towards the end of 1998.



Something old, something new ... a Swedish energy supplier has found the perfect way to upgrade its plant without interfering in production, thanks to Atlas Copco in the USA and local company Senea Service AB. Västeras Energi & Vatten (Energy & Water) had a problem: its heat pump plant, which provides heating and cooling water for industry, the local government, hotels and housing estates in Västeras was not big enough to meet customer demands for 100% backup.

But the company were committed to meeting their existing customers' requirements, so they could not shutdown the existing plant to upgrade it. They needed to build a new plant, but there were many factors to consider.

Firstly the new plant would have to start operating as quickly as possible. It would also have to offer facilities to start operating with R12 refrigerant and then be converted to R134a, the CFC free refrigerant. The reason for this was that under new Swedish legislation, as of 1 January 1995 it became illegal to import R12 refrigerant into the country, and from 1 January 1998 refill existing equipment with R12 will be prohibited.

Västeras Energi & Vatten had to find an economical solution that met this criteria, with the minimum effect on the environment. They enlisted the help of Senea Services AB (formerly Roslags Service AB), one of Sweden's leading specialists in compressor upgrading projects. And under an agreement, made in 1993, Senea Services called upon the technical knowledge and expertise of Atlas Copco for help in developing and installing compressor systems.

"The solution was achieved in two stages," said Nils-Göram Rapp of Senea, "For the first stage, we had managed to locate a second-hand two-stage Sulzer RW45 compressor which was for sale in Stockholm."

"This was dismantled, transported to Västeras and installed in a new compressor house that Västeras had built under our guidance. We chose this unit because being second hand it was obviously cheaper. But more importantly it was available for immediate installation, and timing was critical."

The contract was signed in mid-December 1992, and within seven months the compressor was installed in a new compressor house. The system ran for three months, and was then shut down in October 1993 for the second phase of the upgrade: converting the system to run on R134a. "By changing over the refrigerant type, the system operating pressure needed boosting in order to achieve the same heating/cooling performance," explains Mr Rapp, "One way of achieving this would be simply to increase the compressor operating speed. But after considering the effects of demand, power requirements and increased wear on components, we decided that a more efficient way of increasing the system pressure was to install a booster unit at the front end of the two stage compressor. And that's where the Atlas Copco single-stage GT063TIGI compressor fits into the system."

The new compressor increased the plant power output by around 2 MW. Powered by a 900 kW ABB electrical motor, the compressor operates at a rate of 16 000 m^3/h and a pressure ratio of 1.6.

The process begins with waste water being pumped into an evaporator, where it is cooled from 9-18°C to 2-10°C. This causes the refrigerant to evaporate. The new heat pump has sprinkler evaporator, which is more suitable for R134a refrigerant. The old heat pump system has a tube evaporator and still operates on R12 refrigerant — although there are plans to convert it to R134a within a few years. The evaporated refrigerant passes through the Atlas Copco compressor and the two-stage compressor into a condenser, where it heats the incoming district water return from 50-60°C to about 65-80°C. At the other end of the system, the cold water is pumped from the evaporator to another heat exchanger at temperatures ranging from 2-5°C. Here the district cooling water return is cooled from 16-18°C to 7-10°C. As a back up, there is a 4000 m3 storage tank for the cooling water.

Built at a total investment of SKR 40 million, the new heat pump plant has a total heating capacity of 12-15 MW and cooling capacity of 7-9 MW. Established 100 years ago to provide district heating, the company currently has 10 large customers with a demand for 11 MW of cooling. Connected heating output is 1000 MW.

New Year debut

FOLLOWING North West Water Group plc's acquisition of NORWEB plc, a new company, United Utilities plc came into existence on 1 January 1996.

United Utilities will be the UK's first multi-utility, combining water, electricity, gas and telecommunications. The North West Water and NORWEB names will continue to be used for the regulated water and electricity operations, which will serve up to 7 million customers in the North West of England.

The enlarged group will also compete in the international water and energy markets. North West Water is already the third largest international water business.

With a turnover of over £2.5 billion and a market capitalisation of over £3 billion, United Utilities will be among the 50 largest companies in the UK.

Biocatalytic discovery to reduce costs

ENERGY Biosystems Corp (EBC) of Texas, USA, has filed for patent protection on inventions arising from a newly discovered enzyme believed to be critical for optimal specific activity and reduced cost of their patented biocatalytic desulphurisation (BDS) biocatalyst.

EBC scientists have identified, isolated and characterised this new enzyme, whose activity was discovered to be necessary for desulphurisation and its limited presence was a significant bottleneck to increasing specific activity of the BDS biocatalyst. This development is expected to substantially increase the specific activity of the biocatalyst, and consequently move closer to the economics required for commercialising the BDS process.

Work is currently underway to use the enzyme to produce an improved biocatalyst for use in the company's St Louis-based 5 bpd BDS pilot plant, now in the continuous operation phase development.

First NAMAS accreditation

CHELTENHAM-based energy and environmental consultancy, CRE Group Ltd, is the first UK company to be awarded NAMAS accreditation for the sampling of dioxin, furan, trace metals, PAH and PCB emissions to the atmosphere.

CRE was the first organisation in the UK to obtain NAMAS accreditation for the sampling and analysis of particulates, combustion gases and acid gases. By extending its scope to include sampling of dioxins and trace metals, CRE has further enhanced its service to industry.

The group currently operates three mobile laboratories, two dedicated to sampling major gaseous species and the third to trace emissions. A fourth purpose-built mobile laboratory has been recently commissioned.

Independent check

SOME energy equipment suppliers sell on a guarantee-of-performance basis, but their tests are, by definition, never truly independent, and sometimes may even be unfair. Now an inexpensive independent scheme is available to verify or disprove suppliers' claims for the *in situ* efficacy of their 'bolt on goodies'.

For between £10 and £25 per case, analysts Vilnis Vesma & Co offer to assess a customer's before and after energy consumption patterns. Without being told what was done and when, they can identify not when, and how performance improved, but also what the year-round consumption savings are likely to be. Their independent, objective and unprompted findings can then be compared with the equipment supplier's promises to support the case for accepting or rejecting his invoice.

A fact sheet explaining the operation of the scheme is available from Vilnis Vesma & Co, tel: 01531 821350; fax: 01531 820603.

Triads: weather information for electricity supply

WEATHER information received from the Met Office is of major importance to electricity companies in producing cost-savings for themselves and their customers. Although electricity triads are not as imposing as the infamous Chinese groups, they can still inflict considerable financial hardship.

Tony Bissel is demand forecasting team leader for Midlands Electricity: "Many large consumers chose pool price contracts (PPCs) with their electricity suppliers. This allows the customer to pay for their electricity on the variable half-hourly prices, published on a day-ahead basis. Managers have the opportunity to adjust shift patterns or even shutdown operations if high prices are scheduled.

"Each year, PPC customers also pay a triad charge to the National Grid Company for their use of the network. The electricity triads are defined as the three half hours of peak electricity consumption on the England and Wales transmission network, during November to February, separated by at least ten days.

"Triad charges vary depending on the degree of usage of the NGC network. The plethora of power stations in North East England leads to relatively low charges for PPC customers in this part of the country. Excess generation in Northern England is transported to areas where electricity demand outweighs the generating capacities. This results in the highest Triad charges for PPC customers in London and the South West, where generation is particularly scarce.

"Whereas the average half-hourly pool price is less than three pence per kWh, current triad charges for PPC sites are approximately £2/kWh in Northern England, £8/kWh in Wales and central England, and over £10/kWh in London and the South East.

"The additional difficulty in this case is the fact that the triad periods are not known in advance. However, with the help of accurate Met Office weather forecasts, electricity suppliers can provide triad avoidance schemes to assist their PPC customers.

"By regular assessment of current and forecast weather conditions, using the MIST system, the demand forecasting team at MEB identify triad periods on a day-ahead basis. Triad warning faxes are then sent to all MEB PPC customers, alerting them to the situation.

"In 1994/95, MEB alerted all 3000 or so of its PPC customers to the three triads periods. The customer reaction has been estimated to have produced a total saving of £600 000 for this group of customers. The goodwill this creates more than justifies the financial outlay for the Met Office services.

For further information contact Barbara Richardson, Utilities Manager, The Met Office, Sutton House, London Road, Bracknell, Berks RG12 2SY. Tel: 01344 856765.

Leading UK manufacturer and exporter of chemical products, BASF plc, has signed a 15-year contract with National Power to buy electricity and steam from a new CHP plant. The £32 million plant will be integrated into the existing steam raising plant at BASF's 300 acre complex at Seal Sands on Teeside.

National Power will build, fund and own the CHP plant and will provide a standby supply of electricity as part of the deal. BASF will operate the plant on a day to day basis under a partnership energy management arrangement.

The 75 MW plant will comprise a 40 MW gas turbine generator which will exhaust into a 65 tonne/hour waste heat recovery boiler. The high pressure steam produced, along with the steam from BASF's existing utility plant, will pass to a steam turbine generator producing a further 35 MW of electricity.

PULSAR

— commercially viable, environmentally friendly

IN THE current climate of exacting environmental standards, plant operators are constantly searching for new and improved solutions to ensure compliance with increasingly stringent emissions legislation, as well as demanding improvements in cost efficiency.

Historically, the industrial energy market has offered limited fuel choices, thereby greatly reducing purchasing flexibility. Solving combustion emissions problems by switching to gas is the easy, but potentially inflexible and expensive, environmental option.There is little doubt that operators with the foresight to establish clearly understood dual-fuel status with their pollution regulating authority will benefit from their ability to operate a flexible approach to fuel purchasing and plant efficiency.

Phillips Petroleum's straight-run, high-quality, very low sulphur fuel oil, marketed under the brand name PULSAR (Phillips' Ultra Low Sulphur Atmospheric Residue) offers a commercially viable and environmentally friendly option.

PULSAR is refined to assist users to comply with the requirements of the UK Environmental Protection Act. When used by plant greater than 50 MW, this fuel will help operators to comply with the mandatory obligation to meet 'new plant' limit values as prescribed in their emissions authorisation. It will dramatically reduce smoke and particulate emissions and the extremely low sulphur content should significantly decrease acid dew point temperature, offering greater potential for dealing with persistent acid smutting problems.

Increasingly stringent environmental legislation has meant the stark choice for users of industrial heavy fuel oil-fired boilers of 'scrubbing or switching' — until now. Phillips Petroleum have developed a low sulphur heavy fuel oil, which has the added advantage of improving plant cost efficiency.

The product also offers significant potential for improved combustion efficiency through reductions in excess air and increased boiler cleanliness.

Because of the high quality of PULSAR, the combustion performance compared with that of a typical UK heavy fuel oil is excellent, delivering low emissions with improved combustion efficiency, at a thermally competitive level with the alternatives (ie, other oils and gas).

PULSAR is ideal for those users who recognise the commercial importance of fuel flexibility, but need to comply with the conditions of their emissions authorisation. Additionally, for fuel oil users with immediate emission problems, it offers a viable commercial solution, enabling the retention of fuel flexibility.

PULSAR should enable Part B operators to comply with all 'existing plant' emissions limits and when considered in conjunction with low NO_x burners, all 'new plant' limits. It can deliver Part A 'new plant' SO_x emission limits and has the capability to closely approach the 'new plant' particulate limit. It will significantly enhance the emission performance of retrofitted, low NO_x burners.

