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ATOM

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Enquiries concerning the content and circulation of the bulletin should be addressed to the Editor,
James Daglish
Information Services Branch UKAEA
11 Charles II Street
London SW1Y 4QP
Telephone 01-930 5454

Information on advertising in ATOM can be obtained from
D.A. Goodall Ltd., New Bridge Street House
30-34 New Bridge Street
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Telephone 01-236 7051/4

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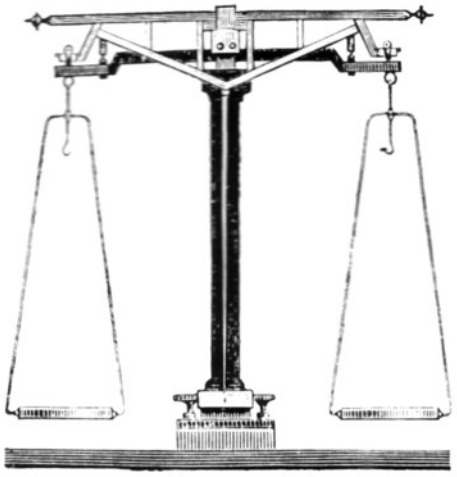
Front cover: The changing skyline—Hunterston B on the left and Hunterston A on the right, on the Clyde coast near Largs, Scotland

MISUNDERSTANDING NUCLEAR POWER

Proponents of nuclear power tend to rely on technical arguments based on probability analysis of risk and what they see as the clearly defined world need for nuclear power. From this standpoint, objectors are seen as misinformed, irresponsible or even mischievous, and a great deal of impatience is therefore developed as a result.



The supporters of nuclear power are seen by their opponents as technocrats, concerned with building bigger, better and more expensive devices for their own gratification; as bureaucrats unconcerned with the welfare and desires of ordinary people; or as fabricators of evidence, designed to mislead the layman.

Sir Francis Tombs, newly-installed President of the Institution of Electrical Engineers, mused on the reasons for the widely differing perceptions of opposing factions in the nuclear debate in his inaugural address in London in October—pointing out that development of "this huge energy resource" requires the consent of the majority. The uncommitted have to be persuaded to spend the time necessary to understand the issues and to evaluate the arguments in an objective way.

Resolution of opposing views of nuclear power is important, but it may be useful to define the area of argument and to understand the issues which motivate the contenders before trying to reach a solution, Sir Francis suggested. The word pictures above were of course caricatures. Most supporters of nuclear power were sincere in their belief that it offered enormous benefit to mankind, and were concerned to discharge their responsibilities honestly and efficiently; most supporters of nuclear power, on the other hand, saw objectors as irresponsible, illogical and sometimes politically motivated. They believed that objectors acted for self-gratification without reference to the greater good: but this too was a caricature, for many objectors were motivated by a sincere concern for the safety of the present generation and for the level of risk bequeathed to succeeding generations.

"Opposition to technological development is not new; we have only to think back to the industrial revolution to see both intellectual and practical examples of such opposition," said Sir Francis. "The Luddites broke the new mechanical looms in Nottinghamshire, and intellectuals such as Morris, Ruskin and Carlyle used impassioned arguments about the debasement of man's state by the march of technology and the development of the factory age.

"There is room for dispute about the balance of advantage of many technological developments, but we might pause to reflect on those areas where technological advance has produced results which could be generally regarded as beneficial—water supply, sewage, electricity, mass travel: all of these are technologies which met their initial detractors.

"Fear of our ability to control the technological future is therefore not new. But it has, today, reached a new level with the aid of the mass media, consumer movements and the welter of legislation dealing with health, safety and product liability. Indeed, a colleague of mine was moved to remark recently that if window glass were to be invented today it would be judged far too dangerous to use."

Opponents of technological change 150 years ago had their counterparts today. Edward Banfield, Head of the Social Science Department at Harvard, believed that western society faced a serious crisis, and asked whether man could continue to live in cities with their long journeys to work, the urban sprawl and air pollution; he likened industrial progress to the mechanical hare at a race track, made to keep ahead of the dogs no matter how fast they ran, seeing in this analogy the problem of rising expectations, which tended to out-pace real progress. Model villages of the early 19th century had their escapist equivalent today in communes, which tended to be equally short-lived; the "Small is Beautiful" movement had its roots in the same arguments, and opposition to nuclear power was accompanied by opposition to motorways, airports and large installations of all kinds.

"Now, it is one thing for western society, comfortably clad, well fed, mechanically transported, to cry 'stop' to future progress," said Sir Francis. "It is an entirely different question for the teeming masses of the underprivileged people of the Third World. For them flood and famine are everyday events, and any improvement in their lot depends upon a plentiful supply of energy. A recent study showed that one-third of the world's population, about 1½ billion people, have as their only source of energy animal dung, cropwaste or trees. Clearly, the first two should be returned to the soil, and extensive use of the third source, timber, is resulting in deforestation and consequent creation of deserts at an alarming rate. Indeed, it is estimated that by the end of this century, when the world population may have doubled, the available arable land will have been reduced by 10 per cent as a result of allowing new deserts to be formed. Seen against this background, the need to conserve fossil fuels and especially oil is paramount, and industrialised nations of the world should surely be making this their highest possible priority in order to make those easily-used fuels available for the poorer, more needy nations.

The largest nuclear reactor serving mankind . . . symbol of protest

"At this point in the argument, the thinking objector generally challenges – with some cause – estimates of future energy supply and demand. The supply of traditional fuels is, he argues, readily supplemented by renewable energy sources such as energy from the sun in the form of direct radiation, wind, waves or hydro power or by energy from the earth in the form of geothermal power or by energy from the tides.

"That all of these are bountiful sources is beyond question. The earth and its atmosphere receives some 5 000 Q of solar energy a year, each Q representing a million million million British thermal units (BTU). This amount of solar energy received each year is at least an order of magnitude greater than the total thermal energy stored in the world's coal resources but, normally, one-third of the solar flux is scattered back into space by the outer layers of the atmosphere, while the remainder is diffused over the surface of our planet in an uneven and intermittent way. It is this diffuseness and intermittency that makes the collection of energy from the renewable sources so expensive. The diffuseness requires extensive capital investment, while the intermittency requires storage arrangements or the provision of standby energy sources.

"The world problem is, therefore, not a shortage of energy but a shortage of economical energy. In general, economical energy is supplied by high density sources. Coal and oil are obvious examples, but the density of energy in uranium exceeds even those. On the other hand, the capital cost of using uranium as a fuel is high due to the extensive safety precautions which have to be adopted in nuclear power stations and ancillary activities."

Sir Francis digressed to make the point that investment in unattractive projects, whether for the supply of energy or for economy in use (the aim of the conservation movement) could only be undertaken by doing without other, more attractive projects and thus diminishing overall prosperity. Preoccupation with economic returns on energy investment was only a special case of a more general approach to the wiser use of capital for the optimum benefit of mankind. Preoccupation with limited supplies of fossil fuel was not a new problem, though it loomed larger today than in the past because of the accelerating rate of consumption.

Objections to nuclear power

Sir Francis next turned to objections to nuclear power, first those motivated by self-interest. The self-interest might be economically based, or "enthusiasm based". Among the economically based self-interested were some miners who might see their future bargaining position in peril – although it was worth noting that the official National Union of Miners' and National Coal Board line was to support nuclear power, recognising the need for both coal and nuclear power to contribute as substitutes for failing oil supplies.

Among the enthusiastically self-interested were some of the proponents of novel energy sources, usually renewable ones. Faced with the fact that many such sources required large capital investments, because of their diffuse and intermittent nature, some enthusiasts attacked the principle of nuclear power in the hope of leaving more room for their pet projects.

Another group of objectors were conservationists, some of whom appeared to put conservation of inanimate resources on a higher plane than the welfare of mankind. "It has often struck me that an organisation known as 'Friends of Mankind' would be more appropriate than the well-known Friends of the Earth, although I hasten to add that, in general, the Friends of the Earth are among the more moderate and rational of the conservation groups," said Sir Francis. "But here again, enthusiasm is sometimes invoked to attack nuclear power *per se,* in order to preserve a particular conservation standpoint. Among such approaches can be found the confident assertions that more conservation, coupled with

solar power, will solve all of our problems—an assertion which does not survive careful analysis.

"Some other objectors are those which I describe as 'crusaders', motivated by the need to embrace a cause and to fight for it. We see them in opposition to motorways, airports, reservoirs, pipelines and the like. They are distinct from local objectors, who have an understandable urge to protect their immediate environment. Crusaders are commonly characterised by extreme dedication and their approach is usually an emotional one, scorning rational arguments. For example, we have SCRAM, the Scottish Campaign to Resist the Atomic Menace, and other organisations whose names betray their provenance. Passionate sincerity to the exclusion of logic is not a new phenomenon. It can be found in religious and revolutionary movements throughout the centuries, but its invocation brings considerable dangers, especially when applied to matters of great import to the welfare of man."

People who protected their own local considerations, he supposed, could also properly be described as self-interested; commonly, they recognised the need for the development in question but argued the case that it should be sited elsewhere, where they would be less incommoded and perhaps where the overall inconvenience would be less. Finally, there were those concerned with the balance of advantages and disadvantages, who were honestly worried that the minuses might outweigh the pluses.

"Of all the groups of objector, this is the one which needs to be taken most seriously," said Sir Francis. "Its motivation is essentially responsible and usually carries a genuine desire to understand and evaluate the arguments. The technological nature of the arguments and the emotional way in which they are presented from both sides makes the task a difficult one."

Approaches to these roughly-drawn categories of objectors were different: the first category, those who were essentially distrustful of technological change, were unlikely to be convinced by numerical argument, no matter how convincing. Their distrust was often reinforced by a general scepticism about authority and the decisions of the establishment. The enthusiastically self-interested valued their ideals too highly to relinquish them easily, and they too would not easily be convinced by numerical arguments. The crusader often needed a cause which he could embrace as an outlet for his sense of social responsibility and sometimes as a panacea for frustration; his crusade was too precious to be given up in response to cold logical argument.

