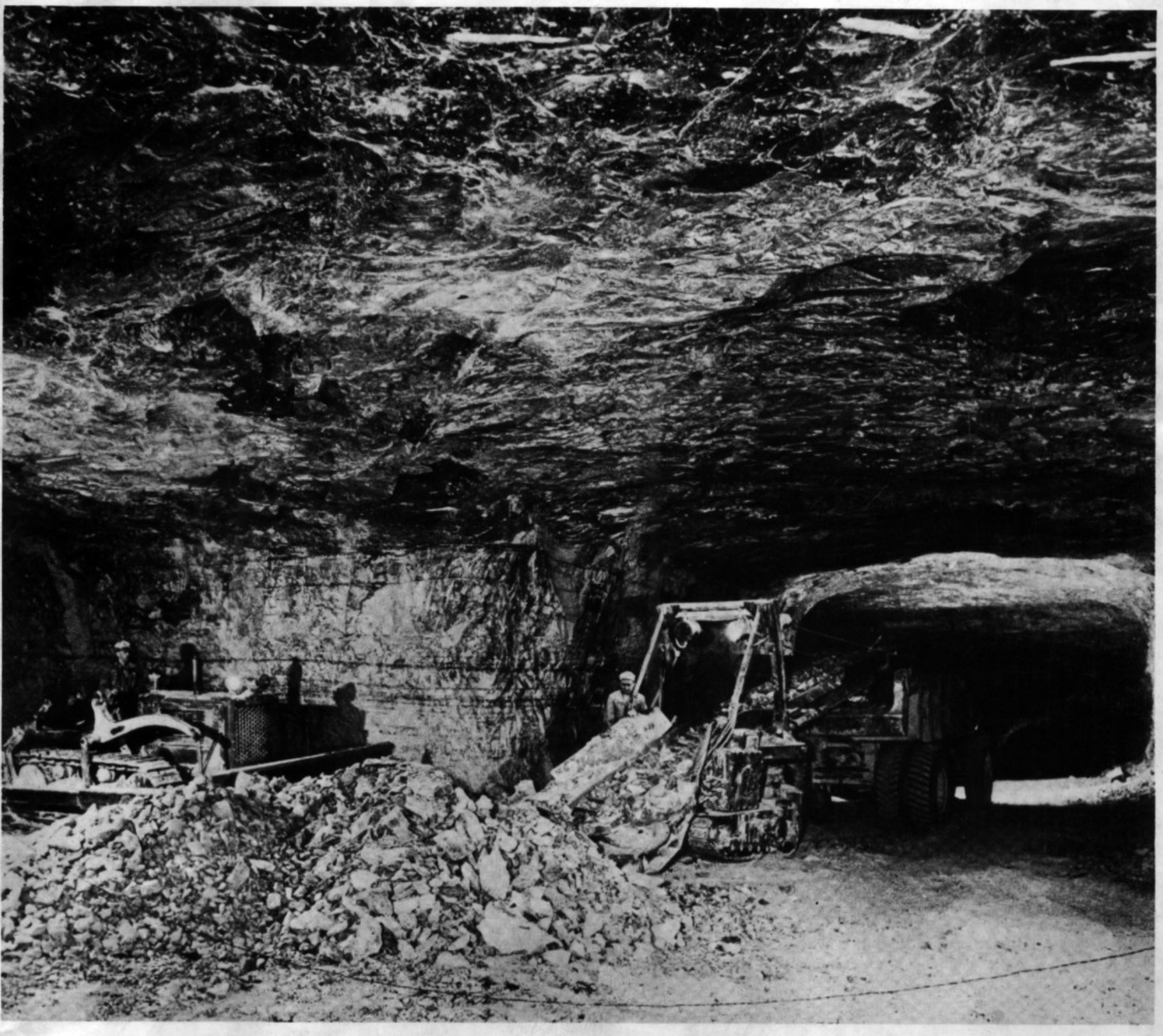
JANUARY 1984 NUMBER 327

ATOM

ACCIDENT SOURCE TERMS—

ENERGY CONSERVATION DEMONSTRATION PROJECTS SCHEME

ELECTROCHEMISTRY AND RADIOACTIVE WASTE



JANUARY 1984 NUMBER 327

ATOM contents

THE MONTHLY INFORMATION BULLETIN OF
THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY

ATOM, the monthly bulletin of the UKAEA, is available free. It has a circulation of about 22 000 and is distributed extensively within the nuclear energy and electricity industries, both in the UK and overseas. Other recipients include the business and financial community, most MPs, universities, polytechnics, libraries, schools and members of the public.

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

Information on advertising in ATOM can be obtained from
D.A. Goodall Ltd., New Bridge Street House
30-34 New Bridge Street
London EC4V 6BJ
Telephone 01-236 7051/4

ISSN 0004-7015

Part of the Billingham mine being considered as a disposal site for long-lived intermediate level waste

ACCIDENT SOURCE TERMS—CAUSE FOR LESS CONCERN

The problem of what values to give to source terms, which are important parameters in evaluating the potential effects of serious damage to the core of a reactor, is discussed by Simon Rippon, European Editor of *Nuclear News*.

One of the few pleasant surprises to follow the Three Mile Island accident in the US was the very small amount of radioactive iodine that was released. This led to questioning about the so called 'source terms'—the fractions of different species of radioactive fission products that have been estimated as likely to be released in theoretical assessments of hypothetical accidents involving severe damage to the core of a nuclear reactor.

The subject is of some importance for the morbid calculations of the worst possible consequences of the worst imaginable nuclear accident. A ten-fold decrease in the overall source term would yield at least a 100-fold reduction in the number of fatalities that are calculated to result from severe accident. That means that for most of the worst-case accident scenarios the chances are that there would be **no** early fatalities among the surrounding population.

The significance of source term reduction goes beyond a mere public relations effort to counter the many frightening headlines that have been seen in the past about the possible results of nuclear accidents. A realistic assessment of consequences is important in formulating emergency plants to be implemented in the event of an accident. If, as now seems increasingly likely, there is no risk of early fatalities then evacuation of the public, with its attendant risks, should no be contemplated in emergency plans—it would be much safer simply to instruct people to stay indoors until any cloud of released radioactivity has dispersed. At the same time a reduction in source terms could have significant longer term implications for the siting of nuclear power stations. They could be closer to centres of population without the imposition of economically crippling layers of additional safety features.

Historically, the first ultra-conservative estimates of worst-case consequences were made in 1957, in the early days of the civilian nuclear power programme in the US, with a study which effectively assumed that by some unspecified accident the entire radioactive inventory of a reactor core was dispersed. Rather more realistic, though still conservative, source term criteria were developed by the US licensing authorities in the early 1960s and these guidelines were adopted, with minor refinements, for most of the subsequent accident risk studies. In particular they were the source terms adopted in the major probabilistic Reactor Safety Study completed in 1975 and variously referred to as the Rasmussen report or WASH-1400. Similar basic source terms were also adopted for the comparable German Risk Study completed a few years later.

At Three Mile Island it was found that although 10 million curies of noble gas fission products (xenon and krypton) were released from the damaged reactor core into the containment building, only about 20 curies of iodine were released. The traditional source terms would have postulated approximately equal releases. This finding started a group at the US Electric Power Research Institute (EPRI) looking at releases from previous accidents, or deliberate experiments, in which reactor fuel had been damaged. There are quite a number of examples to draw upon, starting with the Windscale fire in 1957 and including programmes of experiments at a US desert test site in which reactors were driven to destruction. As a result of this review work, a strong case for possible revision of source terms was presented to the US Nuclear Regulatory Commission (NRC) at the end of 1980. A large programme of work has since been initiated in many countries to try to establish figures which are both more realistic and acceptable to the ever sceptical licensing authorities.

A crop of questions

As is so often the case with analysis of very hypothetical nuclear accidents, the more you look at them the more questions you can raise. This is fine for research workers—a whole crop of interesting new projects have come up on questions of release mechanisms and pathways which are generally related to the source term issue. In most cases the talk is of two or three years before the necessary results are obtained to generate more realistic computer models and satisfy regulatory bodies of the need for significant revisions.

Since the main builders and operators of light water reactors in the US, Europe and Japan are already managing to live with the existing regulations, it seems likely that, while being impatient for revisions, they will be prepared to wait the two or three years for the relevant experimental results. Regulatory bodies in different countries, while looking very seriously at source terms and other questions relating to severe accidents, are clearly not prepared to be rushed into revisions. Even the hope of some sort of interim source terms from the US Nuclear Regulatory Commission, that had once seemed possible in 1983, is now not expected until mid-1984.

The problem is not much in convincing regulators of the very conservative nature of the source terms adopted in Rasmussen's Reactor Safety Study. The Rasmussen report states quite clearly that the assumptions used were probably overly pessimistic and suggested that more detailed study of the subject would be worthwhile. But the more detailed study now taking place, while tending to confirm the conservatism for most of the 'standard' accident scenarios and release mechanisms, inevitably raises questions about yet more remote variations in the scenarios which might just result in conditions unfavourable to the new theories of fission product retention.

Ironically, this means that while the main thrust of developing more realistic models of accident consequences is to avoid excessive pre-occupation with highly improbable large accidents, the result is increased analysis of even more improbable combinations and variations of the scenarios. It has reached the ridiculous state where some of the probability figures now being banded around represent frequencies as low as once in the lifetime of the earth!

An alternative approach to obtaining an interim judgement on source term reduction, first developed by Westinghouse in a study based on the Zion nuclear power plant in the US, has been further developed in the UK and presented as evidence at the public inquiry currently examining the proposal to build a presurised water reactor at Sizewell B. It accepts that it is not possible to say that source terms will be lower in all circumstances but produces a spectrum of probability of them being less by different factors for the various release mechanisms considered in the safety analysis of the plant. While this approach is itself conservative and still yields a small probability that some source terms could in a few cases be as large as, or even slightly larger than, the pessimistic Rasmussen case it shows the strong probability that they will be substantially less in the majority of accident scenarios.

Ultimately it is likely that the two approaches will come together with the more detailed experimental results on release mechanisms and improved computer models providing the input to give more precise figures to the probability of source term reduction. Such results will be compatible with the greater use of probabilistic risk assessment which has already found its way into UK regulation as part of general safety guidelines and is under discussion in the US with the NRC's proposed numerical safety goals.

How could fission products get out?

The basic case for reduction of source terms and a more realistic assessment of accident releases and consequences was fully documented in a series of papers in *Nuclear Technology* (May 1981). Of particular interest from the review of past accidents and incidents was fairly convincing evidence that if there was any water around only a very small fraction of the volatile fission product inventory in the fuel, other than noble gases, was released to the environment. Also well documented are the likely explanations. First, iodine and caesium fission products would be likely to react together in the fuel prior to release so that they come out as highly soluble caesium iodine rather than their more volatile elemental forms. Second, aerosols tend to aglomerate and plate out in a moist atmosphere.

In the last couple of years workers in several countries have extended these arguments by looking in greater detail at the opportunities for retention of fission products in the different designs of commercial nuclear power plants currently in use. In discussion of these problems there tends to be a separation between releases into the primary circuit, where differences in design are not very significant, and release to the containment and auxiliary buildings where there are quite substantial differences in design. But while this segregation is convenient from the point of view of the different experimental programmes, those involved in assessing accident consequences stress the importance of looking at total systems and above all at the likely timing of the postulated accident sequences which can have a dramatic effect in reducing possible excape pathways and on retention of fission products.

The starting point in considering source terms and release mechanisms is a severely damaged—or degraded—reactor core. Getting to this starting point is not exactly an every day occurrence—with the latest designs of engineered safety systems, the probability is about once in a million years of reactor operation. There are then a number of barriers to the release of fission products: the fuel matrix and cladding, the primary coolant circuit, and the primary and secondary containment buildings with the auxiliary building constituting part of the secondary containment.

Release mechanisms from the fuel can be considered under four categories of increasing seriousness and decreasing probability:

- Following clad rupture it is necessary to consider the fractions of fission products that would find their way into the spaces around fuel pellets, and the expansion gaps at the top of fuel pins, since these would be available for more-or-less instantaneous release to the next barrier.
- Core melting would result in the release of noble gas fission products and the more volatile fission products such as iodine and caesium but the relatively slow nature of the melting process is important in determining the subsequent fate of the released fission products.
- Vapourisation of the molten remains of a core might occur, if there is no mechanism for heat removal from the debris, resulting in the release of the less volatile fission products. In such a case all the volatile fission products would have been released to the primary circuit during the earlier melting phase—an important consideration when thinking about extreme scenarios such as vessel melt-through.
- A steam explosion, which extreme pessimists say might just occur if a large volume of molten core dropped into a pool of water at the bottom of the vessel or containment, could distribute fine particles of residual core materials but again only at a later time than the release of volatile fission products.

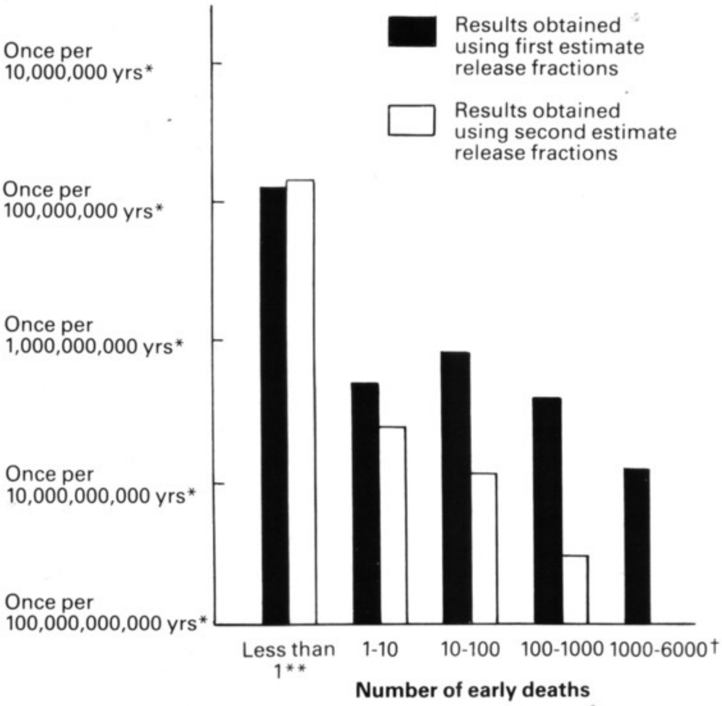
In the event of a loss of coolant accident (LOCA) the primary circuit barrier was given no credit for retention of fission products in the Rasmussen study. For simplicity it was assumed that all fission products escaping from the fuel would eventually find their way to the containment building or auxiliary building. In most of the LOCA scenarios this is clearly an extremely conservative assumption since there are a host of structures within the primary circuit, especially above the core, which would be expected to trap a sizable portion of the released fission products. In particular, aerosols would be encouraged to aglomerate by virtue of their high concentration and would plate out on the vast areas of metal surfaces. But at the same time it is possible to postulate worst case situations, such as a large break in the hot leg of a coolant circuit, which could allow the majority of fission products released from the fuel to be swept out into the containment building.

If fission products do get out into the containment building there are still more potential retention mechanisms to be considered even if the integrity of the containment has also been breached. There are acres of surface area of steel and concrete on which volitile fission products could plate out; there is scrubbing by containment sprays and all the other water there would be if there had been a sizable leak in the primary circuit; there would be trapping in filter systems; and there would be settling of aerosols, again assisted by the high moisture content in the atmosphere.

