ENERGY WORLD

The magazine of The Institute of Energy

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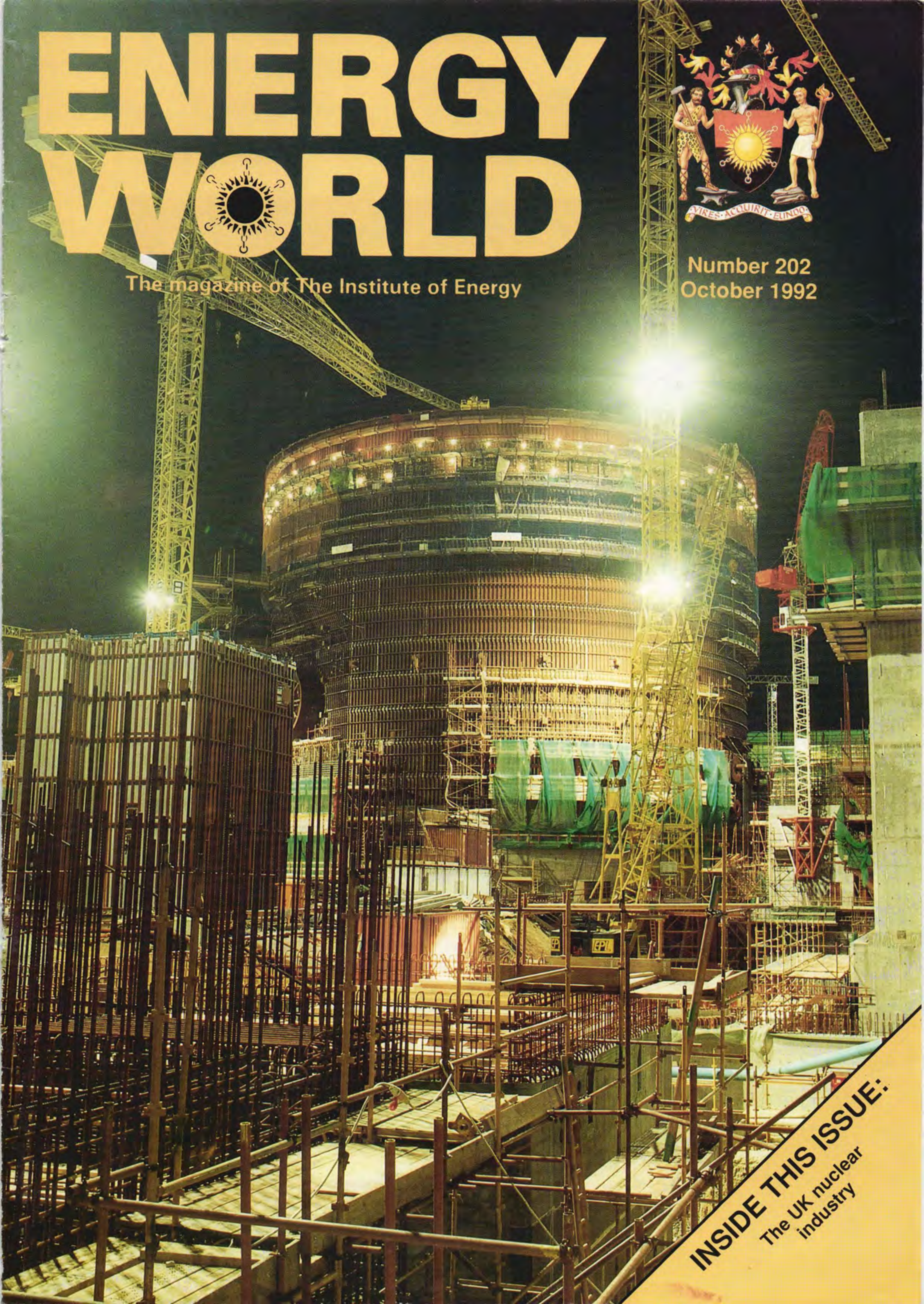

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The UK nuclear industry

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OCTOBER 1992 **Number 202**

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COVER

The front cover this month shows a view of Sizewell 'B' during its earlier construction period. For news of the latest progress at the site, turn to page 8 for a comprehensive update.

Photograph courtesy of Nuclear Electric plc.

Power to the big industries

BRITAIN'S largest electricity users — 160 major industries and public bodies— have asked the European Energy Commissioner to intervene in the way energy prices are determined in this country. They have called for a ruling that the pricing system is uncompetitive and leads to inflated electricity charges. The Major Energy Users Council says that the 15-year contracts being given to some of the new gas-fired power stations preclude competition and freeze out cheaper alternatives as well as permanently damaging the prospects of the British coal industry. The problem springs from the unique history of power generation in Britain.

Electricity supply in Britain was publicly owned for 40 years and in that time produced a unique definition of what was fair pricing policy. Every unit produced was deemed to have the same cost as every other unit produced at the same time and should therefore be sold to customers at the same price, no matter whether the power was used to smelt steel or provide the toast for breakfast: prices were determined by cost and not the market, a definition enshrined when power was privatised.

But in Europe things were different. After the 1979 energy crisis other governments protected their basic industries from third country competition by means of long-term power contractc which did not pass the full effects of price increases to big process users of electricity.

In Britain, the effects were to some extent ameliorated by the intervention of British Coal, who negotiated contracts with the generators which dedicated tonnages of cheap coal to be made into electricity specifically for consumption by the big processing users. But privatisation put an end to that arrangement: competition was to do the job instead. Sadly, however, the new independent competitive generators have proved to be neither competitive nor independent.

The truth about electricity is that although it is a standard product, its range of end-use values is infinite: a tiny amount of power consumed by a computer can add almost unlimited value to an end product, yet it takes massive quantities of electricity to produce relatively low-value bulk commodities like chlorine.

Should the rules be changed now to help ailing heavy industries? The opportunity to do so is here in the re-negotiation of wholesale prices for electricity. Some may say that the decline in British heavy industry is inevitable and will lead to their final closure, so why bother? But it would be the height of folly to assume that even if the basic capacity is closed down we can still hold on to the high margin downstream businesses that depend on those raw materials. When any basic process is allowed to migrate overseas, in the long run the dependent activities inexorably follow.

The rules that define fairness in power pricing urgently require change and only the Government can do that. Politicians seem convinced that to reduce industrial power prices domestic electricity must go up, and that is where every voter in the country has a say. But with the whole energy tariff in the melting pot there is a unique window of opportunity to help British industry reach a more level playing field with their European competitors without damaging the interests of the all-important domestic consumer.

The simplest and probably most effective act would be to relieve the big users of the cost of the nuclear levy. This stands at the moment at 11% on the cost of every unit sold. If by relieving big consumers of the burden of 11% of the cost of the essential item that in many cases represents as much as half of their running costs, the Government might save itself the horrendous costs incurred when major businesses are forced into extinction. If such large industries are allowed to go to the wall, the already chronic over-capacity of power stations and coal mines in Britain will be made even worse. It would make economic sense if the generation of electricity and the coal were charged at bare variable cost and not have to carry a 'proper' share of all those industries' overheads.

What has to be faced is an issue of principle. Would tipping the balance of allocated costs more in the favour of industry — as it is our competitor countries — be so outrageously unpopular as to send politicians running for cover? With our present window of opportunity, probably not. All UK electricity prices could fall by up to 10% with the likely cut in British coal prices. There is an unprecedented opportunity to unravel the tangle of electricity markets and bring in some new rules which are market and not cost based.

The conflict over volume and price which has marked the negotiations between generators and regional electricity companies cries out for a system of tranched volumes at a range of prices reflecting the values electricity has in its wide variety of markets.

Despite their reluctance, the Government may have to become once again accountable to Parliament for the electricity business. The issues are so great and result so much from the Government's own rules that no one would criticise it for acting to straighten out these fundamental problems. Criticism would be far greater if matters were left to ride.

Malcolm Edwards *(Companion)*
Edwards Energy Ltd

Opportunities for UK businesses in India

TRADE and Technology Minister, Edward Leigh, visited India in September to promote opportunities for UK companies.

India is currently undergoing a multi-billion pound economic restructuring. "The next two years will see a major investment in new technologies to restructure the Indian economy into a significant world trading force in the early part of the next century," said Mr Leigh. "This offers a tremendous opportunity for Britain to play a key role. We have long established trade links, with increased trade in both directions this year."

Energy from waste down under

AUSTRALIAN landfill gas is set to produce electricity for hundreds of home in the Melbourne area, following the results of an environmental study.

Proposals have been submitted to build two 10 MW power stations, the largest of their kind in Australia, to generate electricity from landfill gas. System installation should begin later this year, with commissioning in the summer of 1993, if the plans are accepted.

The scheme is the third of its kind in the Melbourne area, the others being a multi-engine project, recently commissioned in the north west suburbs of the City of Sunshine, and a smaller scheme currently nearing completion in the City of Berwick.

Dr Berwick Manley, director of Environmental Resources Ltd, who carried out the study, said:"While as yet there are no formal safety guidelines in Australia for landfill gas power stations, we are complying with those soon to be laid down in the UK by the Department of the Environment, OFGAS and the Energy Technology Support

From oil to aluminium in Bahrain

Natural gas-based combustion power plants and aluminium smelters are in many ways ideal partners, as well as being environmentally friendly. This plant in Bahrain is the result of the far-sighted Emir of Bahrain in 1968 chosing to switch direction from oil to aluminium. At the end of the 1980s the Bahrainis decided on a bold expansion of their smelting capacity, and the German company ABB Kraftwerke won the order to supply sufficient electricity for a total of 288 new electrolyte cells. Powered by two giant combination blocks, each equipped with three gas turbines and one steam turbine, the plant will be capable of a total output of 880 MW.

Czechs to use PFBC technology

THE CZECH utility Moravskoslezske Teplarny a.s. (MST) is to commission a combined heat and power (CHP) plant based on pressurised fluidised bed combustion (PFBC) technology.

The CHP plant will be sited near Ostrava, a city of 350 000 inhabitants, located 350 km east of Prague. It will serve the area with electricity and district heating, as well as supplying process steam to local industry.

The project is being financed by the Swedish Export Credit Corporation and the Nordic Investment Bank on the condition that repayment guarantees are given by the CSFR government. The contract for supply of the plant has gone to ABB Carbon.

The plant will replace a 45-year old facility, and will achieve a dramatic reduction in sulphur dioxide and nitrogen oxide emissions. It will supply around 60 MW of electricity, 100 MW of district heat and 10 MW of process steam. The introduction of PFBC technology also opens up the possibility of utilising coal ash for construction purposes.

The PFBC technology to be used in Czechoslovakia was pioneered in the UK and US. The first commercial plants are now in operation in Sweden, Spain and the US, with two plants under construction in Japan. Unfortunately UK generators have so far shown little interest in this clean coal technology, preferring to concentrate on environmentally friendly CCGT plant, a bias seen by many as rather short-sighted, given the comparative reserves of natural gas and coal in the UK.

Said an ABB spokesman: "This is an important breakthrough in Central Europe and further consolidatesthe market success of the PFBC technology (which is) now established in the major markets of the world."

Licensing round for Cuba

THE REPUBLIC of Cuba's oil exploration and production arm, Comercial Cupet, has announced its intention to hold the first round of licensing in Cuba. The round is part of Cuba's policy to attract foreign investment to its petroleum industry.

The announcement follows agreements already signed, or in negotiation with Total, Canada Northwest, Taurus and Petrobras.

The round will involve a minimum of eight exloration blocks, each with an area between 2000 and 6000 sq km. Cuba's present production comes from four onshore fields.

Comercial Cupet is preparing geological reports and technical data packages to assist companies evaluate opportunities. It is intended to hold international promotional presentations in London and Calgary in the near future. Full details of the applicable legislation, fiscal framework, model contract, bid procedures and schedules will be made available at these presentations.

Germany to privatise lignite and electricity

THE PRIVATISATION of the energy sector in Eastern Germany is one of the largest projects to be under by the Treuhandanstalt (THA). The THA appointed a management team in August to prepare the lignite and electricity industries for sale and to project manage their privatisation.

The aim is to privatise the two closely linked industries simultaneously whilst taking foreign investors into consideration. The THA believes that a market-led approach will increase long-term viability of lignite mining in Eastern Germany, safeguarding the maximum number of jobs and encouraging investment.

Price Waterhouse Corporate Finance Europe has been appointed external advisor.

New complex at ETSU

ENERGY Minister, Tim Eggar, opened a new complex to house staff of the Energy Technology Support Unit at Harwell in Oxfordshire in August.

Mr Eggar commented that the new complex would "enhance the centre's ability to carry out R & D into clean coal technology and all forms of renewable energy."

