ENERGY WORLD

The magazine of The Institute of Energy

Number 183
November 1990

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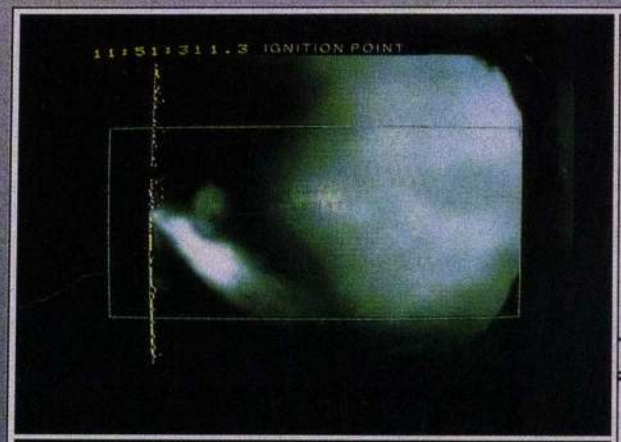
Special features section

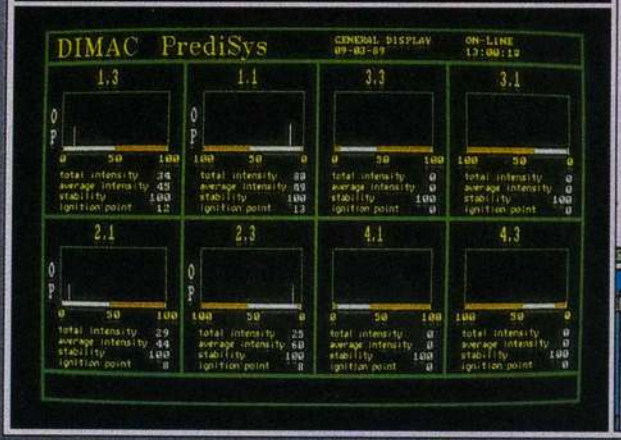
n combustion systems

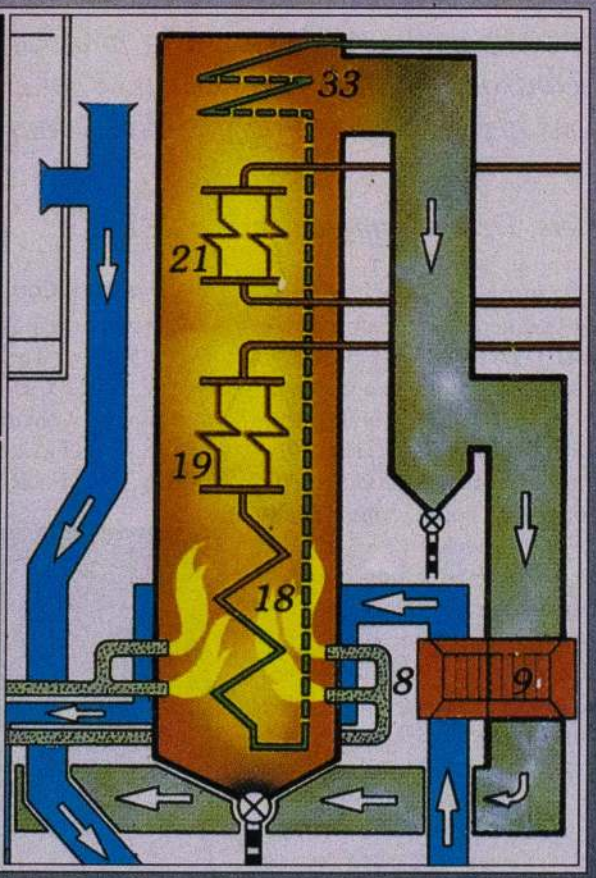
REAL COMBUSTION ANALYSIS WITH

DIMAC

COMBUSTION MANAGEMENT SYSTEM







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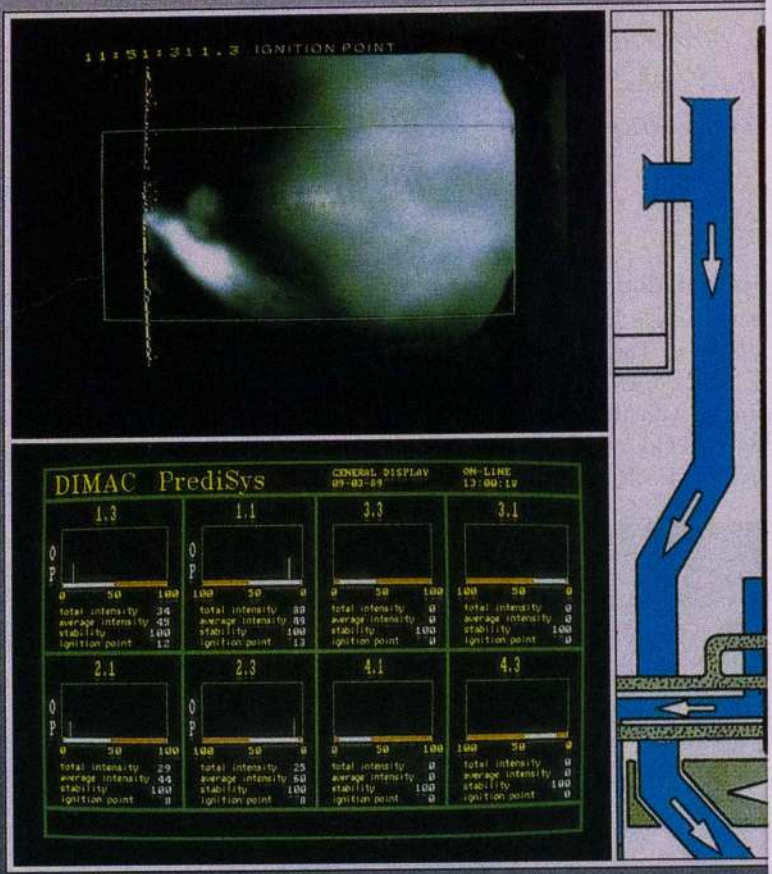

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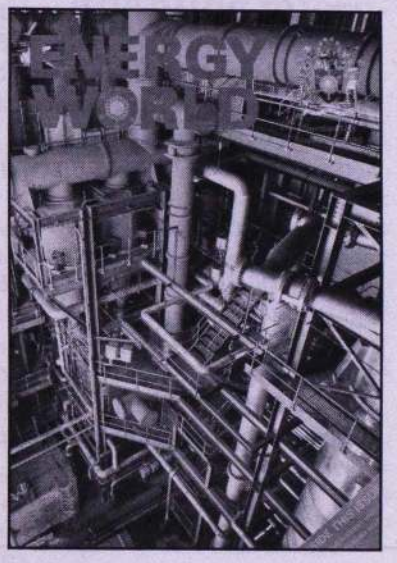
COVER STORY



This month's cover photograph shows the Grimethorpe Pressurised Fluidised Bed Combustion Test facility (PFBC) operated by British Coal. It is the largest of its kind in the world.

The first work carried out on PFBC was in 1968 at the British Coal Utilisation Research Association (BCURA) laboratory at Leatherhead, Surrey. This work continued into the 1970s, establishing the possibility of burning coal directly to provide hot combustion gases for expanding through gas turbines.

The Grimethorpe facility was originally built and operated by NCB (IEA Grimethorpe) Ltd, on behalf of the governments of the UK, West Germany and the US, under the auspices of the International Energy Agency (IEA).

Construction was begun in 1977 and commissioning was completed in 1980. Situated near Barnsley in South Yorkshire, the 80 MWth capacity facility has been used to investigate the potential of pressurised fluidised bed combustion, in terms of combustion efficiency and environmental performance.

Earlier problems with tube wear and component reliabilty have now been overcome and pressurised fluidised bed combustion has been successfully demonstrated for application in a combined cycle generating power from steam and gas turbines.

The PFBC facility will now be used in the next stage of the British Coal Topping Cycle Programme.

*Cover photograph by courtesy of British Coal.

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Does This Common Inheritance have an earthly chance?

RETIREMENT gives time for thought and during such periods of contemplation it strikes me forcibly what a privilege it is to live on this planet and to be a beneficiary of millions of years of natural development. I suppose such feelings are only possible when we are sensibly well-fed, receive good medical attention when we need it and are kept warm by the many sources of energy we all have available to us. Energy which the earth gives up, energy which we can extract because we have been granted the ability to take it, or more generously to extract it. The planet is very tolerant to all our needs and exploitation, but to what degree and for how long it is impossible to say with any certainty. What is clear is that we should apply as much effort to using the energy efficiently and disposing of the waste effectively, as we put into taking the energy in the first place.

The title of this viewpoint has a nice ring to it. I can say this because it is not my own work. It is in fact the work of opposing groups of very powerful people who express different ideas about the same subject. Yet they must be pursuing the same objectives, so is it not better to compromise and agree on something as vital as our inheritance? Indeed we need to keep every avenue open to us, for in the long run we shall need every source of energy that we can get.

It is disappointing to see energy and the environment becoming a political football. How can we expect industry to operate efficiently in such a framework, with one group accepting nuclear, another very lukewarm about it; one group favouring gas for generating electricity, another one not; one group being prepared to import coal, another group wanting to use home produced coal in conjunction with cleaner coal technology; and finally one group saying they can freeze carbon dioxide levels by the year 2000, the other saying 2005?

In my opinion the best way out of this position is to have a national energy plan, a plan that has teeth, a plan that is agreed by our society and by all our political factions, a plan that should incorporate the common sense use of our indigenous fuels and technical capability.

It should start with the efficient use of all our fuels — coal, oil, gas, renewables and nuclear. It should end with a firm programme of work. If we can do it within the market economy structure so much the better, if not, we should do it anyway. Agree the goals, the economic measures and methods now. Clear away restrictive practices such as the fossil fuel levy, or find other ways of extending the payback period for renewables and nuclear. In the case of renewables be bold, determine the time scales now, agree to start work on 1,000MW of plant in 1992 and finish the first stage by 2000. Otherwise we shall be still be talking about it in 2000 and fighting over it by 2050.

In the case of gas fired power plant, get on with it so we can see its worth. Press ahead with fluidised bed combustion. Agree a limited nuclear programme to keep the technology alive.

Use our technical skills to lead the world in such development and become the nation that everyone envies, so putting ourselves in the position of being able to help the less fortunate and at the same time securing our own future.

Contributions are invited from members on this, or any other relevant subject. Such contributions can take the form of a Readers' Letter, or a longer piece, for this Viewpoint page. Any correspondence should be addressed to The Editor.

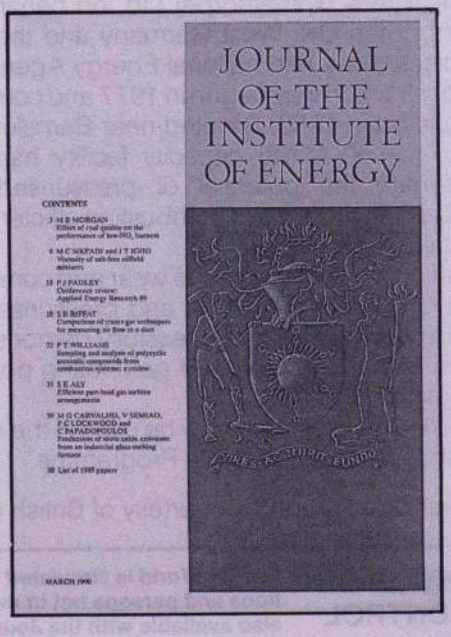
C E Pugh
Past President

Are you missing out on the Journal?

The *Journal of the Institute of Energy* is the technical journal of record for the Institute. Published quarterly, it carries refereed technical papers on a wide range of subjects and it is available to members of the Institute who register their wish to receive it. To put yourself on the mailing list, simply write to the Membership Secretary at The Institute of Energy, 18 Devonshire Street, London W1N 2AU, stating your preference to receive the Journal (please include your membership number in all correspondence).

To those outside of membership, it is available on subscription jointly with *Energy World* — price £140 (UK and overseas).

Examples of papers recently published include: *The burning velocities of methane and SNG mixtures with air* (MS Haniff, A Melvin, DB Smith and A Williams); *Optimisation of the design and operation of coal flames in cement kilns* (TM Lowes and LP Evans); and *Pulverised-coal-fired dilute-phase hybrid boilers: a new concept* (P Basu, EAM Gbordzoe and A Sett).



Agreement signed for phase 2 of EFR project

THE THREE design and construction companies that form EFR Associates have announced the signing of an agreement to co-operate in design work covering phase 2 of the European Fast Reactor Project.

These companies are: Novatome, a division of Framatome for France, Interatom, a subsidiary of Siemens for Germany and NNC, a subsidiary of GEC for the UK.

The successful completion of the two year phase 1 (concept design) programme has combined the best experience available in Europe to provide the outline of a 1,500 MWe fast reactor design. Phase 2 is a three year programme aimed at optimisation and confirmation of design features selected to meet high safety standards and to offer good economic prospects.

These design activities are underwritten by R&D organisations of the partner countries who are already cooperating under established agreements.

The EFR project objectives have been defined by a grouping of European Utilities, the European Fast Reactor Utilities Group (EFRUG), among which Nuclear Electric (UK), EdF (France) and a group of German Utilities: RWE, PreussenElektra and Bayernwerk are supporting the design work.

NEL designs flow facilities for Taiwan

NEL is to provide design and consultancy services to establish comprehensive flow measurement standards facilities in Taiwan.

The agreement was signed by NEL's Flow Centre and the Industrial Technology Research Institute (ITRI) of Taiwan during a recent visit to East Kilbride by a delegation of Taiwanese engineers. The contract is worth over £75,000 and it is anticipated that further work will be placed with NEL.

The delegation was made up of senior staff from that Taiwanese National Bureau of Standards, the China Petroleum Corporation and the ITRI.

Adapting micro-hydro systems

IN NEPAL the small-scale hydroelectric industry has begun to develop and install 'induction generators' adapted from ordinary motors, as an alternative to 'synchronous generators' currently available. These induction generators offer the advantages of being more robust and less expensive, as well as being readily available.

Until recently, however, their use has not been possible where varied demands are made on the system; only fixed loads (such as lighting) have been feasible.

With the development of an improved Induction Generator Controller (IGC) by Nigel Smith of Nottingham Polytechnic, these restrictions have been lifted.

Mr Smith recently visited Nepal to establish the first permanent field trial of the IGC, to examine not only its technical performance, but also the wider implications of installing such a micro-hydro system.

In addition, he visited Pakistan and Sri Lanka to discuss not only the potential for induction generators, but also reversed pumps, which can serve as turbines.

Unlike Nepal, these countries have no strongly developed local capacity to manufacture turbines and rely on expensive imports at present; however, pump manufacture is widespread, and would provide the basis for a turbine industry.

Exploration licence

BRITISH GAS has signed an agreement in Islamabad with the Pakistan Ministry of Petroleum and Natural Resources to explore for hydrocarbons in Block 34 located in central Pakistan.

With a 50 per cent interest in the licence, British Gas will operate the block on behalf of a consortium including Pakistan Petroleum Limited (30 per cent), Tullow Oil plc (15 per cent) and the Oil and Gas Development Corporation of Pakistan (5 per cent).

Block 34 covers an area of approximately 4,500 sq km and lies in an arid area of desert along the eastern margin of the Sulaiman mountain range in central Pakistan. Gas and condensate accumulations are known to exist nearby.

The first phase of the exploration commitment is expected to last three years and will include field geological studies, seismic acquisition and the drilling of one well.

Indonesian refinery contract

PERTAMINA, the Indonesian State Oil Company, and Java Petroleum Investment Co Ltd (JAPIC), the Tokyo-based oil investment company, have signed a contract for the financing of 'EXOR-1', a new $1.8 billion 'grass roots' oil refinery to be built at Balongan on the north eastern coast of West Java, some 250 kms east of Jakarta.

It is the culmination of four years' negotiations by an Anglo-Japanese consortium formed by the Reading (UK) based engineering group, Foster Wheeler Limited. The consortium members are: Foster Wheeler and the BP Group from the UK; JGC Corporation and Mitsui & Company from Japan.

JAPIC is owned by six major Japanese trading firms — Mitsui & Co Ltd, C Itoh & Co Ltd, Toyo Menka Kaisha Ltd, Sumitomo Corporation, Nissho Iwai Corporation and Marubeni Corporation.

Morocco expands electricity supply

MOROCCO'S efforts to expand the supply of electricity in rural areas will benefit from a $114 million loan from the World Bank.

Electricity will be supplied to about 170,000 households in 462 villages. About 5,850 kilometres of distribution lines will be constructed and about 70 megavolt-amperes of transformer capacity will be developed.

Technical assistance will be provided by the World Bank to strengthen the administrative and financial capabilities in the power subsector and to implement institutional reforms.

Stoves project in Kenya

WHILE city dwellers in Kenya are used to buying fuel, in the rural areas many are still able to collect fuelwood locally. In Western Kenya however, the gravity of the fuelwood crisis has reached a critical point whereby villagers are for the first time having to buy wood rather than collect it locally.

Intermediate Technology has been promoting the use of fuel-efficient stoves in the area, and a recent survey cited the IT programme as one of the most successful in Kenya.

Josephine Mutagaywa, IT's stoves project officer, is working with four women's groups who are producing and marketing ceramic liners for stoves. At present demand exceeds supply and it is hoped that additional groups can be trained in stove production both in Nyanza province and other areas of the country.

The answer my friend is blowin' in the wind

WHEN Dŵr Cymru Welsh Water wanted an electricity supply for a new radio communications site in a remote part of the Elan Valley, the South Wales Electricity Board told them it would cost £¼ m, so they turned instead to the wind and the sun for a cheaper solution.

High on Rhos-y-Gelynnen above the Caban Coch Reservoir, north west of Rhayader, the company have installed a unique power system combining wind turbines and solar panels that will provide their needs at a cost of £50,000.

There are two wind turbines, one of which is a Bergey 1.5 KW machine from America which is the first to be installed in Europe. Using state-of-the-art space technology its blades twist and bend automatically to changes in wind speed and direction.

A more traditional North Wind HR1 one KW turbine with wooden blades, also from America, was also erected. Both have been designed to withstand gales of up to 120 mph.

Additional power is generated by 36 Solarex solar panels, with 12 more in reserve, that harness the rays of the sun to produce electricity. Each panel produces 60 watts.

Both sources of energy continually charge a bank of massive submarine batteries. For more than a year extensive tests were taken at the mountain top site to ensure that the elements would together produce sufficient power. 600 watts of continuous energy is required for the first phase of the operation.

Installing the wind turbines.

Childhood leukaemia in W Cumbria

HAVE YOU worked at Windscale/Sellafield at any time since 1949?

The Gardner Report into childhood leukaemia in West Cumbria suggested that the raised incidence of leukaemia, particularly, and non-Hodgkin's lymphoma among children near Sellafield was associated with the fathers of the affected children having been employed at BNFL Sellafield, and having received external radiation doses at the plant before the children were conceived.

Following the publication of this report, the Health and Safety Executive (HSE) announced that it was to carry out studies of the Sellafield workforce designed to throw further light on Professor Gardner's findings and to identify whether any other risk factors may be relevant.

The HSE, subject to the acceptance of its proposals by the medical ethical committees in the United Kingdom, proposes to investigate the work histories of the fathers of the affected children and to compare these histories with those of a sample of other Sellafield fathers through an epidemiological case-control study. Factors such as internal and external exposure to ionising radiation, exposure to known carcinogenic chemicals, involvement in contamination incidents and general occupational activities will be examined. The investigations are aimed at trying to identify factors which could explain the raised incidence of childhood leukaemia and non-Hodgkins lymphoma.

The HSE's proposed investigations have the support of the staff, trade unions and management of BNFL and UKAEA.

Queen's Award for NEI

THE Lord Lieutenant of Derbyshire, Colonel Peter Hilton, presented the Queen's Award for Technological Achievement to NEI International Combustion Ltd on 12 October.

NEI won the Queen's Award earlier this year for its work in designing and producing cobustion equipment which reduces pollution from power stations. The company's special burners reduce the emission of oxides of nitrogen (NO_X) from power stations. The reductions in NO_X emissions are achieved by using burners which mix fuel and air so that combustion occurs in stages, avoiding high temperatures and excessive oxidation of nitrogen.

Following the presentation there was a tour of the company's manufacturing facilities.

National Power announce gas-fired generation plans

NATIONAL POWER plc announced in October their plans to develop further the use of natural gas in the generation of electricity.

As part of its strategy to establish a range of future power generation options, the company is to seek planning consent for two combined cycle gas turbine (CCGT) power stations. The company's first CCGT plant has already been launched at Killingholme, South Humberside, and a planning application for another CCGT station, at Little Barford, Bedfordshire, is well advanced.

An application for planning consent to build CCGT plant of up to 1500 MW at Staythorpe, Nottinghamshire, was submitted. Later this year, the company intends to apply for planning consent to build similar plant at Didcot, Oxfordshire. The sites were selected after detailed investigations at these and two other locations — West Burton, Nottinghamshire and Padiham, Lancashire.

The proposed CCGT plant at Staythorpe would be built next to the company's existing 360 MW coal-fired power station and the planned Didcot plant would be built next to the existing 1900 MW coal-fired station.

As the second part of this strategy, National Power is to carry out further design studies in the use of gas to increase thermal efficiency and output at two of its existing stations. The new studies are to be undertaken at the coal-fired station at Eggborough, Yorkshire, and the oil-fired station at Fawley on Southampton Water.

Negotiations are being conducted with NEI, ABB Gas Turbines Ltd to undertake the design study at Fawley, and with Foster Wheeler Power Products Ltd for the Eggborough project. The two companies are the successors to those which supplied the original boilers at the stations and are therefore ideally placed to undertake the studies.

As the third part of the strategy, National Power plans to develop an upstream interest in gas. The company is to join three bidding consortia in the 12th round of licence applications for gas exploration.

Reactions to the White Paper

THE RECENTLY published Environment White Paper *This Common Inheritance* has excited reaction from all quarters — industry and environment groups alike.

The Chartered Institution of Building Services Engineers (CIBSE) expressed their 'astonishment', describing the document as 'complacent in the extreme'. CIBSE Secretary, Andrew Ramsey, said: "One would have expected that the consistency of advice and suggestions given to the Secretary of State by many expert bodies, including CIBSE, would have resulted in more radical changes to the Government's views."

The Royal Institute of British Architects (RIBA) remarked that "the White Paper bears the imprint of the Treasury more strongly than that of the Environment or Energy departments."

The verdict of the Council for the Protection of Rural England (CPRE) was that the White Paper was "Glossy, but lamentably lacking in vision, commitment and decision: a clear sign that Chris Patten's much vaunted White Paper has been comprehensively sat on by the rest of the Government."

British Gas, on the other hand, praised the White Paper for highlighting environmental issues of public concern.

One of the major criticisms has been that *This Common Inheritance* lacks forcefulness, preferring to leave the business of improving the environment to market forces.

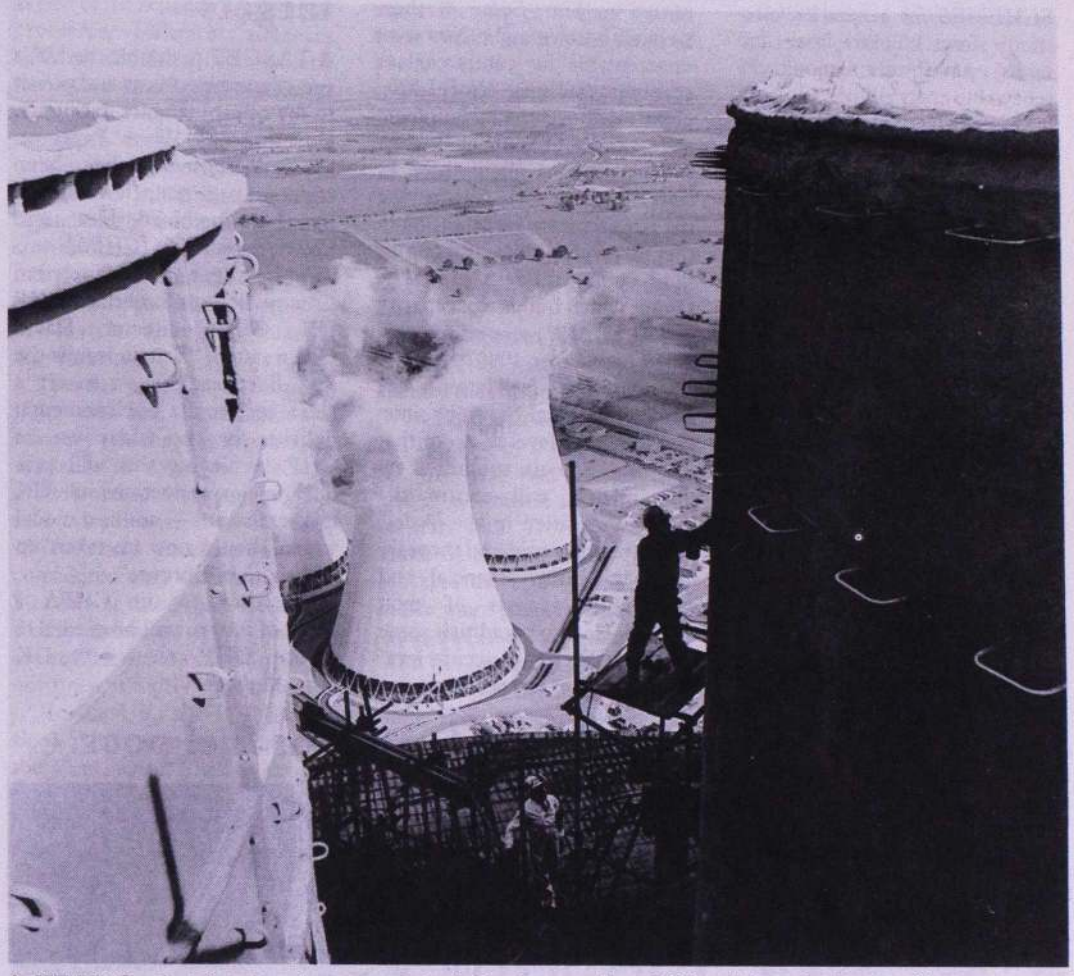
**For further comment on the White Paper, see this month's 'Viewpoint' on page 2.*

The unspeakable Frank N Stein

JOHN LYONS, general secretary of the Engineers' and Managers' Association (EMA), has criticised the recent TV advertising campaign, aimed at raising interest in the imminent electricity share flotation.

Writing in the new EMA journal *EPE*, Mr Lyons attacks what he calls "the unspeakable Frank N Stein promotions," adding that they "insult the industry and everyone who works in it."

Drax FGD plant to be largest in the world



A HEAD for heights is what steeplejack Noel Smith can certainly claim as he works to carry out a routine maintenance 850ft up on Europe's tallest factory chimney at National Power's Drax Power Station in Yorkshire.

Drax is Europe's biggest coal-fired power station.

The proposed flue gas desulphurisation plant costing £700 million is in the first stages of construction at Drax. It will be the largest plant of its type in the world.

The chimney which contains 40,000 tons of reinforced concrete is a three-flue chimney and is the site of the European absailing record, captured by an Army team last year.

New DG for EE Office

WILLIAM RICKETT has been appointed as the new Director General of the Energy Efficiency Office in succession to Dr Elliot Finer, who has joined the Cabinet Office.

Mr Rickett, 37, joined the Department of Energy as an assistant principal in 1975. In 1981 he was appointed Private Secretary (Home and Social Affairs) to the Prime Minister, and in 1983 was seconded to a merchant bank to advise clients on corporate finance activities. In 1985 he rejoined the Department of Energy on promotion to Assistant Secretary, and in 1987 was posted to Electricity Division to head the team advising on the privatisation of the electricity supply industry.

Electricity sell-off incentives

IN ORDER to heighten interest in the sale of the 12 regional electricity companies (TRECs), John Wakeham MP, Secretary of State for Energy, announced in October incentives to encourage potential shareholders.

The voucher scheme is familiar from previous sell-offs, such as British Telecom, but the recently announced incentives are even more favourable to potential investors, who can opt for a £18 voucher off their electricity bills, for every £100 invested. A ceiling point of £270 discount on 1,500 shares has been set.

Perhaps even more attractive is the instalments scheme. Investors will pay the first instalment on application, with two more instalments due in October 1991 and September 1992.

Frank Dobson, opposition spokesman on energy, described the package as "Robin Hood in reverse".

Details of the measures which will be taken to deter and detect fraudulent share applications have been confirmed with the appointment by John Wakeham of Touche Ross as fraud auditors to the share offer.

It will be a criminal offence for an investor to make more than one application for shares in any one of the TRECs.

Friends of the Earth (FoE) recently launched a campaign to reduce energy consumption by 20 per cent. They have warned that as the public become more environmentally aware, so they will begin to cut their use of electricity, which could lead to dramatic reductions in profits for the TRECs.

DGES approves renewables

SCHEMES for generating electricity from chicken litter and hydro power are among 75 renewable energy projects which have been given final approval by the Director General of Electricity Supply, Prof Stephen Littlechild.

The schemes had been submitted to him by the 12 regional electricity companies (TRECs) for approval under the 1989 Electricity Act. He announced approvals on 3 October.

The projects are made up of 26 hydro electric, 24 landfill gas, nine wind, nine biogas and seven waste incineration. Hydro electric account for 11 per cent of capacity; landfill and biogas 36 per cent; waste incineration 46 per cent; and wind seven per cent.

Originally, Prof Littlechild assessed about 100 schemes submitted to him. Some of these were withdrawn and others were unacceptable for contractual or economic reasons. Prof Littlechild made recommendations to the Secretary of State for Energy, John Wakeham, about those he considered capable of satisfying the requirements for inclusion in the first renewables tranche of the Non-Fossil Fuel Order. The Order, which builds to a capacity of 102.25 MW, was announced on 18 September 1990.

Under the legislation, the Director General has to be satisfied to a high level of proof that the arrangements submitted by the TRECs will secure the capacity specified in the Order. He therefore considered the technical, economic, financial and contractual aspects of each scheme. He also noted that some schemes have yet to secure local authority planning permission.

UK sets CHP targets

A TARGET to double the UK's use of combined heat and power in the next nine years, set by the Government's White Paper on the environment, has been endorsed as a realistic challenge by the Combined Heat and Power Association (CHPA).