The Rasmussen study used a computer code known as Corrall to make allowance for likely fission product retention in the containment. The code was based largely on empirical results from the Containment Systems Experiment programme conducted at the Pacific Northwest Laboratory between 1964 and 1970. This way in a one-fifth linear-scale model containment which, while it was very useful in demonstrating the main processes, was hardly representative of the great complex of structures and equipment packed into an actual reactor containment. Nor did it take into account transient heat transfer conditions likely during a real accident and it was only with some difficulty that the aerosols used in the tests were able to be injected into the simulated containment building. Further development of computer codes based on wider variety of experimental results can go some way to giving more realistic figures for fission product retention for the wide spectrum of different situations found, or postulated under accident conditions, in different containments.

Another important consideration is of course, the inclusion or otherwise, of secondary containment. German studies also attribute considerable importance to the amount of space, if any, betweeen the primary and secondary containments even in the most severe postulated modes of failure of both containments. At the same time studies must include consideration of accident scenarios which have the potential to bypass the primary containment, usually to an auxiliary building which by virtue of its standard of integrity can be considered part of the secondary containment.

Even if a sizeable release of fission products were to get out of a reactor containment building, there are still plenty of possibilities for harmless retention before reaching the surrounding population. It is difficult, for example, to imagine

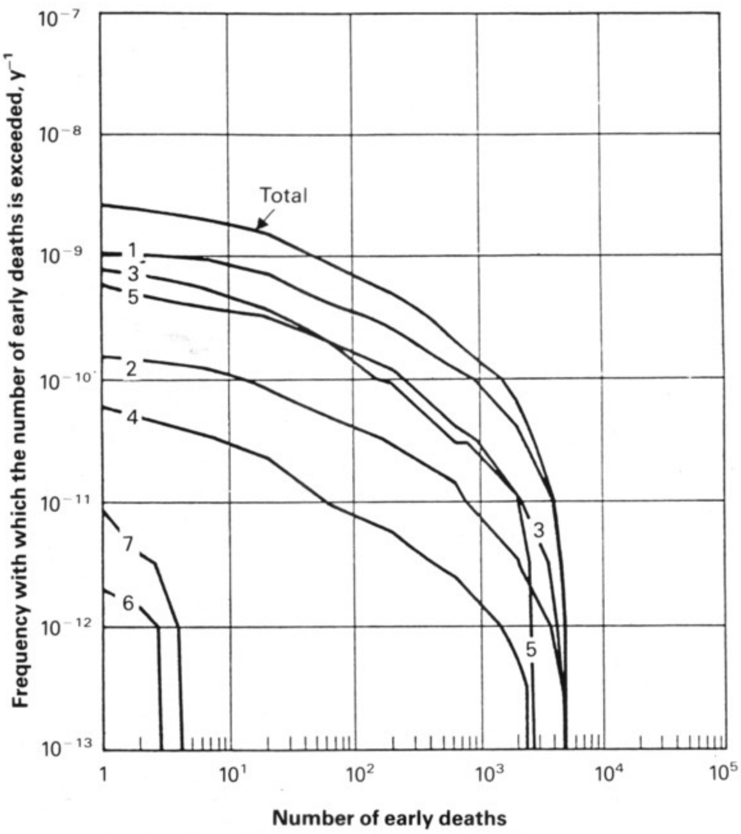


* Means reactor year of operation

** For the majority of these cases this means there would be no early deaths

† The frequency with which more than 1000 early deaths could occur, using second estimate release fractions results, is too low to show on this figure. It is about once per one hundred thousand million years.

Figure 1 Variation of results of early deaths in an accident depending on the source terms used



(Note: Curve numbers refer to release categories)

Figure 2 Number of early deaths due to an accident against the frequency with which it is exceeded. (Both these figures come from evidence given to the Sizewell Inquiry)

any mechanism for blowing a hole in a containment that would not be accompanied by a huge release of steam and water vapour. On encountering the colder atmosphere outside, this would deposit as rain in just the manner needed to pull down any associated aerosol releases of core material. In any case, most of the mechanisms for catastrophic failure of containments that have been put forward as remote possibilities would occur below ground level, or into the complex of surrounding buildings, where there would be considerable potential for filtering effects in the ground and debris.

Factors influencing releases

At all stages on the tortuous route of escape to the environment, the retention of fission products from a severely damaged core is likely to be heavily influenced by two main factors—the physico-chemical nature of the fission products and the timing of the sequence of events creating the pathway to escape. For consideration of the physio-chemical properties the fission products are grouped roughly in order of decreasing volatility.

The noble gases, krypton and xenon, for which the general assumption now is that if an escape pathway opens then all the noble gases will eventually get out. This is actually slightly more pessimistic than the Rasmussen study in which a release fraction of 90 per cent was assumed.

Radioiodine, has been considered the most important category from the point of view of eventual radiological consequences. The Rasmussen study adopted a 70 per cent release fraction based on the distinctly pessimistic view that over 90 per cent of the iodine available for release would be in the volatile molecular form. It is now recognised that, apart from a small fraction of the organic compound methyl iodine, the majority of the iodine will be in the form of inorganic compounds, predominantly the highly soluble caesium-iodide.

Alkali metals, caesium and rubidium, would be expected to be released as vapour if fuel reaches the melting point but would subsequently condense to form aerosols. It is significant, however, that they, like iodine, would be released before other aerosols that would be likely to be produced during the more drastic stages of the core slumping into a molten pool at the bottom of the vessel or containment building.

Tellurium and antimony	These groups would be expected to emerge as aerosols with increasing
Barium and strontium	severity of core damage but tellurium and ruthenium could be
Ruthenium	scavenged by the molten steel and zirconium that would also be
Lanthanum	around.

It is not difficult to see how timing at every stage of a postulated accident would have a major influence on the releases fraction for the different categories of fission products. The progressively more extreme sequence of clad rupture and oxidation, fuel melting and core slumping, and molten fuel interaction with water, pressure vessel and ultimately concrete, would extend over several hours of even days with the different types of fission products being released at different stages and in a variety of forms. In the primary circuit the range of postulated loss of coolant accidents means that released fission products could have a lengthy route to the point of leakage with ample opportunity for retention in the labyrinth of structures above the core or in the miles of steam generator tubing. But in the case of a large hot-leg break they could be swept out in a matter of seconds.

The most important consideration in accident scenarios that culminate with a release to the environment is the time between the initiating event and the failure of the containment. With the majority of postulated sequences of events it is very difficult to see any way in which there could be early failure of the containment. Apart from the special case of a containment being bypassed—which is discussed below—most studies start with containment failure at two and a half hours after the incident and last several days. Clearly this leaves a great deal of time for the different retention mechanisms to have an effect. But it is still necessary in the Devil's advocacy process of regulation to look for any remote mechanisms for early failure of the containment and to see whether these could occur along with fast release sequences from the damaged core and primary circuit. The contention of those now advocating substantial reductions in source terms is that there is no such combination of events to which a meaningful probability can be attached.

There is, however, one accident scenario that has been postulated to cause a rapid bypassing of the containment to the auxiliary building or secondary containment. Ironically it is associated with the engineered safety systems for emergency injection of cooling water. It assumes a blow down to the auxiliary building due to failure of the isolation valves for the coolant injection system. Design improvements have been introduced in recent plants to further reduce the possibility of this particular sequence of events. Recent analysis also indicates that a great deal of steam and water would be associated with the release giving enhanced retention of fission products in the auxiliary building.

Yet another very remote possibility that has been postulated is a steam explosion caused by molten core material in the containment sump. Although this could not occur before release and deposition around the plant of all the remotely volatile fission products, it might just be an explosion of sufficient intensity to cause resuspension of some of the fission products at the same time as blowing a hole in the containment. Most recent analysis, however, is increasingly sceptical about the possibility of getting conditions for such a steam explosion. After melt-through of the vessel it would require a large lump of molten metal to fall into a pool of water in the sump. But it seems much more likely, especially considering the multitude of small penetrations in the bottom of most designs of reactor vessels, that any melt-through would take the form of molten material spraying out in all directions to be scattered around the concrete walls of the reactor vault.

Experimental studies

A wide spectrum of experimental studies is being undertaken in many countries generally related to getting better data for input to the models of fission product release following severe accidents. They range in size from relatively small but quite difficult laboratory scale experiments to determine the physico-chemical characteristics of fission product releases to large blowdown facilties and reactor loops, several of which are internationally sponsored projects.

The characteristics of fission product release at the point of emission from overheated or melting fuel is difficult because it is necessary to ensure that the experimental sampling system does not itself affect the form of the fission product release. The experiments are not made easy by the need to use real fission products, either generated by damaged fuel pins in a reactor loop or by heating samples of highly irradiated fuel in furnaces.

Examples of techniques being used for out of pile experiments are provided by work at the Argonne and Oak Ridge National Laboratories in the US. In the first case the fission product emission from a small hole in a heated sample of irradiated fuel is drawn directly into a mass spectrometer. Initially experiments are with fission product release into a vacuum but later experiments will investigate releases into different mixtures of steam, hydrogen and air to simulate the actual environments likely to be encountered in a failed reactor core.

The other approach involves melting irradiated fuel in an induction furnace and sweeping the released material into thermal gradient tube, in which the temperature drops from 1 000°C to 150°C, and thence into a series of high efficiency filters. Analysis of the activity deposited in the thermal gradient tube and on the filters provides information on the quantity and form of the released material.

With in-pile experiments, the difficulties of measuring fission product release are compounded by all the problems of safe operation within an expensive reactor facility. Experimental programmes tend to evolve cautiously from studies of fuel behaviour under increasingly severe blow-down conditions towards the point of fuel failure and release. Only in subsequent extensions are some of the programmes going beyond design basic accident conditions to look at releases from fuel melting that might result from hypothetcial severe core damage.

Such a programme of experiments is being conducted at the research centre of the French Commissariat à l'Energie Atomique at Grenoble with single-pin rigs in the Siloe research reactor. A rig known as Flash has now been extended to become Flash CSE (Combustible Severement Endommage). The programme also referred to as Flash-TMI is looking at releases from pre-irradiated damaged fuel pins• in the temperature range 1 350°C to 1 800°C that might result from a small loss of coolant accident. This series of experiments is due to be completed in 1984.

Perhaps the most important in-pile experiments directed specifically to getting information on fission product release fractions rather that a wider range of information about severe accident phenomina, are in In-Reactor Source Term Experiments sponsored by EPRI. They will be carried out using pre-irradiated fuel rods from the BR3 reactor—a small experimental PWR in Belgium—in the Treat facility at Argonne. The experimental rig incorporates detectors to measure the physico-chemical properties of the released fission products as close as possible to the source of emission. This programme, which was initiated last year, is due to be completed in 1985.

Larger and more dramatic programmes of experiments aimed at determining the behaviour of multi-pin fuel clusters under increasingly severe conditions are being carried out in special purpose test reactors such as the Power Burst Facility at Idaho in the US and the Phebus reactor at Cadarache in France. Similar experiments are being conducted in loops on the NRU reactor at Chalk River in Canada and on the Steam Generating Heavy Water Reactor at Winfrith. While these experiments are mainly aimed at determining coolability under blow-down conditions and the possible consequences if clad ballooning develops in the bundles, they will in their later stages involve experiments with fission product releases which should help in analysis of source terms. The same is true of two of the experiments in the latest phase of experiments on the Loft reactor in the US which are now being sponsored by a number of member countries of the OECD Nuclear Energy Agency.

Given the thermal-hydraulic conditions, and the chemical composition of iodine and caesium, the prediction of the bahaviour of released material is a straightforward matter for the chemists. But knowledge of aerosol behaviour is relatively less well understood. Work to put this right was first started in connection with development programmes for sodium cooled fast reactors, but having reached the position where aerosol release has been shown not to be the major problem once thought for fast reactors, attention has been turned to studies of the aerosols that might be expected from a severely degraded light water reactor core. From laboratory scale experiments with non-active aerosols, notably at the Karlsruhe research centre in Germany, greatly improved codes have been produced for predicting aerosol transport. In particular it has been observed that in a moist atmosphere aerosols aglomerate readily to form large particles which will settle out on exposed surfaces or clog up in escape pathways.

Similar aerosol studies are being carried out in a number of countries. The main problems are development of larger aerosol generators which will produce a realistic non-active simulation of the mixture of core materials that would be expected from a severe accident and the devising of large chambers, simulated structures and filtering systems to model escape pathways. In France previous work on aerosols in a dry atmosphere will be supplemented next year with a series of experiments known as the Piteas project. These will make use of a 3 m^3 stainless steel chamber to study the behaviour of aerosols in a wet atmosphere.

Two large experimental projects are being developed, with international support, to assess the transport or retention of fission products in aerosol form. The first, concerned with aerosol transport in the primary circuit of a light water reactor, is the Marviken project in Sweden, supported by Canada, Finland, France, Italy, Japan, the Netherlands, the UK and the US. The facilities at Marviken, once intended for a large pressure vessel type of heavy water reactor, have already been used as a blow-down test facility. Now a full scale model pressure vessel is being fitted inside the former reactor pressure vessel together with a large aerosol generator and other simulated components such as core internals, pressuriser and relief chambers. The aerosol generator will be able to produce more than 100 kg of non active material, simulating the aerosols that might be expected from a severely degraded reactor core. Six large scale tests are being planned to measure aerosol behaviour under different conditions. Scheduled completion date for the programme is 1985.

The second large project, currently supported by Germany and Switzerland, is Demona (Demonstration of Nuclear Aerosol behaviour). It is studying aerosol release into a containment building. A one-quarter scale model of the containment of the Biblis B reactor at the Battelle—Frankfurt research centre, previously used for blow-down experiments as part of the German programme of reactor safety studies, will be used for the new series of aerosol tests due to be completed by 1985. While the containment configuration models German PWR plants, the object is to demonstrate aerosol depletion in a large scale facility and to validate further the computer codes which should have more general application.

The great importance of the time between a postulated severe core accident and possible failure of the containment building means that source term studies are very concerned with the results from a great variety of research programmes on containment integrity. It is generally considered that if a containment is going to fail it would be by over-pressurisation developing over several days, but pressure spikes caused by burning of the large amount of hydrogen produced if a core suffers sever damage might just result in earlier failure. There is also the question of whether it is possible to postulate steam explosions or depressurisation accidents of sufficient violence to turn debris into missiles capable of penetrating the containment.

These questions are being addressed in a wide range of experimental programmes ranging from laboratory scale tests on the melting characteristics of fuel material and associated hydrogen production to destructive pressure tests on model containment structures. There are also tests involving the firing of projectiles at concrete walls (see ATOM April 1983 Number 318 p66 and following.)

In an effort to answer once-and-for-all whether there is any possibility of steam explosions following a postulated core melt-down dramatic tests are being carried out at Karlsruhe. Sizeable quantities of molten fuel materials is dropped into pools of water or onto different types of concrete. A new Molten Fuel Test Facility at Winfrith has just been completed and will complement the German work with a programme of experiments including dropping 25 kilogram quantities of molten uranium dioxide into water in a stainless steel test chamber.