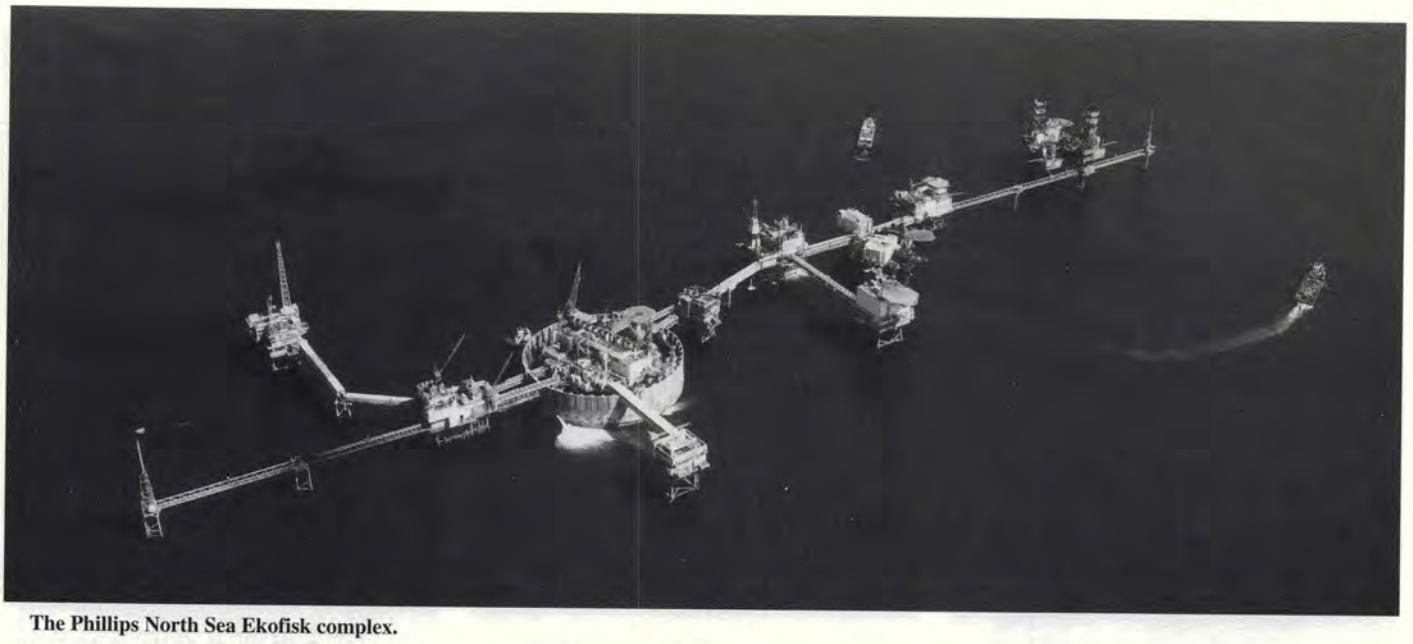
Testing ... testing

PULSAR has been evaluated in comparison with a typical UK heavy fuel oil under normal conditions. Test fired on a typical rotary burner, industrial fire tube boiler, the combustion performance and emissions were monitored. A high level of carbon burn out with low smoke numbers and low excess air were achieved, resulting in improved efficiency. The lower level of combustion air reduced thermal NO_x formation, the test achieving a 25% improvement. The improvement of both SO_x emissions and particulates was dramatic, with both showing one tenth the emissions of standard heavy fuel oil. Improved efficiency is environmentally desirable, since for a given energy output emissions are reduced.

No special equipment is required to handle PULSAR but the higher than usual minimum storage temperature means the oil installation should conform to the minimum require-

Table 1: Control of Pollution Act: residual fuel oil combustion emission limits

	Particulates		NOx		SOx	
legislation	existing	new	existing	new	existing	new
clean air act below 20 MWt	350	350	clean air legislation for small plant is not		clean air legislation for small plant is not	
20-50 MWt Part B	150	150	600	450	as enforced by local authorities	3000 by 1997
50-100 MWt Part A	140	50	650	450	limits as per individual HMIP authorisation	1700 by 2001



The Phillips North Sea Ekofisk complex.

ments of British Standards (BS 799 and BS 5410) and have a capability of sustaining fuel oil storage at 50°C minimum, distribution at 60°C minimum and atomising oil at between 70°—80°C, Thus implying full fuel oil tank heating, outflow heater and fuel lines traced and insulated.

Actual emission and efficiency improvements will, of course, be site specific. However, the fire tube boiler furnace with its generally higher combustion intensity and shorter residence time, is likely to produce the greatest improvements. Water tube boiler plants have generally lower combustion intensities and extended residence times, therefore they are likely to be operating at lower emission levels. Nevertheless these factors enable even tighter combustion conditions to be sustained making room for further emissions and efficiency improvements.

All Phillips products are refined at the Phillips-Imperial Petroleum (PIP) refinery (jointly owned with ICI) at North Tees, which uses as feedstock only low-sulphur crude oil from the North Sea.

PIP is the only straight-run refinery in the UK, ensuring that the high-quality crude remains unadulterated during the refining process and always produces a premium product. In recent years PIP exported a significant percentage of its output to Scandinavia, where environmental standards are the highest in Europe.

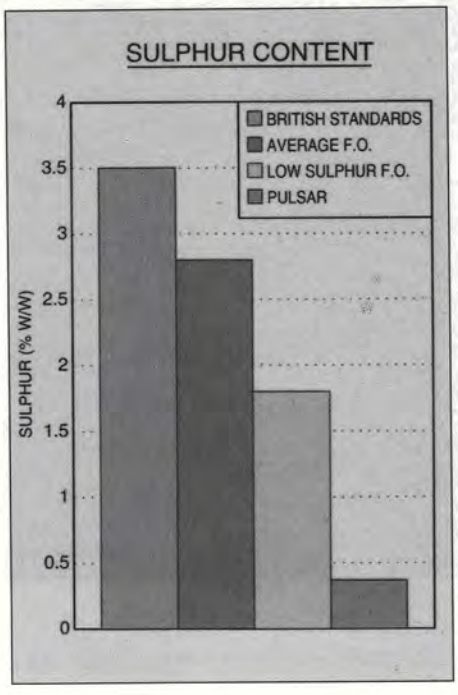
In 1991 PIP achieved the quality standard BS 5750 certification. Phillips and ICI are making considerable investment in the refinery including a new sophisticated desulphurisation unit which meets the most stringent environmental standards. PIP will continue to refine premium products well into the 21st century.

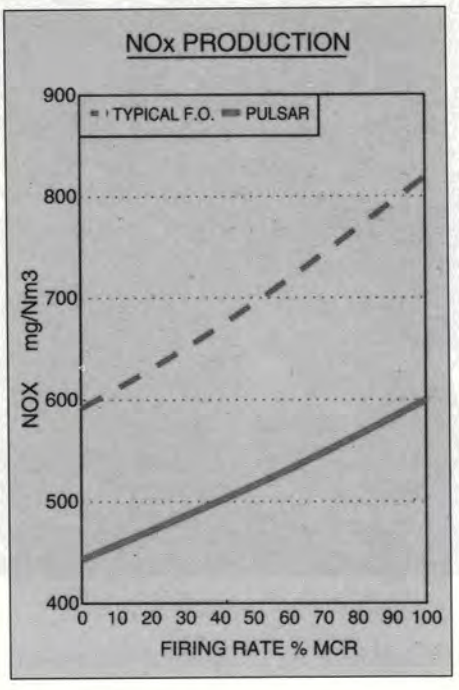
An independent fuel consultant with over 28 years experience in this field and vice-chairman of the Combustion Engineering Association, Mike Drew, said of PULSAR: "This combustion trial illustrated order of magnitude emission reductions possible on a typical industrial fire tube boiler. I have no doubt that with more emphasis on optimisation, further improvements are possible.

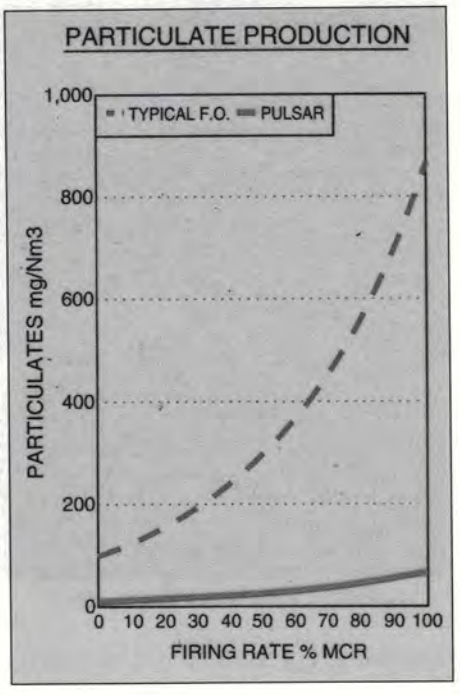
"The excellent combustion and emissions performance of the low sulphur heavy fuel oil, fully confirmed my expectations. As a straight-run atmospheric residue with a stable crude oil source and processing route, this fuel maintains a superior and consistent quality, which I believe is presently unavailable elsewhere in the UK market.

"The consistently low sulphur specification of this material should enable sub-100 MW(th) heavy fuel oil-fired plant opera-

The PIP refinery, Teeside

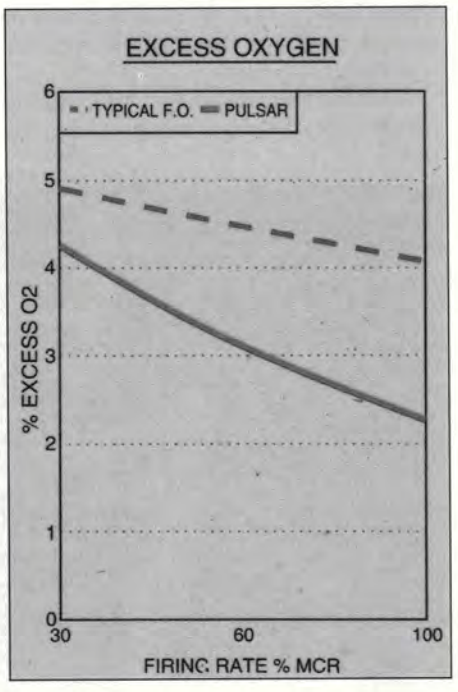






PULSAR properties

- **very low sulphur**
  typically better than 0.4% mass
- **very low ash**
  typically better than 0.002% mass
- **low viscosity**
  typically 20/25 cSt @ 100°C
- **very low metals**
  vanadium: typically less than 10ppm mass;
  nickel: typically less than 10ppm mass;
  sodium: typically less than 10ppm mass
- **low CCR**
  typically less than 6% mass
- **very low asphaltenes**
  typically less than 0.5% mass
- **high calorific value**
  44.48 MJ/kg Gross (41.86 MJ/kg Net)
- **low density**
  typically 0.9323 kg/litre @ 15°C



tors to comply with both existing and new plant SO2 emissions limits.

"The low smoke numbers, excellent carbon burn out and low particulate emissions were achieved at significantly reduced levels of excess combustion air, further reducing emissions per unit of production."

Saake Ltd, a large fuel oil burner manufacturer have also endorsed PULSAR: "We were impressed by the industrial fire tube boiler performance of this low sulphur fuel oil.

"The Saake burner delivered very low particulates, low CO and very acceptable Bacharach smoke numbers and with very low levels of excess air.

The improved particulate and smoke number performance means a cleaner boiler, and with the lower levels of excess air, improved efficiency. A reduction in NOx emission was also noted. In conjunction with retro-fitted low NOx burners, this fuel should enable many operators to meet new plant emission limits.

Any fuel oil user with sulphur or particulate emissions difficulties should seriously consider the benefits of this fuel oil."

For further information about PULSAR, contact either the Northern Region Sales Office, Garland House, 144-146 Borough Road, Middlesbrough, Cleveland TS1 2EP, tel: 01642 247183, fax: 01642 232149; or the Southern Region Sales Office,, Phillips Quadrant, 35 Guildford Road, Woking, Surrey GU22 7QT., tel: 01483 752330, fax: 01483 752718. ❑

Energy World **regularly carries a Readers' Letters page. If you would like to comment on articles, or make other observations on any subjects concerning energy, please send your correspondence to: The editor, *Energy World*, H Howland Associates, The Martins, East Street, Harrietsham, Kent ME17 1HH. Fax: 01622 850977. If possible, please keep your letters to 500 words or less, as this enables us to print as many views as possible. Publication cannot be guaranteed.**

Heavy fuel oil:

acceptable? available? affordable?

*by Steve Reeson**

In the following article the author looks at the choices facing large industrial energy users, with the prospect of increasingly strict emissions limits. He concludes that flexibility, in the form of a dual fuel strategy, is often the best option.

THE ARGUMENTS over what we should and should not be emitting into the atmosphere grow more and more intense. Industrialists, environmentalists, government bodies and pressure groups are engaged in continuous debate over the correct policy for the future.

At the heart of the matter lies one fundamental issue for major industrial energy users: which fuels will be acceptable and what does it mean for industry in formulating future energy strategies?

High profile environmental issues such as global warming, acid rain and urban air quality ensure that the emissions debate is right in the front line. Industrial processes which began 20 or 30 years ago are now being more closely scrutinised in the light of the emissions debate and the development and use of modern abatement technologies.

It is clearly a question of balancing sentiment with sound scientific and common sense. Nobody in their right mind likes to see environmentally damaging pollution emitting from chimney stacks. Yet at the same time fuel suppliers and major energy users are concerned about the way some aspects of environmental legislation and regulation are developing.

Mainstay

For many decades heavy fuel oil (HFO) has been a mainstay of UK industrial energy production. At its peak in the early '70s over 20 million tonnes per annum were consumed by industry though over the last decade industrial use has been at a lower, though fairly consistent, level of 5 to 6 MTe pa. Recent developments in both air emissions regulation and the effects of interfuel competition have meant that many industrial fuel users have been asking themselves the questions — what is the future for HFO and what impact will it have on our energy policy? These concerns may best be addressed by asking three further questions — will HFO be acceptable? will it be available? and will it be affordable?