"If I seem to readily accept the apparently uncompromising stance of these classes of objectors, it is because I believe they contribute substantially to the fabric of society through the sheer scepticism of their beliefs," said Sir Frances. "In any democracy there is room for dissent and if a small part of that dissent cannot be overcome by open argument, then we should cheerfully recognise its persistence. But I believe that such people are relatively small in number and that we should concentrate on the last category of objector—those who are honestly worried about the balance between advantages and disadvantages.

Headlines

"How do such people gain their information? The unfortunate fact is that they gain it mostly from newspapers, magazines, radio and TV, which collectively compose the communications media. This is unfortunate because, with a few exceptions, the media are concerned with impact rather than accuracy—partly no doubt because of the pressure of deadlines, but partly also because their audience prefers entertainment and titillation rather than sober instruction.

"From the viewpoint of the earnest seeker of knowledge this is unsatisfactory. He is assailed by ill-digested stories and prophecies of disaster. Success is a dull story; the thousands of uneventful air journeys which are made daily are not news; the occasional crash is good for a headline.

"The same applies to nuclear power. The 25 years or so during which civil nuclear power has been developed have seen no disaster or damage to the public, yet apprehension has produced banner headlines, and could well do so again tomorrow.

"Why is it that the thousands of deaths from road accidents, air crashes, natural disasters such as earthquakes or floods, famine and diseases are so calmly accepted and yet the hazards of nuclear power are so feared in spite of its substantially unblemished record? Whatever the reason may be, the honestly worried individual finds plenty of cause for worry in the constant stream of reports and comments from the media. He receives a steady stream of biased information and speculation and he must be superlatively sceptical or well-informed if he finds himself able to discount the bias. True, there are plenty of books on the subject but, since they tend to be quite technical in character, they are not always easy for the lay reader to digest. Also, to complicate matters, there are books written by both protagonists and antagonists which, not suprisingly, reach different conclusions.

"So we are faced with an issue of great importance in which the evidence is technically complex and emotions run high. Some respond by choosing the easy route—by accepting wild claims at their face value and rejecting nuclear power. Such a solution, while having the merit of simplicity, is irresponsible in that it avoids the need to analyse the evidence and arguments. Its adoption is encouraged by emotive phrases such as that describing nuclear power as a 'Faustian bargain' and by grossly incorrect statements such as the claim that 'plutonium is the most toxic substance known to man'.

"I believe that an intelligent audience requires more than slogans and assertions."

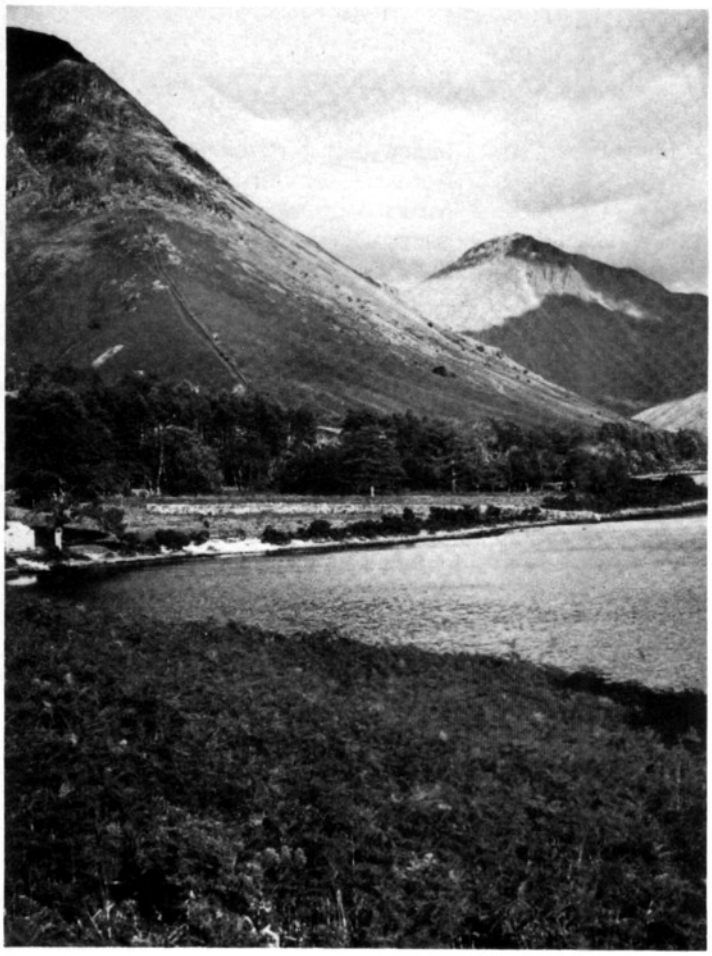
The roots of fear

Sir Francis said the atomic bombs dropped on Hiroshima and Nagasaki had undoubtedly set a terrifying background for the discussion of nuclear issues. The link between the atomic bomb and nuclear power was however as automatic as it was unjustified; it was false and dishonest. The construction of a nuclear power station was such that it was physically impossible for one to explode like a military weapon.

There was however concern that a link could exist between nuclear power and weapons in that nuclear reactors produce plutonium. This concern was connected with two routes for weapons manufacture—the "official" route covering actions by Governments leading to the proliferation of weapons states, and the "unofficial" route involving possible actions by terrorist groups. As to proliferation of nuclear weapons, it must be said that civil nuclear power stations represented a time-consuming and expensive route, requiring complex technology for the separation of plutonium from irradiated fuel. Any state wishing to acquire a nuclear weapon had a range of options of lower cost available to it, involving the separation of uranium-235. It was a matter of no surprise that this appeared to have been the course favoured by new weapon states.

That said, given that uranium-fuelled reactors produce plutonium and that plutonium was the preferred material for nuclear weapons, there was clearly a problem. The solution to it must lie in effective international control, for which the techniques were established. Governments had to act together to establish and reinforce the safeguards in order to control the storage, use and security of plutonium. Sir Francis noted in passing that fast reactors offered the prospect of being convenient and efficient devices for controlling plutonium stocks.

"A great deal has been written about the ease with which a terrorist group could make a primitive atomic bomb and so



Hills of the English Lake District . . . *CLI*

hold the public to ransom," he continued. "Suffice it to say that the task would be exceedingly hazardous to the terrorists themselves, and that the results would be somewhat unpredictable. There are much more predictable, less risky options for terrorists to blackmail society than by the clandestine manufacture of nuclear 'devices'."

Further, the imperceptibility of radiation by human senses could lead to deep-seated fear. But radiation of natural origin was a part of everyday life; wide variations existed in background radiation and the contribution of the nuclear power programme to the total dose received by the population was very small – well within these variations. One result of the general concern about radiation was that a vast amount of research had been carried out into its effects, so that it was probably one of the best understood factors in human life and death. "Curiously, the very intensity of this study has fuelled concern about its importance as a hazard, whereas the paucity of information about other hazards leads to their tacit acceptance: a strange reaction indeed!"

People were worried, and rightly so, about the possibility of a major accident at a nuclear power station which might result in a large release of radioactive products from the reactor core. This possibility was guarded against by multiple safeguard systems designed first to prevent the nuclear fuel from overheating and second to prevent the escape of active species to the environment. For a major accident to occur and to result in a substantial risk to the public would require a number of things to go wrong at the same time. All of the safety steps and barriers were highly developed, with safety as the prime object, and the safety systems were independently duplicated or triplicated.

"Because of its comparatively recent development, safety engineering and analysis in nuclear power is uniquely thorough and is approached only by that of the aircraft industry," said Sir Francis. "Both industries put safety first among their considerations, and both have developed risk analysis to a very high order with notable success – as can be seen from their safety records. . . .

"The point is that we do what is possible and prudent, individually and collectively, to ensure that risks in everyday life are acceptably small, so that the balance of advantage makes the activity worthwhile. The same is true of nuclear power. Each of the successive safeguards built into the design has a low probability of failure so that a coincident failure has a very low probability indeed – very much lower than many other activities which we so readily and unquestioningly accept.

"In all this discussion of risk we must not forget that the alternatives are not themselves risk-free. So, for example, coal-mining is a hazardous operation, and during the 30 years to 1977 in this country alone 8 001 miners were killed underground and almost 50 000 were seriously injured; combustion of fossil fuels produces extensive atmospheric pollution with resulting health hazards and some of the products of combustion give rise to concern about future climatological effects. In all of these comparisons nuclear power has much to offer."

The final cause for concern Sir Francis considered was the storage of active waste. There was no escaping the fact that the long lives of some active products posed special problems of security in storage, he said. The method used at present and in the past had been to store such products in liquid form in multiple-skinned tanks, the interspaces of which were monitored so that any leakage could be detected while still contained. Such methods had been successful but relied upon continued reliable supervision. More recently, vitrification had been developed; contained in a stable glass and enclosed in stainless steel the storage of waste products could be contemplated confidently for the future. Suitable storage places for canisters so constructed would be in geologically stable deposits of granite, salt or clay: the security of such stores would be easily assured, and their isolation from water supplies would be assured by their containment and by the low leachability of the glass.

"Incidentally and interestingly, Fred Hoyle has pointed out that:

> 'The hills of the English Lake District generate within themselves as much radioactive energy as would come from the buried waste products of three or four large nuclear power plants. This natural radioactivity, lying above sea level, inevitably has the heavy rains of the Lake District percolating through it, not water that is imagined to rise miraculously upward from great depth. Yet experience has shown that the natural radioactivity of the lakeland hills does *not* wash out in our streams and rivers'."

Sir Francis concluded: "So much, then, for matters of concern to the open-minded but uninformed. They have, on the one hand, the needs of mankind for energy coupled with falling oil supplies and on the other the media desire for sensational stories and the evangelism of the nuclear opponents. Yet it is the consent of the majority that is necessary for the development of this huge energy resource. The uncommitted have to be persuaded to spend the time necessary to understand the issues and to evaluate the arguments in an objective way. I have done my best, committed as I am, to help them.

