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RISK v. BENEFIT

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BOOK REVIEW

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ATOM contents

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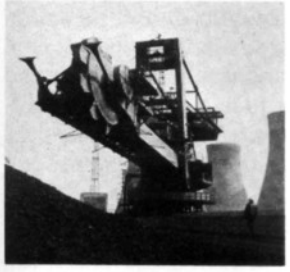

Front cover: Energy policy within the European Community is firmly based on the COCONUC strategy: coal, conservation and nuclear power. In this issue, Sir John Hill argues that the trade-off between risk and benefit rather than risk alone should be considered in the choice of energy systems; Prof. F.R. Farmer notes a steady reduction in the fatal accident frequency rate for miners in the UK; and energy specialists discuss the prospects for "future energy". Pictured: a stocking out and coal reclaiming machine at the 1980 MW coal-fired Drax power station, in Yorkshire

RISK v. BENEFIT

The generation and delivery of plentiful energy always creates some risk to life and health; but against this must be set the benefits that it bestows on society. It is this trade-off between risk and benefit, rather than the risk alone, that should be considered in the choice of energy systems.

Sir John Hill, chairman of British Nuclear Fuels Ltd, urged this view at a Conference on the Hazard in Human Activities in Florence in January, at which he presented the following paper.

There is no doubt that the world needs energy and needs it in increasing quantities. Less than one third of the world's population consumes two thirds of the world's energy. To bring everyone up to the current standard of the developed world would require more than a doubling of supplies. If we now allow for population growth the same *per caput* consumption would, in 2025, require about six times present energy supplies. Such a target is almost certainly beyond our reach. It will of course be reduced by determined conservation efforts but it is still a very large requirement and it includes no allowance for any growth in *per caput* consumption in the industrial world.

Of course energy consumption is not an end in itself. It is the benefits derived from its use that matter. The availability of plentiful supplies of cheap coal was essential to the industrial revolution, as was the availability of oil to the 'golden age' of economic growth in the 1950s and 1960s. The present living standards in the industrial world are a direct consequence of the application of energy to improve man's productivity and to free resources that can then be used to further welfare and cultural development. Energy underpins not only our domestic comfort, industrial production and transport but also agriculture, water supply and the infrastructure of modern society.

In the near and medium term world economic growth potential seems likely to be constrained by limited oil production and this could persist unless large quantities of energy can be produced from other sources. The World Energy Conference repeatedly stressed the need to develop replacement energy sources as rapidly as possible including nuclear, coal and the renewables, to minimise the risks of getting trapped in a period of persistent energy-constrained growth.

To some extent and given time energy sources are interchangeable. In the near term, however, oil is essential to the world's transport systems and could only be replaced by more expensive synthetic products derived from coal. In the longer term electric propulsion and hydrogen (derived by electrolysis) could provide a substitute. Electricity is particularly versatile both in its acceptance of energy inputs from a wide range of sources (fossil, nuclear, hydro, wind, waves, etc.) and in its flexibility in use. It provides heat, light, power, and the medium for information transfer.

Of the potentially available energy sources only coal, nuclear and hydropower look as though they are capable of expansion on a sufficient scale within the time scale set by our knowledge of hydrocarbon resources. Oil will not disappear overnight but by 2020 we could find oil and gas, nuclear and coal contributing roughly equally to the world's primary energy requirements, with a smaller but significant contribution from renewables including hydropower.

Sir John Hill

Oil and coal are better adapted to the needs of the developing countries to replace fuelwood, which because of overconsumption is a depleting resource with serious consequences for climate and agriculture. The efforts of the developed countries to replace oil as a fuel for electricity generation are not only in their own interest but also help to extend the life of the resource, to the advantage of the third world. Similarly, nuclear energy, which in many countries is the cheapest way of generating electricity, will play an important role in keeping energy and electricity prices below what they would otherwise be.

The danger of following a low energy future path, such as that advocated by some pressure groups, is that it may eventually become dangerously self-fulfilling. The costs of inadequate energy supplies are not merely the additional cost of the next best alternative but also their influence on the balance of payments of importing nations, plus the depressing impact on productive output and hence living standards throughout the world. Do we wish to plan for such a future?

The benefits of economic growth are unquantifiable. Gross domestic product is a measure which captures some aspects but it is a poor measure which inadequately reflects changes in the quality of life and even to some degree material living standards. The benefits of energy provision are even less definable because of the complexity of the links between energy and future growth. One can speculate, as has Sir Fred Hoyle in his book "Energy or Extinction"[1]. Should we, he asks, "be concerned about the relatively minor risks of having nuclear energy when, without it, the world would be spiralling downwards towards the major risks associated with severe political instability and increasing international tension over energy supplies". This view is arguable, but the risks attached to failure to provide adequate energy are an essential element of any equation. It is the difference between the situations, whatever these may be, with and without adequate supplies that we would need to measure – but we cannot.

All major sources of energy that are obtainable at reasonable cost need to be exploited. However, the choice of path available to us must be guided by costs and strategic considerations such as security of supply, as well as consideration of the safety aspects of the technologies. The value of security of supply is another unquantifiable benefit but the advent of the fast reactor will eventually enable countries with nuclear power to gain virtual independence from energy imports, for heating and electricity production, should they so desire.

The risk of accident or injury to workers and the general population is not the only factor to be considered in a trade-off between risk and benefit. Damage to the environment and to property are also aspects that should not be overlooked. Corrosion and damage to the fabric of buildings and their contents, including archaeological treasures that have withstood the ravages of the centuries, are a well-known consequence of fossil fuel combustion. The ecological damage resulting from oil spills, or from coal washing plants or atmospheric emissions are also well documented. First, however, let me deal with the human risk element.

There is as yet no consensus on the methods to be used in the comparison of risk and there is a wide range of methods from which to choose. For example, one of the most thoughtful and carefully compiled comparative studies was that done by the UK Health and Safety Commission[2]. Their investigation was confined to occupational hazards where they calculated the accidental deaths for each energy source on which electricity generation was then dependent in the UK: that is coal, oil and gas, and nuclear. The breadth was extended to include as much of the fuel cycle as possible so that accidents occurring in extraction and transport were added to those occurring in the power station itself. The results are presented in Table 1. The authors had to draw on a much earlier attempt made in America to provide a comparative risk-cost-benefit analysis (WASH 1224, ref. 3). This reduced all quantities to monetary terms but was nonetheless exhaustive in its collection of data. The Health and Safety Executive did not feel that the data relating to impacts on the general population were sufficiently well based to be used in their study.

Since that report was prepared, the Health and Safety Executive have conducted a critical survey of the literature in the field of risk comparison between electricity production systems. Their report[14] covers, like their previous one, only the conventional methods of generating electricity, coal, oil and nuclear, in literature published up to May 1980. The authors considered that there was insufficient experience with full-scale plant on which to base a review of the alternative, unconventional energy sources. There had been little or no work which extended beyond the pilot plant stage.

The American Medical Association[4] added public health data to occupational health data and extended their study to include incapacities due to disease as well as deaths. A summary of their findings is given in Tables 2 and 3. The extension to include health effects is based on epidemiological studies and a knowledge of the qualities of pollutants discharged. In the nuclear case there is a considerable body of knowledge on the biological effects of radiation and general acceptance that the adoption of a linear dose-response relationship, with no threshold, provides a reasonable upper bound when extrapolating from effects measured at high doses. Whilst there is a vociferous minority who argue that these assumed relationships understate the health and genetic effects of radiation, there is more evidence that the linear hypothesis overstates the risk at low levels than there is to indicate that it understates the risk.

The treatment of emissions from fossil plant is frequently very different. In the UK it is generally considered that there is

Table 1: Estimated Number of Deaths due to Accidents per GWy (a) **of Electrical Energy sent out** (b)

Primary energy source	Operation	Deaths/GWy sent out Deaths caused by accidents
Coal (c)	Extraction	1·4 (d)
	Transport	0·2 (e)
	Generation	0·2 (f)
TOTAL		1·8
Oil and gas	Extraction	0·3 (g)
	Transport	Insignificant (h)
	Generation	None reported (f)
TOTAL		0·3
Nuclear	Extraction (USA)	0·1 (i)
	Transport	Insignificant
	Generating and reprocessing	0·15 (j)
TOTAL		0·25

Notes

(a) Gigawatt years (giga = 10^9).

(b) Based on average electricity supply from stations for years 1972-74 reproduced in Table 71, Digest of United Kingdom Energy Statistics 1975 which shows relative outputs, for nuclear, oil fired and other steam raising plants (of which the vast majority are coal-fired).

(c) Based on underground mining figures only. Opencast fatalities are not included. (They would have an insignificant effect on the final figures.)

(d) Based on an assumed figure of twenty-six deaths in mining coal for power stations.

(e) Based on estimated number of deaths attributable to the movement of coal by rail not including accidents to the public. Figures for deaths due to the movement of coal by road considered insignificant.

(f) Based on number of deaths to CEGB employees 1970-77. Information supplied by CEGB.

(g) Based on figures for fatal injuries in exploration and production in the United States published in the 46th Annual Review of Fatal Injuries report to the American Petroleum Institute. It is appreciated that the bulk of the fuel oil used in UK power stations is from the Middle East where accident performance may differ sharply from that of the USA. Figures for the Middle East are not available and we have therefore used the American figures as the only available indicator. Making allowance for the lower fuel oil consumption of the UK we have arrived at a figure of approximately two deaths per annum in overseas oil fields attributable to the production of oil for UK. To these we have added the figures for deaths in the North Sea Oil extraction industry published by the Department of Energy. This gives an approximate figure of twelve deaths per annum.

(h) We have been unable to obtain figures for deaths due to the shipping of oil from overseas oil producing countries.

(i) Based on figures from United States uranium mining reproduced in USAEC WASH 1224 Comparative Risk-Cost-Benefit study of alternative sources of electrical energy. It is appreciated that the USA is not the primary supplier of uranium for UK power stations. Again we have used these figures as they are the only ones readily available.

(j) Based on information supplied by CEGB (see *(f)* above) and by British Nuclear Fuels Limited for accidental deaths of employees 1970-77. None of these deaths was due to radiation effects.

Source: The Hazards of Conventional Sources of Energy, Health and Safety Commission 1978.

a threshold effect and that emissions from high stacks are so diluted by the time they reach the ground that health effects are negligible. Indeed the World Health Organisation[5,6] recommends that the daily average concentration of SO_2, one of the principal pollutants from fossil fuel burning, should be below 500 $\mu g\ m^{-3}$ which is considerably higher than the contribution that the modern coal fired power stations are expected to make. During the 1952 smogs in the UK SO_2 levels rose to 3 800 $\mu g\ m^{-3}$ (daily average). From this and other incidents (Table 4, ref. 7) the relationship between air pollution and health became apparent but the precise causal links are still not clear. There is no suggestion that the effects are directly or entirely due to fossil fuel combustion in power generation, but it serves to illustrate the severity of the potential hazard in terms of deaths suffered by the population and the frequency with which such disasters have occurred.

US risk studies such as those of the American Medical Association are based on the observed statistical relationships between pollution levels and health which are extrapolated linearly to low doses. This is precisely analogous to the method adopted for the nuclear case, but yields figures for deaths and health effects from fossil plant that UK workers intuitively find hard to accept. There is, however, widespread acceptance of the damage done in the past by the use of open coal fires in urban areas.

Table 2 Comparison of Health Effects for Alternative Fuel Cycles for Electric Power Production in US in 1975

Fuel	1975 kWhe × 10^9	Equivalent No. of 1 000-MWe plants	Estimated Deaths Occup.	Non. Occup.	Estimated Occup. Impairments
Coal	844	128	69 - 1 024	2 250-53 000	3 330-20 000
Oil	292	44	6 - 57	44-4 400	530-4 100
Gas	297	45	3 - 13	—	180-1 080
Nuclear	168	26	0·9- 25	0·3- 4	100- 340
TOTALS	1601	243	79-1 119	2 294-57 400	4 140-25 000

Source: American Medical Association Report C(A-78) 1978.

Table 3: Enhanced Risk of Death per year from US Electricity Production

Age	Normal Risk of Death/yr	Enhanced Risk of Death per year Coal and Oil	Nuclear
10	1 in 3 800	1·38 in 3 800	1·0008 in 3 800
25	1 in 700	1·07 in 700	1·0001 in 700
45	1 in 200	1·02 in 200	1·0004 in 200
65	1 in 40	1·004 in 40	1·000008 in 40
All ages	1 in 100	1·01 in 100	1·00002 in 100

Source: American Medical Association Report C (A-78) 1978.

A more recent attempt to develop a form of rationale for comparative risk assessment was made by Dr Herbert Inhaber, then on the Atomic Energy Control Board of Canada[8]. He adopted a basic systems approach similar to that used earlier in WASH 1224, but extended this to include not only the risks of acquisition and processing of fuel but also those of construction and fabrication of the station. Both studies considered the environmental effects of the operation of the plant and the impacts on occupational and public health.

Unlike WASH 1224 Inhaber defined a unit which gave the cost in terms of working man-days lost per megawatt year of net electrical output. Having dealt with the conventional technologies, he then examined the so-called alternatives in like manner. His conclusions were that nuclear power was one of the safest systems and certainly safer than the benign alternatives.

This conclusion arose from the large quantities of structural material he estimated to be associated with the alternative sources and was increased by his inclusion of fossil-fuelled power stations to provide back up power when the climate was unfavourable to alternatives. The controversy which followed publication of his report was world-wide. His claim was that this was a demonstration of technique rather than a definitive calculation and he has accepted that the statistics have inadequacies which applied to all the systems. Other objections seem to be emotive and centre not so much on the fossil/nuclear comparisons, where the nuclear advantage is generally accepted, as on the risks assigned to the alternative energy sources, which were being so strongly advocated as the risk free option by anti-nuclear groups. In order to find some means of comparing costs and avoid monetary units, Inhaber expressed everything in terms of man-days lost and equated a premature death to 6 000 man-days lost (30 working years at 200 days per year). This procedure and the introduction of back-up power proved particularly contentious although the omission of the latter would not eliminate the nuclear advantage.

Although there is still a major dispute over Inhaber's work, his introduction of the idea of a full systems approach has merit. It is certainly favoured by the HSE[14] although they felt it had limitations, particularly when a "unified index of woe" was applied to a system *in toto*. It would not be possible to claim any degree of accuracy for such a result and comparison would be better done for each phase of the system, e.g. construction, acquisition of fuel, transport and storage of fuel, etc. The problem lies in the lack of good statistical information to underpin the methodology and the choice of units for intercomparison. Although it has not been raised elsewhere to my knowledge, it also seems inappropriate to deal in terms of absolute risk levels for comparison purposes where the numbers of people occupationally involved differ significantly from one energy source to another. Their marginal change in

Table 4: List of Fog Disasters Occurring in UK Cities During Previous 100 Years

London 1873	Rise in death rate from bronchitis by 268 in one week of chemical fog.
London 1880	Rise in death rate from bronchitis by 692 in one week of chemical fog.
London 1891	Rise in death rate from bronchitis by 572 in one week of chemical fog.
Glasgow 1909	Average death rate from respiratory disease of 57 per week increased in five weeks of chemical fog to 138, 233, 171, 198 and 137.
Salford 1930/31	Average death rate from respiratory disease of 137 per week increased in chemical fog to 592 in 9 days.
London 1952	Three days of chemical fog estimated to have caused 4 000 extra deaths in London area.
London 1954	1 000 deaths directly attributed to respiratory and circulatory disease resulting from exposure to chemical fog.
London 1962	750 deaths attributed directly to chemical fog.

Source: EUR 6417 EN

risk compared with the norm in alternative occupations would probably be a better measure.