At present the major piece of legislation governing the use of HFO is the 1990 Environmental Protection Act (EPA). It was the EPA that introduced the regulatory regime of Integrated Pollution Control (IPC) covering plant greater than 50 MWth and Air Pollution Control (APC) covering plant from 20 to 50 MWth. At present the only air emissions legislation covering the sub 20 MWth sector is the 1993 Clean Air Act (a consolidation of earlier acts). The original of Her Majesty's Inspectorate of Pollution (HMIP) Chief Inspectors Guidance Note for large combustion plant set a new plant limit for sulphur dioxide emissions (SO_2) from HFO burning boiler plant of 1700 mg/Nm^3. This SO_2 level is equivalent to burning 1% sulphur HFO. Existing plant, through the authorisation process, were expected to move towards this limit. This process incorporated the requirements of the European Union Large Combustion Plant Directive (LCPD) which set emissions limits for various pollutants from combustion processes and the first United Nations Commission for Europe (UNECE) Sulphur Protocol.

The legislation and regulation affecting emissions from HFO combustion is influenced by both trans-boundary impacts, eg acid rain, and local air quality issues. This results in authorities using a range of control mechanisms, namely mass and concentration limits from the stack and specifying the fuel sulphur content.

The UK signed the second UNECE Sulphur Protocol in 1994. This calls for reductions in UK SO_2 emissions levels of 80% by 2010 from a 1980 baseline. This is an extension beyond the 60% reduction target by 2006 committed to under the LCPD. The new targets will be incorporated into a UK strategy, including a revised national plan on SO_2 emissions due to be published shortly by the Government.

The European Union has produced a draft Sulphur in Liquid Fuels Directive which proposes a limit on HFO of 1% sulphur maximum for introduction in 2001. It has been opposed by a number of EU member states, including the UK, who have argued that such a directive is not required given the UK's commitments under the second UNECE Protocol and the measures already in place. If it is still uncertain whether this directive will eventually be adopted.

Also of key importance will be the impact of the provisions made under the 1995 Environment Act. This act requires the Secretary of State for the Environment to prepare a national strategy for air quality. This strategy will include:

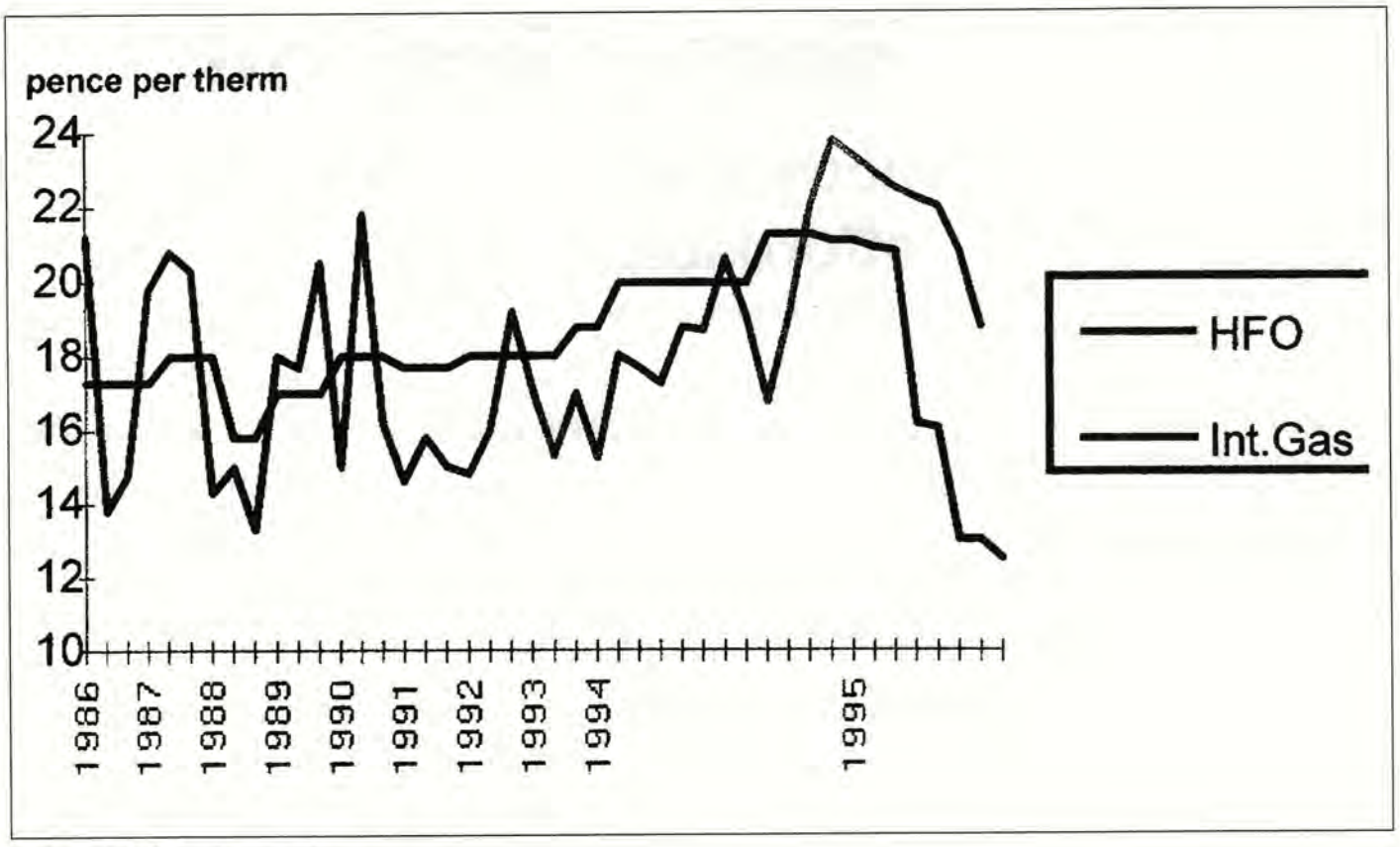
- a framework for setting air quality standards for pollutants of most concern (which includes sulphur, nitrogen oxides and particulates);
- a timetable for achieving the new air quality objectives;
- the measures to be taken by the new environmental agencies and local authorities in order to achieve the objectives and standards.

Clearly this is of major importance and the publication of the national strategy is expected soon. It will be in the detail and resource levels allocated to meet these objectives that a judgement on the full impact on fuel users can be made.

The Environment Act will be a vehicle for the UK to enact the requirements of the European Union Air Quality Directive. Technical committees set up by the EU are preparing daughter directives which will propose air quality standards for adoption by EU member states. Proposals for SO_2 standards are expected later this year.

In November 1995 HMIP published a new Chief Inspector's Guidance Note for large combustion plant. It departs from the format of the note it replaces because it now describes Best Available Techniques (BAT) rather than just presenting a set of emissions

*BP Oil Commercial Fuel Division



Competitive fuel price comparison.

targets. It details technologies that may be used to control emissions and the attainable levels for individual techniques. Boiler plant will be assessed against the techniques detailed in the note, using the principles of BATNEEC (Not Exceeding Excessive Cost), in order to set site-specific emissions levels. The HMIP technical guidance note which covers the NEEC part of the equation has yet to be published. In a revision to early drafts of this document it now acknowledges that, for aggregated plant and for individual boilers less than 100 MWth, use of low sulphur fuels (a definition that covers HFO with a maximum sulphur content of 1%) may be regarded as BATNEEC. Although the note is applicable to new processes it will also be used as guidance for assessing BATNEEC for existing plant.

Whilst acknowledging that environmental regulation is certainly putting pressure on HFO usage it is also true to say that under current and planned legislative regimes there will be scope to use a 1% sulphur HFO. It is very important that industrial fuel users ensure that this is recognised in their IPC authorisations. This is particularly important for HFO and gas dual fuel sites and for those sites on interruptible gas contracts.

However, will a 1% sulphur fuel be available? HFO may be regarded as two products — High Sulphur Fuel Oil (HSFO) with a maximum sulphur content of 3.5% and Low Sulphur Fuel Oil (LSFO) with a maximum sulphur content of 1%. Each product is an internationally traded commodity with its own set of supply, demand and pricing characteristics though there is clearly a close relationship between the two. As well as the industrial market there are also major markets in the electricity generating sector and in international marine bunkers. The European HFO demand is around 130 MTe per annum with, to a first approximation, a third going to each major market sector.

With the exception of a few process-driven applications, a market for LSFO will only develop as a result of environmental legislation. From the environmental pressures described above there is clearly a move in that direction. The rate that the market develops will differ in each European country depending on local demand and the status of national environmental regulation. The major European markets for LSFO at the present time are for electricity generation in Italy and Turkey. The current UK market is around 200 kTe per annum. This is largely due to process requirements rather than environmental though as operators move to meet their IPC authorisations demand is expected to grow.

The ability of a refinery to produce LSFO will depend on a number of factors. These are the crude oil(s) refined, the equipment and upgrading facilities available at the refinery and the demand for, and the prices of, the products it produces. Any decision to produce LSFO will have to be fully integrated into the overall refinery optimisation process taking into account the economics of also producing petrol, chemical feedstocks, jet fuel, diesel and distillate heating oils. Whether to produce LSFO or HSFO is not a decision that can be taken in isolation.

The pressure on refiners to produce low sulphur fuels is not confined to HFO only. For example the sulphur content of gasoil and diesel was reduced from 0.3% to 0.2% on 1 October 1994 with a further reduction to 0.05% for diesel on 1 October 1996. To comply with these requirements the UK refining industry has had to invest £300 million. The European Union is currently considering new directives that would reduce sulphur levels in diesel even further.

LSFO can be and is currently being produced by the UK refining industry and in sufficient quantities to meet likely future demand for this grade. In 1994 over 2 MTe were produced. In the absence, at this point in time, of a significant UK demand for LSFO this fuel has been either exported to markets where there is a demand for this product or has been 'downgraded' to HSFO for sale into the UK market. It is anticipated that LSFO will continue to be produced by the UK refining industry as the current demands and quality pressures on all petrole-

um products and the ready availability of low sulphur crude oils, eg from the North Sea, will continue into the foreseeable future.

LSFO trades at a premium over HSFO in the international market place in the same way that low sulphur crude attracts a premium over high sulphur crude. Over the last 12 months the LSFO premium has varied between $5 to $20 per Te (0.3 to 1.2 pence per litre). The size of the differential reflects supply and demand economics for the two grades. Overall Europe is deficit for HFO though in the UK, refinery supply is close to UK demand.

Finally, will HFO oil be affordable? Clearly it is very difficult and treacherous ground to be on to try to predict future competitive fuel prices. For major industrial energy users who are unable to switch between HFO and gas it is probably the single most important question they would like the answer to.

Historically HFO has been priced very competitively against interruptible gas allowing industry to benefit from the cheapest available fuel at a particular point in time. However, in mid 1995 there was a very dramatic change in the market place. As a result of de-regulation of the gas industry and the fundamental over supply in the gas market coupled to take or pay contracts between producers, suppliers and marketers resulted in very aggressive competition and the price of interruptible gas almost halving and so falling well below HFO.

The very nature of an interruptible gas contract means a site must have access to an alternative fuel source that can be brought quickly on-line if the site wishes to continue production. So far this winter Scotland, the East Midlands, the North East, the North West, South Wales, the South West and Eastern regions have all had periods of interruption. Against firm gas HFO has always been very competitive though with the fall in interruptible gas prices the differential has narrowed. However, it is questionable whether a large industrial user could actually secure a firm gas contract from a gas marketer.

Volatility

What of future prices? It is anticipated that there will be increased volatility in the gas price in the future as a result of increased competition and the development of a spot market for gas. This has already been demonstrated in other de-regulated gas markets such as in the USA.

Other factors which will influence the future will be the Network Code which will require gas users to carefully balance supply requirements and usage to avoid excessive charges. The current marginal cost of UK gas is around 8 to 9 pence per therm, which is significantly lower than the beach price at Zeebrugge, which is closer to 15.5 p/therm. The most likely trigger for a major change in the gas price is therefore anticipated to be the completion of the gas interconnector between the UK grid at Bacton and the continent at Zeebrugge, which is due for completion in 1998. This will probably result in large movements from the UK gas 'bubble' to balance UK supply and demand into the more heavily regulated, and in some aspects, less developed gas markets of Europe and so move the UK back towards balancing supply and demand. In the long term the economics currently dictating gas prices are not sustainable as demonstrated by the unwillingness of gas markets to guarantee low price contracts beyond 1997.