"Perhaps, in closing, it is interesting to reflect that the mental confusion of the more vociferous objectors to nuclear power is shown by their use of the sun as a symbol of their opposition – the sun, which is the largest nuclear reactor known to mankind, a prolific source of cosmic radiation, and the essential provider of life on earth. Here, surely, is a real need for enlightenment." □

The complete text of Sir Francis' lecture is available as a reprint from the IEE, Savoy Place, London WC2R 0BL; and will appear in the IEE *Proceedings*, Part A, Vol. 129, No. 1, January 1982.

Energy and Society

Peter Saunders, of the Nuclear Environment Branch at AERE Harwell, reviews a colloquium on Energy and Society, organised by the Groupe de Bellerive in conjunction with the Academie des Sciences de l'Institut de France, held in Paris on 16-18 September 1981.

The subject of the meeting – Energy and Society – was a very broad one and the papers ranged from general reviews to detailed technical papers requiring considerable technical knowledge to follow. Some of the sessions were not well balanced. For example, K.Z. Morgan and A. Stewart gave papers suggesting that the ICRP estimates of the health risks of radiation were wrong by an order of magnitude and that observations around Three Mile Island showed significant damage to health resulting from the 1978 accident. These views are strongly rejected by the great majority of experts and by all the independent reviews recently published on these subjects, but there were no papers summarising the more generally accepted views on the risks of radiation. Some of the papers were somewhat familiar to anyone who has followed the nuclear debate in recent years. These included Grove-White's on civil liberties, Lovins' suggesting that an advanced industrial country such as France could "operate an economy larger than today's with no changes in life-style, using no thermal power stations of any kind – old or new, fuelled with oil, gas, coal or uranium", and Rotblat's on proliferation risks, calling for a halt to fast reactor development, the phasing out of thermal reactors and a change to alternative energy sources.

An excellent series of papers reviewed the overall world energy situation and the size of the primary resources (oil, coal, uranium, solar, geothermal, biomass, etc.). There were no significant departures from the conclusions of recent major studies such as the World Coal Study and the World Energy Conference. The solar energy paper pointed out the importance to all but the most highly industrialised countries of developing decentralised power sources such as the solar source. The French solar energy programme was described as the largest in the world in terms of research expenditure *per caput*. It was extremely important that biomass plantations for energy should not replace food plantations; energy crops should only be grown on what was now essentially abandoned or badly used land. The danger to the world's ecology from further destruction of forests was also stressed.

Major differences of opinion emerged from a series of papers on the nuclear fuel cycle as being developed in France, with emphasis on the question of indefinite storage or reprocessing of spent fuel. The CEA and EDF views were that reprocessing was essential to ensure that uranium provided more than a short-term easing of energy supply problems. In addition to the inherent disadvantages of throwing away a vast energy resource, techniques for the long term management and disposal of unreprocessed spent fuel had only been studied on paper and major research programmes would be required before the process could be judged to be safe. In contrast, the management of reprocessed wastes has been extensively developed, principally in France and the UK; vitrification was now an established technology and all the studies of storage and disposal methods indicated that safe management of these wastes could be achieved without undue difficulty.

Two papers opposed this view. Shapira claimed that the costs of reprocessing had been seriously underestimated, and that reprocessing inevitably resulted in the discharge of some plutonium to the environment. Evidence from studies of the natural reactor at Oklo indicated that the best long-term way of retaining the plutonium was within the spent fuel itself. Finon argued that since the only object of reprocessing was to recover plutonium all the associated costs should be shown as fuel costs for fast reactors. As a result, these would only become economic if uranium prices rose to very high levels. He claimed that there was no justification for the current large French fast reactor programme. In the subsequent discussion, which was curtailed because of lack of time, Vendryes (CEA) stated that on the basis of current estimates of reprocessing and construction costs, fast reactor generating costs would be comparable with those of coal-fired stations, both being about twice the generating cost of PWRs. The main object was now to reduce the costs of fast reactors and the fuel cycle.

A more general session on energy policy and the relative contributions from conservation, electricity and other forms of energy included the Lovins paper already mentioned. Much of the argument hinged on assumptions about future economic growth rates. Komanoff's analysis of comparative costs of coal and nuclear energy was based entirely on his interpretation of American figures and his suggestion that EDF's costings, showing significant savings from nuclear power, were in error was vigorously criticised by EDF.

Sant described an interesting model, developed at the Mellon Institute in the USA, which analysed what would happen if the only influence on energy systems was purely internal market forces: a "least cost energy strategy". For the USA this would lead to greatly increased use of coal by the year 2000 but no increase in the use of electricity. The analysis suggested that US Government money would be better spent in encouraging business and consumer choice and letting market forces operate than in trying to pursue any particular energy policy such as development of syn-fuel, solar, coal or nuclear. Sant did not suggest that the results were of any direct relevance to the European situation.

Reviewing the comparative risks of nuclear and other sources of electricity, Gauvenet concluded, as many other studies have done, that hydro, gas and nuclear were significantly safer per unit of electricity than coal and oil. However he stressed that all the risks were so small compared say, with those of driving, tobacco and alcoholism, that comparative risk assessment should not play a major part in energy decision making processes.

Two papers on fast reactor technology led to a discussion in which it was clear that the low probability/high consequence problem was far from well understood. Some members of the audience believed that any technology that could conceivably result in very large accidents was unacceptable irrespective of how improbable such accidents were, and there was absolutely no meeting of minds between the scientists and the non-scientists on this issue. Perhaps this dilemma will only be resolved through a growing appreciation that many activities that are accepted as part of modern society, such as flying over densely populated areas, the construction of large dams, and the manufacture, transport and storage of

petrochemicals, also carry very small risks of very large accidents.

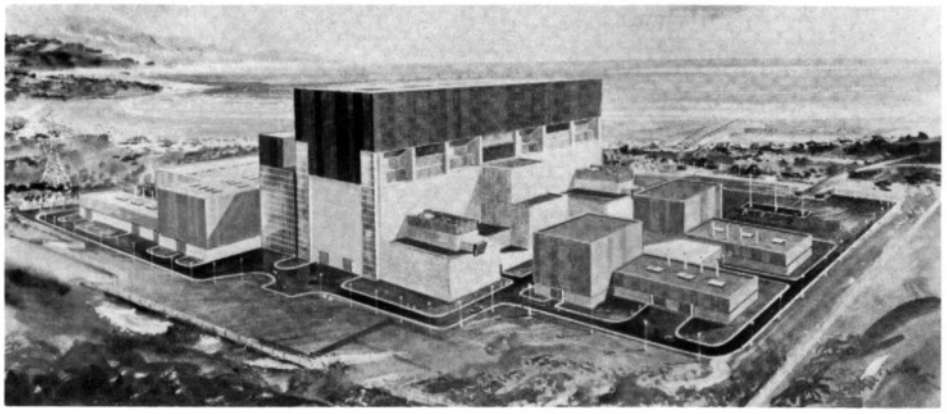
The final sessions included some discussions of the social implications of nuclear power, but concentrated mostly on the workings of the French decision making system. Rotblat's fears that the further development of civil nuclear power could only lead to the proliferation of nuclear weapons were not shared by Goldschmidt or by Petit, who concluded: "So the aim of non-proliferation and the problem of technological and energy development are at the heart of the political implications of international nuclear affairs. Contrary to appearances these aims are not opposed. Since man has never moved backwards in the field of science, the development of weapons will not be prevented if the countries which have now mastered nuclear energy stop or limit its civil development. On the contrary, the feeling of frustration and deprivation of energy which would result for the excluded countries could only push them towards developing programmes with military objectives themselves".

In a two-speaker debate on the democratisation of French energy decision making processes Belorgey made a case for more public involvement but Hamelin asked whether one really needed a special decision making process for nuclear power when no special processes were used for other key issues of national importance such as defence and education. This did not mean that there was not scope for making the process more democratic. Clearly more information could be provided – on economic growth, alternative energy choices, costs, etc. and there was a need to make scientific facts and data more generally understandable. However, procrastination *per se* had to be avoided and too many decision making centres could lead to paralysis of the decision making process. The final decisions must be taken by Government. The encouraging energy scene in France was due principally to firm Government decisions taken since the oil crisis.

Overall the conference succeeded in providing a platform for diverging views on energy matters and the place of nuclear power. Whether any of the more extreme views were in any way modified as a result is more doubtful.

P.A.H. Saunders
Nuclear Environment Branch
AERE Harwell

Heysham AGR contractual arrangements agreed



The National Nuclear Corporation and the Central Electricity Generating Board signed on 15 October an agreement on the contractual arrangements between them for the construction of the second AGR nuclear station at Heysham, Lancashire.

Although these contractual arrangements had been in operation for some time, it was agreed that a status report on all aspects of the project should be prepared and reviewed jointly before the agreement was signed. This review was completed, and both organisations expressed themselves satisfied that Heysham II was on course for completion of the first reactor early in 1987, and the production of electricity for the national grid by mid-1987. The second reactor at the station is planned to be completed a year later. The cost of the station at March 1981 prices is £1·43 billion (£1·27 billion at March 1980 prices), including initial fuel.

The agreement was signed in London by Dr Ned Franklin, managing director of NNC, and by Dr Ian Preston, Director-General of the CEGB Generation Development and Construction Division. Under the agreement, NNC is reponsible for the outline design of the station, preparation of the overall nuclear safety case for approval by the CEGB and presentation to the Nuclear Installations Inspectorate. NNC are also responsible for the detailed design of the nuclear "island", and coordination of construction work within the nuclear island.

Contracts for the nuclear island, representing about half the total cost of the station, have been or are to be let by NNC, the contracts being drawn between the CEGB and the suppliers. NNC, who have been appointed the Board's agents for the construction of the nuclear island, will administer these contracts. The CEGB is to manage directly all contracts for the station's conventional plant. These arrangements are seen as giving acceptable protection for the Board against the commercial risks of the project.

Based on the successful Hinkley Point B station, the design of Heysham II has been updated to take account of design, manufacture, erection and operational experience, and it follows a detailed review by the CEGB of the causes of delays in power station construction and a study of other major projects in the UK and abroad.