The studies mentioned above are concerned with routine operations. Nuclear power stations are designed to minimise the risk of accident with replicated and multiple safety systems. Nevertheless designers also consider accident conditions and ensure that a number of barriers are provided as protection against the results of the unlikely accident and to retain radioactive material within the reactor containment. The assessment of risk and of the consequences of any possible accident sequence are accomplished by the methods of fault-tree analysis which are well known from the Rasmussen[9] report. Although the Lewis committee[10] was critical of the confidence that was attached to some of Rasmussen's probability risk estimates, they were satisfied that the method was appropriate and should be used. No such methodology is applied to other energy sources however, despite the fact that a major accident such as that at Three Mile Island has resulted in no attributable death or disease due to enhanced doses of radiation, whereas major accidents have happened during work with other fuels. One of the most recent is the Alexander Kjelland oil platform which capsized with the loss of 123 lives. Others have since occurred in China and the Middle East. In Bantry Bay an oil tanker tied up at the oil terminal exploded with 51 fatalities. A relatively small quantity of propylene gas in a road tanker which crashed into a camp site in Spain in 1977 resulted in over 100 deaths and 150 received serious burns. An accident in 1978 during the transfer of propane gas from a derailed tank car in the USA caused an explosion with 12 dead and 50 injured. Despite the horrifying numbers, these accidents are not well remembered. Dams have a similar record of disaster (see Table 5, ref. 11), although in the UK there have been no recorded incidents involving injury or death since 1926. In the US, however, more than 100 large dams have failed since 1930. In fact dam disasters in the USA during the earlier half of the decade beginning 1970 caused 355 deaths and widespread damage to property. A National Dam Inspection Act in 1972 brought little relief and as late as 1977 a dam failure caused 39 deaths[12].

A study by Ramsey[13] has sought to bring together the accident and routine risks from the nuclear and fossil production of electricity. His conclusions are summarised in Table 6.

It is sometimes argued that there are two aspects of the risks attached to nuclear power that have no parallel for the fossil fuelled systems. The first is the irreversibility of the consequences of a really big accident. Leaving aside the minimal level of such risk, the question of reversibility can equally be raised on the build up of atmospheric carbon dioxide as a result of fossil fuel combustion. That it occurs is not in dispute. Its long term significance is far from clear. If climatic changes were induced these could be for the better or worse – depending on where one lived. Certainly world agricultural and ecosystems could be greatly and permanently affected. Much more research is needed to establish the scale and nature of the effects.

The second "risk" is that of weapons proliferation. This subject has been discussed and examined at length both nationally and internationally. The question is a mixture of technical, economic and political considerations, and is seen by some as being principally concerned with limiting and controlling the availability of plutonium. I have pointed out elsewhere that the link between civil nuclear power and weapons proliferation is not direct and that a nation wishing to have a nuclear explosive device can find easier and cheaper means to its attainment than through a power programme. The principal deterrent to proliferation is political and the political institutions established through the Non-Proliferation Treaty and International Atomic Energy Agency Safeguards have served us well. They will need to adapt with time to take account of changing circumstances, but there is little to suggest that presence or absence of nuclear power programmes, or particular reactor systems, will radically alter the level of proliferation risk.

Indeed the risks of international conflict, and the use of nuclear weapons, could well be affected to a far greater extent by the failure to provide sufficient energy for people's needs.

Table 5 Catastrophic Dam Failures

Year	Place	Fatalities
1979	Morvi, India	>3 000
1977	Teton, USA	9-11
1967	Koyna, India	180
1963	Vaiont, Italy	2 600-3 000
1961	Kiev (BabiYar) USSR	145
1960	Oros, Brazil	~1 000
1959	Frejus, France	421
1959	Vega de Tera, Spain	123-150
1959	Bhakra, India	10

Source: Greenhalgh: The necessity for Nuclear Power, 1980.

If these views are accepted there is no real distinction in kind between the risks of different energy systems, although there may be quantitative differences. The risks attached to nuclear power are in fact probably better researched and understood than those attached to fossil systems, where a great deal of uncertainty attaches to the cause-effect relationships. Major effects such as climatic change resulting from carbon dioxide build up are possible, but have unquantifiable costs (or benefits) and views on the values to be attached to the relative risks to world peace from inadequate energy supplies or the development of nuclear power are necessarily subjective.

The trade-off

Let me turn now to consider how some of the above information may be applied in everyday decisions. Decisions on future electricity generating plant involve many factors and do not concentrate solely on risk. In addition to health risks, there are many other important factors such as relative social effects, economic advantage, environmental impact and physical damage.

One could in principle draw up lists covering both costs and benefits, to assist in deciding:

(i) the choice between energy systems;
(ii) acceptable level of risk;
(iii) the levels at which emissions or effluent should be set, or
(iv) the directions of research programmes.

However, immediately we are faced with evaluating and comparing dissimilar impacts – for example health against economic gains or visual amenity against damage. To overcome this difficulty economists frequently resort to cost benefit analysis which assigns monetary values to each impact, and the national currency becomes the common unit of comparison. This facilitates the difficult trade-off between different factors, but problems arise. Pollution control or safety costs are usually known fairly well but damage costs are much more controversial and subject to large uncertainty:

(i) we may have insufficient knowledge about the distribution, of certain pollutants, even if we know the quantities produced.
(ii) the dose/damage relationship may be unproven or open to many interpretations – e.g. threshold effects or the effect of releasing large quantities of carbon dioxide to the atmosphere;
(iii) where damage is known it may be extremely difficult to assign or even derive a monetary value – e.g. loss of life, injury, the effect of noise, or air pollution.

Table 6 A summary of data extracted from Ramsay W. *Unpaid costs of electrical energy (Health and environmental impacts from coal and nuclear power)*, a study prepared for the National Energy Strategies Project, published by John Hopkins University Press, 1979.

	Coal-fired stations Events/GWe year	Nuclear stations Events/GWe year
Occupational		
Accidents – deaths	0·57-1·45	0·09-0·31
Disease – deaths	0-4·4	0·09-0·175
Total injuries due to accidents and disabilities due to disease	88-175	17·5-30·7
Public		
Accidents		
Deaths	–	$4·4 \times 10^{-3}$-88×10^{-3}
Injuries/disabilities	–	0·09-0·9
Disease		
Deaths	0·8-32·2	$1·4 \times 10^{-3}$-$6·14 \times 10^{-3}$
Disabilities	6×10^{3}-77×10^{3}	$0·8 \times 10^{-3}$-$7·89 \times 10^{-3}$

Notwithstanding these difficulties, which can be reflected by choosing an appropriately wide range of values, this approach may enable us to obtain a view of the overall costs of energy supply.

There are, however, some broader issues which cost benefit analysis cannot cover. For example concern is sometimes expressed not just on the *marginal* impact of a single nuclear development on civil liberties or nuclear proliferation, but on the *overall* impact of a nuclear programme. In many decisions it is right, in my view, to consider these wider implications. However, this approach to risks should also apply to benefits and this brings in the value to be attached to economic growth, to the avoidance of international conflict and to the improvement of the lot of the third world. All of these major aspects of both risk and benefit are unquantifiable and, indeed, the values attached to them depend as much on the political views of the individual as anything else.

Risk analysis used alone avoids the added complication of attaching monetary value to health or changed chances of death, but does not overcome the problem of comparison of levels of risk with the benefits to be derived from the risk.

It would be a great advantage if we could establish set criteria for the acceptability of risk; we could then design all systems to meet these requirements. This is already done for specific aspects of specific systems, for example radiation exposure at nuclear plant and dust emission from coal-fired plant. Given such standards the choice of fuel for the next power station would become purely a financial decision, since the precautions employed to reduce risks to the prescribed levels would be included in the monetary costs.

Such an approach would not take in the bigger unquantifiable issues raised above on which political and technical judgment have to be brought to bear.

Summary and Conclusion

I have indicated the very large but unquantifiable benefits associated with the provision of adequate supplies of energy and drawn attention to the need to exploit all sources capable of making a significant contribution at reasonable cost. I have also pointed to the potential costs in social and economic terms associated with failure to provide this energy for both the developed and the developing world.

These benefits have to be set against the risks and costs of energy supply. The conference has concentrated on risks to life and health, but environment and property can also be affected. Existing studies range from those which look at accidents in the course of operation, through risks to the population from routine emissions to the consequences of major accidents. Some seek to extend risk analysis to embrace the whole system including building materials, construction and maintenance. The data are often poor and causal relationships in health and other damage effects inadequately understood. On the whole the nuclear industry appears to be the best documented and most studied. On all these bases nuclear energy seems to carry relatively low risks.

The extension of "risk" to embrace wider effects such as climatic damage or weapons proliferation brings in unquantifiable trade-offs. The emissions of carbon dioxide from fossil fuelled plant or low levels of radiation from nuclear plant are unavoidable, although the latter can be controlled to set limits. There is no simple method whereby all these aspects can be brought together in a single decision criterion. Cost benefit analysis can go so far but, if carried too far, obscures rather than clarifies the trade-offs being made.

It seems to me that those responsible for making decisions on energy are better served by having presented to them statements of the risks to health and life, the effects on the environment and property and the full financial implications, than they would be by some composite index which is based on the value judgments of those who compiled it.

Insofar as it becomes possible to establish acceptable levels of risk to the workforce or general public, much of the complexity may vanish in that safety costs would be built into the costs of plants. Nevertheless some trade-off will always have to be made in setting the levels of acceptable risk if one is to avoid misallocation of national resources. Some believe that there is already over-investment in nuclear safety compared with that in many other higher risk ventures. □

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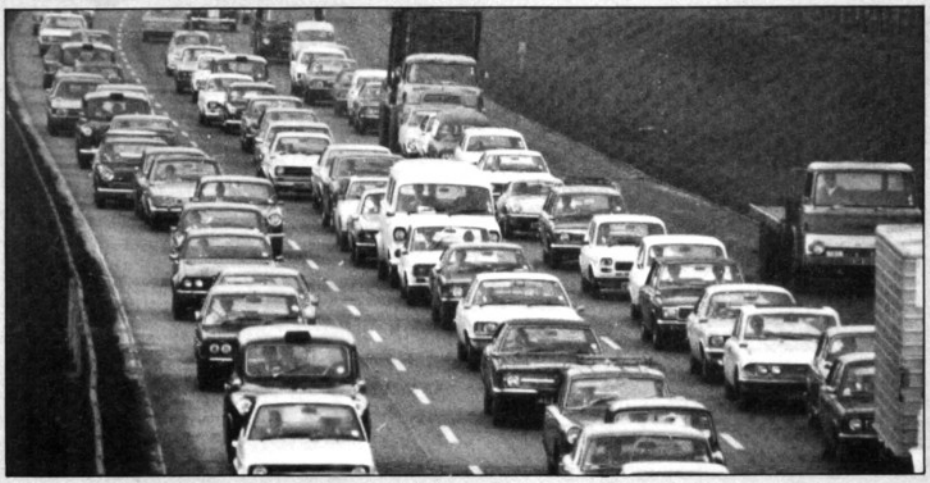
The need for caution

In a separate presentation at the Florence conference Prof. F.R. (Reg) Farmer, latterly safety adviser to the UKAEA, noted that there was a clear indication that most risks were steadily decreasing: the risk of harm to people was much less now than in previous generations. In spite of this, perhaps as a consequence, there seemed a growing awareness of and reluctance to meet risks which were new or newly perceived.

Like others reported in ATOM in recent months, Prof. Farmer mused on the fact that the degree of concern, as deduced from press and public reaction, seemed not to be related to the potential harm. "Those of us who have been involved in the development of atomic energy have accepted the high safety standards, largely self-imposed, within the industry but are concerned at the intensity of reaction even to trivial events in the operation of nuclear plant," he said.

But a phenomenon was not limited to the public perception of the nuclear industry; there were signs that the potential hazards of other industries were no longer being accepted as a necessary consequence of industrial development.

The main thrust of Prof. Farmer's paper however lay in his insistence that risk tables—setting out "comparative" risks in various activities—should be viewed critically and used cautiously. Data relating to occupational risks was useful when following the changes in any one activity for which the data were obtained, as in mining. In the UK the fatal accident frequency rate for miners had fallen from 3 140 per million per year in 1875 to 300 in the decade ending 1972, and showed a persistent fall of 35 per cent a decade. The average for all recorded UK factory fatalities showed a fall of 5 per cent a decade. But even if death was—as it often was—the easiest parameter to measure some weight should also be given to injury and other harmful effects. Another difficulty lay in deciding what weight to give fatalities of different types at different ages: circumstances which involved a risk of death occurring on average early in life were ordinarily likely to be regarded as more detrimental than those involving an equal risk of death late in life.



Motor vehicles: young men at higher risk

Inevitably, however, comparisons would be made not only from industry to industry but with other accidental risks. Occupational risks were generally averaged over all those employed in a given industry but could sometimes be more selective: as in mining, where data could be presented for underground face workers and for above-ground workers. Averages for industries might also include office workers, or white collar workers, together with those on the factory floor. Then again, it had been said on the basis of "averages" that it was more dangerous at home than at work—but the perspective altered when it was recognised that more than 80 per cent of accidental deaths in the home arose from falls and fires affecting people over the age of 65; for those under 65 the "home risk rate" fell to 26 per million per year. [See the accompanying table.]

So far he had been talking about accidents which might kill or injure single individuals, but they had also to be concerned about accidents which could kill many people at the same time. Any concern for occupational hazard should also consider the possibility and effect of major hazards; in complex and extensive modern installations, as in the petrochemical industry, such concern should lead to further increase in safety consciousness and reduce the risk of minor hazards as well as major ones. Efforts to reduce risk to the public would also reduce risks to employees. □

	Average	Specific
Accidents		
Motor vehicles	130	
Young males		370
Home	120	
Over 65, female		820
Less than 65		26
Work	34	
Engineering textiles		23
Chemical		87
Shipping		162
Mining		300
All Causes		
Age 5-14 Male		300
Female		200
35-44 Male		2 000
Female		1 400
55-64 Male		18 000
Female		10 000

Comparing average with more specific risk rates (all per million per year)

FUTURE ENERGY

At two-yearly intervals energy specialists from many countries gather in London to examine the prospects for "future energy", at a conference organised by the Science, Education & Technology and Power Divisions of the Institution of Electrical Engineers in association with other bodies in the UK and Europe. The third in the series, attended by 263 delegates, was held in London in January. James Daglish reports

R.C. Hills, chairman of the IEE Science, Education and Technology Division, opened the conference with a stark statement of energy prospects as he saw them. "The need to husband reserves of fossil fuels is very evident; the work which is going on on the renewables and conservation is clearly of vital importance. Time is not on our side in what could be a crucial struggle for survival."

Dr A.A.L. Challis, chief scientist at the Department of Energy, might have found this a hard act to follow; but he was able to announce that the Department had as he spoke announced support for the immediate building of a 250 kW wind generator on a site in the Orkneys, to be operational in October this year, and to be followed by a 60m aerogenerator with an output of 3 MW, expected to be operational in 1983 or 1984. [See p. 88]

Dr Challis noted that many of the papers to be presented at the conference dealt with generation; very few considered conservation. It could be argued that conservation was a specialised area, "but very great intellectual effort goes to the 'demand' end and there is call for rather more high-grade effort in the whole area of conservation," he said.

Many "future concepts" of energy had electricity as their end product. Electricity has some non-substitutable uses, in lighting, in domestic appliances, in electrochemical plants and small dedicated power sources. They were premium uses of electricity which were of key economic importance, and were clearly where the future of electricity must lie. "It is I would also believe where electricity use is likely to increase with general prosperity; capital investment in increased labour productivity tends to involve the use of electricity in one or other of its non-substitutable modes."