Addressing a special European Commission conference on CHP UK, CHPA director, David Green stated: "Britain is now the first European nation to set a clear goal in its environmental policies for the wider use of CHP. Achieving this will produce major reductions in UK CO_2 emissions — and is a model which should now be taken up elsewhere in Europe."

According to the CHPA a range of actions will be needed to ensure CHP meets its UK growth target.

DEn questioned on costs of offshore dispute

FRANK DORAN, MP for Aberdeen South, and Labour Party spokesman on oil and gas, tabled a parliamentary question to the Secretary of State for Energy. The question addressed the extent of losses by the oil industry during the offshore industrial dispute this summer.

In an attached note to the question, Mr Doran calculated the level of losses caused to the industry by project delays to be in the region of £500,000 per day for the operators of North Sea production platforms. He put the overall loss over the entire period as being between £50 and £70 million.

Mr Doran said: "The oil-workers' dispute has been a bitter and expensive one. Until now the oil industry has claimed that they have suffered no losses. The real picture is very different as these figures show. The cost to the industry has been heavy. Yet the only thing which the industry has to show is a frustrated and bitter workforce, the likelihood of poorer safety as industrial relations deteriorate further, and the strong possibility of further and more damaging disputes in years to come.

"It is time that the oil companies cut their losses and sat round the table with the trade unions."

Gas donates to energy-saving charity for fuel poor

NEA Director Andrea Cooke (centre) receives the cheque from George Langshaw (second left) and Robert Jones (second right) of British Gas. Far left is the guest speaker that evening, weatherman Michael Fish, and far right is NEA executive, Jenny Saunders.

A NATIONAL charity that promotes practical solutions to the heating problems of people on low incomes received further help from British Gas in Liverpool in September.

Since it was set up in 1981 the Neighbourhood Energy Action group (NEA) has established a national network of community energy projects which have insulated the homes of over 800,000 elderly and disabled people. The organisation has also developed a series of nationally recognised, certificated courses in energy efficiency work which has led to improvements in technical standards in draught proofing and loft insulation.

Opencast increase

OPENCAST coal production rose during 1989/90, for the third year in succession, according to *Opencast Coalmining Statistics 1989/90*, recently published by the County Planning Officers' Society.

At over 18.6 million tonnes for the UK it reached the highest level in the seven years since figures were first published by the Society, exceeding the 1988/89 figure (the previous highest) by 3 per cent. It was almost 4 million tonnes (26 per cent) higher than the production figure recorded for the first year covered by the booklets (1983/84).

Despite the increase in production, the reserves of opencastable coal with planning permission for working remaining at the year end (March 31 1990) exceeded 85 million tonnes.

Can gas meet the projected growth in electricity market?

AT LEAST 15 new gas-fired power stations will be needed by 1997 if the predicted increase in demand for electricity of 500 megawatt (MW) a year is to be met mainly by gas, as many energy experts forecast, said British Gas Chairman and Chief Executive, Mr Robert Evans, in London in October.

Addressing a conference on electricity from gas organised by The Institute of Energy, Mr Evans said that, including the predicted substitution of old coal plant by new gas generation conservatively estimated at 4 gigawatt (GW) by 1997, 7-8 GW of new capacity consuming about 12 million therms of gas a day would be able to meet almost all the growth in electricity demand by the end of the century. Depending on the ratio of base load to peak load, the demand could consume an additional 3,000 million therms a year, implying a capital growth of about £1bn.

Mr Evans said it was a far cry from the days of the first oil crisis when gas was commonly accepted as a national resource too valuable to burn in power stations. Today there was far greater availability and estimated reserves were much higher; natural gas, being the cleanest of all the fossil fuels, was perceived as part of the solution to pollution problems; technical advances such as combined cycle generation were much more efficient than the simple steam cycle; combined cycle plant was not only more energy efficient it was quicker to build, had a lower capital cost (about half the cost of conventional coal plant), and individual units could be multiplied easily to build up capacity to match changing market requirements.

"Recent capacity assessments give me the confidence to reassure you that gas supplies are available to meet the potential growth of electricity generation," said Mr Evans. "In the early 1970s world gas reserves were considered only sufficient to last 20 years at that level of demand. Today estimates show reserves are sufficient for over 56 years at our present high demand level.

"In the UK, the 1990 Brown Book put proven gas reserves in the Continental Shelf at around 20 trillion cubic feet, representing 13 years at current rates of production. Probable reserves add another 22 trillion cubic feet and possible reserves a further 21 trillion — a total of 63 trillion cubic feet representing 42 years at current production rates. World proven reserves are currently around 4,000 trillion cubic feet — equivalent to 56 years' worth at the 1989 levels of production."

Mr Evans said reserves were not spread evenly. The Soviet Union accounted for 38 per cent of reserves and 37.5 per cent of the world's current production, while the Middle East had 31 per cent of reserves yet accounted for only 5 per cent of total production.

"Development in these two areas will be particularly important for the European gas market. West European demand is expected to grow by 2 per cent a year for the next two decades with power generation accounting for at least half. Developments in Eastern Europe could further increase the rate of demand... while more gas will be available from traditional suppliers — notably the Soviet Union, Norway, and North Africa — costs will be somewhat higher as fields in distant and difficult areas replace low cost fields," Mr Evans warned.

Nonetheless, British Gas expect the market will be stimulated and strengthened by their participation in launching new power generation schemes. "It is my intention that British Gas should seek opportunities both in the UK and throughout the world. Our resources and expertise will help to develop successful schemes and, of course, in the process create profits for British Gas shareholders.

"The large scale power generation opportunities in the UK seem endless, judging from the very large number of feasibility studies being carried out," he said. "I look forward to the next few years when a number of new power generation stations will be commissioned using gas turbines on a simple or combined cycle configuration.

"British Gas intends to become proficient in handling all aspects of the power generation market. In some cases we will only supply gas, but in others we may be able to provide a complete service to include design, construction and operation of power stations. We also intend to be joint venture partners; our first — in which we have joined forces with Utilicom to form 'Citigen' — is already under way and will supply heat and power to a number of buildings within the City of London.

"The future for electricity from gas looks challenging, exciting and, I hope profitable for producers, contractors, suppliers and pipeline companies — and will create economic prices for electricity," Mr Evans concluded.

IEEIE joins Huddersfield Poly to improve training

THE 30,000 strong Institution of Electronics and Electrical Incorporated Engineers (IEEIE) has joined forces with The Polytechnic of Huddersfield in a new venture for the accreditation of training placements.

A mechanism is to be piloted giving formal recognition to the training undertaken by electronic and electrical engineering sandwich course students as part of their BTEC Higher National Diploma course.

In granting IEEIE approval for the Polytechnic effectively to accredit training up to a maximum period of one year, Graham Guest, IEEIE's Assistant Secretary, said: "We welcome the opportunity to support The Polytechnic of Huddersfield in this new venture. The scheme will involve each training placement being rigorously assessed by means of the Polytechnic's quality control process and HND students will be encouraged to become Student members of the Institution."

As an authorised body of The Engineering Council, the IEEIE already accredits academic courses and training schemes against the requirements for Incorporated Engineer and Engineering Technician registration.

The arrangement with The Polytechnic of Huddersfield highlights still further the importance of training as part of a total professional qualification comprising academic award, training and responsible experience, leading to IEng registration with The Engineering Council.

IMM awards — trust funds, bequests and fellowships

THE Institution of Mining and Metallurgy has issued details of its trust funds, bequests and fellowships to which applications are invited for grants.

Approximately £3,000 will be available in 1991 for grants from the Bosworth Smith Trust Fund for the assistance of postgraduate research in metal mining, non-ferrous extraction metallurgy or mineral dressing. Applications will be considered for grants towards working expenses, the cost of visits to mines and plants in connection with such research, and purchase of apparatus.

Applications are invited from the income of the G Vernon Hobson Bequest, established for the 'advancement of teaching and practice of geology as applied to mining'. It is expected that approximately £2,000 will be available in 1991. One or more awards may be made for travel, research or other objects in accordance with the terms of the Bequest.

In addition, applications are invited for Stanley Elmore Fellowships, which are awarded by the Institution and tenable at UK universities, for research into all branches of extractive metallurgy and mineral processing. Two or three Fellowships, to a value of some £8,000 per annum, will be available from October, 1991.

Application forms are available on request from The Secretary, The Institution of Mining and Metallurgy, 44 Portland Place, London W1N 4BR. Preference will be given to members of the IMM, but others may apply. Completed forms must be returned by 15 March 1991.

WHERE ARE WE NOW ON NUCLEAR POWER?

A one-day seminar organised by The Institute of Energy

13 March 1991

The Conference Forum, London E1

World energy supplies are clearly finite, rapidly diminishing and under tremendous pressure. 38 per cent of world energy comes from oil, 30 per cent from coal, 20 per cent from gas, seven per cent from hydro and four per cent from nuclear.

The best use of all energy must be achieved by greater efficiency at the same time other energy sources such as renewables and nuclear must be fully exploited. If nuclear power is developed to its full potential it can provide an energy source capable of supplying substantial amounts of electrical energy for a long period of time.

Public perception is a vital issue following the Three Mile Island and Chernobyl accidents and as a consequence the industry needs to restore public confidence and at the same time, the economic position highlighted during privatisation of the electricity supply industry, needs to be re-examined and a more realistic position established.

This seminar will bring together a group of distinguished people to examine these problems and state their views and objectives on **Where Are We Now On Nuclear Power?**

The programme will concentrate on four main strands:

- Energy supply and world needs
- Financial viability of nuclear plant from a UK and World Perspective
- Public image
- UK nuclear future and how to retain our skills.

The Speakers are:

- J Collier, Nuclear Electric
- R Yeomans, Scottish Nuclear
- J Gittus, British Nuclear Forum
- D Taylor, NNC Ltd
- J Lakey, INucE
- J C Charrault, DGXVII The European Commission
- C Harding, BNFL Ltd
- S Goddard, Nuclear Electric
- C E Pugh, Institute of Energy

Please telephone Judith Higgins on 071-580 0008 for further information or return the reader enquiry card number.

Enquiry Card No. 102

PFBC development — an overview of the achievements

*by Stephen G Dawes BSc CEng FIChemE**

During the period 1985 to 1988 the British Coal Corporation (BCC) and the Central Electricity Generating Board (CEGB) carried out a £29 m joint programme to develop Pressurised Fluidised Bed Combustion (PFBC) for power generation applications. The overall objective of the project was to develop the technology to a stage where a sound assessment could be made of the design features and economic status of PFBC power generating plant required to meet CEGB performance specifications. This technology would provide the design basis for any UK demonstration PFBC power plant. The main achievements of the project are summarised in this article.

PRESSURISED Fluidised Bed Combustion (PFBC) is the basis for an advanced and efficient coal-fired power cycle with in-built environmental protection features.

In the PFBC, combined cycle compressed air is used to fluidise a bed of ash particles. Coal, crushed to a top size of around 3 mm, is added to the bed and burned under pressure. Particulates are removed from the combustion gases, which are then expanded through a gas turbine. High pressure steam is raised in tubes within the bed and used to drive a steam turbine. Limestone is added to the bed to absorb sulphur dioxide and retain it as calcium sulphate.

Thermodynamic studies of a typical PFBC cycle indicate that it has a net generating efficiency (on the basis of gross calorific value) of 40.5 per cent, a substantial improvement over the 37 per cent to 37.5 per cent of a conventional pulverised fuel (PF) station with flue gas desulphurisation (FGD).

Recent design studies have suggested that the capital cost of PFBC should be lower than that of PF + FGD and, for unit sizes less than around 400 MW(e), the overall cost of generating a unit of electricity should be lower than that of a conventional plant of similar size. It is therefore a clear contender when technologies are being considered which are smaller than the 660 MW(e) units that the CEGB has built previously.

The first work carried out on PFBC was in 1968 at the British Coal Utilisation Research Association (BCURA) laboratory at Leatherhead in the UK. This work eventually led to the construction under the auspices of the International Energy Agency (IEA) of the 80MW_{th} PFBC test facility at Grimethorpe.

The IEA experimental programme lasted from September 1980 to March 1984, and was successful in demonstrating the potential of PFBC, in particular with regard to its combustion and environmental performance. However, a number of uncertainties remained at the end of the programme. The most important of these was the concern over tube bank lifetimes arising from the wastage rates of in-bed tubes experienced in the IEA tests. This problem had not been found in the earlier small scale rigs.

In 1984, therefore, British Coal and CEGB agreed to fund further work on PFBC to resolve these remaining uncertainties.

The BCC/CEGB programme costing £29 m was supplemented through funding totalling around £11 m provided by US Department of Energy (USDoE), the Electric Power Research Institute (EPRI), the European Community and some residual funds from the previous IEA work.

Facilities

The main PFBC experimental facilities were the Grimethorpe PFBC Establishment in Yorkshire, and a smaller unit at British Coal's Coal Research Establishment (CRE) near Cheltenham. The Grimethorpe Facility was first used for component development and extended tests. Two test series were planned; Test Series A1 and Test Series A2. These were complemented by short performance tests at CRE to extend the range of operational parameters investigated. Supporting work on basic science was carried out at CEGB and British Coal laboratories.

The heart of the facility is a pressurised fluidised bed combustor consisting of a 2m square, 8m tall water-cooled chamber suspended in a pressure shell. Air for combustion and fluidisation enters the top of the pressure

** Research Manager, Power Generation Branch Coal Research Establishment, British Coal Corporation*

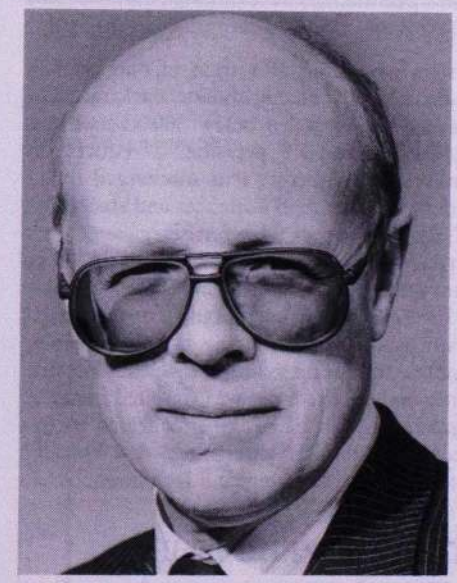
The author

Stephen Dawes graduated in Chemical Engineering at Sheffield University. Then followed one year on VSO work in Nigeria before joining British Coal in 1966.

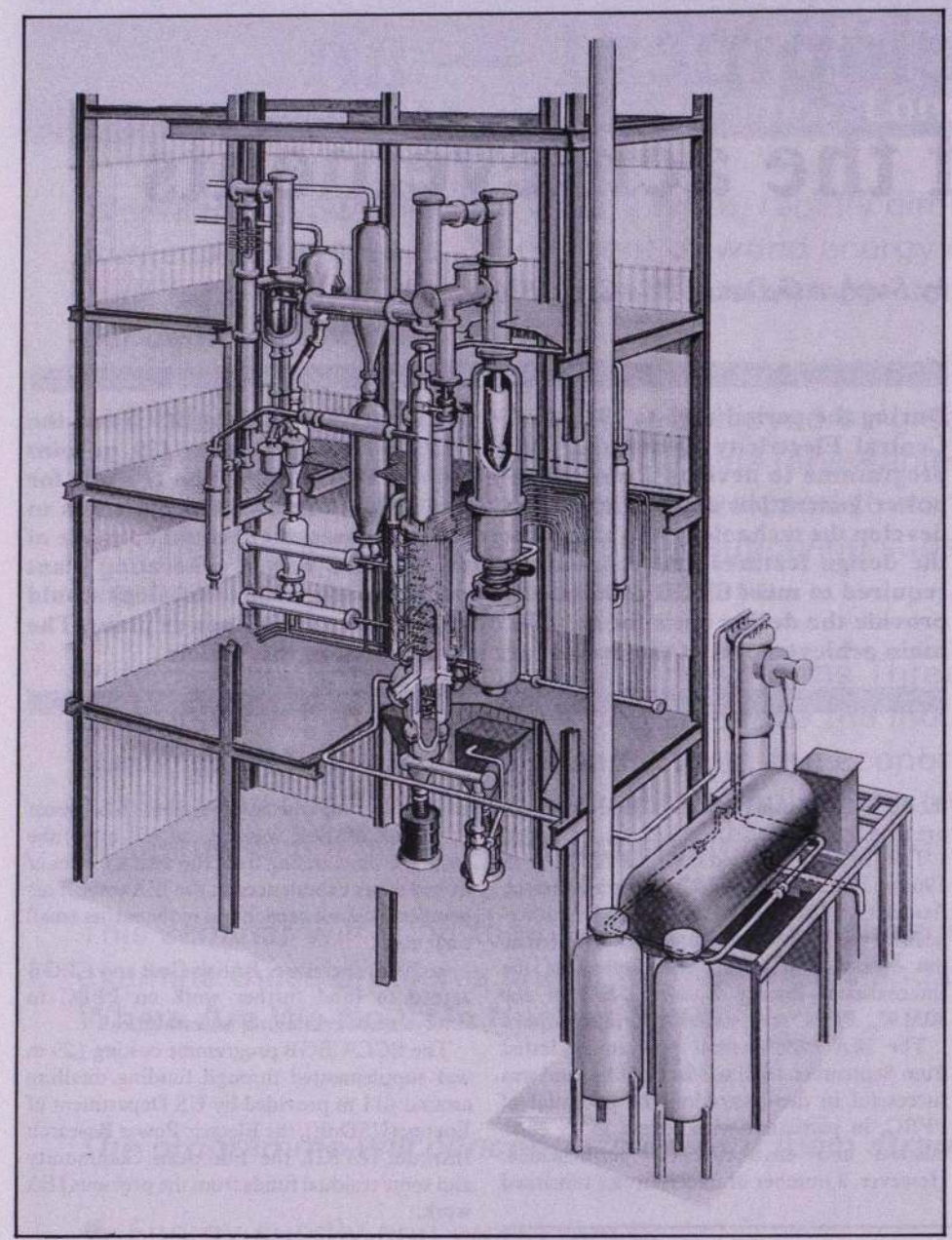
After completing preliminary underground training at Bentinck Colliery in Nottinghamshire, he joined the Coal Products' Graduate Training Scheme. He worked mainly in the Midlands Region in the technical department and as Assistant and eventually Works Manager of a coking plant near Pontefract.

In 1978 he moved to South Wales and was Manager of a foundry coke plant at Cwm and General Manager of the Phurnacite briquetting plant at Aberdare.

He was appointed Director of Grimethorpe PFBC Establishment in 1984 at the start of the CEGB/British Coal programme.



Mr Dawes is currently working at the Coal Research Establishment, Cheltenham as Research Manager (Power Generation) with continuing responsibility for Grimethorpe.



The CRE PFBC facility.

shell and flows down the annular space before entering the combustion chamber through a distributor plate, and fluidising the bed of ash particles. Heat is removed by a tube bank immersed in the fluidised bed which forms part of a once-through boiler system, generating superheated steam.

Coal blended with sorbent can be supplied by a pneumatic system through a pressurised lock-hopper system and conveying lines or as a coal-water mixture, in which case sorbent may be fed dry or mixed into the coal-water mixture. Typical coal throughput is around 3t/h. The coal-water mixture feed system added in 1989 was supplied and tested through fundings supplied by the USDoE.

Provision is made to supply old bed material for start-up, and for the removal of hot ash by pneumatic conveying into a wet quench system. This is a convenient process for the Grimethorpe scale of operation, but a dry ash removal system would be used on a commercial plant.

From the combustor, high temperature ducting directs the exhaust gas into a dust removal system consisting of a train of one primary cyclone and one secondary cyclone. The cleaned gas is cooled below 380°C in a heat exchanger, and its pressure is reduced by control valves, before it is discharged to the atmosphere through a silencer and stack. Part of the hot gas can be further cleaned in a tertiary cyclone before being accelerated through a turbine cascade or target section.

In 1987, a second, parallel, dust removal train was added consisting of a pre-cleaning cyclone followed by a high-efficiency positive filter system: the latter was supplied under an agreement with EPRI. Dust collected by this second system is discharged dry through cooled screw conveyors and lock hoppers.

The CRE PFBC facility

The combustor consists of a refractory-lined pressure vessel providing a fluidised bed with a cross section of 0.3m × 0.3m. The bed and freeboard together occupy a height of 4.8m. Fluidising air enters through a sparge-pipe distributor at the base of the bed. Coal, at typical throughputs of around 120kg/h, and sorbent are fed pneumatically using a dilute phase system. Immersed within the bed is a tube bank comprising numerous water-cooled and uncooled tubes. The facility is designed to operate over a wide range of temperatures, pressures, fluidising velocities and excess air levels. To meet each desired combination of conditions the appropriate number of cooling tubes are installed.

The programme comprised the following eight areas of work:

- in-bed tube bank life;
- combustor performance;
- hot gas clean-up;
- gas turbine blades and downstream materials;
- component assessment and development;
- instrumentation development;
- ash disposal and utilisation;
- turndown and control.

The following paragraphs summarise the main achievements of the programme under the eight work area headings given below.

Reduction of in-bed tube wastage

At the beginning of the BCC/CEGB programme severe wastage of the in-bed tube bank had been identified as a major problem for the technology.

During Test Series A1 at Grimethorpe, the combustor was operated with a new tube bank, tube bank D, for just over 500 hours. The results showed that by appropriate choice of alloys and fluidising conditions (lower fluidising velocity and bed particle size compared to the IEA phase) superheater tubes could give acceptable wastage rates. However, in the upper parts of the bed conditions were still somewhat too severe for commercial evaporators to give acceptable loss rates.

In order to provide further data for the design of a new tube bank, a large cold model experiment was initiated at Grimethorpe, backed up by smaller scale studies at CRE. The cold models were used to simulate particle movements within the combustor, and to investigate the impact of changes in tube bank design and operating conditions.

The cold model studies indicated that significant reductions in peak wear could be obtained by optimising tube bank geometry and fluidising conditions, in particular by reducing bed particle size to the minimum practicable. The lessons learnt were used in the design of a new tube bank ('E') and in choosing the fluidising conditions for the second test series at Grimethorpe, Test Series A2.

Tube bank 'E' contained a number of short test sections manufactured from candidate evaporator and superheater materials operating over a range of temperatures typical of a commercial plant. Test sections were welded together before precision machining.

Wall thicknesses were measured using a specially developed transducer based instrument capable of measuring to tolerances of ± 3 microns at four standard deviations.

Several tubes with fins and other special features were included in the tube bank to meet

USDoE interests and those of the tube bank supplier, Foster Wheeler Development Corporation.

The results from Test Series A2 suggest that with appropriate choice of alloys, operating temperatures and fluidising conditions, a commercially acceptable tube bank can be designed to give lifetimes probably well in excess of 100,000 hours, without recourse to protective devices such as fins or studs.

Examination of high temperature materials contained in the bed during the tests has also indicated that, by the appropriate choice of tube materials, full CEGB superheated steam temperatures could be achieved without excessive corrosion of the tube bank. This information is of great commercial value for the future of PFBC technology.

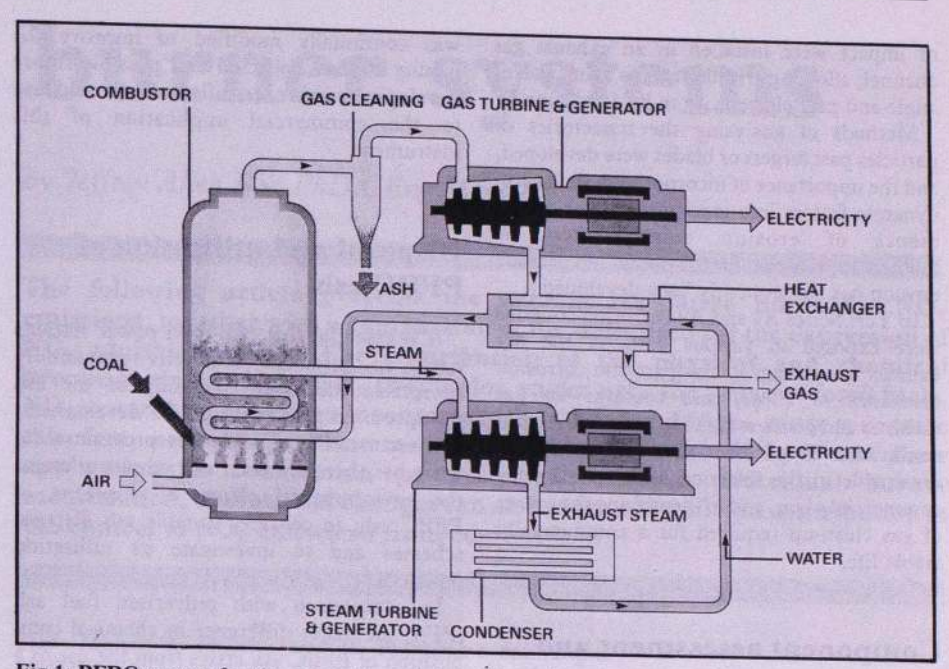


Fig 1: PFBC system for the generation of electricity using a combined cycle.

Combustor performance

The ability to retain sulphur in the bed is a major advantage of PFBC technology. The joint programme has shown that high levels of sulphur retention (typically around 90 per cent) can readily be achieved using a range of limestones with feed rates significantly lower than those required in previous testing, using dolomite as the sorbent. As a result, it is expected that limestone addition at a calcium to sulphur ratio of around 1.8 will be required for 90 per cent sulphur retention. The confidence with which these experimental data can be scaled up to commercial plant has been improved by the development at the Marchwood Engineering Laboratory of a computer model of sulphur retention in PFBC.

NO_X emissions from PFBC are low, in the range 100-150 ppm (normalised to 3 per cent oxygen in the flue gas). Even so work at CRE has indicated that it may be possible to reduce these low levels still further, to 30-50 ppm, without prejudicing combustor performance, either by modifying the combustion process, or by injecting additives into the gas stream.

While the investigation of combustion efficiency has not been a major objective of the programme, results obtained during the tests have confirmed previous findings that combustion efficiencies greater than 99 per cent can readily be achieved for a wide range of coals.

Heat transfer rates measured during the joint programme were better than those achieved during earlier work at Grimethorpe, and have been analysed to give more accurate heat transfer correlations, so increasing the confidence with which commercial tube banks can be designed.

Hot gas clean-up

The hot pressurised gases from the PFBC carry with them a heavy loading of dust, composed of coal ash and spent sorbent. This dust would be very damaging to a gas turbine, since it would cause blade erosion or fouling.

Ceramic filters offer the promise of providing more efficient gas cleaning than that achievable by the more established system of a series of cyclones. They would also avoid the need for a gas clean-up stage after the gas turbine. Porous hollow cylinders, typically 1.5m long × 0.06m diameter, are arranged in large numbers in parallel. Each element has a nozzle supplying a high pressure reverse pulse of air to clean it when required.

The largest scale test in the world to date, to demonstrate the durability of this type of filter, was conducted as part of the joint programme on the Grimethorpe PFBC, under a collaborative agreement with EPRI. The filter unit installed and tested at Grimethorpe incorporated up to 130 filter elements, enabling it to clean about half of the gas produced by the combustor.

The filter elements, manufactured by Schumacher GmbH, were made of clay-bonded silicon carbide grains. Each element had a thin superficial coating to promote surface filtration, in order to minimise pressure losses after extended exposure.

The filter unit was operated during Test Series A2 for over 800 hours under a range of conditions. Extended periods of several hundred hours of reliable operation at full throughput were achieved, during which emission levels were well below any projected gas turbine or environmental limit. This was a major achievement in view of the novelty of the technology.

A great deal was learnt about the best way to design and operate future units, and about the behaviour of ceramic filter materials in this application. The tests identified the need for further work on the development of filters with better durability and sealing mechanisms.

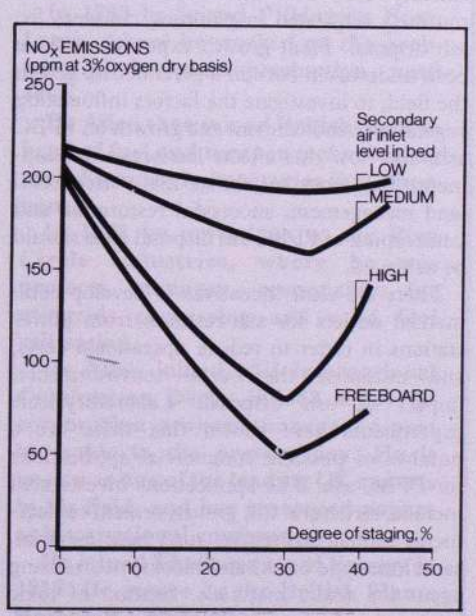


Fig 2: Reduction of NO_X emissions from PFBC.

Gas turbine blades and downstream materials

At the start of the programme a number of areas of potential concern had been identified, as follows:

- erosion of the gas turbine blades by particulates not removed by the hot gas clean-up system;
- "hot" corrosion of the gas turbine blades caused by the sodium and potassium salts released from the coal;
- low temperature corrosion caused by condensation of acids.

The joint programme has addressed these problems and has solved them or made major advances towards their solution in all cases.

Prior to Test Series A2 at Grimethorpe, a target test section was installed to provide fundamental data on the erosion process in a gas turbine. Targets made of the gas turbine blade alloy IN738LC with well defined angles

of impact were installed in an exhaust gas channel, allowing erosion rates as a function of angle and particle velocity to be determined.

Methods of analysing the trajectories of particles past targets or blades were developed, and the importance of incorporating such aerodynamic factors into measurements or assessments of erosion demonstrated. A mathematical model for the prediction of blade erosion has subsequently been developed.

In Test Series A1 and A2 corrosion coupons were exposed in various parts of the hot exhaust gas stream to compare the corrosion resistance of alloys, and coatings for gas turbines and ductwork, in the range of relevant conditions. The information derived will be invaluable in the selection of materials for a commercial plant, and in identifying the extent of gas clean-up required for a commercially viable life.

Component assessment and development

Many of the plant components in a PFBC system will be of novel design and will operate under severe duty. All components relevant to the pressurised section of the Grimethorpe facility were therefore inspected after the end of Test Series A1 and again after Test Series A2. Any components failing during the course of the project have been investigated and improved designs have been developed as necessary.