For the first time all 200 of ETSU's staff will be accomodated together, allowing the scientists and engineers greater space to work on innovative energy projects.

The new complex centres on three buildings just outside the security perimeter of the Harwell Laboratory. Space has been provided for a large lecture theatre and a permanent exhibition area to publicise the unit's work.

ETSU's current programme involves research into wind, wave, solar, geothermal, biofuels, hydro and tidal technology.

Rail freight grant in Wales

UNDERGROUND coal producer and subsidiary of the Ryan Group, Ryan Mining Ltd has been received a rail freight grant from the Welsh Office.

The grant supports Ryan's plans for a new rail terminal at Cwmgwrach in the Vale of Neath on the reinstated Neath Valley Rail Line, which has been out of commercial use for the last six years.

The terminal is a key feature in a project that Ryan hopes will create 600 jobs in the locality. It is being built to transport coal from local mines and it is anticipated that other coal operations will use it, relieving congested roads.

At Cwmgwrach the existing coal processing site will be redeveloped, landscaped and used for loading trains to transport coal.

The Ryan Group, the UK's largest private sector coal company, now sees itself in a strong position to participate in the Government's plans to privatise British Coal.

Unique power deal paves way for investment in UK

National Power's Eggborough power station.

A PIONEERING ten-year power agreement was signed in London at the end of August which should encourage two European industrial gas producers to build jointly their first air separation plant in the UK.

The £20 million project is to be developed alongside Eggborough power station in North Yorkshire, by a company called Air Gas Production Ltd — a joint venture between AGA Gas Ltd and Distillers MG Ltd, the UK subsidiaries of AGA AB of Sweden and Messer Griesheim GmbH of Germany.

The plant, with a 10 MW electrical load, will be supplied by National Power from a direct connection to the existing power station, avoiding the use of the local electricity system, with resultant capital and revenue cost savings.

The air separation plant will produce nitrogen, oxygen and argon. Electricity will account for a major part of production costs.

Under the agreement National Power will lease land at its Eggborough site, provide on-site services, including cooling water. The plant should be operational by the end of 1993.

Leaks abound, but no annoucement yet

VARIOUS leaks have indicated that the number of British Coal pits could fall from the current 48 to 12, or even fewer, a gloomier picture than was painted by the N M Rothschild report a year ago.

But despite the consistancy of the rumours, the coal contracts with the generators have yet to be announced, at the time of *Energy World* going to press.

The leaks were given greater credance by revealations in *The Guardian* newspaper that senior BC directors are understood to have approached the Treasury for increased resources to meet redundancy terms for sacked miners.

The new coal contracts with the generators are expected to require 40 million tonnes from British Coal in the first year, falling to 30 million thereafter, compared to the 65 million tonnes per annum supplied under the current contract.

Controversy is also raging around the EC RECHAR programme, set up to aid coal communities devastated by the closure of pits. *The Guardian* has reported the contents of a letter from an industry minister to the Treasury which reveal that the Treasury had blocked £38 million in RECHAR funds.

The Labour Party's industry spokesman, Derek Fatchett, has pointed out that £110 million has so far been refused, of which £19 million was earmarked for South Wales and the Midlands, £20 million for Yorkshire.

The money is the first tranche of the RECHAR programme. The UK Government's failure to pay out the money could jeopardise the country's chances of receiving the remaining £86 million designated to UK coalfields. Under the programme, which only releases portions of funding at a time, the further release of allocated funds can only proceed once the original allocation has been spent.

International Call for Papers

INTERNATIONAL SYMPOSIUM ON

COMBUSTION & EMISSIONS CONTROL

Cardiff, 21—22 September 1993

The Institute of Energy is pleased to announce a major International Symposium on Combustion and Emissions Control.

With ever stricter legislation, technologists need to strive continuously to improve the performance of combustion systems over their whole operating range. The conference will concentrate on the important topics listed below, the aim being to address them both from a practical and fundamental viewpoint so as to encourage dialogue between delegates in order to identify ways forward. A number of prestigious reviews will be given.

1 Low NOx burners for utility and industrial boilers
2 Combustion with vitiated air
3 Non-fossil fuel combustion
4 Developments in gas turbine combustors
5 High temperature processes — preheated air and O_2 emissions
6 Process intensification
7 Predictive methods for pollutant emissions

If you wish to submit a paper to this prestigious conference please submit an abstract by **Tuesday, 1 December** to the Conference Department, Institute of Energy, 18 Devonshire Street, London W1N 2AU.

Authors will be informed of the acceptance of their abstract by 10 January with full draft papers (5,000 words maximum) required for review by **31 March 1993**. Final versions of the paper on camera ready format will be required by **30 June**. The Institute will publish the proceedings in a bound volume.

The meeting will be for two days and will be of interest to industry, both process users and manufacturers, research workers, pollution control personnel and academia. It is intended that the meeting acts as a discussion catalyst between the various workers in the field.

Low cost accommodation will be available in a conveniently located University Hall of Residence. The event will be held on 21—22 September at the University of Wales, Cardiff.

For further information contact:

Conference Department, The Institute of Energy, 18 Devonshire Street, London W1N 2AU
Ph: 071-580 0008 Fax: 071-580 4420

Energy updates available

SOLICITORS Nabarro Nathanson have recently begun to publish a regular Energy and Natural Resources Bulletin.

Energy specialists, they have set up an Energy Group within the company, two of whose members, John Byrne and Mark Saunders, edit the Bulletin.

The Autumn 1992 issue deals with the EC Utilities Directive and the proposed carbon tax, amongst other pertinent subjects.

Nabarro Nathanson are happy to supply free copies to readers of *Energy World*. If you are interested please address your request to Nabarro Nathanson, Energy Group, 50 Stratton Street, London W1X 5FL.

CDTV as guide to visitors

NUCLEAR ELECTRIC are installing eight Commodore Amiga CDTVs in three of their plants: Wylfa in Anglesey, Trawsfynydd in North Wales and Heysham in Lancashire.

Using software developed by Distance Learning Systems, the machines will allow power station guides to show visitors both text and graphics. The CDTVs will be installed in the visitor centres at each power station, and in the viewing galleries which overlook the pile caps of the reactors.

Nicolas Mullane, Publicity Services Officer of Nuclear Electric, said: "We decided on CDTV for its reliability and cost. Previously our guides would use slides, prone to break down or become jammed. In addition the computer generated visuals improve the presentation of the information.

Nuclear Electric received 155 000 visitors at its 12 sites last year, and expects that figure to rise to around 250 000 this year. The CDTV will be considered for use at Nuclear Electric's remaining nine power stations.

Commodore believe their CDTV has many applications in the sphere of business.

Emission control for CHP plant

The air fuel ratio controller and catalyst under field trials at Cansfield School, Wigan.

A NEW computerised emission control system for gas engine combined heat and power (CHP) systems has been jointly developed by Combined Power Systems and British Gas (Midlands Research Station).

The environmental benefits of CHP have long been recognised and for some organisations the desire to be 'green' has become as important as the need to save money.

With the new computerised control system, CHP emissions can be successfully reduced to levels well below the world's most stringent regulations.

At the heart of the system is an 'intelligent' air to fuel ratio controller which continually modulates the gas pressure delivered to the fuel/air mixer in response to signals received from an oxygen sensor in the exhaust. This achieves very precise fuel/air ratio control within the narrow operating range in which a three way catalyst can efficiently convert exhaust pollutants to minimal levels.

The system and catalyst were put through an extensive 2400 hour field trial on a Combined Power Systems 75 kW CHP unit at Cansfield School in Wigan. Emissions were monitored monthly by the chemistry Division of BG's Midlands Research Station to assess long-term performanace of the controller in conjunction with the catalyst.

The results of the trial show that emissions can be reduced to levels well within the stringent limits set by the German TA Luft standard.

Trials of the new system are continuing and Combined Power Systems and British Gas expect to make it commercially available in the spring of 1993.

Explosions will improve safety

GAS explosions set off by a Cheshire research establishment will help to increase the safety of offshore oil and gas platforms.

The series of 12 explosions, the biggest of their kind, are the climax of a world-leading project by Shell's Thorton Research Centre, near Chester.

Close analysis will result in a hazard assessment model, SCOPE, capable of predicting the effects of gas explosions in large confined areas, such as offshore installations, more accuately than before.

This in turn will help designers to build in the best possible safety measures. The findings will also be useful for onshore installations such as liquid natural gas terminals, refineries and chemical plants.

Thornton Research Centre has already carried out 80 smaller explosions in a 2.4 cubic metre box to provide data for the £750 000 Shell Offshore Large Vented Explosion Project (SOLVEX).

However there is no substitute for the real thing, and the new explosions are in an open-ended steel box big enough to hold six container lorries.

Combustion and Hazard Research manager Dr David Bull explained: "The small-scale explosions we have carried out have enabled us to develop the computer model we need. But the only way to check that the model's predictions are correct is to take measurements of something much closer to full size."

The explosions took place during the summer near Buxton in Derbyshire, and were set off at dusk so that the resulting fireball can be filmed against a dark background. A high-speed video records the explosion at 500 frames per second.

Two key aspects of gas explosion were measured in the tests. First, to assess damage potential; second, the development and speed of the flame front.

The project is largely funded by Shell companies, with the principle co-sponsor being the Health & Safety Executive.

Obituary: Geoffrey Joseph Gollin: Past President

GEOFFREY JOSEPH GOLLIN died peacefully at his home on 11 August. He was 90 years of age.

After leaving Clifton he went to Gonville and Caius College, Cambridge when he took the Mechanical Science Tripos in 1923. After serving an apprenticeship with the Mersey Docks and Harbour Board and English Electric Co Ltd at Rugby, he joined the staff of Shell-Mex Ltd and worked with Isaac Lubbock in the Fuel Oil Technical Department which was transferred in 1930 to the Asiatic Petroleum Co Ltd (later Shell International Petroleum).

During World War II, he was engaged on work with Lubbock in connection with aero-gas turbines and liquid propellant rockets. The experimental work carried out at Chessington and Longhurst was an important milestone in the evolution of rocket power which, at the time, was 'Top Secret'. 'Lizzy', as the Shell rocket prototype was affectionately nicknamed, was the brainchild of Issac Lubbock. Subsequently a special corner was set aside at the Science Museum in South Kensington, illustrating Lubbock and Gollin's pioneering work on what is today accepted and utilised technology. During the war, Gollin was a member of the Anglo-American Scientific Mission sent to Poland via Russia to investigate the V2 rockets so devastatingly employed by our adversaries. To commemorate this work, he founded the Lubbock-Sambrook Award of the Institute of Energy.

On returning to civilian activities, he became manager of the Shell oil burner laboratories at Fulham. Later he was appointed Head of Technical Division, Fuel and Light Oils Department, Asiatic Petroleum Company and ultimately Technical Advisor, Oil Products Division, Shell International Petroleum Co Ltd; this latter position brought him into contact with many overseas leading fuel technologists.

During the post-war 'fuel crisis', there was a great demand by industry and he became heavily committed. Professor Thring, then actively engaged in liquid fuels utilisation for glass tanks and open hearth steel furnaces, began his work on a heat flow meter for measuring flame radiation. Gollin became very interested and they both were in at the beggining of the International Flame Radiation experiments on flame luminosity with a furnace, internationally funded in Holland. He was also a founder member of the British Committee. Among his many interesting activities during the fuel shortage period was the conversion to oil firing of the boilers at Windsor Castle, Buckingham Palace and the Houses of Parliament. He lectured and also contributed many articles for the technical press on oil burning equipment and its applications. His advice was frequently sought by many overseas industrialists and fuel technologists. Being a member of the Institution of Mechanical Engineers and a member of the Institution of Heating and Ventilating Engineers, it was not surprising when on retirement from Shell International in 1961, he undertook a number of consultancy projects. He was also appointed Honorary Lecturer in Liquid Fuels Combustion at Sheffield University.

After having served on many of the Institute of Fuel's committees, he was elected President in 1965. One day during his period of office, he received a phone call from the Secretary, Dr Roland Jackson, informing him that a member of the New Zealand branch and his daughter, on their way home from Africa, were stranded at Heathrow and in financial difficulties. As there was no provision within the Institute's constitution for assistance in such circumstances, Geoffrey Gollin arranged transport and accomodation at the RAC Country Club until suitable flight arrangements could be made; there was no cost to Institute funds. Subsequently Geoffrey Gollin founded the Institute's Benevolent Fund.