There did seem to be, simply as a matter of observation, a very solid relationship between growing energy use and growth of electricity use. "Conservationists have argued that they can be decoupled, that they should be uncoupled and that they must be uncoupled if mankind as a whole is to look forward to lives that are anything other than short, brutish and nasty," said Dr Challis. "But the conservation measures which have been coming for many years do seem to have been remarkably slow acting. There do seem however to be some signs that the decoupling process may arguably be visible. As of now we have recession, not growth. I am saying not that energy use has gone up more slowly than prosperity, but that energy use has gone down faster than recession. Perhaps what we are looking at is a secondary effect of recession and not decoupling at all. I don't know, and I suspect that those who say they do are not particularly credible."

Keynotes

The first keynote address was given by P. Blakeley, Oil Operations Director of Imperial Chemical Industries Ltd, UK. He started from the fact that supplies in the world oil market were now tight, and there was very little room for manoeuvre in resuming growth in the world economy. The situation was in marked contrast to that which obtained in the 1950s and 60s; it might be attributed to the fact that oil output had been curtailed to an even greater extent than might have been foreseen, "but I think it must also be attributed to the fact that the growth in 'alternative energy' use has been very modest."

What then of the future? The outlook was for continuing limitation of growth potential: free world economic growth rates would be not more than the sum of the rate of growth of energy savings and the rate of growth of energy supply. This could be calculated to be likely to be just over 3 per cent for the free world as a whole, and 2·5 per cent in the developed world. Could the energy growth rates be improved to such an extent that economic growth could be greater?

"I believe this conclusion might fairly be reached: that the free world as a whole and the developed part of it in particular has a choice between accepting limitation of economic growth potential—or to put it another way, a balancing of

energy supply and demand more by the suppression of demand than by increase of supply – or conspicuously more vigorous development of alternative energy sources. The task one is talking about is a very large one. Free world investment in energy supply and use required by the year 2000 appears to be something in the order of several trillion (10^{12}) dollars: which is a lot of investment. I would suggest that what this means is that it is really of vital importance that the preferred technologies are identified and implemented as speedily as possible."

His message to the conference would be this: consider the various possibilities from the point of view that it would be better to go for those developments which could be brought to commercial maturity in the least possible time, which did not involve excessively long lead times and, because capital was scarce in a low growth environment, those which involved lower rather than higher capital expenditure.

"Throughout the world since 1973 governments have been playing an increasing role in the formation of energy policy, and in the redistribution of energy profits," said Mr Blakeley. "They have therefore a very important role to play in carrying alternative energy programmes forward and in the same vein I would suggest it is very much to be hoped that their role will be positive and constructive. In the UK it might seem because of North Sea oil and gas that we are somewhat exempt from the need to take urgent action. The energy world however is very highly interdependent, and I believe it would be in our own interest to move with all possible speed. Any successes will be used in other parts of the world and we may derive benefit from that as well as from contributing to a less tight situation."

Dr Günter Schuster, Director General for Research, Science and Education in the Commission of the European Economic Community, in his keynote address agreed that it was vital to maintain economic growth, and that energy conservation must receive strong and increased support. Secondly, the Community must identify and develop all possible indigenous resources of energy. Thirdly, the Community must develop and improve relations with energy producers, and in particular with the oil producing countries of OPEC. This third general principle was not amenable to technical solution. The first two could however be refined to give five general policy objectives to be achieved for the Community as a whole by 1990.

- To reduce to 0·7 or less the ratio between the growth of primary energy consumption and the increase in Gross Domestic Product.
- To reduce oil consumption to about 40 per cent of total energy demand.
- To increase to 70-75 per cent the contribution of coal and nuclear to electricity production. Since this contribution was at present about 50 per cent, a considerable investment would be required to effect such a large change.
- To encourage the growth of renewable energy resources.
- To pursue the development of pricing policies which would help to attain the overall objectives of the Community.

Obviously, national considerations sometimes affected the priority given to these objectives within the member States. The UK for example had already over-performed in two of the areas listed. Oil formed only 39 per cent of primary energy supply, while coal and nuclear fuel met more than 80 per cent of the needs of electricity production. The same could not be said however of other countries in the Community such as Italy. The Community objectives provided a reference framework to guide national pricing policies and a gauge of the effort which the Community was making to resolve the greater world energy problem. They gave the Commission a basis for coordinating, stimulating and, if necessary, complementing national measures more effectively.

R&D strategy

The Community R&D strategy was guided by four general principles. First, they had to attack all possible options in parallel, keeping all options open and discarding any only when it had been proven unrealistic for technical, economic or environmental reasons. Secondly, the future energy supply structure would not and should not be monolithic. A multiple choice approach was necessary to avoid dependence on one particular energy source and to provide specific solutions to meet the local needs of different regions within the Community. Thirdly, changes in energy structure took a long time, because of the long lead times involved; and R&D actions must therefore be initiated early. The time needed to achieve the benefits was sufficiently long, the required scale of effort sufficiently large, and the inherent risk in development sufficiently great to require that there be significant and continuing Community and Government involvement. Fourthly, because of the long lead times, the uncertainties were great. Energy R&D strategies formulated on one set of assumptions could be upset by unforeseen changes in the world situation or by unexpected results in the development process.

"It is important to realise that Community activities are mainly concerned with medium and long-term R&D objectives," said Dr Schuster. "Short-term measures are more the concern of industry.

"The bulk of the R&D work in Europe is carried out within the national R&D programmes of the ten Member States. What then is the role of energy research at European Community level? It should be underlined that the European Community is not just adding a programme of an eleventh state to these activities; rather, its role is to coordinate national activities, to avoid useless duplication and to stimulate and reinforce the national work by implementing cooperative programmes in specific sectors of priority and interest for the European Community and the Member States."

Community R&D programmes therefore concentrated on programmes meeting one or more of the following conditions.

- Creation of stimuli for the launching or development of research projects in the rational use of energy
- Support of key long-term projects which require intensive and prolonged public funding, such as fusion, solar and geothermal energy
- Encouragement of worthwhile high risk projects with limited chances of success but for which a sharing of the costs would facilitate their execution – such as deep sea drilling
- Pursuit of projects for which the European Community has special experience and in which it has traditionally been interested, such as coal and steel
- R&D work on projects which, in their way, are of Community interest, such as the security of nuclear energy, environmental and social factors, and the treatment and storage of radioactive waste
- And the pursuit of projects at the Community level to improve coordination and optimisation of existing national activities, such as the recycling of plutonium.

In a number of sectors the feasibility of a particular process had been demonstrated through the research programmes of either the Community or the member States, but its commercial viability was still in doubt. Alternatively, the financial risks might appear too high at the moment for large scale development to occur naturally. In such cases, the Community might support demonstration projects to investigate viability and to give an incentive for further application.

"Of course, the overall guiding objective for Community R&D work is to facilitate, for Europe, a transition away from oil over the period from 1980 to 2030," said Dr Schuster.

"This is a period which is longer than has previously been assumed.

"It seems clear that in the short-term the contributions of energy R&D are limited to a small number of areas. Political actions and economic incentives have definite priority here. The medium-term priorities are perfectly evident: until the year 2000 there are only three real possibilities for making up lost time and for making good any shortages, namely conservation, coal and nuclear energy – priorities which we call COCONUC. Until the year 2000 we have to base our strategy on the COCONUC approach as there is no other solution. Because of the long lead time for the introduction of nuclear power and new coal technologies, concentrated and energetic R&D in these fields is mandatory. And with regard to the conservation sector it might even be reinforced by legislative measures.

"Other medium-term components are solar and geothermal energy, but these will be later contributors because of the industrial infrastructure which has to be developed. Recent studies undertaken on energy from biomass show that there is a considerable medium term potential even for Europe.

"For the long-term there are three priorities: thermonuclear fusion, fast breeders and solar electricity. With regard to thermonuclear fusion – a field in which the European Community is involved with a powerful R&D programme, including the JET project at Culham – it is commonly agreed that the final answer on its feasibility is not yet known. On the other hand, its possible contribution to energy supply by about 2000 is very high. Fast breeder reactors are the logical and necessary follow-up to the nuclear fission line and it is to be hoped that Europe can carry to fruition the technical lead it [now] has here. With respect to solar energy production the developing technology is direct conversion with semiconductor cells. In this field, considerable progress has been made in recent years, but a large-scale impact is to be expected only after the turn of the century."

Dr Schuster concluded with two "battle cries." "In the short-term the Community as a whole should be as well protected as possible from uncertainties in oil supply, and in the long-term we have to prepare for the time when oil and gas reserves are diminished," he said.

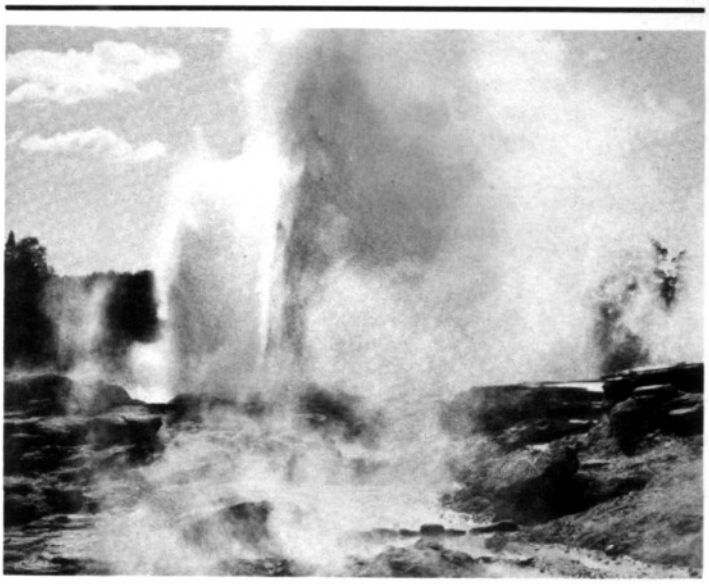
"Thus it centres on two battle cries, *escape from oil* and *develop substitute fuels*. Anything that can materially assist in achieving these two ends should be encouraged, and we hope that the activities of the Commission of the European Communities in this field will assist Europe in meeting the energy problem of the end of this century and beyond."

The conference continued over four days; it is hoped that the fourth in the series will be held in January 1983. The overwhelming majority of the papers and discussion dealt with the "renewables"; but the fact that nuclear energy must form part of the future energy mix was highlighted in the presentations reported above, and in the closing "open forum".

The contribution of the renewables

Dr A. Stratton (ICI) recalled that on the first day Mr Blakeley had shown the contribution required to be made to future energy supplies from non-oil sources; it was postulated that the need would be met largely by coal and nuclear energy. Were the renewables ever going to contribute sufficiently, on a world scale, to meeting world energy needs?

Prof. D.T. Swift-Hook, of the Central Electricity Research Laboratories, echoed the question: Why the enthusiasm for "alternative energy"? "I used to go around saying that it was insurance; any sensible person I think would be pretty sure that the future will lie with coal and nuclear, but no person can be 100 per cent sure. Wouldn't you like to give me a fraction of 1 per cent of the nuclear budget to take care of the 1 per cent or 5 per cent uncertainty about the future of coal and nuclear? That seems to me be justification alone, bearing in



mind the scale of investment that is going into these alternatives.

"One problem I face is that more recently, particularly in the United States but to a certain extent in this country, the price of the renewables has been going down, and going down dramatically. If you extrapolate forward you get to break-even. If there is even a chance of break-even we need to be doing something about it now." The renewable resources were quite substantial; Gerald Leach would say we wouldn't need them; but we were not dealing with certainties.

Sir Hermann Bondi, chairman of the Natural Environment Research Council and former chief scientist at the Department of Energy, pointed out that full-scale exploitation of any energy source required heavy investment; but in general they were not now thinking of investment in the alternative or renewable sources. They were being investigated, at quite modest cost. "I always like to tell a story from the wartime," he said. "When France fell this country was cut off from its supply of onions, which was bad. What was worse was that at that time there did not exist a variety of onion suitable for commercial growing in the UK, and it took about two years to develop one. I regard that as a failure of government: whenever onion supply is cut off, the government should have varieties available that commercial organisations may pick up and grow. It is not the business of government to do the commercial operation, but to guard against contingencies is very much its job. . . . That, as long as one can do it fairly cheaply, seems to me a sensible thing to do.

"The future energy picture of the world is a very confused one. It is I think not right to assume that there will be totally free trade at cost-plus in all forms of energy. We don't have it today, as a matter of fact. So a reasonable insurance premium is well paid. Whether the amount of attention it gets is more than it deserves is a question much more for the media than for me; but I think the amount of finance that is going that way is not unreasonable for the purpose."

Dr M. Klein, senior assistant to the President of the US Electric Power Research Institute (EPRI), agreed. "I personally feel it is more than insurance," he added. "I do think that there will be some significant contribution that will be made in the next several decades from at least some forms of renewable energy source. Solar heating in some substantial regions I think is a distinct possibility, and while I cannot at all envision it replacing the more conventional systems such as coal and nuclear nevertheless every 1 per cent is an important contribution. Secondly, there may be some special circumstances where some forms of renewable energy will have an impact perhaps greater than the macro-contribution would imply. In rural areas disconnected from networks there

Fusion programme review

The first meeting of the European Fusion Review Panel (EFRP) set up by the Commission of the European Communities to study Community activity in the field of controlled thermonuclear fusion was held in Brussels in early January.

The Committee was formed on 26 November last year. At the first meeting Dr Günter Schuster, Director-General for Research, Science and Education, reminded members of the importance the Commission attributed to their work.

The task given to the EFRP is to study in an international context:

- the present situation and progress in R&D work under the Community fusion programme;
- prospects for the development of fusion as a source of energy for the Community;
- future plans for the Community programme;
- and to make recommendations on the future strategy to be followed and on action to be taken.

Under the Community's present five-year programme, which runs from 1979 to 1983, 145 m European Units of Account (EUA), 80 per cent of the total of 181·25 m EUA, has been appropriated to finance JET, which is being built at Culham. In addition, some 191 m EUA have been appropriated for the fusion programme excluding JET. Taking into account intervening price increases, the cost of the Community effort, in which Switzerland and Sweden are also participating, will be approximately 1 000 m EUA.

A model of the buildings being constructed for the JET project

The chair at the first meeting of the EFRP was taken by Professor K.H. Beckurts, vice-President of the board of Siemens AG. The members of the EFRP are Sir John Adams (director-General of CERN), Prof. C. Bernardini (University of Rome), Mr C. Bienvenu (Deputy Director at EDF), Mr J.R. Goens (Adviser to CEN/SCK), Prof. H.L. Jordan (President of the German Space Research Association), Sir John Hill (chairman of BNFL and immediate past-Chairman of the UKAEA), Mr L.H. Rey (Director of the NSBED, Sweden), Prof. G. Stoppini (member of the Executive Board of CNEN, Rome), Prof. J. Teillac (Commissioner for Atomic Energy, France), and Prof. H.G. van Bueren (President of the Advisory Council for Science Policy in The Hague). □

may be such a contribution. I emphasise maybe: we will have to see. We in the industrialised countries must have some concern apart from our own self-interest; some areas in the developing countries may indeed find that these are feasible in making a contribution where 'conventional' energy sources are difficult to use."

Walter Patterson, international editor of the *Bulletin of the Atomic Scientists,* urged that "uncertainty" about the future of energy supply extended to the coal and nuclear sources as well. "There are many unanswered questions not only about the technologies associated with coal and nuclear use but about their economic status now and in the future, and about their political and social context.