Speaking after the signing of the agreement, Mr Dennis Lomer, a CEGB executive board member, said that Heysham II would create some 150 000 man-years of work, much of it in areas where unemployment was at a high level. The South of Scotland Electricity Board's Torness AGR project would create similar job opportunities. In addition, the two stations would maintain a nuclear capability which might have been lost if further stations had not been ordered.

Mr Lomer said that while industrial relations and productivity on sites had been a major problem in the past, over the past two years the industrial relations scene had improved considerably. The latest coal-fired station to be started, at Drax in Yorkshire, which was based on many of the concepts being used for Heysham II, was on target.

"The new concept for improving construction performance and reducing industrial unrest on site which were introduced for Drax completion are also being implemented at Heysham and this, together with other actions being taken nationally to harmonise conditions and rates and to foster better industrial relations, thereby improving productivity, give good hopes for a successful construction phase," he said.

Mr Lomer went on to stress the vital importance of building large projects to time. Whether in the public or the private sector, it was viable to embark on large projects only if the client could be sure that they would be completed to time and budget. □

BOOKBRIEFS

Who? What? How?

World Nuclear Directory, 6th edition. ***Francis Hodgson Reference Publications, October 1981; 1050 pp; £70. ISBN 0 582 90010 7.***

This directory appeared first in 1961; the fifth edition was published as the Nuclear Research Index in 1976. This new edition carries information on 2 500 organisations in more than 90 countries which conduct, promote or encourage research in the nuclear field – liberally defined to cover everything from nuclear and high energy physics, through reactor technology and instrumentation, materials and manufacturing in the nuclear industry to law and insurance and economics and forecasting and a multitude of other topics beside. The presentation is alphabetically by country, indexed by title, keyword and subject. Valuable on the library shelf: but what a pity the cost is so high, especially as some of the entries (e.g., that for the UKAEA) have been outdated during production.

The Multilingual Energy Dictionary. Dr Alan Isaacs, Ed. ***Frederick Muller, November 1981; 284 pp; £10·95. ISBN 0 584 95568 5.***

Indispensable for anyone who wishes to know that a fast breeder reactor is a *Schnellbrüter* in Germany, a *reactor reproductor rápido* in Spain, a *réacteur surrégénérateur rapide* in France, a *reattore veloce autofissilizzante* in Italy and a *reactor reproductor rapido* in Portugal – or needs translation of 1 599 other terms to or from the six languages used. Potentially I would have thought of greatest use to the energy specialist reading outside his own field.

Elements of Nuclear Power, 2nd edition. D.J. Bennet. ***Longman, June 1981; 232 pp, indexed; £7·95. ISBN 0 582 30504 7.***

This is a useful introduction, based on a one-year course given to final year students of mechanical engineering at the University of Strathclyde, to the principles of electricity generation from nuclear fission. The discussion is lucid, though it assumes a good working knowledge of mathematics – understandably, given the intended audience.

Fast Breeder Reactors: An Engineering Introduction. A.M. Judd, Dounreay Nuclear Power Development Establishment. ***Pergamon,*** **1981;** ***161 pp, indexed; £10·50 (hard cover), £5 (flexi.). ISBN 0 08 023220 5 (h) and 0 08 023221 3 (f).***

Judd's stated purpose is to introduce the newcomer to the study of fast reactors, either as a student or at a later stage of his career. The book will be most useful to someone who already has some knowledge of reactors. Judd acknowledges in the preface that it is not comprehensive; but there is an extensive list of references. As is implied by the title, the treatment throughout is solidly grounded in practical considerations of real reactor engineering requirements.

James Daglish
Editor, ATOM

ACHE to improve

The "crowding" of air-cooled heat exchangers – ACHE for short – in banks results in a far greater deterioration in their performance than had been believed.

Tests carried out by the Heat Transfer and Fluid Flow Service at AERE Harwell on a large ACHE test rig confirmed that the effects of inlet-air flow restriction were much worse than had been assumed in current design practice. The results of the test point to the need for a new approach to the layout of large banks of exchangers as used typically in the oil and chemical industries.

The results of this investigation, together with those from other HTFS programmes on boiling, condensation, two-phase flow and fouling were presented at the HTFS Sponsors' Research Symposium held in Oxford recently. HTFS, which is operated jointly by Harwell and the National Engineering Laboratory and is funded by industrial sponsors and by the Department of Industry's Materials and Chemicals Requirements Board, carries out major research programmes on industrial heat transfer. The results of the research are incorporated in design reports and computer programs and made available to industry through the HTFS Subscription Information Service.

Enquiries about HTFS should be addressed to Dave Butterworth, Project Manager HTFS, Building 397.2, AERE Harwell, Oxon OX11 0RA; tel. 0235 24141, ext. 4762. □

HTFS woos smaller companies

The Heat Transfer and Fluid Flow Service has introduced a new scale of membership subscriptions to encourage more of the smaller UK heat transfer equipment manufacturers to use its information and advice.

Under the new arrangements, the 1982 subscription fees for small to medium sized manufacturers (those with an annual turnover less than £70 million) will be £2 400 – in effect, a 30 per cent reduction. Discounts have also been introduced in subscriptions from smaller UK process engineering contractors and users of heat transfer equipment.

The HTFS project manager, Dave Butterworth, said the change was designed to persuade smaller companies to use a service which would help them compete in international markets. HTFS design codes were widely accepted as international references, and were often specified by process plant operators and contractors. HTFS already served some of the world's largest companies, but many smaller organisations had now acquired the computer and design facilities which would allow them to use HTFS methods.

HTFS is operated jointly by Harwell and the National Engineering Laboratory, and is funded by industrial sponsors and the Department of Industry's Minerals and Chemicals Requirements Board. It carries out major programmes of research into all aspects of industrial heat transfer, and uses the Subscription Information Service to transfer the results to industry. Enquiries about the service should be addressed to Dave Butterworth at Building 392.7, AERE Harwell, Didcot, Oxon. OX11 0RA; tel. 0235 24141, ext. 4762. □

Risk, cost and pollution

Lord Ashby, distinguished environmental scientist, educationalist and former chairman of the Royal Commission on Environmental Pollution, is to give the keynote address at the seminar on Risk, Cost and Pollution to be held in Oxford in April next year.

The seminar, which is the fourth in the Harwell Environmental Series, will examine the theory and practice of pollution control in Britain, Europe, America and the Third World, and the relationship between perceived environmental risks and real pollution problems. It will consider techniques for striking the balance between risks and costs in a range of industrial activities; and will aim to provide a 'workshop' atmosphere for detailed

discussion of the issues.

Other distinguished speakers include: Dr M.Nay Htun of the United Nations Environmental Programme and Mr Delogu of the EEC Environment and Consumer Protection Service, who will lay down international perspectives; Mr J. Beighton, of the Health and Safety Executive and Mr J. Elkington, Director of Environmental Data Services Ltd, who will consider current practice and the economic, social and political factors which shape environmental awareness; Prof. T.R. Lee, of the University of Surrey, who will examine perceived risks and public anxieties; and Dr G. Munday of the Insurance Technical Bureau, who will consider risk assessment techniques. Full programme details will be announced later.

The seminar will be held on 14 and 15 April at the Inorganic Chemistry Laboratory, Oxford University, with optional accommodation at Wadham College. Further details of conference fees and registration forms can be obtained from Mr L. Evans, Harwell Education and Training Centre, AERE Harwell, Oxon. OX11 0QJ; tel. 0235 24141, ext. 3106. □

New head for EC R&D

Mr Paolo Fassella, a noted biochemist and professor at Rome University, has been named successor to Dr Günter Schuster as head of the European Commission's recently streamlined science and research activities.

Professor Fassella was born in Rome, and graduated from the Medical School of the University of Rome in 1954. He received a Ph.D in biochemistry in 1960 and was associate professor at Rome from 1963 to 1968. He has done research and taught at MIT and Cornell in the United States, and became full professor at Parma in 1968, returning to Rome in 1971. Since 1970 he has been involved in a consultative capacity in industrial and biomedical applications of biochemistry.

In 1972 Prof. Fassella was appointed chairman of the European Community Commission for Radiobiology and Molecular Biology, and from 1973-77 he was president of the European Molecular Biology Conference. In 1979 he became a member of the European Committee for Research and Development (CERD), the Commission's principal scientific advisory body. He has published more than 140 scientific papers on various aspects of biochemistry; his most recent work has been concerned with the structure and function of several brain-specific proteins. □

Dating the past

A major improvement in carbon-14 counting facilities at AERE Harwell offers new opportunities to scientists and archaeologists by allowing measurements on samples weighing as little as 10 milligrams. It is to be used by the Low-Level Measurements Laboratory at Harwell in environmental, geological, hydrological and nuclear studies and in the investigation of archaeological finds.

The first commercial application has been in the authentication of barbarian gold and silver treasure to be sold by Sotheby's in London on 14 December. The treasure comprises 122 gold and silver belt fittings which, after extensive research, is believed by Sotheby's to date from the Second Avar period (*circa* 650-700 AD) when the Barbarian Avar tribe were the dominant power in Eastern Europe. It contains pieces closely related in style and decoration to the celebrated treasure hoard found at Vrap in Albania which is thought to have been an Avar treasury and workshop. Most of the Vrap hoard now resides in the Metropolitan Museum in New York.

Fibrous materials, identified as flax, were found on the belt fittings, and the Low-Level Measurements Laboratory was able to obtain a 300 mg sample for analysis. The results indicate that the samples have a carbon date of approximately 700 AD, consistent with the available historical evidence.

Carbon-14 occurs naturally in atmospheric carbon dioxide and, as a constituent of CO_2, is absorbed continuously in minute quantities by all living organisms, animal and vegetable. After death the CO_2 is no longer absorbed and the residual carbon-14 decays slowly with its characteristic half-life of 5 730 years. By counting beta particle emissions from the decaying carbon-14 it is possible to determine the fraction of carbon-14 which remains, and hence to date any object or material originally derived from organic matter.