During his Presidency he made the significant statement that Council had made a formal request to the College of Heralds for a grant of arms. Agreement was required on the device that would appear on the arms, which had to be symbolic of the Institute's activities. In the event the Institute received the grants of arms from the College of Heralds in 1967 and the detailed plans for the original design submitted to the College were the work of Geoffrey Gollin. Again, at no cost to the Institute. His year of office was an outstanding success in every respect, in consequence he was unanimously elected to Honorary Fellowship. His continued interest in the Institute was such that he attended every AGM held in London, from 1945 to 1989; indeed a record for any past or present member!

The final gesture of his interest occurred two years ago, when he invited all 21 surviving Past Presidents to a luncheon party at the Royal Thames Yacht Club in Knightsbridge. 19 were able to accept what proved to be a most pleasant and memorable occasion.

His wide range of non-professional activities was so considerable that it is difficult to imagine how he found the time to accomodate them all. For over 40 years he played an active part in the Scout movement, ultimately becoming District Commissioner for Leatherhead. Although compelled to retire at the stipulated age limit, he retained an interest until his death.

He was a Past Master of the Worshipful Company of Gardeners, a Freeman of the City of London and a member of the Samuel Pepys Society. His knowledge of the history of the City of London was most profound. Having an extensive library and so well used, it was no surprise when he was invited to give a lecture on 'First Editions' at the Royal Institution. He was also a member of the Leatherhead Historical Society and after much research published a book on the history of Ashtead, where he lived. He was Chairman of the Board of Governors at Parsons Mead, a girl's public school in Ashtead; until his death he remained on the governing body.

Last week I received a letter from a member of the Institute who knew him well. Included was this statement: "He was by example an inspiration to us all. Ever uppermost in his mind was the welfare of others, a concern for the rightness of things and the maintenance of professional standards." Of his consideration for others, I illustrate but two of the many examples I could quote.

At the White House where he lived in Ashtead, Thursday was affectionately termed 'Old Bods day'. On that day every week for many years, Geoffrey and his wife Mary collected from surrounding areas a number of aged, infirm and lonely people for a day's hospitality and companionship at the Peace Memorial Hall in Ashtead.

About 15 years ago (he was then 75 years of age) on a freezing cold Sunday morning, I saw him cycling past my house with a tool bag on the carrier. It later transpired that the central heating boiler in an old people's home had cut-out and could not be restarted. A number of phone calls by the Warden failed to obtain any professional assistance. Geoffrey heard of this and cycled a distance of four miles to rectify the fault.

Our thoughts go out to Mary Gollin and family at this hour. His consideration for the welfare of others is an example to us all.

Leigh Hunt (1784-1859) wrote a famous poem entitled *Abou Ben Adhem*; it is so applicable to Geoffrey Gollin and his way of life that I can think of no more suitable epitaph than 'May his tribe increase.'

CAR

Sizewell 'B' — progress to date

by Eur Ing F John L Bindon

Until the Government review of nuclear power, due to take place in 1994, Sizewell 'B' in Suffolk is the only nuclear power station under construction in the UK. Nuclear expert Eur Ing Bindon reports here on its recent progress, in terms of design and construction, commenting that not only is the station ahead of schedule, it is also well within budget.

IN JANUARY 1981 the CEGB applied for consent under section two of the Electric Lighting Act, 1909, to build a pressurised water reactor (PWR) at Sizewell on the Suffolk coast, the site of an existing Magnox nuclear power station.

The Government set up a public inquiry under Sir Frank Layfield, which ran from 11 January 1983 until 7 March 1985. Its 345 'sitting days' constituted the longest ever public inquiry in Britain.

The final report was published in January 1987, when it was presented to the Secretary of State for Energy. The Minister gave his approval to the consent to build on 12 March 1987. A site licence was obtained by the CEGB on 4 June 1987 and preliminary work commenced some three weeks later, on 1 July 1987.

The whole project is committed to a 72 month construction programme (measured from the pouring of the first permanent structural concrete to the loading of the fuel). The target construction programme is shorter, some 63 months. The programme aims to load fuel into the reactor in November 1993 and to achieve full commercial output by May 1994.

Station design

The Sizewell 'B' station is based upon a proven design, a Westinghouse 4-loop PWR, with the station layout to an arrangement developed by the Bechtel Corporation for such power plants as Callaway in Missouri and the Wolf Creek PWR station in Kansas, USA. Interestingly, the Sizewell PWR will be the 165th nuclear reactor to be built worldwide using the basic Westinghouse design.

Changes have been made to meet the UK regulatory requirements, although none of these have impacted on the fundamental primary circuit technology in any appreciable manner or required further major development work.

An outline of the SNUPPS (Standarised Nuclear Unit for Power Plant Systems) power block is shown in figure 1 (overleaf). Here the shape and size incorporates a single 1200 MW, 1800 rpm turbine generator. This gives a comparatively narrow turbine hall and does not necessitate a spread of steam pipework as with a multi-turbine design, and therefore no mechanical annexe is required. The safeguard systems are designed on the basis of having two trains of equipment to achieve hot and cold shut down conditions, the emergency supplies provided by two diesel generators.

The Sizewell design is a modified SNUPPS design, changed to be compatible with UK design practice and safety criteria. The changes are minimal but the following fundamental changes should be realised:

two 625 MW, 3000 rpm main turbine generators;

all electrical equipment was based on the UK standard frequency and voltages. This led to a number of alterations in the layout because the UK equipment was generally larger than comparable equipment in the USA;

an increase in the containment building diameter from 42.6 m to 45.7 m was to accomodate increased plant sizes and improve access for maintenance;

a secondary containment is provided;

the capacity of the emergency core cooling system was increased by having four rather than two high head safety injection pumps and by increasing the size of the four accumulators, located inside the primary containment by 50%;

the reliability and diversity of the auxiliary feed system was improved by using two turbine driven feed pumps to back up the

The author

Eur Ing Bindon, an independent specialist in nuclear matters, has been an active member of the Institute of Energy since the early 1950s.

He began his career in the electricity supply industry at the Hams Hall group of power stations in the Midlands, joining the nuclear industry in 1959. He retired from the CEGB in 1985, having gained experience in the commissioning, operation and maintenance of nuclear power stations.

In addition to sitting on the Institute's Publications and Conferences Committee, Eur Ing Bindon is technical editor of *The Nuclear Engineer*, and serves on the editorial board of the journal of the European Nuclear Society, *Nuclear Europe Worldscan*.

electrically driven pumps, rather than one as provided in the SNUPPS design;

an emergency charging system employing steam driven pumps, separate from the chemical and volume control charging system was introduced, located in the steam and feed cell;

in line with the significant system change of having four trains of safeguard equipment for shutting down the reactor and maintaining it in hot shut down conditions, four 100% capacity diesel generators provide power for the four principal safety separation groups. The two additional diesels are located in the auxiliary building separate from the power block and on the side remote from the two diesel generators included in the SNUPPS design.

The overall effect of incorporating such changes can best be appreciated by comparing figure 1 with the layout for Sizewell in figure 2. The turbine hall is considerably wider than in the SNUPPS design, and a mechanical annexe provides space for the main steam and feed pipework to and from the two main turbines. The four diesel generators are located in separate buildings on opposite sides and some distance away from the main power block. Two are in a building near the control block and two in a building adjacent to the auxiliary shut down building.

Progress

Table 1 (above right) shows key parameters for the project, whilst figure 3 (overleaf) shows the target construction programme.

The net electrical output is 1175 MW, but the well proven thermal rating of the reactor, 3411 MW and the GEC Alsthom guarantee on the turbine generator, could mean an output of 1188 MW being realised.

The reactor pressure vessel is considered to be a component which will determine the working life of the station. On the basis of the extensive evidence of vessel integrity a 40 year life is expected with a possible extension to 60 years.

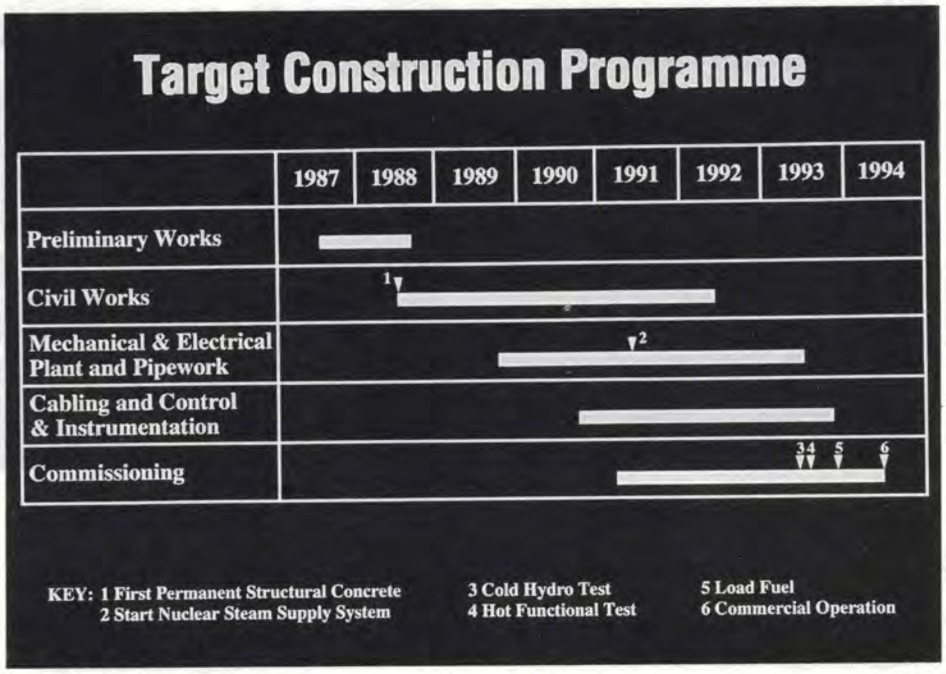


Table 1: Target construction programme for Sizewell 'B'

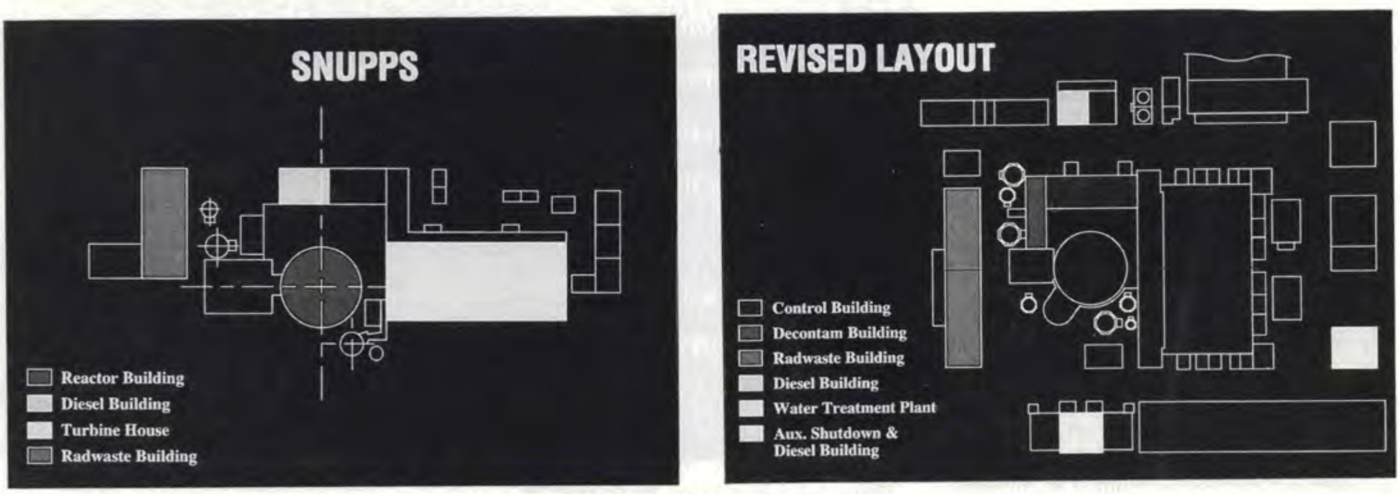
Tables 2 and 3 (overleaf) give an indication of the material quantities associated with the station and its design.

After the preliminary work on the site which occupied some 15 months, work on the various stages of the permanent structural concrete started in August 1988. By May 1991 nearly 90% of the main civil engineering work was completed with the mechanical and electrical installation work also well under way in a number of areas.

At the public inquiry an undertaking was given to use sea-borne aggregates in the construction of the station wherever possible and to use rail transport for bulk materials. Almost all the sand and aggregate used was dredged from the bed of the North Sea near Great Yarmouth and transported to a point near the station. It was then pumped to a lagoon, via a pipe on the sea bed.