"At the moment we are able to pursue the alternatives simultaneously, but my guess is that we are before long going to have to confront major choices as to where we are going to put our efforts, particularly in investment, and what particular objectives we most want to meet.

"For me the obvious approach to achieving a final utility by using energy is to minimise vulnerability to interruption of fuel supply by minimising the need for fuel supplies. If you can put in place a converter of some kind which will do the larger part of the job by converting ambient energy, that seems to me the highest option."

A.C.J. Baker, of Binnie and Partners, said that with hindsight the Magnox stations built in Britain were a very good investment, but at the time they were built they were considered uneconomic or marginal. This change in their economic merit arose because of the effect of inflation on other fuel prices. Should we not take likely future inflation into account in analysing the renewables – especially those with high capital cost and low running cost.

Patterson agreed that if you could put in place a system which would not be subject to escalating operating costs, whether they were due to rises in fuel prices of whatever, that was clearly the soundest way of coping with inflation – "provided you do not thereby stifle subsequent, relevant innovation". Sir Hermann Bondi added: "I tend to think that in general we invest too little and consume too much – over a very wide range, from housing, to transport, to energy supplies. If we put more resources into investment, which or course means having less to consume, I am sure we and our successors would be very grateful."

M.J. Platts, of Wavepower Ltd, noted that the conference had spent several days talking about innovative technology and R&D on the supply side, but there had been only odd references to conservation, on the demand side, where by and large the technology already exists. What could be done to increase conservation efforts?

Sir Hermann Bondi agreed that this was an important area; it was an area not so much for R&D in the physical sciences, as for institutional and social science work. He was himself "enormously keen" on conservation, and had tried while at the Department of Energy to encourage it: for example, by urging a scheme under which building society surveyors when inspecting properties which were on the market might look in the roof of, say, a house and classify its insulation as good, mediocre or non-existent, and put the assessment in the report to the client. If such a scheme were in operation people who were selling a house might spend a little on improving the standard of roof insulation, he thought. "But I got a bloody nose," said Sir Hermann. "The building societies just said their surveyors were already very busy. Full stop." □

BOOK REVIEW

The Greatest Power on Earth: The Story of Nuclear Fission, **by Ronald W. Clark;** *Sidgwick and Jackson, London 1980; 342pp, £8·95. ISBN 0283987154.*

Here, in some 300 pages, is an authoritive and immensely readable account of the origins and development of atomic energy. Ronald Clark has much experience of his subject. He published *The Birth of the Bomb* in 1961, and since then his impressive list of scientific biographies has included some of the men who played great or small parts in atomic energy history—Einstein, Tizard, Appleton, Russell.

Since 1961, there has been a flood of books, papers and articles on every conceivable aspect (military and civil) of atomic energy in USA, Britain, USSR, Canada, Germany, France and Japan. There have been, in all, six volumes of official history written in Britain and USA, and innumerable other historical studies, commentaries and analyses, as well as diaries, letters, memoirs and biographies. Important primary sources, too, have become available—especially papers opened up in our Public Record Office and in US official archives, and the US State Department documents on foreign relations. For his new book Ronald Clark has made copious use of all this material, with ample quotation, and he produces some interesting matter which does not appear to have been published before. (The account mentioned on the dust-jacket—of the coding error in a 1943 telegram from Roosevelt to Vannevar Bush—is however *not* new).

The story Clark tells—while not differing in essentials from the much fuller accounts of the official historians—not only brings together a great deal of information and makes it easily accessible, but is original and fresh. It is also objective and eminently fair. Deploring chauvinism, he sees the British, American, French, Russian or German points of view impartially. He is scrupulously fair too to individuals, trying to understand their problems and motives sympathetically even when disliking or regretting their actions. Sparing with comments, his own views show more in a tone of voice than in explicit judgments.

As the subtitle—The Story of Nuclear Fission—is so wide it may be useful to indicate the scope and balance of the book. The reader will not find much technology or hardware in it, or much about organisation, or civil nuclear power, or post-1960 nuclear weapons programmes; for these he will have to go to the official historians and other authors.

After 60 pages which recount the scientific history up to the discovery of uranium fission in December 1938, the rest of the book deals mainly with the political and military results of that discovery. 200 pages are devoted to wartime developments concluding in the bombing of Hiroshima and Nagasaki, and the postwar period up to the US H-bomb test in 1954; 10 pages to fallout and the campaign against nuclear weapons in the late fifties and the early sixties; 17 pages to radioisotopes and civil nuclear power.

In a brief epilogue, the book considers the chances that "we may . . . fumble the last catch of all" and bring about a nuclear holocaust by accident or design. For this is largely a book about accidents and "fumbled catches"—lost opportunities of avoiding or halting the nuclear arms race.

Ronald Clark's themes are the almost inevitable momentum of events; failures of vision at those few points when crucial choices were possible; the deterioration of moral perceptions; and the lack of imaginative understanding by politicians of a new and apocalyptic power. If there is one hero in this sombre story it is the great Niels Bohr.

A few detailed criticisms. The "Smythe Report" (p226) should be the "Smyth Report". The 1954 fallout in the Pacific (p270) did harm, and is still harming, many Marshall Islanders. Production reactors are not fast reactors (p287); and highly active waste storage tanks are not sunk deep in the sea (p294).

Lorna Arnold
Authority Historian's Office

THREE MILE ISLAND REVISITED

Plant and animal health

"In the months following the March 1979 accident at the Three Mile Island Nuclear Power Station many questions have been asked and many concerns voiced: did the accident—or even the normal operation of the plant—have any effect on animal and plant life in the vicinity of the plant?" The short answer, according to a report published by the US Nuclear Regulatory Commission toward the end of last year*, is 'no'.

The report notes that TMI is situated in a part of central Pennsylvania that contains productive farmland as well as several small and medium-sized cities. The region has rich, fertile valleys and rolling hills; agriculture contributes in a major way to the area's economic wellbeing. After the accident, the Pennsylvania Department of Agriculture conducted a number of surveys to determine whether there were any unusual agricultural problems which could be related to TMI; a veterinarian with a long-established practice in the agricultural areas immediately west of TMI testified before the Pennsylvania Public Utilities Commission, outlining abnormal increases in reproductive, bone and muscle problems among farm animals. During NRC public meetings at Middletown and Baltimore regarding cleanup of TMI comments were made about unusual animal health problems in the TMI area.

Were there in fact any problems which could be related to the operation of the plant or the accident? The reporters think not. "While in some instances not enough data were available for a detailed evaluation to be made, none of the reported problems could be linked to TMI and no general pattern of such effects could be seen."

The report says a major difficulty encountered in the study was the determination of what constituted "unusual" animal health problems. "There is a lack of background information on the incidence of a large number of animal diseases and other animal health problems," the report says. "The incidence of dangerous transmissible diseases (such as tuberculosis, rabies and hog cholera) that can devastate the livestock industry or cause serious human health problems is well known; large sums of money are spent annually to identify and eradicate these diseases. However, other animal diseases and health problems have not generated sufficient concern within the livestock industry to warrant the cost of an in-depth animal morbidity and mortality data collection and evalua-

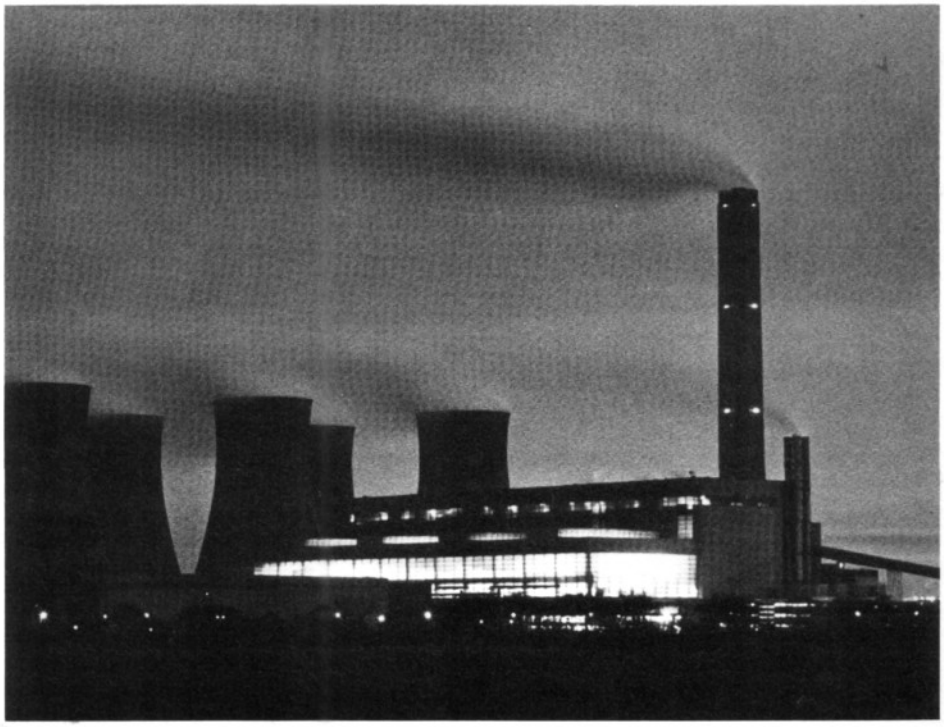
Investigations of reported plant and animal health effects in the Three Mile Island area, by Gerald E. Gears, Dr Germain LaRoche, Dr John Cable, Dr Bernard Jaroslow and Dr Don Smith, US Nuclear Regulatory Commission, Washington D.C. 20555. NUREG-0738. Unpriced.

tion programme. . . . Therefore, the use of the terms 'unusual' or 'abnormal' to describe animal health problems in this report cannot be supported by long-term documented data, but rather reflects the opinions of those interviewed."

The study concluded that radiological releases from TMI would not have resulted in the types of problems reported: the level of radiation exposure from TMI was less than a thousandth of that which might have caused clinically detectable effects in the animal population which was exposed. The complaints were related to reproductive and bone problems and a miscellany of others. Although some of the symptoms could be produced by radiation doses exceeding 50 rem, there were no substantiated experimental data that showed that any of these symptoms would have been caused in animals exposed to the levels of radiation received by those in question. Isolated reports of developmental malformations that were labelled "mutants" were most likely to have resulted from non-genetic factors which were known to cause them—infection, malnutrition and the like. The probability that they could have been caused by radiation from the reactors in normal operation was extremely low because of the extremely small additional annual exposure rate. None of the vegetation problems discussed in the report could have been caused by TMI.

The reporters venture to suggest causes for some of the reported sicknesses and deaths among livestock. Several animals were diagnosed by laboratory tests as having rickets. Some might have been suffering from selenium deficiency. The symptoms described in the many cases of deaths of cats and kittens in the area suggested that infectious diseases were the cause; and so on.

"To summarise, while many of the symptoms reported are characteristic of radiation sickness as well as many other common diseases, the necessary spectrum of symptoms which would establish a causal link between the reported problems and TMI was not in evidence." the report says. "Taken in conjunction with the lack of any systematic geographic pattern of reported problems and the power plant, as well as with the fact that many of the problems were diagnosed as common occurrences in domestic and wild animals, the staff has concluded that no relationship can be established between the operation of TMI or the accidental releases of radioactivity and the reported health effects." □



Pollution digest 1979

The Department of the Environment published at end-year a wide-ranging *Digest of Environmental Pollution and Water Statistics,* available from HMSO at a cover price of £9·80. The Digest draws upon information scattered through a large number of technical reports; it includes statistics on for example air pollution from industry and from road vehicles, freshwater quality, radioactive discharges, oil pollution, waste and noise. Statistics on water supply and use, previously included in a separate Departmental publication, are also included. Together the data form a snapshot of the state of the environment and how it is changing.

The Department notes that improvements in environmental quality were generally less marked in 1979 than in earlier years. The long-term downward trend in emissions and concentrations of smoke and sulphur dioxide showed signs of levelling off. Estimated total UK emissions of smoke from coal combustion were 0·35 million tonnes in 1979, 3 per cent higher than 1978 but 80 per cent lower than the estimate of 1·75 million tonnes in 1960. Estimated total UK emissions of sulphur dioxide from fuel combustion were 5·26 million tonnes in 1979, 5 per cent higher than in 1978 but lower than the average of 6 million tonnes a year recorded in the 1960s.

The highest exposure to environmental radioactivity of any member of the public is shown as having been about 3 per cent of the ICRP dose limit for any one radionuclide and, in most cases, to be about 1 per cent of the limit. Trends in the concentrations in milk of radioactive substances from worldwide fallout, giving a good guide to the contamination of the average mixed diet in the UK, indicate that levels reached a peak in 1964, dropped sharply in the following three years and have declined steadily since then. The UK annual average of the ratio of strontium-90 to calcium in milk was slightly higher in 1979 than a year earlier, but was still less than 10 per cent of the 1964 peak level; the annual average concentration of caesium-137 in milk fell in 1979 and was less than 5 per cent of the 1964 level.

The Digest shows that consumption by an infant of 0·7 litres of milk daily from a farm within two miles of Windscale would have resulted in an exposure of 2·5 per cent of the ICRP dose limit for Sr-90, lower than in 1978. On farms 20 miles from Windscale the annual mean concentration of Sr-90 in milk fell off sharply: in 1979 the corresponding exposure would have been 0·6 per cent of the limit.

The Digest shows that of the liquid radioactive discharges from BNFL Windscale to surface and coastal waters, the total beta content doubled between 1970 and 1975 to more than 80 per cent of the authorised limit. Since 1975, however, the discharges have fallen and were 37 per cent of the limit in 1979. At UKAEA Dounreay, liquid radioactive discharges reached a peak of 73 per cent of the authorised limit in 1972/73 but have declined substantially to less than 5 per cent in 1979. The levels of exposure which would result from discharges at the limit of the Authorisation are lower than the annual internationally-recommended dose limits. □

Common views on site licensing

Site selection alone should not be used to supplant the basic goal of achieving nuclear plant safety by attention to engineering and operation of the plant, the sub-committee on licensing of the Committee of the Safety of Nuclear Installations (CSNI) said in an agreed statement released by the OECD in January,

The OECD said in a background note that the safety record of the nuclear power industry is unequalled: "its excellence results from the engineered safety features and special operating procedures carefully developed in many countries to attain (and exceed) the safety objectives specified in the nuclear plant licensing process. These safety provisions cover a wide domain, extending from the technical measures in the plants to the qualification of the operators and the criteria used for selecting sites.

"Since the 1979 accident at the Three Mile Island nuclear power station in the United States, the authorities in that country have been studying proposals for new siting criteria which would place greater weight on the density of population in the neighbourhood of any nuclear site. These proposed criteria are such that they would rule out nuclear power plants being located in certain regions where local population densities are higher, despite the possibility in practice of maintaining the level of public protection by introducing additional 'engineered' safety features.

"If these criteria are accepted, the United States would be adopting an approach to nuclear siting different from that presently established within most NEA member countries."