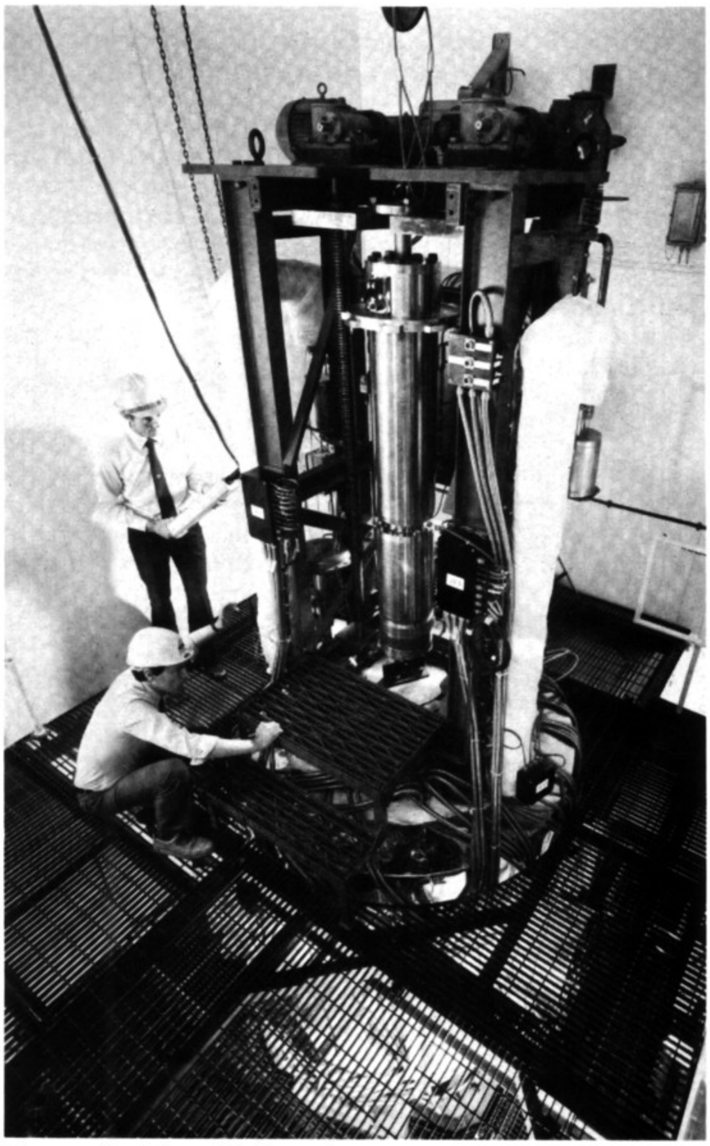


Figure 3 The 25 kg charge container being installed in the insertion mechanism for the Molten Fuel Test Facility at the Winfrith Atomic Energy Establishment

Programmes by the US Nuclear Regulatory Commission are underway at Sandia National Laboratory to determine the behaviour of containment buildings, including electrical and mechanical penetrations, when subjected to an extra sever accident. Scale model tests of free standing steel containments are in progress and a reinforced concrete containment model is being designed. The programme is intended to provide bench mark data for evaluating computer codes and to give some estimates for possible leak rates through penetrations.

Where do we stand on source terms?

Readers will no doubt have realised that the biggest problem is to pull together all the different aspects of the source term subject so that more realistic assessments of possible fission product releases and the associated consequences can be adopted for future regulation of nuclear power plants. It would be nice to think that definitive results from the various experimental programmes will, in a few years, yield a revised set of release fractions for the different fission product categories and that it will be possible to feed these into Rasmussen type risk studies to obtain revised probability curves for fatalities and damage. But those safety review bodies that have looked at the

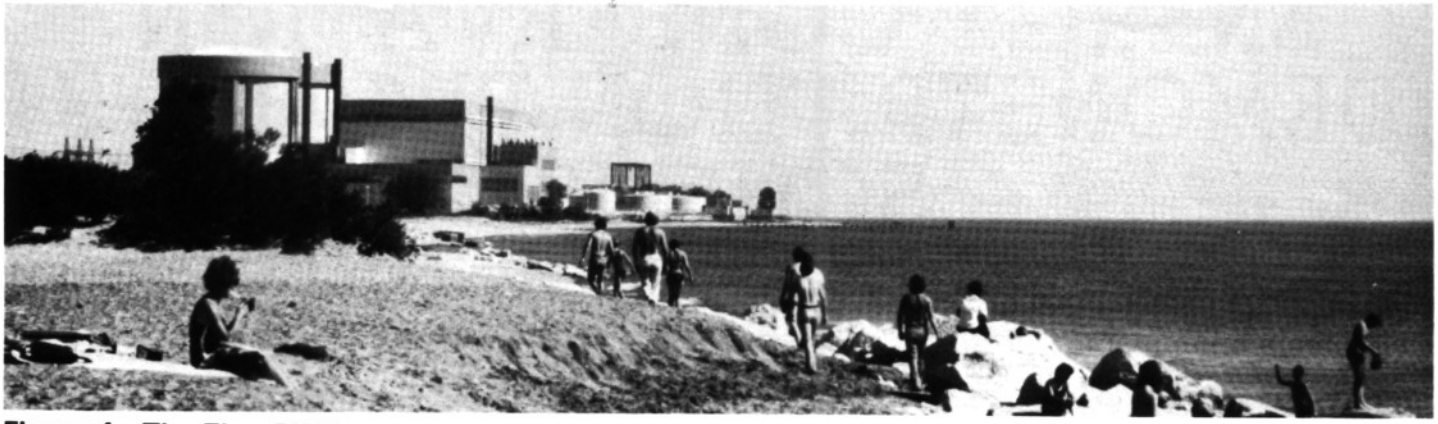


Figure 4 The Zion PWR

problem in any sort of detail seem to agree that there is no prospect of a single set of revised release fractions. Rather there are going to be different sets of release fractions for different accident sequences and different plant configurations.

That said, it is clear there is a broad consensus that in the majority of accident sequences a substantial reduction is likely for iodine and the other fission products and that only with an accident sequence that includes some form of early containment failure might the release fractions for these fission products approach those used in the Rasmussen study. Since the probability of such an accident sequence is very small—some would say negligible—the final result should still be a substantial reduction in the probability-consequence curves. But it may require an exercise on the scale of the Rasmussen study to establish these revised curves.

The interim approach used in the submission to the Sizewell B inquiry is illustrated with just two diagrams from the mass of information presented on the subject of degraded core accidents. Figure 1, shows the probability curves for early fatalities for six accident sequences resulting in release from the containment. It is based on calculation methods and source terms similar to those used in the Rasmussen reactor safety study. Figure 2 provides a comparison of total probabilities for four of the accident sequences with a so-called second estimate in which a probability spectrum for reduction in the release fractions has been factored into the calculations. It should be noted that the accident sequences considered include two (1 and 2 on the diagram) which assume early containment failure, one through a bypass to the auxiliary building and the other as a result of a steam explosion. It is also clear in going through the carefully worded submission that even the second estimate release fractions err heavily on the conservative side.

Preliminary re-runs of some of the consequence models of the German Risk Study, using improved estimates of fission product release from the Karlsruhe research work, have suggested a reduction by a factor of 100 in the number of early fatalities that might be expected in the case of failure to isolate the containment after a degraded core accident. The previous projection of no early fatalities following a late overpressurisation failure of the containment, has been further strengthened following experiments in which molten core material has been contacted with the silicon used around German reactors. These results, together with the high pressure and double containment structures used, suggest that failure would not occur for at least five days rather that the 27 hours assumed in the earlier German risk study.

Work sponsored by NRC at the Battelle Columbus laboratories is directed towards new risk assessment of the relevant accident sequences on five representative plants—a PWR plant like the Surrey unit, which was used as a reference in the Rasmussen study, along with the Peach Bottom and Grand Gulf BWRs, the Sequoyah PWR with ice condenser containment and the Zion PWR. Even with this range of plants, the biggest problem emerging from the studies is the applicability to the wider range of containment designs already in use and in particular to the crucial question of probability of early containment failure. Reports on all five plants should have been available at the end of 1983. Formal peer review of the studies will be conducted by the American Physical Society, this is scheduled to be completed by June 1984. Also due in June is the NRC's draft position on the source term (eventually to be published as NUREG 0956.)

A parallel effort being undertaken by the Industry Degraded Core Rulemaking (IDCOR) working group under the aegis of the US Atomic Industrial Forum is conducting studies based on the same group of representative plants, excluding Surrey. The project was originally scheduled for completion in July, but has been delayed somewhat. The working group planned to have the results by the end of last year. Early information on the results indicate that they are likely to be very much lower than results produced by NRC and Battelle. The main difference is related to the assumptions made on the possibility of early containment failure.

Finally a committee set up by the American Nuclear Society is attempting a quantitative assessment on the factors effecting fission product retention in a nuclear plant, with particular attention to containment systems and accident sequences. The Committee is aiming to release a draft report at the end of the year.

Internationally, efforts to collect and review the expanding body of source term information are being undertaken by the NEA's Committee on the Safety of Nuclear Installations and the International Atomic Energy Agency. But the industry and regulators in other countries are very aware of the major impact that deliberations of the US NRC will have upon the final outcome and there seems to be little prospect of any of them adopting interim or revised source terms before the US. □

Reprints from ATOM

From time to time main articles in ATOM are reprinted as separate booklets. Recent reprints from ATOM include:

Studies of the effects of missile impacts on structures by Peter Barr (April 1983)

New technologies in a changing energy situation by Sir John Hill (May 1983)

Winfrith – enhanced oil recovery by Dr W N Fox (May 1983)

Consequences of release of activity during irradiated fuel transport by R H Clarke and K B Shaw (June 1983)

For copies of these reprints please write to Room 119, UK Atomic Energy Authority, 11 Charles II Street, London SW1Y 4QP.

ENERGY CONSERVATION DEMONSTRATION PROJECTS SCHEME

The importance of energy conservation, called by some the fifth fuel, is being increasingly recognised. Dr W M Currie of the Energy Technology Support Unit explains the workings of the Energy Conservation Demonstration Projects Scheme which ETSU helps run to for the Department of Energy

There is enormous scope for improving the efficiency with which energy is used throughout the economy, that is for reducing energy consumption per unit of economic activity. The Energy Technology Support Unit at Harwell (ETSU) has estimated that it is technically possible to reduce UK energy consumption from the present 310 million tonnes of coal equivalent (Mtce)/year to around 200 Mtce/year, a reduction of about one third, while maintaining the same level of economic activity. This degree of energy saving is impracticable and uneconomic in the short-term; but there is widespread agreement that savings of around 20 per cent or so are economically feasible at the present time.

Why a demonstration scheme?

If real energy prices continue to rise the savings will eventually come about as a result of normal economic processes; but the timescale will be extremely long. This is because of various barriers which impede the rapid operation of market mechanisms, especially when innovation is involved. Among the barriers to innovation in this field are:

- the risks associated with the adoption of new techniques and even new applications of existing techniques, particularly when they are not central to the production process;
- the lack of information about the performance, reliability and economics of new equipment and processes;
- the weakness of the industry which manufactures and supplies conservation equipment and systems.

The aim of the Energy Conservation Demonstration Projects Scheme (ECDPS) is to accelerate the adoption of new or improved energy-use technology by overcoming these barriers. The rationale is as follows. The Scheme:

- provides grants to offset the risks associated with novel projects; in return for the grants, companies must allow their projects to be monitored and reported on by independent consultants appointed by the Government;
- disseminates independent technical and economic information about projects to other potential investors; this is done in close collaboration with equipment suppliers;
- provides marketing and technical back-up to the energy conservation equipment supply industry.

The Scheme is, therefore, an exercise in collaboration between energy users, equipment suppliers and the Government. The objective set by the Department of Energy is to stimulate at least £5 per year of energy saving for each £1 of the taxpayer's money spent on the Scheme, including the costs of programme management and the associated publicity and information programme.

How it works—the need for replication

Consider a novel heat recovery project costing £100 000 which offers energy savings of £50 000 per year; that is a payback time of two years. In order to encourage the use of the technology the first user receives a grant of 25 per cent, ie. £25 000. The monitoring of this project might cost £10 000 and the associated management and publicity £15 000. The total cost to the taxpayer is therefore £50 000 and the project itself will save energy worth £50 000 per year. These numbers are illustrated schematically on the left-hand side of figure 1.

Suppose now that as a result of the monitoring report and the publicity given to the project a further five companies decide to put in similar installations, each costing £100 000 and providing £50 000 per year of energy saving, as shown on the right-hand side of figure 1. These companies will not normally receive any grant, so they each have to find £100 000 from their own resources. However, they will benefit greatly from the published information about the demonstration and from the opportunity to talk with the host company. Hence the risks will have been considerably reduced for these five companies, enabling them to replicate the demonstration with confidence. This replication of the original project will result in total energy savings worth £300 000 per year, from all six installations; and the total capital investment stimulated by the £50 000 of Government pump-priming money will amount to £600 000. The bulk of this capital investment will take the form of equipment sales for the energy conservation supply industry.

In this hypothetical case the 5:1 objective has been achieved; but it was only achieved through replication. Hence replication is what the Scheme is about and the projects themselves are a means to that end rather than an end to themselves. Because of this the selection of projects for support under the Scheme is greatly dependent on:

- their innovatory features, economic attractiveness and perceived risks;
- the national energy saving potential that is available for replication;
- the market penetration that might be realised in practice by the equipment supply industry, assisted by the ECDPS.

An illustrative industrial project

A simple but more concrete illustration can be given. It concerns waste heat recovery in the sulphuric acid industry. There is a stage in the manufacture of sulphuric acid where hot acid

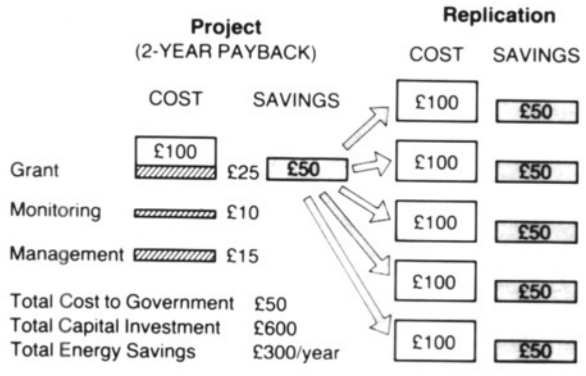


Figure 1 The arithmetic of replication, in £000

has to be cooled down. Until a few years ago this was done by passing the acid through a cast iron heat exchanger and sprinkling cold water on it, with the result that about 200 000 tce of waste heat was dissipated to the environment each year. The reason that no heat was recovered was the fear that acid might leak through any heat exchanger and find its way into the system where the heat was used.

In 1978 Berk Spencer Acids Ltd. (BSA), submitted an ECDPS proposal to recover some of this waste heat in order to pre-heat boiler feed water. Their solution to the acid problem was:

- to use a heat exchanger made of Hastelloy 'C' corrosion resistant metal, and,
- to incorporate an intermediate closed loop, with pH alarm meter, between the acid and the boiler.

By this means BSA hoped to save 1 250 tce year of energy and they were happy to have the project monitored by the National Industrial Fuel Efficiency Service (NIFES).