Fuel oil clearly faces an uncertain future, both on the environmental and on the economic front. The consequences of being regulated out of the market would be long term and far reaching for UK industry. The sensible course of action for any large industrial energy user is to keep the options open, follow a duel fuel strategy and to ensure through their IPC authorisations that this option remains fully open to them in the future. This will allow them to benefit from the lowest cost alternative fuel at any particular point in time, reduce their exposure to the volatility of individual fuels, maintain full operation flexibility and achieve continuity of energy supply. ❑

Changing role of the IAPWS

by J R Cooper and R B Dooley***

Many readers will not be familiar with the International Association for the Properties of Water and Steam (IAPWS) and its activities. At a time when the area of interest of the association is changing, it is appropriate to provide information about IAPWS and its connection with the UK National Committee for the Properties of Steam (UKNCPS).

INTERNATIONAL collaboration on the properties of steam (and water) commenced in 1929 with the first International Steam Table Conference (ISTC) in London.

The reason for this conference was because of the industrial importance of steam in electricity generation and large discrepancies in existing steam tables. There was a necessity for agreement on property values for commercial reasons when considering performance of steam plant.

The first international tables were the International Skeleton Tables of 1934 (IST 34). International collaboration interrupted by World War II recommenced in 1954 with a change of title to the International Conferences for the Properties of Steam (ICPS). The importance of transport properties for heat-transfer calculations in electrical power plant resulted in IST 63 having a supplementary release in 1964 (IST 64) of tables of viscosity and thermal conductivity (with interpolating equations).

The arrival of the computer made it possible to extend the activity of those involved in properties of steam. At the 1963 ICPS work on a different form of international standard was introduced. An International Formulation Committee (IFC) was established. This committee developed formulations for thermodynamic properties of ordinary water. One of these, IFC 67 for industrial use, is still used in the electric power industry.

At the time of the 1968 ICPS it was decided that a permanent secretariat was required to coordinate matters on the international collaboration for the properties of steam. The range of properties of interest has expanded from the thermodynamic properties for ordinary water, considered in 1929, to a wider range of properties important in engineering and science. Also the interval between the International Steam Conferences was too long for the pace of development. The International Organisation for the Properties of Steam (IOPS) was then established.

In 1972 the name was changed to the International Association for the Properties of Steam (IAPS). The organisation with agreed statutes commenced its activities with an executive committee, a permanent executive secretary and three working groups, on equilibrium properties (thermodynamic properties); transport and other properties (including static dielectric constant, ion product, refractive index and surface tension).

Initially in 1970 there was little support for considering any binary (aqueous systems), however a decision was taken to include, in addition to ordinary water, heavy water: no doubt a consequence of proposed use of heavy water in some nuclear plant.

As the organisation has evolved, changes are apparent as it adjusted to the requirements of the membership and industry.

In 1972 an *ad hoc* task group was established to study the need for a working group for trace components with water substance for power cycles.

Table 1: main international events for the properties of steam 1929-1995

1st	ISTC	1929	London	
2nd	ISTC	1930	Berlin	
3rd	ISTC	1934	New York	IST 34
4th	ICPS	1954	Philadelphia	
5th	ICPS	1956	London	
6th	ICPS	1963	New York	IST 63
				IST 64
				IFC 67
7th	ICPS	1968	Tokyo	IFC 68
	IOPS	1968		
IAPS	1972			
8th	ICPS	1974	Giens	
9th	ICPS	1979	Munich	
10th	ICPS	1984	Moscow	
11th	ICPS	1989	Prague	
	IAPWS	1989		
12th	ICPWS	1994	Orlando	

Table 2: The working groups and sub-committees of the executive committee of IAPWS from 1972 to 1995

IAPS	Pure H2O, D2O			
1972	WGI, WGII, WGIII Aqueous systems — Chemistry			
1975	WGIV			
1979	Industrial calculations			
1985	WGA	WGB		
IAPWS				
1990	SIC	TPWS	PCAS	PCC
	Industry manufacturers			Industry utilities

**Dept of Mechanical Engineering, Queen Mary and Westfield College, President IAPWS 1993-94, current chairman UKNCPS*
***EPRI USA, Executive Secretary IAPWS*

Working group IV (chemical thermodynamics in power cycles) was established in 1975. Thus power-cycle chemistry and aqueous solutions became a part of the IAPS activity. A sub-committee for industrial calculations was established in 1979.

This aqueous-solution, power-cycle chemistry activity has expanded during the past twenty years, with the four working groups being reorganised into WBA and WGB in 1985.

Thus in 1985 the ratio of pure substance activity to water chemistry-aqueous solution activity of IAPWS judged in terms of working groups, changed from four to one, to two to one.

Further adjustment of activity is evident in 1990 when this his ratio became one to one with the new working groups, following the Association changing its name to the International Association for the Properties of Water and Steam (IAWPS) and the conferences being renamed International Conferences for the Properties of Water and Steam (ICPWS) at the 1989 ICPS.

As stated in its statutes: 'The objectives of IAPWS are to advance the knowledge of the properties of water, steam and aqueous systems.'

This is done through:

- International Conferences on the Properties of Water and Steam (ICPWS) and the published proceedings of these conferences;
- critically evaluated data and formulations representing this data. This information is made available from IAPWS in the form of releases and guidelines. Releases provide carefully evaluated agreed data and formulations of properties for which measurements of high quality exist. Guidelines are prepared as releases, but for situations where measurements of high quality do not exist. It is accepted that guidelines can be expected to need revision as new measurements or new formulations become available.

For the pure substance there is not too much difficulty in producing releases as already described. There is a large amount of accurate data. In the case of power cycle chemistry, the problems of interest are those of operating plant and cannot be dealt with in documents such as the release or the guideline, because of their complicated nature and lack of data. Thus these have not been natural products of working groups WGIV WGB and PCC. A document which has recently emerged from IAPWS is the Certified Research Need (ICRN).

The ICRN has been introduced to give information to the outside world on the areas where the assembled experts in an IAPWS working group identify gaps in knowledge that are important, for instance, to the economic operation of a steam plant.

Current IAPWS guidelines and releases

- **Release:** ***IAPS Skeleton Tables 1985 for the Thermodynamic Properties of Ordinary Water Substance*** **(September 1994) (This is a revision of the 1985 release)**
- **Release:** ***Surface Tension of Water Substance*** **(September 1994) (This is a revision of the 1976 release)**
- **Release:** ***Surface tension of Heavy Water Substance (D20)*** **(September 1994) (This is a revision of the 1985 release)**
- **Guideline:** ***Solubility of Sodium Sulphate in Aqueous Mixtures of Sodium Chloride and Sulphuric Acid from Water to Concentrated Solutions, from 250°C to 350°C*** **(September 1994) (This is a revision of the 1990 guideline)**
- **Guideline:** ***Solubility of Simple Apolar Gases in Light and Heavy Water at High Temperature*** **(September 1993)**
- ***Release on the Pressure along the Melting and Sublimation Curves of Ordinary Water Substance*** **(September 1992) (This is a revision of the 1986 release)**
- **IAPS Supplementary Release:** ***Saturation Properties of Ordinary Water Substance*** **(September 1992) (This is a revision of the 1986 release)**
- **Release:** ***Values of Temperature, Pressure and Density of Ordinary and Heavy Water Substances at their Respective Critical Points*** **(September 1992) (This is a revision of the 1983 release)**
- ***Release on the Refractive Index of Ordinary Water and Steam as a Function of Wavelength, Temperature and Pressure*** **(September 1991)**
- **Guideline:** ***Electrolytic Conductivity (Specific Conductance) of Liquid and Dense Supercritical Water from 0°C to 800°C and Pressures up to 1000 MPa*** **(May 1990)**
- **Release:** ***IAPS Formulation 1985 for the Thermal Conductivity of Ordinary Water Substance*** **(November 1985)**
- **Release:** ***IAPS Formulation 1985 for the Viscosity of Ordinary Water Substance*** **(November 1985)**
- **Release:** ***IAPS Formulation 1984 for the Thermodynamic Properties of Heavy Water Substance*** **(December 1984)**
- **Release:** ***IAPS Formulation 1984 for the Thermodynamic Properties of Ordinary Water Substance for Scientific and General Use*** **(December 1984)**
- **Release:** ***Viscosity and Thermal Conductivity of Heavy Water Substance*** **(February 1984)**
- **Release:** ***Ion Product of Water Substance*** **(May 1980)**
- **Release:** ***Static Dielectric Constant of Water Substance*** **(1977)**
- ***The 1967 IFC Formulation for Industrial Use***

It is hoped that the ICRN will highlight these gaps, encourage research on these problems and provide some assistance to researchers in obtaining financial support from sponsors.

Also with the aim of advancing the knowledge of the properties of water, steam and aqueous solutions IAPWS sponsors a limited number of projects. These are not extensive research projects but are normally for situations where an IAPWS document, involving members of an IAPWS working group, is in preparation and requires the skills of a research worker, who is not an IAPWS working group member, to work away from home. IAPWS will fund the required travel and subsistence.

The members of IAPWS are countries acting through their national committees. The members are either full members, normally called 'members', who pay dues, or associate members, who do not pay dues.

The executive committee (EC) is responsible for the operation of IAPWS and comprises the national delegates of the full and associate members and the chairman and sub-committees of the EC and of working groups. Only the delegates of the full members have voting rights.

The membership of the working groups includes, in addition to experts from the national committees of the members, other people who are authorities on topics considered by the working group from member and non-member countries. Also the working groups call on, from time to time, experts who are not members of the working group in the process of obtaining carefully evaluated data and formulations.

At the present time, conferences (ICPWS) are held every five years. The EC and its sub-committees and working group meet

IAPWS Certified Research Needs (ICRNS)

1 Evaluation of Binary Nucleation Models. Issued September 1993. Expires September 1996. IAPWS Contact: F Sigon.

2 Solubility of Sodium Sulphate in Superheated Steam. Issued September 1993. Expires September 1996 IAPWS Contact: K Daucik

3 Solubility of Spinels in the Chemical Conditions of Nuclear Reactorse. Issued September 1993. Expires September 1996. IAPWS Contact: I Lambert

4 Interaction between Sodium Salts (Phosphates, Sulphates, Silicates, Borates) and Transition Metals Oxides. Issued September 1993. Expires September 1996. IAPWS Contact: J Stodola

5 Origin, Behaviour and Fate of Organics in the Power Cycle. Issued September 1993. Expires September 1996 IAPWS Contact: R Gilbert

6 Thermophysical Properties of Ammonia-Water Mixtures. Issued June 1994. Expires June 1997. IAPWS Contact: W Parry

7 Carryover Coefficients of Salts and Metal Contaminants in Boiler Water. Issued June 1994. Expires June 1997. IAPWS Contact: P Tremaine

8 Development of an Accurate External Reference Electrode for use in High Temperature and High Pressure Aqueous Solutions. Issued August 1994. Expires August 1997. IAPWS Contact: S Lvov

9 Thermodynamic Models for Transition — Metal/Water Systems under Steam Generator Conditions. Issued September 1994. Expires September 1997. IAPWS Contact: P Tremaine

annually. Also business, particularly of the working groups, is conducted by post and other means between meetings of the EC.

Amongst the duties to IAPWS of the members are the procurement of the services of qualified personnel to participate in the IAPWS scientific and technical activities; and to bring to the attention of IAPWS the relevant research in the member country. The national delegate will have another important duty, not to IAPWS but to his national committee. This is to report back to the national committee the activities of the IAPWS.

At the present time, although earlier statements have indicated a major shift from the pure substance activities of IAPWS, the working groups, Thermophysical Properties of Water and Steam (TPWS) and the Subcommittee for Industrial Calculations (SIC) are very active.

In the case of SIC it had been felt, about five years ago, that the formulation used by industry for the thermodynamic properties of H2O, IFC 67, should be examined. Industry with IFC 67 already installed on their computers would not be particularly keen to make changes unless any replacement were significantly faster in computing time and not less accurate. IFC does have some disadvantages in that it is based on the IST 63 and is not accurate in the critical point region and, perhaps more important, since the formulation comprises six subregions with discontinuities between sub regions problems result when iterating across boundaries. A task group is currently working on a replacement which will, it is hoped, be at least twice as fast as IFC 67 and may become available in 1995 or 1996.

The revision of the International Temperature Scale four years ago made it necessary for IAPWS to review its releases, supplementary releases and guidelines. It may be remembered that the change from the International Practical Temperature Scale of 1968 (IPTS-68) to the International Temperature Scale of 1990 (ITS-90) caused water to change its boiling point from 100°C to 99.974°C. Most of these IAPWS documents are the concern of working group TPWS.

Also the IAPS Formulation of 1984 for the Thermodynamic Properties of Ordinary Water Substance for Scientific and General Use has some imperfections that were felt worth correcting in the critical point region as well as for the liquid at temperatures below 0°C. It is anticipated that a new formulation replacing the 1984 formulation will be available soon. Data from it will be used in the preparation of the final version of the new industrial formulation to give consistency between the two formulations.