The note says this makes obvious the interest of an exchange of view at the international level. To facilitate such a discussion the Nuclear Energy Agency of the OECD arranged a special meeting of the CSNI sub-committee on licensing at which the agreed statement [see box] was drawn up. The statement makes the following main points:

- Site selection alone should not replace engineering and operating measures to achieve safety, although the choice of a site can evidently also make a contribution to public health and safety.
- Selection of a site is, naturally, governed by practical conditions in the country or region concerned. In some countries, the choice is made independently of the specific plant design; in others, however, engineered features are considered as factors in the final site selection in order to provide an adequate level of safety independent of a particular population density.
- When selecting a site it is important to consider the feasibility of implementing an emergency plan in case of an accident extending beyond the plant site, as the ability to take quick emergency measures is also a factor in achieving protection of the public.
- Analysis of the relationship between siting, emergency planning and engineered safety provisions enables regulators to judge the overall safety of a nuclear plant. To improve definition of this relationship, further research should be continued at national and international levels on certain topics, including: the expected amount and composition of fission product release from the core as a result of a hypothetical accident (the 'source term') the dispersion of radioactive materials released in such an accident and their deposition within the plant and in the environment; assessment of potential health consequences; and development of risk assessment techniques for nuclear plants. □

THE MAIN CONTRIBUTION towards the protection of public health and safety from the risks arising from the operation of nuclear power plants derives from the high quality standards achieved in the design, construction and operation of these plants. Nevertheless, advantage should be taken of the contribution which can be made to public health and safety by choice of sites. However, site selection alone should not be used to supplant the basic goal of achieving assurance of overall nuclear plant safety by the engineering and operation of the plant.

The practical choice of sites for a nuclear power programme in any country or region is predetermined by existing conditions in that country or region and site selection is therefore an optimisation process of the factors which influence both the safety of the plant and the public. These methods, as well as their parameters, may vary in different countries depending on the use of nuclear power plants (for electricity generation, district heating, process heat, etc.) and on their natural, technical and socio-economic situations. In some countries, site selection is viewed in practice as a process independent of specific plant engineering features, while in other countries it is viewed more as only one element in the overall process.

Emergency planning is a necessary and prudent measure which also provides an additional safety precaution against highly improbable severe accidents. The feasibility of emergency measures should be taken into account in site selection within the context of the siting options in the particular country or region.

It is recognised that further study of such questions as source terms, dispersion and deposition models, uncertainty analyses for accident consequences, and health effects models, and the continued development of risk assessments for nuclear plants will assist in improving understanding of the relationships among siting, emergency planning and engineered safety features as well as verification of the effectiveness of emergency response procedures. International cooperation on these questions should be encouraged. □

CSNI initiate new work on accident prevention

The Committee on the Safety of Nuclear Installations has intensified its efforts in accident prevention with two additions to its work programme.

First, it has set up a senior group of experts to examine those hypothetical accidents which, although having such a very remote chance of occurring that they are not usually considered 'credible', would have major public health consequences if they were to occur. Secondly, the Committee has approved a new three year programme for the inspection of steel components – PISC II – involving the ultrasonic examination of four heavy steel sections supplied by the Federal Republic of Germany, Japan, the UK and the US in a "round robin" test series. [Work within the PISC I programme was described in ATOM No. 285, July 1980.] Ultrasonic test methods are used to verify the integrity of major components such as the reactor pressure vessel during plant operation, thus ensuring the detection of potentially dangerous faults. The test plates to be used in the PISC II programme are to be shipped to some 30 testing houses in 12 European countries, Japan and North America; it is estimated that the programme will cost $10 million.

The CSNI, a committee of the Nuclear Energy Agency of the OECD, directs the NEA's programme of work

1980
Enrico Fermi Award

Sir Rudolf Peierls and Dr Alvin M. Weinberg received the US Department of Energy's Enrico Fermi Award for 1980 in recognition of "exceptional and altogether outstanding scientific and technical achievement in the development, use or control of atomic energy".

The award consists of a presidential citation, gold medal and $25 000.

Sir Rudolf's citation notes his "many pathbreaking discoveries in theoretical physics, including contributions to the understanding of the nucleus and the solid state, inspiration to several generations of students, pioneering contributions to early atomic energy developments in England and America, and efforts in working towards the responsible development and control of nuclear weapons." Dr Weinberg was cited for "pioneering contributions to reactor theory, design and systems, untiring work to make nuclear energy serve the public good, both safely and economically, inspiring leadership of the Oak Ridge National Laboratory, and wise counsel to the executive and legislative branches of government."

The Fermi award dates from 1954, when the US Atomic Energy Commission presented a special award to Enrico Fermi himself, the leader of the team of scientists who achieved the first self-sustaining, controlled nuclear reaction in 1942. The US AEC established an award in honour of Fermi in 1956; it was last given in 1978. Past recipients include Dr John Von Neumann, Dr Ernest O. Lawrence, Dr Eugene P. Wigner, Dr Glenn T. Seaborg, Dr Hans A. Bethe, Dr Edward Teller, Dr J. Robert Oppenheimer, Admiral Hyman G. Rickover, Professor Otto Hahn, Professor Lise Meitner and Professor Fritz Strassman, Dr John A. Wheeler, Walter H. Zinn, Norris E. Bradbury, Dr Sheilds Warren and Dr Stafford L. Warren, Dr Manson Benedict, Dr William L. Russell, Dr Harold M. Agnew and Dr Wolfgang K.H. Panofsky.

Sir Rudolf Peierls was born in Germany in 1907 and was educated at the Universities of Berlin, Munich and Leipzig, taking his Ph.D. in 1928. He was at Birmingham University at the outbreak of World War II; early in 1940 he and Prof. O.R. Frisch prepared an historic memorandum in which they set out theoretical estimates of the critical mass of uranium-235 and suggested how U-235 might be separated from other isotopes. The Peierls-Frisch memorandum initiated intensive work by British scientists in the early war years; in 1943 Peierls took up residence in the United States, where he led a group at Los Alamos concerned with the theory of implosions.

After the war Peierls returned to academic life as professor at the University of Birmingham until 1963, and professor at the University of Washington until 1977. In addition to his many honorary degrees, Sir Rudolf has received the Royal Medal of the Royal Society, the Lorenz Medal of the Royal Netherlands Academy of Sciences, the Max Planck Medal of the Association of German Physical Societies, and the Guthrie Medal. He was knighted in 1968.

Dr Weinberg was born in Chicago in 1915, where he was educated. He was trained as a mathematical biophysicist, but in 1942 he joined the Metallurgical Laboratory at the University of Chicago where Arthur Compton had undertaken to develop the uranium chain reaction for plutonium production. After the successful conclusion of that project Dr Weinberg began a long campaign to use the neutron chain reaction for peaceful purposes in research, in power production, in materials for medical application and in desalination.

He became research director at the Oak Ridge National Laboratory in 1948, and Laboratory Director in 1955, a post he held until 1974. He became Director of the Office of Energy Research and Development in the Federal Energy Administration in 1974, and Director of the Institute for Energy Analysis in 1975.

Dr Weinberg has received many honours, including the Ernest O. Lawrence Memorial Award of the US AEC in 1960, the same year as he won the Ford Foundation's Atoms for Peace Award. □

in nuclear safety and brings together the most influential voices in nuclear safety research and licensing from the OECD area. CSNI seeks to intensify cooperation in nuclear safety research and provides a forum for the exchange of information and views.

Re-evaluation of nuclear safety programmes and priorities in the light of the Three Mile Island accident has led to a general conclusion that greater attention should be paid to the less severe but more likely accident; but the accident also provoked a renewed interest in 'Class 9' accidents: those accidents which are hypothetically credible only if all engineered safety devices fail during an accident and large amounts of radioactivity are released to the environment. This is the background to the establishment of the CSNI group of experts now announced; the group will examine the interactions of reactor systems with a degraded core, the effects of 'Class 9' accidents on mechanical structures and the 'source term' (the amount and type of fission product release) that could be expected. The group will also study the applicability of current analytical and assessment tools to accident research and point out areas where in their view new methods should be developed.

The test specimens for PISC II are two flat plates and two nozzle specimens, taken from commercial manufacturing shops and containing implanted flaws. They will be inspected using a number of techniques supported by a programme of parametric studies. The plates, weighing up to 8 tons each, will eventually undergo destructive examination at the Joint Research Centre at Ispra, and the results from this will be compared with those of the non-destructive examinations. □

Inverness 82

Radiation protection – advances in theory and practice

The Society for Radiological Protection is to hold its Third International Symposium at the Eden Court Theatre, Inverness, Scotland from 6 to 11 June 1982. The scientific programme will cover most aspects of radiological protection with emphasis on recent advances in theory and practice.

A brochure and call for abstracts is now available, and authors wishing to present papers are invited to submit abstracts for consideration by the Scientific Programme Committee. The brochure contains a form for submission of abstracts and details on methods of presentation. The majority of papers, proffered and invited, will be presented in oral sessions in the Eden Court auditorium; poster presentations can be accommodated in areas adjacent to the auditorium. The symposium will be conducted in English and French and simultaneous translation will be available for both languages at the oral sessions. Posters may be presented in either language. Papers will be printed in the symposium proceedings prior to the symposium and will be distributed to all scientific delegates.

A trade exhibition will be staged adjacent to the symposium. The exhibition will enable delegates to update their knowledge of the wide range of products, services and information available to those involved professionally in radiological protection.

Copies of the brochure and call for abstracts may be obtained from the Symposium Organiser, SRP International Symposium, c/o NRPB Harwell, Didcot, Oxon OX11 0RQ. Abstracts must be received by 15 July 1981 and papers for publication by 15 February 1982. □

New Year Honours

The Authority are happy to record that HM The Queen has been pleased to make the following awards in the New Year Honours list:

MBE Mr R.J. Waite, scientific officer, Chemical Technology Division, AERE Harwell.

BEM Mr R.H. Killip, Chargehand, Windscale Nuclear Power Development Laboratories, Northern Division. □

CEGB selects wind-power site

The Central Electricity Generating Board announced on 12 January it had selected this site at Carmarthen Bay power station, Burry Port, Dyfed, on which to build a medium-sized wind-powered generator and that an application would be made shortly to the Secretary of State for Energy for consent to build the machine.

The Board said it was also to begin the detailed investigation of three possible sites for the first large-scale wind-powered generator. The sites, all owned by the Board, are at a disused airfield at Wigsley, near Lincoln; Bradwell nuclear power station, Essex; and Richborough power station, Kent.

The CEGB said it was proposed to bring the medium-sized generator into service as soon as possible, probably during 1982. This would then give operating experience and research information to help in the choice of the first large wind-powered generator.

Investigation of the sites for the large machine would involve the recording of wind and other data and consultation with the statutory authorities, amenity organisations and other interested parties. Each site is to be assessed for its suitability for the first large machine and the surrounding areas will also be assessed for extending the installation off the site at a later date to form a cluster of perhaps ten machines spaced about half a mile apart.

The CEGB said this work should lead to the selection of a preferred site during 1982. Subject to the usual statutory consent and consultation procedures it was proposed to have the first large machine in operation during 1985.

The CEGB is also participating actively in studies of the potential of offshore wind generation within the national programme led by the Department of Energy and within the International Energy Agency programme. As part of this work the CEGB is to collect data at suitable locations around the coast. □

Medical appointments

Dr Norman Stott, Head of Medical Services at Harwell, has been appointed Chief Medical Officer of the UKAEA in succession to Dr Maurice Hill, MBE, who retired on 31 December. In his new post Dr Stott will continue to be based at Harwell. Dr Colin Evans has been appointed (Acting) Head of Medical Services at that establishment.

Dr Stott studied medicine at the University of Aberdeen, graduating in 1954; after hospital appointments in Aberdeen and Glasgow he served for three years in the RAF Medical Branch. He joined the UKAEA in 1959 as Medical Officer at Dounreay, and in 1965 became Head of Medical Services at Harwell. Dr Stott is a member of the Council of the Society of Occupational Medicine and editor of the *Journal of Occupational Medicine*.

Dr Evans studied at the Welsh National School of Medicine, Cardiff, and qualified in 1951. He too served with the RAF as a Medical Officer and in 1955 was appointed National Coal Board Area Medical Officer for the Rhondda Valley. He was appointed a medical officer at Harwell in 1959; he became a member of the Faculty of Occupational Medicine of the Royal College of Physicians in 1979. □

Radiation, ethics and law

The Society for Radiological Protection is to hold a meeting on ethical and legal aspects of radiological protection at Imperial College, London, on Tuesday 31 March.

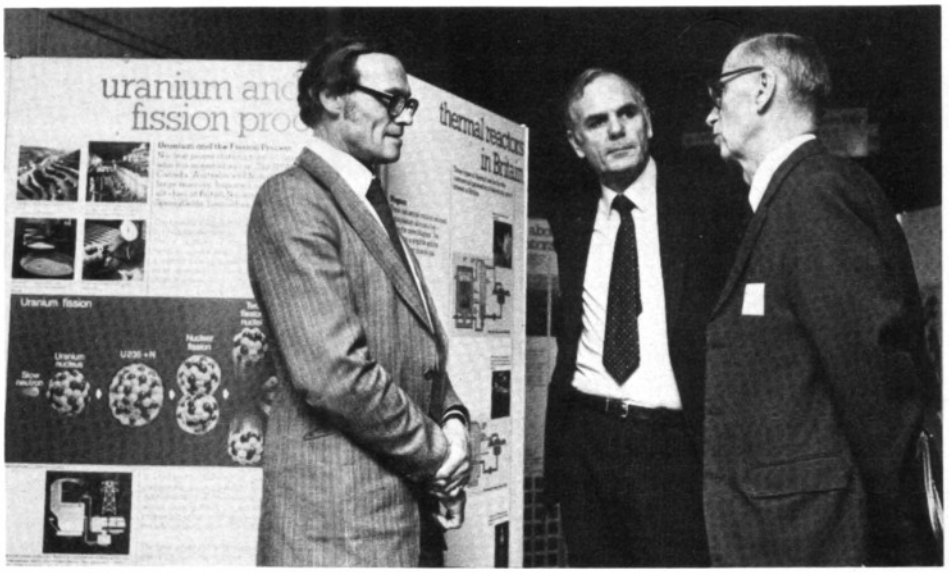
Enquiries about the meeting should be directed to the programme committee secretary, Prof. J.H. Martin, Department of Medical Biophysics, Blackness Laboratory, University of Dundee, DD1 4HN. □

IAEA scientific meetings programme

The International Atomic Energy Agency is to convene nine major scientific meetings, five of them in cooperation with other international organisations, during 1981. Detailed information about the meetings may be obtained from the appropriate national authorities in member States – Ministries of Foreign Affairs, or the national atomic energy authorities or commissions, or by writing directly to the IAEA at P.O. Box 100, Vienna International Centre, A-1400 Vienna, Austria.

Participants in IAEA meetings are designated either by the Government of a member State of the Agency, or by a co-sponsoring organisation, or by an international organisation invited to participate. If individuals wish to attend meetings they are admitted as observers only. The Agency will publish the proceedings of each meeting about six months after its conclusion. Details of the meetings are given below.

- FAO/IAEA International Symposium on Induced Mutations as a Tool for Crop Plant Improvement, Vienna, 9-13 March
- International Symposium on Methods of Low-level Counting and Spectrometry, West Berlin, 6-10 April
- International Symposium on Quality Assurance for Nuclear Power Plants, Paris, 11-15 May
- IAEA/WHO/UNEP International Symposium on Health Impacts of Different Sources of Energy, Nashville, USA, 22-26 June
- FAO/IAEA International Symposium on Sterile Insect Technique (SIT) and the Use of Radiation in Genetic Insect Control, Neuherberg, Fed. Rep. of Germany, 29 June-3 July
- International Symposium on the Use of Nuclear Techniques in the Study of Parasitic Diseases of Man and Animals, Vienna, 29 June-3 July
- IAEA/CEC/NEA International Symposium on Migration in the Terrestrial Environment of Long-lived Radionuclides from the Nuclear Fuel Cycle, Knoxville, USA, 27-31 July
- International Conference on Industrial Applications of Radioisotopes and Radiation Technology, Grenoble, France, 28 September-2 October
- IAEA/WHO/NEA/ICRP International Symposium on the Application of the Dose Limitation System in Nuclear Fuel Cycle Facilities and other Radiation Practices, Madrid, 19-23 October □



UKAEA at science teachers meeting

Distinguished visitors to the UKAEA exhibit at the annual meeting of the Association for Science Education at Warwick University from 2 to 6 January included Sir Arthur Vick, a former director of Harwell and a pro-Chancellor of Warwick University.