On the basis of market research it was concluded that enough companies might take up this technology for there to be an overall national energy saving of 40 000 tce/year. This figure was therefore set as the target for the project and approval was given in 1979. The direct cost to the Government, including the monitoring, was £19 100 and the project proved to be very successful, achieving a payback time of 17 months from savings worth £37 000 per year. The project was, therefore, publicised through visits to other companies by ECDPS staff, a press briefing in London, an open-day at the BSA site, direct mail follow-up, and further visits and correspondence to potential users.

At the time of writing five other companies have put in six similar installations as shown in Table 1.

Company	Investment	Payback Time	Date	Energy Saving
Scottish Agric Ind.	£200 000	1 year	1981	3 000 tce/year
Staveley Ind.	£200 000	1 year	1981	3 000 tce/year
BTP Tioxide	£250 000	1 year	1981	3 500 tce/year
Courtaulds	£274 00	10 months	1982	5 300 tce/year
Norsk Hydro	£200 000	1 year	1983	2 700 tce/year
BTP Tioxide	£500 000	1 year	1983	8 500 tce/year

Table 1 Companies replicating heat recovery from sulphuric acid cooling scheme

Including the original Berk Spencer Acids installation, a national energy saving of 26 500 tce/year has been realised so far. This is worth nearly £2 m year, and it is well on the way to the original target of 40 000 tce/year.

Management of the scheme

The Energy Efficiency Office of the Department of Energy is responsible for the ECDPS. However, the Department has contracted its financial and technical management to the United Kingdom Atomic Energy Authority. All ECDPS contracts are therefore placed by the UKAEA, acting as principal, with the Department retaining policy control.

Technical management is handled by staff in the Energy Technology Support Unit (ETSU) at Harwell and in the Buildings Research Energy Conservation Support Unit (BRECSU) at the Buildings Research Establishment. ETSU deals with projects in industry and non-domestic buildings while BRECSU handles the domestic sector. Organisations which wish to apply for support under the scheme discuss their ideas with the relevant staff in these units. Strict confidentiality is maintained in all such discussions and the staff concerned steer promising proposals through the decision making machinery. They also select and appoint the monitoring organisation who will assess each project and write a report about it.

An important part of the machinery is the ENCORD Programme Committee which consists of half a dozen government officials and 10 senior and independent experts whose combined experience covers most aspects of energy use in industry and buildings. This committee considers the merits of each proposal, makes recommendations for support and monitors the progress of the programme.

The Department of Energy's Information Division is responsible for the marketing and promotional aspects of the Scheme, sharing the day to day work with ETSU and BRECSU. In particular ETSU operates an enquiries bureau which provides information, on request, about the projects and their results.

What is being demonstrated?

The technical coverage of the Demonstration Scheme is extremely wide, ranging from the optimisation of fine bubble aeration in a sewage works to a buildings 'breathalyser' for controlling the air conditioning ventilation rates in a cinema. However, there are some common technical themes which are repeated in different forms and for a variety of applications and concerning which ETSU and BRECSU have now developed considerable knowledge. A few examples of these will illustrate the sort of technology which is being demonstrated, particularly in industry.

Waste heat recovery

There are 63 projects concerned with industrial waste heat recovery. The BSA project is just one of these, peculiar to sulphuric acid production, but there are others concerned with such things as bread ovens, whisky distilleries, metal holding furnaces, paper making machines and laundry driers. At the small scale end of the spectrum is a very successful project in the pottery industry. Past attempts to recover heat from tunnel kilns have proved unsuccessful because of the fouling of heat exchanger surfaces. Having studied these problems Twyfords Ltd. proposed the adoption of a widely spaced ceramic tube recuperator and this has proved very cost effective and easy to clean. The cost was £28 000 and the energy saving was 244 tce/year, giving a payback time of one year. So far one other company is known to be considering the idea.

One of the general waste heat recovery techniques which is featured in several projects in the metals industries is self-recuperative burners. These have been developed over some years, principally by British Gas, who have just won the Royal Society Esso Energy Award for the work, and they are manufactured under licence by four UK companies. Over 2 000 units have been sold and the burners are now well established in certain types of plant. The Demonstration Scheme features several novel applications of these burners. One is with Dudley Port Rolling Mills Ltd., on a pusher reheating furnace, which is illustrated in the background of figure 2. Twelve burners extract the hot exhaust gases through themselves, using the 25 per cent recovered energy to pre-heat combustion air. In addition, by means of mathematical modelling, Dudley Port and British Gas have so designed the system that there is a net mass flow of hot gas along the furnace to pre-heat incoming stock, so saving a further 5 per cent. The project cost £122 000 and energy savings worth £50 000/year are being achieved as well as improvements in product quality through more uniform heating and reduced scaling. Dudley Port are so pleased with the project that they themselves have replicated on two other furnaces and three other companies have also taken up the technique.

Perhaps the biggest waste heat recovery project is with Conoco Ltd., at their Humber refinery where they are recovering hot exhaust gases from a 10 MW gas turbine to use as com-

Figure 2 Heat recovery at Dudley Port Rolling Mills (picture by courtesy of British Gas)

bustion air for a group of three fired process heaters. Very substantial energy and cost savings are achieved through this new approach to combined heat and power generation. The project cost £3·6 m and it has so far achieved a payback time of 1·6 years through energy savings of 20 000 tonnes of oil equivalent (32 000 tce)/year. A report has just been published and an open day was held at the refinery in December 1983 when interested parties from the oil, chemicals and steel industries heard about the project and saw the plant.

Heat pumps

A closely related topic is heat pumps although that technology is not yet so well established, despite a great many publications and conferences. In theory heat pumps could save vast amounts of energy in industry and all types of buildings; in practice it is quite difficult to find situations where the technology is sufficiently well developed, reliable and cost effective to attract investment. One promising industrial situation is in malt kilns where a great deal of relatively low grade energy is required to dry the malt and where a gas fired heat pump can be operated over a small temperature range, thereby achieving a high coefficient of performance both to heat the malt and to recover latent and sensible heat from the kiln exhaust. By this means an input of 100 thermal units of gas can result in up to 180 thermal units being delivered to the kiln, i.e. an efficiency of 180 per cent. One of the demonstration projects is with Associated British Maltsters Ltd. at their Wallingford maltings. Two 750 kW gas engines each drive an electrical generator and a single screw compressor and, in conjunction with a run around coil heat recovery network and supplementary gas burners, the system will drive the three kilns at the maltings as well as meeting half the electricity demand. It is the biggest industrial heat pump installation in Europe and an idea of its scale can be gained from figure 3 which shows one of the gas engines. At the time of writing this project is just becoming operational.

Another situation which is technically very similar arises in swimming pools. They need to be heated and de-humidified and, once again, heat pumps can operate over a small temperature lift around the dew point, with a high coefficient of performance. Several firms supply electrically driven heat pumps for this purpose and with the help of publicity by the Electricity Council about 150 have been installed in the UK without any need for ECDPS support. However, there are also situations, such as in leisure centres, where additional heating is required for adjacent squash courts and so on and where the more novel gas engine driven heat pump has advantages. Three such demonstrations are being supported with local authorities. One is with Rushmoor Borough Council at Farnborough Recreation Centre. Two 25 kW gas engine units are used to dehumidify the air to the pool and to heat the centre. Moist air from the pool hall is passed through a cross flow heat exchanger and through the evaporator of the heat pump for dehumidification. The dehumidified air is then heated in the cross flow and also by the heat from the heat pump which is also sufficient to heat the pool water and meet some of the other needs of the centre. Monitoring results are just being analysed and an open day at Farnborough is planned for the near future.

Waste as fuel

ETSU has estimated that about 6 Mtce/year of energy could be supplied cost effectively in the UK from various waste material resources. These comprise industrial waste, domestic refuse, agricultural and timber residues, and methane gas from wet waste. However, while the techniques are relatively simple in theory there are many practical difficulties to do with waste handling, combustion, system design etc., which have so far prevented this resource being exploited on a substantial scale. To help with the proving of the technology two dozen demonstration projects are being supported within a strategic framework which could lead to a third of the potential being taken up within the next 10 years.

The biggest industrial waste project is with the Ford Motor Co. Ltd., at Dagenham, using the principle of starved air incineration, as illustrated in figure 4. About 300 t/week of combustible factory waste (paper, cardboard, wood, plastic, rubber) is fed into a primary chamber where it is slowly pyrolised at around 800°C. This results in all the volatile material being converted into combustible gases which are then fully burnt in the secondary chamber, leaving only a fine ash residue. The hot gases, at around 1 000°C, are then taken to a conventional waste heat boiler to generate 30 000 lb/hr of steam. The advantages of this system are that handling and processing of the waste are minimised and the exhaust gases should be very clean. The project is costing £1·8 m and a payback time of around 4 years is anticipated from energy savings of 8 500 tce/year and reduced waste disposal costs. The plant is just being commissioned. It will be monitored by Warren Spring Laboratory and, if all goes well, will be publicised in 1984.

A totally different type of waste project has been developed by Thames Board Ltd. It is at their paper mill in Purfleet, Essex, and uses gas from domestic refuse landfill sites. The organic materials in such a site are slowly decomposed to produce a gas which contains 55-60 per cent methane. Such gas can be extracted from the ground and used in a suitable burner

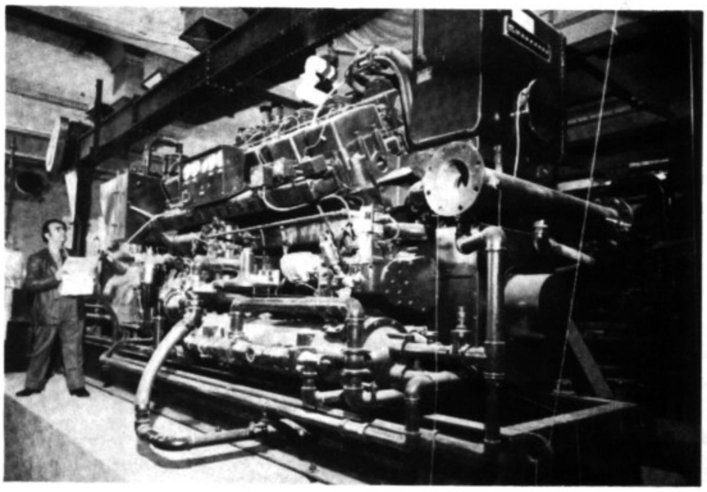


Figure 3 Heat pump gas engine at ABM Wallingford

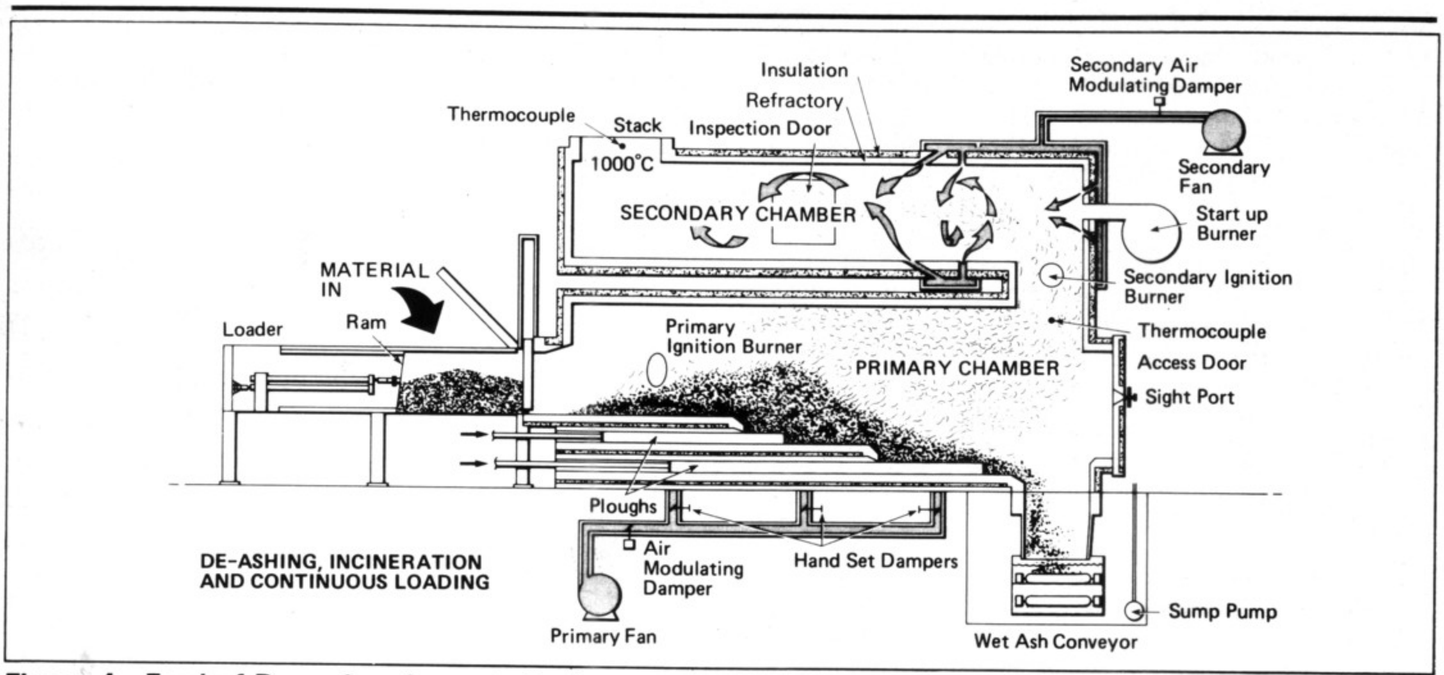


Figure 4 Ford of Dagenham's waste incinerator

to heat a boiler. In this project the gas is produced from a 66 acre site by Aveley Methane, a joint venture by the GLC and NCB, who sell the gas to Thames Board, who in turn use it to meet base load requirements on a large 200 000 lb/hr steam boiler. The project, which cost £243 000, is now operational and the initial results indicate that it will save around 18 000 tce/year of energy for the company, giving a payback time of 2 years.

Energy management systems

Finally, one of the fastest moving areas of technology covered by the ECDPS is electronic energy management systems for buildings, which are featured in over 30 projects. Such systems exploit microprocessors to control, optimise and monitor both plant use and comfort conditions in one or more buildings as well as providing improved energy management information. Some of the most innovative projects are concerned with distributed intelligence systems, as illustrated schematically in figure 5.

An example of this is with the Cornwall and Isles of Scilly Health Authority. It links a central supervisory data processing station in the Truro headquarters of the Authority to local intelligent outstations in six outlying hospitals which are too small to justify sophisticated energy management systems on their own. These outstations are able to provide detailed control of heating and hot water in terms of timing and temperature set points but are remotely reprogrammed as required from the central station using automatic telephone links. The outstations are also able to send in reports on comfort conditions and plant status as well as alarm messages. The cost of the system was £80 000 and energy savings are expected from tighter control as well as improved standards of operation and maintenance. Such projects are difficult to monitor and independent results are not yet available but the Health Authority believe they are achieving a payback time of less than three years and they are currently expanding the system to include other hospitals as well as clinics and ambulance stations.

Because of wide interest in this technology coupled with the enthusiasm of the 50 or so equipment suppliers operating in the UK the Department of Energy, with the help of ETSU and the regional energy efficiency officers, has organised a programme of regional seminars to promote awareness and discussion and to disseminate information and advice from the ECDPS as it becomes available. Seven of these seminars have been held since March 1983 each attracting an average of 200 energy users, who see exhibits by 10 equipment suppliers and hear a programme of talks by ETSU and by user and supplier companies. Feedback from the equipment suppliers indicates that these seminars are having quite a stimulating effect in the market place, which illustrates the importance of marketing and promotion as an intrinsic feature of the Scheme.