The other two working groups, Physical Chemistry of Aqueous Solutions (PCAS) and Power Cycle Chemistry (PCC) are both very active. Their current areas of interest are indicated by the list of ICRNs. All but one of these ICRNs have come from these working groups in the last two years.

It is hoped that this article has provided some enlightenment on international collaboration on the properties of steam and the connection to IAPWS through the UKNCPS.

On the assumption that the electric power industry, and others, in the UK have problems with steam and the impurities which may be present, it is pointed out that they have access to IAPWS and are able to influence IAPWS activities through the UKNCPS.

Copies of the releases, guidelines and IAPWS Certified Research Needs are available from: Dr R B Dooley, Executive Secretary of IAPWS, Electric Power Research Institute, 3412 Hillview Avenue, Palo Alto, CA 94303, USA; or Mr J R Cooper, Department of Mechanical Engineering, Queen Mary and Westfield College, Mile End Road, London E1 4NS. ❑

IAPWS Membership (1995)

Members

Argentina
Canada
Czech Republic
Denmark
France
Germany
Japan
Russia
UK
USA

Associate Member

Italy

2nd International Conference: Combustion and Emissions Control

by R M Davies

The second international conference on combustion and emissions control was held in London at the beginning of December 1995. As previously, the emphasis was on research and development into pollutant reduction from a wide range of combustion plant and processes.

THE Institute of Energy's second international conference on combustion and emissions control was held on 3-5 December at the Commonwealth Conference and Events Centre in London.

There were seven principal technical sessions held in two streams over two days. The main themes of stream one were: emissions control, plant performance, industrial burners and furnaces. Stream two covered energy from waste and biofuels, modelling for industry, advanced power generation and internal combustion engines.

Following a welcoming speech by Professor J S Harrison on behalf of the Institute of Energy, the plenary lecture was given by Professor Janos M Beer of the Massachusetts Institute of Technology. Professor Beer's theme was *Trends of combustion R & D in the USA: are environmental regulations driving?* The speaker after outlining the environmental regulations in the USA described the technological response and the resultant R & D programmes with emphasis on utility power generation, including the Coal 2000 programme.

'Emissions Control' formed the largest single session with 12 papers including keynote addresses by Dr T M Lowes of Blue Circle Industries (emissions from cement kilns) and Dr M Bigg of Her Majesty's Inspectorate of Pollution (HMIP) (protection of the environment). The contributed papers to the session and to the conference in general originated from a range of universities, equipment manufacturers and plant operators. The major topic within the session was NO_x control. Twist and Hargreaves of Bray Technologies and Solero and Beghi of Worgas Bruciatori described design aspects of low emission burners for the domestic gas market. At the other end of the application scale were several papers concerned with utility power generation dealing with NO_x control by coal selection, air staging and reburning. There were also two papers concerned with control of N_2O reduction from fluidised bed combustors (Chalmers University, Sweden and the Universidade Nova, Lisbon).

Completing the session were papers on prediction of phases and compositions present in power station fly ash and their influence on use and disposal, on flue gas desulphurisation and on the formation of ammonia in advanced coal power generation schemes of the air-blown gasification cycle type.

'Plant performance' opened with a keynote address by Professor Arthur Lefevre on *Gas turbine combustor design trends for low emissions* which described the requirements for advancing from low NO_x combustors to ultra-low NO_x via a number of fuel and air mixing strategies including lean premix and staged combustion.

The other six papers in the session involved a wide range of plant types.

Natural gas utilisation was represented by papers from British Gas concerned with the emissions produced when supplementary fuel is burnt in gas turbine exhausts and from Middlesex University, which reported performance data from a laboratory pulse combustor rig. The combustion of low CV gases was catered for in a paper from the University College of Wales, Cardiff, in which detailed studies of flow patterns and temperature fields in swirl burners were reported.

The operational factors which control the emissions from stoker fired boilers were detailed in a paper from Babcock Energy/ETSU.

The results of the implementation of low NO_x burners for oil and gas firing on utility boilers in the USA (AUS/Hamworthy) and of combustion modifications plus FGD on a brown coal fired boiler in Germany (Steinmuller) were described in the remaining two papers in the session.

Professor James Harrison, a past president of the Institute, pictured left with Professor Janos Beer of the Massachusetts Institute of Technology

PHOTOGRAPH: JOHN BAKER

The reduction of NO_x emissions in glass melting by optimisation of firing arrangements was further considered in a joint paper by Gasunie and British Gas. The use of gas burners with precessing vortex cores in cement kiln firing was described by Dr Nathan of the University of Adelaide. The session was completed by a contribution from Italy on the ability of water in fuel oil emulsions to reduce particulates, NO_x and SO_3 emissions.

Energy from waste and biofuels featured a keynote address by Professor Klaus Hein from the University of Stuttgart who described the results of a European Union programme on *Co-combustion of coal and biomass in pulverised fuel and fluidised bed systems.* The results of the recently completed programme showed that significant amounts of straw, wood and sewage sludge can be combusted in conjunction with coal and that co-combustion offers one of the cheapest opportunities for the thermal utilisation of large amounts of biofuel. Two other papers in the session were also concerned with aspects of co-combustion. The IFRF reported on trials in a boiler combustion chamber simulator at IJmuiden with a combined pulverised coal/biomass/straw burner. Portugese authors from ITE-INETI described the results of combined straw-coal combustion in an atmospheric FBC. Devolatilisation and combustion characteristics of sewage sludge in a fluidised bed were outlined in a joint German/Belorussian paper. The issue of incinerator control was addressed in a paper from Sheffield University in which a spectroscopically based 'peak seeking' method which offers advantages over existing methods was described.

In contrast to reports of experiments, the sixth paper in the session was a theoretical study of the economics of wood-fired power generation by authors from the University of Ulster. A conclusion of the study was that plants of over 500 dry tonnes per day are economically viable and that plants > 1000 tonnes/day should be competitive with large-scale conventional coal-fired units.

'Modelling for industry' consisted of five papers with a keynote address by Barry Jenkins of Fuel and Combustion Technology, who reviewed and described the use of physical flow models for industrial combustion plant applications. Three of the other papers in the session essentially involve computational fluid dynamics; UCW Cardiff — prediction of velocity, NO_x and temperature distribution in a cyclone combustor; University of Queensland — NO from a pulverised coal flame with an emphasis on the nitrogen chemistry; University of Athens — prediction of slag formation and surface motion in a pulverised coal combustor. The session was completed by reporting a process flow sheet modelling study of a number of 'clean' fossil fuel power generation technologies by authors from the University of Ulster with an emphasis on the cost of reducing CO_2 emissions.

A break for coffee, and a chance to discuss the proceedings so far.

PHOTOGRAPH: JOHN BAKER

'Advanced power generation' was reviewed by the keynote speaker Mr M Coney of National Power in which the opportunity was taken to cover developments in both gas and coal-based systems. The remaining four contributions to this session dealt with somewhat diverse power sources. The paper by Wolpert *et al* of Nottingham University describes a system in which heat from a solar collector is used to run a Rankine cycle from which any surplus electricity can be stored as hydrogen via electrolysis; the hydrogen can be converted to electricity by means of a fuel cell. In a further paper from the University of Ulster a detailed environmental study was made of power generation based on molten carbonate and solid oxide fuel cells. Timnat and Goldman from Technion-Haifa describe the use of a coal-burning countercurrent combustor plus multicyclone and barrier filter to eliminate ash prior to expansion through a turbine. In the paper by Milani and co-authors an account is given of a steelworks power system in Italy in which low calorific value process recovery gases are used to fuel a gas turbine-based combined heat and power system.

Exhibitors included the DTI, Land Combustion, National Power, PowerGen, Codel, the Technology Foresight Programme, and Mitsu Babcock Energy.

PHOTOGRAPH: JOHN BAKER

'Internal combustion engines' consisted of three papers including the keynote address by Professor Dinos Arcoumanis of Imperial College; the paper forming the address was co-authored by colleagues from ICSTM and the Ford Motor Company, UK. The paper dealt with various methods that had been investigated for reducing particulate emissions from diesel engines including reduced soot formation, enhanced soot oxidation and after treatment devices. Also from Imperial College was a paper on computer modelling of a diesel engine to define optimum turbo-compounding arrangements. The final paper, from Birmingham University, was devoted to the concept of onboard reforming of fuel to produce a gas which has a substantial hydrogen content. Experiments showed that up to 55% NO_x reductions were achieved on a single cylinder test engine.

41 papers were presented at the conference of which 25 were from the UK, indicating the success of the conference as an international event.

The sessions were chaired by Tom Lowes (Blue Circle Industries), Anu Sanyal (IEEC), Klaus Hein (University of Stuttgart/University of Delft), Alan William (University of Leeds), Arthur Lefevre (Cranfield University), Peter Roberts (IFRF), Nick Syred (UCW, Cardiff).

The conference was accompanied by a popular exhibition. ❑

Report from Council

A MEETING of Council was held at 18 Devonshire Street on Thursday, 2 November 1995, chaired by the President, Mr D G Jefferies.

Under 'matters arising' from the previous meeting the President highlighted our proposed conference on energy policy to be held in April 1996. This was to be a high level event, coming as it did at a time when energy markets were changing rapidly.

The Hon Secretary reported that the British Energy section of the World Energy Conference were discussing UK energy policy and had invited the Institute to be involved in the discussions.

The President introduced the report of the Working Group who had been looking at the alternatives open to the Institute for the future. This group had been exploring the possibility of working together with another institution, to give financial savings which could be channelled into better services for members. Unfortunately the Working Group could not recommend to Council that the current negotiations with another institute should continue, but it was agreed that further investigation of possible alliances with other institutions would continue and a report be brought back to the next meeting.

Executive committee

Council was informed that the Institute had been reaccredited as a nominated body of the Engineering Council and is now accredited until November 2000.

The collaboration between the smaller institutions in College D (endorsed by Council on 11 May 1995) was now proceeding and the first representative on Senate will be from IGasE with IoE supplying the second in two years' time.

Council was made aware of the current portfolio of project work which the Institute is engaged in tand the Institute Secretary pointed out that projects were becoming an increasing income provider. During 1995 the Institute has been engaged on TEMOL; the Energy Efficiency Training Series; National Occupation Standards for Energy Management; CPD in Energy Management;; Enabling Effectiveness in Energy & the Environment; Good Practice & Appraisal of Energy Management Projects; Energy Efficiency Training Days; and in the Energy Efficiency Accreditation Scheme. Through this the Institute has been developing a new corporate identity.

Election 1996

The Institute Secretary reported that in accordance with the byelaws of the Institute, five ordinary members of Council chosen by rotation of continuous service were required to retire at the conclusion of the AGM to be held in May.

The Chairman of Membership Committee stated that all branches except one now had membership advisors and he thanked the branches for the response.

He also pointed to the excellent job the Institute has made on the Career Management Planner for CPD and said that it was another example of 'this Institute leading the way'. Finally he appealed for someone who is well versed in NVQs to join the committee.

Council was informed that the Institute had been put in the 'Engineering at Home' category, but had also applied to be involved with 'Engineering for the Environment' and 'Engineering at Work'

Council endorsed the recommendation that the recipients of the Recognition of Services Award for 1995 be Mr G Orme, Mr M Allen and Dr P Mullinger.

The Institute had received a letter from the Engineering Council in which institutes were invited to take the lead in setting up one of four activities: transport, environment, energy and communications.

Engineering Council

It was decided to reply positively for the energy activity, and also offer to participate, with others, in the environment activity.

Ideal small venue

THE Institute of Energy's headquarters at 18 Devonshire Street, in the West End of London, near Regents Park, offer a pleasant and convenient venue for small meetings. The accommodation comprises two meeting rooms, seating up to 30 people,

Situated between Harley Street and Portland Place, 18 Devonshire Street is only a few minutes from London Underground stations Portland Place, Baker Street and Regents Park and rail termini, and has the added advantage of being able to offer the hire of catering facilities and overhead projectors.

Rates of charge are lower than you would expect for such a prestigious and convenient venue, and special rates are available for members of the Institute.

For more information on availability and rates, please contact Derek Smith on 0171 580 7124.

The Institute of Energy needs you!

ARE you a qualified NVQ assessor? Are you an energy management professional? Does your organisation have an NVQ Centre, or is it interested in the provision of NVQs for employees?

If you can answer 'yes' to any of these questions, and you are keen to take part in the Institute's role to assist in the provision of NVQ Units in Energy Management, please contact Louise Evans, tel: 0171 580 7124, or fax: 0171 580 4420.