A major component development area within the project concerned coal-water slurry preparation and feeding systems. The Grimethorpe combustor was fired using coal-water mixtures and coal sorbent-water mixtures of various water contents for some 600 hours during the second half of Test Series A2.

The trials have shown that such slurries can be produced, handled and fired effectively. The operation of the PFBC with such feedstocks is reliable and trouble free, and does not adversely affect combustor performance. Low water contents in the slurries are preferred as they minimise any penalty on cycle efficiency, compared to dry feeding. The tests have shown that pumpable slurries can be achieved with free water contents as low as 21-22 per cent.

Instrumentation development

An objective of the joint programme was to develop on-line instruments to monitor the concentration and size grading of the dust in the hot gas entering the gas turbines. Tests were carried out of a laser particle monitoring system from the Atomic Energy Research Establishment, Harwell.

The laser particle monitor was designed to measure on-line dust loadings and particle size distributions over the range 1 to 10 μm. It is based on computer analysis of Doppler signals produced by sampled particles passing through laser generated fringe patterns. The system was first commissioned at CRE, and then at Grimethorpe at the inlet to the turbine materials erosion test channel. The equipment was continually modified to improve the quality of data collected and possible future developments were identified which could lead to the commercial application of this instrument.

Disposal and utilisation of PFBC ash

It is essential that coal-fired power stations have an effective and environmentally acceptable means of disposing of the ash produced. As part of the PFBC development programme, a comprehensive programme of work has therefore been carried out to assess the environmental effects of disposing of PFBC ash, to consider suitable ash disposal schemes and to investigate its utilisation potential.

In comparison with pulverised fuel ash (PFA) the major difference in chemical composition of PFBC ash arises from the use of a sulphur sorbent, resulting in higher levels of calcium (and magnesium, if dolomite is used as sorbent), and sulphate. The concentrations of trace elements are generally in the same range as for PFA.

PFA is disposed of by wet and dry routes. This study has shown that PFBC ash could be disposed of by both these routes. In the wet route, because of the potential alkalinity of PFBC ash, the pH of the lagoon effluent would need to be monitored. However, on the basis of PFA experience, the lagoon effluent from typical PFBC ash (free lime content <1 per cent) would not require any treatment.

Issues considered in the dry disposal route were run-off from the slopes of a mound, and the long term effect of PFBC ash leachate on surface and ground waters, both of which were studied in the joint programme. These studies indicated that the run-off and leachate from PFBC ash disposal sites should not pose a problem.

In most cases of PFA disposal, steps are taken to restore the surface to agricultural or amenity use. Full landscape schemes are routinely requested in planning consents for ash disposal. Plant growth experiments have been undertaken both in a greenhouse, and in the field, to investigate the factors influencing vegetation establishment and growth on PFBC ash, and how this affects landscape development. This work has shown that with careful land management, successful restoration and landscaping of PFBC ash disposal sites should be achieved.

There are clear incentives to develop commercial outlets for ash residues from power stations in order to reduce operational costs, and minimise the overall environmental impact of ash disposal. Laboratory-scale experiments have shown that there are a number of possible commercial applications for PFBC ash. The applications investigated include: structural fill, grouts, cement replacement, asphalt aggregate, road base material, sand/lime-type bricks and blocks, neutralising agent for acidic materials, fixation of toxic wastes, synthetic aggregate, filler in plastics, alumina extraction and soil conditioner.

Turndown and control

Studies on the full and part load performance and on the response of PFBC cycles have been carried out as part of the joint programme. Whole plant models of advanced fluidised bed cycles have been successfully developed. The models have been used to review the performance parameters (temperatures, pressures, thermal efficiencies etc) for a commercial PFBC plant at steady state, full and part load, culminating in the definition of the optimum cycle arrangements, and the identification of strategies for turndown of PFBC combined cycle plant.

Frequency response tests were carried out at Grimethorpe to measure the temperature response of the bed, tube bank output and the off-gas path. Results are expressed as time constants which can be used in dynamic models of Grimethorpe and the commercial plant to design fuel feed rate control systems and to help predict power plant response rates. Whilst the control system may well need refinement to allow for the details of real plant, the dynamic analysis does provide a sound basis for the design of a commercial plant control system.

The future

The successes of the British Coal/CEGB programme may be summarised as follows:

- it has shown how to overcome the high tube metal loss experienced at the start of the project, and gives confidence that commercially acceptable tube bank lifetimes can be achieved.
- The work had advanced the understanding of sulphur capture and NO_x emissions to the extent that further improvements in both of these aspects can be expected.
- The data base for the design of combustors for commercial plants has been extended and the degree of uncertainty in scaling up from Grimethorpe to a commercial plant has been reduced.
- Collaborative work with USDoE and EPRI has led to valuable demonstrations of new coal feeding and gas clean-up techniques.
- Safe disposal routes for PFBC ash have been identified.
- The relative merits of alternative turndown and control methods have been investigated against the targets set by the CEGB.

Theoretical prediction of gas turbine erosion indicates that gas turbine operation using PFBC gases cleaned by cyclones is viable, although a demonstration of gas turbine operation in a PFBC cycle is still required.

The project was initiated against the background of studies overseas. These showed PFBC to have a lower generating cost than PF plant plus FGD, principally at unit sizes smaller than around 400 MWe. The parallel UK design studies have confirmed this in respect of the financial and fuel cost parameters current at the time of the project.

As a result of the considerable advances made during the joint programme, the technology for the design of demonstration and commercial plants has a sound base. □

Low NO_X burner systems

*by Jeffrey Allen BSc PhD CEng MInstE**

The following article presents the current legislative limits for NO_X emissions, together with a comparison of the units used for the expression of NO_X emission levels. The contribution of the physical and chemical processes giving rise to NO_X production varies over the range of fossil fuels. NO_X control mechanisms incorporated into burner designs must recognise this fact, and this is illustrated in individual burner designs and their application in combustion processes. As well as individual burner modification, operational changes can also make a significant contribution to the control of NO_X emissions from combustion.

EUROPEAN Economic Community (EEC) directive 88/609/EEC prescribes limits for the omission of Nitrogen Oxides (NO_X) from new large combustion plant together with targets for NO_X reduction from existing plant.

Large plant is defined as above 50 MWth (megawatt thermal input) on a nett calorific value basis.

For new plant the NO_X emission limits apply as in Table 1.

Table 1: NO_X limits of large new plants

Fuel type	Limit value mg/Nm^3
Solid fuel generally	650
Solid with < 10% volatiles	1300
Liquid	450
Gaseous	350

The figures are based on an oxygen content in the dry waste gas of 6 per cent in the case of solid fuel and 3 per cent in the case of liquid and gaseous fuels. Although aimed at new plant, these emission levels have become target norms for the retrofitting of NO_X control equipment to existing plant. The NO_X limits do not apply to high temperature processes found, for instance, in the glass, cement and steel making industries.

Directive 88/609/EEC also defines reduction targets in NO_X emission from the various EEC countries, which in the case of the UK requires a total NO_X emission reduction of 15 per cent by 1993 and 30 per cent by 1998, with 1980 NO_X emissions taken as the base level.

In the UK, consideration is being given by Her Majesty's Inspectorate of Pollution (HMIP) to NO_X emission levels from plants in the 20-50 MWth range, and the limits under discussion are broadly similar to those of the EEC directive. However, a distinction may be made between distillate and residual oil firing with NO_X limits of 280 and 450 mg/Nm^3 respectively. A reduction in the EEC large plant emission limit for gaseous fuels is also under consideration.

The units adopted for the expression of NO_X emission level are not standardised, although mg/Nm^3 is becoming the most commonly used throughout the EEC. Parts per million (ppm) or lbs per 10^6 Btu heat input are other terms frequently used.

NO_X formation

In establishing these NO_X emission limits, obviously the nitrogen content of the fuels is taken into account. Typically this will be in the 1-2 per cent range for solid fuels, up to 0.5 per cent for liquid fuels and below 0.1 per cent for natural gas.

However, NO_X is not only derived from the N_2 content of the fuel, high temperature reactions between N_2 and O_2 in the combustion process also contribute to NO_X emissions. This thermal NO_X contribution is small below temperatures of 1200°C increasing at temperatures of 1400°C+.

Peak flame or combustion chamber temperatures are used as a guide to thermal NO_X production and can be controlled by the fuel and air mixing processes, the combustion intensity, the excess air level and combustion air preheat temperatures.

Not all the nitrogen in the fuel reacts to form NO_X. The evolution of the nitrogenous species from the fuel under reducing atmospheres favours the formation of N_2 rather than NO_X. Pyrolysis compounds found in oxygen deficient areas of the flame can reduce NO_X back to N_2, as can reactions in the latter stages of the flame with CO and carbon. Fuel and air mixing is therefore the principal factor in the control of NO_X formation, as this determines the oxygen concentration, the rate of release of fuel nitrogen species in the critical areas and temperature of the flame.

Internal probing of flames has shown the critical reactions occur in the near burner region, probably within a burner diameter. The CO/carbon reactions occurring in the latter stages of the flame can be regarded as fine tuning of the overall NO_X emission. The three parameters affecting overall NO_X emissions are therefore the temperature, oxygen concentration and residence time in the critical flame areas. Burner designs and combustion chamber operation techniques are available to influence these basic NO_X formation parameters in combustion systems.

By controlling the rate of mixing of fuel and combustion air, individual burners can be designed to minimise the formation of NO_X.

The author

Dr Jeffrey Allen began his career at Sheffield University, where he studied chemistry and fuel technology and chemical engineering.

In 1960 he joined Pilkington Bros, Lancs, where he worked on the problems of flat glass production, until 1966.

Dr Allen then joined British Steel as head of fuel and furnace technology at their Swinden Laboratories in Rotherham.

In 1972 he moved on to the Blue Circle Industries, where he was projects manager, responsible for minerals processing and solid fuel utilisation.

Dr Allen joined NEI International Combustion, Derby, in 1982, as special combustion projects manager; a post he holds to the present day. He is known as one of the leading UK experts in his field, and has presented papers at international conferences.

He joined The Institute of Energy in 1959. He serves on the British Flame Research Committee.

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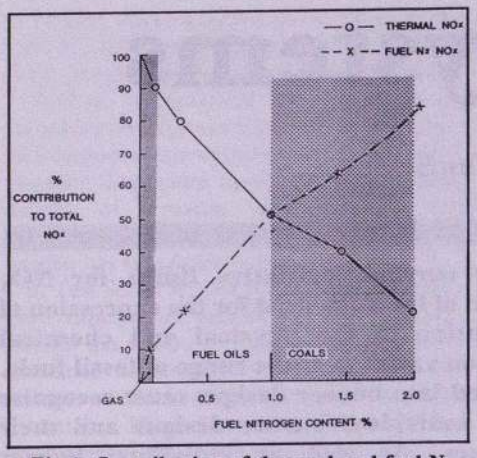

Fig 1: Contribution of thermal and fuel N_2 reactions to total NO_X production.

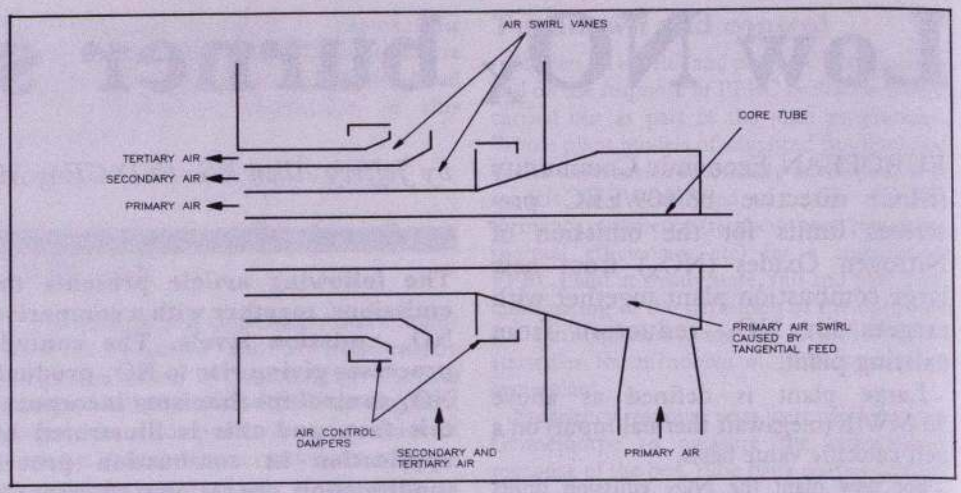

Fig 2: Air staged low NO_X coal burner.

These designs produce fuel rich zones which inhibit NO_X formation from fuel N_2 and the peak flame temperature is also reduced, resulting in lower NO_X. Typical low NO_X burners have multiple air channels with facilities for control of fuel and air mixing. Proportioning of the combustion air between the various channels is achieved by carefully selected burner geometry, and flexibility of this operation is increased in some examples by the provision of air control dampers.

Variable air swirl may also be provided in these air channels to control both the initial fuel air mixing and final flame length. These techniques have generally become grouped together under the heading of 'air staging'.

Many burner designs also incorporate fuel staging, in addition to this air staging, as a means of NO_X control in the flame. Fuel staging introduces a series of fuel rich streams into the critical flame region, further minimising NO_X formation.

The incorporation of a duct within the burner body to introduce recycled flue gas (RFG) to the core of the flame can be a particularly effective means of NO_X control in combustion systems in which thermal NO_X is predominant. RFG has been demonstrated to be effective in reducing peak flame temperatures, when targeted between the fuel and air stream in the burner. Because it primarily limits thermal NO_X formation, the use of RFG is more effective in gaseous and liquid fuel firing.

Furnace operation for NO_X control

Air and fuel staging techniques can be introduced into combustion chamber design and operation to minimise NO_X formation.

The two most significant modifications in this category of NO_X control technique are the use of over fire air (OFA) and the low NO_X corner fired system, introduced into utility boiler operations. In the OFA system, air is taken from the main burner and introduced via separate ports, usually located above the burners. The main burner system therefore operates at low excess air, minimising NO_X formation.

In the case of utility boilers the OFA system is more effective in tangential and opposed fired units, rather than the single wall fired boilers. This is because the aerodynamics of the systems give better mixing of the OFA, taken from the common windbox, in the two former systems. Separate higher pressure air, from separate fans, enhances the effectiveness of OFA in completing combustion within a fixed volume, as evidenced by the use of secondary air jets in stoker fired systems. The OFA technique can also be incorporated in separate air ducts adjacent to the individual burner(s) in an attempt to use the combustion chamber air staging technique more effectively. In running the main burner system under low excess air conditions, care must be taken to avoid reducing atmospheres, which may harm combustion chamber materials or the material being processed.

In corner fired utility boilers, the low NO_X corner firing system (LNCFS) provides an oxidising atmosphere adjacent to the boiler walls, and thus minimises corrosion and also slagging in this area of the boiler. The burner columns located in each corner of the boiler also incorporate OFA techniques, and the system has been demonstrated to be effective in NO_X control. All the UK coal corner fired boilers will be operated on this system, making a significant contribution to the 15 per cent and 30 per cent UK reduction 1995 and 1998 NO_X targets.

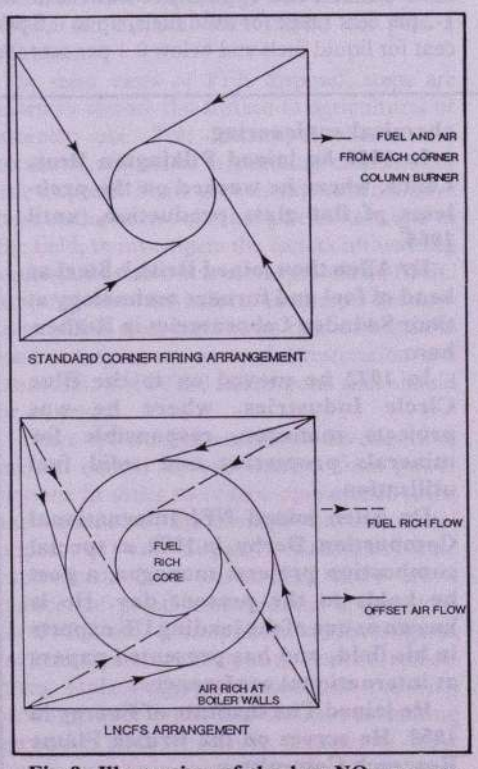

Fig 3: Illustration of the low NO_X corner firing system principle.

OFA can be introduced at a single level or further staged levels into the combustion chamber to control NO_X production and maintain efficient combustion.

Chemical reduction of NO_X in the combustion chamber can be achieved by using what is generally known as 're-burn technology'. This is, in effect, both fuel and air staging taken to a high degree. In this system, a portion of the fuel is fired to produce reducing conditions above the main burner system. Reductants formed in this, the re-burn or de-NO_Xing zone, react with the NO_X from the main burner system. OFA is introduced above this reaction zone in order to complete combustion. A critical factor in the successful application of re-burn is the residence time in the de-NO_Xing zone. NO_X levels for the main burner system and de-NO_Xing zone temperatures have also been shown to influence the final NO_X emission level from re-burn systems.

In multi burner units, the burners in the centre of these systems will tend to produce higher temperature flames, and hence higher thermal NO_X levels. NO_X can be decreased by taking such burners out of service, the remaining burners must of course be capable of operating effectively at the overload levels required, by taking burners out of service (BOOS). Leakage or cooling air is supplied via these non firing burners, although in some applications, increased air flow through the out of service burners may be further used to effect NO_X control by air staging.

In multi burner systems a rich/lean burn (RLB) technique may be employed. Certain burners may be run under fuel rich conditions, and others under fuel lean conditions, in order to maintain the required overall stoichiometry while effecting some reduction in NO_X levels.

Potential for NO_x reduction

Unfortunately the NO_X reductions techniques applied to burner design and combustion chamber operation are not additive. For example, fuel on air staging

Table 2: NO_X emission level interconversion

To convert from		To convert to (multiply by) mg/Nm³	ppm	lb/10⁶ Btu coal	oil	gas
mg/Nm³		1	0.487	8.14 × 10⁻⁴	6.51 × 10⁻⁴	6.28 × 10⁻⁴
ppm		2.05	1	1.67 × 10⁻³	1.34 × 10⁻³	1.29 × 10⁻³
lbs/10⁶ Btu	coal	1230	598	1	1	1
	oil	1540	748			
	gas	1590	775			

Coal emissions are based on 6% O_2 in the dry flue gas and oil and gaseous emissions on a 3% O_2 dry flue gas content.

applied to a burner design can effect NO_X reductions in the order of 40 per cent. However, a burner design incorporating both fuel and air staging will effect NO_X reduction in the order of 50-60 per cent from the combined techniques.

OFA, Reburn, RFG, RLB, OFA and BOOS can make a further contribution to NO_X levels. However, it must be pointed out that the optimum combination of these techniques has yet to be established.

Obviously the largest single NO_X reduction effect is achieved using purpose designed low NO_X burners. OFA or furnace air staging is the next most significant technique, the effectiveness of RFG depends on the fuel type and the predominance of the thermal NO_X element. Application of RLB or BOOS techniques may probably be site specific as they can lead to unacceptable combustion chamber conditions or combustion efficiencies.

Re-burn has potential as a significant NO_X reduction technique and could probably, in conjunction with a low NO_X burner system, be optimised to achieve the ultimate in NO_X reduction. Natural gas would probably be the ideal de-NO_Xing fuel for this application, although this may have the disadvantage of requiring a significant second fuel supply to coal and oil fired systems.

Current projects being supported by the DoE under the heading of clean coal research are being carried out by various organisations in the UK, aimed at achieving the ultimate in NO_X emission reduction using these various techniques. Their findings will be available in approximately three years time.

Future requirements

Much work is being carried out in the development and analysis of low NO_X combustion systems, attempting to define the ultimate NO_X reduction which can be achieved by combustion modification, and to provide validation data for the calculation of NO_X levels from a given set of input parameters and furnace sizes.

Combustion modification can meet the NO_X limits defined in the current EEC directive relating to large combustion plants. Meeting the NO_X targets under discussion for plant in the 20-50 MWth range could be more difficult, primarily because of the high heat release rates associated with the smaller combustion chamber sizes. Low NO_X performance has to be achieved without affecting the combustion efficiency in terms of overall heat transfer, and minimum combustion losses in the form of CO or particulate carbon in the exhaust gases.

Further legislation will impose more strict NO_X emission limits, possibly beyond the most optimistic forecast. The EEC position is due for review in 1995 in order to set the pattern from the year 2000 onwards.

In the short term, the increased use of natural gas for utility boiler firing in combined cycle or dual fuelled gas/coal combined topping cycles, will minimise NO_X emissions, as should improved efficiency cycles based on fluidised bed combustion/gasification.

Ultimately, gas clean-up systems for NO_X reduction may have to be introduced. Currently these systems are based on the reduction of NO_X by ammonia (NH_3) under carefully controlled conditions. In one technique NH_3, or compounds which dissociate to NH_3, are injected into the combustion gases, in the furnace, at a selected temperature level. In another technique, the NH_3 is mixed with the waste gases in the exhaust duct then passed over a catalyst bed to effect the required NO_X reductions, this process again requires carefully controlled temperature conditions, and the catalyst may be sensitive to the dust in the exhaust gases. Both systems could have NH_3 utilisation and leakage problems, and also suffer from undesirable side reactions. Their capital and running costs are minimised by the utilisation of combustion modification as the prime element of NO_X control.

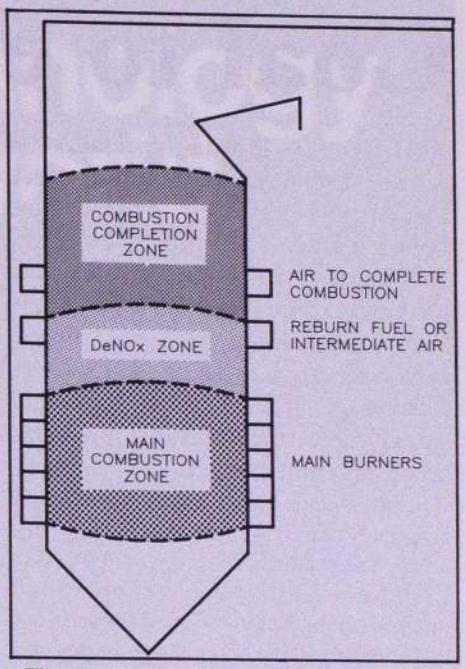

Fig 4: The reburn NO_X reduction technique.

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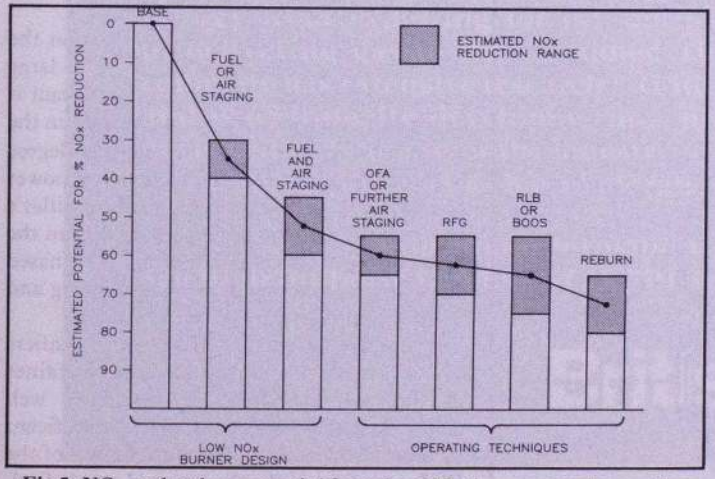


Fig 5: NO_X reduction potential from low NO_X burners and operating techniques.

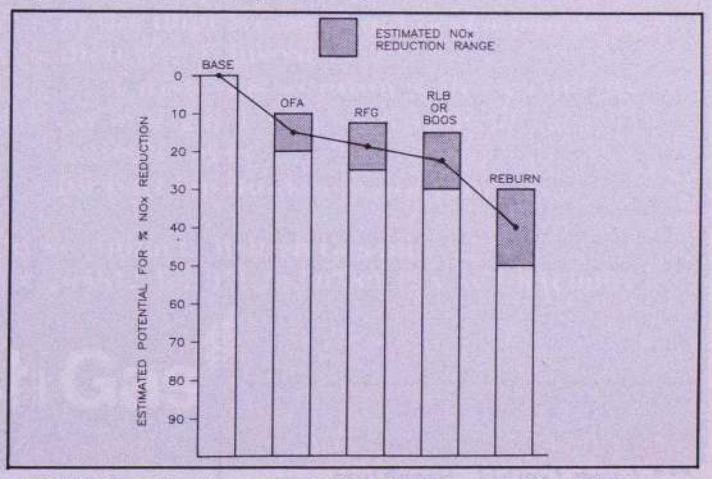


Fig 6: NO_X reduction potential from furnace operating techniques.

Coal to electricity — the BGL GCC system

by Dr B H Thompson, Dr J A Lacey** and Dr H E Vierrath****

Worldwide reserves of coal are large, and only gasification offers the advantages of highly efficient use, while at the same time achieving this in an environmentally friendly way. British Gas and Lurgi are carrying out, at the Westfield site in the UK, a demonstration programme for the conversion of coal into clean gaseous fuel. This article, originally given as a paper at an EPRI Conference in 1989, looks at the programme, which is based upon the gasification of coal in the British Gas/Lurgi slagging (BGL) gasifier.

THERE IS growing pressure to reduce emissions of sulphur, dust, metals and nitrogen oxides from power plants. The application of the BGL gasifier to combined cycle power generation offers the ability to achieve very high sulphur recovery (99 per cent and higher) using well-proven technology. It also ensures that emissions meet the highest projected environmental standards.

Studies have shown that a net thermal efficiency of over 43 per cent (net heat rate below 8,000 Btu/KWh) coal to electricity, LHV basis, is achievable with present gas turbine technology. With advanced gas turbines net efficiencies above 45 per cent (7,600 Btu/KWh) are expected to be achievable in the near future.

Use of the BGL gasifier in a gasification combined cycle (GCC) system leads to the production of cheaper electricity than conventional power plant and competing gasification combined cycle systems, for comparable emission standards. The BGL-GCC system is currently being considered for the GCC demonstration plants to be built in a number of European countries, as well as in the USA. The BGL gasification system is based on well proven, fully developed technology, and is available on commercial terms.

BGL gasification process

The BGL gasifier is a state of art, second generation fixed bed gasifier, in which coal is gasified under pressure using steam and oxygen. It utilises a refractory lined water-cooled double-wall reactor, based on the design of the Lurgi gasifier, which has seen widespread commercial operation over several decades. Coal is fed into the top of the gasifier via a simple, well proven lock hopper system, and descends countercurrently to the products of gasification. The steam and oxygen are injected into the hearth of the gasifier via tuyeres (water cooled injection tubes) which are comparable with those used in other technologies.

The countercurrent flow within the gasifier ensures a very high thermal efficiency, for the conversion of coal to fuel gas and hence electricity. Ash is discharged from the gasifier as an odourless, inert, granular, glassy frit suitable for landfill.

The slag tapping system is fully automatic, and readily responds to variations in slag quantities, composition and viscosity. The crude gas from the gasifier is cooled; liquid hydrocarbon byproducts are separated from the product gas and recycled via a closed loop circuit to the gasifier for gasification to extinction.

BGL gasification has a net overall cold gas efficiency for the conversion of coal to clean fuel gas of approximately 89 per cent (LHV) when gasifying a typical bituminous coal such as those used for the bulk of power generation from coal in the USA and Europe. Carbon conversion to product gas is well in excess of 99 per cent.

These features result in a number of major benefits, due to the countercurrent operation of the gasifier, the temperature of the product gas leaving the gasifier is low. Heat exchanger equipment is simple and manufactured mainly from carbon steel. No significant corrosion/erosion has been measured even when using high sulphur or high chlorine content coals, largely because of low product gas temperatures and the high pH of any condensed gaseous material. Expensive and cumbersome high temperature heat exchangers, gas cyclones and filters are unnecessary. Alternative gasification processes utilising high temperature heat exchangers have met problems due to deposition on heat transfer surfaces, corrosion of materials and erosion. Scale up of such equipment has yet to be proved.

The factors given above all lead to a high availability for gasification combined cycle systems using the BGL gasifier. This is reinforced from the record of performance of the numerous commercial dry bottom Lurgi gasifier installations operated worldwide over may decades, including those formerly operated by British Gas. These dry bottom gasifiers only differ from the BGL gasifier in the method of steam/oxygen injection and ash removal. The largest part of the BGL gasification system is practically identical to the well proven Lurgi dry bottom system.

For combined cycle power application the fact that the gasifier does not produce large amounts of byproduct high pressure steam is important. Such steam can only be used in the steam turbine, increasing the required degree of integration between gasification and power generating equipment. The BGL gasifier's energy product is mainly potential heat in the clean fuel gas which is important for phased construction, intermediate load following and intermittent operation of power plants.

It is often stated that fixed bed gasifiers cannot tolerate any significant amount of fines in the coal feedstock. It has been well demonstrated at Westfield that a significant amount of fines can be fed into the top of the BGL gasifier with the normal coal feed, depending upon the properties of the coal. Top

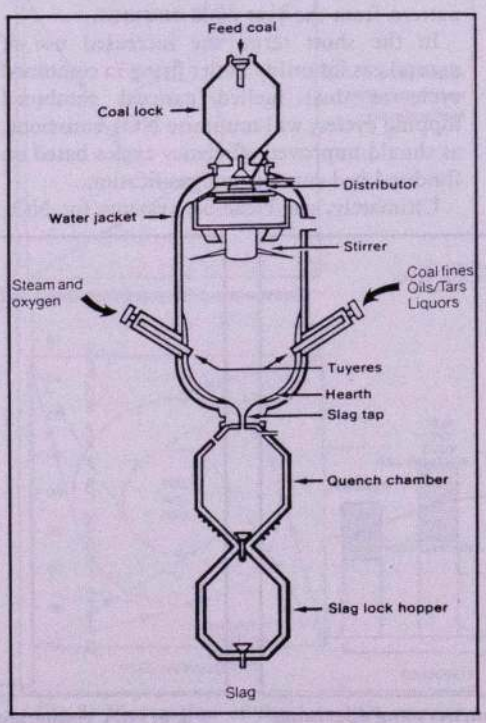


Fig 1: The British Gas Lurgi (BGL) gasifier.