The importance of marketing

Because the essential purpose of the Scheme is to stimulate the market it is necessary to plan and manage it in a manner similar to that in which an efficient company runs its business. There are several strands to this.

First there is market research. This is necessary to ensure that the Government invests its money in worthwhile projects and that the replication investments and energy savings aimed for are realistic. It is also necessary to determine in detail who the potential investors are who can benefit from the information which will be generated by the projects and on what sort of timescale the targetted savings might be realised. The general findings of this market research are made available to the equipment suppliers but not, of course, any confidential information.

Second, it is necessary to ensure that the objectives set for the Scheme are consistent with the marketing plans of the equipment suppliers. The Scheme itself can only provide in-

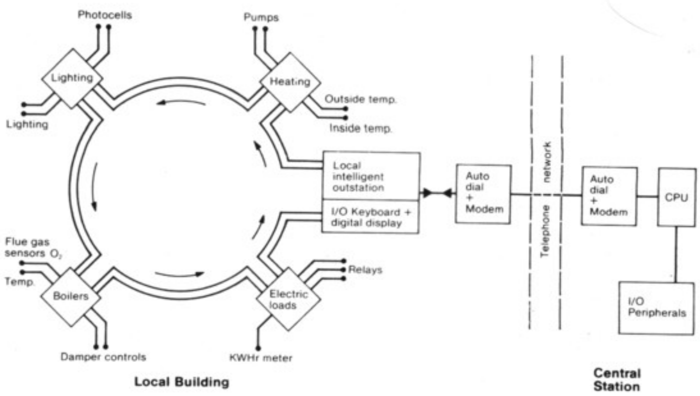


Figure 5 Schematic of a distributed intelligence energy management system

formation: the onus is on the equipment suppliers to achieve the scales which this information might give rise to. Obviously, therefore, there has to be a dialogue between the ECDPS staff and the equipment suppliers to ensure maximum benefit both for energy users and for the UK equipment supply industry. This dialogue takes account of such things as export potential.

The third strand is targets. To focus effort and monitor the impact of the Scheme targets are formulated for each project. The procedure is illustrated in figure 6. The technical potential referred to there is the energy saving which could be achieved if the technology were fully developed and applied wherever it is technically feasible, without regard to commercial constraints. Often there is more than one technical option and so allowance has to be made right away for competition between different technologies. Then commercial realism has to be applied to estimate what sort of market penetration might be achieved in the long-term, eg. by the year 2000. Finally, depending on the state of the project, the receptivity of the industry and the capability of the suppliers it is essential that milestones be set along the path towards the long-term target. Currently there are three milestones:

T1 = April 1984 — the targets for this date were set in July 1982 and will probably be exceeded,

T2 = December 1985 — this can still be influenced significantly by promotion in 1983/1984,

T3 = June 1988 — this is the current 5-year target towards which promotion is being planned.

The project officers at ETSU and BRECSU are responsible for ensuring that the targets are achieved.

Fourth, and very important for the achievement of targets, the Department's Information Division has a promotional programme to promulgate the results of demonstration projects to potential investors. This programme is implemented in close collaboration with equipment suppliers, trade associations, research associations, professional bodies and so on. It embraces a wide range of information and publicity techniques, for example:

- project profiles are available on all projects and at appropriate times monitoring reports and technological guides are issued;
- an enquiries service is operated jointly by the Department, ETSU and BRECSU;
- there is a growing programme of promotional seminars and conferences organised on a project, technology or sectorial basis and always involving equipment suppliers;
- advertising, mail shots, films, exhibitions, editorial coverage and Prestel are all used to reach appropriate audiences.

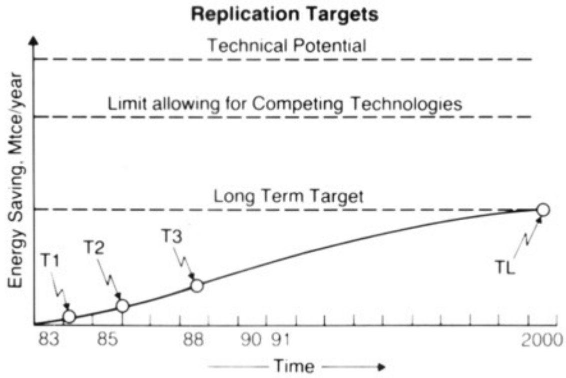


Figure 6 ECDPS replication targets

As time goes on an increasing proportion of the total programme effort will move from the generation of projects to the promotion of results.

Finally, it is necessary to monitor the impact of the Scheme by quantifying the replication which takes place. For this purpose any investment which is closely similar to the demonstration and which takes place after the project has been announced is counted as replication. In some cases there is clear evidence that particular investments have been directly influenced by the Scheme; in other cases it is not possible to establish such a causal link, the influence being more indirect; in still other cases relevant investment decisions are simply not known to ECDPS staff. Because of these factors the assessment of the impact cannot be very precise. Nevertheless, with the help of equipment suppliers, market research and personal contacts ECDPS staff endeavour to keep track of the number of investments similar to each demonstration and they estimate as best they can the sales value and resulting energy savings. The results are analysed regularly and used in the management of the Scheme.

Progress to mid-1983

During the summer of 1983 a thorough review of the Scheme was carried out. The findings were generally encouraging and can be summarised quite briefly. By July 1983 the statistics of the Scheme were as follows:

Number of projects approved	219
Host contracts placed	184
Installations operational	159
Projects with monitoring reports	60
Projects with replication	61
Total cost of projects	£60·0 m
Cost of projects to Government	£15·8 m
Project target energy savings	0·25 Mtce/year
Replication target	3·5 Mtce/year.

An analysis of project results suggests that 70 per cent of the present portfolio, or about 150 projects, can be expected to be successful, a successful project being defined arbitrarily as one which stimulates energy savings worth at least £10 per year for each £1 spent directly on the project. Some projects are unsuccessful in a technological sense; they don't work or, at least, they don't save enough energy. Others are unsuccessful in a marketing sense; they work but are not taken up sufficiently in the market place.

Of the 30 per cent of projects which are not successful about half still have some worthwhile benefit, although not necessarily energy saving. For example there are some buildings projects which have not saved significant amounts of energy but they have led to energy being used more effectively, e.g. by reducing condensation or improving comfort levels. The other half are total failures. Where appropriate the results of these projects, including some total failures, will be disseminated to the industries concerned since even negative findings can sometimes be of value. In a few cases the failure is one of monitoring; the independent monitoring consultant has been unable to determine whether or not there was an energy saving and so no useful information can be disseminated.

Market research suggests that of the 150 projects which are expected to be successful the majority will not stimulate as much replication as was anticipated when they were first considered for support. It is tentatively estimated that successful projects might on average stimulate half the energy saving which was originally hoped for. The original energy saving targets for the 219 projects when they were first proposed, totalled about 10 Mtce/year. Only 70 per cent of these will be

ECDPS Targets & Replication (1983)

SECTOR OR TECHNOLOGY	REPLICATION (tce/year) JULY '83	TARGETS (tce/year)	
		APRIL '84	DEC. '85
En. Man. Systems	98,000	90,000	215,000
Other Non Dom. Bldgs.	37,000	14,000	135,000
Metals Industries	5,000	73,000	220,000
Ceramics Industries	58,000	110,000	580,000
Chemicals, Oils etc.	24,000	22,000	33,000
Food, Paper, Text., etc.	67,000	30,000	135,000
Waste as Fuel	4,500	33,000	162,000
TOTAL	293,000	372,000	1,480,000

Figure 7 Replication achieved, versus targets

successful and these successful projects might achieve only 50 per cent of their original targets. Hence, the overall impact expected from the current portfolio of projects in the long-term is the 3·5 Mtce/year given above, which is worth £270 m per year at present day values and will require a total investment of over £800 m.

By July 1983 a total of 130 replications had been indentified in industry and 1 200 in non-domestic buildings. The estimated energy savings associated with these are given in figure 7 along with the corresponding short-term targets, broken down by market area. To achieve the targets set for December 1985 a total of 5 800 investment decisions or sales will be required, 1 100 in industry and 4 700 in non-domestic buildings. On average each replication in industry saves 940 tce/yr while each in non-domestic buildings saves 40 tce/yr. As yet there are no short term targets for the domestic sector. The progress of replication against the first two short term targets is also illustrated graphically in figure 8. This suggests that the target for April 1984 will be exceeded and that there is a good prospect of achieving something close to the December 1985 target. If that happens then it is very likely that the bulk of the 3·5 Mtce/year long term target can be achieved within the present decade. The benefits in terms of money saved and

Replication and Targets Aug. 1983

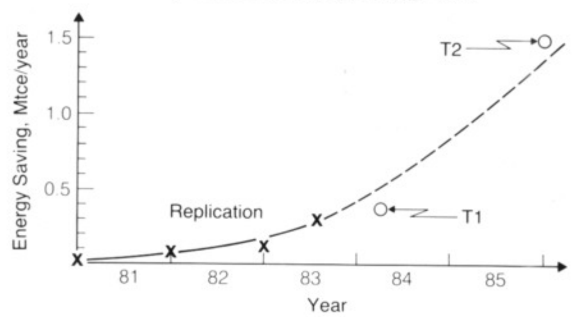


Figure 8 Trend of replication seen against the overall targets

ECDPS Energy Saving & Investment Targets

	219 Projects	REPLICATION RESULTS/TARGETS			
		To Date (Jul. '83)	BY Apr. '84	BY Dec. '85	LONG TERM
Energy Saving (tce/year)	250,000	290,000	330,000	1,400,000	3,500,000
Annual Value of Energy Saving	£19M	£22M	£25M	£106M	£270M
Necessary Investment	£57M	£66M	£75M	£320M	£820M

Figure 9 Financial implications of targets

Proposed ECDPS Plan

	No. of Projects	Energy Saving Target (000 tce/yr)	Cost to Government
Industry	345	6,000	£26M
Non Domestic Buildings	110	2,000	£7M
Domestic	95	2,000	£7M
TOTAL	550	10 Mtce/yr	£40M

Figure 10 Possible future expansion of the Scheme

capital investment stimulated are tabulated in figure 9.

As indicated in figure 9 the achievement of 3·5 Mtce/year will be worth £270 m per year at present day prices. Against this must be set the cost of projects, which totals £16 m, and the overhead cost for management and promotion of the 219 projects to completion which is estimated to be £11 m. Hence the total once-and-for-all cost to the taxpayer is £27 m. It follows that if the 3·5 Mtce/year target can be approached then the original objective of £5 per year for each £1 spent will have been achieved.

Future plans

From their knowledge of the various market sectors and the state of the art in energy conservation technology the staff of ETSU and BRECSU have drawn up plans for further cost effective demonstrations which, if implemented, would help to bring about the adoption of most of the known technology for improved energy efficiency. Most of these plans have been discussed with the relevant sectors and received broad endorsement.

The plans call for a total programme up to 1990 of about 550 projects, broken down as indicated in figure 10, and having a total long term target of 10 Mtce/year. This target allows for technical failure and excessive market optimism. Such an energy saving would be worth £750 m per year and would require something in the region of £3 billion of investment for its realisation. The total cost to the Department of Energy of implementing such a programme would be around £40 m for the projects, plus about £20 m or so for management and promotion, say a total of £60-70 m at 1983 prices over 10 years. This includes the cost of existing projects and all the projected costs of ETSU, BRECSU and associated publicity.

The implementation of such a plan will depend on Government policy, the availability of money and manpower, the receptivity of the market and the extent to which existing projects live up to expectations. However, if the proposed plan were to be successfully implemented then the Demonstration Scheme would make quite a significant contribution to the national energy economy. An energy saving of 10 Mtce/year represents 3·2 per cent of 1982 UK energy consumption. To put this into perspective, hydro-electricity contributed 0·8 per cent and nuclear power about 5·1 per cent of 1982 energy consumption; and current thinking on renewable energy sources is that they might contribute 2 per cent by the year 2000.

Strictly speaking, of course, the Demonstration Scheme cannot be compared directly with these contributions to energy supply, For one thing, the ECDPS is not generating results which are absolutely new; rather, it is assisting trends and developments which are already under way in the market place. Nevertheless, seen in this light the Scheme appears to offer a very cost effective means by which the Government can help energy users and equipment suppliers to exploit the most promising innovations for improved energy efficiency. □

ELECTROCHEMISTRY AND RADIOACTIVE WASTES

The prospects of using electrochemical methods as a step in treating radioactive wastes prior to disposal is investigated by Dr A D Turner and Dr R M Dell of the Materials Development Division at the UKAEA's Atomic Energy Research Establishment, Harwell

Every secondary school-child is introduced to electrochemistry through learning about Faraday's laws of electrolysis and by seeing water split into its elements, hydrogen and oxygen. Each of us has experienced electrochemistry in action by way of flashlamp batteries, car starter batteries and. less desirably, the corrosion and rusting of metals.

The *extent* to which electrochemistry affects our lives is generally not appreciated. Only now is it becoming clear what an important role electrochemical processes play in living organisms by controlling the biochemical processes which are at the heart of physiology; the hybrid subjects of bioelectrochemistry and bioenergetics are now recognised as important branches of the life sciences to which the electrochemist can make a valuable contribution.

Electrochemistry is central to many industrial processes, such as the manufacture of chlorine and caustic soda. Metals such as aluminium and magnesium are extracted electrolytically from fused salt baths. Fine chemicals and intermediates may be synthesised electrochemically. In the engineering industry and in the jewellery trade articles are electroplated with chromium, silver, gold, etc. Electrochemical machining is used to form complex shapes such as turbine blades. Indeed, the industrial uses of electrochemistry are legion.

What of the nuclear industry? Among modern industries it has been slow to exploit the potential of electrochemistry. The only large-scale use has been in the manufacture of fluorine to make uranium hexafluoride. Research has been carried out in the electrolytic extraction of uranium metal and on the electrochemical reduction of Pu^4 to Pu^3, but these processes have not found general favour. It is the authors' conviction that the inherent advantages of electrochemical processes (ease of control, flexibility, convenience, cleanliness) are such that they will, in the long run, have a greater part to play in the nuclear industry. In this article we consider the potential for electrochemical techniques in the treatment of liquid radioactive wastes and describe research in progress at Harwell. A future article will deal with the electrochemical decontamination of metallic wastes.

Basic concepts

Before discussing the application to radioactive wastes it is appropriate to review briefly the basic concepts of electrochemistry. A battery is a simple electrochemical system consisting of two dissimilar electrodes immersed in a solution of an electrolyte which conducts ions. When the electrodes are joined externally by a wire a current flows. The electrodes are the interface at which the ionic current of the internal circuit meets the electronic current of the external circuit. All practical batteries and fuel cells are, in effect, electrochemical devices which convert the chemical energy of reactants present at the electrodes into electrical energy.

The electrolysis cell, is the converse of the battery. The electrodes are generally inert and an external voltage is applied from a power supply. The cations and anions of the electrolyte migrate to the negative and positive electrodes and are there discharged. Typically, the cations plate out as metals (Cu, Ag, Co etc.) although the more electropositive metals (Na, K, Mg, Ca, Al) discharge hydrogen preferentially in aqueous solution. Some oxygenated cations (e.g. UO_2^{++}) discharge as oxides (UO_2). The anions may discharge as elements, e.g. oxygen or chlorine, or may oxidise the positive electrode material.