The Institute of Energy

Presidential officers and honorary officers 1996/97

THE UNDERMENTIONED have been elected by Council to take office following the Annual General Meeting on 2 May 1996.
P H J Johnson to become President: **M B PITTWOOD** — Honorary Treasurer

Election of Council 1996/97

Following the AGM, the undermentioned will retire and are not eligible for re-election:
A W COLES, PROF D T SWIFT-HOOK
The undermentioned members will retire but are eligible for re-election for a further year:
H ETHERINGTON, A J MINCHENER, J D SUTHERS
The Honorary Secretary, **H F FERGUSON**, will retire and will not seek re-election.
The undermentioned have been nominated by Council:
H ETHERINGTON, A J MINCHENER, J D SUTHERS, J BAILEY (IEng representative), **S TAULBUT** (IEng representative), **DR P J MULLINGER** (Honorary Secretary).
Any 10 Corporate Members may nominate, in writing, any duly qualified person to serve on Council.
Any 3 Corporate or Associate Members may also nominate in writing an Incorporated Engineer to serve on Council. A vote for Associate Members would be by Associate Members only.
All nominations, together with the written consent of the nominee to serve, should reach the Secretary of the Institute not later than eight weeks before the AGM, but preferably earlier. (Members are not, however, permitted to join in the nomination of more than three persons in any one year.)

Group Affiliates meeting — report

FOLLOWING our report in *Energy World* last year (May 1995) on the success of the first meeting to debate international activities on climate change and sustainable development, a second meeting chaired by Professor James Harrison was held in September 1995 at the Institution of Gas Engineers by invitation of British Gas, one of our Group Affiliate members participating in this important debate.

Group Affiliate members of the Institute of Energy, Government officers and industrial representatives were briefed on the developments of the Climate Convention which included the Berlin Mandate and the establishment of subsidising bodies on Implementation and on Science and Technology.

Acknowledged experts who had represented the UK at the International Convention meeting discussed the implications for industry and the possibilities for improving industry input to the international process.

Dr F Shephard, British Gas Research Centre, and Consultant Dr K Gregory highlighted the aim of the Berlin Mandate as negotiating further commitment from industrialised countries to be able to produce a Protocol for signature in 1997, with enforcement in 2000, with set targets for emissions reduction of greenhouse gases. The UK view is that reductions of 5-10% by 2020 should be possible in industrialised countries.

Dr Fish, who had led the UK delegation at the Geneva meeting in August, emphasised that the UK position was to take policies and measures aimed at achieving reduction but respecting specific timetables as targets to be unrealistic. The UK national report has made this position clear and new figures cited in the next greenhouse gas emissions report which would be available shortly would be used as the basis for discussion.

The discussion focused on the relationship between the restructuring of the energy industry and reduction in greenhouse gas emissions which had followed, largely achieving the targets for 2000. Stabilising the reduction of CO_2 for the next decade and the reduction of other gases, such as methane, presumed that total greenhouse gas emissions would be reduced. However, CO_2 emissions are predicted to rise sharply after 2010 from the transport sector.

This being the case, in order to meet national targets to reduce emissions, a call for Government action beyond current support will be required. It was also acknowledged that there is still much scope for further emissions reduction through energy savings. Government representatives endorsed the last comment but acknowledged industry representatives difficulties in getting priority for energy projects. Energy savings were too often regarded as discretionary activities with company spending priorities.

It became obvious that there was still much to be done in terms of educating energy users and consumers that spending less initially is not likely to save more in the long term and that sharing costs is equally as important as generating income on the bottom line and should rank equal priority.

It was though that cases for consideration should include obligatory standards for efficiency and grants and tax benefits to promote energy saving equipment and manufacture and sale.

As a conclusion to the meeting Dr Gregory reported on Geneva discussions regarding subsidiary bodies. The SB on Implementation had met without discord, but the SBSTA had, even with extra time been unable to complete its programme. They agreed the fullest use of IPCC to provide advice, even in the next five years. The stumbling block was the two technical advisory panels, an accepted Methodologies one and a Technologies one, which could not be agreed. An argument about who was going to advise whom about what essentially!

These issues were not resolved and must now wait until the next meeting in February, which will hold up some aspects of work under the convention.

The next meeting of Group Affiliate members will discuss the new national report of greenhouse gas emissions and industry input to the convention industrial workshop.

Obituary

Antony William Thomas Cleaver

A FUNERAL service for the late Antony William Thomas Cleaver, who had died on 30 November 1995, aged 67 years, was held at the Collegiate Church of St Michael and All Angels, Tettenhall, Wolverhampton, on Friday 8 December.

Tony, as he was known to his many friends, joined RTZ after leaving Cambridge with an MA in natural science. Later he moved to the post of fuel engineer at the Weldless Steel Tube Company in Wednesfield, before becoming a fuel engineer for the Tube Investments Group. Subsequently, he became a consultant, when TI Group Services were disbanded.

This distinguished career was matched by a magnificent record of service to the Institute in general, and the Midland branch in particular. After joining the Institute in 1964, Tony became a member in 1970 and was elected a fellow in 1974. One year later, at the proposal of the late Edward Raybould, Tony became Chairman of the Midland branch, but instead of leaving the committee after his year as immediate past chairman, he stayed on to become successively the branch's honorary secretary, honorary treasurer and a Council member, and was honorary treasurer again at the time of his death. In total Tony gave 22 years of continuous service to the Midland branch committee, and justly deserved the Institute's Special Services Award. This service to the Institute will long be remembered by his many friends, whose lives he enriched by his friendship. Tony's other great interest was campanology, which was the subject of his chairman's address, and it was fitting that the church bells were rung in his remembrance at the funeral service. Our sincere condolences go to his wife Mavis, who had been Tony's constant partner for some 40 years, and to his family.

D E A Evans

Restructuring the electricity and gas markets: the new scene

DURING the last twelve months, the UK electricity and gas markets have experienced considerable structural changes.

Restructuring the electricity and gas markets: the new scene is the timely title of an Institute of Energy conference, to take place on 24 April at the CBI in London.

While organisations within the electricity and gas markets seek to stabilise and strengthen their positions, competition grows stronger as the market becomes increasingly diverse. Dynamic combinations of management, strategies and alliances are emerging to cope with the restructuring of the market place and the emergence of the reconfigured utilities.

The conference will examine and debate some of the future policies that key market players see as vital to the successful development and progression of the energy markets into the next millennium.

Speakers will include David Jefferies CBE FEng, Prof John Chesshire of SPRU, Ed Wallis (PowerGen), John Devaney (Eastern Group), Ian Blakey (CBI), Cedric Brown (British Gas) and Sir Philip Jones (Total Marine Oil).

For further information about this conference, telephone 0171 580 0008.

Range of options

'Power from coal — where to remove impurities' by Gordon R Crouch. Published by IEA Coal Research, Report 82, London, 87 pp, £450.00

IN THE long chain of processes that stretch from the virgin seam of coal to the clean energy that maintains our civilisation, the links which remove unwanted 'impurities' from the natural raw material gain greater significance with every step in the legislative procedures towards global environmental protection.

Gordon Crouch's latest report covers specifically the combustion and gasification of coal for power generation in the meticulous and thorough-going fashion we have come to expect in his many IEA papers.

His discussion considers the mechanisms of removal at different stages and leads to an increased understanding of the possibilities of where to remove impurities in different circumstances.

During FBC and pf combustion, coal particles and the impurities present are subjected to markedly different time-temperature cycles, and the same is true of the variety of gasification methods. There is also a fundamental difference between the chemical environment experienced in gasification compared with combustion: therefore the behaviour of the impurities and the chemical transformations that take place are different.

A review of traditional practices for the removal of impurities is made necessary by a range of factors: the tightening of emission limits for particulates; concern over CO_2 emissions; increasing concern over the environmental effects of disposing of residues; the need for higher energy efficiencies; the greater pressure for reduced power station operating costs; and new technical developments which make fresh solutions possible and economic.

Impurities present in coal may increase transport costs, cause plant operating problems, or harm the environment if not controlled on release. The materials are mainly inorganics present either as mineral matter or as chemically combined elements within the organic structure. Some impurities may be picked up during the handling or treatment of coal before it is used — for example, small quantities of magnetite may be discarded during dense-medium washing, and sulphur in varying proportions is found in the form of mineral matter and organically bound.

Changes in the many regulations affecting emissions and the disposal of residues are altering the economics of coal usage, and regulations and restrictions are being applied in an increasing number of countries. There is often a choice between removing a component before coal is burned or gasified, or removing it from flue gas before discharge.

It may be possible to avoid the presence of some impurities by selective mining. Others can be removed or reduced by cleaning at the mine before transport. New processes under development offer the possibility of treatment at the site of use, and greater thought should be given to liberating minerals during milling.

As the power of computer-based analysis grows it is becoming easier to pinpoint causes and effects. Models which address the whole coal-to-electricity chain need to be developed and validated. It is already apparent that there is a range of options available for meeting the requirements of low-cost power **and** environmental acceptability. The extent of unknown factors which may affect the cost of coal-to-electricity must be reduced. At the same time, use must be made of developing technology and understanding, and areas of further research identified. Areas of incomplete knowledge must be improved by further development so that commercial decisions can be taken with greater confidence.

Peter Heap

A valuable service

'Clean coal technologies for developing countries' by E Stratos Tavoulareas & Jean-Pierre Charpentier, World Bank Technical Paper 286 — Energy Series. Published by The World Bank, Washington DC, 83 pp.

WHILE coal remains by far the largest fossil fuel resource available to mankind and is the most widely distributed across the five continents, there is a pressing need for a continuing dissemination of information about the technologies available for burning it as cleanly as possible and with the greatest possible efficiencies.

Much of the yet-to-be-exploited world coal resources lie in the regions where developing countries predominate, and where most coal is still consumed in inefficient and polluting ways. The World Bank has done a valuable service in Technical Paper 286 of its well-respected Energy Series *Clean Coal Technologies for Developing Countries* by surveying the range of developments available which have **practical** value in economies of limited means.

The report concentrates on commercially available technologies that are currently suitable and affordable. But it also reviews more advanced demonstration-stage projects in anticipation of both increased regulatory requirements and a drop in the costs of such technologies that would make them both necessary and practical for developing countries some time in the future.

The paper is especially concerned to help policymakers choose and justify technologies appropriate to their needs. Three chapters are devoted to the relationship between environmental regulations and the choice of technology, screening methods for evaluating relevant technologies, and the World Bank's recommendations on strategy for promoting the dissemination of clean coal techniques.

Although there have been previous surveys of established and burgeoning clean-coal developments, this is the first look at the subject on a global scale with the specific economic and financial needs of developing countries as its main consideration.

It has three main recommendations for the World Bank to promote benign technologies without encouraging countries to choose high risk/high cost options:

- develop criteria that must be met by any technology before it can qualify for use in developing countries;
- undertake a technology risk assessment that identifies the risks associated with any individual technology and propose a risk management plan;
- initiate a study to assess the cost-effectiveness of power plant life extension or rehabilitation technologies.

Recently published

'Engineering applications of pneumatics and hydraulics' by Ian C Turner, in collaboration with the Institution of Plant Engineers. Published by Arnold, London, December 1995, 192 pp, £14.99. Available from Arnold, 338 Euston Road, London NW1 3BH. Tel: 0171 873 6000; fax: 0171 873 6325;
e-mail: arnold@hodder.mhs.comuserve.com

'UK industrial and commercial coal markets' by Malcolm Rainbow and David Price. £350.00. Published by McCloskey Coal Information Services, P O Box 15, Petersfield, Hants GU32 3RG. Tel: 01730 265095; fax: 01730 260044.

'Italian electricity towards privatisation and beyond 2000: an alternative prospectus' by David Lane. Published by FT Energy Publishing, November 1995, £350.00. Available from FT Energy Publishing, Maple House, 149 Tottenham Court Road, London W1P 9LL. Tel: 0171 896 2241; fax: 0171 896 2275.

'Clean air around the world' Edited by Loveday Murley. Published by IUAPPA, 1995, 400 pp, £49.00. Available from NSCA, 136 North Street, Brighton BN1 1RG. Tel: 01273 326313; fax: 01273 735802.

Europe's biggest wind farm

Energy World has published two more letters on the renewables (Readers' Letters, December 1995) which are ill-directed as far as wind power is concerned.

Mr R G Loram flatters me, although I am sure it is unintentional. He says that it is incumbent upon me to declare how much wind farm capacity can be installed before it is necessary to make provision for alternative generating capacity, specifically to replace wind power when it is not available.