Until now, the use of very small samples has been precluded by difficulties in ensuring the stable operation of counters over long periods, and in eliminating natural background radiation. The extension of proportional counting techniques (using CO_2 as the counting gas) to very small samples has been pioneered by the Brookhaven National Laboratory, in the United States, which has developed counters capable of holding about 10 mg of CO_2 and entirely free of plastic or organic material in contact with the counting gas. A new method of background reduction using a large (305 × 305 mm) sodium iodide crystal counter to eliminate emissions originating from cosmic radiation has also been developed at Brookhaven and has been further exploited at Harwell. Harwell has also developed data handling and analysis equipment, including graphics display, which will allow the new technique to be used on a routine basis capable of handling 250 samples a year.

Further information may be obtained from Bob Otlet, of the Nuclear Physics Division, Building 10.16, AERE Harwell, Didcot, Oxon. OX11 0RA; tel. 0235 24141, ext. 2443/2336. An article explaining the technique of "carbon dating" in more detail appeared in ATOM **269**, March 1979, pp. 63-68. □

Dr Eklund honoured

The IAEA General Conference decided by acclamation to confer upon the retiring Director-General, Dr Sigvard Eklund, the title Director General Emeritus.

Ambassador Maurice Copithorne, chairman of the Board of Governors of the Agency, underlined in a tribute the fact that during the 20 years that Dr Eklund had served the Agency "nuclear energy has firmly established itself as the only foreseeable alternative to fast disappearing fossil fuels. This is in no small part the result of Sigvard Eklund's personal conviction and determination concerning the potential of nuclear power to enhance the quality of life of mankind." Ambassador Copithorne added: "Over these past 20 years the Agency's membership has more than doubled. There have been many crises, some small and some large. Always, Sigvard Eklund's calm counsel and personal dedication have carried us through."

The Board of Governors adopted unanimously a resolution which was endorsed by acclamation by the General Conference. The text of the resolution read:

"The Board of Governors,

Recalling that Dr Sigvard Eklund has served the Agency throughout his 20 years of service as Director General faithfully and with untiring dedication;

Deeply appreciative of the contribution he has made to the promotion of the peaceful uses of atomic energy and the cause of peace;

Conscious that no man has done more than he to further the development of the Agency and the attainment of the objectives of its Statute;

Mindful of his great human qualities and his achievements as a statesman and scientist;

Expresses its sincerest gratitude and deepest appreciation to him for the way in which he has discharged the responsibilities of his high office." □

Education conference

Nuclear engineering educationalists will hold their annual conference in Cambridge from 31 March to 2 April next year. The conference takes the form of an informal meeting of those in the UK concerned with teaching and research in all aspects of nuclear engineering in the universities: appropriately, this year, in the city in which Chadwick identified the neutron half a century ago.

The programme will include reports of research at universities; developments at the university research reactors and radiation centres; teaching developments; graduate research contributions; and discussion of university-industry cooperation. A special feature will be accounts of university research and teaching for the engineering of fusion reactors in Europe and elsewhere, in a session under the chairmanship of Prof. Arthur Shercliff, FRS.

The conference is organised by the Department of Engineering at the University of Cambridge and is co-sponsored by the Institution of Nuclear Engineers. As in previous years, the Institution is offering a prize and certificate for the best paper given in the session for graduate students. The subject of the paper may be any topic within a broad definition of 'nuclear engineering'; eligibility for the award is for graduate students registered or within a year of being registered for a graduate degree (M.Sc. or Ph.D.) at a UK university or polytechnic. Offers of papers in this category to the organising secretary should be accompanied by a letter from the head of department confirming the eligibility of the student author together with a one page abstract.

Accommodation for the conference will be available in Emmanuel College, Cambridge. Further information and registration forms are available from Dr J.D. Lewins, Engineering Laboratories, Trumpington Street, Cambridge CB2 1PZ; tel. 0223 66466, ext. 266. □

Electroheat conferences

The British National Committee for Electroheat is arranging two conferences on the use of electricity for industrial heat processing.

There may – just – still be time to arrange attendance at a one-day seminar on industrial processing using radio-frequency and microwave techniques, to be held at the Sudbury House Conference Centre, Newgate Street, London EC1 on 10 December. This seminar is intended to provide an introduction to the wide range of techniques available with this method of heating and their application in industry.

A technical conference, on electroheat for metals, is to be held at St. John's College, Cambridge, from 21 to 23 September 1982. This conference will be concerned with the growing impact of electrical process heating methods in the metal industries. Papers and discussions will cover new technologies as well as experience of established techniques and practices. The conference will be of interest to those concerned with the production of metal components and assemblies which require heating during the course of manufacture.

Further information about both meetings may be obtained from the Secretary of BNCE, 30 Millbank, London SW1P 4RD; tel. 01-834 2333, ext. 6339. □

Condition monitoring

Condition monitoring is essential for the safe operation of aircraft and certain types of process plant. In recent years the techniques of condition monitoring have been widely applied to other plant and machinery in an attempt to improve productivity, mainly by reducing downtime and directing maintenance to where it is needed.

The success of these efforts will be assessed at the 1982 COMRAD conference at the Cavendish Conference Centre, London, which will consider the reliability, costs and benefits of condition monitoring systems. Speakers from the petrochemical, metal production, component mass production, food and beverage processing and other industries will relate their experiences of condition monitoring systems. Presentations from equipment manufacturers, system installation and service engineers will be restricted to descriptions of instruments and installations which have been operational for sufficient time for a meaningful assessment to be made.

The aims of the meeting organisers are to provide a forum for discussion between end users of condition monitoring systems and the suppliers, and an opportunity for potential end users to determine likely advantages and limitations.

Enquiries should be addressed to the conference secretariat, at the British Institute of Non-Destructive Testing, 1 Spencer Parade, Northampton NN1 5AA; tel. 0604 30124. □

Waste management

An international conference on radioactive waste management, sponsored by the Canadian Nuclear Society, is to be held at the Winnipeg Convention Centre, Winnepeg, Manitoba, from September 12 to 15, 1982. Further information may be obtained from M.A. Faraday, Technical Program Chairman, at the Chalk River Nuclear Laboratories, Chalk River, Ontario, Canada KOJ 1JO. □

Drains inquiry report

Only negligible amounts of radioactivity, comparable to natural background levels, escaped from the damaged drains at AERE Harwell [ATOM 299, September 1981, p. 247], an internal Board of Inquiry has found. No member of the staff or member of the public was put at risk, but the Board has recommended increased maintenance, a review of procedures for handling low-active liquid laboratory wastes, and a tightening up of internal reporting procedures.

The inquiry was set up by the Director of Harwell, Dr L.E.J. Roberts, after the discovery that superficial defects found in drains and drain ducts some months before could have allowed slightly radioactive liquid to escape into the soil. Temporary repairs needed to keep laboratories operational have already been carried out.

The Board, whose recommendations have been accepted by the Director, found that inspection and maintenance of the low-active drainage system had been reduced in recent years as the volume and activity of discharges into the system had been reduced. This level of inspection was inadequate and should be increased, the Board said.

The drains are fitted with traps to stop any solid materials; liquids flow through a ceramic pipe contained within an asphalt-lined reinforced concrete duct to a delay tank outside the laboratory served. The liquids in these tanks are sampled and, if the level of activity is low enough, they are piped to a treatment plant on the site where they are decontaminated. After treatment and further monitoring the liquids are eventually discharged to the Thames in accordance with Government authorisations.

Damage to the drain pipes themselves was discovered in 1980, but it was only when superficial faults in the asphalt-lined ducts were discovered that any possibility of activity escaping into the soil was recognised and the incident reported. The Board recommended that the internal criteria for reporting an incident be tightened up.

Low-active liquids had leaked into the ducts, but measurements in the surrounding soil showed that only activity comparable to natural background activity was present. Any contamination present was close to the lowest levels of measurements, and presented no hazard.

The Board found some inadequacies in the records of the locations of drain pipes, and consideration is to be given to setting up a site records office.

Because of the reduction in the use of the active drainage system, the Board suggested that consideration should be given to taking parts of the system out of commission and extending the use of containers to move low-active liquid laboratory waste to the treatment plant. □

Capenhurst contraction

British Nuclear Fuels Ltd announced on 27 October that almost 500 jobs would become redundant during 1982 and 1983 at its Capenhurst uranium enrichment plant, near Chester.

BNFL said it was offering early retirement and voluntary severance terms which it hoped would reduce considerably the number of employees who would have to be made compulsorily redundant.

In a statement the company said four factors had contributed to the forthcoming loss of jobs: the planned closure in 1982 of the obsolete diffusion plant; a delay of two years in the construction of a new plant, for the Ministry of Defence, to produce fuel for the Royal Navy's nuclear submarines; a reduction, due to the recession, in the number of employees leaving of their own accord, which had cut 'natural wastage' to a quarter of its former level; and a fall in enrichment work for electricity utility customers over the next few years. If the naval fuel plant were to be cancelled outright, rather than being merely delayed, further redundancy would result.

The company said the 350 industrial jobs which would be lost included 95 skilled workers. The 146 'staff' posts involved ranged from senior managers to clerks and typists.

Mr Con Allday, managing director of BNFL, said the company regretted having to announce this redundancy, which resulted from a number of special circumstances affecting the enrichment works. The company hoped the set-back would be only a short-term one. "We are confident that the long-term future of the modern centrifuge enrichment process at Capenhurst is secure," he said. "The other main parts of our business, fuel manufacture and reprocessing, are not affected directly, although pressure on costs and difficulties in overseas markets is causing us to review some investment plans."

Metal jointing

A major new R&D programme on the technology of jointing composite materials to metals has been established at AERE Harwell. The ultimate aim of the project is to save energy in transport by reducing vehicle weight.

One half of the programme, which is sponsored by a number of 'clients' and is worth £280 000 over two years, is funded by the European Communities under the Energy Conservation R&D programme, in order to encourage international cooperation between industries. The balance is funded by the UK Department of Industry, a consortium of British and European vehicle manufacturers and materials suppliers and British aerospace companies. Participating companies include BL, British Petroleum, Ciba-Geigy, Fiat, Ford, P.SA, Renault, Rolls-Royce, Shell, Volkswagen, Volvo and Westland Helicopters. Other major companies are involved in discussions with a view to joining the project.