The essential requirement for an electrolyte is that it shall be an ionic conductor, of as high a conductivity as possible, and an electronic insulator. Any electronic current in the electrolyte merely serves to short-circuit the cell. The best known electrolytes are aqueous solutions (e.g. acids, alkalis) or molten salts. These may be either free liquids or supported in a porous separator or diaphragm. Some solids and polymers also show excellent conductivity for specific ions and polymeric membranes are used in certain industrial electrolysis cells.

Another aspect of electrochemistry is concerned with the surface charge on particles of colloidal size. When a solid is suspended in an electrolyte, it assumes a surface charge by absorbing or releasing cations or anions. The charge is balanced by a diffuse layer of counter ions extending into the solutions—the electrical double layer. If an electric field is applied parallel to such a charged surface, equal and opposite forces are exerted on the charged particles and the solution part of the double layer, and one moves relative to the other (figure 1). If the liquid is essentially stationary, the charged particles move towards the electrode of opposite charge (in figure 1 the cathode). This phenomenon is known as *electrophoresis*. The particles may be deposited as an adherent coating. This is the basis of electrophoretic paint deposition e.g. in priming car bodies. Conversely, if the solid is essentially stationary and the liquid flows past it under the influence of the field gradient on the excess ionic charge the phenomenon is termed *electro-osmosis*.

What has all this to do with radioactive waste treatment? In order to make this clear we must first discuss briefly radioactive waste.

Radioactive waste

Radioactive waste may be categorised according to

- the type of radiation given off (α or $\beta\gamma$),
- the level of radiation (dose rate),
- the physical or chemical form of the waste.

As regards radiation type, it is conventional to differentiate between α active waste (e.g. from glove boxes) and $\beta\gamma$ active wastes (e.g. from reactor irradiation of materials). Because of the toxicity and long half-life of α emitting isotopes, notably plutonium, it is particularly important that these isotopes should not enter the biosphere. $\beta\gamma$ wastes also need careful processing and disposal. A particularly difficult category is $\alpha\beta\gamma$ waste which contains both $\beta\gamma$ activity and actinide isotopes. An example would be irradiated fuel element cladding containing residual irradiated fuel. For purposes of treatment and storage, it is convenient to categorise this class of waste into three sub-divisions, high ($\alpha\beta\gamma$), low (α) high ($\beta\gamma$) and low ($\alpha\beta\gamma$).

The second broad classification of wastes is according to activity level. Straightforward $\beta\gamma$ wastes are normally divided into three categories:

- High activity wastes, such as fission products from reprocessing plants, which are currently stored as liquids in fully engineered and supervised stores. Ultimately it is expected that these wastes will be converted to glasses.

The volumes of high activity wastes are quite small.

- Medium activity wastes. The amounts involved will become too large for engineered stores, while the radiation levels may be rather high for shallow land burial. Disposal options under consideration for immobilised waste include engineered deep trenches and storage in mines or natural caverns.
- Low activity wastes. This represents the vast bulk of radioactive waste. It is generally suitable for shallow land burial or deep sea disposal under conditions approved by responsible government bodies and subject to international agreement.

For liquid wastes of medium activity, one possible solution is to process the liquid to split it into a bulk of low activity waste and a small volume of higher activity waste. Much current research is directed towards this goal.

Finally, there is the physical state of the waste and its chemical nature—aqueous solution, paper, plastic, metal, glass etc. Sometimes a mixed state can occur, as in wet slurries or precipitates. Also the size and shape of waste may vary enormously: for example, metal waste may vary from huge reactor components or whole glove boxes to finely divided metal powders.

For the processing of medium active wastes to be economic it may be necessary to decontaminate, more and less rigorously, most of the large metal objects. This may be done by either chemical or electrochemical methods. Either way, the contamination will be transferred into solution, or into a colloidal suspension, of medium activity. This, along with other medium activity liquid wastes, may then have to be split into high and low activity components.

Currently, medium and low level liquid wastes are treated by ion-exchange, or perhaps more commonly by the precipitation of a floc that adsorbs the active species. The solid phase forms a smaller volume of higher activity waste, while the bulk of the decontaminated liquid can be safely discharged. The programme in Applied Electrochemistry Group at Harwell is being directed towards the evaluation of alternative electrochemical treatment processes that, although speculative, have the promise of improved performance over these traditional methods. Initially, a number of different techniques were explored in a programme which began in January 1981 and is funded jointly by the Department of the Environment and the Commission of the European Communities. Now attention is focussed on two approaches, electro-osmosis and electrochemically assisted ion-exchange, and these are described below, along with some recent results.

Harwell electro-osmosis (HELOS) process

The most general method for the removal of radioactive ions or colloids from liquid wastes is by adsorption on (or inclusion in) a suitable floc, for example iron hydroxide. After settling, the floc slurries generally average ~5 per cent solids content and it is necessary to dewater them further, ideally to 15-35 per cent solids, to prepare a material suitable for immobilisation. This dewatering step must be achieved with very high solids retention to maximise the decontamination factor. Sludges which may arise in the treatment of spent fuel claddings may also require dewatering before disposal.

Conventional dewatering processes, e.g. various forms of filtration, are not completely satisfactory as regards either the retention of colloidal matter achieved or the solids content of some resulting filter cakes. Ultra-filtration, using a microporous filter, yields acceptable decontamination of the permeate solution, but the filter rapidly becomes clogged and the separation process ceases thus necessitating periodic backwashing. Electro-osmosis offers the possibility of overcoming these problems.

Figure 2 shows the effect when the positive anode is on the slurry inlet side and the negative cathode is on the extract outlet side. The negatively charged particles are first allowed to coat the pores of the membrane giving it a surface charge. When the field is applied across the membrane, further colloidal particles are transported away from it towards the positive counter electrode. Solvent (water) molecules and cations from the diffuse double layer are attracted through the micropores in the membrane towards the cathode. At the anode water is split to yield oxygen and the liquid permeate becomes acidic:

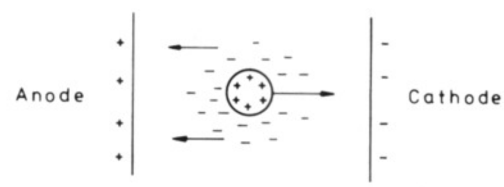


Figure 1 Electrophoretic transport of a positively charged particle in an electric field

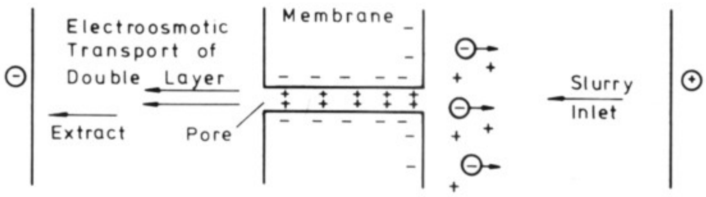


Figure 2 Electro-osmotic transport through a capillary under the influence of an electric field across a negatively charged membrane

$$2H_2O \rightarrow O_2 + 4H^+ + 4\,\varepsilon$$

Conversely, at the cathode local alkalinity is produced, e.g.

$$NO_3^- + 6H_2O + 8\,\varepsilon \rightarrow NH_3 + 9OH^-.$$

Clearly, for electro-osmosis to take place the liquid phase must contain free ions to conduct electricity; in the above example a nitrate-containing solution is assumed. When the colloid is positively charged the electrodes are merely reversed in polarity and anions accompany the water through the micropores.

The apparatus required for electro-osmotic dewatering on the laboratory-scale is simple to construct. In the experimental programme cellulosic membranes of controlled pore size in the range 0·1-8·0 μm have been used in the treatment of colloidal materials. For flocculated precipitates, cambric cotton is an excellent membrane. In a commercial unit more radiation-resistant materials may be required. Electrodes of platinum or, more economically, stainless steel cathodes and platinised titanium anodes are suitable. A stabilised, low voltage D.C. power supply provides the electric field.

Numerous colloids and flocs have been investigated, including the hydroxides of titanium and iron (III), ceria and plutonia; also various waste treatment floc simulants and low level active slurry from the Harwell effluent plant. The results of these laboratory-scale investigations have been most encouraging. Figure 3 shows a typical experiment for the dewatering of ferric hydroxide colloid generated at pH 1·35 from milli-molar Fe^3 solution.

As the voltage across the membrane is increased in steps (10 V-30 V) there is a corresponding increase in the current density (up to 3·5 kA m^{-2}) and in the dewatering rate (approaching 600

Lh^{-1} m^{-2} at 30 V). The dependence on pore size is interesting; clearly, 0·1 μm pores are too small to be effective, while 0·22 μm pores support a somewhat slower separation rate than the larger pores. The separation factors achieved increase with increasing applied voltage. At 20-30 V the 0·22 μm membrane gives a totally transparent permeate with separation factor >2500. The fast dewatering rate in the presence of an applied field is due both to rapid pore transport of water and ions from the diffuse double layer and to electrophoresis of the colloidal particles towards the counter electrode, thereby limiting fouling of the membrane.

The Harwell ferric hydroxide effluent slurry contained low level (0·1-0·3 μCi l^{-1}) Co^{60} and Cs^{137} as well as α emitters. No Co^{60} or α could be detected in the extract from electro-osmosis, although some C^{137} was found. For all three isotopes performance was significantly better than vacuum filtration. Further development and scale-up work is in hand.

A study of the factors which determine the flocculation and settling of ferric hydroxide is helping to define the optimum treatment conditions for subsequent electro-osmotic dewatering. From the research to date it seems likely that it will prove possible to dewater effectively a wide range of slurry and floc radioactive effluents with excellent decontamination factors and modest energy consumption (~ 5 per cent of that required for evaporation). The research is now moving to continuous flow extraction cells where sludges have been dewatered to as high as 35 per cent solids. We are also concerned with larger scale units and higher activity levels.

Harwell electrochemical ion exchange (HELIX) process

Ion exchange processes using zeolites or organic resins are employed extensively in the purification of water. They can be used to extract fission products from solutions but there are certain limitations. Many reprocessing liquids are moderately acidic. To treat these it is necessary first to neutralise them either with alkali or by denitration, or to use strong acid ion exchangers. Neutralisation with alkali leads to an increase in the salt content of the solution, which is undesirable as it adds to the quantity of radioactive waste, while strong acid ion exchangers are expensive and difficult to regenerate.

Electrochemically-assisted ion exchange adds a new dimension to traditional ion exchangers. In this process a weak acid ion exchange resin is incorporated in a porous, conducting carbon electrode, for example carbon felt. When this electrode is made cathodic a local alkaline environment is generated in its immediate vicinity

$$H_2O + \varepsilon \rightarrow H_{ads} + OH^-.$$

This leads to ionisation of the weak acid resin

$$R-COOH + OH^- \rightarrow RCOO^- + H_2O$$

followed by cation absorption from solution

$$RGOO^- + M^+ \rightarrow RCOOM.$$

The generation of the local alkaline environment allows the absorption of cations from a mildly acid solution by a weak acid resin, which otherwise could only be used in an alkaline medium.

To desorb the cations and regenerate the electrode it is simply necessary to reverse the polarity of the cell when the above sequence of reactions is reversed. This is the great strength of the HELIX process; the ion exchanger is eluted electrochemically without the need for adding further inactive chemicals, with associated cost and addition to the burden of active waste. The electron is the ideal reagent for radioactive waste treatment as it is versatile, remotely controllable, cheap and has negligible mass.

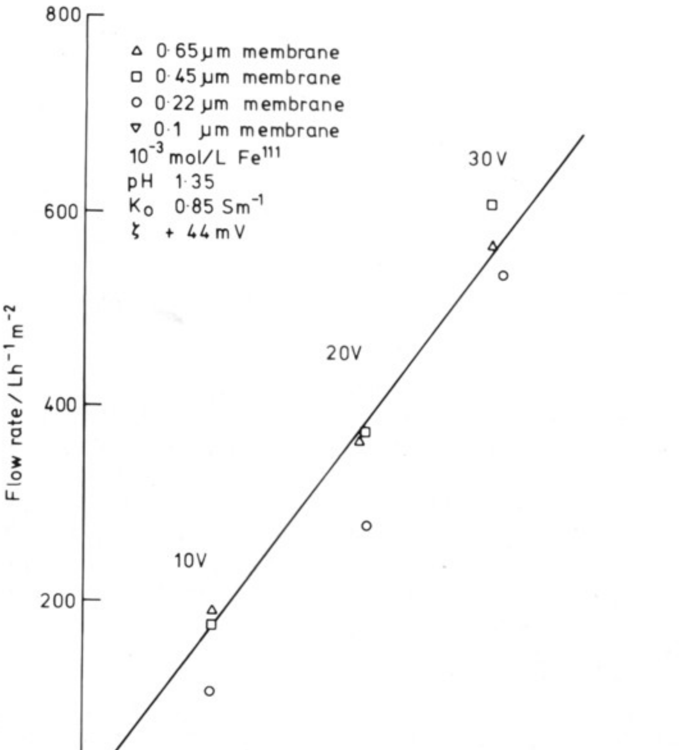


Figure 3 Electro-extraction of ferric hydroxide colloid as a function of current density and membrane pore-size

Medium activity

In the treatment of medium activity liquid wastes, for example for the removal of $^{90}Sr^{++}$ or $^{137}Cs^+$ cations, the solution would first be adjusted for pH and conductivity and then fed to an electrochemical cell in which the cathode is a porous carbon electrode loaded with cation exchange resin. As the solution flows through the cell, the radioactive cations are adsorbed quantitatively at the cathode, thanks to the local alkaline environment generated electrochemically. When the resin electrode is fully loaded, the cell is purged, the potential reversed and the radioactive cations are desorbed into a small volume of liquid. In this way, a dilute radioactive solution is concentrated.

By way of example, figure 4 shows the electro-sorption of Cs^+ in a stationary cell from a solution containing initially 100 ppm Cs^+ as $CsNO_3$. As sorption proceeds at the cathode, the pH of the overall solution falls because of the generation of an equivalent number of protons at the counter electrode. In this experiment Cs^+ was removed down to a few ppm, although with Cs_2CO_3 solution it has been possible to remove the cation to below 0·1 ppm. After 118 minutes the potential was reversed and the Cs^+ was then quantitatively desorbed.

Experiments have also been made with flow-through cells in which the Cs^+ was quantitatively removed to ~0·1 ppm, even when the pH of the bulk solution was as low as 4·0 (figure 5). This corresponded to a decontamination factor of 2 000, far better than can be achieved for Cs^+ by other methods. During elution demineralised water was used and a peak concentration in the eluant in excess of 3 000 ppm Cs^+ was measured. There is scope for even greater volume reduction factors.