* *British Gas plc, London*
** *British Gas plc, Solihull*
*** *Lurgi GmbH, Frankfurt*

coal feeds with up to 35 per cent of the material below 6 mm in size have been used. Any surplus of fines can be utilised as agglomerates, in admixture with the coal feed. Alternatively such surplus can be fed down the tuyeres of the gasifier, either as a coarse slurry or by gas entrainment. Other gasification systems do require the crushing of any lump coal, and in many cases the fuel has to be ground to a very fine size (below 90 microns). For the BGL system only the excess fine material has to be crushed.

Hydrocarbons are produced in the gasifier by the pyrolysis and devolatilisation of the coal near the top of the gasifier. Both hydrocarbons and water vapour are condensed in the cooling train. The hydrocarbons are separated from the resultant aqueous liquor before recycling back to the gasifier. These hydrocarbons are beneficial, however, in that condensed hydrocarbon material covers heat exchanger surfaces downstream of the gasifier and protects them from corrosion. Moreover, in condensing, they essentially remove all the dust in the gas stream carried over from the gasifier. The dust is then returned with the hydrocarbon recycle back to the gasifier and gasified to carbon extinction. The gas therefore is particulate-free downstream of the first heat exchangers, and the ash in the coal only appears in the slag from the gasifier base. Unlike other systems there is no fly ash to dispose of, only the inert granular slag from the gasifier itself. This slag is benign and suitable for building material or landfill.

As to coal feedstock quality the fixed bed gasifier has desirable advantages. Any type of bituminous coal can be gasified. The ability to add flux to the gasifier coupled with a significant residence time of the coal in the gasifier enables coals with a wide variation in ash content and composition to be handled even when changes are sudden, of considerable magnitude and unpredicted.

This is often the case in the field of power generation when coal can come from a variety of sources. Even coals with a very high silica content, and hence refractory ash, can be gasified readily in this way whilst the slag removal system can easily cope with variations in slag production rate and viscosity.

Status of technology

The demonstration programme at Westfield commenced in 1975 using a 350 tonnes/day unit and with a reactor diameter of 1.8 m and was replaced in 1981 by a 500 tonnes/day unit with a reactor diameter of approximately 2.3m. This unit incorporates in its design and construction the experience gained with the earlier unit. Performances of the two units were similar and confirmed scale up parameters and expectations.

These units have operated with a wide range of UK and US coals, ranging from non-caking to highly caking and swelling coals with ash contents ranging up to 25 per cent. Over 160,000 tonnes of coal have been gasified.

Over the wide range of coals gasified, the product gas composition remains substantially constant with a calorific value of approximately 350 Btu/scf.

Table 1: Feedstocks tested in the BGL gasifier

Fuel	Proxamite Analysis H_2O	Ash	VM	FC	Swelling No	Caking Index	Sulphur %	Origin
Blast Furnace Coke	0.7	9.7	1.9	87.7	0	A	0.69	England
Rawdon	7.3	5.1	39.4	48.2	1	B	1.45	England
Seafield (Unwashed)	6.3	21.0	28.2	44.5	1	A	0.39	Scotland
Markham Main (Washed)	10.0	4.3	30.4	55.3	1.5	C	1.17	England
Markham Main (Unwashed)	6.1	20.1	29.4	44.4	1	B	1.24	England
Rossington	6.9	4.3	33.3	55.5	1.5	E	1.03	England
Manton	3.0	7.3	31.9	57.8	6.5	G_5	2.00	England
Pittsburgh B	2.1	11.5	36.1	50.3	7	G_7	1.87	USA
Ohio 9 (Washed)	1.4	12.0	39.7	46.9	6	G_4	3.30	USA
Ohio 9 (Unwashed)	1.2	20.8	32.3	42.2	3.5	G	3.29	USA
Petroleum Coke	1.5	0.6	3.5	90.3	0	A	1.46	North Sea Oil
Pelleted Markham Main	26.0	11.0	22.35	40.65	1	C	1.20	England

Table 2: Performance results with briquettes and slurry injection

Run No	18	19	20
Coal	Markham Main Power Station Fuel	Illinois 6	Pittsburgh 8
Method of Fines Gasification	Briquettes Mixed with Lump Coal	Slurry Injection at Tuyeres	Slurry Injection at Tuyeres
% Fines in overall coal feed to gasifier (dry)	55	38	49
% Fines in lump coal feed	10	19	30
% Fines as briquettes	50	0	0
% Fines as slurry to tuyeres	0	24	27
Steam/oxygen ratio	1.09	0.65	0.58
Gas outlet temperature (°C)	284	398	404
Gas composition (vol %)			
CH_4	6.8	5.4	5.2
CO	56.5	54.5	55.6
H_2	26.6	29.5	29.6
CO_2	5.9	5.8	5.3
N_2	3.0	2.6	2.6
Oxygen consumption lb O_2/lb daf coal	0.55	0.68	0.68
Steam consumption lb H_2O/lb daf coal	0.34	0.25	0.22

Hydrocarbon byproducts are easily recycled to the reactor and gasified to extinction. This is standard practice. Up to 40 per cent of the coal feed has been injected in pulverised feed form entrained in gas down the tuyeres.

The tuyere injection system has been used to show that the aqueous liquor from the gasification system can be recycled through tuyeres, thus substituting part of process steam at the same time.

During the demonstration it was shown that the gasifier could be subjected to rapid load variation including turning up and down from 30 per cent to 110 per cent of design without significant variation in gasification pressure and gas composition. Overnight shut down of the plant to hot stand-by was proven out, with rapid return to gas making over a short period of time, which is of vital importance for many cases of power generation where overnight and weekend shutdown is required.

A slurry plant has been commissioned and operated providing a coarse slurry containing approximately 70 per cent by weight of coal which can be fed down the tuyeres into the gasifier. This has been demonstrated with both non-caking and caking coals.

Extensive operating periods have been undertaken using US and UK coals, demonstrating the suitability of these coals for the BGL gasifier. The ability to use run-of-mine coal has been demonstrated by injection of the surplus fines, over and above the quantity which can be fed with the top coal feed as an aqueous slurry down the tuyeres of the gasifier. The alternative of agglomeration of the excess coal, and adding the agglomerates (pellets or briquettes) to the top coal feed, has likewise been demonstrated with up to 50 per cent of the top feed consisting of agglomerates.

During a 60 day run carried out recently it has been demonstrated using the Rectisol unit that the gas from the BGL gasifier can readily be purified to reduce its sulphur content to less than 0.1 ppm, a necessary requirement if the gas is to be methanated to produce SNG.

Also during the recent 60 day run, SNG production was demonstrated in the British Gas HICOM process. This process was developed by British Gas specifically for the methanation of gases containing a high proportion of carbon monoxide, and a low proportion of carbon dioxide, and only moderate amounts of methane, typified by the

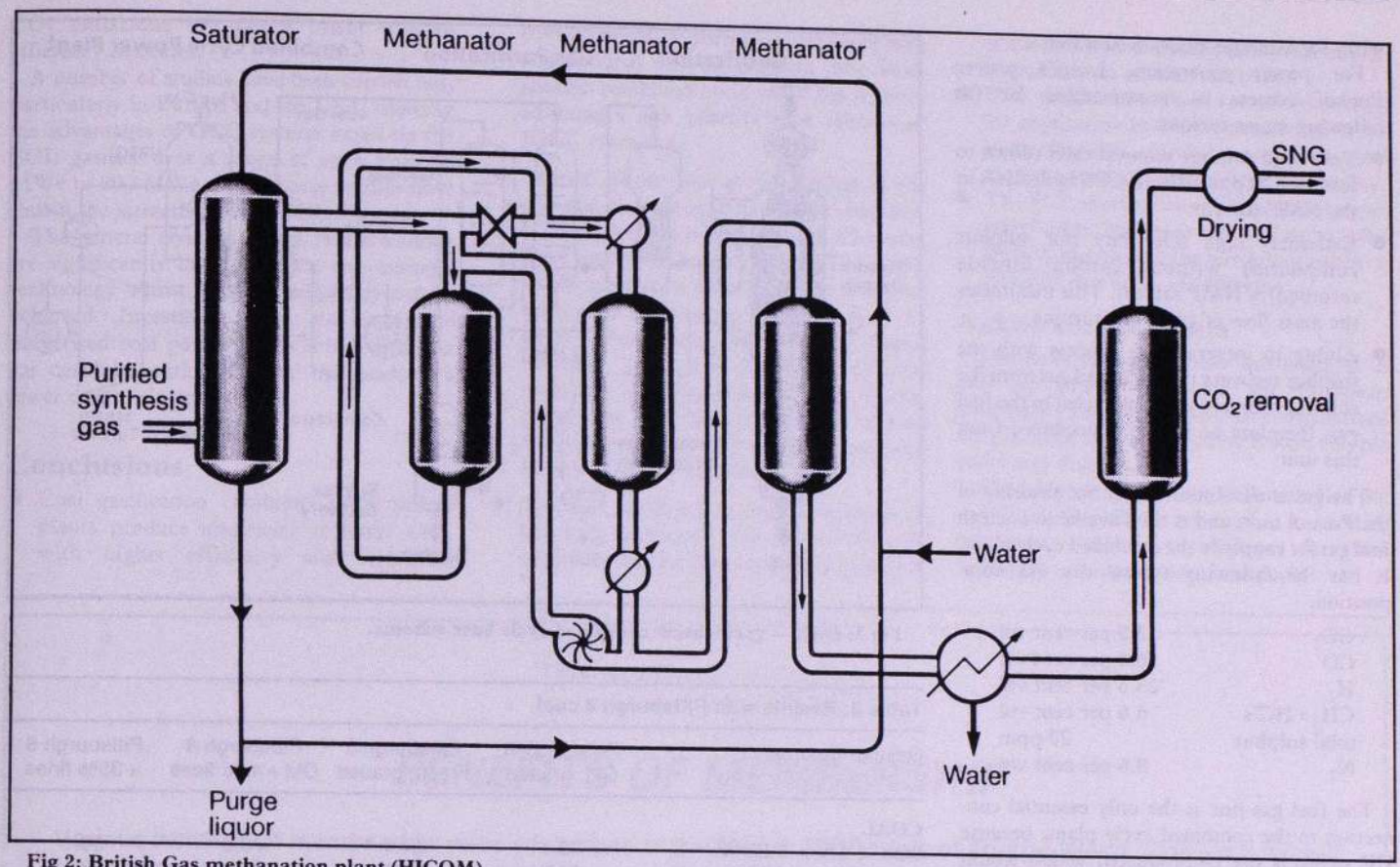


Fig 2: British Gas methanation plant (HICOM).

gas from a BGL gasifier.

The catalyst used for methanation which has been developed by British Gas showed an excellent performance. Based on 40 days of operation of the plant it was confirmed that a catalyst life well in excess of one year can be expected. During this run UK coals and a high sulphur Illinois 6 coal were used, and the purified gas was fed to the HICOM unit. A robust, flexible and very operable route to SNG was demonstrated.

Treatment of the aqueous liquor, if not recycled to the gasifier, is necessary before any discharge. In a side stream unit it has been demonstrated that using a biological treatment route this can readily be done, purifying the liquor to an acceptable level for discharge to rivers, or for reuse in the plant. It has been demonstrated that the purified liquor meets the most stringent European and US discharge standards. Tests have been carried out on behalf of the Electric Power Research Institute (EPRI) and the Gas Research Institute (GRI) using Pittsburgh 8 coal liquor. Plants of this type have been in operation treating similar liquor from the Lurgi dry bottom gasifier for many years.

The alternative route of liquor incineration is offered commercially by Lurgi, and has been demonstrated in the Lurgi laboratories in Frankfurt using gas liquor from Pittsburgh coal gasification. It was demonstrated that, as expected, no dioxins are formed, and that incineration meets very stringent environmental regulations. The inorganic compounds, mainly chlorides not included in the slag, are recovered as a small amount of salt.

BGL gasifier slag is recovered as a glassy frit generally less than 6 mm in size. It contains some free iron which is readily removed by magnetic separation.

Slag produced by the gasification of coal in the BGL gasifier has been examined by a number of authorities, as well as by British Gas and Lurgi. They have been subjected to leachability tests including those required by the US Resource Conservation and Recovery Acts (RCRA) guidelines, and other guidelines derived from the US Secondary Drinking Water Standards, Irrigation Water Standards (IWS) and EEC Drinking Water Maximum Advisable Concentration (MAC). It has been concluded that the slag is not a hazardous waste as defined by RCRA.

Product gas from the gasifier can be utilised in a Rolls Royce SK30 gas turbine unit (27 MW), to produce electricity which is supplied to the South of Scotland Electricity Grid. This turbine has been used for NO_X suppression trials using steam and water injection on behalf of EPRI under a contract with Rolls Royce. It was shown that the NO_X concentration in the flue gas could be reduced to 40 ppm volume by water injection.

Gasifier scale-up

The BGL gasifier presently in operation has a nominal capacity of 500 tpd of coal. Its capacity is only limited by the available infrastructure of the former town-gas plant with Lurgi-grate gasifiers. In other words, it was not possible to build a larger gasifier without major expenditure. Besides, the capacity of 500 tpd was considered suitable for commercial application. Nowadays interest arises in even bigger units mainly from the electric utility industry.

The main prerequisite of efficient performance of fixed bed gasifiers is good heat and mass exchange between solids and gases. Therefore, the mode of distribution of the fuel at the shaft top, and of the gasification agents at the bottom are the main parameters to be considered for scale-up. However, Lurgi have already built fixed bed gasifiers, with a rotating grate, incorporating with diameters up to 5.0m with a history of reliable operations.

The BGL gasifier differs only with regard to the ash removal system, solids distribution requirements being similar to those of the dry ash gasifier. Hence there is minimal scale-up risk involved. Even distribution of steam/oxygen is mainly achieved by the number and positions of tuyeres and blast velocity.

Extensive scale-up work, including the use of established models has already been carried out and BGL is prepared to build gasifiers with capacities up to 2,000 tonnes/day. The main limitation on size is only the transportability of the vessel by road or ship, if site manufacture is to be avoided.

All other equipment is already available in large sizes from commercial operation of Lurgi gasification plants.

The BGL 'gas island' comprises all the process steps from the coal pile to the clean fuel gas, including recovery of elemental sulphur and treatment of process water.

Lump coal and briquetted or slurried fine coal (less than 6 mm) is gasified under pressure using steam and oxygen.

The crude gas leaves the gasifier at a moderate temperature (around 800°F). The crude gas is first scrubbed in a wash cooler with recycled process water to remove any entrained dust particles and to condense heavy hydrocarbons arising from coal devolatisation. In a subsequent heat exchanger the crude gas is further cooled down, generating low pressure steam for use within the 'gas island'. The gas is then cooled down to 90°F by heat exchange

with, for example, boiler feed water.

For power generation, Lurgi's proven Purisol process is recommended for the following major reasons:

- Very high sulphur removal rates (down to less than 20 ppm) due to COS hydrolysis in the NMP-solvent.
- Extremely high selectivity (for sulphur compounds without carbon dioxide recorded) of NMP solvent. This maximises the mass flow of gas to the turbine.
- Ability to integrate the process with the sulphur recovery unit. The tail gas from the sulphur recovery unit is recycled to the fuel gas; therefore no off-gas is produced from this unit.

The gas is desulphurised in the absorber of the Purisol unit, and is then available as clean fuel gas for supply to the combined cycle plant. It has the following typical dry gas composition:

CO_2	2.8 per cent vol
CO	56.4 per cent vol
H_2	25.6 per cent vol
CH_4 + HC's	6.6 per cent vol
total sulphur	20 ppm
N_2	8.6 per cent vol

The fuel gas line is the only essential connection to the combined cycle plant, because HP steam is not co-produced, which would need to be supplied to the steam cycle of the power generation unit. This is advantageous for phased construction.

BGL are in close co-operation worldwide with leading suppliers of combined cycle power plants (GE, ABB, KWU) and their respective licensees. They have confirmed that the fuel gas is well suited for their gas turbines, including advanced machines. Combined cycle power plants — the efficient combination of gas and steam turbines — have been built in large numbers all over the world.

The sour gas, mainly H_2S, is converted catalytically to elemental sulphur of sales quality. The off-gas from sulphur recovery still containing some unconverted sulphur compounds is totally recycled to the undesulphurised main gas stream. This conversion of sulphur compounds to elemental sulphur is complete. Overall sulphur recovery can be as high as 99.5 plus, independent of the coal's sulphur content.

Aqueous liquid, mainly arising from coal moisture and a small amount of unreacted gasification steam, is condensed during gas cooling. The water, which contains organic and inorganic compounds from the coal, passes to the aqueous liquid separation unit where hydrocarbon oils are separated by gravity, and recycled to extinction down the gasifier tuyeres. The aqueous liquid can be treated biologically followed by reverse osmosis to produce water suitable for re-use.

Alternatively, for zero water discharge, incineration of the small amount process water is proposed. Prior to incineration the water is concentrated through evaporation by a factor of ten to twenty. The vapours, free of inorganics (alkalis, metals), are condensed and can be used for fuel gas saturation. In this way the coal moisture is utilised for NO_X suppression in the gas turbine. Only a very small amount (the concentrate) of the process water is sent to incineration to convert residual organic compounds to CO_2 and water.

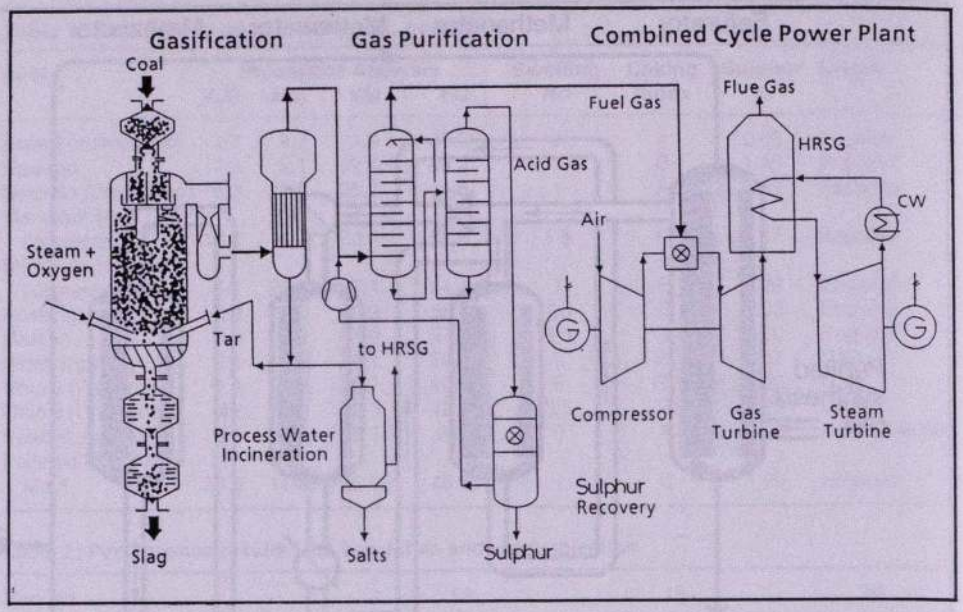


Fig 3: BGL — gasification combined cycle base scheme.

Table 3: Results with Pittsburgh 8 coal

Gasifier Summary		Pittsburgh 8 Old, graded	Pittsburgh 8 Fresh, graded	Pittsburgh 8 Old + med fines	Pittsburgh 8 + 35% fines
COAL					
Size % w/w > 0.25 in		78.1	84.4	70.0	66.1
% w/w < 0.25 in		21.9	15.6	30.0	33.9
Proximate	F.C.	46.46	48.18	45.84	46.27
(a.r.)	V.M.	34.16	35.08	33.81	33.13
	mois	6.46	4.85	7.40	7.96
	ash	12.92	11.89	12.95	12.64
B.S. no		6	6	5.5	5.5
Steam/Oxygen ratio		1.22	1.22	1.26	1.27
Gas outlet temp. (deg C)		430	429	402	396
Product	CO_2	4.16	4.43	5.21	5.11
(% vol)	CO	56.71	56.70	55.03	55.25
	H_2	27.55	27.33	28.63	28.02
	CH_4	6.82	6.87	6.80	6.68
	N_2	2.60	2.54	2.58	2.55
	C_2H_4	0.11	0.11	0.10	0.11
	C_2H_6	0.44	0.44	0.44	0.44
	H_2S	0.80	0.74	0.82	0.82
Oxygen Consumption (lb/lb daf)		0.57	0.57	0.60	0.57
Steam Consumption (lb/lb daf)		0.40	0.39	0.43	0.41

Another advantageous feature of a BGL-GCC plant is the possibility of integration of the air separation unit (ASU). Air withdrawn from the gas turbine compressor is sent to the oxygen plant operated at pressure. Both oxygen and nitrogen contribute to the mass flow through to the gas turbine. Oxygen is used as gasification agent and becomes part of the fuel gas as carbon oxides.

Nitrogen is added to the fuel gas downstream of gas purification for NO_X suppression in the gas turbine. As oxygen consumption of the BGL system is the lowest when compared with other gasification systems, ASU integration is an advantage with regard to efficiency, but there is no necessity as with the other gasification systems.

Future potential

The most important potential in the future improvements of GCC's plants in general is in the gas turbine technology, which is rapidly developing. There is further potential both in capacity and efficiency of gas turbines. At present eg Alsthom GE France is designing the 9F gas turbine, the 50 cycle version of GE's 7F gas turbine, for Electricite de France, with a net capacity of 212 MWe. Furthermore, turbine manufacturers are developing advanced gas turbines with inlet temperatures of above 2,200°F. This will lead to an efficiency increase of 1 to 2 percentage points. In other words, net efficiencies of above 46 per cent (LHV) can be expected in the near future. This is at least 15 per cent higher than for current pulverised coal fired power plants with flue gas scrubbing. Moreover, emissions (dust, SO_X, etc) are considerably lower. There is no disposal problem of gypsum or fly ash; and

CO_2 emissions are much lower due to efficiency increases.

A number of studies have been carried out, particularly in Europe and the USA, showing the advantages of GCC systems based on the BGL gasifier over a range of sizes from 70 MWe to 800 MWe units. These studies have shown the attractiveness of BGL systems.

The general conclusion was that emissions are significantly lower than for conventional technology whilst a higher efficiency can be achieved. Investment costs are similar to pulverised coal power plants fitted with flue gas desulphurisation. Overall this leads to a lower cost of electricity.

Conclusions

- Coal gasification combined cycle power plants produce electricity at lower cost, with higher efficiency and improved environmental performance compared with conventional coal fired plant. The BGL gasifier combined cycle route has distinct advantages and benefits over competing IGCC processes.
- At least 99 per cent of the sulphur in the coal can be recovered as saleable sulphur. NO_X in flue gas is well below 5-15 ppmv. Dust emissions are negligible. The entire sulphur emission from the plant as a proportion of flue gas can be as low as 10-15 ppm. There need not be any liquid effluents. There is no fly ash and all solid waste can be readily disposed of. Such GCC plants can meet the requirements of load following and two shift operation required in power station practice.
- The BGL gasification system is well proven and fully developed. There is no need for high temperature heat exchange equipment in contrast with entrained flow processes. It is available on commercial terms.
- BGL gasification is well suited technology for application in GCC systems due to its high efficiency, excellent economics and the low risk, coupled with high availability.
- The BGL gasifier can easily be scaled up to larger units than those operated up to now, thereby minimising the number of gasifiers required in a GCC installation.

Acknowledgements

The work described above was financed in part by EPRI, GRI and the European Economic Community and their contributions are gratefully acknowledged by British Gas plc and Lurgi GmbH.

The authors wish to thank British Gas plc and Lurgi GmbH for permission to publish this paper and their colleagues for their assistance in preparation of the paper.

The Institute of Energy

BENEFITS OF MEMBERSHIP

Various benefits of membership were advertised in the **March 1990** issue of *Energy World*. One such benefit referred to discounts available to members on car hire from Hertz. The Institute has now received a supply of Hertz Business Partners Club cards and any member wishing to obtain a card should write to: The Membership Office (Ref MB), The Institute of Energy, 18 Devonshire Street, London W1N 2AU (Tel: 01-580 0077).

Notice concerning mail losses

The Institute has been experiencing severe problems in loss of mail to and from Devonshire Street; and not least in relation to lost manuscripts pending publication, or for conference preparation.

It would be helpful if authors and referees would post manuscripts back to us by *recorded delivery*, or by *registered post* from overseas.

Occasionally MSS reach us in envelopes that are insufficiently strong for the weight of their contents, which may cause delay or loss.

Topping cycle development

*by Andrew J Minchener BSc MSc CEng MInstE**

British Coal, in collaboration with PowerGen plc, are developing an advanced clean coal power generation system. Further funding is being provided by the UK Department of Energy, the Electric Power Research Institute (EPRI) and the EEC. This concept is based on a combined cycle system that includes the partial gasification of coal in conjunction with a fluidised bed char combustor. This system (known as the 'British Coal Topping Cycle') offers significant advantages in terms of improved thermal efficiency, reduced capital cost and low environmental impact. The R&D programme is outlined in this article.

WITHIN the United Kingdom, the major fuel used for power generation is coal, with the majority of this being supplied by British Coal. However, the impending privatisation of the electricity supply industry, and the growing concern over environmental issues, is leading to increasing pressure on this market from competing fuels.

The privatised generating companies will need to achieve early returns on investment. This may well lead to a diversified fuel mix strategy to take advantage of short-term price differentials for various fuels and, where new plant needs to be constructed, an emphasis on smaller and lower cost stations that are of high efficiency with a high environmental performance.

Thus the new companies have indicated that they may opt where possible to burn low sulphur imported coal in existing stations. They are also starting to introduce modern combined cycle gas-fired plant which is cleaner and more efficient than existing coal-fired technology.

In order to ensure that it can remain competitive, British Coal is committed to the development of an advanced combined cycle coal-fired power generation system. This process could increase the efficiency of producing power from coal by 20 per cent, compared to conventional power generation systems, and could result in lower costs for electricity with low environmental emissions. This could make it competitive with the modern gas fired plant while at the same time ensuring that the UK can take advantage of the long term benefits of using its indigenous supplies of coal.

The features required of such an advanced coal-fired technology are:

- high efficiency and low capital costs, combined with short construction periods;
- good environmental performance, and in particular low emissions of SO_2 and NO_X;
- availability, turndown and response competitive with conventional options;
- ability to handle variations in coals as, in the UK, power stations normally take coals from several collieries.

As is indicated in a companion article, British Coal and the CEGB had shown previously that a pressurised fluidised bed combustion system offered a substantial generating efficiency advantage over conventional coal-fired plant, even where a low sulphur coal might be burned. However, further improvements in such a system are limited by the temperature at which the combustion bed, and hence the gas turbine, can operate.

In order to achieve higher generating efficiencies it is necessary to take advantage of increases in gas turbine inlet temperature that have been made possible by developments in gas turbine technology. To do this, all or part of the coal needs to be converted to a hot gas which is then burned to produce the necessary high turbine inlet temperatures.

A wide range of power generation systems based on coal gasification have been proposed. Systems may be based on 'total' gasification of the coal, in which case they are termed 'integrated gasification combined cycles'. Alternatively they may be based on 'partial' gasification of the coal, with the unconverted coal being consumed in a separate combustor. These systems are called 'topping cycles'. British Coal's technical and economic valuation of the options has led to the selection of a system as described below.

British Coal topping cycle

The power generation system proposed by British Coal is based on a two-stage fluidised bed process, comprising a combustor and a gasifier.

Coal is gasified in an air-blown spouted bed gasifier, operated at elevated pressure and temperatures up to 1000°C. Sorbent is also injected into the gasifier to retain sulphur which would otherwise be released in the gas.

**Head, Power Generation Branch Coal Research Establishment, British Coal Corporation*

The author

A graduate from the University of Leeds, Andrew Minchener joined the Coal Research Establishment (CRE) in 1975. He worked for several years on various atmospheric fluidised bed combustion programmes, including international collaborations with the Electric Power Research Institute. From 1980, he was closely associated with the pressurised fluidised bed development activities, firstly to support the IEA project at Grimethorpe and then for the British Coal/CEGB programme.

In 1988, he became Deputy Head of the industrial development branch, working closely with British Coal marketing department and various manufacturers, to establish new and improved equipment, improving the environmental acceptability of coal-fired appliances and providing expert technical advice to customers.

He took up his current appointment earlier this year as Head of the Power Generation Branch. He has responsibility for the R&D activities to support the use of indigenous coal in conventional power generation systems, and for the CRE programme to develop advanced clean coal combined cycle technology.

The fuel gas from the gasifier undergoes an initial stage of cleaning in a cyclone. The raw gas leaving the cyclone, at close to 1000°C, is then cooled to about 600°C via a heat exchanger; it still contains some fine particulate material which is then removed using ceramic candle filters. At this temperature almost all the volatile alkali salts condense out from the flue gas onto the filter medium.

The clean fuel gas is finally advanced to the gas turbine combustor. The combustion of the fuel gas in the gas turbine combustor produces hot combustion products at about 1260°C. These are passed to the turbine expander stages which drive the turbine compressor and an electric power generator. The exhaust gases pass to a waste heat boiler, and then via a stack to atmosphere. The gas turbine used in this application is a state-of-the-art machine.

Between 70 and 80 per cent of the coal is converted into a low calorific value fuel gas. The 20-30 per cent of the gasifier coal feed which remains unconverted is removed from the gasifier, mainly as fines collected by the cyclones and hot gas filters. These fines are transferred to the circulating fluidised bed combustor (CFBC) where, together with any residual carbon removed from the base of the gasifier, they are burned to raise heat for the steam turbine cycle, thereby resulting in additional power being generated. Sorbent is also fed to the combustor to complete the sulphur retention process and to form the combustion bed, together with ash from the coal.

The predicted efficiency for a commercial power plant based on such a topping cycle system is around 45 per cent (higher heating value basis). This assumes the use of a commercially available gas turbine and a subcritical steam cycle. There will be scope for significant improvement on this efficiency value in due course. Thus ongoing development programmes should lead to gas turbines being capable of achieving higher gas inlet temperatures. Similarly the development of advanced supercritical steam turbines will mean that supercritical steam cycles can be readily introduced (for which the FBC system is particularly well suited). Such advances are predicted to raise the cycle efficiency to around 50 per cent or more.