25% wind power

It is not innate modesty that compels me to say that my own views on the question cannot matter so very much. On the other hand, the official views of the government department responsible for energy do matter, and I am happy to quote them. The latest *Assessment of renewable energy for the UK* (HMSO, 1994) for the Department of Trade and Industry states that: **'Technically there is no firm limit to the non-firm power than can be accepted by the electricity supply system. Before privatisation of the ESI, the CEGB estimated that up to 20% of the peak power demand on the grid could be provided from non-firm sources without changes being necessary to the grid operating system.'**

Germany has installed more wind power over the last two or three years than any other country in Europe, more than 800 MW in fact. It is interesting to note that the province of Schleswig-Holstein can now generate 25% of its maximum demand from wind power without experiencing any great difficulties.

Adequate reserves

It would be foolish to allocate reserve capacity specifically for one particular type of plant on the power system, as Mr Loram suggests. Imagine refusing to keep the system running just because the wrong type of plant had gone out of service! All reserve capacity is kept available to meet any shortfalls, whatever sort of plant may fail, and so the cost should not be aggregated with any specific method of generation. In the foreseeable future, nuclear (and to a lesser extent large coal) plant will continue to present the greatest problems with loss of availability because of their large unit sizes. Already their liability to fail at critical periods has pushed up the pool price of electricity by more than 40 times, on occasions — to over 110 p/kWh!

By contrast, experience with wind is quite favourable. The availability of power plant (wind, nuclear or any other) only becomes crucial at times of peak demand. This is reflected in the TRIAD payments to the National Grid Company which cover the three half-hours of greatest demand in a year. National Power have demonstrated that their wind farm capacity factors are typically 50% higher during periods of peak demand than average all-year capacity factors. This has already resulted in substantial extra value for the electricity from their wind farms, which NP estimate at around 0.25 p/kWh.

Mr Loram asks who would be responsible for securing adequate generating capacity. Following the privatisation of the CEGB, that responsibility lies with the electricity regulator, with help from the National Grid Company. I am not aware of any intention to change that arrangement and greater wind penetration will certainly not make it necessary to do so. TRIAD and Loss of Load Probability (LOLP) payments are ways in which they promote competition to this end. It is only fair to point out, however, that the most serious power supply difficulties the country is ever likely to face over the next decade or two are not lack of availability, but rather over-capacity due to cheap gas. This will inevitably result in the closure of coal mines and the stagnation of the nuclear industry.

Mr Loram's fears for wind power can be laid to rest. The DTI (and myself) see no difficulty in wind power meeting 20% or more of system demand. Far from shortage of wind being a particular problem, there is extra credit for wind plant because the wind tends to blow harder during the crucial TRIAD periods of peak demand.

Wind prices are converging

Turning to Mr Daniel's letter, he still seems unfamiliar with the wealth of published data on costs and performances of wind farms that is readily available. He should consult the annual conference proceedings of the British Wind Energy Association (Published each year by MEP, London) as well as those produced by the European Wind Energy Association, the EU (formerly the EC) and the American Wind Energy Association. A huge volume of information on wind energy and data on wind farms is readily accessible.

He does not seem to appreciate the all-embracing nature of NFFO (and similar Scottish and Irish orders) prices for renewable energy agreed by the DTI. These prices have to cover all the items he mentions and many more because they are paid only for electricity actually produced. In 1995, many NFFO 3 bids were to accept payments of 4 p/kWh against typical average generation costs across the system of 3.5 p/kWh. Readers of *Energy World* should keep an eye open for the outcome of NFFO 4 which has just been announced. Bids are expected to be yet more competitive.

Europe's biggest wind farm

Starting motors are not used on most modern wind turbines as Mr Daniels imagines,

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Coalfield Campaign

The organisers of the Coalfield Communities Campaign do not win friends for their campaign by making misstatements about rival fuels (Viewpoint, *Energy World,* November 1995).

The Magnox nuclear stations do not have 'incredibly high operating costs', neither was this the reason why they were not included in the privatisation proposals. On the contrary, the avoidable cost per kWh of running the Magnox stations — in other words what would be saved if they were closed down — is the lowest on the system, distinctly lower than that of the coal-fired stations. Low operating cost is something Magnox share with all nuclear stations, so it follows that a positive response to the Campaign's plea for a return to merit order operation — with stations being brought on line in reverse order of running cost — would mean nuclear always being brought on line before coal — surely hardly what the Campaign is seeking.

Why the Magnox stations were excluded from the privatisation proposals is all to do with decommissioning costs, not running costs. With Magnox the nuclear companies inherited the inequitable combination of short remaining working life and high decommissioning costs, with the Exchequer having retained what the CEGB had set aside for decommissioning. The nuclear levy was supposed to compensate the nuclear companies for the irksome responsibilities, but they have long made it clear that they would gladly forego the levy in return for relief from them. It was recognition that the decommissioning liability would constitute a poison pill for investors that led the government to exclude Magnox from their proposals.

The Magnox stations are very hardy old gentlemen, with life expectancy much greater than their book lives. With low running costs and high ultimate shut-down costs, why not let them carry on indefinitely? The problem is the cost of meeting the Nuclear Installations Inspectorate's stipulations for renewal of their operating licences when they expire — a problem not unlike that of the cost of installing equipment in coal-fired stations to up-date their environmental standards.

Dr L G Brookes *(Fellow)*
Bournemouth

Clean coal technologies — the continuing debate

I REFER to comments by Richard S Courtney in *Energy World*, December 1995, on my article 'Clean fossil fuel power generation', published in the October 1995 issue.

I hope I am on the same side as Mr Courtney in fighting to maintain a viable coal industry in the UK. I contend we can only do this if the industry can compete with gas, which at the moment is running away with the market for coal principally because it is clean, and because it is low in capital and running costs.

The development of the air-blown gasification combined cycle system is an important step in the right direction, and I wholly support it, but I believe development of any new system which can improve coal's competitiveness with gas should be encouraged. I contend that my rotary gasification-combustion system (RCG) is such a system, and should be backed by industry and Government in view of its potential.

My system has been studied exhaustively and commended by two independent reports. The first was a large-scale study by Professor Levy's team at LeHigh University, USA. The second was by the technology department of PowerGen in the UK.

The latter carried out a study of the procedures for calculating, among other data, the in-bed char concentration and corresponding mean residence time and their relationship to the in-bed carbon conversion. The LeHigh study developed a whole range of procedures for designing and calculating associated data, and I have since added to this. The study enables designs to be carried out for any given application.

Dealing first with the 100 MW(e) combined cycle system described in my article: Table 1 shows performance data for the system, and Table 2 the calculated in-bed char concentrations and mean residence times, and the overall carbon concentration in-bed for a 50 mm bed thickness. The mean residence time is defined by PowerGen, in their study, as 'the average time which the solid particles leaving the fluidised bed have spent in the bed'. This is rather different to the mean residence time of the carbon in the bed, as the carbon may leave the bed, either in the solids phase, or (as CO or CO_2) in the gas phase. Char in the bed may leave in one of two ways: elutriation with the gas flow or removal with the ash. Further solid carbon conversion occurs in the over-bed vortex gas flow as it exits the gasifier.

The rotation of the bed and the resultant centrifugal force acting in opposition to the drag force of the incoming oxidant, ensures the bed particles are retained in the bed until the various reactions take place to give the required design carbon conversion.

Similar small-sized limestone particles are introduced into the rotating fluidised bed and as the coal gasifies the sulphur combines with the limestone and at bed exit the sulphur capture is estimated to exceed 90%. Further sulphur capture may occur in the vortex region.

On leaving the gasifier the fuel gas enters the deNO_x section consisting of the small double cyclones and air/fuel gas cooler (reduced to 600°C) in which the fuel nitrogen is fixed before the fuel gas flows into the afterburner section for the burn-off of the fuel gas by the hot air from the gas cooler and additional air from the compressor to reduce the overall temperature to 1260°C (the same as for the ABGC) as required by the gas turbine, taking into account heat abstracted by the steam superheater were fitted.

In the steam circuit heat is abstracted from the gasifier bed by the small diameter Dowtherm coolant tubes connected through bearings to an external heat exchanger. The steam flow then enters the gas turbine exhaust boiler and then flows to the afterburner superheater where it reaches the pressure and temperature required by the steam turbine. The combined cycle efficiency on a gross CV basis is 51.16%, and higher than this on a net basis. The efficiency will thus exceed on a net basis ((ie, 53.55%) the figure of 46.9% given by Mr Courtney in his graph, by a figure of 6.65%. This is a very significant improvement in efficiency over that of the ABGC system claimed by Mr Courtney, and would result in a fuel saving of 12.4%, which combined with the lower capital cost of my system would give the lowest cost/kW of electricity generated from coal.

The 100 MW (e) design for combined cycle applications has the following advantages: very compact because it is a pressurised system of gasification and generation; the capital cost/kW is likely to be lower than for other coal systems because of the need for less components and the absence of char burning plant; and the efficiency is higher for the reasons shown in the footnotes of Table 1.

Applications of the Hunter systems, whether pressurised or atmospheric pressure, will vary, but include: upgrading of coal or oil steam-cycle power station plant by replacing pf burners with rotary gasifiers supplying low SO_x and NO_x fuel gas to new boiler burners; full or partial conversion of existing steam cycle plant to combined cycle plant by fitting gas turbine plant and associated rotary gasifiers and combustion plant; new combined cycle plant; new gas turbine plant fired by coal or oil rotary gasification-combustion plant.

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Table 1: The Hunter gasification combustion system: data for 81-100 MW(e) combined cycle system

equivalence ratio	0.373
steam ratio	0.50 kg/kg coal
carbon conversion	90%
bed temp	1000°C
coal CV gross	26068 KJ/kg
coal gasification rate	7.498 kg/s
diameter of rotary distributor	1.075 m
length of distributor	1.398 m
mean size of coal	180 micron
fluidisation velocity	2 m/s
pressure ratio	15:1
gas turbine inlet temp	1260°C
fuel gas flow actual	9.441 m^3/s
turndown ratio	5:1
bed depth	25-50 mm
coal sulphur	1%
coal ash	15%
c/s ratio	2
in-bed carbon concentration	31.6%
compressor airflow through gas cooler	13.885 kg/kg coal
total gas entering turbine	18.763 kg/kg coal
compressor airflow into afterburner	0.561 kg/kg coal
gas turbine power	62.0905 MW (e)
steam turbine power	37.9095 MW (e)
total power	100 MW (e)
combined cycle efficiency	51.16%
steam conditions	1500 psi g/950°F
steam boiler rating	32.8178 kg/s
cooler outlet gas temp	600°C
distributor speed range	333-841 rpm

Notes:

a) the small size of the distributor should be noted smaller than the shell diameter of the BC jet type gasifier

b) along with no requirement for a char burner this means the overall capital cost will be much smaller than the BC topping cycle system

c) the high turndown ratio should be noted. Turndown is controlled electronically, controlling the distributor speed in phase with the compressed air supply and coolant pump flow

d) the high combined cycle efficiency should be noted. This is based on the gross CV of the coal. The reason for such a high efficiency is associated with the fact that the system layout ensures that with the high carbon conversion more fuel gas is generated per kg of coal input and combined with airflow through the gas cooler and air into the afterburner, more total gas enters the gas turbine, generating a greater proportion of the total power than is the case with the topping cycle. There the ungasified carbon from their gasifier is diverted through their circulating fluidised bed combustor which leads to a lower overall efficiency than is the case with mine. My overall circuit layout is similar to a gas-fired combined cycle and helps to explain the higher claimed cycle efficiency in the above Table. The system can also be designed for all forms of liquid fuels.

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The report by LeHigh University highlights important features of my rotary gasification-combustion system. These are: design and operating advantages due to the gasifier being separate from the afterburner; greater control of the gasifier bed temperature; an additional degree of freedom is available by varying the pump circulation of Dowtherm fluid through the small bed tubes, thus varying the heat abstracted from the gasification in-bed process, and closely controlling the bed temperature irrespective of load conditions. All these design features point to a plant which is highly sensitive and flexible to sudden load changes.

To take up a point raised by Mr Courtney, the coal input does not require being put through a ball mill to reduce it to pf size, thus generating high preparation costs. Its mean size is 180 mm (larger than pf) and as such could be prepared in a simple attritor plant to give the size required by the gasifier. This would use less kW/kg of coal than a pf ball mill, and the capital cost would be less. The input limestone could be similarly treated.

While my rotary gasification system is not yet developed, important experiments were carried out by the University of Sheffield on a small rotary fluidised bed combustor burning 2-4 mm coal among other fuels. The bed was cooled by water carried by tubes. All this contrasts with my design, where the coal is smaller in size, it is a gasifier, not a combustor, and has smaller size bed tubes with Dowtherm as a coolant instead of water. The Sheffield experiments proved the principle of the rotary fluidised bed and concluded along the lines of my experience in the work I have carried out over the years.