These examples illustrate the potential of the HELIX process for the concentration of dilute Cs^+ solutions. The ease of

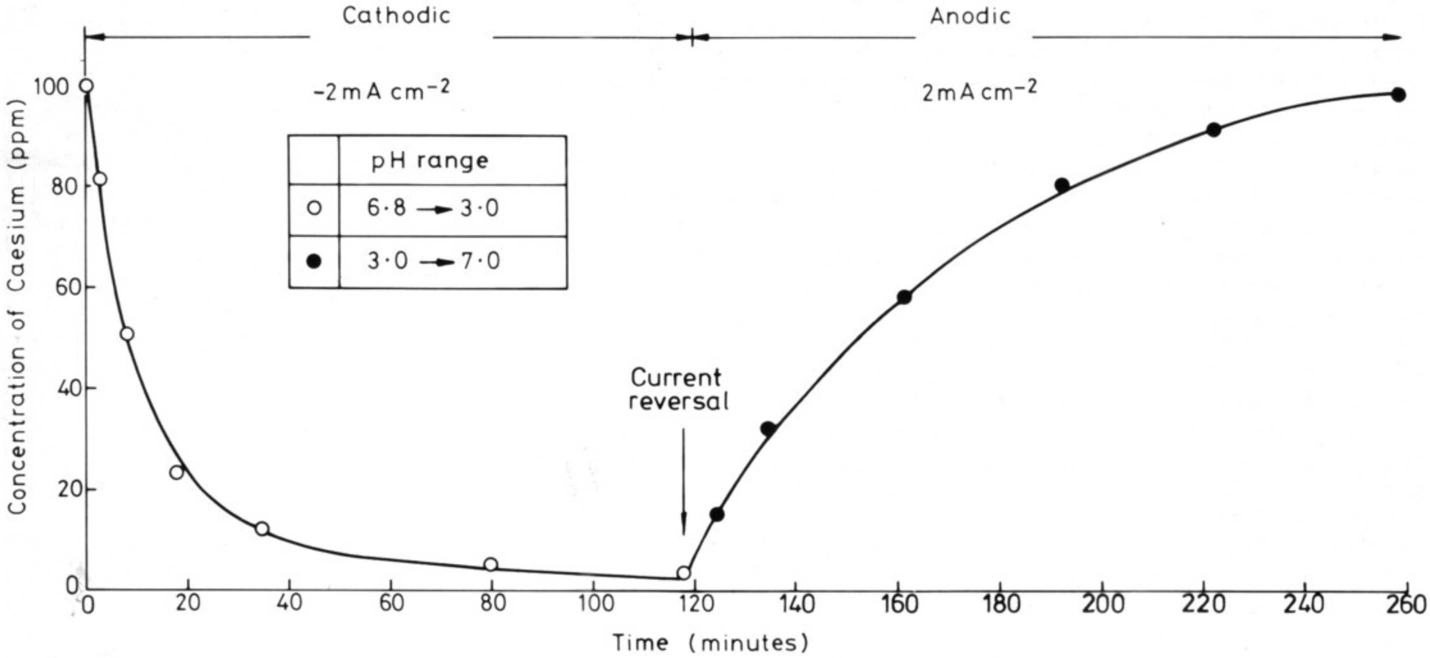


Figure 4 Adsorption/desorption of caesium using an ion-exchange/graphite electrode

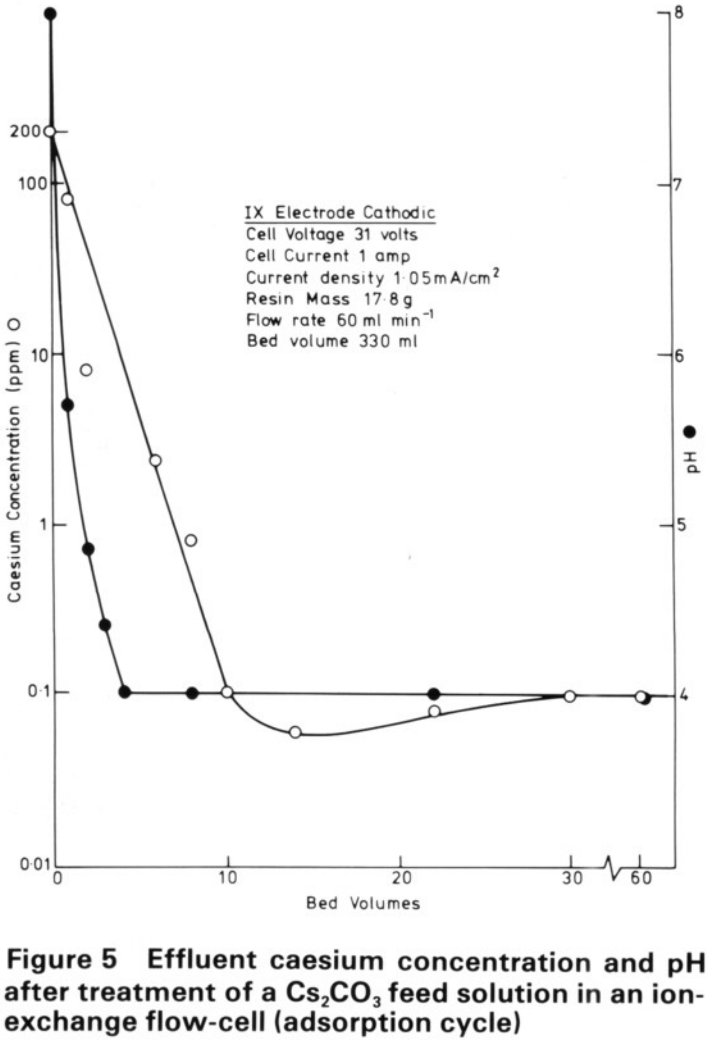


Figure 5 Effluent caesium concentration and pH after treatment of a Cs_2CO_3 feed solution in an ion-exchange flow-cell (adsorption cycle)

remote, automatic electrical control makes electrochemical ion exchange an attractive process for the nuclear industry. Further work is in progress on the design of electrodes and continuous flow cells and on selective adsorption of specific ions from solutions of mixed ions.

Both the HELOS and HELIX processes are at early stages of development but are now being taken beyond the laboratory scale. The preliminary indications are that these electrochemical processes hold out considerable promise for the treatment of medium active liquid wastes. It has been shown that the processes are capable of achieving high decontamination factors and useful volume reductions without the need for adding chemical reagents and at modest power consumptions. The two processes are complementary in that one is useful for the dewatering of flocs and slurries and the other for the deionising of solutions.

Further work is in progress to engineer the processes and to evaluate fully their advantages and limitations. Systems and economic assessments also must be carried out. At this stage a measure of optimism is warranted based upon the results to date and the inherent advantages of electrochemical processes—flexibility, remote control and the use of the electron as a substitute for chemical reagents. It will not be surprising if electrochemistry, a fundamental and ubiquitous science, has a role to play in the nuclear industry as it has in so many other industries.

Acknowledgements

This work has been commissioned by the Department of the Environment, as part of its radioactive waste management research programme. The results will be used in the formulation of Government policy, but at this stage they do not necessarily represent Government policy.

The authors are pleased to acknowledge the work of their colleagues Dr W R Bowen and Mr N J Bridger in this programme, and also the sponsorship of the Commission of the European Communities under their radioactive waste management programme. □

Full scale tests on CEGB transport flasks

As a demonstration of its confidence in the transport of spent nuclear fuel, the Central Electricity Generating Board is planning to undertake impact tests at full-scale on flasks used to contain the radioactive fuel. The first phase of the programme will involve full-scale drop tests at the Board's Structural Test Centre at Cheddar, Somerset. The tests will be held as soon as preparations at the site are complete.

The second phase will demonstrate how the conditions to which a flask could just conceivably be subjected in a very severe train crash compare with those during impact testing to meet the IAEA regulations. The CEGB is discussing with British Rail the provision of suitable railway rolling stock and test track for the test.

A Magnox fuel flask of the latest type, loaded with iron bars to simulate spent fuel rods, will be used. No radioactive material will be involved in any of the tests.

Commenting on the tests, a member of the CEGB, John Baker said: 'In 21 years of transport of CEGB spent nuclear fuel there has never been any incident involving the accidental release of radiation or danger to the public. The CEGB gives absolute priority to safety and the full-scale tests are further steps to demonstrate the CEGB's determination to be vigilant and responsive to concern expressed in some quarters about the transport of spent fuel.'

Old flasks withdrawn

The CEGB have also announced in a further safety move that it is replacing the old style Magnox fuel flasks more quickly than originally intended. The current replacement programme, which started in 1979, was due to be completed next year. But the Board says that following tests on quarter and half-scale models of flasks similar to the flasks now being replaced, it is ending the use of the remaining Magnox flasks of that type ahead of the planned schedule.

The tests were carried out recently as part of 'an on-going and comprehensive programme concerned with maintaining the transport of spent nuclear fuel to the highest safety standards' the Board says. They showed that in one particular circumstances a small crack could occur in a seal weld of the flask model. This meant although that particular type of flask could be used without any significant risks, it might not meet the very stringent international safety regulations covering the transport of spent fuel in respect of leak standards following tests designed to simulate very severe accidents. □

Timely proceedings

The Uranium Institute has managed what one might have been forgiven for thinking was impossible. They have brought out conference proceedings, in hardback form, less than three months after the event!

Entitled *Uranium and Nuclear Energy: 1983** it includes all the papers presented at the Uranium Institute's Eighth Annual Symposium held in London on 24-26 August 1983 (see ATOM, October 1983 p220). Also included are a list of the world's nuclear reactors and a list of the world's uranium production facilities. These will be a regular reference feature in future.

The date of the ninth symposium is 5-7 September 1984, in London as usual.

*Uranium and Nuclear Energy: 1983, Uranium Institute, 350pp, UK £35 or US $52. Available in US from the American Nuclear Society, elsewhere from the Uranium Institute.

Materials unaccounted for—1983

The United Kingdom Atomic Energy Authority and British Nuclear Fuels Limited have published the inventory differences, known as material unaccounted for (MUF), arising from the use of uranium and plutonium in their civil nuclear programmes during 1982/83.

The figures show no adverse trends. They conform to the pattern in previous years and give rise to no concern over either the safety or the security of the operation of UKAEA and BNFL plant.

Accounts of the movements and stocks of nuclear material are maintained at all UKAEA and BNFL sites and comparisons are made regularly, within defined accounting areas, between the quantity of material determined at each stocktake and the quantity recorded in the book inventory; this latter takes account of receipts and despatches, etc. since the previous stocktake. The difference between the two figures constitutes MUF.

Nuclear materials accounting procedures are well developed but the chemical and physical form of many of the items to be measured and the nature of the measurements involved are such that absolutely accurate material balances are not always possible (see December 1983 ATOM, p292). Thus, a negative figure in the statements of MUF does not necessarily mean that nuclear material has been lost or that it has been stolen or otherwise removed: a much more likely explanation is that the difference arises from uncertainties in the measurements on which the material balance has been based. Because it is most improbable that nuclear material is ever brought surreptitiously into a plant, a positive MUF is a clear indication of the uncertainty of measurements. □

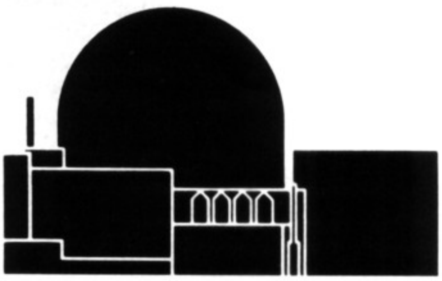
Materials unaccounted for at AEA and BNFL sites in 1982/83

Site or Works	Plutonium kg[1]	HEU kgU235[2]	LEU kgU[3]	Natural U teU[3]	Depleted U teU[3]
AEA					
Dounreay	−1·0	−1·1	−1·6	+0·003	−0·053
Harwell	+0·2	★	Nil	+0·053	−0·012
Springfields	N/A	★	−6·9	−0·018	+0·013
Windscale	+0·2	★	−0·9	−0·013	+0·035
Winfrith	+0·1	Nil	−1·5	+0·001	−0·002
BNFL					
Springfields	N/A	N/A	+26·5	−0·8	+9·0
Sellafield	−0·5	−0·3	+15·8	<+0·1	−4·9
Capenhurst	N/A	N/A	←	−0·7 te U	→

+ apparent gain; − apparent loss; ★ negligible, i.e. less than smallest unit of account; N/A not applicable; < less than.

1. The figures for plutonium cover all plutonium isotopes.
2. The figures for Highly Enriched Uranium (HEU) are for the uranium 235 content of uranium enriched to above 20 per cent of that isotope.
3. For completeness, the published figures include low enriched uranium (LEU), natural uranium, and depleted uranium, even though these grades of uranium cannot be used to make explosive or dispersal devices.

SIZEWELL B INQUIRY



The last report from the Sizewell Inquiry covered the cross-examination of the CEGB's witnesses on need and economics up to 21 October. The next CEGB witness to appear after this was Mr George head of the PWR taskforce. His evidence, on the design of Sizewell B, is primarily concerned with safety issues but does have economic implications, and it was on the latter that he faced cross-examination. Questioning focussed on project management and the allocation of responsibility for the project. Issues highlighted in Sir Alistair Frame's evidence on project management were raised with Mr George, including the roles of Bechtel and Westinghouse, and the need to be as close as possible to a final design before construction begins. More technical questions on pipework contracts, steam generators design and quality assurance were also raised.

The next witness to appear was Dr Avery, Deputy Managing Director of British Nuclear Fuels Limited, who was cross-examined on BNFL's evidence and particularly the estimated reprocessing and waste management costs for fuel over the proposed stations' lifetime. Counsel to the Inquiry had a few questions to ask, on the timing of reprocessing, reprocessing plant capital costs, or the comparison of reprocessing costs given to the Sizewell B and Windscale Inquiries.

On 26 October, Dr Wright of CEGB, who had earlier been cross-examined on alternative means of electricity generation was recalled to face cross-examination on his evidence on the nuclear fuel cycle. Mr Round of Norfolk County Labour Party questioned Dr Wright on the relative economics of reprocessing and long term storage. Dr Wright identified the timescale of fast reactors and uranium prices as the determining factors.

Before Mr Jenkin, the CEGB's final witness on need and economics, returned to be cross-examined on the need for Sizewell B, the Greater London Council began presenting their evidence on economic issues. Mr D Hutchinson was the Council's first witness, presenting evidence on the GLC's interest in electricity supply issues, its support for combined heat and power and district heating (CHP/DH) and energy conservation in preference to increased nuclear capacity, and its concern with social and employment implications of investment decisions. These themes were taken up by subsequent witnesses.

On 27 October, Dr N Mason, a GLC Research Officer, presented evidence on macro-economic and employment effects. Dr Mason claimed that while Sizewell B might increase national income up to the end of the century, an energy conservation programme on a CHP/DH scheme would generate more sustained benefits. He also believed that conservation and CHP/DH schemes would have greater positive effect on employment, particularly in Greater London, than would Sizewell B.

M F Nectoux, who had previously appeared on behalf of the Council for the Protection of Rural England, was the next GLC witness. His evidence on energy conservation concluded that 'public sector investment in domestic energy conservation and electricity conservation in the Greater London area would be a socially cost-effective way to allocate public sector resources'. Mr S Hodgkinson, began his evidence which pursued the theme of energy conservation, describing 'public sector opportunities in Greater London for investment in improved insulation and airtightness of the existing housing stock'. He concluded that 'the opportunity exists for public sector investment in loft insulation, cavity wall insulation, draught stripping and solid wall insulation . . .' which would yield 'an internal rate of return of around 20 per cent'.