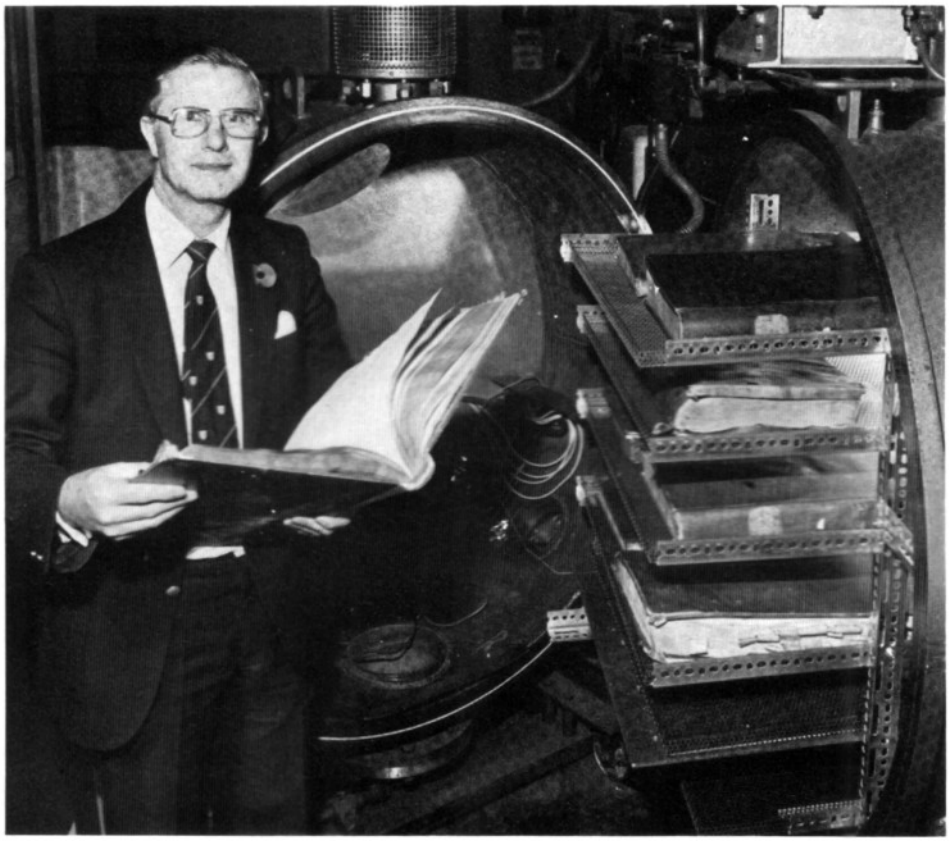
The programme is to be centred on the Materials Engineering Centre at Harwell (HMEC), and will draw on the laboratory's multi-disciplinary expertise in fibre composites, metals technology, adhesive bonding and design engineering. The project leader will be Dr Peter McGeehin of HMEC. The work will concentrate on developing design principles for adhesively bonded or bonded/mechanically fastened joints between composite materials and metals. Materials and joint geometries to be investigated have been chosen to reflect the potential application of composite materials in vehicles and aircraft. The design work will be supported by a thorough programme of mechanical testing, allowing designers to evaluate lightweight composite materials at the conceptual stage in vehicle and component design.

Further information on HMEC and the composite-metal jointing programme may be obtained from Dr P. McGeehin, Materials Development Division, AERE Harwell, Didcot, Oxon. OX11 0RA; tel. 0235 24141, ext. 4163.

AEA Board member

Mr Nigel Lawson, Secretary of State for Energy, has appointed Mr John Bullock as a part-time member of the United Kingdom Atomic Energy Authority for a period of three years from November 1, 1981.

Mr Bullock is Managing Partner of the United Kingdom practice of Deloitte Haskins & Sells, chartered accountants. □



Harwell's expertise in industrial drying has been used to save valuable historical documents from the Archives of the Oxford Area Health Authority.

Several weeks ago disaster struck when a cellar containing historical documents from the Old Radcliffe Infirmary was flooded. Fourteen volumes of 18th and 19th century medical registers, considered to be of outstanding historical significance, were damaged.

The Archivist, Mrs Brenda Parry-Jones, rapidly took the essential remedial measure of individually wrapping and then deep freezing the 12 volumes which had suffered the most damage, and then sought assistance from Harwell's Separation Processes Service (SPS).

At Harwell the books were placed in a large vacuum dryer where the pressure was gradually reduced. Using this technique no heat is required but as the pressure is gradually reduced the water is sucked out and instantly evaporated. It took over 170 hours to complete the drying operation and the books were returned to the Oxford Area Health Authority in early November.

SPS carried out a similar rescue operation for the Taylor Institute in 1979 when 200 valuable and rare books dating back to the 16th century were successfully dried out after a flood. □

More overseas associates for SRS

Two more overseas organisations have joined the Systems Reliability Service Associate Membership scheme run by the UKAEA. This brings the total such membership to 88, and the overseas total to 51.

The new members are Comprimo BV, engineering contractors of Amsterdam, and Elf Aquitaine, offshore oil engineers of Stavanger, Norway.

The Systems Reliability Service (SRS) grew from the UKAEA Safety and Reliability Directorate (SRD), and was formed as a separate organisation in 1970. It is managed by the UKAEA under the auspices of the Department of Industry, and seeks to transfer knowledge and experience gained in the nuclear industry to industry generally. SRS has undertaken reliability assessments ranging from heart pacemakers to entire industrial complexes.

The Associate Membership Scheme is open to firms, Government bodies and state corporations, and has members all over the world. Members share in the research and development of safety and reliability technology, and exchange information through the world's largest computer data base of its type. They also benefit from SRS consultancy work. □

Risks to man

The Nuclear Energy Agency of the OECD has published a report prepared by an international group of experts set up by the NEA Committee on Radiation Protection and Public Health, on *The environmental and biological behaviour of plutonium and some other transuranium elements.* *

The report is a comprehensive review of currently available information about the environmental and biological behaviour of plutonium and other long-lived transuranics, putting into perspective the health hazards for man resulting from exposure to these elements in his environment, and from their presence in food and water. The report describes the processes involved in the generation of plutonium and other transuranics, and the main sources from which they are derived: it notes that the amount of plutonium in the environment attributable to the nuclear fuel cycle can be considered negligible in comparison to that remaining in the environment as a result of the testing of nuclear weapons in the atmosphere during the 1950s and 60s.

The study goes on to discuss the quantities of plutonium that may be transferred from the environment to man, which depend on its behaviour in the atmosphere and in terrestrial and aquatic environments including the food and animal chains. The health hazard, the report notes, depends on the way in which isotopes are incorporated—by inhalation, ingestion or through skin absorption—and on removal or deposition after entry in the bloodstream. The report shows that despite the fact that "rather large" quantities of plutonium have been dispersed in the environment, very little has been incorporated by man. The report includes a summary of existing data on human exposure, primarily from fallout but also from occupational and medical uses of plutonium, and these are used to estimate the effects of ionising radiation on man and the risks of incorporating transuranics, and to develop radiation protection standards. □

**The environmental and biological behaviour of plutonium and some other transuranium elements.* 116 pp, OECD, Paris, 1981. £4·60 from HMSO and other OECD sales agents. ISBN 92 64 12246 X.

AEA REPORTS

The titles below are a selection of reports published recently and available through HMSO.

AERE-G 1484 (rev.) *Multi-element airborne dust measurements for Walsall Metropolitan District. Report for year December 1977 to November 1978.* By K. Playford and N.J. Pattenden. July 1981. 26pp. HMSO £2·00. ISBN 0 70 580664 2

AERE-G 1733 (rev.) *Multi-element airborne dust measurements for the Borough of Walsall. Report for year January 1979 to December 1979.* By J.R. Branson and N.J. Pattenden. July 1981. 23pp. HMSO £2·00. ISBN 0 70 580654 5

AERE-R 10005 *Two utilities for the maintenance and distribution of large programs.* By C.R. Kirby. March 1981. 43pp. HMSO £3·00. ISBN 0 70 580843 2

AERE-G 1788 (rev.) *Measurements of trace elements in resuspended dust from school playgrounds.* By N.J. Pattenden, J.R. Branson, E.M. Bones and E.M.R. Fisher. July 1981. 9pp. HMSO £2·00. ISBN 0 70 580674 X

AERE-R 9873 *Studies of environmental radioactivity in Cumbria. Part 2. Radionuclide deposits in soil in the coastal region of Cumbria.* By J.D. Eakins, N.J. Pattenden, R.S. Cambray, A.E. Lally and K. Playford. June 1981. 33pp. HMSO £3·00. ISBN 0 70 580534 4

AERE-R 9933 *An analysis of the estimated capital cost of a fusion reactor.* By A.A. Hollis. June 1981. 28pp. HMSO £2·00. ISBN 0 70 580724 X

AERE-R 10027 *The radiation chemistry of heterogeneous and homogeneous nitrogen and water systems.* By J.K. Linacre and W.R. Marsh. June 1981. 64pp. HMSO £4·00. ISBN 0 70 580574 3

AERE-R 10110 *Calculations of the reflection and transmission of ultrasound by rough planar defects containing water, manganese sulphide or alumina in a steel host.* By J.A.G. Temple. June 1981. 41pp. HMSO £3·00. ISBN 0 70 580524 7

AERE-R 10120 *A user's guide for the program NAMMU. 1. General information.* By J. Rae, P.C. Robinson and L.M. Wickens. June 1981. 89pp. HMSO £4·00. ISBN 0 70 580554 9

AERE-R 10274 *A user's guide for the program NAMMU. 2. An example problem.* By L.M. Wickens. September 1981. 26pp. HMSO £2·00. ISBN 0 70 580764 9

CLM-R 214 *On the interpretation of line-of-sight integral measurements on two-dimensional density functions.* By F.M. Larkin. 1981. 34pp. HMSO £3·00. ISBN 0 85311 096 4

CLM-R 215 *Culham conceptual Tokamak mark 2. Design study of the layout of a twin-reactor fusion power station.* By J.A.S. Guthrie and N.H. Harding. 1981. 51pp. HMSO £3·00. ISBN 085311 097 2

IN PARLIAMENT

BY OUR PARLIAMENTARY CORRESPONDENT

Incident reporting

19 October 1981

Mr John Moore, Under-Secretary of State for Energy, in a written answer to a question from Dr John Cunningham, said:

At about 10.45 a.m. on Sunday 4 October 1981 the radioactivity monitor on the exhaust stack from the Magnox fuel separation plant at British Nuclear Fuels Ltd site at Sellafield, Cumbria, gave a warning of an abnormally high release of radioactivity. The monitor is set at low levels. The plant, in which irradiated Magnox fuel is dissolved, was promptly shut down in accordance with the company's safety procedures.