Cooling system

Ten pre-cast tunnel units, each 100 metres long, and weighing around 3000 tonnes, were built on Teeside and floated down to Sizewell, some 240 miles by ocean-going tugs before being installed in the sea bed in the summer of 1990. Seven of those units form the intake of the station's sea water cooling system, the other three forming the outfall culvert. When the station is operational more than three million litres of cool-



Figures 1 and 2: SNUPPS power block (left), and right, the revised layout design for Sizewell 'B'

SIZEWELL 'B' - QUANTITIES

Reinforced concrete	400,000 cubic metres
Reinforcement bar	68,000 tonnes
Pipework	100,000 metres
Valves	29,000
Pumps	670
Heat exchangers	1,100
Electrical†/C&I* panels & racks	3,200
Main cables	34,750
Main cable terminations	475,000

† excludes switchboards
*C&I - control & instrumentation

SIZEWELL 'B' - ARCHITECT ENGINEERING

Systems	170
System drawings	77,500
Civil drawings	20,500
Other drawings	48,000
Equipment specifications	4,900
Other documents	122,100

Tables 2 and 3: left, quantities for Sizewell 'B'; and right, architect engineering for Sizewell 'B'.

ing water will flow through this system.

Figure 5 (opposite) shows an aerial view of the site in May 1991, when several of the major buildings had reached full wall height. The cylindrical reactor building can be observed in the centre of the picture, providing the primary containment for the nuclear steam supply system. The prestressed concrete wall of the containment can be seen, with its rectangular shaped opening to provide access for the reactor pressure vessel (RPV) and the steam generators which were on site by May 1991.

Crane

The hemispherical dome was prefabricated in sections on the ground before finally being installed using a Gottwald MK 1500 crane (figure 6, opposite). The crane is one of the largest transportable construction cranes in the world.

The RPV was manufactured by Framatome in France at their Chalon-sur-Saone works. The 327 tonne RPV was tranported by barge down the Rivers Saone and Rhone to Port St Louis near Marseille. This was at the end of November 1990. At this point, the cargo was transferred to a large ocean going vessel for the 4000 km journey, through the Bay of Biscay and the English Channel to Sizewell. It arrived on 20 December 1990.

Figure 4 was taken in April 1991. Some of the circular ducts through which the reactor coolant pipes will pass to and from the RPV) can be seen just below the centre of the picture. Following this time, the installation of the stainless steel liner for the reactor refuelling pool was installed around the top of the reactor cavity.

In August 1991 came one of the largest lifts for the Gottwald crane. This involved 'capping out' the reactor building by lowering into position the huge steel domed roof liner in a spectacular operation. The top cap of the dome was constructed on site in three separate 'onion' ring sections, the total weight being 600 tonnes.

First to be lifted was the dome's bottom ring which alone measures some 44 metres in diameter, nine metres high and weighing 190 tonnes. This first section was positioned on 31 May 1991, the second section was installed 16 days later. Finally the top dome was set in position in July 1991. All this work was accomplished without a hitch, a tribute to all those involved.

The RPV was the next major lift, the vessel being moved precisely into position in August 1991. The transport from France of the RPV has already been described above. The vessel had been contained on site in an air-conidtioned tent since December 1990.

No sooner was the reactor pressure vessel successfully installed than the four steam generators were taken inside the building by the same route and positioned around the RPV. Each of the steam generators weighs over 400 tonnes.

Other important operations were proceeding to plan during the time of these important lifts, such as work on the turbine hall and auxiliary buildings. Following the installation of the two permanent overhead cranes for the turbine hall early in 1991, work began on the erection of the first two turbine generators.

Sizewell 'B' - Key Parameters

Target construction time	63 months*
Cost to completion	£2030 million**
Settled annual availability	75%
Net electrical output	1175 MW
Working life	40 years

* from First Permanent Structural Concrete to Load Fuel

** April 1987 prices

Figure 3: key parameters for Sizewell 'B'.

The associated condenser units for the turbines were by April 1991 already in place, as were the boiler feed pumps.

The equipment and the installation of all the numerous items involving electrical cables, pipework and HVAC went ahead of the scheduled programme. Much of the station's general mechanical services pipework, for example, had been installed and around 44 km of the main cable steelwork representing some 50% and 30% respectively of the total quantities.

By the beginning of early autumn 1991 plant and equipment was arriving thick and fast, as the civil construction stages switched to the mechanical and electrical plant. The first unit in the turbine hall was by now 20% complete, while the work on the auxiliaries also advanced. Other items such as the water treatment plant were at the stage nearing completion in order to provide high quality water for station commissioning. Work on the CW system was advancing to the stage where much of the plant and equipment was being installed following the civil work.

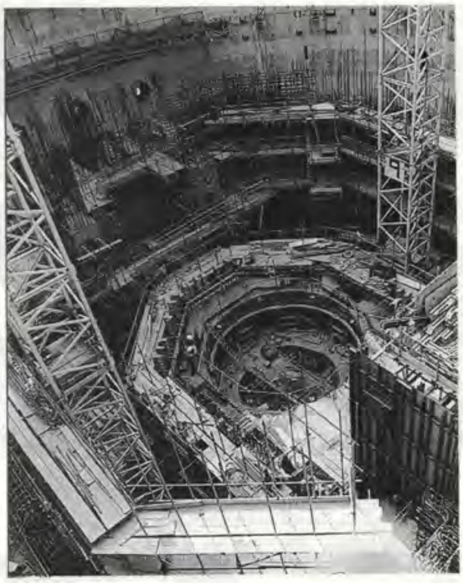


Figure 4: view inside containment.

Monitoring

During 1991 a problem occurred over the development of a piece of equipment which was at the heart of the Integrated System for the Centralised Operation (ISCO) of the whole station. It concerned a piece of equipment, known as P20 Controbloc, the data acquistion, control and monitoring system.

This equipment produces a hierarchy which supports plant interfaces, processing and man-machine operations. Space forbids a more technical explanation. Suffice to say the product was being developed by a French contractor, CEGELEC, for use in two French nuclear power stations. However, EdF in late 1990, abandoned its support for the product and this demanded a rethink for the control system of Sizewell 'B'. Following discussions in 1991, Nuclear Electric awarded a contract to Westinghouse to provide their tried and tested system for the ISCO operation. There is no question that this change will have any influence on the principal safety requirements demanded. The Westinghouse equipment will interface with other equipment being supplied by CEGELEC.

Sizewell 'B' will have perhaps the most sophisticated control and instrumentation system ever installed at any power station worldwide. The system will ensure that the station will be operated smoothly and safely.

All the equipment is designed to offer safety in depth. First, there is the station's inherent safety defenses. For example, a statement from Lloyd's Register earlier this year spoke of the RPV as being manufactured and installed to the highest standard that has ever been achieved in engineering. This is supported by many engineered safety features, providing a large degree of diversity. There is the primary and secondary protection system which comprises a technology capable of detecting faults in exceptionally fast time periods with great accuracy, one which will always ensure the reactor is shut down safely. All embody the latest in seismic technology. Overall, the station's safety philosophy is defence in depth.

Electrical system

The station's 11 kV electricial system was energised in November 1991, another important feature bringing commissioning nearer. A large mechanical item, the reactor pressuriser was in position also in the same month, following the installation of the four steam generators.

The year 1991 ended most successfully, a year in which major items of plant had been installed, and one which saw the end of the major part of the civil works and greater emphasis on the mechanical and electrical plant. Sizewell 'B' was well on target. Nuclear Electric announced that its operator training facility at Cliff Quay, near Ipswich, was completed to schedule, and staff were undergoing intensive training. This matter of training was one of the important recommendations made in the Layfield Report.

1992 has been a year of no lesser high industrial activity than 1991, now the container dome is in place and the major items

Figures 5 and 6: Left, aerial view of the site in May 1991. Right, shows the hemisspherical dome and the Gottwald crane.

for the reactor fully installed. All equipment to be fitted inside the containment now has to be brought through a sealed air lock to ensure absolute cleanliness. All the primary circuit welding was completed three weeks ahead of schedule, a most laudable achievement. Work continues on many other buildings, and the installation of materials and equipment such as the fuel building and the radwaste building, which will process liquids, solids and gases arising from the station's operation. The fuel building, which is connected to the reactor building, contains the storage pond for irradiated fuel assemblies and will also store the new assemblies.

The civil workforce on the site has started to reduce now that the civil work is virtually completed, and as the installation of equipment moves towards the commissioning stages. By April 1992, the civil staff had declined from a peak of 2500 to less than 500. However, the mechanical and electrical disciplines have grown so that the total numbers of workers is now around 4500 (May 1992). Another factor of interest is of that number, nearly 50% are from the local area.

Much work remains to be accomplished but the achievements to date have been of the highest standard, a tribute to all those who have been involved.

Speaking at Nuclear Electric's AGM, the chairman, John Collier, stated that the construction of the station, which is well ahead of target time and within budget, is the one most important yardstick against which the nuclear industry's ability to perform will be judged. This will be closely examined in the Government's 1994 review of the UK nuclear industry.

Acknowledgements

The author wishes to thank all those who have assisted with the preparation of this article and in particular Nuclear Electric for permission to publish the photographs and other material.

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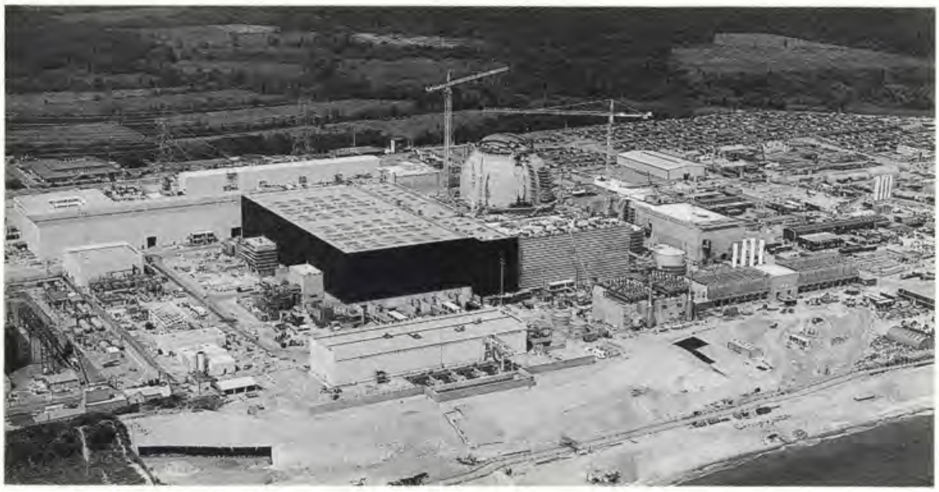


Figure 7: aerial view of the site in July 1992.

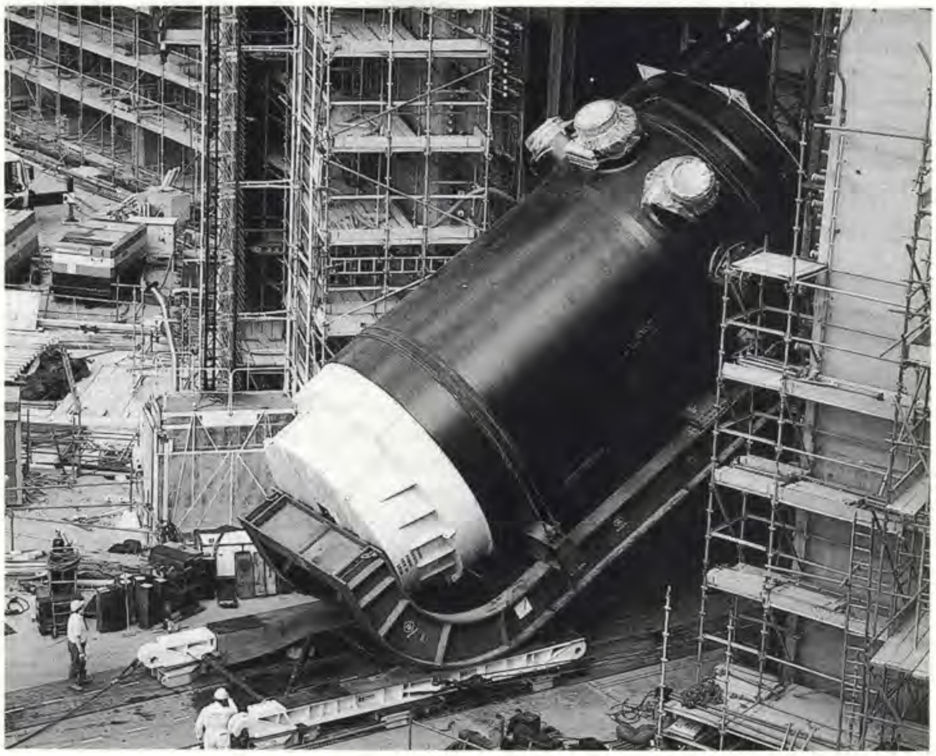


Figure 8: RPV being moved inside containment.