Sir Arthur is pictured (right) with UKAEA officials Dr David Locke, Head of Information Services, Northern Division, and John Bird of the Information Services Branch, London.

The UKAEA stand featured a new mobile exhibition and the prototype of a teaching resource pack, both designed to aid in the presentation of nuclear power and related topics in schools and colleges. The mobile exhibition comprises 12 lightweight linked panels (each 2 ft 6 inches wide and 6ft high), free-standing and adaptable to a variety of layouts, which illustrate graphically the role of nuclear power. The exhibition touches on the history and development of nuclear power, its costs, types of reactors, waste disposal, safety, fusion and alternative energy sources. It will be available on free loan to educational institutions and other interested organisations throughout Britain. (Information about loan arrangements can be obtained from the Information Services Branch at the UKAEA's London headquarters.)

The teaching resource pack is being developed in conjunction with Gerald Lloyd of the Bath University School of Education. Work on the pack began after a study by Bath University, commissioned by the UKAEA, on how and to what extent nuclear power is covered in school curricula, indicated a clear need for syllabus-related resource materials. The pack will contain an integrated set of information materials including study booklets for pupils, film strips, wallcharts, task cards and a teacher's guide. The materials, which will be tested in school before production, will be available to teachers during 1981. Schools will be advised when and how they can be obtained. □

Shaft plugging

The Nuclear Energy Agency of the OECD announced at end-year publication of the proceedings of a workshop on *Borehole and Shaft Plugging* in relation to radioactive waste disposal.* In a note on the publication, the NEA says the concept of geologic disposal of radioactive wastes relies on the capability of many types of geological formations to contain the waste in the long term. The safety of this method may be partially dependent on the successful plugging of boreholes and shafts used for the initial geological analysis, and for the subsequent emplacement of the waste, in that they could provide a pathway between the disposal zone and the biosphere. Borehole plugs in the context of radioactive waste disposal must therefore be as sound as the original isolating geological formation, be chemically stable and withstand the temperatures and radiation doses to which they may be exposed.

The workshop was organised by the NEA in cooperation with the US Department of Energy in May 1980; the objectives of the meeting were to review data and experience in the field of borehole and shaft plugging, to exchange views on various approaches to the design of long-lived plugs, and to promote cooperation. □

Borehole and Shaft Plugging, 434 pp., OECD 1980. £12; available from OECD Sales Agents including HMSO. ISBN 92 64 02114 0.

Tape library for dose calculation

The National Radiological Protection Board (NRPB) has established a computer tape library which can be used to calculate the collective dose to the population of the European Communities from discharges of radioactive effluents.

The tape library can be used to determine the collective dose to, and hence the radiological impact on the population of the Communities of:

- airborne discharges from any location in the Communities;
- liquid discharges to the marine environment from any location in the Communities; and
- liquid discharges into the Rhine and Rhone rivers from any location

The tape library itself can be obtained, at a cost of £200 + VAT, on request from Dr R.H. Clarke, Head of Nuclear Assessments Department, National Radiological Protection Board, Harwell, Didcot, Oxon OX11 0RQ.

The tape library is based on a methodology[1] for evaluating the radiological impact of effluents discharged in the normal operation of nuclear installations. The methodology was developed by the National Radiological Protection Board (UK) and the Commissariat à l'Energie Atomique (France). It comprises a series of interlinked models which describe the transfer of radioactive materials through the various parts of the environment and enables the exposure of the affected population to be estimated.

Because of the wide interest shown in the methodology and its potential applications the Commission of the Communities placed a contract with the NRPB to develop a procedure whereby the methodology could be provided to other organisations in a form that could be readily applied. This has been accomplished by producing a computer tape library containing a matrix of results which can be used to evaluate the radiological impact of effluent discharges.

The matrix of results in the tape library has been compiled by applying the methodology to a wide range of circumstances. It contains data on the dispersion of nuclides in the atmosphere and in various aquatic environments, the transfer of nuclides through the parts of the environment, details of the distributions of the population and of agricultural products in the Communities, and dosimetry. Atmospheric discharge results are given for some 95 nuclides and aquatic discharge data for 41 nuclides. The contents of the tape library and its method of application are described in a recently published report[2].

To apply the tape library results, the user must specify various data which are particular to and characterise the actual discharge location.

The tape library can be written on to nine-track magnetic tape in several ways and the preferred format should accompany any request. The available options are:

6 250 bits per inch (bpi) with standard IBM labels,
6 250 bpi without labels,
1 600 bpi with standard IBM labels, and
1 600 bpi without labels

Further information is available from the Information Officer, National Radiological Protection Board, Harwell, Didcot, Oxon OX11 0RQ. Tel. Abingdon (0235) 831600, ext. 410. □

1. NRPB/CEA, *Methodology for evaluating the radiological consequences of radioactive effluents released in normal operations. Joint report prepared by the National Radiological Protection Board (UK) and the Commissariat à l'Energie Atomique (France). Luxembourg, CEC,* Doc No V/3865/79-EN, FR (1979).
2. Jones, J.A. and Kelly, G.N., *Collective dose assessment of radioactive effluents: a computer tape library applicable to the EC.* Luxembourg, CEC Doc No V/4115/80-EN (1980).

Open Day at Harwell Catalyst Unit

The Harwell Catalyst Unit is to hold an Open Day for its industrial users on 2 April 1981. The occasion will provide an opportunity for a progress review of the Unit's activities, and for visitors to tour the facilities and laboratories which are used by the Unit.

The Open Day will mark the third anniversary of the Unit which was established in 1978—with the financial support of the Department of Industry's Chemicals and Minerals Requirements Board (CMRB)—to develop specialist catalytic materials and analytical techniques, and to make these available to industry on a commercial basis.

Senior managers and researchers from industry and research associations with an interest in catalysis are invited to attend the Open Day, which will include a series of presentations on the work of the Unit and its future objectives. (Open Day visit application forms can be obtained from the Unit and those wishing to attend are reminded that there will be a limit on the total numbers that can be accommodated during the day.)

Since the formation of the Unit a key component of its programme has been the development of ceramic dispersions and their application to Fecralloy® steels and other substrates. Work has concentrated on the development of high surface area ceramics with particular emphasis on high performance coatings for both monolithic and tubular reactors. The Unit has developed a number of analytical techniques, based on neutrons and charged particles, for the characterisation and evaluation of catalysts and catalyst supports. These have been used to determine carbon deposition profiles, and internal porosity, and for elemental analysis. The Unit also provides testing and developing facilities which companies can use to supplement their own research.

The Unit's commercial activities are underpinned by a basic research programme which is supported by the CMRB, and guided by an advisory panel which draws its members from UK industry and the universities.

Further details and application forms for the Open Day, and more information on the work of the Unit, can be obtained from Dr Chris Wright, Harwell Catalyst Unit, Building 521, AERE Harwell, Oxon OX11 0RA. Tel. Abingdon (0235) 24141, ext. 5208 or 4564. □

CEGB place contracts for Heysham II

The Central Electricity Generating Board placed two of the main contracts for the Heysham II nuclear power station in Lancashire with Taylor Woodrow Ltd and NEI Parsons Ltd on 29 December 1980.

The contract with Taylor Woodrow is for the main civil engineering and building works, and that with NEI Parsons for the supply, delivery and erection of two 660 MW turbine generators plus condensing and feed heating plant and boiler feed pumps. The approximate combined value of the two contracts is £230 million.

Contracts for other major items of plant such as the boiler systems, the reactor gas circulators and the reactor fuelling machine were to be placed shortly in conjunction with the National Nuclear Corporation.

Heysham II is one of the two new AGR stations authorised by the Government. The other is at Torness, which is being built for the South of Scotland Electricity Board. The two stations are being built to the same design; each will have two reactors with a combined output capacity of about 1 300 MWe. □

Courses at Harwell

Microcomputers: an introduction
6 to 8 April and 1 to 3 June

This course, aimed at applied scientists and engineers, seeks to impart a general understanding of the architecture, software aspects and system configurations of microprocessor-based microcomputers. The course (which is being repeated) is divided into three parts occupying about a day each. The first part covers the principles of digital computing; the second with software engineering, outlining machine code, assembly language and high-level language programming. Examples will be given of low-level language programming. The final part illustrates typical microcomputer systems, ranging from small development kits to large microcomputer installations. The final lectures describe the developments which have resulted in the powerful second generation microcomputers now becoming available.

A comprehensive set of notes, including a supplement on binary number systems and Boolean algebra (a knowledge of which is assumed) will be provided at the beginning of the course. Fee: £186 + VAT.

High vacuum technology
27 April-1 May

This course is intended primarily for graduate engineers and scientists who need a broad and comprehensive introduction to high vacuum systems and techniques. Technical and experimental staff who have some vacuum experience but who need an introduction to advanced systems and techniques would also find the course useful. Visits will be made during the course to the Harwell and Culham laboratories where large, high vacuum, systems are in regular use. Fee: £310 + VAT.

Process instrumentation
6 to 10 April
This course deals with the instrumentation of process plant, nuclear reactors and scientific apparatus; it is intended primarily for engineers requiring a knowledge of process instrumentation not necessarily in their own specialisation. Experience gained by the UKAEA and BNFL is described and demonstrated. Fee: £310 + VAT.

Further information and application forms for these courses are available from the Education and Training Centre, AERE Harwell, Oxon OX11 0QJ. Tel. Abingdon (0235) 24141, ext. 2469. □

NRPB training courses

The National Radiological Protection Board is organising more than 60 courses for training in radiological protection this year. They include courses for safety officers, competent persons (radiological protection supervisors), environmental health officers, workers on offshore installations and radiation workers of various kinds. The subjects covered include the nature and use of radiation, biological effects, requirements of Regulations and Codes of Practice, the roles of national and international organisations, methods of protection, personal dosimetry, accidents, radiation monitors and so on. There are also courses on "non-ionising" radiation, including lasers, ultraviolet, microwave and radio-frequency radiations.

In addition to its scheduled courses, the NRPB also provides custom-designed training courses. These can vary from half-day appreciation sessions to five-day residential courses, and can be held at times and places convenient to customers. They have the advantage that they can, when necessary, be oriented to the particular need of the customer.

The courses are organised by the NRPB's Technical Service Centres at Glasgow, Leeds and Harwell and are described in three new brochures. These, with information on custom-designed courses, are available from:

Training Officer
NRPB Scottish Centre
155 Hardgate Road
Glasgow G51 4LS
(Tel. Glasgow (041) 440 2201)

Training Officers
NRPB Northern Centre
Hospital Lane
Cookridge
Leeds LS16 6RW
(Tel. Leeds (0532) 679 041)

Training Officer
NRPB Southern Centre
Harwell
Didcot
Oxon OX11 0RQ
(Tel. Abingdon (0235) 831 600) □

All STATUS Users' Group established

Users of STATUS – the information retrieval software package developed by AERE Harwell – have established an All STATUS Users' Group.

The new Group, which was formed at the first All STATUS Users' meeting held at The Royal Society on 15 January, will act as an information exchange for ideas on the applications of STATUS and play a representative role in discussions with Harwell and franchise holders on future developments and enhancements of the STATUS package.

It will be an umbrella organisation for *all* users and will operate alongside the existing PRIME and ICL STATUS users groups, and other specialised groups which may be formed.

At the meeting, attended by representatives of 25 user organisations, a steering committee was elected to consider the terms of reference and structure of the new body. Membership of the committee comprises Percy Fairburn (The Wellcome Foundation), George Gibb (Health and Safety Executive), Jim Hetherington (Howson-Algraphy, Vickers Ltd), Judy Lay (Rutherford and Appleton Laboratories, SRC), Derek Matkin (Harwell), John Potter (Institute of Flight Safety) and Brian Stops (W S Atkins and Partners).

Details of the latest development – STATUS Version 80 – which are currently being released to franchise holders and users, were also announced at the meeting. In producing this new version, the main objective has been to improve the performance and robustness of the system, but several new and extended features have also been incorporated. One of these is a powerful facility for multi-line command macro processing, which will allow the occasional user straightforward access to complicated search and retrieval commands.

Further information on STATUS and its applications can be obtained from Derek Matkin, Commercial Manager, STATUS, Marketing and Sales Department, Building 329, AERE Harwell, Didcot, Oxon OX11 0RA. Tel. Abingdon (0235) 24141, ext. 2704 □

Electricity Council appointments

Mr David Howell, Secretary of State for Energy, announced on 21 January that he had appointed Mr Austin Bunch, CBE, FCA, Comp.IEE, to be chairman of the Electricity Council.

Mr Bunch, who had been deputy chairman of the Council since 1976, succeeds Sir Francis Tombs, who relinquished the chairmanship on 31 December 1980. His appointment is until 31 March 1982.

Mr Bunch's successor as deputy chairman is to be Mr Alan Plumpton, CBE, CEng, FIEE, FRSA, chairman of the London Electricity Board, who has been appointed for a period of five years from 1 February 1981. Mr Plumpton was chairman of the LEB from October 1976. □

AEA REPORTS

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

AEEW-R 1359 *The determination of the residual plutonium masses in glove boxes, by remote measurements using solid thermoluminescent dosemeters.* By H.E. Preston and W.J. Symons. October, 1980. 40pp. HMSO £3·00. ISBN 0 85182 051 4

AERE-R 8730 (1980 rev) *MA28—A set of Fortran subroutines for sparse unsymmetric linear equations.* By I.S. Duff. November, 1980. 105pp. HMSO £5·00. ISBN 0 70 580593 X

AERE-R 9022 *High resolution γ spectra of 40-44 Mev γ photon activation products. Part 3. A summary of γ rays, radionuclides and nuclear interferences observed.* By D.R. Williams and J.S. Hislop. September, 1980. 32pp. HMSO £3·00. ISBN 0 70 580892 0

AERE-R 9185 (1980) *Harwell subroutine library. A catalogue of subroutines* (1980). Compiled by M.J. Hopper. September, 1980. 71pp. HMSO £4·00. ISBN 0 70 580553 0

AERE-R 9367 *Variable dead time counters. 2. Computer simulation.* By B.W. Hooton and E.W. Lees. September, 1980. 36pp. HMSO £3·00. ISBN 0 70 580972 2

AERE-R 9764 *Improvements to a flame photometric detector to allow measurement of sulphur gases in ambient air.* By B.M.R. Jones and S.A. Penkett. October, 1980. 21pp. HMSO £2·00. ISBN 0 70 580583 2

AERE-R 9766 *A stepper motor controller utilising mouse module hardware.* By J. Huddleston. September, 1980. 71pp. HMSO £4·00. ISBN 0 70 580982 X

AERE-R 9802 *The development of instrumentation for nondestructive testing.* By M.C.B. Russell. June, 1980. 67pp. HMSO £3·00. ISBN 0 70 580752 5

AERE-R 9815 *The calculation of methane profiles in AGR graphite structures. Part 1. Cylindrical geometry.* By R.L. Faircloth. August, 1980. 38pp. HMSO £3·00. ISBN 0 70 580902 1

AERE-R 9871 *Semi-automated testing of proportional counters.* By S.J. Sangwine. October, 1980 14pp. HMSO £1·00. ISBN 0 70 580523 9

AERE-R 9857 *Studies of environmental radioactivity in Cumbria. Part 3. Measurements of radionuclides in airborne and deposited material.* By N.J. Pattenden, R.S. Cambray, K. Playford, J.D. Eakins and E.M.R. Fisher. September, 1980. 36pp. HMSO £2·00. ISBN 0 70 580952 8

AERE-R 9882 *An investigation into exponential fitting by the method of moments.* By D.M.E. Cook. August, 1980. 11pp. HMSO £2·00. ISBN 0 70 580922 6

AERE-R 9995 *Code of practice and design principles for portable and transportable radiological protection systems.* By F.H. Wells and R.G. Powell. October, 1980. 118pp. HMSO £5·00. ISBN 0 70 580533 6

ND-R 467(S) (pt.1) *Small-angle neutron-scattering experiments. Part 1. Use of the Harwell small-angle diffractometer.* By A.D. Hardy and M.W. Thomas. November, 1980. 31pp. HMSO £3·00. ISBN 0 85 356133 8

ND-R 512(S) *Creep-fatigue behaviour of four casts of Type 316 stainless steel.* By J. Wareing. January, 1981. 31pp. HMSO £3·00. ISBN 0 85 356134 6

IN PARLIAMENT

BY OUR PARLIAMENTARY CORRESPONDENT

PWR inquiry

21 January 1981

The Government expect the inquiry into the pressurised water reactor to be held in 1982, Mr Norman Lamont, Under Secretary of State for Energy, said in the course of a Commons debate on energy policy.