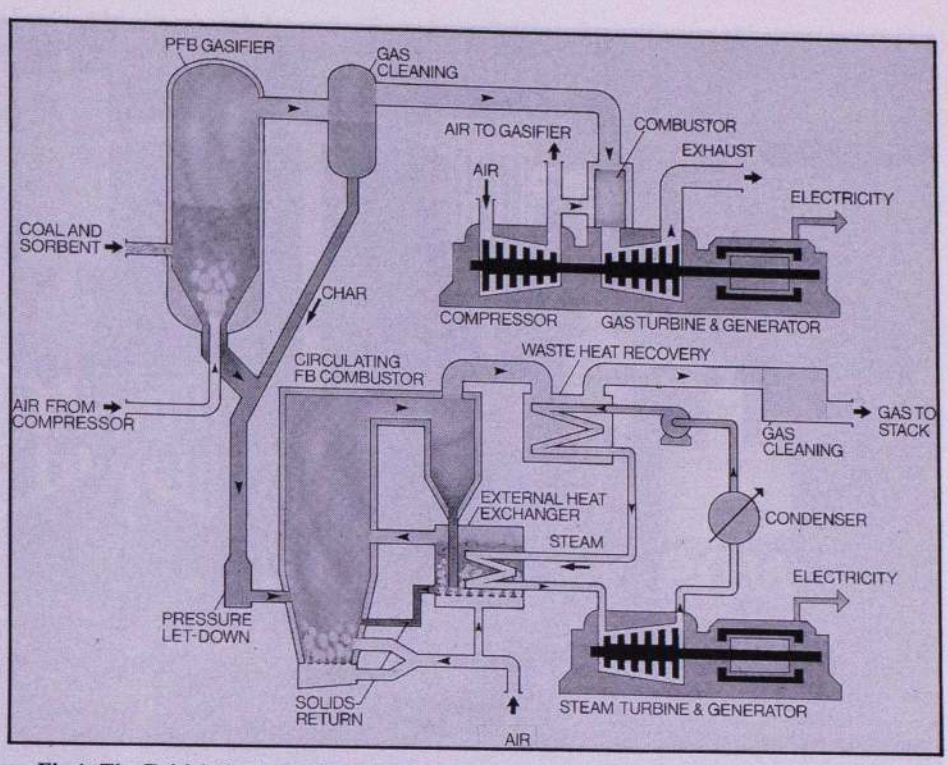


Fig 1: The British Coal topping cycle for clean power generation.

A key feature of this topping cycle is the use of an air blown pressurised fluidised bed gasifier. The gasifier is air-blown, rather than oxygen-blown, because oxygen plant is expensive, and has high power consumption, which is a significant penalty on cycle efficiency. The low calorific value gas produced by an air-blown system should give low levels of NO_x when burnt.

The fluidised bed gasifier, at around 1000°C, operates in the temperature 'window' that avoids excessive tar production, very high alkali contents and sticky ash particles in the gas. The bed temperature, particle residence time and good contacting in the fluidised bed, permit in-bed sulphur retention, saving the cost of a separate sulphur retention stage. These two factors mean that a hot gas clean-up system may be used to remove particulates. This results in a higher cycle efficiency than if a cleaning system incorporating cooling to low temperatures, scrubbing of particulates, and physical absorption of sulphur is used. Fluidised bed gasifiers are also tolerant to coal size and quality, and so can accommodate changes in coal and ash properties which may be the case if several collieries supply one power station.

The adoption of a partial gasification approach means that the char combustor is available to generate high temperature steam, thus ensuring that state-of-the-art steam cycle conditions (and hence efficiency) can be achieved.

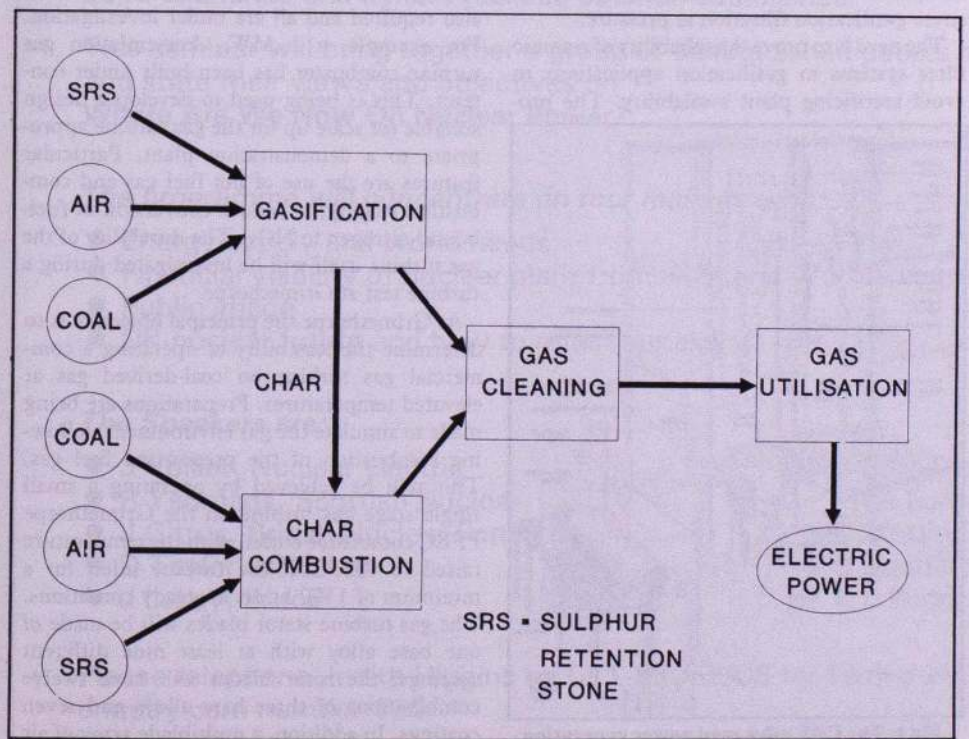


Fig 2: Topping cycle development.

Development programme

The British Coal programme is designed to develop the four main components of the topping cycle:

- partial coal gasification at elevated pressure;
- cleaning and combustion of low calorific value gas;
- utilisation of partially cleaned products of gas combustion to drive a gas turbine;
- utilisation of gasifier char in a fluidised bed fired combustor.

The work is supported financially by British Coal, PowerGen plc, the UK Department of Energy, the EPRI and the EEC.

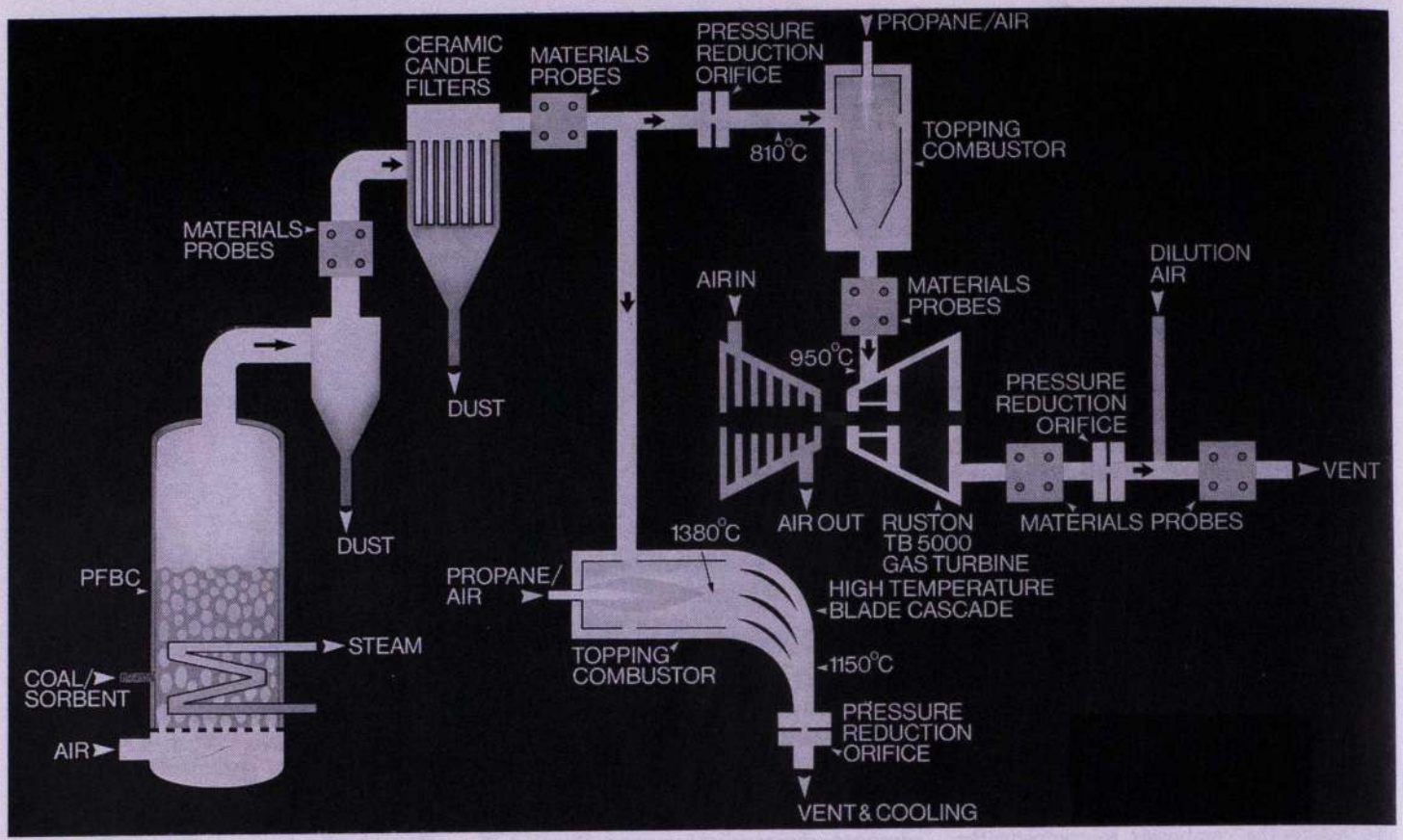


Fig 3: The Grimethorpe topping cycle project.

The British Coal pressurised fluidised bed gasifier is a development of an atmospheric pressure spouting bed design, which has been developed for industrial fuel gas applications. There is, therefore, a substantial base of successful experience from which to progress. For example, the atmospheric gasifier was developed specifically to handle a wide range of bituminous coals, in terms of swelling characteristics and ash properties. Coal conversions of around 90 per cent were achieved at the semi-commercial scale on a pilot plant at CRE with a throughput of 12 tonnes per day. Sulphur retention by limestone addition was also demonstrated.

The pressurised pilot plant, which is being used for this development, has a coal throughput of 12 tonnes per day and can operate at pressures up to 20 bar. It incorporates a 0.34 m diameter pressurised vessel. There are facilities for coal and sorbent feeding, gas cleaning and gas disposal. It is intended that a series of extended operating runs will be carried out. Tests will be aimed at establishing the gasification performance in terms of conversion of coal to gas, and in producing a gas of adequate calorific value for combustion in a gas turbine. The tests will include limestone addition to remove sulphur from the fuel gas.

Subsequently on a CFBC test facility at CRE, combustion tests will be undertaken using residual char and fines produced from the gasification tests. The aim will be to identify operating conditions, and provide data on the combustion efficiency, heat release rates and retention of sulphur within the residues.

Before fuel gas can be passed to a gas turbine it must be adequately cleaned. CRE have had a programme for several years which has examined the use of ceramic filters, for both gasification and combustion duties. This culminated in the construction and operation, at Grimethorpe, of a candle test unit for use on pressurised combustion flue gas. Work on filtration of gasifier fines has to date been confined to atmospheric pressure operation. Further work on ceramic filtration for both combustor and gasification applications is therefore in progress, to improve the durability and performance of the filters, and to demonstrate gasification filtration at pressure.

The need is to prove the reliability of ceramic filter systems in gasification applications to avoid sacrificing plant availability. The programme will identify optimum construction materials for filter media and appropriate sealing arrangements for full sized filter systems. There will be test work undertaken to prove materials choices in terms of filtration performance and durability.

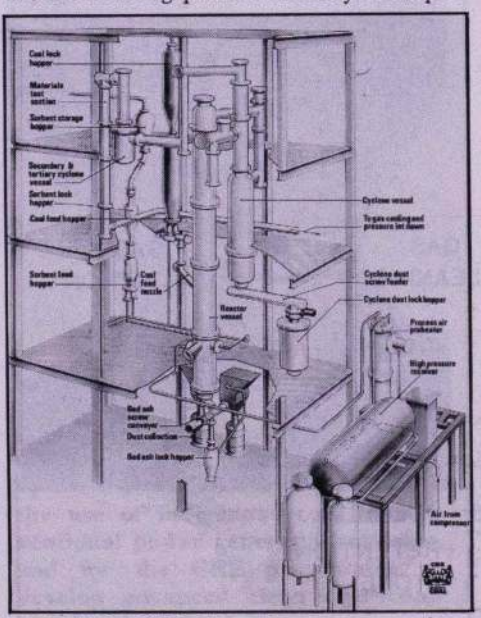


Fig 4: The CRE advanced power generation test facility.

In addition to cleaning the gas, fuel control, distribution and combustion systems are required for the turbine. Control technologies for the gas turbine and topping cycle plant as a whole, to meet power system requirements, are also required and all are under investigation. For example, a 1 MW_{th} low-emission gas turbine combustor has been built under contract. This is being used to develop a design suitable for scale up for the gas turbine appropriate to a demonstration plant. Particular features are the use of hot fuel gas and combustion staging, to reduce conversion of fuel-bound nitrogen to NO_X. The durability of the gas turbine itself will be investigated during a turbine test at Grimethorpe.

At Grimethorpe the principal objective is to determine the feasibility of operating a commercial gas turbine on coal-derived gas at elevated temperatures. Preparations are being made to simulate the gas environment, following combustion of the pressurised fuel gas. This will be achieved by operating a small single stage gas turbine on the Grimethorpe PFBC combustor outlet, with the temperature raised to 950°C at the turbine inlet, for a minimum of 1500 hours at steady conditions. The gas turbine stator blades will be made of one base alloy with at least nine different coatings; the rotor blades will have twelve combinations of three base alloys and seven coatings. In addition, a multiblade array of air film cooled airfoils will be exposed in a side

stream from the PFBC combustor outlet, with the entry temperature raised to 1200-1400°C by the combustion of propane, for a minimum of 1500 hours at steady conditions. There will be additional cooled turbine materials coupon probes at locations upstream and downstream of the turbine and in the side stream, again for a minimum of 1500 hours at steady conditions.

This work will allow predictions to be made of the lifetime of the most promising materials for the construction of topping cycle gas turbines under the conditions tested at Grimethorpe. Extensive modelling will be undertaken so that component lifetimes at expected utility turbine operating conditions can be predicted. From this the viability of utility scale machines in proposed topping cycles fired with natural and low calorific value (LCV) fuel gas can be determined.

The overall objective is to establish a demonstrated technology by year 2000. In order to achieve that aim there will need to be follow-on work following the basic development of the topping cycle concept as outlined above. Thus the subsequent phase will require the scale-up, and demonstration, of the pressurised fluidised bed gasifier, together with gas cleaning and combustion.

Linked to this will be the need to demonstrate char combustion in a large fluidised bed boiler.

Finally there will be the need to undertake the prototype commercial scale demonstration of the integrated topping cycle concept. Options for achieving this aim are being actively pursued at present.

Conclusions

The continued use of coal beyond the year 2000 as a major fuel for power generation will depend on the availability of high efficiency clean coal combined cycle technology. Topping cycle technology as proposed by British Coal offers an attractive route towards achieving this goal.

A collaborative programme to develop the basic components of the technology has been initiated. It is intended that this will be followed by scale-up, and finally demonstration, of a commercial prototype. □

A change in policy

'The Market for Energy'
Edited by Dieter Helm, John Kay and David Thompson
Clarendon Press, 1989
449 pp. £40.00

Energy policy changed dramatically in the 1980s. State ownership, central planning and industrial monopolies increasingly gave way to laisser-faire, privatisation, and liberalisation and the process continues. This volume has grown out of the Institute for Fiscal Studies (IFS) energy research project, funded by the Economic and Social Research Council. It takes a timely look at the new policies, analysing and appraising the developments of the past few years and examining the options for the introduction of further elements of competition in the energy markets.

The book opens with a major survey introduction by the editors. This reviews the institutional background and regulatory framework evolved in the UK in the post-war period and examines the policy changes instituted since 1979. Most of the papers which follow have developed from the IFS research project, others have originated from invited specialists.

The first two parts deal with the major economic principles and issues. Part I is devoted to 'Energy Policy' and consists of three chapters. The first is Nigel Lawson's speech of 1982. The second is by David Newberry and deals with 'Energy Policy Issues after Privatisation'. The final paper in this part is an IFS contribution of 'Energy Policy, Merit Goods and Social Security'.

Energy modelling and performance is the title of Part II. It consists of four papers by invited specialists. The subjects dealt with are: 'Demand for Energy'; 'Modelling Public Enterprise Performance'; 'Performance of Public Sector Energy Utilities' and 'Rationale for Marginal Cost Pricing'.

The remaining four parts look in detail at the key industries and markets. Part III consists of six chapters on the electricity industry, of which three are contributed by invited specialists. Two of these specialists are from National Economic Research Associates USA: Richard Schmalensee writes on 'The Potential of Incentive Regulation' and Ian Jones on 'Risk Analysis and Optional Investment in the Electricity Supply Industry'. The other invited paper is 'Regulating Issues in the Electricity Supply Industry' by George Yarrow. The remaining three papers are concerned respectively with 'Competition', 'Electricity Supply in Europe' and 'Combined Heat and Power'.

The gas and coal industries are the subjects of Parts IV and V. Gas is covered in two papers: 'Gas Privatisation — Effects on Pricing Policy and Regulation of the Gas Industry'. Two papers are also devoted to the coal industry. The first by Colin Robinson discusses 'Liberalising the British Coal Industry' and the second by Bill Robinson deals with 'Economics of Coal'.

The final part looks at the oil industry or, more specifically, North Sea oil. Three subjects are examined: 'The Economic Implications of North Sea Oil Revenue'; 'The Macroeconomic Impact of North Sea Oil'; and 'The British Experience of Taxing Oil Extraction'.

An overall comment should be made. The development of energy policy in the 1980s has been rapid, and therefore many of the papers respond to particular events: the privatisation and regulation of gas; the early proposals on electricity; and the development of tax and macroeconomic responses to the growth of oil production. They are therefore inevitably a product of the state of the policy debate at the time they were written, and this context should be borne in mind. Nevertheless this is a very useful and informative collection of papers which address the theme — the market for energy, and the appropriate role for state intervention and regulation.

The editors are to be congratulated in producing an integrated volume by supplementing the IFS research project with papers by leading experts in the economics of energy sectors. They all raise general questions of wide applicability, demonstrating the role and limits of the market in each energy industry.

Dr Norman A White

Can it expand?

'The Future of Nuclear Power'
by Geoffrey Greenhalgh
Graham & Trotman, 1988
214 pp. £39.50

This is a readable and interesting book written by Geoffrey Greenhalgh, who has made a considerable study of the subject matter over the years.

The nine chapters are logically arranged, starting with a treatise on "understanding the problem". The acceptability of nuclear power differs from country to country as does the public's attitudes and fears. The author discusses these aspects and presents both the social and environmental debate and the views of those who oppose nuclear power.

Other chapters look at the world's energy needs and the requirements of the increasing population, particularly in the developing countries. An interesting chapter deals with the relationship between supply and demand and presents some stark conclusions.

Other contents cover radioactivity and the environmental and economic advantages of this energy source measured against the possibility of accidents. Accidents are included in another chapter with design, quality assurance and the human factors involved.

This is a readable book and the author has provided a whole range of useful references. The summary and conclusions are post Layfield Inquiry. The author reiterates the point made by many others, that we can only continue to expand our nuclear power programme insofar as it is completely acceptable to the public at large.

The book does not contain an index, which is to be regretted.

F John L Bindon

Not recommended

'Waste Management'
by O P Kharbanda and E A Stallworthy
Gower Publishing Company, 1990
268 pp. £25.00

One is tempted to try and be kind to this book by saying that it is like 'the curate's egg', but that would be inaccurate as in the Victorian joke the curate was assuring his Bishop — who had perceived from its smell that the curate's breakfast was definitely bad — that "parts of it are excellent". Unfortunately, although parts of this book are sound commonsense, none of it could be described as excellent whilst quite a lot is definitely bad.

The book is an ambitious attempt to review the whole subject of waste management starting with an advocacy of a 'non-waste technology' (without getting to grips with what the term implies), through waste minimisation to recycling and the various methods of waste disposal. But it needs a good deal more than 260 pages and a much greater knowledge of the subject than the authors display to do that with any hope of authority.

The book is eclectic and is mainly a not very coherent assembly of other people's opinions, which are more in evidence than hard scientific facts; that there is hardly a page that does not contain at least one sentence beginning "It seems that ..." or "It is said ..." and the number of times that I have been moved to write "nonsense" in the margin dictates a harsh review. Their choice of references, which are plentiful, is not entirely reassuring either as no less than 31 per cent are taken from newspapers or non-technical magazines such as *Time* and *Newsweek*.

I have to conclude that, at £25, this book cannot be recommended to members of the Institute, even for a general study, as so much of it is open to question.

R G Loram

Recently published

The Watt Committee on Energy Report, Number 21
'The Membrane Alternative: Energy Implications for Industry'
Edited by John A Howell
Elsevier Applied Science, 1990, 172 pp. £55.00.

'Coal-use Technology in a Changing Environment'
by Walter C Patterson
Financial Times Business Information, 1990, 118 pp. £215 (UK); £225 (overseas); (incl p&p).

'Europages'
The European Business Directory
Eurédit SA, Paris, 1990, 1429 pp. Distributed free to European purchasing managers.

Risk too great to tolerate

Sir,

I have no quarrel with most of Mr Willis' 'Viewpoint' entitled 'Setting a new agenda' (*Energy World*, June 1990). The education of the public and of politicians as to how much could be saved might, perhaps, have received more prominence.

I do however strongly disagree with his statement: "The reconsideration of nuclear power on the basis of its economies, public acceptability and the disposal of radioactive waste will be necessary very soon . . ." On this I have the following comments to make.

Firstly, if an accident can happen, sooner or later it will. How many Chernobyls, Three Mile Islands, Windscales . . . do we have to have?

Secondly, there is no method of disposing of nuclear waste that is safe for all time. In geological time, a thousand years is only a moment.

Thirdly, in back issues of the *Bulletin of the Atomic Scientist* there is ample evidence of: a) the difficulties with nuclear waste, eg the Hanford reactors; and b) a number of 'near misses' of reactor accidents.

Finally, it is a most elementary principle of management in both the fields in which I have experience — war and business — that one never takes an irreversible action, or even a possibly irreversible action, the down side risk of which is so great that it could not be tolerated. Nuclear power falls into this category.

Jasper Mardon *(Fellow)*
West Vancouver, BC
Canada

The future of the Institute

Sir,

I read with much concern that the President of The Institute of Energy feels that the Institute 'cannot properly respond to the opportunities offered by the growing importance of our subject.' (*Energy World*, June 1990). I find it perplexing that an organisation whose charter is to promote ENERGY should quote as its reason for imminent demise the growth in importance of that same industry.

I view this statement from two positions. Firstly, if the Institute cannot capitalise on the growth in the energy field to an acceptable level of quality then the Institute has served its purpose admirably. My second view is that this is a sad time for an Institute as large and as important as ours to be considering a merger or any other of the suggestions made by our President. I say this because we are seeing a revolution in the energy industry as a whole, examples including my own industry, electricity supply. Other examples include emerging competition in the gas industry, the changes in the coal industry, the massive interest in energy conservation and the environment and of course the current Gulf crisis to name a few. Energy has finally become a subject of great importance not only in the media but throughout the economic world, and I believe the Institute can and should capitalise on this importance as an independent body encompassing the depth of knowledge throughout its membership.

There is of course a practical side to the running of the Institute as I can fully appreciate and the lack of funds will be an overriding factor in its future. It therefore seems sensible, however regrettable this may be, that if the Institute is unable to continue in its present form it is now important to evaluate the options and get the best results for its members.

To me there appears to be only one satisfactory solution to this problem which will ensure the work, knowledge and status of the members of our Institute is not lost — a merger with a larger Institute. I would favour the IChemE, in preference to the IMechE, and forming a substantial Energy Division within the new group. It is important there is no compromise reached in getting the best result for our Institute and I believe the IChemE would welcome the substantial increase in its membership should a merger take place.

Simon A Wilce *(Graduate)*
Swindon, Wilts.

Warning bells

Sir,

I was interested in the articles on Orimulsion (*Energy World*, June 1990). I noted particularly that it is based on Venezuelan extra heavy crude oil.

This information immediately rang warning bells in my head, for I was mindful of the fact that all oils from Venezuela contain considerable proportions of vanadium.

I was, therefore, disappointed to note that little mention was made of the toxic nature of vanadium oxides, and the consequent hazard posed to operators of boilers using such fuel. True, the material can be 'scrubbed out' in several ways so that it does not pollute the environment, but the danger arises at the boiler tube and ancillary component cleaning stages.

A few years ago, I, as the Health and Safety Adviser at my place of work, was notified that one of the boilerhouse attendants was suffering from respiratory distress after starting to clean the combustion tubes of one of the boilers. In addition he was rather pink. This immediately suggested vanadium poisoning.

After many enquiries, I confirmed that the oil supplier had been changed by our headquarters purchasing authority, and that the material currently being burned was a blend containing Venezuelan oil. This was later confirmed by analysis. This was the first time we had ever used such fuel, and I made strong and successful representations to have the supplies discontinued.

Thankfully the man was not chronically disabled, and subsequently much greater personal respiratory precautions were taken, in addition to enclosing the whole operation, so that the risk was controlled.

I feel that this information needs to be published for the benefit of others who may unwittingly find themselves with a similar problem. Under today's Control of Substances Hazardous to Health Regulations 1988 (COSHH), there is a legal requirement to assess such processes in boilerhouse operations, where the workforce may be exposed to potentially toxic materials.

William Martin MBE *(Member)*
Reading, Berks

Consideration of overall energy-use

Sir,

'Viewpoint' by past president Prof Ian Fells (*Energy World* September 1990) spells out much that needed to be said to put the current crisis into perspective. As he says, the impact, if it is not too diffuse, could succeed in warning of the need to wean the world economy off cheap oil on to a balanced fuel diet.

His references to energy efficiency and conservation, and the 1973 OPEC debacle, come earlier in this 'Viewpoint' and while in total this opinion is a very clear summary of events, it offers little to any of us for a new route to follow. With respect, we need leadership — of the kind that not so long ago converted Fuel into Energy. In those same seventies Prof Fells went to some lengths to advocate the establishment of an Energy Council; a letter in The Times is well remembered. Advocacy of combined heat and power was strong; virtually nothing has come of either, where UNICHAL's members have recently been discovered to have been quietly successful in expanding the Stadwerke and allied principles; there are now astounding achievements in both energy conservation and pollution abatement.

While none can disagree that there is a crisis, nor that the impact is spread, perhaps too widely, the very breadth and area of contact means only a small dent and a resilient rebound. Among other effects the very populations likely to demand more energy for their emergent changes will scarcely miss what they haven't had and cannot obtain. None of this, of course, exerting the right kind of pressure for drastic change of energy strategy.

This may well resemble an opportunist plea for linking propaganda for specific technology to an overt warning of possible energy disaster, but in every such event the established energy industries manage to evade enquiry into their fundamentals, always continuing precisely as before. Readers may like to be referred to *Energy Policy* for last June and the 'Viewpoint' entitled 'It is Energy We Need Not Electricity.' Maybe this is just the time when consideration of overall energy-use strategy — for all, emergent or established — should be undertaken as an urgent priority.

But, such are the ramifications of the energy industry, their deeply entrenched influences and unquestioned methods — despite perpetuation of 100 year-plus procedures — it would seem virtually impossible to find completely unbiased investigators to begin again, taking energy as the yardstick and not one or more of its components.

Norman Jenkins
Farnham, Surrey

Call for tax relief campaign to boost professional updating

A CAMPAIGN urging the Government to allow tax relief for individuals who pay for their own continuing education and training has been launched jointly by The Engineering Council, which has 300,000 engineers and technicians on its register, and the Engineering Employers' Federation, representing 5,000 companies.

The UK is out of step with leading competitor countries in its tax treatment of professionals' training expenses, say the two organisations.

Launching the document: "Individual taxation — The need for change," The Engineering Council's Director General, Denis Filer, FEng, and the Engineering Employers' Federation Director General, Peter Brighton, said in a statement: "This anomaly will become increasingly glaring as the European market develops and the UK needs to have a reasonable parity of treatment between our professional, technical and other manpower and those in leading competitor countries."

The document states: "The existing UK lack of tax relief for individuals' education and training expenses is also at odds with the declared policy of the UK Government to encourage individual self-development.

"The Government, The Engineering Council and the Engineering Employers' Federation are all agreed that the individual must bear part of the responsibility for maintaining his or her employability; and that individuals need to develop continuously their skills and knowledge in their current job and may need to change jobs or occupations several times during their working lives."

The document says that the taxation of expenses incurred by an individual who has to pay for his or her own vocational education and training, in addition to the taxation of future income derived from applying that education and training, is a form of double taxation and a disincentive to self-development.

In view of the urgent need to improve the competence of the UK workforce, it argues for an early change in the UK tax rules to allow individuals tax relief for their continuing education and training expenses.

Tax relief should be available for the fees paid by individuals to education and training providers and for examinations; for travel and subsistence; and for books and equipment. These items were already eligible for tax relief in competitor nations including Belgium, Denmark, France, Germany, The Netherlands, Sweden and the United States.

The tax relief campaign is being supported by 45 leading trade associations and professional institutions.

BCS 'recognised'

THE Engineering Council has announced that the British Computer Society (BCS) is now fully recognised as a Chartered Engineering Institution.

This means that the BCS can nominate its appropriately qualified members for registration with The Engineering Council as Chartered Engineers or Incorporated Engineers.

BCS membership requirements for information systems engineers are now aligned with those of the other major engineering professional bodies, although it retains alternative membership criteria for computer professionals who are not engineers.