Control and monitoring

COMPUTERISATION is of vital importance throughout industry, but particularly in the energy field, and even more so in the nuclear industry. More and more software is being designed specifically for the energy industries, much of it for single detailed applications.

A contract to supply a supervisory control and monitoring system at British Nuclear Fuels' (BNFL) Windscale Vitrication Plant (WVP) was recently completed.

Instem Computer Systems have supplied the supervisory system for the four autosamplers, the transport system and associated equipment.

BNFL has reprocessed over 30 000 tonnes of spent fuel at Sellafield since 1952. The process involves the separation of the residual uranium and the by product plutonium, both important reusable materials, from the waste fission products. After concentration the highly active liquid waste has been stored in cooled tanks. This storage method has proved to be effective, but was not perceived as a permanent solution.

BNFL's new approach aims to immobilise highly radioactive waste by the process of vitrification. To this end the Windscale Vitrification plant was built at Sellafield for the conversion of liquid waste to a solid glass-like form.

The Windscale Vitrification Plant (WVP) and its associated administration and change room centre at BNFL's Sellafield site in West Cumbria

Auto-sampling

An important part of this process is the monitoring of the level of radioactivity of the liquid effluent at various points in the plant. To achieve this, BNFL introduced an autosampling system that takes samples at designated intervals and, in turn, transports them to a laboratory for analysis. The sample bottles are then transported around the plant inside sealed stainless steel carriers via a pneumatic pipe transport system.

Instem's system is designed to control and monitor the various stages within the autosampling process, from the dispatch and receipt glovebox, where empty sample bottles are introduced into the system, to the carrier monitoring station, where bottles are monitored for surface contamination.

The control system is based on a DEC computer, which acts as the central supervisory computer for the operation of the four auto-samplers and, in addition, interfaces to the autosampling dispatch and receipt areas. Running SCADA software (written by Instem) the supervisory system is equipped with disc storage, display screens and alarm printers.

The supervisory computer oversees a combination of seven DEC Instematic programmable controllers each running 'Inscribe' — the special control engineering language developed by Instem for use in industrial computer based applications. Inscribe offers user orientated 'English' commands with multi-tasking programmes to provide powerful real time data acquisition and process control facilities, in either a stand-alone or network environment.

The Instematics control and monitor each of the four auto-samplers; the bottle transfer facility which comprises a back up active sample bottle transfer unit; the transport system controller which sets up routes, dispatches carriers and monitors carriers' progress; the laboratory receipt facility where the samples are received for analysis and, finally, a remote I/O in the processing plant via a high speed data link.

The supervisory computer also supervises two Instem digital link-on multidrop I/O stations, one in the dispatch and one in the receipt glovebox where empty sample bottles are introduced into the system. A third link-on monitors for surface contamination.

Two DEC based operator workstations, one in the vitrification plant control room, and the other in the DRG area in the processing plant, provide system access and printers provide alarm and event logging for sample analysis reports.

Instem Computer Systems is an operating division of Instem plc, the Staffordshire based electronics and information systems group.

Cimage International Ltd is a software company which develops and integrates document management systems designed for the capture, editing, control and distribution of high-volume documentation.

The company's product line addresses the problem faced by many manufacturing and engineering companies of how to manage the information workflow, communicating revisions of a huge volume of manually created paper drawings, film-based information and CAD data often across multiple sites and varied systems.

At the heart of the Cimage system is 'document manager', a powerful networked relational database application, which can be integrated with corporate systems.

In addition, Cimage's 'imagemaster' user interface features a series of software modules allowing users to capture, edit, redline and view documentation. Each Cimage system features integration of application software across a wide variety of hardware platforms, and is customised to the specific needs of a range of construction, manufacturing and engineering service industries, including petrochemical and utilities.

The system can take in diverse data from any CAD system, converting it to a single raster format and creating a totally flexible image, which does not require specialist skills to manipulate and which includes raster-to-vector and vector-to-raster functions.

One of the main benefits of the system is that it reduces the time between design and manufacture, and therefore to market. With conventional methods of handling paper and film copies, it can take weeks for a design to reach the shop floor in a manufacturing company.

For BP the system has helped manage the documentation of the construction of a North Sea oil rig, tracking changes in the different components of the rig, distributing the latest updated information via satellite to the wide range of contractors involved in building the rig and ultimately speeding up construction.

Electricity production at Nuclear Electric's Heysham 2 AGR has seen an improvement with a document image processing system from Cimage, which reduces reactor shut down for refuelling from three days to one hour.

At Heysham, refuelling is totally automated and involves using remote control to extract spent nuclear fuel rods from the reactor core and inserting new ones. Flow charts define the computer software used to control the many operational sequences performed during refuelling. These flow charts are currently being updated as part of an exercise to enhance methods of fuel handling and improve efficiency.

Previously the flow charts were originated and amended by hand. The new system allows all of Heysham's 3 000 flow charts to be input to a database and edited on computer screens. The system quickly distributes the input to users at the power station, thus saving more time.

Cimage have also sold their system to Scottish Nuclear, to help improve efficiency at Torness power station's fuel route. Shut down for refuelling at Torness usually requires reprogramming the computer software by modifying some of the 10 000 flow charts. The Cimage system allows the flow charts to be revised or changed and even cleans them up in the scanning process.

The capabilities of the system were first pointed out to Scottish Nuclear by NNC, who built the Torness fuel route. □

Model of a vitrified waste container, sectioned to show the glassified waste inside.

Nuclear Electric's Heysham 1 and 2 power stations.

The central control room at the Wylfa Magnox power station, in Gwynedd, the first CEGB power station to use centralised control based on computers. Commissioned in 1972.

The THORP project

*by Harold Ashurst**

The debate continues as to how we should deal with our nuclear waste. At BNFL confidence in reprocessing is running high following the completion of their thermal oxide reprocessing plant (THORP). With 30 contracts from nine countries already signed, BNFL are looking forward to a bright future.

BRITISH NUCLEAR FUELS has been reprocessing Magnox fuel at Sellafield for more than 40 years. The thermal oxide reprocessing plant (THORP) will enable the company to reprocess fuel from the more modern reactors such as Britain's advanced gas-cooled reactors (AGRs) and light water reactors (LWR).

Due to go into operation early next year, THORP is one of Europe's largest and most complex engineering projects. The cost of the plant, together with its share of supporting facilities, amounts to £2.8 billion.

THORP combines all the facilities necessary for reprocessing nuclear fuel in one plant, enabling the fuel to be received at one end, and the recycled uranium and plutonium to be supplied at the other. The plant is fully integrated with Sellafield's waste treatment plants, and routes incorporated in the design allow the transfer of each class of waste to the relevant treatment plant.

After preliminary cooling in reactor ponds, irradiated fuel is transported to Sellafield in heavily shielded flasks, the number of assemblies in a flask depending on factors such as the size of the assembly, its heat generation, fissile content and so on.

Very strict regulations, based on International Atomic Energy Authority guidelines, govern irradiated fuel transport by air, sea and land and cover, amongst other things, radiation protection, prevention of criticality and heat loading. In a majority of cases the assemblies are transported in multi-element bottles (MEBs) or other containers within the flask. In order to minimise the spread of contamination (active debris from reactor operation), to expedite unloading and for radiation protection it is normal for the fuel to remain in the container whilst in reprocessing plant pond storage.

Aerial view of THORP, receipt and storage facility and pond extension.

Delivery of fuel to THORP may occur from about six months after reactor discharge. Optimisation of plant design and operation indicates that reprocessing should occur after about five years' cooling for LWR (three years for AGR) and the fuel is pond-stored in the meantime. This compares with a minimum of six months' total cooling of Magnox fuel and reflects not only the increased activity of oxide fuel but also the much greater corrosion resistance of its stainless steel or zirconium alloy cladding. In the pond the containerised assemblies are located vertically on the pond floor in a fixed geometry and with appropriate neutron absorbers to prevent criticality. A minimum depth of three metres of water above the fuel flask assures radiation protection. Twenty years' experience of storing oxide fuel at Sellafield and elsewhere demonstrates that very low radiation dose and high water-clarity can be maintained

Head end plant

After debottling, LWR fuel can be sheared directly, but AGR fuel, due to its graphite sheath and, to a lesser extent, its open structure, has first to be dismantled and packed in a more compact array for shearing. The AGR pins are pulled from the assembly and packed in a slotted stainless steel can, which holds the pins from three assemblies (108 pins). The can has to be slotted in order to ensure satisfactory shearing. The remnants of the original assembly — graphite sheath, grids, spacers, etc are stored separately and treated as intermediate level waste (ILW).

LWR fuel will be sheared as complete assemblies. The massive, hydraulically-operated shear machine is designed to cut fuel assemblies of up to about 30 centimetres square cross section laterally in pieces

* British Nuclear Fuels plc

between two and half and about 10 cm in length. Because of wear on the shear blade, the cutting assembly will be replacable and built in modular form for ease and simplicity of replacement and maintainance.

The sheared fuel prices, comprising cladding and fuel, fall down a chute into a perforated basket which is suspended in hot (90 degrees C) nitric acid. A large percentage of the fuel dissolves very quickly after contact with the acid, the dissolution rate being controlled by the shearing rate (if a basket were to be prefilled with sheared fuel and put into a hot acid, problems would occur due to excessive foaming interfering with the off-gas clean-up system). The acid dissolves the fuel leaving the cladding pieces or 'hulls' in the basket and these are withdrawn from the dissolver, monitored for fuel residue and treated as intermediate level waste.

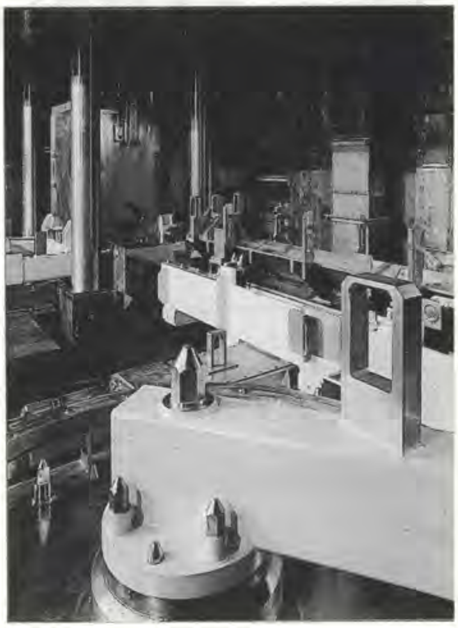
The process is thus batched, for although designs of continuous dissolvers have been developed, their use necessitates fuel dismantling prior to shearing and this is difficult when high output is required. The achievement of high batched throughput necessitates fairly large dissolvers which require, in turn, criticality prevention by the addition of soluble poisons, such as gadolinium, in view of the significant initial enrichment levels and plutonium contents of oxide fuels.

Considering the fuel types and designs to be reprocessed, the achievement of a design throughput of 1200 tU pa requires that three batch dissolvers each of about 1.7 tU capacity are employed.

As the fuel dissolves, the inert gases, krypton and xenon, and other volatiles such as iodine and carbon dioxide are released, together with nitrogen oxides and steam. The dissolver off-gas system recovers much of the nitrogen oxide as nitric acid which is recycled and a caustic scrub removes residual nitrogen oxides, the carbon dioxide and iodine. The caustic solution is treated as an effluent.

The fuel solution contains fine particles of two types; cladding fines and insoluble fission products. Cladding fines (stainless steel and zirconium alloy) are small in number and fairly large in mass. They generally settle in the dissolver when the fuel solution is cooled and are collected and treated along with the hulls. Insoluble fission products are small particles of noble metal alloys (molybdenum, technetium, rhodium and palladium in varying proportions) and with high activity. They must be removed prior to solvent extraction as they may accumulate at the solvent aqueous interfaces and lead to solvent degredation.

A centrifuge, identical with the one installed in the La Hague OP2 plant, removes the insoluable fission products (and residual cladding fines) as a 'cake', a waste which is suitably treated. The fissile content of the clarified dissolver liquor is assayed for safeguards and plant control purposes before being fed to the solvent extraction plant.



The shear machine, in the shear cave, THORP head end.