An important step forward in the rotary gasification principle has been taken in the USA. This refers to a UD company which has been contracted to develop a rotary fluidised bed, clean burner unit for granular coal for the upgrading of steam cycle power station boilers. The gasifier section is designed for 90% sulphur capture of the input coal. My system is an important advance in power generation technology and as such deserves support to get it off the ground.

John Hunter *(Fellow)*
Edinburgh

Table 2: Char concentration and residence time as a function of overall conversion

Overall carbon conversion X	char concentration k	mean residence time T (seconds)
33%	78.3%	48.65
60%	68.3%	71.08
80%	51.8%	108
90%	35%	145.7
95%	21.2%	176.7
100%	0%	224.3

Notes: The above data is based on a 50 mm bed thickness. Taking into account further carbon conversion in the above-bed vortex region there is a chance the complete carbon conversion of 100% may occur. PowerGen in their analysis assumed a 20 mm bed thickness with a mean residence time of 55 seconds for 90% carbon conversion, and 81 seconds at 100%. The effect of the thicker bed is therefore significant. It seems reasonable to expect a 100% carbon conversion when the residence time in-bed and in the vortex region is taken into account. The data in Table 1 therefore assumes this in calculating the table data.

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and his suggested 250 kW machine is out of date. The trend is for much bigger units. For instance, 56 Bonus machines, rated at 600 kW were been ordered last year by National Wind Power for Carno in Wales. When it is completed later this year, Carno will be Europe's biggest wind farm, rated at 33 MW.

Mr Daniels mentions transmission losses, but many wind farms are embedded in the distribution network. These avoid using the high voltage transmission grid altogether, and so they should be able to claim up to 0.5 p/kWh extra credit for all their electricity.

Mr Daniels' calculation arriving at only 1.2% of rated output — "just enough to boil a kettle and make a pot of tea" — is very amusing. It is also seriously misleading and out of touch with reality. I am not sure whether that is what he intended or not, but he should know that published capacity factors for recent British wind farms average over 35% throughout the year. During the crucial periods which determine the TRIAD payments and the maximum system demand, they can be very much higher. National Power have published figures showing that many of their wind farms achieve capacity factors of around 60% when it matters.

Europe has now overtaken America with more than 2 GW of wind power. The UK has the largest wind energy resource in Europe and we are building the biggest wind farm. Wind power is second only to gas in the amount of generating plant now being built in Britain. Commitment to less successful technologies should not deflect attention from these important energy developments.

D T Swift-Hook *(Fellow)*
Chobham, Surrey

Sir John Fairclough honoured for unification success

THE retiring chairman of the Engineering Council, Sir John Fairclough FEng, has been honoured for his contribution in bringing to fruition his initiative to unify the engineering profession.

The Duke of Kent, and president of the Engineering Council, presented Sir John with the Council's President's Award of an engraved crystal bowl and paid tribute to his vision and persistence in bringing change to the profession.

His Royal Highness said: "It would not be an understatement to say that without Sir John's personal grit and determination the unification initiative could not have been brought to successful fruition. It has the full support of the Institutions. We are at the beginning of a new era for the engineering profession marked by partnership, common purpose and optimism. What a staggering achievement!"

Sir John launched the unification initiative, which has seen the creation of the new Engineering Council, when he became chairman in 1991. The Council began operation as a unified body at the beginning of this year, to represent and focus the interests of the profession. It consists of a senate of 54 members from which two operating boards are drawn.

Sir John, who had a distinguished career in industry and is a former chief scientific adviser to the Cabinet Office, said: "I am encouraged that there is a clear determination and optimism for change in the whole profession. It coincides with a recognition of the need for change in industry at large."

Dr Alan Rudge CBE OBE FEng FRS FIEE, a past president of the IEE, is the first chairman of the senate. Among the institution council elected members are Dr Susan Boyle, of BRE; Prof C W Davidson, professor emeritus at Heriot Watt University; Prof P J Dowling, vice-chancellor of the University of Surrey; Dr Roger Johnson, lecturer and researcher at Birkbeck College, University of London; Dr R W Ernest Shannon, director of special projects, global, British Gas; Prof Raymond V Thompson, dean of the faculty of engineering, University of Newcastle upon Tyne; and Mr F Chris Price, president of IMechE and director of USM Texon Ltd.

Sir John Fairclough FEng (right), outgoing chairman of the Engineering Council, handing over the Council's charter and bye-laws to Dr Alan Rudge FEng, incoming chairman of the Council's first senate. As of 1 January this year, the Council's focal point is an elected senate, comprising members elected by Institution councils, members elected directly by engineers and technicians registered with the Council and six members appointed by the Privy Council. The senate operates through two executive boards. The Board for Engineers' Regulation will set and monitor standards for education and continuing professional development (CPD). The board for the engineering profession will be responsible for the promotion of the profession and engineering in the public interest, and for issues where a profession-wide approach is needed. The new Council should provide a unified voice for the profession, bringing together the views of institutions, industry and academe. It will enable a coordinated approach to the major issues facing engineers, and will provide a framework for harnessing the resources of the profession to best effect for the nation.

February 1996

UK Gas Market
4th annual forum, 5-6 February, London. Details from IIR Ltd, 29 Bressenden Place, London SW1E 5DR. Tel: 0171 915 5055; fax: 0171 915 5056.

Volatile Organic Compounds: legislation and solutions
One-day seminar, 8 February, Capenhurst, Chester. Details from Mrs Del Bennett, Event Administrator, EA Technology, Capenhurst, Chester CH1 6ES. Tel: 0151 347 2557; fax: 0151 347 2178

Oil & Gas Industry in Russia and Governmental Regulation
1st post-election international conference, 8-9 February, London. Details from Suzie Parsons, Financial Research Associates Ltd, 20 Dock Street, London E1 8JP. Tel: 0171 702 4671.

Cables for Power Systems: Design, Operation & Rating of Power Cables
Course, 13-14 February, Capenhurst, Chester. Details from Mrs Del Bennett, Course Administrator, EA Technology, Capenhurst, Chester CH1 6ES. Tel: 0151 347 2557; fax: 0151 347 2178

Power Cables — use, diagnostics & fault location
Course, 14-15 February, Capenhurst, Chester. Details from Mrs Del Bennett, Course Administrator, EA Technology, Capenhurst, Chester CH1 6ES. Tel: 0151 347 2557; fax: 0151 347 2178

Global warming: a scientific update
Royal Society Technical Lecture by Sir John Houghton CBE FRS, 15 February, London. Details from The Royal Society, 6 Carlton House Terrace, London SW1Y 5AG. Tel: 0171 839 5561, ext 2576.

On-line Slurry Instrumentation Seminar
15 February, Harwell, Oxon. Details from Mrs Margaret McCulloch, AEA Technology, 404 Harwell, Didcot, Oxon OX11 0RA. Tel: 01235 434626; fax: 01235 432313.

The Annual Electricity Conference: balancing customer and shareholder interests
16 February, London. Details from Zelda Stewart, The Economist Conferences, 15 Regent Street, London SW1Y 4LR. Tel: 0171 830 1008; fax: 0171 931 0228.

European competition law: how it affects your business
Seminar, 19 February, London. Details from Delores Broni, Marketing Executive, The Economist Conferences, 15 Regent Street, London SW1Y 4LR. Tel: 0171 830 1076; fax: 0171 409 3296.

Efficiently allocating & managing costs in the electricity, gas & water industries
Conference, 19-20 February, London. Details from Ben Gallienne, Customer Services Manager, IIR Ltd, 6th Floor, 29 Bressenden Place, London SW1E 5DR. Tel: 0171 915 5005; fax: 0171 915 5056.

What's so exciting about dirty heat exchangers?
Inaugural lecture by Prof Hans Müller-Steinhagen, 21 February, University of Surrey, Guildford. Details from University of Surrey, Guildford GU2 5XH. Tel: 01483 571281.

Electricity pool developments and their impact on pool prices
5th annual forum, 21-22 February, London. Details from Ben Gallienne, Customer Services Manager, IIR Ltd, 6th Floor, 29 Bressenden Place, London SW1E 5DR. Tel: 0171 915 5055; fax: 0171 915 5056.

Opportunities for renewable energy technologies in Europe
Annual conference, 22-23 February, London. Details from Jenniy Gregory, tel/fax: 01252 22968.

Powders & Bulk Solids Industry Education Week
27-29 February, London. Details from Powder Advisory Centre, P O Box 78, London NW11 0PG. Tel: 0181 343 4357; fax: 0181 343 4583; e-mail: 100274.3335@compuserve.com

National Seminar on Thermal Power Generation — coping with challenges of the 21st century
28 February - 1 March, Calcutta, India. Details from Mr Paramesh Chandra Gupta, Operation Cell, PC-8th Floor, Development Consultants Ltd, 24-B Park Street, Calcutta 700 016. Tel: 249 7601 5; fax: 033 249 2897.

March 1996

BOT / BOO / BOOT Investments in Asia
3rd annual pan-Asian summit, 4-7 March, Hong Kong. Details from IIR Pte Ltd, Suite 08-03 Golden Wall Centre, 89 Short Street, Singapore 188216. Fax: (65) 334 6055.

Building for the Future
Seminar, 8 March, Nottingham. Details from Rob Dyer, Marketing Services, East Midlands Electricity, Woodyard Lane, off Lambourne Drive, Wollaton, Nottingham NG8 1GB.

CERI North American Natural Gas Conference and Calgary GasExpo'96
11-12 March, Calgary, Alberta, Canada. Details from CERI Conference Division, tel: (403) 282 1231; fax: (403) 289 2344.

Closure of Industrial Sites: environmental constraints
Conference, 14 March, London. Details from SCI Conference Secretariat, 14/15 Belgrave Square, London SW1X 8PS. Tel: 0171 235 3681; fax: 0171 823 1698.

Developing an East Asian business strategy
Conference, 18-19 March, London. Details from Julia Thomas, The Conference Unit, RIIA, Chatham House, 10 St James's Square, London SW1Y 4LE. Tel: 0171 957 5700; fax: 0171 321 2045 / 957 5710.

DEGREE DAYS: NOVEMBER 1995

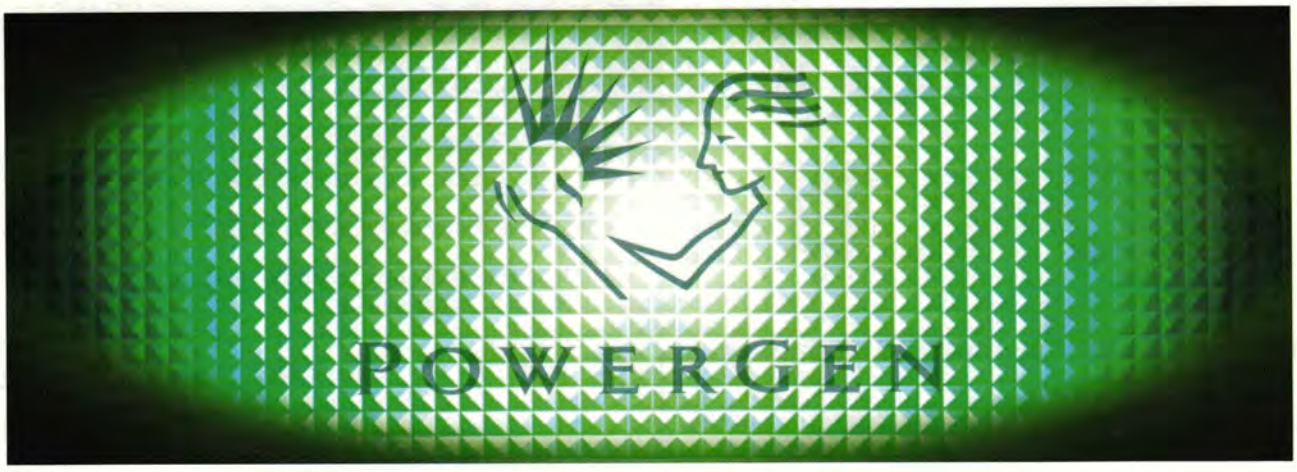
Source: **Degree days direct**

These regional figures, calculated from daily outside air temperatures, provide an index of demand for space heating over the month and thus enable excessive consumption to be detected.

A well-controlled heating system should manifest a straight line relationship between monthly fuel used and the local degree-day value; any significant deviation from this 'target characteristic' is likely to signal the onset of avoidable waste (such as a stopped timeswitch or an open isolating valve).

Readers can get more information on the use of degree days from Vilnis Vesma, 17 Church Street, Newent, Glos GL18 1PU (01531 821350)

 Note: the figures given here have been calculated to correspond as closely as possible with those published by government sources. However, because of differences in observing stations, close agreement cannot always be guaranteed.



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