The Engineering Council is to publish the names of some 4,200 existing BCS members who have qualified for registration as Chartered Engineers. These, when added to those BCS members who have already qualified as Chartered Engineers through other routes, add up to more than 40 per cent of the corporate membership. This figure is expected to rise to 60 per cent over the next five years.

The agreements between The Engineering Council and the BCS also provide for the registration of HNC/D qualified members as Incorporated Engineers and for the BCS to be authorised to accredit courses of education and training under The Engineering Council's procedures.

Follow the sun

CENTRONIC photodetectors are being used by Luz solar power stations to help them gather the optimum amount of solar energy.

The solar power stations work by utilising a field of parabolic reflectors which direct sunlight onto a unique heat collecting element positioned at the focus of each mirror. Synthetic oil is heated to about 390°C and is then passed through a heat exchanger to produce superheated steam. Electricity is then produced via turbine generator in the same manner as conventional power stations.

A Centronic two element linear array photodetector, the LD2 (8.4) — 5T is used to track the sun through the day so that the reflectors are positioned in their optimum setting to gather the incidental sunlight.

The entire system is controlled by a customer-designed microprocessor unit.

Centronic Ltd, based in the UK, specialise in designing and building photodetectors, and also offer a full development and manufacturing facility for customers requiring custom-built models.

For further information, please contact Centronic Ltd, Centronic House, King Henry's Drive, New Addington, Croydon CR9 0BG.

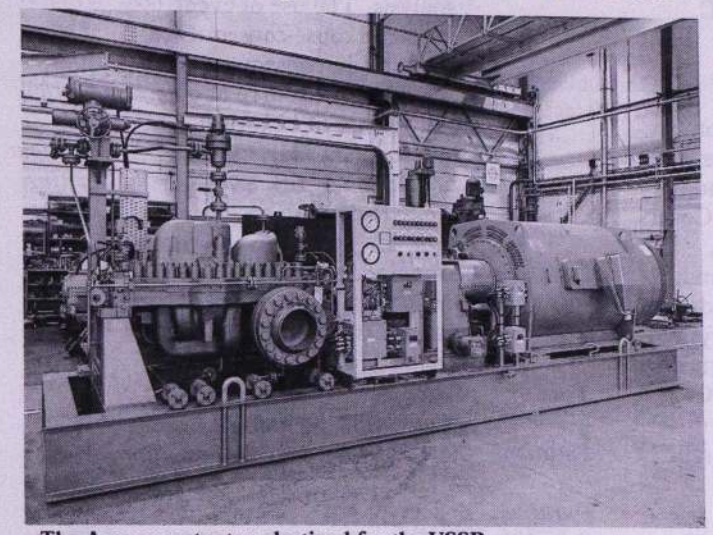
Change of status

BHRA, The Fluid Engineering Centre (British Hydromechanics Research Association) is to change its corporate status from Research Association to Independent Technology Group, wholly owned by its management and staff.

The Rt Hon Douglas Hogg MP, Minister for Industry and Enterprise launched the new organisation, BHR Group Ltd (British Hydromechanics Research Group Limited) on a visit to the company's laboratories in Cranfield, Bedfordshire.

Effected through a management and staff buyout, the transition will be the first of its kind for a research association, and will allow the company to expand and progress business development in both new and traditional markets — providing major benefits for industry.

International co-operation on USSR contract



The A-range actuator, destined for the USSR.

A ROTORK Actuation 'Syncroset' A-range actuator sits atop a skid-mounted pumping system destined for the USSR trans-Siberian liquefied gas pipeline.

The electric actuator operates the automatic vent valve on four identical pumping packages, that have been supplied by Ingersoll Rand of Gateshead — together with the main microprocessor-based control equipment — to each of two pumping stations on the pipeline.

Two other A-range actuators — for the pump suction valve and discharge valve — also form part of the equipment. Further actuators for connection to separate 30-inch pipeline filter units were supplied for fitting on site.

Bath-based Rotork Actuation received the order from Petrocon Flotec of Mildenhall, Suffolk, supplier of the valves.

These were follow-up orders for all three British companies as they supplied similar equipment for the pipeline in 1985.

Ada development contract award

NUCLEAR Electric has awarded a £150,000 design study contract to Ferranti Computer Systems Limited (FSCL). The study is to carry out the top level design of a new generation distributed computer system to monitor and control four of its advanced gas cooled reactor (AGR) nuclear power stations.

Central to the project is the requirement of contractors to develop the new system using the computer programming language Ada — which until now has rarely been used in civil computing systems.

By using Ada, coupled with the Ferranti Integrated System Development Methodology (ISDM), future real-time systems are expected to achieve a reduction of software life-cycle costs of up to 40 per cent.

The power station at Dungeness will be first to be updated with an Ada-based control system, followed by Hinkley Point, Hartlepool and Heysham 1.

Monitoring of emission limits

LAND Combustion's new production data sheet 135 introduces their Model 4500 Dust Density Monitor, for continuous reliable measurement of dust, smoke or particulate levels from combustion and production processes.

The Land Model 4500 is designed to measure trace concentrations of particulate, and is ideally suited for applications such as the measurement of dust concentration of flue gases, the monitoring of emission limits established by government agencies and the controlling of production processes.

The instrument offers an economical step towards clean stack emissions and legislation compliance. Features include double pass monitoring, long term unattended operation, measuring paths up to 20 metres and fully automatic zero and span calibration.

Further details are available from Land Combustion, Dronfield, Sheffield S18 6DJ.

Portable aid to analysis

THE EB1228 portable electrical energy analyser/monitor/controller from Kane-May Ltd of Welwyn Garden City has been developed to satisfy the needs of both the electrical engineer and the energy manager.

The unit is programmable and automatically monitors all aspects of three phase, single phase or DC supplies to enable analysis of consumption. Reports can be provided via its integral display and printer, or to an IBM compatible PC. In addition there are nine analogue recorder outputs. All options can be defined and are set by the user via the integral keypad.

Of particular note is the unit's frequency response of up to 200 kilo hertz. This allows the measurement of power supply and consumption parameters of pulse width modulated speed controllers and high frequency drives in 50/60 Hz networks and frequency chance stations.

For further information contact Kane-May Ltd, Swallowfield, Welwyn Garden City, Hertfordshire AL7 1JP.

In situ repair

A GERMANIUM gamma-ray detector from EG&G ORTEC, the Customer-Neutron-Damage-Repairable GAMMA-X, is equipped with a unique internal heater so that the user can perform his own repair for radiation damage caused by fast-neutron fluxes present during many physics experiments. The modification means that even a severely radiation-damaged germanium detector can be restored, in just a few hours, to its original energy resolution specifications. It is no longer necessary to tolerate the time and expense of returning the detector to the manufacturer.

This new capability is important for experiments involving detector arrays, where downtime for any element is unacceptable, as well as any case where having to replace and recalibrate the gamma-ray detector during an experiment would be highly undesirable.

For further information contact EG&G Instruments, Sorbus House, Mulberry Business Park, Wokingham, Berks RG11 2GY.

Title: **Advanced energy waste detection with a PC.**
Location: London W1.
Duration: 1 day.
Starting: 6 December 1990.
Content: Practical workshop for intermediate and advanced users of Lotus 1-2-3 and similar programmes. Covers theoretical principles, practical techniques and spreadsheet skills needed to create an automated system for detecting and diagnosing waste. Sole use of a PC included.
Contact: Mid-Career College on 0223 880016.

Title: **Strategy for electricity purchase.**
Location: Belgrave Square, London SW1.
Duration: 1 day.
Starting: 7 December 1990.
Content: Structure of new electricity industry; licences; role of the Regulators; pooling and settlement arrangements; use of the system; private generators, CHP? Buying direct, negotiating the contract.
Contact: Mid-Career College on 0223 880016.

Title: **Plant reliability and risk assessment.**
Location: Research Laboratories, Health & Safety Executive, Sheffield.
Duration: 1 day.
Starting: 10 December 1990.
Content: The basic concepts, techniques and potential of reliability engineering. The theory and practice of availability and reliability assessment. Systems analysis and assessment. Fault tree analysis. The use of event trees and cause-consequence diagrams in consequence analysis. The source of data and the use of historical data in frequency analysis. The calculation of risk levels for comparison with acceptance criteria.
Contact: Conference Section, Institution of Chemical Engineers on 0788 478214.

Title: **Robotics in the power generation industry.**
Location: The Portman Hotel, London W1.
Duration: 2 days.
Starting: 11 December 1990.
Content: The aim is to show the robot as a powerful technique for ensuring the highest standards of cost-effective safety. The programme will include some examples of maintenance work on power plants being decommissioned which clearly show the benefits of remote technology.
Contact: Katie Lye, IBC Technical Services Ltd on 071-236 4080.

Title: **Computerised maintenance management systems.**
Location: Westminster SW1.
Duration: 1 day.
Starting: 12 December 1990.
Content: Asset registers; maintenance task control; cost information; BMS interfacing; condition based maintenance; maintenance contracts; choosing the right system; solutions to practical problems; designers role; getting the best from the system and the supplier.
Contact: Mid-Career College on 0223 880016.

Title: **Boiler plant efficiency.**
Location: Institute of Energy, London W1.
Duration: 1 day.
Starting: 14 December 1990.
Content: Basic combustion calculations, the importance of air supply, use of charts in efficiency calculations, energy balances and overall plant efficiency, case study on waste heat recovery.
Contact: Mid-Career College on 0223 880016.

Title: **Steam**
Location: Institute of Energy, London W1.
Duration: 1 day.
Starting: 30 January 1991.
Content: The efficient generation, distribution and use of steam; the practical measurement of boiler efficiency (BS845). Economics of altering steam pipework. Steam quality, traps and condensate. Control and measurement.
Contact: Mid-Career College on 0223 880016.

Title: **Lighting controls in offices and shops.**
Location: Balham SW12.
Duration: 1 day.
Starting: 31 January 1991.
Content: Trends in lighting and lighting control — energy savings and green issues; design solutions for quality, illuminance and aesthetics; Automatic control in accordance with daylight, time and occupancy.
Contact: Mid-Career College on 0223 880016.

November 1990

Lodestones to Load Carriers
IEE Faraday Lecture, now until 14 March 1991, country-wide.
Details from The Faraday Officer, IEE, Michael Faraday House, Six Hills Way, Stevenage, Herts SG1 2AY. Tel: 0438 313311.

Historic Buildings — Conservation & Energy Efficiency: Are They Compatible?
Seminar, 20 November, Cambridge.
Details from Godfrey Smith, tel: 071 215 0607, or Rex Bowen, tel: 0992 555120.

Introduction to Project Management
Seminar, 29 November, London.
Details from IEEIE Professional Development Seminars, Savoy Hill House, Savoy Hill, London WC2R 0BS.

December 1990

What Price Quality & Safety?
Conference, 3 December, London.
Details from ICM Marketing Ltd, tel: 0483 37557, fax: 0483 33082.

NEMEX '90
Conference and exhibition, 4-5 December, Birmingham, UK.
Details from Energy Systems Trade Association, tel: 0453 873568.

Environmental Protection In Practice
Conference, 10-11 December, London.
Details from Clare Lally or Elaine Hendry, Legal Studies & Services Ltd, Bath House, 56 Holborn Viaduct, London EC1A 2EX. Tel: 071 236 4080, fax: 071 489 0849.

Vibrations in Centrifugal Pumps
Seminar, 11 December, London.
Details from Paul Gallagher, IMechE, tel: 071 222 7899, ext: 222, fax: 071 222 4557, tlx: 917944 IMELDN.

Reactions of Nitrogen in Coal Combustion
Conference, 12 December, London.
Details from IChemE Conference Section, tel: 0788 578214.

Architecture in Climate Change
Conference, 18 December, London.
Details from UK-ISES, King's College London, Atkins Building South (128), Campden Hill Road, Kensington, London W8 7AH. Tel: 071 333 4314.

January 1991

RICS National Research Conference
Conference, 10-11 January, London.
Details from RICS on 071 222 7000.

Single Market Seminar: 'The developing role of the engineering institutions in western & eastern Europe
14 January, London.
Details from Mr J B Senior, Deputy Director Professional Institutes, 10 Maltravers Street, London WC2R 3ER. Tel: 071 240 7891; fax: 071 240 7517.

Lighting Developments & Applications
Conference and exhibition, 16 January, London.
Details from Linda Jelly, Conference Organiser, ERA Technology Ltd, Cleeve Road, Leatherhead, Surrey KT22 7SA. Tel: 0372 374151, ext: 2290/2461.

The Continuous Measurement of Gaseous Pollutants Issuing from the Metal Industry
Seminar, 22-23 January, London.
Details from The Institute of Metals, 1 Carlton House Terrace, London SW1Y 5DB. Tel: 071 839 4071.

The environmental challenge facing the oil industry
IMM Petroleum Lecture, 24 January, London.
Details from IMM, 44 Portland Place, London W1N 4BR. Tel: 071 580 3802, tlx: 261410.

Future energy supplies: exchange of opinions between East and West
Lectures and discussions, 29 January-1 February, Düsseldorf, Germany.
Details from CTI compass tours incoming gmbh, Barbarossawall 11-23, 4000 Düsseldorf 31. Tel: 02 11/40 70 21, fax: 02 11/40 77 14, tlx: 8 585 518.

February 1991

Worldwide Engine Emissions Standards & How to Meet Them
Seminar, 12-14 February 1991, London.
Details from Julie Brown, IMechE. Tel: 071-222 7899, ext 237.

Nuclear Safety
Conference, 27-28 February, Brussels.
Details from Katie Lye, IBC Technical Services Ltd, tel: 071 236 4080, fax: 071 489 0849, tlx: 888870.

March 1991

Offshore Safety and the Environment
Lecture, 6 March 1991, London.
Details from The Royal Society, 87 Gower Street, London WC1E 6AA.

Desulphurisation II
Conference, 20 March, Sheffield, UK.
Details from IChemE Conference Section, tel: 0788 578214.

April 1991

International Science Festival
1-4 April 1991, Edinburgh, UK.
Details from Edinburgh Science Festival Ltd, 20 Torphichen Street, Edinburgh EH3 8JB. Tel: 031-228 4756, fax: 031-225 9613.

Coal in the Environment
Conference and exhibition, 3-5 April, London.
Details from World Coal Conference and Exhibition Secretariat, 8 Cotswold Mews, Battersea High Street, London SW11 3JE. Tel: 071 228 8034, fax: 071 924 1790, tlx: 917712 POLYBS G.

British Wind Energy Association 13th Annual Conference
10-12 April, Swansea, UK.
Details from Victoria Fenton, Garrad Hassan & Partners, 9-11 St Stephens Street, Bristol BS1 1EE. Tel: 0272 250518.

Municipal Waste Combustion
2nd international conference, 16-19 April 1991, Florida, USA.
Details from Debbie Reichert, Air & Waste Management Association, PO Box 2861, Pittsburgh, PA 15230, USA.

Fluidised Bed Combustion
11th international conference, 21-24 April 1991, Montreal, Canada.
Details from the ASME, 345 East 47th Street, New York, NY10017, USA.

Flanders Technology International
International trade fair, 22-28 April 1991, Ghent, Belgium.
Details from Flanders Technology International, Jozef II-straat 30, 1040 Brussels, Belgium.

May 1991

Biological Processing of Coal
2nd international symposium, 1-3 May 1991, California, USA.
Details from Stan B Yunker, Generation & Storage Division, EPRI, Palo Alto, CA 94304, USA. Tel: (415) 855-2815.

Flow Induced Vibrations
Conference, 21-23 May 1991, Sussex, UK.
Details from Alison Elgar, tel: 071-222 7899.

June 1991

The Environmental Business Show
Exhibition, 4-6 June 1991, London.
Details from Caroline D Baker, Exhibition Manager, tel: 071-724 0851.

Power System Monitoring & Control
3rd international conference, 26-28 June 1991, London.
Details from Conference Services, IEE, Savoy Place, London WC2R 0BL. Tel: 071-240 1871, ext 222.

INSTITUTE OF ENERGY CONFERENCES

The following programme is currently being organised by The Institute of Energy.

For further details please contact Judith Higgins or Jill Leigh on 071-580 0008.

In 1991

20 February
ENERGY INVESTMENT: LIMITING THE RISK
Venue: CBI Conference Centre, London WC1
Chairman: Mr D M Willis (Institute of Energy)

13 March
WHERE ARE WE NOW ON NUCLEAR POWER?
Venue: The Conference Forum, London E1
Chairman: Mr C E Pugh CBE (Institute of Energy)

30 April-1 May
FIRE & EXPLOSION HAZARDS: ENERGY UTILISATION
Venue: Fire Service College, Gloucestershire
Chairman: Mr P G Redpath (British Steel)

17-19 May
THE INSTITUTE OF ENERGY ANNUAL CONFERENCE
Venue: Bournemouth
Chairman: Mr D M Willis (Institute of Energy)

SCRUBBING OR SWITCHING — MEETING THE DIRECTIVE ON ACID RAIN
Venue: Millbank Conference Suite, London SW1
Chairman: Mr D M Willis (Institute of Energy)

Autumn
ENERGY FROM WASTE (provisional title)
Venue: to be confirmed
Chairman: Mr B Lees (Institute of Energy)

Autumn/Winter
5th International Fluidised Bed Combustion Conference:
FBC TECHNOLOGY TO MEET THE ENVIRONMENTAL CHALLENGE
Venue: to be confirmed
Chairman: Mr J S Harrison (British Coal)

Conferences co-sponsored by The Institute of Energy

In 1990

4-5 December
National Energy Management Exhibition & Conference NEMEX '90
Contact: Energy Systems Trade Association on (0453) 873568

12 December
The Reactions of Nitrogen in Coal Combustion
Contact: Institution of Chemical Engineers on (0788) 578214

In 1991

Jan/Feb
Practical Solar Energy: New Opportunities in Europe
Contact: The Solar Energy Society on (071) 333 4314

20-25 March
2nd International Conference on Desulphurisation
Contact: Institution of Chemical Engineers on (0788) 578214

21 May
New Technologies For Air Pollution Reduction
Contact: Pauline Sim on (0494) 713664

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The Institute of Energy

To: Membership Officer

I am interested in applying for membership of The Institute of Energy. Please send further details and an application form to the name and address below.

I fulfil one of the membership criteria indicated below (please tick):

- ☐ Chartered Engineer or equivalent.
- ☐ Incorporated Engineer or equivalent.
- ☐ Degree in engineering/scientific discipline.
- ☐ Other professional qualification and an active interest in energy.
- ☐ Academic qualification recognised by The Engineering Council.
- ☐ Engaged on a relevant course of study (Student applicant).

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THE INSTITUTE OF ENERGY REPORT AND ACCOUNTS 1989

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The Institute of Energy

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Nominated Body of The Engineering Council

The Council (as at 31 December 1989)

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A J Williams BSc CEng FBIM

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Hon Secretary: C S Ellis

London and Home Counties
Chairman: G A Jones PhD CEng MIGasE AFIMA
Hon Secretary: N Rigby BSc CEng

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Chairman: E F B Croft MSc CEng
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North Eastern
Chairman: A W Coles CEng
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Northern Ireland
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Chairman: B Jones
Hon Secretary: C E Davies PhD

South African
Chairman: C M Eleftheriades PhD(Eng) ACGI PrEng CEng
Hon Secretary: R A Stephenson PrEng CEng MI(SA)MechE MIMechE

USA
Chairman: Prof R G Jenkins CEng
Hon Secretary: F Derbyshire PhD CEng

Annual General Meeting

NOTICE IS HEREBY GIVEN that the sixty-third Annual General Meeting of the Institute of Energy will be held at the Hotel St Nicholas, Scarborough, at 11.00 am on Saturday, 19 May 1990, to transact the following business:

1 To sign the minutes of the 62nd Annual General Meeting held on 25 May 1989.

2 To receive the Annual Report and Accounts of the Institute for the year ended 31 December 1989 together with the report of the auditors.

3 To receive the Annual Report and Accounts of the Benevolent Fund of the Institute of Energy for the year ended 31 December 1989, together with the report of the auditors.

4 To elect Messrs Harris Kafton, chartered accountants, to serve as auditors for the ensuing year and to agree that their remuneration be fixed by the Executive Committee.

5 To announce the names of new members of Council.

Dated this 12th day of April 1990
By Order of the Council

COLIN RIGG
Secretary

Administrative Officers

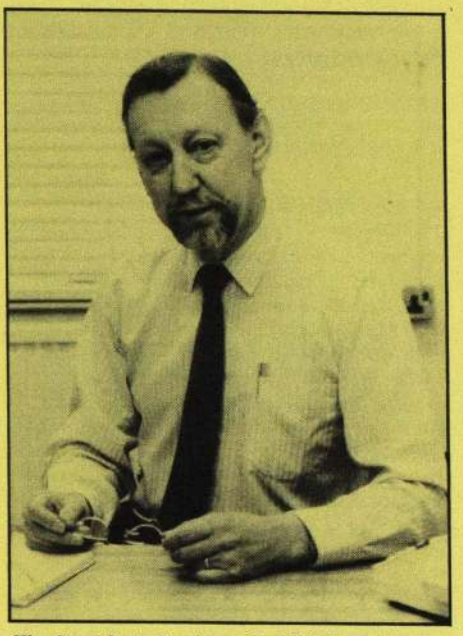
C Rigg TD BSc(Tech) MA CEng MBIM *Secretary*
J Banerjee ACMA ACIS *Finance Officer*
J E H Leach *Deputy Secretary*
K B Harrison NCTJ *Editor*
Ms J Higgins *Conference Manager*
Miss C A McCarthy BA *Education Secretary*
Ms P Powell-Fuller *Membership Secretary*

Presidential Review 1989-90

Improvements to the Institute's activities have continued over the past year, especially as a result of recent staff appointments approved by Council. Changes in the style and content of Energy World have been in evidence as the Editor Ken Harrison aims to serve the needs of members and to make our bulletin more attractive to advertisers. An abundance of good material is coming forward for The Journal and developments are planned for The Yearbook.

Meetings promoted by our Conference Manager, Judith Higgins, have ranged over topics from the technical and economic, such as Applied Energy Research and Ceramics in Energy Applications to the social and political, such as Coal Privatisation and the Role of Government in Energy. The Institute is becoming better known as a result of our positive approach to these and other ways of widening our contacts by attendance at exhibitions, for instance. Our involvement continues with ventures such as the Centre for Research, Education and Training in Energy (CREATE), which has been operating from our HQ building in Devonshire Street. As one of the Founder Members of CREATE, we shall be looking to strengthen our connection with schools and colleges, supplementing the work of our Education and Training Committee on the accreditation of degree and diploma courses in energy.

Our support for the energy managers' movement entered a new phase with the launch of the National Energy Efficiency Association, which is to establish its office at Devonshire Street. Council has authorised the appointment of a Technical Officer, to promote wider contacts and the role of the Institute as an authoritative source of information on energy matters to professionals, the media and decision-makers. This may extend to continental Europe through the European energy information organisation proposal by a working group on which we have been represented by the Deputy Secretary, Jim Leach. We are gratified that the Secretary of State for Energy, John Wakeham, recognised us by consenting to address the assembly at the Annual Luncheon.



The President: Professor B J Brinkworth MScEng PhD CEng FInstE MIMechE MRAeS MInstP.

Services to members have been strengthened in other ways also. Bill Tipler, a long-serving committee member, is to set up arrangements for keeping in closer touch with our retired members and for increasing the effectiveness of the Benevolent Fund. Members overseas are being encouraged to form local societies, and Council has adopted standard arrangements for associating them with the Institute and promoting reciprocal relations; the proposed South African Institute of Energy is likely to be the first to use these.

Doug Willis, the President-Elect, who chairs the International Committee, has also encouraged an initiative by the Membership Committee to widen our industrial membership through an increase in the number of Group Affiliates.

In the small space available, I cannot mention all significant activities, or name the many devoted individuals who continue to serve the Institute so well. We are in much better shape now than we have been in recent years, though our numbers remain static, and we have not yet managed to build up the financial margin needed to support the further developments required for professional institutions today. With this in mind, Council has been turning its attention towards long-term matters. This year, it adopted a revised statement of our aims — to promote the effective provision, conversion, transmission and utilisation of energy in all its forms, with due regard to the prudent use of resources and the protection of the environment. But we are conscious of being one of the smaller professional bodies within the Engineering Council, and there is a view that we could not serve these wide-range and growing ideas far into the future while at this size. Mergers, even between much bigger institutions, are in the air and Council has held a series of special debates on whether our objectives could be served better by collaborations of one kind or another. This is a very sensitive, not to say emotive issue, but the level of debate has been serious and thoughtful. Meanwhile, Branches have been trying to establish the opinions of the membership at large on some of the leading questions involved.

I hope to be able to report on these moves at the Annual Conference and Social Weekend at Scarborough (another new venture, initiated by George Burbage-Atter), which will incorporate this year's AGM.

B J Brinkworth

Honorary treasurer's report

In 1989 for the first time the accounts show the effect of Council's new policy dated from March 1988 to apply the Institute's reserves to developing its future. It was resolved to allot £20k in 1989 for the expansion of conference activities, and the test of success will be whether conference surpluses grow significantly in the next two or three years (there would obviously be no need for special provisions if results were to flow in the same year).

The surplus on ordinary operations of £5,083 is after taking a credit of £20,000 from the Accumulated Fund at 31 December 1988 via a newly created "development fund".

There was also an investment surplus in the year of £9,232. In my report last year I explained that the corresponding figure, which in 1988 had been £48,632, should be regarded as a windfall, helping our book position but not to be counted upon as a regular contribution: it is too dependent on the accidental factors, because under normal accounting practice capital appreciation can be brought to book only when there is an investment transaction. The figure is lower in 1989, but the warning still applies.

The consequence is that the Institute's accumulated reserves have been reduced by a total of £5,685 compared with the previous year.

A presentational change this year is to show actual surpluses on the two "trading" operations, namely conferences and publications: previous practice had been to show income and expenditure for each in the main account, leaving the calculation of surplus (or deficit) to the notes (those are still there as notes 3 and 4). I am hoping to make other presentational changes next year so that members can see more clearly what is happening, a reform made easier now that computerisation is in place.

It will be noticed that Engineering Council income and expenditure are shown in full, not net, to underline that the Institute is merely a collecting agent, even though overpayments are not corrected until the following year.

P C Warner

Standing Committees: the chairmen report:

Executive

When reviewing the progress of any activity, it never fails to amaze me how rapidly the time has passed, and how difficult it is to recall what has been done. However, reporting Executive Committee's activities is relatively simple, as much of the subject matter is quite properly described in the report of each standing committee and honorary offices, and the details of progress can be seen there.

On the administration front, the most visible change can be seen by visitors to 18 Devonshire Street, where one was greeted by a totally repainted and recarpeted reception area and stairway. A less visible but more important change has been the commissioning and application of the computerised financial management system. Despite a prolonged, agonising start-up period, the system now provides regular information on the current position by cost centre, enabling all activities to be properly managed and controlled within target.

A subject much debated by the Committee has been about the direction which the Institute should take in the future. As is to be expected, the reviews into long term options for the Institute with regard to location and potential future partners in joint operations have to be carefully researched and appraised. This process takes longer than we hope, but progress is being made, and is (I presume) being shown elsewhere in this annual report. There were however some conclusions which arose that indicated we needed to take action to improve the Institute's services and main functions.

We have been able to progress towards these improvements through selective application of some reserves via the "development fund". The progress of each initiative is being closely monitored to assess cost against budget, and performance against target. The improvement in the Institute's range of seminars and conferences, and the increased attendances, is the first visible return. It has now been agreed that there should be a facility for responding more swiftly to the increasing number of individual enquiries on technical matters, and to provide a reasoned response on government papers relating to energy matters.

The most immediate task during this year is the completion of our response to Engineering Council in the vital process of applying for nominated body status, to act as a qualifying body, for the succeeding five year period. This status is essential to the successful development of our Institute and its work, particularly in view of the closer links with parallel bodies in Europe due to start in 1992.

In closing, I wish to thank all members of Institute staff for their efforts during the year, and on a personal basis my own thanks to Colin Rigg and Jim Leach for their considerable help in keeping the Institute running. I also wish to thank those members who sadly are leaving this Committee, as they are retiring from Council in May. They are:

Jim McCarthy, who has directed Membership with a firm hand and good humour through a very heavy workload.

Norman Worley, who similarly has skilfully guided Publications and Conferences through some very turbulent waters.

Mike Roberts, who has chaired the advisory group through hurricane and tempest.

My thanks to you all, and good wishes to all members.

B G Gills

International

The International Committee has continued on the three main areas of activity as reported last year. These were:

1. *Association with societies overseas*
The arrangements for association have been approved by Executive and by Council as also have been the special rates for those wishing to be individual members of the Institute whilst belonging to an overseas body in association with the Institute. The aim is to encourage groups to set up similar bodies overseas but provide the ability to maintain links with the Institute. It seems probable that the branch in South Africa will reform as an associated body on the lines of the Australian Institute of Energy and hopefully other countries will establish similar professional institutes.

2. *The European Dimension*
During the year the Deputy Secretary has represented the Institute at a number of meetings with other European bodies to establish a Euro Energy Information network. The meetings were initiated by the L'Institut Francais de l'Energie and included the Verein Deutscher Ingenieure, two of our associated societies. As a result of this we have become founder members on the new organisation and this will lead to improved intelligence on an European scale in energy matters. It is hoped by the International Committee that this will promote closer co-operation in a number of other areas, particularly as we move towards 1992.

3. *Energy in the Third World*
The initiatives, started by Guy Masdin when he was President, are now coming to fruition in that UNIDO have agreed to fund, with support from Shell International, a workshop on energy from biomass waste products. This workshop will be held in London from October 2nd to October 6th and will be aimed at identifying three or four relatively small practical projects in biomass utilisation. The intention is that these projects will be of use to small communities in a number of developing countries and that they will be capable of replication. The committee feels that there should be scope for encouraging small practical schemes which may not attract the publicity of the large mega project but which will give practical benefits to the developing world.

D M Willis

Education and Training

The Committee has progressed Energy Education and Training in several important respects during the past year. It could have achieved a great deal more if more time could have been committed to the task by the voluntary members of the Committee (including the Chairman). It is appropriate to make two points:

(a) the permanent members of staff are to be commended on the support and help they provide

and

(b) the Institute would benefit from a greater involvement in National Committees by people committed to the task and with time to commit to the task.