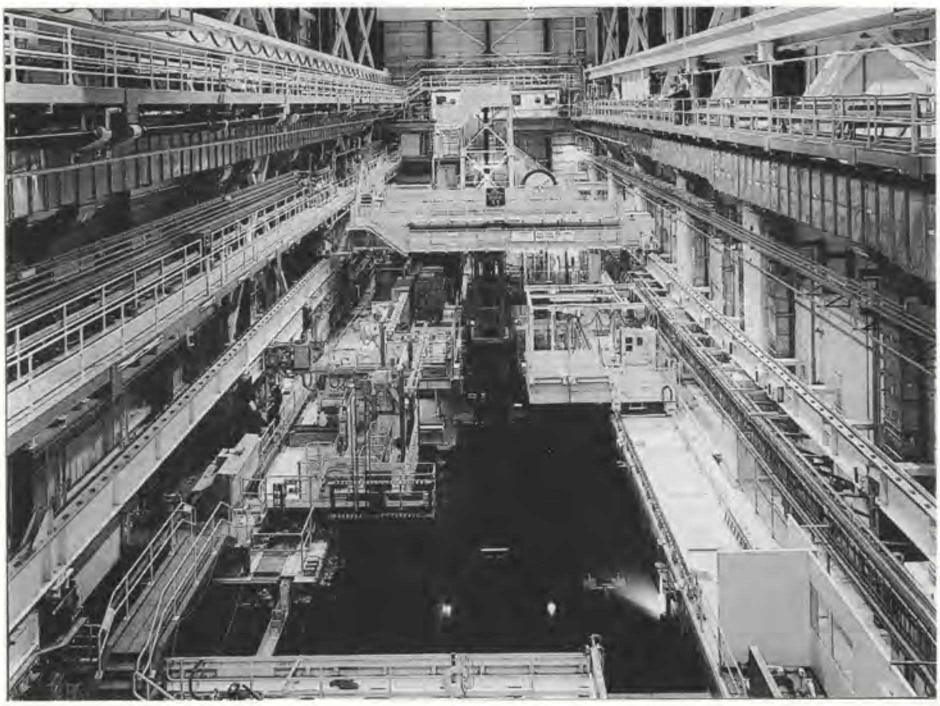
Solvent extraction

The THORP solvent extraction process is of Purex-type, employing TBP diluted with odourless kerosene (OK), and utilities pulsed columns in highly active and plutonium purification areas and mixer-settlers in uranium purification. The uranium/plutonium separation (split) will be in the first cycle and, in order to maximise subsequent waste evaporation factors, U4+/Pu3+ reduction will be destroyed later in the process, again as a means to avoid salts.

Although the fundamental principles of the Purex process are the same as in previous plants, there has been a great deal of optimisation and change in detail to deal with the higher activity of oxide fuel (as compared with Magnox). The higher activity, greater fission product concentrations and tighter product specification require higher decontamination factors, the higher initial U235 enrichment and final plutonium concentrations in the fuel require much greater attention to criticality prevention and process control, and the very strong desirability of minimising the numbers of waste streams and their volumes necessitates very substantial amounts of work in optimising reagents and conditions.

Uranium/plutonium separation

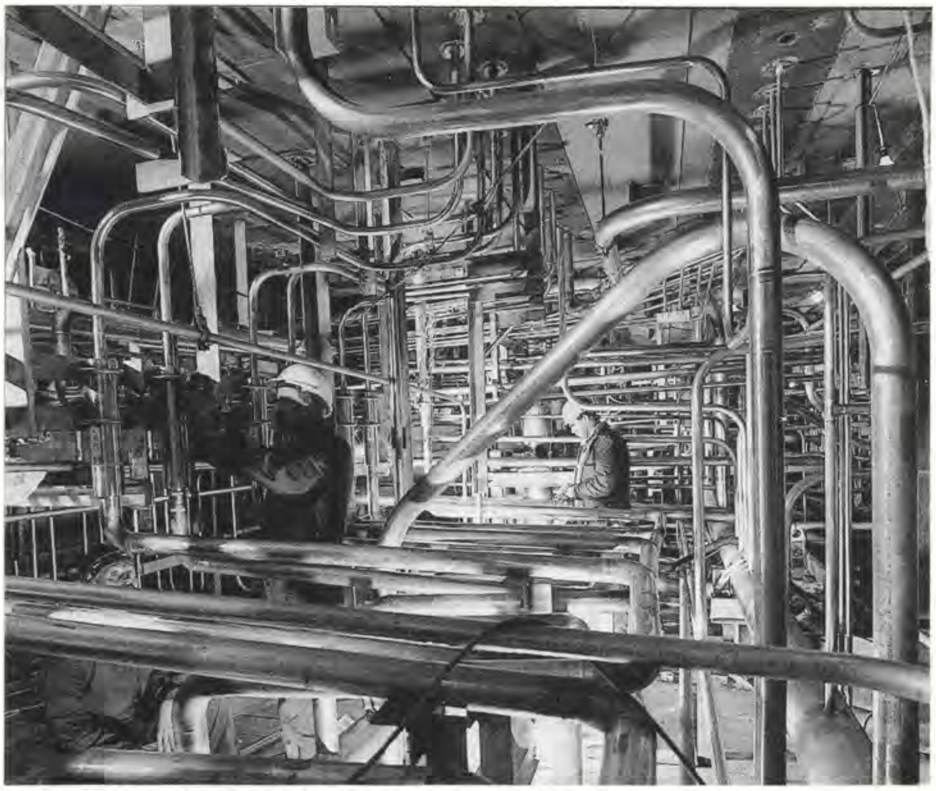
The clarified liquor is held temporarily in a buffer tank which also serves for accountancy (measuring the fissile content of the solution) and may, in addition, be used for conditioning the plutonium to Pu4+ or Pu6+, both of which are extractable into the solvent



Fuel removal pond, THORP head end. Centre, is the rack handler machine, fuel removal R/H machine and LHS maintenance machine.

(Pu3+ is not). This liquor is fed to the first pulsed column (designated the HA column) countercurrently to the solvent feed (30% TBP/OK) which is in the continuous phase. The uranium and plutonium are extracted into the solvent while the vast majority of the fission product activity (more than 99.9%) remains in the aqueous phase, which is routed to highly active storage via steam-stripping to remove entrained solvent. The ascending solvent becomes loaded with uranium and plutonium and is 'scrubbed' with aqueous acid in the upper part of the first column, to maximise decontamination from fission products. The solvent overflows to the next column (HS).

Eventually the solvent passes to the highly active solvent wash system, which 'cleans' the solvent for re-use. There are three wash contractors. The first uses sodium carbonate to remove acidic impurities and trace plutonium in a soluable form. The second wash uses sodium hydroxide to complete the removal of acidic impurities and the third wash is with nitric acid to neutralise residual sodium carbonate and hydroxide before solvent is recycled to the process. The aquenous raffinates pass to salt evaporation.



View of pipework at 8 metre level in the chemical separation cell 307 area in THORP.

Product finishing

Uranium — Uranyl nitrate from the UP cycle is steam-stripped free of solvent and evaporated. Although some concentrate is required, for substitute feed make-up for example, the majority is fed batchwise via heated lines (to prevent crystallisation) to the thermal denitration reactors. Reactors and fluidising air are heated electrically and the UO3 product powder overflows and is cooled prior to drumming. Drums are sealed remotely and externally decontaminated before removal for storage. Off-gases are cooled, scrubbed and the resultant liquor routed to salt-free evaporation.

Plutonium — Plutonium nitrate from the PP cycle passes to a conditioning stage to ensure plutonium is in the tetravalent state. Oxalic acid is then added to precipitate plutonium oxalate. The precipitate is filtered under vacuum on a rotary filter, the cake scraped off and dried. The dry powder is next calcinated under argon between 500 and 900 degrees C to convert the oxalate to the dioxide, carbon oxides being driven off. The Pu02 powder is finally packaged in stainless steel cans under argon to prevent absorption of air and moisture, which could be detrimental during storage. The filtrate solution — oxalate mother liquor — is cooled and concentrated prior to destruction of excess oxalic acid and recycle of residual plutonium to the separation plant.

A number of plants have been designed to treat the various wastes arising from Sellafield operations, including those from THORP.

The sections of cladding material which are left after the fuel has been dissolved are classed as intermediate level waste and are fed to one of the encapsulation plants. Here the waste is safely contained in cement inside steel drums which are placed in a purpose-built store.

High level liquid waste resulting from reprocessing is transferred via a shielded pipebridge to the vitrification plant, where it is converted into a solid glass-like form.

Immobilisation of the highly-active liquid waste into solid form has several advantages; it greatly reduces the long-term potential for escape of radioactivity; it reduces the volume; safe supervision is easier and cheaper, and it is more suitable for returning to overseas customers and for eventual disposal.

Low level waste such as paper towels, plastic sheeting and protective clothing, which may have been contaminated with low levels of radiation, are contained and disposed of at Drigg, BNFL's disposal site about six kilometres south east of Sellafield.

Waste gases arising from the THORP process are passed through a complex and sophisicated gas clean-up process consisting of various scrubber and filtration systems. This removes harmful chemicals and radioactive material before the gaseous discharges are monitored and released to the atmosphere.

Low level liquid waste is treated and monitored before being discharged at sea. The site ion exchange effluent plant (SIXEP), costing some £200 million, has dramatically reduced the radioactivity of the low-level discharges to the sea. A further £500 million has recently been invested in additional effluent treatment plants. All discharges from THORP are subject to strict rules set down by the Government Authorising Departments.

The waste arising from the reprocessing of fuel from overseas will be treated in exactly the same way as waste arising from UK fuel. However, there are clauses in all overseas contracts signed since 1976 which allow BNFL to return the waste to the country of origin.

Radioactive discharges reaching the environment are minimised through THORP's extensive treatment and monitoring facilities. The plant has been designed and constructed to keep radiation doses to BNFL's workforce and the general to a minimum limit of 15 mSv per year.

Thirty customers from nine countries have signed contracts for reprocessing in THORP over its first ten years of operation. The order book is approximately split equally amongst the UK, mainland Europe and Japan. The business, which makes BNFL one of the UK's biggest earners of Japanese yen, contributes positively to the nation's balance of payments.

In addition agreements have been reached with UK and German utilities for some 3 400 tonnes of business in the second decade of THORP operations, bringing total amount of fuel committed for reprocessing in THORP to over 10 000 tonnes and the total order book to £9 000 million in 1992 money values. □

Controlling your utility bills— the easy way

*by Andrew Johns**

DURING the past year UK consumers once again suffered dramatically high utility costs — some of the highest in Europe. Whether electricity, gas or water these consumers generally paid more for these services than their counterparts in the world's major industrial nations, setting them at a distinct commercial disadvantage.

Those managers looking to cut overheads and remain competitve in a time of recession are not only faced with high prices but with utilities caught in the confusing aftermath of privatisation and the move from monopoly to consumer choice.

Take, for example, the electricity industry. Although large consumers have generally benefitted from better prices under privatisation, large electricity consumers in the UK saw the largest percentage increase in seven years. The rise was higher than the 12 other industrialised countries surveyed in the May 1992 National Utility Services international electricity price survey.

Cutting costs

In the light of these conditions and the tariff structure in Britain, even the most astute managers have a difficult path to follow when trying to cut costs.

One must understand that cutting utility expenditure — without changing usage — involves three essentials: a vast amount of knowledge, including information about all the possible tariffs available; employees who understand the workings of the utility boards and are able to negotiate the most favourable terms from the supplier; and employees with the time to pursue this endeavour.

Utility companies in Britain charge customers on a tariff basis or on a special contract. This pricing structure is extremely complex and prone to change. Tariffs are, in fact, a complicated set of mix-and-match figures, set individually by utility boards to align with the demands of their users.

Continuous selection of the most economical tariff or contract for each individual operation is a situation that faces every manager as utility suppliers are not bound to offer the lowest prices and it is up to the buyer to select and negotiate the mosr favourable tariffs and terms for their own requirements.

The main problems from a consumer's point of view, even if he is aware of the specific conditions under which he is being charged, is that prices and tariffs are ever changing, and some go unpublished. There are also hundreds of tariffs — more than 500 for electricity alone in the UK and Ireland — and this figure does not even attempt to take into account the plethora of special agreements.

** National Utility Services Ltd*

An exacting science

So called 'utility cost analysis', therefore, is a science that comes from years of experience and relies on information not available to the ordinary company. An executive or manager working on his own does not have the ability to determine if the correct tariffs are being applied, as the analysis process relies on a vast database of information built up during an extended period of time.

In addition, few companies have the resources or time to devote to this complex analysis process.

What then can managers do to cut through this maze of uncertainties and control utility costs? Surprisingly to most managers there is a rather simple way to deal with the inequities that surround utility prices, and that is to hire a firm of professional utility cost analysts.