Analysis of the stack samples confirmed that a release of the radioactive isotope iodine-131 had occurred. The plant was therefore kept shut down until company personnel were satisfied that it was safe to restart operations.

They concluded that some fuel which had been stored for too short a period in cooling ponds had been inadvertently fed to the dissolver. (Pond storage is provided at nuclear power stations and reactor sites mainly to allow the iodine-131 in irradiated fuel to decay to an acceptably low level.)

The BNFL management decided, after assessing the potential environment effects, to restart the plant. The removable iodine was flushed out of the dissolver and safely discharged to the sea. The plant was restarted at about 10 a.m. on 5 October using fuel of proven long storage.

Careful surveillance, including monitoring of further releases of iodine still within the plant, continued. The release from the stack of iodine-131, which had been measured at about 1·9 curies in the first 24 hours after the abnormal level was identified, had declined to about 0·4 curies per day by the morning of 8 October and has continued to decline. To date about 7 curies have been discharged.

The company are required by the authorising departments, Department of the Environment and Ministry of Agriculture, Fisheries and Food (DoE and MAFF), to use the best practicable means to minimise discharges. Over the past four years, the annual discharge has been less than 1 curie.

On Tuesday, 6 October, BNFL informed DoE and MAFF under arrangements for the reporting of abnormal releases to those Departments. At about 4 p.m. on that day, BNFL also informed the Nuclear Installations Inspectorate (NII) that further investigations had revealed a breach of technical plant operating limits on 4 October in that irradiated fuel containing an excessive quantity of iodine-131 had been fed to the dissolver.

On the late afternoon of 7 October BNFL advised the NII, DoE and MAFF that iodine-131 had been detected, by monitoring, in samples of milk gathered at two farms within a two-mile radius of the Sellafield site. The highest value measured from the samples collected then and later was 5 000 picocuries (i.e. million millionths of a curie) of iodine-131 per litre. On this basis, it is estimated that radiation doses to the critical group most liable to be affected, young children drinking this milk, would be no more than a small fraction of the International Commission on Radiological Protection's (ICRP) recommended annual limit to members of the public. On the basis of the daily information obtained, the MAFF, who are responsible for environmental monitoring of foodstuffs, consider that the measured levels of iodine in milk confirm this. Milk sampling is continuing at 20 farms of which 12 are close to the site. MAFF have not considered it necessary at any stage to ban the sale of affected milk.

I am satisfied that this incident, although resulting in a release of iodine-131, has caused no hazard to public health. The amount released to the atmosphere was very small because safety precautions came into play. The NII is investigating the full circumstances of the incident. The inspectorate advise me that, in the light of their investigations, steps are being taken to ensure that no irradiated fuel will be moved from nuclear power stations to Windscale for reprocessing until it has been stored for at least 90 days to allow the radio-iodine to decay.

My department was informed on 7 October by the NII and BNFL of the incident. On 8 October the NII submitted a formal report to the Secretary of State on the basis of the information then supplied to them by BNFL. On 9 October, following the receipt of further detailed information from BNFL, the NII submitted a further report to the Secretary of State which amplified the initial report.

I have asked that the reporting procedures at all stages for such instances be urgently examined by the NII. I intend to satisfy myself that such procedures are adequate, and that procedures for informing the local community in the event of such incidents are satisfactory.

Waste heat

19 October 1981

Mr Hooley asked the Secretary of State for Energy what studies were currently being undertaken by the Energy Technology Support Unit on the use of waste heat from power stations.

Mr David Mellor, Parliamentary Under-Secretary of State: The potential for utilising waste heat from power stations is being considered under my Department's feasibility programme on combined heat and power and district heating. Mr Moore announced on 23 June the appointment of consultants to examine nine potential sites for such schemes.

Mr Hooley: To spend £2 000 million to make use of the waste heat from existing power stations would be approximately 50 times more productive than spending £2 000 million on a discredited American-designed nuclear reactor at Sizewell. Will the Minister impress on his new chief of Department the need for a drastic reappraisal of the Government's energy priorities?

Mr Mellor: The potential for CHP projects in the inner cities is quite considerable and has been carefully examined. However, there was no evidence in the report to my Department to indicate that that would in any way replace the future need for nuclear power.

PWR design proposals

19 October 1981

Mr T.H.H. Skeet asked the Secretary of State for Energy when he expected to receive firm design proposals for the first pressurised water reactor.

Mr Moore: The PWR task force, chaired by Dr Walter Marshall, has advised me that it has reached agreement on a reference design. I understand that NNC has approved that design and that the CEGB expects to be able to adopt it on 23 October.

Mr Skeet: Does the Minister fully appreciate the importance of nuclear power in the economics of electricity? Is he aware that the operating costs of a PWR are between 5 per cent to 10 per cent below that of Heysham AGR and 60 per cent lower than those of a coal-

fired power station such as Drax?

Mr Moore: I have no doubt, in common with members who have been legitimately asking questions about relative energy prices, especially those of our own industry, about the nature of nuclear power's safety and the long-term opportunity it gives us to have secure, cheap electricity. It is a little early to give a reliable estimate of the construction costs of the particular design in the United Kingdom to which I have referred. However, the present view is that it should be substantially cheaper than the new AGR.

Mr Palmer: Will the Minister say something about the varying estimates of costs which have been given for a PWR to be constructed under British conditions? Does the Minister agree that the cautious view of the Select Committee on Energy is probably about right?

Mr Moore: I hope that the House will have an opportunity to debate the Select Committee report. However, other than making a general comment, it would be premature to comment on the detail of the relative price. I repeat that the present view is that the PWR options should be substantially cheaper than the AGR.

Mr Viggers: The nuclear construction industry welcomes the Government's attitude and was appalled by the attitude of the previous Government, who held up orders for so long it was difficult for our construction industry to stay in business.

Mr Moore: I welcome Mr Viggers comments with regard to the future, because that is what we are discussing in the House. There is now a unanimity of view about the future need for safe and secure nuclear power for electricity generation.

Mr Campbell-Savours: Has the Minister considered delaying the PWR programme in favour of a plutonium-using FBR programme? Is he not deeply disturbed by reports that BNFL is entering into talks with the US Government with a view to supplying plutonium to them, when the effect of that will be to release plutonium produced domestically in the US for the nuclear weapons programme?

Mr Moore: This is not directly related to the question, but it is important to draw attention to a written question I have answered today—which was asked by Mr Mudd—in which I bring out the important nature of the IAEA safeguards that are relevant to any sales of plutonium from the UK to the US.

"Alternative" and "renewable" energy sources

19 October 1981

Mr David Atkinson asked the Secretary of State for Energy to make a statement on the Nairobi conference on the development of alternative and renewable energy sources, at which he represented the UK and the European Economic Community.

Mr Mellor: There was general agreement at Nairobi on the importance of seeking a transition from the current major dependence on oil towards a greater use of other sources of energy.

The official report on the conference has not yet emerged from the United Nations Secretariat.

Mr Atkinson: At Nairobi, was a follow-up conference planned, and, if so, when will it be? Was attention given at the conference to accelerating international efforts to harness solar energy, bearing in mind that the vast majority of Third World countries have an abundance of sun?

Mr Mellor: One of the primary conclusions of the conference was that more effort should be concentrated on new and renewable sources of energy. Mr Atkinson will be happy to know that the British Government earmarked £2 million as a special allocation toward an energy resource assessment scheme. For the detail, he will have to await publication of the report.

Mr Stoddard: Does the Minister agree that, compared with the amount of money that we are spending on the development of nuclear energy, and particularly the dangerous—according to medical experience—PWR, with the fears of cracks in pressure vessels and so on, we are spending only a few million pounds on renewable sources because the Government are completely tied up and obsessed with the development of the PWR?

Mr Mellor: Mr Stoddard unnecessarily confuses two different strands of policy. We are spending what appears to be an appropriate sum—certainly, it bears comparison with the previous administration's record—on developing new and renewable sources. I am sure that there will be an appropriate occasion on which to acquaint the House with the details of what is being done.

Mr Hannam: In view of the importance of energy to the poorer, developing countries, are the Government planning any positive initiative at the Mexico summit especially with regard to setting up a world energy fund through the World Bank?

Mr Mellor: I am happy to tell Mr Hannam that the UK is ready to support that proposal provided, as we hope, that the proposal attracts support from the oil exporting countries.

Severn Barrage

19 October 1981

Mr Geoffrey Johnson Smith asked the Secretary of State for Energy to make a statement about the report of the committee on the feasibility of the Severn Barrage.

Mr Mellor: As the Secretary of State for Energy informed the House, decisions, for example about the further studies recommended in the report, will be taken in the light of comments from interested parties on the complex issues raised.

Mr Johnson Smith: Can Mr Mellor assure the House that this report has already been widely welcomed? Will he as a matter of urgency set up an inquiry into the environmental aspects of a barrage which, as he knows, are not perfectly understood?

Mr Mellor: A number of responses to the report have been received and it would be wrong to indicate that they have all gone one way. The Government hope to receive all the responses by the end of the year. Attention will then be given to all proper considerations, including the environmental ones.

Exports of plutonium

19 October 1981

Mr David Mudd asked the Secretary of State for Energy what exports of plutonium to the United States had recently been authorised, and for what purpose.