The Committee is unique within the Institute for having, in effect, an executive arm; the now independent organisation CREATE (Centre for Research Education in Training). Its very major achievements, influence and opportunities are summarised below. As a vehicle for incisively reacting to opportunity the creation of CREATE (sorry) has proved of major benefit to the Committee and, in my opinion, to the Institute.

In the overall strategy of advancing Energy Education and Training the Committee have now instituted major initiatives at all levels of education. The last area to be tackled, that of energy reseach, has now been reviewed under the guidance of Dr John Padley and a course of action proposed to the newly formed Technical Committee. The Education and Training Committee identified the need for a systematic and up-dated database of research on energy related topics. This would be of use to those defining new research, those involved in research and those seeking to answer queries on energy matters.

The progress of the Engineering Technician and indeed of the Incorporated Engineer as a recognised career within the Institute has recently been reviewed. As in other areas recruits to the Committee's work in this area would be welcome.

It is customary in annual reports to list the documents reviewed and initiatives followed during the year. This Committee receives more than its fair share of such tasks — some of which it does adequately, others less than adequately.

It is more appropriate in an age when Energy is beginning to be recognised as the integrating element of so much educational and social activity that the Institute should be seen to lead the initiatives not follow. It is my pleasant task to report on a committee, and on the sub-structure of that committee, which espouses that view. I am grateful to all those who help, all members of the committee, of sub-committees and of panels — keep up the good work.

Now to CREATE: The Centre for Research, Education and Training in Energy was set up by the UK Department of Energy in 1988 with pump prime funding. It is now an independent organisation looking after the interests of energy education in the United Kingdom. Its main role in education is to develop and co-ordinate the energy initiatives which are evolving and to ensure that a balanced education is available for all children in which social, political, economic and environmental aspects are given due recognition.

This influence has extended to other parts of Europe and beyond, and programmes are being produced with a number of national and international agencies.

In addition, localised energy groups of teachers are being formed to determine what is being done at a regional level, what requires to be done and to assess and meet regional needs. These are being set up jointly with branches of the Institute of Energy and local education groups such as the SATROs or ASE branches. These are in the developmental stage but a network of such groups should be in existence by the end of 1990. It is hoped that they will increase the Institute of Energy's ability to work much more efficiently in energy education at school level.

CREATE is also becoming increasingly involved in energy training at post school level. The main thrust at present is in the field of energy management where major changes are envisaged or are already occurring in

higher education and mid career training. Higher education and training programmes in renewable technologies are also under active consideration.

At present more than 26 major projects are at various stages of negotiation or production. We think this is an impressive performance.

We would welcome a closer collaboration with the 'energy industry' whether as producers or major users of energy, or producers of materials or products concerned with energy efficiency and conservation. We both have much to offer in developing an energy aware population and in enhancing the opportunities of the 'energy industry' in attracting young people of the highest calibre to careers which are energy orientated.

A J Williams

Membership

I am privileged to have taken over the chairmanship of the Committee from James MacCarthy in September 1989. I begin this report by expressing the deep thanks of the Institute and the Membership Committee to James MacCarthy for his contribution to its work over 13 years, of which for five years he was its Chairman. His excellent chairmanship and conscientious attention to the responsibilities of the Committee in its qualifying role have set a standard it will be challenging to maintain. Fortunately for me he is continuing to serve on the Committee and hence we will have the benefit of his wisdom and experience to draw upon. During his chairmanship considerable efforts were made to improve and update membership procedures, with particular emphasis in recruiting student members. We are indeed very indebted to James MacCarthy for his services to the Institute, and pay tribute to him for his unstinting efforts.

The Committee met seven times during 1989 to process applications for membership to the Institute and transfer to higher grades. As usual many applicants were interviewed for their suitability to join the Institute. There were 179 new individual members elected and a further 53 transfers within grades.

Although the Institute gained 179 new members in 1989 it also lost 218 former members, for a variety of reasons. (37 died, 84 retired and resigned their membership, 97 failed to renew membership despite reminders). It is therefore disappointing that we must record a net loss of 39 members at the year's end.

The Committee is continuing to explore ways of encouraging an increase in student membership — the future lifeblood of the Institute — and it is gratifying to note that these efforts are meeting with some success. Group Affiliate Membership (previously called Collective Membership) is also very important to the Institute, for membership by organisations and companies identified with all aspects of the energy scene ensures that the Institute is kept abreast of current and longer-term thinking in this field. We look to Branches to promote this form of membership wherever appropriate and possible.

As the new Chairman, I would like to express my sincere thanks to Jim Leach and Pauline Powell-Fuller for their knowledgeable and efficient help with the management and administration of membership activities and business over the past year. They have given valued support in the duties and responsibilities of my task.

Finally, my thanks to members of the Committee for their dedicated work and the time they devote to the meetings of the Committee.

Peter H Johnson

Engineers' Registration

This year, for the first time for a number of years, the number of engineers put forward to the Engineering Council for registration has increased. Congratulations are due to all those members, both at Devonshire Street and in the branches, who have made strenuous efforts to improve recruitment. Let us hope that continuing efforts bring further increases in the future.

The increase this year applies to both CEng and IEng registrants, althouth the number of IEng's is smaller than we would like.

It is also pleasant to report that the great majority of new members satisfy the educational requirements for registration by having a degree and also that the number of new members who are in membership of other institutions remains at a satisfactorily low level.

W A Simmonds PhD

Publications and Conferences

1989 was a year of changes in the publications and conferences of the Institute of Energy. The change most evident to Members has been associated with the Institute's magazine *Energy World*. There have been two principal aims. The first is to provide members with a magazine with a contemporary appearance (but not too *avant garde*) with feature articles on a different main subject in each edition backed by news related both to energy and the Institute's affairs, book reviews, etc. A panel under the Chairmanship of Professor Cleland McVeigh meets the Editor regularly to fix the forward programme and to make suggestions on article author's and subjects. The second aim is to provide a basis for attracting advertising partly to defray the high costs of producing and circulating the magazine but also, in the longer term, to lay the foundations for some increase in the number of pages to allow better coverage of events both inside and outside the Institute.

These changes have been associated with changes in staffing and have inevitably led to some problems in production and members will not have received either as many *Energy World's* as in previous years nor were they generally issued on time. After Ms S Dorrell resigned, a temporary editor was appointed while a new permanent editor was sought. The new Editor, Mr Ken Harrison, has, in fact, been responsible for the changes to the magazine and in addition to the day to day work of bringing out *Energy World* he has produced an information package on the Institute's publications, its membership and the subscribers for the advertising agent.

The changes to the *Journal* have been less obvious. The Institute's coat of arms on the cover has been sharpened, but although there has been a change in printer the aim has been to maintain a standard of material and format consistent with a publication which is the technical prestige journal of the Institute. Some flexibility in the number of pages has allowed the *Journal* to publish rather more papers than in 1988. The speed with which a paper can be published after receiving the draft from the author varies enormously and often depends on the referee and how much change to the text is required. Many papers are from overseas writers and the text often requires major modification to make them suitable for publication. A panel under the Chairmanship of Professor N Syred decides on which papers should be accepted and decides who should be invited to referee them. Often when the referee is not happy with the material a 'second opinion' is arranged with another referee. The material received has been predominantly on combustion and fuel topics althouth some review papers have been invited and others covering other energy related fields have been received or commissioned by the panel.

The Energy World Yearbook panel is chaired by Mr B Locke. The editors are Mr A Field and Mr G Webb. The topic for the series of feature articles was energy and the environment. The contents and layout are actively discussed at the panel meetings and are steadily being improved.

The arrangements for the publication and printing of all these publications have been reviewed as the current contracts expire early in 1990. The targets for the new contract will ensure that continuing progress and improvement in the publications is maintained and prompt circulation re-established whilst improving the financial situation for the Institute.

The development on Conferences have been significant too. The Institute has been fortunate in attracting a good conference manager, Ms J Higgins. The two main technical conferences in 1989 broke new ground for the Institute. Both were technical successes but attracted poor attendances. The conference on Industrial Energy Management was held at the National Exhibition Centre, Birmingham and the Applied Energy Research Conference was at Swansea University. A welcome innovation for the Swansea conference was the publication of the papers (with the exception of a few late arrivals) in hardback compact book form. This gives the material a more pemanent format and, in due course, will lead to increased sales. It is hoped that it will be possible for most future technical conferences to have hardback books covering the papers received. In the spring there was a joint meeting with the Watt Committee at the Institute on the 'Greenhouse Effect' under the Chairmanship of Dr G Thurlow.

An important innovation for the Institute has been the launching of a series of one day seminars on topics of current interest or debate. These have been organised by panels under the Chairmanship of Mr D Willis president elect for 1990.

The seminars in the autumn of 1989 covered topics of coal and electricity privatisation under the title of 'Fission or Fusion' and the 'Generation Gap'. Others are planned for 1990 on Orimulsion and although the conferences are not held in 1989, committee work arranging and planning future conferences are necessary and have been active during 1989. These cover the 'Role of Government in Energy', 'Ceramics in Energy Applications', 'The costs of flue gas desulphurisation', 'Electricity from gas', 'Building energy management' and 'Energy and safety'. Receiving preliminary thought were new conferences on Fluidised Beds, Research Energy Management. A European conference for 1992 is being considered. Planning for the first Annual Conference 'How Green is our Energy' was part of the work in 1989.

The important feature of activities in publications and conferences is that new ideas are being discussed and new ventures planned. This is healthy for the Institute.

On a personal note, my span as Chairman of the Publications and Conferences Committee ends in June 1990. The past five years have seen major changes in staffing and activities, although a major element of continuity has been maintained. I would like to express my thanks for the voluntary work of members (and sometimes non-members) on the committees and panels, the writers of papers and articles and referees. The staff at

(continued on page VII)

Membership Tables

Individual membership (31 December 1989)

Individual membership by branches	Honorary Fellow	Senior Fellow	Fellow	Companion	Member	Associate Member	Professional Associate	Asociate	Graduate	Student	Total individual membership
United Kingdom											
East Midlands	—	7	51	1	223	14	2	8	20	20	346
London and Home Counties	6	17	252	4	787	31	9	53	64	74	1297
Midlands	—	6	63	1	329	11	4	15	18	29	476
North Eastern	—	2	33	—	135	6	1	5	5	47	234
Northern Ireland	—	1	20	—	42	13	3	7	1	6	93
North Western	—	3	73	—	283	35	3	12	22	34	465
Scotland	1	3	53	—	210	16	2	9	28	32	354
South Coast	—	9	78	1	178	8	2	18	10	13	317
South Wales and West of England	—	9	81	1	279	19	2	11	19	26	447
Yorkshire	1	10	58	—	233	14	1	9	17	49	392
Total United Kingdom	8	67	762	8	2699	167	29	147	204	330	4421
Overseas											
India	—	3	6	1	16	—	1	1	—	—	28
New Zealand	—	—	5	—	12	1	—	1	1	—	20
Republic of Ireland	—	1	1	—	17	3	1	1	—	—	24
South Africa	—	1	15	—	21	1	—	4	1	1	44
USA	—	4	25	—	34	—	1	1	3	1	69
Other overseas countries	—	15	114	—	242	6	2	28	31	11	449
Total overseas	—	24	166	1	342	11	5	36	36	13	634
Address not known	—	2	3	—	3	—	—	1	—	1	10
TOTAL INDIVIDUAL MEMBERSHIP	8	93	931	9	3044	178	34	184	240	344	5065

Total corporate membership: 4076

Total non-corporate membership: 989

Honorary Fellows: HRH Prince Philip, Duke of Edinburgh KG PC; Dr J H Chesters OBE FRS; Lord Ezra of Horsham MBE; G J Gollin; The Lord Gregson; Sir John Hill FRS; Sir Ian MacGregor; Sir Dennis Rooke CBE FRS

Group Affiliate membership (31 December 1989)

Group Affiliate membership by branches	Group Affiliate	Representative	Nominated student
United Kingdom			
East Midlands	2	1	1
London and Home Counties	11	26	1
Midlands	2	4	—
North Eastern	3	8	—
Northern Ireland	1	3	—
North Western	2	2	—
Scotland	1	4	—
South Coast	—	—	—
South Wales and West of England	—	—	—
Yorkshire	2	5	—
Total United Kingdom	24	53	2
Overseas			
India	—	—	—
New Zealand	—	—	—
Republic of Ireland	—	—	—
South Africa	1	1	—
USA	—	—	—
Other overseas countries	2	4	—
Total overseas	3	5	—
TOTAL GROUP AFFILIATE MEMBERSHIP	27	58	2

(continued from page V)

Devonshire Street have been vigorous in their support and the professionalism of both Ms Higgins and Mr Harrison have been outstanding during 1989. A special thank you is due to Ms J Deakin who, although retired, has frequently helped with the high volume of work on publications.
N G Worley

Fuel and Energy Abstracts

The past year has seen several improvements to the format of the journal, with shorter and more concise abstracts, an updated inside front cover and the inclusion of a calendar. A full list of journals searched is about to be published.

Subscriptions now appear to have steadied at 340, which is above the 300 predicted last year, and it is hoped to have FEA online with Orbit by the end of 1990.

The journal has been exhibited at a wide range of conferences, and planning continues into the extension of the editorial panel to include representatives from overseas.
E M Goodger PhD

Standing and Sub Committees

Executive

B G Gills *Chairman*
Prof B J Brinkworth *President*
D M Willis *President-elect*
R Evans CBE *Vice-President*
C E Pugh CBE *Past President*
P C Warner *Honorary Treasurer*
Prof A Williams *Honorary Secretary*
P H J Johnson
J P MacCarthy
M B Pittwood
M C Roberts
A M Warris PhD
A J Williams
N G Worley

International

D M Willis *Chairman*
Prof B J Brinkworth *President (ex officio)*
R Evans CBE *Vice-President*
C E Pugh CBE *Past President*
H B Locke
A Sanyal PhD
W Tipler
A Wheldon PhD
Prof A Williams

Education and Training

A J Williams *Chairman*
Prof B J Brinkworth *President (ex officio)*
Prof A Williams *Hon Secretary (ex officio)*
D R Browning
I M Coe
R A Coldicott
M E Horsley PhD
G J Levermore PhD
N P W Moore
A Otsa
P J Padley PhD
C Ryder
R G Temple PhD
M Tims
Prof G N Walton
J R Willetts
C M Wood

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M F Bakowski PhD
R A Dawe PhD
W A Gray PhD
N P W Moore
J P Roberts PhD
Prof J Swithenbank
D G Walton
Prof G N Walton
A J Wharton
A J Williams

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H Collier
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Prof B J Brinkworth *President (ex officio)*
Prof A Williams *Hon Secretary (ex officio)*
I Boustead PhD
F Broomhead
C R Chapman
C Davies PhD
B Gills
J P MacCarthy
J Masters
W A Simmonds PhD
P Tate
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G G Thurlow PhD
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D M Willis

Chartered Engineer Registration

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D N Gwyther PhD
M L Hoggarth
B Lees
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L A N Tozer PhD
G W Waterhouse PhD

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I Owen PhD
P Sage
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The president in office (*ex officio*)
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A Capp
D Chisholm
A Feltoe
A Field *Joint Editor*
D Gregory
H R Hoy OBE
B Lubert OBE
V G Neal
T Price
P Reynolds
D F Rosborough
C Ryder
G Webb
W Webb
N White PhD
N G Worley

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M C Roberts
A Melvin PhD
N G Worley
F Lockwood PhD
Prof B Brinkworth
K Matthews
B Cross PhD

Fission or Fusion

D M Willis *Chairman*
J A Higgins
C Rigg
P Heap
J Plowman
H Howland

The Generation Gap

D M Willis *Chairman*
C Rigg
J A Higgins
P Heap

Branch Activities

East Midlands

The year began as the previous one left off, with increased attendances at technical meetings. Unfortunately, this improvement was not maintained due to various outside influences (privatisation programmes, take-overs etc) which affected the time availability of both branch and committee members.

The first three technical meetings of 1989 were all held jointly with other bodies — in January with the Lincs Iron and Steel Institute at BSC, Scunthorpe, when the topic was "Quality Integrity within the Automotive Industry", followed in February by a meeting with the Coke Oven Managers Association at Orgreave when a packed audience listened to a presentation by R C Mills, BSC General Steels on "Process Control Development at Dawes Lane Coke Ovens".

In March a meeting with the Coal Industry Society, was held at the British Coal HQ Technical Department, Bretby at which Dr D Buchanan, Manager Technical Strategy, addressed the members on Developments in Mining Techniques. The talk was preceded by a tour of the Technical Department and machinery exhibition.

A well attended afternoon meeting in April, at the Scientific and Technical Centre of the CEGB Power Station, Ratcliffe-on-Soar, heard Mr J Cooper of CEGB Barnwood give a presentation on "Flue Gas Desulphurisation" which was followed by a Station Visit.

After the summer recession two more meetings — in November on "Recent Developments in Industrial Electricity Utilisation" by Mr R Benstead of the Electricity Council Research Centre at Capenhurst, Chester followed in December by a mine visit to Ollerton Colliery, North Notts — rounded off the year's technical meetings.

During the year, finishing touches were put to the design and production of two formats of notice board publicity posters for display in industrial and academic establishments. These posters promote The Institute of Energy and are intended for long term display with provision for short term, over display, of notices giving details of Branch meetings, etc. Any Branch wishing to purchase copies of these posters (for a nominal fee to cover the cost of printing) may do so by contacting the East Midlands Branch Secretary.

A lump sum, for payments of student membership fees, has been donated to the Branch by a company based in the East Midlands area with the intention of encouraging college students to join the Institute before gaining their qualifications and, hopefully, becoming Corporate Members in the fullness of time — a number of students have already taken advantage of the offer.

In keeping with most other professional bodies, our own Institute continues to suffer from a decline in the number of its members which is a matter for all concerned. During the year, committee members in particular, have had the opportunity to discuss the situation and express their views on the subject and it is hoped that the right solution can be found in time to ensure the "Future of the Institute".

P Lynd-Evans

London and Home Counties

The London and Home Counties Branch programme of major lectures was held at the Royal Institution, London. In February Lord Ezra of Horsham gave a challenging lecture with the title "The world context of the energy situation in Britain — a personal view". In March, Mr Rhodri Morgan MP spoke to the branch to put "The case against electricity privatisation". Also in March the effect of the 1992 developments in the EEC and the "Internal Market" were discussed by Mr Clive Jones, Deputy Director General for Energy at the EEC. This meeting was a joint meeting with the Institute of Petroleum. The autumn programme commenced in October with a talk by Mr Ian Flindall, the Energy Spokesman for the Green Party who gave a talk in which he developed his ideas for the world and this country in particular to move "Towards a Sustainable Energy Policy". Then in November, Mr Malcolm Keay, the Deputy Director General of Ofgas gave a talk entitled "Gas Industry Regulation". He reviewed the reasons for setting up the Office of Gas Supply, its objectives and the issues for the future.

Energy conservation, energy efficiency and the mechanisms by which they can be enhanced have been an important feature of the lecture programme, and this theme will be continued in next year's programme.

In October, Ian Boustead resigned as Branch chairman due to work commitments abroad and the committee would like to thank him for his leadership.

The committee are keen to encourage greater participation from student and graduate members and a small task force is investigating the most effective support the branch can provide for these members.

As a pilot project to provide a better service to all members outside London, an Essex sub-branch under the Chairmanship of Alfred Kearsey has been formed and will organise its own local programme of activities. I would be delighted to hear from any other members who would be willing to set up a sub-branch in their locality under the aegis of the branch committee.

During the coming year, the branch will seek to develop its membership base and to provide a range of events to encourage greater participation by the membership.

G A Jones

Midland

The Midland Branch has completed a full technical and social programme during 1989, which will perhaps be remembered as a year of change. Traditional events have however been maintained and links with other organisations preserved in a very friendly atmosphere.

Six of the technical talks helds at Aston University attracted an average audience of 32. The seventh, a lecture by Professor Ian Fells on "Electricity Generation and the Environment", was attended by an estimated audience of 150. Environmental and safety issues have tended to dominate much of the varied technical programme. The year saw the launch of the Jim Ellis Memorial Lecture, the future format of which will be left largely to the discretion of the incumbent chairman. The inaugural lecture was held at British Gas, West Midlands, Solihull. As an introduction Jeff Masters paid tribute to Jim Ellis's long service to the Institute and again thanked Jim's widow Muriel for the donation of the new chairman's chain of office. The lecture "Gas Offshore to the West Midlands" was presented by Mr Don Young, Chairman — West Midlands Region of British Gas.

Committee activity has had to adjust to the standing down of two if its hard working officers — Malcolm Hoggarth and Tony Cleaver as Honorary Social Secretary and Honorary Secretary respectively. New officers backed by supportive members have already laid plans for future activity. Sub-committees have been formed to plan a further McAndrew Award (the section's Student paper competition) and also to consider a junior version of the same based on secondary school projects.

Members of the committee followed up the 1988 "Questionnaire to Members" by telephoning names emerging from an analysis of replies carried out by Dr Rachel Palmer. Furthermore, all members of the Midland Branch were sent a copy of the Institute leaflet on membership to pass to colleagues.

The major special event of the year — the annual dinner dance — was held in October at Edgbaston County Ground, a trial alternative venue for the event. The Branch was pleased to share the company of both the National President Prof B J Brinkworth, the President-elect Doug Willis and the President of the North Staffs Fuel Society Mr George Saville. A reciprocal invitation from Mr Saville proved equally enjoyable.

At the social evening held in March at the Birmingham Chamber of Commerce, members and their guests were given a fascinating insight into the repair and restoration of valued ceramic and glass. Needless to say the venue of the Ind Coope Brewery proved a popular venue for the AGM.

My thanks go to all members who have served on the committee during the year. Many find that additional responsibilities at work do occasionally limit their Institute activity. However, their service is valued even more on that account. Equally, the Branch is mindful of the debt it owes to the many organisations who release speakers for the technical programme and support the social functions and also to the loyal group of members who regularly attend.

E F B Croft

Merseyside sub-branch (NW)

Technical meetings this year were on a variety of energy related subjects, including energy efficiency achievements with condensing boilers, an interesting tour of the Dista Products plant in Liverpool and our March meeting was held at our new venue, the Merseyside Innovation Centre, the subject for discussion was energy efficient use of heat pumps.

The ladies evening held again this year at the Devon Doorway Restaurant was excellent, with 35 people attending the evening.

The committee were saddened to hear of Rob Thompson's death. Rob, who always had a pertinent question for the speaker at our technical meetings, will be greatly missed.

Once more the committee is grateful to Eric Curd for his assistance in organising the Branch activities.

In conclusion, a successful year, although an increase in the number of members attending technical meetings would improve the quality and enjoyment of the meetings.

D G Connell

North Eastern

In 1989 the Branch held nine events of varying nature. The attendance was generally about 70, however many of the events were held jointly with the local branch of other learned societies such as: the Institution of Gas Engineers, the Institution of Chemical Engineers, the Institution of Plant Engineers, and the Institution of Mining Engineers.

Lectures have included Engineering change in British Coal, Submerged Combustion and Engineering as a Career. A public debate on open caste coal mining versus the environment was well supported.

Special efforts were made to recruit new members and close contact continued with local energy managers groups, the Energy Efficiency Office and Newcastle University. The recruitment of students from the university and polytechnics has been most encouraging.

The AGM was held in May at the Durham factory of Phillips Components followed by a visit to the television tube manufacturing lines.

The two social events were well attended, over 70 enjoying the dinner dance at the County Hotel, Newcastle the other being a visit, with our ladies, to The Washington Wild Fowl Park and the winding house of the old "F" pit.

The Branch held its second one day conference at the Moat House Hotel, Wallsend, the theme being 'Building Energy Management and Control', the attendance proved disappointing at 46 but a small profit was made. A proposed one day conference on small power generation has been deferred until next year.

The year has been a successful one and the Branch has continued its close cooperation with fellow bodies and it is hoped this will continue in the future.

A W Coles

Northern Ireland

1989 commenced with a combined lecture between IEE power section and the local Branch, when the subject of Landfill Gas — "An Environmental Problem and Energy Source" given by D J V Campbell of Harwell Laboratories was appreciated by all who attended. Mr Campbell outlined the many problems and the solutions encountered by his company to harness this source of energy throughout the world. An excellent debate followed as there are many problems locally associated with this gas where it had not been controlled or extracted correctly for burning.

Our Annual Dinner in March was again well supported and a most enjoyable evening was had. Our principle guest speaker was Dr Beveridge, President and Vice Chancellor of The Queen's University of Belfast who proposed the toast of the Institute, our own National President Mr C E Pugh responded. The guests were welcomed by the Chairman and in reply Mr C T Hogg made a suitable and a most entertaining speech.

The AGM in June concluded the winter programme and the Chairman Mr Swindells was requested to remain in office for a further year. The committee were re-elected with the exception of the past Chairman D Patterson, who was thanked for his contributions in past years.

In 1988 we invited David Browning of CREATE to address the Branch on the objective behind the formation of this Centre for Research, Education and Training in Energy. At that meeting we had the Senior Inspector for Secondary Schools in N Ireland, following that meeting it was arranged to have one of the workshops sponsored by Esso to which teachers preparing pupils for energy related subjects would be invited. The workshop took place in October 1989, and was entitled "Meeting the needs of teaching of Energy subjects across the National Curiculum and GCSE". The Chairman and one of our retired members assisted throughout the day and David Browning and his staff must be congratulated on the preparation and collection of the relevant literature for those teachers in attendance, the course included information and training on how facts and figures can be extracted from Data Banks as most schools now have computer terminal links.

In our last lecture of this year we combined with CIBSE for a talk on "Methods of energy saving in water pumping and air conditioning systems" given by Tony Embrey of Danfoss.

We look forward to the challenge of 1990 and the contribution we as engineers responsible for energy savings make to our economy and improved atmosphere conditions.

We regret the passing of A K McAuslan one of our esteemed members.

W Swindells

North Western

The 1988-89 programme concluded with the Annual General Meeting held at Salford University. J G Odgers was re-elected for a second term of office as Chairman, and commented on the change in style of meetings held during the year. An afternoon into evening format produced an increase in attendance albeit with the assistance of the local energy managers group.

In May we held the Chairman's visit. This time it was to the experimental coal liquefaction plant at the British Coal Point of Ayr colliery. This venture into North Wales did have a disappointing attendance — disappointing considering the trouble British Coal went to.

The 1989-90 session was planned along familiar lines. A joint evening was held with the Blackburn Plant Engineers which reviewed the latest developments in the gas industry, and the energy implications of the fluorocarbon issue were discussed at a meeting at Salford University. An extended meeting is arranged for March 1990 on CHP and is promoted as the Liverpool University Lecture.

The Merseyside sub-section has traditionally operated its own programme, but a move was made to integrate the publicity within the North West Branch in order to boost attendances.

The Annual Dinner was held in February when we were honoured to have as our guests the President of the Institute Prof Brian Brinkworth; Frank Fitzgerald, Managing Director Technical, British Steel and Reg Dixon, Regional Marketing Director, British Gas.

My thanks go to all committee members for their efforts during the year.

I have to end on a sad note with the news of the untimely death of George Lyne, a long standing and valued member of the Branch committee. He will be greatly missed.

J G Odgers

Scottish

The first meeting of the year was our Young Engineers Evening, an annual event at which short technical papers are presented by the authors for the John Rayner Shield. The prize was awarded to Steven Marshall whose paper assessed the results of a CHP project at a colliery and we were fortunate to have Mr E Gowans, Scottish Energy Efficiency Officer, to present the Shield. Despite the ongoing difficulty in persuading students and young engineers to submit papers for the competition, the Committee feel that it is a valued aid in our drive to bring young engineers into the Institute. However, we were encouraged by the fact that the Roscoe prize for 1988 was awarded to a John Rayner shield finalist, Mr Robert Stafford.

On the following month, February 1989, Professor T Patten who is well known in both industry and academic circles, presented a paper on recent developments in the offshore oil and gas industry. The presentation included an excellent film showing the development and launching of oil and gas rigs.

Following discussions with other Institutes such as CIBSE and British Wind Energy Association and with the financial support of the Scottish Development Agency, it was agreed that our technical meeting scheduled for 7 March 1990 would become a joint event. This turned out to be a very successful evening attracting almost 100 people to hear Mr Andrew Warren of ACE talking on the subject of Energy Conservation. It clearly demonstrated that the way forward to higher attendance is via co-operation with other Institutes and Associations.

The AGM and Annual Dinner were both held in April 1989. The President-elect, Professor Brian Brinkworth, attended both events, the guest speaker at the dinner being Mr Gavin Laird CBE, General Secretary of the AEU. The audience of around 120 were treated to a powerful and forthright speech by Gavin Laird who dealt with a range of subjects both during his talk and afterwards via questions asked by those attending.

In addition to the technical programme a number of technical visits were organised by the Chairman, Mr John Hoyle, during the first half of 1989 — one to Scottish Grain Distillers to view their gas turbine based CHP unit and one to the newly constructed St Enoch Centre shopping complex in Glasgow. The theme for the 1989/90 session was Electricity, Generation Use and Conservation and the speakers were selected in an attempt to blend the technical and commercial aspects of the subject in order to widen the appeal and to attract a larger attendance. The first meeting held in October 1989, was entitled "Application of Electric Processes in Energy Saving Situation" and was given by Mr J Forbes of the SSEB. It turned out to be an interesting, if provocative, talk which was rounded off in the best way — an excellent meal generously provided by the SSEB to all who attended. In November Mr Roger Prosser of Emstar gave a fascinating talk on the technical and financial aspects of installing a large scale CHP project. Our thanks go to Emstar for sponsoring this meeting which attracted a good attendance including over 25 students from Napier Polytechnic. The year was completed in December with a talk by Mr C Halpin of NIFES on the application of small scale CHP to a hospital situation. Mr Halpin, who stood in at the last minute when our scheduled speaker was taken ill, gave a very informative talk which generated many questions from the audience.

In considering the programme the Committee is conscious of its responsibility to provide a varied and interesting programme for our members. Successive Chairmen have

striven to achieve this aim but attendances at meetings continue to be disappointing. I urge members to support the work of the Scottish Branch and would remind members that your Committee would welcome suggestions for meeting subjects or any comment on the programme.