These analysts can, through the use of computers, their own expertise and precedents set elsewhere, examine a company's paid energy and water bills, to ensure that the most advantageous price and tariff arrangements apply. They do this by guiding clients through the puzzle of different rates offered by utility suppliers and inform them of concessions and special arrangements available to them. The result is typically dramatic cost savings for customers and the realisation by them that they are paying more than they need for utilities.

The process

The cost analysis process begins by thoroughly examining a company's paid utility invoices and contracts for the most recent 12-month period. This involved procedure confirms the accuracy of the calculations, the meter readings and provides a precise picture of the company's pattern of energy and water usage and the pricing for each utility used. Based on their expertise, the analysts can also compare organisations with similar utility usage profiles. This enables them to quickly judge if the business is being charged on the correct tariff scale.

Once the bills are checked for mistakes, the analysts complete a detailed report recommending specific action to reduce ongoing costs and/or to obtain refunds on past overpayment. This examination of bills continues every time a bill is paid, a new contract is signed or a rate change occurs. Through this continuous examination and auditing process, the utility cost analysts ensure that their clients are paying the optimum rate at any given point of time.

In all appropriate cases, the client company is provided with the necessary documents, enabling direct negotiation with the utility supplier. However, when necessary, analysts are available to act in support of the company in face-to-face negotiations with a utility board.

Consultant's role

One note of warning for those deciding to hire a utility cost analyst firm. The expertise required to guarantee the greatest savings necessitates that you take a long hard look at the consultancy. Ascertain how long the firm has been in business, the degree of information available and how the analysts are trained. As in most service inductries, there is a 'cowboy' element that should be carefully avoided.

One can best liken a utility costs analyst's role to a tax consultant. When filling in a tax form, it is the responsibility of the individual to make sure he requests the concessions to which they are entitled. If we want to make sure we haven't missed any tricks, we consult a tax consultant whose job it is to ensure that we pay as little tax as possible.

We all understand the benefits of tax consultants. Once company directors fully understand the benefits of utility analysis, they will appreciate how important savings can be made. □

Essential reading

'Beyond the Limits: Global Collapse or Sustainable Future' by Donella H Meadows, Dennis L Meadows and Jorgen Randers, published by Earthscan Publications Ltd, London, 1992, 300 pp, £9.95 P/B, £19.95 H/B.

MANY will remember the impact of the report for the Club of Rome's project on the predicament of mankind: *The Limits of Growth*. An international research team at the Massachusetts Institute of Technology concluded in 1972 that, even under the most optimistic assumptions about advances in technology, the world could not support the rates of economic and population growth experienced at that time for more than a few decades. Only by a concerted attack on all the major problems at once could man achieve the state of equilibrium necessary to his survival. Noting that many people did not accept these conclusions, three of the four original authors have examined the global scientific evidence since 1972 and produced this new text.

Originally they had intended to update their work, with sections on new approaches to topics such as energy efficiency, the use of new materials and international protocols to protect the ozone layer. But as they looked at the new data and ran the computer models, they found that in spite of the world's improved technologies, the greater awareness of the main issues and stronger environmental policies, many resource and pollution flows has grown beyond their sustainable limits. However, their computer model indicated that while some options for sustainability had narrowed, yet others had opened up, and there are still real possibilities for reducing the streams of resources consumed and pollutants generated by the human economy while increasing the quality of human life. But their work shows very clearly, through a detailed examination of the various assumptions for improved technologies and population growth, that there has to be a fairly rapid improvement in the efficiency of material and energy use, the equity of material and energy distribution, and a sustained reduction in population growth. These are the reasons behind their choice of this completely new text.

The book starts with a careful explanation of exponential growth, followed by a look at resources, both renewable and non-renewable, and sinks for pollution and wastes. The main thrust of the book starts in the fourth chapter, where the dynamics of growth in a finite world are introduced very elegantly, together with their computer model, World 3. The reader is then taken through a logical sequence of assumptions which give a series of different forecasts, all displayed with excellent graphics. Here, many will recognise the shapes of the limited growth logistic models (the familiar S-curve, for example) for resources, population, industrial output, pollution and so on, all plotted on a time scale from 1900 through 2000 to 2100. The final chapter is very positive, encouraging people to think about these issues and to act on them. For example, they point out that although the book contains a warning about the future, it is not a prediction of doom, rather a recommendation to follow a different path. On growth as a concept, they comment that not all growth is good, without question. Equally they point out that not all growth is bad. Rather, that what is needed is not growth, but development. Insofar as development requires physical expansion, it should be equitable, affordable and sustainable.

The footnotes are very full and detailed, there is an annotated bibliography, a glossary and details of how to obtain the computer software for research and teaching.

This is a book which is both stimulating, controversial, informative and above all beautifully written, with many complex concepts and ideas explained with great clarity. In the words of Gro Harlem Brundtland, Prime Minister of Norway and Chairman of the World Commission on Environment and Development: "This book is essential reading for everybody who is concerned with the central issue of our times: how to achieve a transition to a sustainable global future."

Dr Cleland McVeigh

Limited appeal

'Nuclear Juggernaut' by Martin Bond, published by Earthscan Publications Ltd, London, 1992, 240 pp, £11.95.

THE TRANSPORT of irradiated fuel concerns many people despite the indisputable fact that no accident has ever occurred which has resulted in a release of radioactivity.

Every day in Britain and many other countries around the world, movements of radioactive materials take place by road, rail, sea and air. These materials range from the transport of spent fuel to the many thousands of packages of radioactive isotopes for use in industry, agriculture and medical applications.

The work by Martin Bond is a readable book but written in a style which in many ways over elaborates and tends to bias the reader by presenting the underlying impression that the author wishes to portray an opposition far more anti-nuclear than at first glance may seem to be the case. One is left with the feeling that a catastrophic accident is just around every corner where the transport of nuclear materials is involved.

Martin Bond's introduction begins by saying the transport of radioactive materials is totally safe, but almost immediately qualifies the statement. He sees the record of the last few decades of transport of such materials as almost perfection, yet sets about the undermine the record.

On the positive side, the book gives a thorough account of what is moved, by whom and for what purpose. It examines the risks, including that of terrorism, the safety record and the precautions taken, bound as they are by International and National Regulations and Codes of Practice.

The book contains some 18 chapters covering the whole of the subject matter, radiation, regulations and container design to spent fuel transport in Britain. It covers the import of irradiated matter to the UK, its transport, accidents and the human reliability factor.

Nuclear Juggernaut also contains a large amount of reference matter, but will regretably have only a limited appeal.

Eur Ing F John L Bindon

Conference proceedings

'The Mathematics of Oil Recovery' edited by P R King, published by Clarendon Press, Oxford, 1992, 817 pp, £95.00.

THIS publication is based on the proceedings of an international conference organised by the Institute of Mathematics and its Applications in association with the Society of Petroleum Engineers, and held at Robinson College, Cambridge, in July 1989.

Heterogeneous three dimensional problems involving large sums of money expended in a short period of time have been the spur for this conference, and the oil will probably run out before the mathematical problems are satisfactorily resolved. Nevertheless the simulation techniques associated with oil and gas reservoirs generated 46 papers by 86 contributors. Grid and network simulation finite element methods are used, some with moving boundaries.

Non-fracture and fracture fields with problems of geological faults, temperature, pressure, stress, depth, heat and fluid flow cover physical models which have to be included in the physical models. A few colour plates illustrate the work of computations but many of the predictions were shown only in black and white, which is unfortunate for those readers who were unable to attend the conference. Numerical predictions are needed to guide the operator in the efficient and economical recovery of petroleum energy resources, which in the past have depended very much on the work of the geologist. This now depends on the interpretation by the statistician and upon the model used.

Nigel Gwyther

Sound reading

I FOUND Dr G Cole's article "Provision of the world's energy need' (*Energy World*, June 1992) very interesting. However I feel I must correct a few inaccuracies.

The quantity of energy required by an individual to maintain life is indeed about 150W (not per second!), but this equates to $13MJ/m^3$, unless Dr Cole is referring to producer gas.

Finally, 30 acres is around 12 hectares, not 134ha.

Nevertheless I found the article sound reading. I was particularly interested to learn that a coal-fired power station releases about three times the radioactivity of a nuclear station.

Chris Finn *(Member)*
Beverley, Hull.

Questionable

WE ARE puzzled by the recent Manx Electricity Authority (MEA) publishing claims that modern containerised high speed diesels need heavy maintenance and large space requirements compared to slow speed sets as selected for the new Peel power station on the Isle of Man.

Modern, highly rated high speed engines up to 1.6 MW can be fully packaged in standard sound attenuated ISO containers complete with fuel, switchgear, protection and on-board cooling. They can run unmanned and be remotely started, stopped and supervised. By contrast slow speed heavy fuel burning engines need massive expensive buildings to achieve sound attenuation, standby sets to cope with outages and maintenance, fuel stores and treatment, cooling systems, workshops, staff accomodation and car parks.

We understand the proposed 40 MW plant is to be 2120 sq m. In contrast, 40 MW of containerised power module would require only half this area (25 x 40 ft ISO containers with 1.5 m spacing gives an area of 1100 sq m). The containerised sets could be spread around the Island, unobtrusively, and close to load, obviating the need for further expenditure on distribution. High speed engines operating aon low sulphur distillate fuel do not need the unsightly 80 m chimney proposed for what is a popular tourist area.

Long-term maintenance costs on high speed engines, including all attendance, overhauls, consumables, allowances for unscheduled maintenance is in the region of 0.5 per kWh. The corresponding figures for slow speed engines are around 1p to 2p per kWh.

It would appear from the MEA's Annual Report that the slow speed engines on heavy fuel have a marginal price, ie, fuel, maintenance, operation per delivered kW similar to, if not more expensive than, the high speed engines. But the slow speed engine has a far higher capital cost than the high speed — some £1000 per kW fully installed, compared to £200 for the high speed (including switch gear, transformers, etc). Thus, overall, the high speed engines deliver cheaper power than the slow speed, even when cheaper fuel for the latter is taken into account.

The MEA have stated they need to have at least 2 x 9.6 MW sets in hand (one down for maintenance, with a 12 week overhaul period assumed). High speed engines offer long-term availabilities of 98% and can have engines changed or overhauled in less than a week, and the smaller incremental size means a much smaller plant margin would be needed — typically only 5 MW to meet the Isle of Man's 50 MW peak. Extra plant in 1.6 MW increments can be readily added in weeks rather than the two years required to add a minimum increment of 20 MW for slow speed engines. Overall, larger, slow speed sets imply much larger, costly supply capacity.

High speed engines can be remotely started, synchronised and brought to full power in less than 30 seconds. It can take up to 30 minutes for slow speed engines to reach full load, and this cannot be done unmanned.

We can furnish examples of high speed engines with total operating hours in excess of 200 000 at full load with long-term availabilities of 97-98% (eg, North Sea oil rigs).

Slow speed engines need a massive, sprung concrete blocks for vibration insulation. Containerised sets can sit on sleepers laid on a gravel bed, and are installed literally in hours, as opposed to two years for slow speed sets.

The proposed water cooled sets on the Isle of Man will deplete an important amenity — a nearby river — whereas containerised sets use an on-board radiator.

Finally, should a cable or gas main be laid to the Island, making diesel generation less important, surplus containerised sets can be readily sold on the world market. Not so with slow speed sets.

Based on developments both here in the UK and overseas, the decision of the MEA to build such expensive and unsightly plant is highly questionable.

David Andrews
Power Projects, Windsor, Berks.

Any time to spare?

I AM sure readers of *Energy World* will be pleased to learn that handicapped and disabled people in Kent can now use a free service to obtain equipment designed and made for their special requirements. This is made possible by the recent formation of a branch of REMAP (Rehabilitation Engineering Movement Advisory Panels) consisting of voluntary engineers, craftsmen and occupational therapists who will investigate their individual problems, and devise appropriate apparatus entirely free of charge.

REMAP needs experienced engineers, designers and craftsmen of all disciplines, whether employed, unemployed or retired, to spare a few hours a month as part of a team to provide this service, for which they will receive expenses.

Enquiries regarding volunteers should be made to: Eur Ing J Wright, 'Hazedene', Ightham, Sevenoaks, Kent TN15 9AD, tel: 0732 883818.

If any member would kindly consider giving a donation to enable this worthwhile work to proceed, I can assure them that such contributions will be gratefully received, and will be used to enrich the lives of the unfortunate patients (some of whom are children) who are forced to endure such suffering. Cheques should be made payable to: 'REMAP — East Kent' and sent to: M Harris (Hon Treasurer), 'RTB', 63 Noakes Meadow, Ashford, Kent TN23 2RA.