"I cannot say what the precise form of the inquiry will be, except that it will be as wide as possible," he said. "We want maximum discussion, and it is hoped that the construction of PWRs can be started in 1983.

"It was suggested that the nuclear programme was not going fast enough. But when we have been through a decade when the industry has had no inquiries and is run down, I do not believe that we can go quicker than we are just now. I do not believe that we could build more stations and build them to time. Heaven knows, we have had enough problems building them in the past. We have of course discussed with the industry what the scale of the programme should be."

Mr Lamont said the Government had been criticised for building nuclear power stations in rural areas. The implication was that the Government thought them unsafe. He went on: "The nuclear industry and the Government simply cannot win. To satisfy public opinion and allay anxieties, they do not build nuclear power stations in the middle of cities, but they are then accused of doing so precisely because they know they are unsafe. It is a ridiculous argument."

IEA meeting

16 December 1980

Mr Skeet asked the Secretary of State for Energy if he would make a statement about the meeting of the governing board of the International Energy Agency at ministerial level on 9 December.

Mr David Howell: The governing board of the International Energy Agency met at ministerial level on 9 December under the chairmanship of the Secretary of Energy of the United States, Mr Charles W. Duncan. I represented the United Kingdom.

Ministers considered both the short-term oil market situation and the structural changes required in the medium-term to enable IEA countries to move away from dependence on imported oil.

Ministers noted with concern that events in the Middle East had cast new uncertainties over future oil supplies and that the risk of a new spiral in oil prices threatened the world economy with further loss of growth, increased inflation and unemployment. Ministers were determined that the industrialised countries should do all in their power to prevent a repetition of the events of 1979. In their view the overall oil market situation, given the combination of high stock levels, declining consumption and the helpful action of several OPEC countries by way of increased production, should remain manageable. They reaffirmed the measures agreed on 1 October 1980 and extended them for the first quarter of 1981. Ministers agreed that, in the fourth quarter of 1980 and the first quarter of 1981, the balance between oil supply and demand should be maintained by continuing to draw on stocks. They also emphasised the need to discourage undesirable purchases, which brought undue pressure to bear on the market, and to keep oil consumption under control. They decided on a system to manage any serious country and company imbalances which might arise. The collective result of these actions, as estimated by the IEA secretariat, would be to reduce demand by IEA countries for oil on the world market by 10 per cent – from 264 million tonnes in the first quarter of 1981 to 238 million tonnes. Their effectiveness will be the subject of rigorous monitoring.

Ministers also reviewed progress made in achieving the structural change necessary to ensure that energy shortages do not act as a constraint to growth in the medium term. They noted that stronger measures to manage energy demand and reduce oil requirements would be needed if further slippage in the prospects of economic recovery in the middle 1980s was to be avoided. They had in mind in particular measures to increase coal production trade and use on which they received a valuable presentation by the Coal Industry Advisory Board, an expansion in the development of nuclear power, an increase in the production, trade and use of natural gas, the development of alternative sources of energy and the vigorous promotion of energy demand management through energy conservation and the substitution of other energy forms for oil.

The importance of the price mechanism and the view that domestic oil prices should reflect world prices was reaffirmed. Officials were asked to examine the pricing of energy in general and to institute more effective monitoring systems on energy pricing. Ministers will return to this question at their next meeting.

H.M. Government believe that effective implementation of the conclusions of the IEA meeting is essential if the short-term difficulties now being experienced in the oil market are not to lead to a further damaging price explosion. In the medium term sound pricing policy is fundamental to ensure the adaptation of our economies to new patterns of energy use. Implementation of both the short-term measures and of those necessary in the medium-term will require political commitment on the part of all member Governments. H.M. Government will approach the IEA conclusions in this spirit.

District heating

16 December 1980

Mr Robert C. Brown asked the Secretary of State for Energy what proposals he had to encourage local authorities in North-East England to investigate further and where possible introduce district heating schemes and to give financial support for such schemes.

Mr John Moore: The Secretary of State for Energy announced on 2 April (1980) a programme of work to test the feasibility of combined district heating and power generation in specific locations. The city of Newcastle-upon-Tyne and Tyne and Wear County Council are amongst those local authorities which are participating in this programme. Information from this work will enable judgments to be made on the desirability of providing funds and on the scale of involvement by central and local government and other bodies.

Protection of nuclear material

16 December 1980

Mr Chapman asked the Secretary of State for Energy to publish the text of the Convention on the Physical Protection of Nuclear Material; and whether it was the Government's intention to ratify the convention.

Mr Norman Lamont: Cmnd. 8112, copies of which have been placed in the Library of the House, contains the

text of the convention, which was prepared under the auspices of the International Atomic Energy Agency (IAEA) and opened for signature in Vienna and New York on 3 March [1980]. The convention will come into force 30 days after 21 countries have ratified it.

Under the convention, which applies to civil nuclear material, a signatory will be obliged to:

(a) take steps to ensure that nuclear material in the course of international transport is protected to specified levels while under its jurisdiction;

(b) not to export or import such material except on the basis of assurances that it will be so protected during transport outside its jurisdiction;

(c) to cooperate on request with other parties on the recovery of material should it be stolen;

(d) take steps to ensure that certain specified offences which are broadly concerned with the unlawful taking, possession and use of such material, including in certain circumstances a threat to commit such offences, is punishable under its law; to enable the courts to exercise more extensive jurisdiction over such offences; and to provide for the extradition of persons accused or convicted of committing these offences.

Twenty-six countries have so far signed the convention, including the UK, all other members of the European Atomic Energy Community (Euratom). The European Commission has signed on behalf of the Community. One country has ratified it so far.

It is the Government's intention to ratify the convention when the necessary legislation to amend our criminal law, to extend the jurisdiction of our courts and to amend our extradition law, has been enacted. The Secretary of State for the Home Department will introduce legislation for this purpose in due course.

With regard to the physical protection standards set out in the convention, these correspond to those described in existing guidance by the IAEA. The UK has always subscribed to these. The convention's standards have therefore been applied for a number of years to civil nuclear material under UK jurisdiction.

Radiation hazards

19 December 1980

Dr Roger Thomas asked the Secretary of State for Energy what steps were taken to monitor any effects from radiation of temporary workers employed by the various generating boards in such operations as the delagging of radioactively contaminated pipes.

Mr Norman Lamont: I understand that as regards CEGB power stations in England and Wales temporary workers are fully subject to radiological control where this is appropriate and that records of exposure to radiation are maintained by the station and by the men's employers.

These are matters within the day-to-day management responsibilities of the Central Electricity Generating Board, and I am asking the chairman to write to Dr Thomas.

The electricity boards in Scotland come within the responsibility of the Secretary of State for Scotland.

Generation costs

19 December 1980

Mr Geoffrey Johnson Smith asked the Secretary of State for Energy what estimates he had made of the relative costs of electricity generated by coal and advanced gas-cooled reactor nuclear power stations.

Mr Lamont: In January 1978 the Department published as Energy Commission Paper No. 6 an evaluation of comparative coal and nuclear (including AGR) power station costs at January 1977 prices. . . . These studies are kept under review.

The CEGB has published information in its annual report for 1979-80 on the relative historic costs in that year of electricity generated by an AGR station (Hinkley Point B) and a comparable coal-fired station (Drax first half); the board has also published calculations in its annual report of the net effective cost of future nuclear and coal-fired stations, at March 1980 price levels, which are used to assess investment decisions.

Combined Heat and Power

19 December 1980

Mr Spearing asked the Secretary of State for Energy what progress he had made in identifying possible areas for demonstration projects for schemes of CHP.

Mr John Moore: Consultants working on behalf of the Department of Energy are currently examining the potential for combined district heating and power generation of the areas where the local authority has expressed an interest in participating in the Government's CHP Feasibility Programme. An announcement will be made in the New Year of the five or six areas where further work under this programme will be carried out.

AEA Constabulary

19 December 1980

Mr Kilroy-Silk asked the Secretary of State for Energy (1) if he would make a full statement on the actions and activities of the Atomic Energy Authority Constabulary since its inception in 1975; and (2) whether he would set out the number of arrests, detentions of suspects for questioning and the searchings of premises by the AEA Constabularly in each year since 1975.

Mr Lamont: The UKAEA Constabulary (UKAEAC) was formed in April 1955 under authority conferred by the third schedule to the Atomic Energy Act 1954. It exists to police and protect establishments and materials of the UKAEA and British Nuclear Fuels Ltd. Its duties include the control of access to establishments; crime prevention and detection; and escort duties relating to the movement of nuclear materials. Its actions and activities since 1975 as earlier are in pursuance of these responsibilities.

I am advised that the number of arrests and searches of premises in each year since 1975 were as follows:

	Arrests	Searchings of premises
1975	1	4
1976	2	1
1977	8	5
1978	11	10
1979	10	12
1980	14	8

No suspects were detained for questioning.

All the arrests were made at or in the vicinity of UKAEA or BNFL establishments and the arrested persons were transferred to the custody of the Home Department police forces of the areas where the establishments were located. The premises searched were those of employees of the UKAEA or BNFL, or employees of contractors of the UKAEA or BNFL.

Fuel transport

19 December 1980

Mr Arthur Lewis asked the Minister of Transport whether he had received an approach from the London borough of Newham on the question of the transporting of irradiated nuclear fuel by sea as opposed to the present practice of conveying it through highly populated and industrial areas of London and Greater London.

Mr Kenneth Clarke: Yes, the borough has asked my Department about this possibility. Whilst it seems attractive at first sight it would not in fact provide a practical alternative to rail for this particular type of traffic.

Energy policy

13 January 1981

Mr Michael McNair-Wilson asked the Secretary of State for Energy what information the Government had recently sent to the Commission about the UK's energy policy programme up to 1990.

Mr David Howell: It was agreed at the Council of Energy Ministers in May 1980 that member States would submit to the Commission each year details of their energy policy programmes up to 1990 so that the Commission could assess these programmes in the light of the Community's energy policy guidelines for 1990. The Commission recently sent a request to member States for answers to four questionnaires about their national energy programmes. I have placed in the libraries of both Houses a copy of the UK Government's reply recently sent to the Commission.

Nuclear Installations Inspectorate

14 January 1981

Mrs Renée Short asked the Secretary of State for Employment what evidence he had that the wages of the various grades in the Nuclear Installations Inspectorate were lower than their comparable equivalents in industry; and what plans, if any, he had to make restructuring and grade changes in the NII.

Mr Waddington: Inspectorial work on nuclear installations is largely confined to the Government and there is no clear basis for comparison between the work of nuclear installations inspectors and posts in the nuclear industry. However, a job evaluation study of all Health and Safety Inspectorates has recently been completed including an evaluation of the work of the NII. The report of the study, which contains recommendations for the development of a common grading structure across the inspectorates, including the NII, is currently under consideration.

- Mrs Short also asked why three scientists from the nuclear industry had been seconded to the NII, and what their duties were to be.

Mr Waddington: I am advised by the chairman of the Health and Safety Commission that three officers in the professional and technological grades have been seconded from the UKAEA to the NII. The officers will provide support to NII staff engaged in the inspectorate's current pressurised water reactor assessment and will be working under their direction. These arrangements have been made because of the specialised and temporary nature of the duties on which they will be employed.

- Lastly, Mrs Short asked how many vacancies there were now in the NII, and if he remained satisfied that it was able to carry out its duties effectively.

Mr Waddington: I am advised by the chairman of the Health and Safety Commission that the executive is seeking to recruit up to 16 additional people to the NII. He remains satisfied that the essential functions of the inspectorate can be maintained at the present level of staffing.

Energy resources

19 January 1981

Mr Hooley asked the Lord Privy Seal what would be the approximate disbursements of official aid in the current financial year for development of energy resources as between coal, oil, gas, nuclear and renewable sources of energy.

Mr Marten: Details of expenditure for the current financial year are not yet available.

Mr Hooley: Does the Minister agree that developing countries with few or no assets in the form of hydrocarbons could find that renewable sources are extremely important, namely, solar, wind and tidal power? Will he give an assurance that that will be reflected in the balance of the aid programme that relates to energy help?

Mr Marten: I think that that will be the case. Disbursements of project aid on energy projects in 1979 amounted to £34 million about three quarters of which went to non-renewable power projects, and the remainder to renewable projects. I hope that that will continue.

Fire at Cap de La Hague

20 January 1981

Mr Hooley asked the Secretary of State for Energy what information or warning was received from the French authorities about the fire at the nuclear fuel reprocessing plant at Cap de La Hague near Cherbourg on 7 January which led to the release of strontium-90 and plutonium contaminants, and whether the Channel Islands were affected.

Mr Lamont: I am advised by the Health and Safety Executive that, on 7 January, the French regulatory authorities informed the Nuclear Installations Inspectorate (NII) of the incident under a formal arrangement with the Executive providing for the exchange of information about nuclear safety matters. They advised that on 6 January radiological surveillance at La Hague had shown a slight rise in radioactivity, and that this radioactivity was traced to an underground waste store from which wisps of smoke were emerging. Action was taken to control and extinguish any fire. They further advised that the increase in the level of radioactivity detected did not exceed permitted limits during the incident.

I understand from the Home Secretary that in accordance with the arrangements agreed with the French Government, the Prefect of the Departement of La Manche notified the Channel Islands authorities of this incident on 7 January.

The NII are maintaining contact with the French authorities and expect in due course to receive further information concerning the circumstances of the accident when these have been evaluated. I expect to be further advised when that information is available.

PFR load factor

23 January 1981

Mr Cook asked the Secretary of State for Energy to publish in the *Official Report* the annual load factor of the Dounreay PFR for the most recent 10 years.

Mr Lamont: The load factor figures for PFR since it first generated electricity during 1975 are set out in the following table. As stated in the UKAEA's last annual report, despite good performance by the reactor itself, electrical output has been constrained by problems with other parts of the plant and the needs of the experimental programme.

Prototype Fast Reactor annual operating statistics:

Year	*Percentage of time reactor operational*	*Electrical Load Factor % (i.e. actual electrical output as a percentage of design output)*
1975	88·1	8
1976	83·2	20
1977	79·8	29
1978	54·6	33
1979	56·5	27
1980	84·9	21

PWRs

20 January 1981

Mr Cook asked the Secretary of State for Defence to make a statement on the construction of a pressurised water reactor at HMS *Vulcan*.