R McElroy

South Coast

The AGM was the first event of significance in the 1989 calendar. Held at the New Theatre Royal in Portsmouth, this event provided members and guests with an opportunity to view the Matchem-designed theatre during its restoration from a fire-damaged shell. Members were delighted to welcome Mr Doug Willis to the AGM and greatly appreciated the opportunity to quiz a representative of the Institute's hierarchy.

Although this has not been one of the branch's conference years, a number of important activities has taken place. A joint Institute of Energy/Hamworthy Combustions Ltd prize has been instituted and awarded for the first time in 1989. The prize, which goes to the Mechanical Engineering Student at Portsmouth Polytechnic who submits the best final year project on an energy-related subject, was awarded to Andrew Dance for his project entitled "An Assessment of Computer Modelling for Fluidised Bed Systems". The branch is grateful to Mike Purvis, who, as usual, did most of the organisation and to Jim Champion of Hamworthy for his continued encouragement and support. Drs Purvis and Hardman and Messrs Bartlam and Hillyer were responsible for scrutinising the short-list of candidates.

The Chairman visited Sri Lanka in September and was able to present the Institute's sole representative on the island with a framed membership certificate. The recipient, Mr Rohan Amarasinghe, formerly worked in the UK for British Gas and NIFES, respectively.

The only technical lecture of the year took place in November, when Mr Malcolm Denham, of BP Research, spoke on the subject of "Unleaded Gasoline". The lecture was held jointly with the Portsmouth and District Chemical Society, without whose support the 30-strong audience would have been lighter by 25! Again, the branch's main problem was highlighted; too few of its 300 or so members take any part in its activities.

At this time, we should have a conference on the stocks for 1990, but there is a marked unwillingness by the usual small band of workers to submit themselves to the rigours or organising yet another event. Unless new enthusiasts come forward, it is unlikely that South Coast Branch will be able to organise another conference. However, this problem is not unique to the Institute of Energy and there is concerted activity by local branches of the engineering institutes to organise more joint events. Surely, 14 institutes, acting together, should be able to produce something?

My thanks go to all who have supported and assisted the branch over the last year.

J S Hardman

South Wales and West of England

Although lectures have been arranged at various venues the attendances have been extremely poor, all efforts that have been made by the branch committee having had little or no effect.

The Annual General Meeting was held in Cardiff on the 26 April 1989. However, few members found the time to attend this important meeting.

As usual, the highlight of the year was the Idris Jones Memorial Lecture. The sixteenth lecture entitled "Trends in Energy Consumption and Non-Ferrous Extractive Metallurgy and the Effect of Metals Recycling" was given by John F Castle, of RTZ Consultants Ltd, on 5 July 1989 at Ashton Court Mansion, Bristol. The generous support of RTZ Consultants Ltd was appreciated by all who attended this function.

The first lecture of the 1989-90 session was held at the University of Exeter on the 24 October 1989. An interesting and informative paper "Coal Combustion in Fluidised Beds" was presented by Mr Ian Summerfield of the CRE, Stoke Orchard.

A joint meeting, with the Institution of Chemical Engineers, was held at the Polytechnic of Wales on the 12 December 1989. Mr A Mercer, ETSU described "Novel Technology for Energy Efficiency in the Process Industries".

On the 14 February 1990 a "Young Persons Papers Evening" was held at the University of Bath. The prize for an undergraduate was awarded to a student from the University of Bath, whilst the post-graduate prize was gained by a research student from the Polytechnic of Wales.

Mr Roger Martin arranged a works visit to the BP LPG Facility, Avonmouth on Wednesday, 14 March 1990. The section wish to offer their thanks to Mr Martin for arranging this visit.

Members are invited to contact the chairman or vice-chairman should they have either suggestions for forthcoming events or comments about branch activities.

Finally, I would like to thank both the committee themselves for their support over the last two years and those few but dedicated members who continue to support the activities of this branch.

L Lee

Yorkshire

One of our main topics for the year has been "The Future of the Institute". Our discussions both in committee meetings and in an open meeting, have been very wide ranging. They have demonstrated that there is considerable depth of feeling amongst the Yorkshire Branch members for their energy interests to continue to be represented by the Institute of Energy, ideally as a separate body, but if that does not prove possible, then as a separately identified group of another body. The attendance and active participation at our open meeting in September to discuss this subject was encouraging, and enabled a significant feedback to be given to the Council.

The wide range of topics for our technical lectures have also indicated a forward looking theme, with Mr C E Pugh, during his term as President, giving us a well attended lecture on "Nuclear Energy — Critical for Britain's Future". This continued the tradition of holding our technical meetings at a variety of venues in the region, but always including Leeds and Sheffield Universities, as one means of continuing the strong links that have been maintained with them over many years.

Two visits were held in February and April to the Yorkshire Mining Museum at Caphouse Colliery, Wakefield and to Longley Farm, near Huddersfield, to visit the wind generator installation and hear a presentation on "Alternative Energy — Blowing in the Wind" given by Mr Joseph Dickinson. Both visits were very well supported and probably point the way to future similar functions.

Our annual joint meeting with the Institute of Petroleum was held in Leeds and a reasonable size joint audience heard details of "Coal Liquefaction — Bridging the Gulf in the 21st Century" by Mr G Kimber, Technical Manager of the Point of Ayr plant.

The annual dinner dance was again held at the Cairn Hotel in Harrogate, and a most enjoyable evening was spent, attended by our President and 200 members, their wives and guests.

At the AGM in April I was able to thank Malcolm Pittwood for his enthusiastic year as Chairman, knowing that it would be difficult to follow. This it certainly has been, but thanks to regular attendances at our committee meetings by many officers and committee members, at last I've been able to delegate some of the year's tasks! My thanks are due to all who have assisted me during the year.

In October we had a talk and site visit at Eggborough Power Station on "Recent Developments in Flue Gas Desulphurisation and Low NO_X". This proved to be a large subject for one session, but thanks to the concise presentation by Mr David Penfold of National Power, we were brought up to date with the current, rapidly changing, scene.

At our annual dinner, held once again at Barnsley, Mr G T B Camsey of National Power was the guest speaker. The attendance was a record in recent years for the event and contributed to our theme of the Institute providing a forum for the "meeting of minds" involved with energy matters.

Our final technical meeting of 1989 was held at Sheffield University and was given by Mr D Lowe of British Coal on the subject of "Small Power Generation".

Overall, 1989 has been a reasonably satisfactory year, with attendances at lectures being better than in the recent past. If the wide range of topics and the choice of venues have helped then these points will certainly be considered in preparing future programmes. Finally, I would urge all Yorkshire Branch members to attend at least one meeting per year, where a warm welcome awaits you.

P J Spencer

Obituary

The following deaths were recorded in *Energy World* during 1989-90:

T Butler (*Member*) December 1989

Dr D T Davies (*Senior Fellow*) 21 May 1989

W C Hankins (*Fellow*) 20 February 1989

D H Johns (*Member*) 7 July 1989

R H Thompson (*Member*) 6 April 1989

L G Webb (*Member*) 24 June 1989

Branch Committees

East Midlands

P Lynd-Evans *Chairman*
D C Rushworth *Hon Vice Chairman*
N M Potter PhD *Hon Vice Chairman*
B A Chamberlain *Vice Chairman Descending*
M A Read *Vice Chairman Ascending*
C Ellis *Hon Secretary*
M J Allen *Hon Assistant Secretary*
B J Pearcey *Hon Treasurer*
V I Hanby PhD *Hon Education Officer*
D Eastwood *ECRO Representative*
I Bagworth
P R Beal
B Birtles
P Bonham
T Fretwell
A F M Hallam
R J Hemmings
D G Kingerley
P Tate
R K Thorley
D A Whetton
B Williams

London and Home Counties

G A Jones *Chairman*
N Rigby *Secretary*
E J Bell *Treasurer*
M Paliga *Assistant Secretary/Meetings Secretary*
L J Jones *Visits Secretary*
K A Galloway *Academic Liaison*
N A Smith *Members Secretary*
A E B Kearsey *Regional Affairs*
P H Johnson
L A N Tozer
I M Vince
S D Fawkes
I Boustead
S D Probert

Midland

E F B Croft *Chairman*
A H Bridge *ECRO Rep*
A W T Cleaver *Ex-officio*
C S Elliot
D E A Evans
H Freeman
R A Freeman
N Fricker PhD *ex-officio*
L Green *Hon Secretary*
K B Hill *Hon Social Secretary*
J D Kirby
S McMaster
J Masters *Past Chairman*
J E Mosley
M R Palmer PhD
C Postins *I Eng Rep*
Dr R G Temple PhD *Educational Rep*
R Wainwright *Hon Treasurer*
R J Webb

North Eastern

A W Coles *Chairman*
W R Story *Vice Chairman*
G McIntosh *Vice Chairman*
C R Howarth *Hon Treasurer*
A W Laws *Hon Social Secretary*
D N Gwyther *Education Officer*
L J Clarke *Hon Member*
Prof I Fells *Hon Member*
W E Bouch *Hon Member*
A W Cox PhD *Hon Secretary/Public Relations Officer*

Northern Ireland

W Swindells *Chairman*
C J Monaghan *Honorary Secretary*
R Stewart *Honorary Treasurer*
F R McBride
E Spratt
P Huggins
J McDonald
D Raymond
R Hobson
H Wright

North Western

J G Odgers *Chairman*
P Cull *Senior Vice Chairman*
G Lyne *Junior Vice Chairman*
D Callandar *Hon Secretary*
E Curd *Hon Programme Secretary*
N E Connor *Treasurer*
J O'Connell
B N Bradley
J Davies
W N Lindley
J D Mason
G Ward
D Unsworth
P Wilkinson

Merseyside sub-branch

D G Connell *Chairman*
E F Curd *Hon Secretary*

Scottish

R McElroy *Chairman*
J McColl *Vice Chairman/Honorary Sec*
J D Hoyle *Retiring Chairman*
B Coll *Honorary Treasurer*
R H H Wood *Social Secretary & PRO*
Committee Members
W S Bannister
T Crampton
H Crooks
I Forrest
A L Hannah
G Howes
J Jamieson
R Wilkie

South Coast

M E Horsley PhD
M R I Purvis PhD *Hon Secretary*
J S Hardman PhD *Chairman & Treasurer*
G Orme *EC Rep*
B Chojnowski *EC Rep*
R A Coldicott
W Reynolds
S M Taulbut
M J Webb
A Whitehead
A Youle PhD
J Bartlam
G R Hazell
C R E Hillyer

South Wales and West of England

L Lee *Chairman*
J D Suthers *Senior Vice Chairman*
H J Hibberd *Junior Vice Chairman*
G B Spiller *Hon Secretary*
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A T Rogers *Past Chairman*
S A McGregor PhD *Asst Hon Secretary*
M Biffin PhD *Asst Hon Treasurer**
S Ashcroft PhD*
J T Edmunson PhD
R Martin
C Davies PhD
T David*
A Hughes
J A Carter *ECRO South West Representative*
P Jenner *Incorporated Engineer Representative*

Yorkshire

P J Spencer *Chairman*
W L Evans *Vice-Chairman & Hon Social Secretary*
A Mallalieu *Hon Secretary*
M B Pittwood *Immediate Past Chairman & Hon Treasurer*
H Etherington *Hon Education Secretary*
P T Williams *Hon Publicity Officer*
G Williams *ERCO Representative*
S Benson *Benevolent Fund Secretary*
P Aveyard
M J Broadhead
M G Burbage-Atter
P J Foster PhD
W A Gray PhD
D Merrick PhD
K Speakman PhD
J L Gilbert
W Stockdale PhD
G H Thompson
C H Russell *Co-opted Graduate Member*
S Mantell & J Bourchier *Co-opted Student Members*
A B Hedley
Prof J Swithenbank
Prof A Williams *Ex-officio Members*

India

S B Sarkar *Chairman*
B Acherjee PhD *Hon Secretary*

New Zealand

B Jones *Chairman*
C E Davies PhD *Hon Secretary*

South Africa

C M Eleftheriades *Chairman*
R A Stephenson *Hon Secretary*

USA

R G Jenkins *Chairman*
F Derbyshire *Hon Secretary*

Awards

Melchett Medal	To: Dr David Lindley (Managing Director, Wind Energy Group Ltd)	The award is made without restriction as to nationality or to membership of the Institute of Energy for outstanding work, whether in research, administration, construction or other professional activity involving the scientific preparation or use of fuel, the results of which have recently been made available to the community.
Recognition of Services	To: W N Lindley N G Worley	Award for special services to the Institute of Energy.
R H Gummer Exhibition 1988 *(thirty-fourth award)*	To: L Lindskog	The award is made annually to a student nominated by Imperial College of Science and Technology for work at undergraduate or postgraduate level, in energy technology.
Foxwell Memorial Award *(twenty-eighth award)*	To: Miss L Mansur (University of Leeds) Jing Cao (University of Sheffield)	The award is made annually to one student nominated by the University of Leeds and one student nominated by the University of Sheffield for work at undergraduate or postgraduate level, in energy technology.
Foster Wheeler Award of Institute of Energy *(seventh award)*	To: A Lyngfelt and B Leckner for their paper *Sulphur Capture in Fluidised-Bed Combustors — Temperature Dependence and Lime Conversion*	The award, sponsored by Foster Wheeler Power Products, is made for the best paper published by the Institute of Energy in the year under review, contributing to the increase in knowledge of combustion, or benefiting combustion and/or its associated technology.
Lubbock-Sambrook Award 1989	To: M J Pegg for his paper *Pilot-scale combustion tests: a comparison of heavy fuels and coal-water mixtures* (JInstE September 1989)	The award is made for the best paper on liquid fuels from whatever source, published by the Institute of Energy in the year under review.
Steetley Award of the Institute of Energy	To: T M Lowes and L P Evans for their paper *Optimisation of the design and operation of coal flames in cement kilns* (JInstE December 1989)	The award is made for the best paper on an energy conservation subject, published by the Institute of Energy in the year under review.
Townend-BCURA Award *(fifth award)*	To: E Hampartsoumian, M Pourkashanian and A Williams for their paper *Combustion rates and carbonaceous residues* (JInstE March 1989)	The award is made for the best paper on the subject of production, distribution and utilisation of coal, published by the Institute of Energy in the year under review.
Babcock Power Award of the Institute of Energy *(sixth award)*	To: F R Stewart and D N Trivic for their paper *An assessment of particle radiation in a pulverised coal fired boiler* (JInstE September 1989)	The award is made for the best fundamental scientific paper published in the *Journal of the Institute of Energy* in the year under review.
The J Sainsbury Prize at the University of Surrey	To: G N Sheppard	The prize is awarded annually to a student nominated by the University of Surrey and selected as achieving the best all round performance based on course work, examinations and project in the MSc Energy Engineering degree course.
The J Sainsbury Prize at the South Bank Polytechnic	To: Not available at time of going to press	The prize is awarded annually to a student nominated by the South Bank Polytechnic and selected as achieving the best all round performance based on course work, examinations and project in the MSc Environmental Engineering degree course.
The Kodak Ltd Student Prize	To: J R Gibbins	The prize is awarded annually to a student nominated by Imperial College making the greatest contribution to efficient energy utilisation through his/her project or research activity on an undergraduate or postgraduate course of study.
The Shell Petroleum Co Ltd Student Prize	To: E P L Roberts	The prize is awarded annually to a student nominated by the University of Cambridge and selected as the best first year student on a research programme associated with an energy related topic.
The Hamworthy Combustion Systems Ltd Student Prize	To: A Dance	The prize is awarded annually to a student nominated by Portsmouth Polytechnic on the basis of presenting the best final year project report in an energy related topic on one of the BEng Mechanical Engineering, BEng Engineering and Engineering Systems or BEng Manufacturing Systems Engineering courses.

The Institute of Energy

Incorporated by Royal Charter

Balance Sheet as at 31 December 1989

	Notes	1989 £	£	1988 £	£
Fixed assets	1	37 614		51 323	
Investments	2	324 699		322 520	
Institute Award Funds	11	45 032	407 345	35 462	409 305
Current Assets					
Debtors and prepayments		25 585		19 134	
Bank and cash balances		130 367		187 044	
		155 952		206 178	
Less: Current Liabilities					
Subscriptions received in advance		59 395		105 397	
Creditors and accrued charges		35 491		54 373	
Due to Institute Award Funds	11	39 618		30 048	
		134 504		189 818	
Excess of Current Assets over Current Liabilities			21 448		16 360
			428 793		425 665
Less: Liabilities due after one year					
Lease obligations			4 957		5 714
			£423 836		£419 951
Represented by					
Accumulated Fund			378 804		384 489
Institute Award Funds	11		45 032		35 462
			£423 836		£419 951

Approved by:
Prof B J Brinkworth *President*
P C Warner *Honorary Treasurer*
28 March 1990

Accumulated fund
Income and Expenditure Account for the year ended 31 December 1989

	Notes	1989 £	1988 £
INCOME			
Subscriptions		215 280	206 831
Engineering Council fees		21 104	19 875
Other fee income		26 785	17 950
Royalties – FACTs		2 932	3 606
Conferences – net surplus	3	15 955	20 381
Publications – net (deficit) surplus	4	5 107	(7 390)
Interest and investment income	5	36 755	33 272
Rating grant		–	580
Rental income		24 000	16 635
Other miscellaneous receipts		6 336	5 508
		354 254	317 248
EXPENDITURE			
Salaries and related staff costs	6	193 940	170 372
Accommodation	7	12 558	13 135
General communication	8	51 757	61 406
Professional expenses	9	9 004	9 292
Registration fees to Engineering Council		23 551	19 874
Branches and overseas committees	10	13 721	11 137
General expenses		27 222	35 686
Computer expenses		2 733	7 465
Finance charges		4 048	4 834
Equipment, furniture and building repairs		10 637	7 098
		349 171	340 299
SURPLUS (DEFICIT) OF OPERATING INCOME OVER OPERATING EXPENDITURE		5 083	(23 051)
Surplus on sale of investments (reinvested)		9 232	48 632
SURPLUS OF TOTAL INCOME OVER TOTAL EXPENDITURE		14 315	25 581
Accumulated Fund			
Balance brought forward		384 489	358 908
less transfer to development fund	12	(20,000)	–
Balance carried forward		£378 804	£384 489

Accounting policies

(1) Accounting Convention
The accounts are prepared under the historical cost convention.

(2) Income
a) Subscription and conference income is included in the year of receipt, except that income relating to future years is taken into the year to which it relates, net of irrecoverable amounts.
b) Royalty, advertising, rental and investment income is included in the year to which it relates.
c) Publication income and other income is included in the year of receipt.
d) Other fee income includes amounts receivable from outside bodies by way of contribution to office facilities provided by the Institute.

(3) Fixed Assets and Depreciation
Fixed assets are stated at cost less accumulated depreciation. The cost of leasehold property is depreciated evenly over the term of the lease (expiring in 2009) and does not represent the current market value. The fixtures and fittings are depreciated on a straight line basis over their estimated useful lives at the following rates:
Fixtures and Fittings 10%, Electrical Equipment 25%

(4) Investments
Investments are stated at the lower of cost and current market value. Where applicable, current market value is calculated on a portfolio basis. Profits and losses on disposal are taken direct to Accumulated Fund or Institute Award Funds as appropriate. Investment income is taken direct to the appropriate fund. Proceeds from sales of investments have been reinvested by Singer and Friedlander Investment Management Limited on behalf of the Institute and included in the portfolio of investments.

(5) Branches
These accounts incorporate the expenditure of regional branches and their funds at 31 December. Funds generated by the branches themselves from their other activities are not included in the accounts.

(6) Finance Leases
Assets held under finance leases and the related lease obligations are recorded in the balance sheet at the fair value of the leased assets at the inception of the leases. The excess of the lease payments over the recorded lease obligations is treated as a finance charge and amortised over each lease term to give a constant rate of charge on the remaining balance of the obligation.

(7) Building Maintenance and Dilapidations
In view of the length of the unexpired leases the Institute believes it has sufficient accumulated fund to meet unforeseen maintenance of the building and to cover its liability for dilapidations under the terms of its lease having regard to the date of expiry of the lease and current property value. The position will be kept under annual review.

(8) Development Fund
Certain expenditure of a developmental nature is where so authorised by the Council disbursed from this fund which is funded by transfer from the Accumulated Fund.

Statement of Source and Application of Funds for the year ended 31 December 1989

	1989 £	£	1988 £	£
SOURCE OF FUNDS				
Operating surplus/deficits for the year		5 083		(23 051)
Adjustment for items not involving the movement of funds:				
Depreciation	15 655		19 633	
Profit on disposal of tangible fixed assets	–		(365)	
Transfer to development fund	(20,000)		–	
		(4 345)		19 268
TOTAL GENERATED (ABSORBED) BY OPERATIONS		738		(3 783)
FUNDS FROM OTHER SOURCES				
Sale of tangible fixed assets	–		365	
Sale of investments	136 719	136 719	344 508	344 873
APPLICATION OF FUNDS				
Purchase of tangible fixed assets	(1 946)		(46 016)	
Purchase of investments	(129 666)		(306 310)	
		(131 612)		(352 326)
		£(5 845)		£(11 236)
INCREASE/(DECREASE) IN WORKING CAPITAL				
Debtors	6 451		(11 502)	
Subscriptions received in advance	46 002		(42 232)	
Creditors	19 639		(24 992)	
Institute Award Funds	(9 570)	62 522	(10 098)	(88 824)
Increase/(decrease) in net liquid funds:				
Bank and cash balances		(56 677)		77 588
		£5 845		£(11 236)

Notes to the Accounts

1 Fixed Assets

	Total £	*Leasehold Property* £	*Fixtures Fittings & Equipment* £
Cost			
At 1 January 1989	130 128	23 460	106 668
Additions	1 946	–	1 946
At 31 December 1989	£132 074	£23 460	£108 614
Depreciation			
At 1 January 1989	78 805	15 793	63 012
Charge for the year	15 655	384	15 271
At 31 December 1989	£94 460	£16 177	£78 283
Net book values			
At 31 December 1989	£37 614	£7 283	£30 331
At 31 December 1988	£51 323	£7 667	£43 656

Included in the net book value of fixtures, fittings and equipment are assets held under finance leases with a net book value of £3 410 on which depreciation of £1 750 was charged in the year.

2 Investments

	1989 £	1988 £
At cost	£324 699	£322 520
Market value	407 478	£334 845

Investments are held by the investment managers, Singer and Friedlander Investment Management Limited, registered in the name of their nominees. Investments relating to the Award Funds are dealt with under Note *11*.

3 Conferences

	Income £	*Expenditure* £	*Surplus/(Deficit)* £
1989			
Applied Energy Research	10 170	10 502	(332)
Power Plant Exhibition	–	44	(44)
British Coal Privatisation fission or fusion	22 146	16 734	5 412
The Generation Gap	16 316	6 725	9 591
Previous years conferences	–	1 720	(1 720)
Branch conferences	–	286	(286)
Industrial Energy Management	–	283	(283)
Misc. conferences expenditure	–	347	(347)
Post conference proceedings sales	3 964	–	3 964
	£52 596	£36 641	£15 955
1988			
Gasification – status and prospects	29 197	20 853	8 344
Fluidised combustion in practice – clean, versatile, economic	31 078	21 233	9 845
NO_x generation and control in boiler and furnace plant	3 445	2 936	509
Energy efficiency in buildings	3 365	2 224	1 141
National energy managers exhibition	–	438	(438)
Post conference fees 1987	980	–	980
	£68 065	£47 684	£20 381

4 Publications

	1989 £	1988 £
Income		
Publications sales	7 684	8 635
Journal subscriptions	62 981	63 151
Advertising	7 499	4 824
Energy for the future	–	1 157
	£78 164	£77 767
Direct expenses		
Printers' charges	57 793	64 163
Advertising expenses	829	1 191
Postage	14 435	18 183
Energy for the future	–	1 620
	73 057	£85 157

5 Interest and Investment Income

	1989 £	1988 £
Bank deposit interest (Gross)	13 020	6 368
Investment income (Gross)	23 735	26 904
	£36 755	£33 272

6 Salaries and Related Staff Costs

	1989 £	1988 £
Salaries and National Insurance	175 073	154 962
Superannuation	18 192	14 812
Luncheon Vouchers	675	598
	£193 940	£170 372

7 Accommodation

	1989 £	1988 £
Rent and rates	7 138	6 837
Lighting and heating	2 907	3 023
Depreciation of fixtures, fittings and leasehold property	2 513	3 275
	£12 558	£13 135

8 **General Communication**

	1989	1988
	£	£
Printing and stationery	7 611	14 912
Postage and telephone	12 224	13 771
Travelling and subsistence	18 780	16 365
Depreciation of communication equipment	13 142	16 358
	£51 757	£61 406

9 **Professional Expenses**

	1989	1988
	£	£
Audit fees	5 500	4 500
Investment management services	2 054	1 981
Other professional services	1 450	2 811
	£9 004	£9 292

10 **Branches and Overseas Committee Expenses**

	1989	1988
	£	£
North Western	817	1 846
East Midlands	846	428
Midland	1 927	992
North Eastern	624	639
Yorkshire	1 489	840
Scottish	1 415	1 141
South Wales and West of England	837	759
South Coast	836	481
London and Home Counties	4 389	3 389
Northern Ireland	392	622
New Zealand	149	–
	£13 721	£11 137

11 **Institute Award Funds**

	Total	*Foxwell Memorial*	*Gummer Exhibition*	*R H Thring Award*	*Lubbock Sambrook Award*	*Roscoe Bequest*	*The Townend & BCURA Award*	*British Steel Award*	*Shell Award*
	£	£	£	£	£	£	£	£	£
Movement of funds									
Balance at 1 January 1989	35 462	12 394	5 670	1 098	1 675	5 711	983	5 075	2 856
Donations received	5 125	–	–	–	–	–	125	–	5 000
Interest and investment income	4 395	1 814	828	118	170	514	88	456	407
Prior year adjustments	2 300	–	–	–	–	(200)	–	–	2 500
	47 282	14 208	6 498	1 216	1 845	6 025	1 196	5 531	10 763
Less: Awards	2 250	500	250	–	250	250	250	500	–
Balance of funds at 31 December 1989	£45 032	£13 708	£6 248	£1 216	£1 595	£5 775	£946	£5 031	£10 513
Represented by:									
Investments at cost	5 414	3 263	1 435	236	480	–	–	–	–
Due from the Institute	39 618	10 445	4 813	980	1 115	5 775	946	5 031	10 513
Total net assets as shown in Institute's Balance Sheet	£45 032	£13 708	£6 248	£1 216	£1 595	£5 775	£946	£5 031	£10 513

The Melchett Medal was transferred to, and the Award is now wholly funded from, the Accumulated Fund. Investments are held by investment managers, Singer and Friedlander Investment Management Limited. The market value of investments held at 31 December 1989 was £26 541 (1988: £15 319). There is no fund for the Steetley, Babcock Power, Foster Wheeler and Sainsbury Awards. The sums received for those Awards are paid out to the prize winners concerned. Where awards anticipated in the previous year were not, in the event, made and vice versa the amounts involved are shown as prior year adjustments.

12 **Development Fund**

	£
Transfer from Accumulated Fund	20,000
Expenditure on conference organiser	(20,000)
Balance at 31.12.89	£ –

Auditors' Report

We have audited the accounts set out on pages XIII to XV in accordance with approved Auditing Standards.

In our opinion these accounts give a true and fair view of the state of affairs of the Institute as at 31 December 1989 and of the surplus of income over expenditure for the year then ended.

Lawford & Co
Chartered Accountants

6 Martin Lane
Cannon Street
LONDON
EC4R 0DP

28 March 1990

The Institute of Energy Benevolent Fund
Annual Report and Accounts 1989

Balance Sheet as at 31 December 1989

	1989 £	1988 £
INVESTMENTS		
National Savings Deposit Bonds	10 375	9 394
Other investments	21 231	8 888
CURRENT ASSETS		
Debtors	–	173
Due from the Institute of Energy	305	258
Cash on deposit	404	9 318
Cash on bank current account	3 226	5 106
	£35 541	£33 137
Represented by:		
CAPITAL ACCOUNT		
Balance at 1 January 1989	33 137	33 522
Surplus (Deficit) for the year	2 404	(385)
Balance at 31 December 1989	£35 541	£33 137

Income and Expenditure Account for the year ended 31 December 1989

	1989 £	1988 £
INCOME		
Subscriptions and donations	908	931
Profit on sale of ties and shields	7	22
Profit on sale of investments	–	15
Deposit interest and investment income	1 964	2 013
	2 879	2 981
EXPENDITURE		
Printing, stationery and postage	176	110
Assistance rendered – members	1 411	1 099
Assistance rendered – students	230	482
Investment management fees	190	143
	2 007	1 834
Surplus of operating income over operating expenditure	872	1 147
Provision for diminution in value of investments written back (1988 provided)	1 532	(1 532)
SURPLUS/(DEFICIT) FOR THE YEAR	£2 404	£(385)

ACCOUNTING POLICIES

(1) Accounting Convention
These accounts have been prepared under the historical cost convention.

(2) Income
All income is included in the year of receipt.

(3) Investments
Investments are stated at the lower of cost and current market value. Investments are held by the investment managers, Singer and Friedlander Investment Management Limited, registered in the name of their nominees.

P C Warner
Honorary Treasurer

28 March 1990

Report of the Auditors to the Management Committee of the Institute of Energy Benevolent Fund

We have audited the accounts set out on this page in accordance with approved Auditing Standards.

In our opinion these accounts give a true and fair view of the disposition of the Fund as at 31 December 1989 and of the surplus of income over expenditure for the year then ended.

Lawford & Co
Chartered Accountants

6 Martin Lane
Cannon Street
LONDON
EC4R 0DP

28 March 1990

Report of the president

In 1988 Mr C E Pugh, as President, sent a letter to retired members. The response overwhelmed our administrative system but it did highlight the interest and good will of retired members to the Institute.

This year I wrote to retired members in the United Kingdom encouraging them to attend Branch functions, wherever possible, or to meet together in an informal way. The response to this has shown up the many interesting activities of retired members and has enabled old friends to meet up again. The activity and longevity of many members was astounding — but there still could be those less fortunate in their health or financial state with whom we have lost contact and the help of all members to provide companionship and support would be most welcome.

It has been possible to provide more help to individuals this year than has previously been the case and it is possible that more active contact with retired members could increase the calls onf the fund.

As the fund is quite small, the subscriptions and donations are received with gratitude if it is to be active and provide genuine help.

B J BRINKWORTH
President