Mr Moore: Approval in principle has been given to the export of UK civil plutonium to the US for civil use in their fast reactor programme. Preliminary discussions only have been held with US Government officials on this subject. It has been made clear in these discussions that any civil plutonium exported would have to remain subject to IAEA safeguards when exported to the US. The export would be subject to satisfactory commercial negotiations on price, quantities and timescales. These negotiations have not yet commenced.

NPT safeguards

19 October 1981

Mr Frank Hooley asked the Secretary of State for Energy what was the total staff of the International Atomic Energy Agency concerned with inspection and control of nuclear installations around the world to enforce the provisions of the Non-Proliferation Treaty; how many countries had accepted inspection by the IAEA; and what was the total number of installations subject to inspection?

Mr Moore: The International Atomic Energy Agency has 133 inspectors to carry out inspection duties in countries with nuclear facilities. Safeguards agreements have been concluded and are in force between the Agency and 87 countries. Of this number, 36 do not yet have any nuclear facilities which require safeguarding. Inspections are made at 789 installations.

Plutonium stockpiling

19 October 1981

Mr Hooley asked what was the economic cost of stockpiling plutonium for civil power generation.

Mr Moore: The cost of storing plutonium for civil power generation is a negligible component (less than 1 per cent) of the total cost of reprocessing irradiated fuel.

Conservation funding

19 October 1981

Sir David Price asked the Secretary of State for Energy how much his Department was spending in the current year on energy conservation.

Mr Mellor: The Department of Energy is planning to spend £9·5 million in 1981-82 on energy conservation. This is part of a total planned expenditure by all Government departments of £149 million.

EEC funding

21 October 1981

Mr John H. Osborn asked the Secretary of State for Energy how much the UK had received from the European Community for research into nuclear power (including fusion), for energy saving and for projects in the hydrocarbon sector since 1973.

Mr Gray: Since 1973, UK bodies have been awarded approximately £24 million for research, development and demonstration work in nuclear power (including fusion), £9 million for energy savings, and £32 million for offshore oil and gas technology. Contracts are negotiated directly between the Commission and the body concerned, and the payments are usually spread over a number of years.

Radioactive materials transport

22 October 1981

Mr Parker asked the Secretary of State for Transport if he would hold a public inquiry into the safety of the transport of radioactive materials through urban areas.

Mr Kenneth Clarke: No. I am satisfied that public safety is fully protected by the present arrangements. An inquiry would serve no useful purpose.

Northern Radiological Protection Board

23 October 1981

Mr Cryer asked the Secretary of State for Social Services to make a statement on the proposal to close the northern centre of the National Radiological Protection Board, giving the number of jobs lost and the alternative means envisaged of carrying out the work.

Mr Geoffrey Finsberg: This is primarily a matter for the NRPB. I understand that the board has decided against closure of the northern centre for the present and will be considering longer term arrangements there and elsewhere for the organisation of the services it provides.

Plutonium sale

26 October 1981

Mr Allaun asked the Secretary of State for Energy whether, and for what reasons, he was negotiating to sell increased quantities of plutonium from the Calder Hall plant to the United States; what quantities were involved; and if he would secure an undertaking that it would not be used to replace the increased quantities of plutonium to be supplied from the US fuel plants for the increased nuclear arms programme of the US.

Mr Moore: I refer Mr Allaun to the answer given to Mr Mudd on 19 October. This plutonium would be derived from civil nuclear power stations. It would be subject to IAEA safeguards and would not therefore be available for military purposes. How the US uses its own plutonium is a matter for the US Government.

Radiological "pollution"

28 October 1981

Mr David Atkinson asked the Secretary of State for the Environment to make an assessment of the level of risk of radiological pollution off the Dorset coast from nuclear power stations on the French coast.

Mr Alick Buchanan-Smith, Minister of State for Agriculture: I have been asked to reply.

It is already a requirement of the Euratom treaty that member States submit information on their plans for the disposal of radioactive waste from nuclear facilities so that the Commission can determine whether these plans would adversely affect other member States. This information has been submitted for the nuclear power station at Gravelines, although not yet for the other two power stations being built by France on the Channel coast. The Commission, on the basis of expert advice, concluded that normal operations at Gravelines would have no significant effect on the UK. Special bilateral arrangements which would apply in the case of a serious incident are under discussion; my own experts, however, advise that it is highly unlikely that any release of radioactivity from Gravelines would have radiological implications for the Dorset coast. The routine monitoring carried out by this Department in the area would, of course, detect any sudden increase in levels of radioactivity.

Magnox generation

28 October 1981

Mr Robin F. Cook asked the Secretary of State for Energy what was the total amount of electricity generated in megawatt-hours to date by all Magnox stations in Great Britain other than Calder Hall and Chapelcross.

Mr Mellor: The total was 415 777 thousand megawatt-hours to the end of September 1981.

● Mr Cook also asked what was the total amount of electricity generated by Calder Hall and Chapelcross power stations.

Mr Mellor: By the end of September 1981, Calder Hall and Chapelcross power stations had generated totals of 37 261 and 37 645 thousand MWh respectively.

PWR safety documentation

28 October 1981

Mr David Ennals asked the Secretary of State for Energy if he would take steps to publish the pressurised water reactor safety documents in relation to the Sizewell public inquiry.

Mr John Moore: The then Secretary of State, Mr Howell, told the House on 18 December 1979 [ATOM **280,** February 1980] that the principal documentation on safety will be made available to the public inquiry. I understand that the Central Electricity Generating Board and the Nuclear Installations Inspectorate intend to publish reports as soon as practicable and well in advance of the public inquiry.

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After the Great Nuclear Debate
Sir John Hill to the Heriot-Watt University, Edinburgh.

The Assessment and Perception of Risk
James Daglish reports on Royal Society Discussion meeting.

Plutonium: Fast Reactor Fuel
Dr. J.F.W. Bishop to the British Nuclear Energy Society.

Book reviews:
"From Hiroshima to Harrisburg"
"Nuclear Power: What it Means to You"
"Anti-Nuclear Now . . . or Never"

Nuclear Power in West Germany
by Annette Allen.

Nuclear Safety in France
by Isabelle Whitby.

FEBRUARY

Planning for uncertainty
Glyn England, Chairman of the CEGB, to a meeting of the British Nuclear Energy Society and British Nuclear Forum, in London.

Neutrons as research tools
by Peter Schofield and Lynne Garne.

Nuclear Energy 1980
Sir Francis Tombs to the Institution of Nuclear Engineers in London.

Book review:
Whole City Heating: Planning tomorrow's Energy Economy

The risks of electricity production systems
A critical survey of the literature by the Health and Safety Executive.

Materials Unaccounted For – 1979-80

MARCH

Risk v. Benefit
Sir John Hill to a conference on the Hazard in Human Activities in Florence.

Future Energy
Report of a conference organised by the Institution of Electrical Engineers and other bodies.

Book review:
The Greatest Power on Earth: the Story of Nuclear Fission

APRIL

Nuclear Energy: the Way Ahead
Prof. Ian Fells reports on a conference at the Ditchley Foundation.

Energy Futures
The Schumacher Lecture given by Gerald Leach.

Dr. Walter Marshall interviewed by Simon Rippon

Select Committee on Energy's First Report

CEGB seek consent for PWR at Sizewell

MAY

Shades of Grey
The Dallas Lecture given by Sir John Hill to the Junior Chamber of Commerce, Glasgow.

Learning from the Past
Presidential lecture given by Prof. Jack Edwards to the Institution of Nuclear Engineers in London.

The Public Mind
A survey of opinion polls.

Book review:
"Towards the Nuclear Holocaust"

Matters arising
Notes from correspondents on the accuracy of beliefs about risk.

JUNE

Genetic Effects of Ionising Radiation
by Peter Saunders.

Toward Remote Handling
by Dr. Lynne Garne.

The 'Good Life' and the New Technology
by Viscount Thurso.

Nuclear heat for fossil fuel processing

WAGR ends electricity production

Book review:
"Nuclear Power, Man and the Environment"

JULY

The Environmental Impact of Nuclear Power
Report of a BNES conference.

What Future for the 'Breeder'?
Report on a conference on fast breeder reactors held in London.

The Monopolies Commission report

AUGUST

The Effects of Radiation on Man
by Peter Saunders.

Radioactive Waste Management Advisory Committee Annual Report

LOMI reagent trial
by Gerry Comley.

Book review:
Radiation Protection Optimisation: Present Experience and Methods

SSEB annual report

SEPTEMBER

Sea Disposal – Radioactive Waste Management
by Dr. John Lewis.

Impacts of Energy
A report by Peter Saunders of an International Symposium held at Nashville, Tennessee.

British nuclear strategy reaffirmed
White Paper: the Government's Response to the Select Committee's Report on the Nuclear Power Programme.

Electricity Council annual report

CEGB annual report

European Fusion Review Panel report

NEA Activity Report

Book reviews:
"Energy in a Finite World"
"How Safe is Nuclear Energy"
"World Energy: The Facts and the Future"
"Availability of World Energy Resources"
"The Nuclear Apple and the Solar Orange"

OCTOBER

UKAEA annual report

The disposal of high-level radioactive waste
by Dr. Walter Marshall.

BNFL annual report

"Secret" fallout?

Book review:
"Shaping tomorrow"

Severn Barrage Study

IAEA annual report

Amersham International annual report

NOVEMBER

UKAEA annual report Press Conference
Review of the year by Dr. Walter Marshall.

The Radiography of Swaythling Bridge
by D.A.W. Pullen and R.F. Clayton.

Radiation and Nuclear Power
by Dr. Brian Wade.

Commissariat à l'Energie Atomique annual report

International Atomic Energy Agency annual report

Reviews:
The FREIR Report
Plasma Physics and Nuclear Fusion Research

DECEMBER

Misunderstanding nuclear power
Sir Francis Tombs' 1981 Presidential lecture to the Institution of Electrical Engineers, in London.

Energy and Society
A report by Peter Saunders on a colloquium organised by the Groupe de Bellerive in Paris.

Bookbriefs:
World Nuclear Directory
The Multilingual Energy Dictionary
Elements of Nuclear Power
Fast Breeder Reactors: An Engineering Introduction