Mr Speed: Prototype pressurised water reactors for the Royal Navy have been undergoing development and testing at HMS *Vulcan* since 1966. A new generation of reactor plant, designated PWR2, is now undergoing design and development for future classes of Royal Navy submarines. A prototype reactor assembly will be installed within a new shore test facility on the *Vulcan* site. It is expected that the PWR2 will come into operation in the mid-1980s and have an overall life of 20-25 years. It is intended that the

PWR2 will have a number of advantages over its predecessor, both militarily and in the areas of operability and maintenance. It will, of course, be designed to comply with all the latest safety standards.

Combined Heat and Power

26 January 1981

Mr Spearing and Mr Rost asked about the progress of the CHP feasibility programme.

Mr John Moore: The Department has now received from its head consultants, W.S. Atkins and Partners, a report which contains its recommendations on the areas for further work under the CHP feasibility programme. . . . We shall be considering these recommendations together with the views of the local authorities which have participated in the programme, and will announce our response shortly.

Mr Spearing: Are any programmes in London, in particular in east London?

Mr Moore: One of the six areas recommended covers east central London. The Atkins report suggests that the following London boroughs could be included in the east central London scheme: Camden, Southwark, Tower Hamlets, Barking and Newham.

Mr Rost: As one of the criteria which the Secretary of State said he is applying in selecting a suitable site for a lead city CHP scheme is the availability of a suitable power station, what is he doing to prevent the CEGB from closing any more of these suitable power stations and scrapping them? The closure of some stations already has probably prejudiced the development of CHP in some city centres.

Mr Moore: I ought to have congratulated Atkins and Co. on the speed of its report. I also thank the fuel authorities and the local authorities which have cooperated so well. Mr Rost is right in his remarks, with his long background in the subject. There is a need for the availability of a suitable power station or power station site. That was one of [the] three important factors considered by W.S. Atkins. I ask, however, that members including Mr Rost should consider the detailed report which I have placed in the Libraries of both Houses.

The nuclear programme

26 January 1981

Mr Adley asked the Secretary of State for Energy to make a statement on the progress achieved in the expansion of the nuclear programme; and Mr Geoffrey Johnson Smith asked whether the Secretary of State was satisfied that the reorganised nuclear industry would be able to meet cost and time targets for the UK's new nuclear power stations.

Mr Lamont: Following the Secretary of State's statements of 18 December 1979 and 14 April 1980 the structure of the nuclear industry has been strengthened and work is in hand on the two new advanced gas-cooled reactors and on the design of the proposed pressurised water reactor. The opportunity now exists for the creation of a strong and efficient nuclear industry in the UK.

Mr Adley: Does Mr Lamont agree that some of those who criticise the Government's nuclear policy on safety grounds are implying incompetence, evasion or dishonesty by the CEGB? As that is a most unfair and improper suggestion, will he and his colleagues be rather more robust in defending the Government's policy and explaining it to ordinary people?

Mr Lamont: We shall certainly be robust. I am somewhat surprised at Mr Adley's suggestion, since we are frequently accused of being simply a mouthpiece for the nuclear industry – whereas the Government wish the nuclear debate to be an open one. However, the Government have made no secret of their view that this country, particularly in view of the concern about energy prices, needs a strong and larger nuclear component.

Mr Johnson Smith: Can Mr Lamont reassure the House that the development of a British version of the PWR remains on schedule?

Mr Lamont: The development of a British version of the PWR does remain on schedule, but Mr Johnson Smith will know that we are still at the preliminary stage of doing the design work. The NII is doing its work for the inquiry. So far we are on target, but matters are at a very early stage.

Mr John Home Robertson: The nuclear programme at Torness in East Lothian is likely to run into some difficulties if the authorities continue to ignore the undertakings given about the employment of local people. There are 643 unemployed construction workers in East Lothian but the contractors at Torness are busing in 614 workers from outside the Lothians and Borders.

Mr Lamont: I note what he says, but I am afraid that Torness is the responsibility of the Secretary of State for Scotland.

Mr Patrick McNair-Wilson: Can Mr Lamont give us any idea of the timescale that the Government have in mind for the development of a commercial fast breeder reactor?

Energy statistics

22 January 1981

Mr Rowlands asked the Secretary of State for Energy what was the actual or estimated UK production, net imports and consumption in million tonnes of oil equivalent of (a) coal, (b) oil, (c) gas and (d) nuclear power in 1979 and 1980; and what assumptions he was making for the years 1981 to 1985.

Mr David Howell: The information for 1979 and 1980 is as shown in the table.

Production and net arrivals do not necessarily balance with consumption because of stock changes and statistical differences.

My main assumption for the years up to 1985 is that these aggregates will be determined by market forces. These are likely to be affected by a great variety of factors, especially the development of the UK economy generally and the future movement of world oil prices. In these circumstances it is unwise to adopt any single view of energy demand and supply.

		Coal	Petroleum	Natural Gas	Nuclear electricity
		(million tonnes of oil equivalent)			
Production	1979	72	78	34	8
	1980 (partly estimated)	77	80	32	8
Net arrivals	1979	1	19	8	–
	1980 (partly estimated)	2	1	9	–
Consumption*	1979	76	94	42	8
	1980 (partly estimated)	73	81	41	8

**Includes petroleum for non energy uses and marine bunkers.*

Mr Lamont: I cannot say when an announcement might be made. No decision has yet been taken. There have been various discussions between the AEA and people in other countries about the possibility of collaboration, but I stress that no decision has yet been taken. This House will, of course, be informed at an early stage.

Mr Penhaligon: At the open and public inquiry into PWR safety, will the Government be prepared to ensure that those objecting to the PWR do not lose their case in the face of Government propaganda because of a lack of finance?

Mr Lamont: It has never been policy that objectors to projects should be funded at the taxpayers' expense. We have no present plans to alter that policy.

Mr Ancram: Is Mr Lamont concerned at the escalation in the projected outturn costs of the new AGRs at Heysham and Torness? Is he still satisfied that they are justified economically?

Mr Lamont: I am concerned about the escalation of costs for AGRs generally. Certainly there is a large margin. However, I strongly believe that the industry has to get to grips with those costs or the economic case for nuclear power will be endangered. The situation is not one which can leave us complacent.

Mr Eadie: Since, in reply to Mr McNair-Wilson, the Minister was not very specific, and since he must have seen the trailer running in the press to the effect that most of the experimental processes at Dounreay are almost complete, will he try to avoid giving the impression that the Government are complacent about this? Will he ensure that the House receives a statement about this matter, arising from statements which have appeared in the press?

Mr Lamont: I have seen many statements in the press, including many misleading and totally inaccurate statements, and I do not think that we should make a statement to the House on the basis of them.

The PWR

26 January 1981

Mr Hooley asked the Secretary of State for Energy when he expected the first pressurised water reactor power station to begin supplying electricity to the national grid.

Mr Lamont: Work is now proceeding on the design of the PWR and on the preparations for the public inquiry, but it is too soon to say when the PWR might be commissioned.

Mr Hooley: Does Mr Lamont agree that on all the evidence this fantastic £25 billion programme will not make any serious contribution to Britain's energy strategy for decades, if at all? Would it not be more sensible to abandon it and to concentrate on conservation and other energy sources that are much more likely to yield a good result?

Mr Lamont: First, it is a £15 billion programme and not £25 billion programme. Perhaps it should be £25 billion. Secondly, Mr Hooley says that it takes a long time to construct a nuclear power station or to get a nuclear programme under way and that it would be better to abandon it. I cannot accept that. We have already had many questions about energy costs. One reason why our electricity costs compare badly with those in France, for example, is that the French have a higher proportion of nuclear energy than we do. That is why we must press ahead and why we must build nuclear stations in Britain in time and to cost.

Mr Rost: There is already a serious slippage in the timetable for the design of the British PWR. How does Mr Lamont think that this will affect the timetable for its construction and completion?

Mr Lamont: I do not think Mr Rost is quite right. Mr Howell and I had a meeting last Friday with all those involved in the preliminary work on the PWR. It is not right to say that there is a slippage. Indeed, there is not a slippage on the design work. We know very well that there have been problems with power stations both nuclear and conventional. The industry must get to grips with these problems, otherwise nuclear electricity will not be economic.

Mr John Evans: In view of the doubt cast upon forecast demand for electricity at the end of the century, and bearing in mind the public hostility towards the PWR project, does the Minister think it necessary to go ahead with its development?

Mr Lamont: There may or may not be arguments about demand for electricity. However, to accept those arguments would be to accept arguments against power stations of any type and not necessarily against the PWR project. As Mr Evans knows, the electricity industry, in consultation with the Department, continually revises and re-examines its forecasts. We are satisfied that in the 1990s there will be a need for more nuclear electricity. Mr Evans should not forget that nuclear electricity is cheaper than other forms of electricity. We need cheaper electricity as well as more electricity.

Mr Merlyn Rees: Regardless of whether there is slippage in the conventional sense of the term, Mr Lamont will recall that in last week's debate he announced that there were no terms of reference and no timescale for the inquiry. Does that not mean that there will be delay in the PWR project and that the Department should be considering further orders for the AGR project?

Mr Lamont: No. I said that we expected that the inquiry would begin in 1982, and without in any way pre-

EUROPEAN PARLIAMENT

The nuclear state

Human society is in danger of having to subordinate its organisational shape to a structure of energy production which was once treated as no more than a means to an end, said a report by the Energy and Research Committee of the European Parliament, accepted by the Parliament on 15 January. The report went on:

> As a specific example of how this leads to involvement in the energy debate, we may take the 'plutonium state': opponents of the development of fast breeders fear that the large quantities of plutonium – raw material for nuclear weapons – that will then be available can only be manufactured and transported in conditions of such strict security that the nature of the State would be completely transformed in our countries, despite the fact that burning plutonium in fast breeder reactors is the best way to dispose of it.

A British MEP, Mr Madron Seligman, a member of the committee said during the debate on the report that every time the environmentalists prevented the building of a nuclear station they destroyed thousands of jobs for construction workers and equipment makers. Nuclear scaremongering was a luxury the west could not afford.

The motion accompanying the report called on the EEC Commission to draw up, as part of a comprehensive energy policy, a programme to develop and exploit all forms of decentralised and renewable energy production. □

suming what the inquiry's findings will be, if the findings are in favour of the PWR, construction will be in 1983. The construction of the station could take six or seven years. We are at a stage where much work has still to be done on the design.

Wind energy

27 January 1981

Mr Rost asked the Secretary of State for Energy what progress was being made in harnessing wind energy in the United Kingdom.

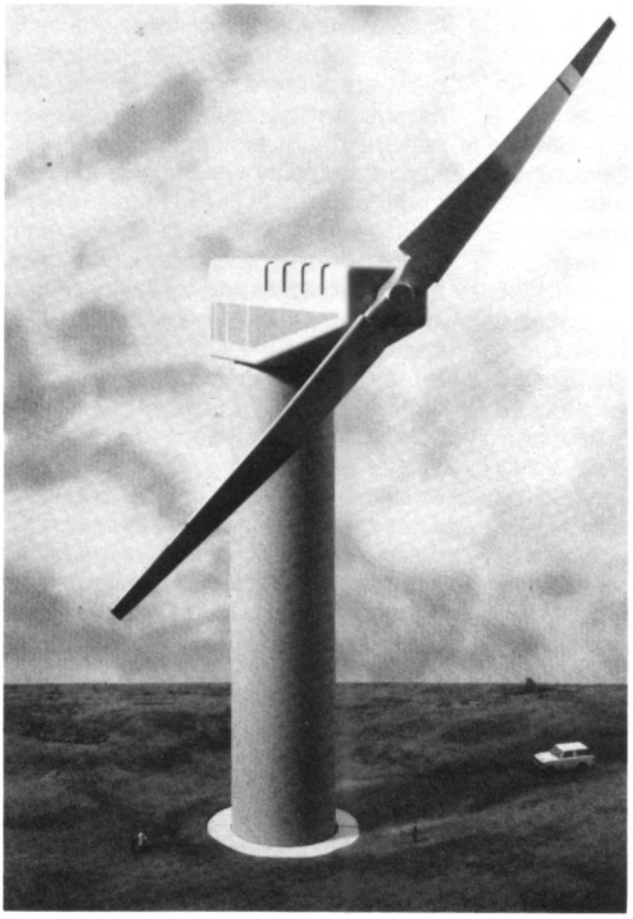
Mr David Howell: It is hoped that a major step forward in the development of wind energy in this country will be taken with the building of the UK's first megawatt-sized wind powered generator – aerogenerator. Subject to planning consents and contractual arrangements, the machine will be built at Burgar Hill, Orkney. It will have a 60 metre blade diameter and a generating capacity of about 3 megawatts. It is hoped to have the machine in operation by 1983-84, and connected to the island's electricity supply.

My Department will provide support of up to £4·6 million for the project. The North of Scotland Hydro-Electric Board (NSHEB) will provide the remaining £1 million, and will also provide the site. In addition, my Department will meet the costs of monitoring the aerogenerator performance.

The aerogenerator will share the site with a smaller, 20 metre machine of 250 kilowatt capacity, which is expected to come into operation in October 1981 and will provide some useful data for the larger machine.

This project is an important step in the development of wind power in the UK and will enable us to gain experience of the basic problems of aerogenerators through the development of a large prototype. The wind speeds on Orkney together with its relatively small capacity electricity grid and the high generating costs of its diesel sets make it a good site for testing wind generators.

This type of grid is a characteristic of other isolated communities which often rely on diesel generation and these too could benefit from the use of wind power. □



A model of the 3 MW, 60 m diameter wind turbine to be built on Burgar Hill, Orkney, for the North of Scotland Hydro-Electric Board and the Department of Energy. It will generate about a seventh of the electric requirements of the island, which is now supplied by diesel generators

IN THE LORDS

Wavepower systems

13 January 1981

Lord Beaumont of Whitley asked the Government why only one of the wavepower systems under development was to be chosen for full-scale trials, as reported in the *Financial Times* of 27 October 1980.

The Earl of Avon: The report in the *Financial Times* of 27 October is speculative and no decision has yet been made on whether large or full-scale sea trials should take place or on the type or number of systems which might be involved.

Lord Beaumont: May I ask whether he agrees that, in view of the ongoing energy crisis, there is a very forceful case for trying out with full-scale trials any experiment which seems likely to succeed?

The Earl of Avon: Yes. The Government are fully aware of this and are proceeding at what I think the noble Lord will find to be a very satisfactory speed.

Cancers

15 January 1981

The Duke of Hamilton and Brandon asked the Government whether there was any evidence to suggest that there was a greater incidence of cancer, and in particular cancer of the bowel, in workers with radioactive materials than in workers in chemical, mining and other industries.

The Earl of Gowrie: There is no evidence to suggest that under present conditions workers with radioactive materials have a greater incidence of cancer, including bowel cancer, than do workers in chemical, mining and other industries. Certain studies suggest that workers with radioactive materials have a higher incidence of certain types of cancer, but these studies have involved small groups who may have been exposed to high doses of radiation in the past. Research currently under way should provide a fuller picture of the overall incidence of cancer among radiation workers.

Accident statistics

19 January 1980

The Duke of Hamilton and Brandon asked how many fatalities and serious injuries had been reported to the Secretary of State for Energy over the last 10 years related to different types of electricity generating installations, indicating the ratio of such occurrences to the total amount of energy passed to the national grid.

The Earl of Gowrie: The total number of deaths and injuries occurring at electricity generating installations in England and Wales which have been reported to the Secretary of State for Energy over the 10 years to 31 March 1980 are 92 and 201 respectively, and the ratios of such occurrences to the Board's total electricity output in the same period are 1 per 23 000 gigawatt hours and 1 per 10 000 GWh respectively. Information on the distribution of such occurrences between different types of generating installations is not readily available.