Eur Ing Henry Watts
Broadstairs, Kent.

Correction: Not so bad

Prof Swift-Hook's letter (*Energy World*, July/August 1992) should have read 'flue gas decarbonisation can solve the greenhouse problem as far as carbon dioxide is concerned. The financial cost will be significant (an extra 50% or more) but the energy cost will be relatively modest (only 20% or 30%).' In the original letter 'flue gas decarbonisation' was editorially abbreviated to 'FGD', which normally refers to flue gas desulphurisation. And the offshore wind farm built last year in Denmark is at Vindby, not Vindy, as previously stated. We apologise for these errors.

Your views, please

The editor welcomes letters for publication from readers of *Energy World*. Correspondents are requested to keep their letters to a maximum of 500 words. This will enable us to publish the views of as many readers as possible.

Young woman wins Young Engineer for Britain 1992 title

18-YEAR-OLD Caroline Gledhill of Ringwood, Hampshire, has won the coveted title of Young Engineer for Britain 1992, the first young woman ever to receive the accolade.

Along with the title, Caroline received the trophy, a £500 personal prize and £1 500 for the purchase of engineering equipment for educational use. She also carried off The Engineering Council's WISE (women into science and engineering) award for the best project by a girl.

Caroline's winning invention is a low-cost, high-quality measuring device for all high-speed tape recorders, developed whilst working at Racal Recorders of Hythe, Southampton as part of the Year in Industry work experience scheme.

41 national finalists took part in this year's competition, which is the leading event of its kind in Europe. They had been selected from over 500 young people at 11 regional finals staged throughout the country.

Runners up received prizes of study visits and cash prizes for themselves and their schools.

Caroline Gledhill with her project the PEA, which ran away with several awards at the Engineering Council's Young Engineer for Britain awards.

Occupational standards

THE AIMS of a new organisation to co-ordinate the development of standards of competence in the UK's engineering sector have been set out in a new leaflet, available free of charge from The Engineering Council.

The Engineering Occupations Standards Group (EOSG) has been set up with funding from the Employment Department. It aims to develop a coherent set of occupational standards and related assessment systems for the full range of engineering occupations. In conjunction with awarding bodies, it aims to develop qualifications based upon these standards which will be accreditable by the National Council of Vocational Qualifications (NCVQ) and the Scottish Vocational Education Council (SCOTVEC).

The EOSG is a voluntary association of four Industry Standing Conferences: the Construction Industry Standing Conference (CISC); the Engineering Services Standing Conference (ESSC); the Standing Conference for Engineering Manufacture (SCEM); and the Standing Conference for Extraction and Processing (SCEP). Each of these organisatins comprises representatives of employers, training organisations, engineering institutions and professional bodies.

Trevor Wiltshire, Chairman of EOSG, said: "Engineering qualifications based upon occupational standards, set and maintained by industry to meet recognised real needs, represent a fundamental change leading to improved workforce competence."

Communication links are being sought with industry, academia and professional bodies. The leaflet suggests how such organisations can participate in setting standards and ensuring that they are relevant to real needs. They can, for instance, support working parties and steering committees; send volunteers to workshops; offer venues for meetings; and provide feedback for the EOSG. Contact names are listed in the leaflet.

'A' levels stepping stone to tertiary education

FOLLOWING its success in persuading the Government to revise the subject of technology in the national curriculum, The Engineering Council has now turned to the subject at 'A' level. At present there is no obvious stepping stone from technology in the national curriculum to technology in higher education.

Research carried out by Prof Alan Smithers and Dr Pamela Robinson of Manchester University's School of Education has led them to put forward eight recommendations to the Secretary of State for Education, John Patten.

Their report concludes: "The great difficulty with the technology area at 'A' level is that hardly anyone seems to know what it is or how it is expected to fit in. It lacks a clear concept and identity. Tortuous labels like Design and Technology (Technology), Design and Technology (Design) and Design and Technology (Communication) not only tend to get stuck on the tongue, but leave the subject largely unrecognised in higher education."

The Engineering Council is recommending that there should be 'A/AS' level syllabuses in technology consisent with the national curriculum subject as it is to be re-defined, acting as a bridge to technology at tertiary level. They suggest the simple label 'technology', to make the subject readily recognisable with a sharp focus. They also recommend that engineering and technology departments in higher education should look for evidence of abilities in applying, sythesising and making — such as could be provided by 'A'/'AS' technology — as well as maths and pure science on which they have traditionally recruited. In addition they call for due regard to be paid in vocational qualifications to providing a platform of general education for progression to the next stage, as well as specific mastery of the subject.

October 1992

Transmission and distribution of gas in the emerging markets of Central and Eastern Europe
Two-day conference, 26-27 October, London.
Details from Monique Quant, IBC Financial Focus Ltd, 57/61 Mortimer Street, London W1N 7TD. Tel: 071-637 4383; fax: 071-323 4298.

November 1992

Housing ecology — the quest for sustainable urban living
Course, 2 November — 3 December, Dartington, Devon.
Details from: The Administrator, Schmacher College, The Old Postern, Dartington, Totnes, Devon TQ9 6EA.

An appreciation of modern developments in airport fuelling operations
Short course, 2-3 November, Cobham, Surrey.
Details from Dr Eric Goodger FInstE, RouteSouthWest Ltd, 28E Jessop Road, Norwich, Norfolk NR2 3QB. Tel/fax: 0603 51842.

European fuel and lubricants retailing conference and exhibition
Two-day conference, 2-3 November, London.
Details from Mireia Mangual, WEFA Ltd, 60/62 Margaret Street, London W1N 7FJ. Tel: 071-631 0757; fax: 071-631 0754.

European autumn gas conference 1992
Two-day conference, 3-4 November, Berlin, Germany.
Details from Overview Conferences, 82 Rivington Street, London EC2A 3AY. Tel: 071-613 0087; fax: 071-613 0094.

PetroTech 92
Trade fair, 3-5 November, Amsterdam, The Netherlands.
Details from RAI International Exhibition and Congress Centre, Europaplein, NL-1078 GZ Amsterdam. Tel: +31.(0)20.54912112; fax: +31.(0)20.6464469.

Safety of electrical equipment in potentially explosive atmospheres
Three-day course for scientists, engineers and technical managers, 3-5 November, Bromley, Kent.
Details from Sira Communications Ltd, South Hill, Chislehurst, Kent BR7 5EH. Tel: 081-467 2636 (ext 373); fax: 081-467 7258.

The law and practice of the transport of waste
Conference, 5 November, London.
Details from Christine Rickards, IBC Legal Studies & Services Ltd, 57-61 Mortimer Street, London. Tel: 071-637 4383; fax: 071-631 3214.

Civil engineering aspects of combined cycle gas turbine projects
Conference, 5 November, London.
Details from Miss Carol Chin, The Conference Office, Institution of Civil Engineers, 1 Great George Street, London SW1P 3AA.

The global LPG business — supply, markets and international trading
Course, 9-13 November, Singapore.
Details from the Registrar, The College of Petroleum and Energy Studies, Sun Alliance House, New Inn Hall Street, Oxford OX1 2QD. Tel: 0865 250521; fax: 0865 791474.

Marinflex 92
1st European conference on flexible pipes, umbilicals and marine cables, 10-11 November, London.
Details from Bob Gibbins, Marinflex 92 Conference Secretariat, 2 Tavistock Place, London WC1H 9RA. Tel: 071-837 6362; fax: 071-837 0822.

Elmia subcontractor
Exhibition, 10-13 November, Jonkoping, Sweden.
Details from Anna Small, Engineering Industries Association, 16 Dartmouth Street, London SW1H 9BL. Tel: 071-222 2367.

Doing business with Russia
Conference, 11-12 November, Moscow, Russia.
Details from Financial Times Conference Organisation, 102-108 Clerkenwell Road, London EC1M 5SA. Tel: 071-251 9321; fax: 071-251 4686.

Furnaces Asia 92
Conference and exhibition, 11-13 November, Seoul, South Korea.
Details from FMJ International Publications Ltd, Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS. Tel: 0737 768611; fax: 0737 7661685/760467.

Implications of Biocide use within the petroleum industry
Conference, 12 November, London.
Details from Miss Caroline Little, Conference Officer, The Institute of Petroleum, 61 Cavendish Street, London W1M 8AR. Tel: 071-636 1004; fax: 071-255 1472.

Thermofluid dynamics: computational fluid dynamics
Post-experience course, 16-18 November, Imperial College, London.
Details from Nicky Scott Knight on 071-225 8965 or Caroline Hopkins on 071-225 8873.

The management of irradiated nuclear fuel
International conference, 17-18 November, Manchester, UK.
Details from IMechE Conference Department, 1 Birdcage Walk, London SW1H 9JJ. Tel: 071-973 1318; fax: 071-222 9881.

Technologies for the efficient and clean combustion of lignites
International symposium, 17-18 November, Thessaloniki, Greece. Details from LDK Consultants Engineers and Planners, 7 Sp Triantafyllou Str, GR-113 61 Athens, Greece. Tel: +30-1-8629660; fax: +30-1-8617681.

Thermofluid dynamics: turbulence models for computational fluid dynamics
Post-experience course, 18-20 November, Imperial College, London.
Details from Nicky Scott Knight on 071-225 8965 or Caroline Hopkins on 071-225 8873.

NVQs opportunities and implications
Symposium, 18 November, London.
Details from Roger Bradley, Projects Manager, FETA, Sterling House, 6 Furlong Road, Bourne End, Bucks SL8 5DG. Tel: 0628 531186; fax: 0628 810423.

4th International festival of films on Energy
18-21 November, Lausanne, Switzerland.
Details from Direction du Festival International du Film sur l'Energie, Lausanne (FIFEL) Case postale 88 — Chauderon, 1000 Lausanne 9, Switzerland.

Energy efficient refurbishment of social housing
Seminar, 19 November, Altrincham, UK.
Details from Peter Weedon, Camargue House, Wellington Road, Cheltenham, GL52 2AG.

NEMEX '92
National Energy Management Exhibition & Conference, 24-25 November, Birmingham, UK. Details from ESTA, PO Box 16, Stroud, Gloucestershire GL5 5EB.

December 1992

Electricity purchasing strategies for the over 100 kW user
One-day concentrated briefing, 1 December, London.
Details from Starform Communications Ltd, Heather House, Heather Gardens, London NW11 9HS.

INSTITUTE OF ENERGY CONFERENCES

The following programme is currently being organised by The Institute of Energy.
For further details please contact the Conferences Department, Tel: 071-580 0008 or Fax: 071-580 4420

1992

15 October — **UK COAL '92 - OPPORTUNITIES FOR TRADE**
Venue: The Cafe Royal, London W1
Chairman: Dr Andrew Cox *(UK Coal Review)*

25 November — **ENERGY, TRANSPORT & THE ENVIRONMENT**
Venue: The New Connaught Rooms, London WC2
Chairman: Prof Tony Ridley (Imperial College)

1993/94 Proposed Programme (titles to be confirmed):

Air Pollution	London	April
Dash for Gas	London	May
Energy and the Greenhouse Effect	London	June
Combustion	London	September
UK Coal '93	London	October
Energy from Waste	Glasgow	September
Making Energy Privatisation Work - The future of regulation	London	November
Energy in Ceramics Applications	London	early 1994

Conferences co-sponsored by The Institute of Energy

13 October — **Natural Gas Vehicles — The Way Ahead to a Cleaner Environment**
Contact: David Suthers, Combustion Engineering Association
Tel: 0685 879119/874201

5 November — **Civil Engineering Aspects of CCGT Projects**
Contact: Carol Chin, IoCE on 071-839 9803

1993

17 March — **Waste Management Duty of Care**
Contact: David Suthers, Combustion Engineering Association
Tel: 0685 879119/874201

Mid March — **The Use of Oxygen in Combustion**
Contact: David Suthers, Combustion Engineering Association
Tel: 0685 879119/874201

22/23 March — **3rd International Conference on Desulphurisation**
Contact: IChemE on 0788 578214

Energy World Yearbook 1993

The 1993 Energy World Yearbook is due to appear in February 1993.

Covering every aspect of the energy scene, the 1993 Yearbook will include: a comprehensive and extensive buyers' guide, technical and bibliographic data, as well as information on The Institute of Energy, worldwide energy events, awards, education and training, funding programmes, European organisations and associations. Members of the Institute of Energy receive a free copy of this valuable publication.

However, if you are not a member, but would like to receive a copy, you may subscribe before 31 December 1992 for the cost of the 1992 subscription, £35. Simply fill in the coupon below, and send to: H Howland Associates, The Martins, East Street, Harrietsham, Kent ME17 1HH. Tel/fax: 0622 850100

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