The case for the Town and Country Planning Association was opened on 1 November. The TCPA considered that the proposed Sizewell B power station represented a high risk venture with a strong probability that it would fail to realise the economies predicted by the CEGB. The Association maintained that if this happened there would have been no point in ordering it ahead of need; the consumer would be faced with higher, not lower charges, and the country would be deprived of investment resources which could have been more profitably used in other ways. The Association also argued that prolonged or premature closure of the reactor bought about by public concern over safety would be a heavy financial burden and that it was unwise to commit over one billion pounds to the introduction of a new type of reactor in the present state of the economy.

The TCPA believed that it would be wiser to follow a deliberate policy of risk minimisation even if this did not in the event prove to be the cheapest solution.

The first witness for the Association was Professor P Odell who holds the chair in International Energy Studies in the Economics Faculty of Erasmus University, Rotterdam. He gave evidence on the future supply and price of oil. During the rest of this Inquiry week evidence was also heard from a colleague of Professor Odell's, Mr R Steenblik on the price of coal and from Mr M Ince, on the 'implication for the British power plant manufacturing industry'. Mr M Prior, gave evidence for the TCPA on aspects concerning fossil fuels as the last witness of the week.

On 8 November, as the Inquiry convened for the week, the Inspector, Sir Frank Layfield, announced that the Secretary of State had agreed to his request to appoint Professor J M Alexander as an Assessor to the Inquiry. Professor Alexander was head of the Department of Mechanical Engineering at the University College of Swansea prior to his retirement and had previously spent 21 years at Imperial College, London. The Inspector said 'he will be advising me solely on the engineering and applied mechanical aspects of the transport of irradiated nuclear fuel'.

The TCPA case was then resumed with evidence on some policy implications of the proposal to build Sizewell B. The witness for this proof was Mr C Sweet, the Director of the Centre for Energy Studies at the Polytechnic of the South Bank, who told the Inspector that his evidence had two purposes. 'Firstly, it is a critique of the CEGB's case at the Sizewell B Inquiry. As such, it extends not only to the material included in that case but considers the implications that the Board's programme would have in the UK economy. It criticises the CEGB for a lack of strategy and a failure to relate their future investment programme to the UK economy and the proper use of resources. Secondly, it offers the outlines of an alternative strategy and argues that this strategy is economically more attractive, particularly in holding down the real costs of energy'.

The TCPA case was adjourned on 9 November to enable Sir Alistair Frame who had read his evidence to the Inquiry on 27 September to be cross-examined. Sir Alistair, the Chief Executive of Rio-Tinto-Zinc, had been asked to give evidence by the Inspector in view of his experience in managing large construction projects. CEGB, NNC and others put questions to Sir Alistair on the criticisms he had made of the proposed management of and coordination with the overall Sizewell B project relating to: the organisation of the project and the need for close links between designers and those concerned with safety; the attributes necessary to manage successfully a large project such as Sizewell and the individual responsibilities with the management group; the roles of Bechtel and Westinghouse; overseas expertise; and costs and contingency allowances.

The TCPA case was resumed on 10 November with the further cross-examination of Mr Sweet and with the evidence and cross-examination of Mr S Crowther, a Senior Lecturer in Industrial Relations at Sunderland Polytechnic on the Social Costs of a Nuclear Power Programme. Mr F Jenkin of the CEGB was recalled on 11 November to be cross-examined by Wansbeck District Council, the Communist Party, the Stop Sizewell B Association and the GLC. Mr Brooke, Counsel to the Inquiry then began his cross-examination of Mr Jenkin.

On 15 November the Inspector replied to an application previously put to him by the TCPA to adjourn the Inquiry at the end of the need and economics case rather than continue to hear the safety case and matters concerning the local environment. The Association had also requested that the Inspector make a report to the Secretary of State on the present phase of the Inquiry as, if it can be seen that the economic case is not established, it would be wasteful to continue the hearing.

The Inspector's decision against the application, which was personally found 'alluring' to relieve him from the burden of further hearings, was because he had no powers under his terms of reference to stop the Inquiry until he had heard all the evidence. The Inspector having ruled against the application on these grounds then went on to explain why, even if he had the power to grant the request, he would not feel able to do so.

Mr Jenkin of the CEGB was then recalled to be further cross-examined by Mr Brooke. During questions on the need for, and economics of the proposed Sizewell B reactor Mr Brooke pursued the questions of interconnections with the French grid and European supply links in general; the place of renewables and of conservation; and the load factor of stations of various types. He also queried CEGB's assumptions about PWR and AGR lifetimes, a matter previously raised by Norfolk County Labour Party in cross-examination of Mr Wilson.

Programmes Branch,
UKAEA

IN PARLIAMENT

Radioactive wastes

25 October 1983

The Secretary of State for the Environment, Mr. Patrick Jenkin made the following statement about the procedures for dealing with radioactive wastes:

The White Paper of July 1982 stressed the great importance that the Government attach to the safe and effective management of radioactive wastes. These wastes, which vary greatly in type and source, are a necessary product of modern society. Their effective disposal, in ways which have been shown to be safe, is well within the scope of modern technology.

It has been decided already that the high-level, heat-generating wastes from nuclear fuel should be solidified and stored for at least 50 years. This will allow the radioactivity to decline and the necessary information to be collected for an eventual choice of the best means of disposal. However, there is no scientific reason for deferring the disposal of other categories of waste, and that is what the rest of this statement is about.

For many years, low-level waste has been regularly disposed of, both on land and at sea. The Government firmly believe that sea disposal is a safe method for certain kinds of lower-level wastes from laboratories, medical uses and other sources. It has been authorised by successive Governments, and is permitted under the London convention. It is overwhelmingly supported by scientific evidence but the Government regret that they have not so far succeeded in persuading certain trades unions of this. If there were authoritative evidence of a real risk to human health, or of significant and permanent damage to the marine environment, of course it would cease to form part of the national waste management strategy. A sea disposal operation will not take place this year, and the waste for which sea disposal is planned will be stored on land for the time being.

There is, in any event, a need to bring into operation by the end of the decade land disposal facilities for intermediate level wastes. The responsibility for providing those facilities falls to the nuclear industry and the generating boards acting through NIREX, the Nuclear Industry Radioactive Waste Executive. A copy of its first report has been placed in the Library of the House. The technology for constructing and monitoring such facilities is well developed. NIREX will be able to draw on extensive research and operational experience in other countries.

Two new facilities are likely to be needed, one consisting of a concrete-lined trench and the other of a deep underground cavity. NIREX is today announcing two sites which it considers sufficiently promising to justify further investigation. The possible site for a deep facility is at Billingham in Cleveland, and the possible site for a shallow facility at Elstow in Bedfordshire. Copies of the NIREX statement are available in the Library.

The decision by NIREX whether to proceed with proposals for these sites will depend on the outcome of survey, drilling and other investigatory works. It is possible that, depending on what is involved, such works may require planning permission. If so, I shall call in the relevant applications for determination after public inquiries. And I emphasise that these inquiries would give an opportunity for expressing views on the investigatory works themselves, having regard to their planning implications. They should not be seen as a forum for considering the merits of disposing of wastes at the sites.

If NIREX wishes in due course to propose that a disposal facility should be established at one of these sites, or at any other site, planning permission will be necessary. It is my intention to call in any such application and arrange for a public inquiry to be held under an independent inspector at which the merits of disposal at the proposed site will be considered in the light of the views of all concerned.

In addition to planning permission, any arrangements for disposing of radioactive waste in England will also have to be authorised by me, acting jointly with my Right Hon Friend the Minister of Agriculture, Fisheries and Food, under the Radioactive Substances Act 1960. I have today published, and placed in the Library of the House, a consultation document embodying the principles which it is proposed that the authorising Departments should apply in assessing schemes. All concerned are invited to comment on the draft principles. I intend to seek the advice of the Radioactive Waste Management Advisory

Committee and to strengthen the committee by appointment of additional members. The final statement of principles will be published as a framework for consideration of the individual schemes.

The sites will also be subject to licensing by the Nuclear Installations Inspectorate of the Health and Safety Executive, and appropriate regulations will be brought forward in due course. Approval of the schemes will depend on satisfying a comprehensive range of exacting requirements designed to safeguard the public and the work force.

The Government are committed to the safe and effective management of radioactive wastes. Additional land facilities are needed for the disposal of intermediate level waste. It is essential that decisions should be taken on the basis of informed scientific advice and after rigorous study of the views of all concerned, and that the installations and operations should be subject to stringent scrutiny and monitoring. The Government believe that the proposals I have announced represent an effective procedure for achieving these ends.

Mr Denis Howell asked the Secretary of State what consultations took place between his Department or NIREX and the appropriate local authorities prior to his announcement today. Does the Right Hon Gentleman appreciate that when he says in the second paragraph of the statement that the effective disposal of such wastes is safe and well within the scope of modern technology, and in the fifth paragraph that the technology for construction and monitoring is well developed, he is making assumptions that many people believe are far from proven, expecially given the time scales involved.

The Right Hon Gentleman has made a unique proposal in the decision to hold two public inquiries. Am I right to assume that they will be preliminary inquiries before the surveying and site investigation begin, and well before the full-scale planning inquiry? If so, what rules will govern that new and unique procedure? What will be possible? What evidence can be given? Who can be represented?

In the seventh paragraph, the Secretary of State says that the inquiries will not be a forum for considering the merits of disposing of wastes at the sites. How is it possible or proper to divorce the merits of waste disposal from the choice of site and investigation, especially when the chosen area for the first site is beneath a housing estate? How will that local authority and the representatives of the people be able to express their concern about their houses unless they can discuss the merits of dumping waste beneath them?

The Elstow site

In the 1982 White Paper the Government said that "economic and social factors" were an important consideration and would have to be considered. Does that apply to these inquiries? Will the Right Hon Gentleman give an assurance that it will be proper for the representatives of the people and the amenity and environmental organisations to concern themselves with such economic and social factors at the preliminary inquiries? Will he note that although we appreciate that he has placed a consultation document in the Library of the House and that he says that appropriate regulations will have to be laid before the House, this is a matter of such fundamental importance that we shall insist on holding a debate on that document?

Mr Jenkin: I understand the Right Hon Gentleman's request for a debate, and no doubt that can be discussed through the usual channels. Consultations with the local authorities would not have been appropriate at this stage. We are making the statement at the earliest possible moment when the possible sites have been identified by NIREX. However, nothing can be done until full consultations have taken place and the planning inquiries have been held. Obviously, they will provide ample opportunity for local authorities and other groups, such as the local residents, to be consulted and to express their views.

The Right Hon Gentleman drew attention to some of my remarks about safety. Of course, I shall receive very high level scientific advice from the Radioactive Waste Management Advisory Committee, and from the National Radiological protection Board about the difficult decisions that will have to taken. I have made it clear that I regard the public's safety and the integrity of the environment as paramount.

The Right Hon Gentleman also asked several questions about the public inquiries. The procedure that I outlined was intended to provide a double safeguard. We envisage that the first inquiry, if it is necessary, will be of comparatively limited scope, and will relate to the investigatory works themselves. The point is that if somebody wished to undertake, for example, test drilling to determine the character of the subsoil or to undertake some other such work, that would of itself require planning permission. The location of the drilling and so on would be a very proper matter for investigation at that stage. However, there would be no presumption whatever at that stage that it would result in a firm proposal, which would open up the much wider issue of whether facilities should be used. Those questions would be aired at the second public inquiry.

It may well be that investigations can proceed on, for example, an underground mine without engaging in any operations that would require planning permission. In those circumstances I would envisage that there would be the one major inquiry on the application to use the site for disposal. Such cases would involve any evidence relevant to the use of the site, and of course those concerned would be entitled to be represented. The Right Hon Gentleman also asked me whether the criteria in the 1982 White Paper, which my predecessor published July last year, still stood, and the answer is yes.

Mr Nicholas Lyell: Does my Right Hon Friend recognise that such an announcement is bound to cause grave anxiety to my constituents in Elstow and Stewartby and the surrounding villages? Can he confirm that no radioactive waste will be placed in the soil of Mid-Bedfordshire, whether on an experimental or permanent basis, without the Government's absolute assurance that it is perfectly safe to do so? Will he further assure the House that full planning considerations, including the possible blight to neighbouring districts, will be taken into account so that land that could otherwise be profitably used for residential, industrial or agricultural purposes is not so blighted?

Mr Jenkin: I can well understand the anxiety to which my Hon and Learned Friend has drawn attention. Perhaps it will go some way towards reassuring him and his constituents if I say that in the two areas in question, NIREX will undertake a substantial public information campaign, as it is extremely anxious that people should understand the full nature of what is—or, I must say at this stage, might be—proposed. They can then make an informed judgement about the matter if it comes before a public inquiry.

I can confirm that the disposal of radioactive waste will be conducted in such a way as to ensure the safety not only of present but future generations. After all, the half life of some of the products extends well beyond one generation.

After the work has been completed on a site such as is currently envisaged might be established at Elstow, there would have to be some limited restriction on what might happen at that site. However, it will be considered perfectly safe—if appropriate—for the public to have access to the site. That is the standard of safety that is applied by other countries that have adopted similar facilities for the disposal of their intermediate waste.

Mr Frank Cook: The announcement that the Right Hon Gentleman has made today ends more than nine months of acute anxiety in my constituency. In February of this year we had word that Billingham might be under consideration. During those nine months we tried to obtain information from NIREX but that has been singularly unforthcoming. The Secretary of State has assured us that there will be a public inquiry. Will he ensure that the inquiry is informed of the 35 000 people who live only 400 ft above the site of the proposed waste? Will he also ensure that the inquiry is fully informed of the nature of the high concentration of industry in that area, of the wide range of very volatile substances that are stored in subterranean caverns, cheek by jowl in the same area, as well as the liquified petroleum gas, the Calor gas, the propane, the ethylene and the ethylene oxide? Will the Right Hon Gentleman ensure that the inquiry is made fully aware that 14 per cent—one sixth—of the registrable hazardous locations on this country are located in that area?

The Secretary of State referred to the half life of waste which goes beyond the life of a generation. We are referring to toxic substances that can have a 5 000-year half life at an intermediate level and at the end of 5 000 years still remain toxic. It is worth noting that 5 000 years is more than twice the period since Julius Caesar landed on these shores. Will the Minister ensure that the inquiry understands what is meant by half-life and that the substances may have a toxic duration of 200 000 years?

Mr Jenkin: I fully understand the problems faced by the Hon Gentleman and his constituents. I am sorry if he considers that he has not been given the required information. This is the earliest possible opportunity that the Government or any public inquiry have had to come forward with a firm proposal that there exists in the Hon Gentleman's constituency a site that is worth examining further. That is the only decision that has been made. My statement was intended—I hope that it has in some way succeeded—to reassure the Hon Gentleman that the procedures and safeguards and the various steps which must be taken before a single ounce of radioactive material is stored in the anhydrite mine at Billingham are stringent and will give his constituents every possible opportunity to express their views.

I have the responsibility, as Secretary of State for the Environment, to ensure that the management of such radioactive waste material is conducted in a way that will ensure the safety of this and future generations. Judgements must be made in some cases. The Government are correct to consult and take the advice of the most authoritative members of the scientific establishment in this country because they are the people best able to advise us on this.

If either the Hon. Gentlemen or my Hon and Learned Friend the Member for Mid-Bedfordshire (Mr Lyell) wishes to discuss this matter with me or my Ministers, we shall be very pleased to see them.

Mr T H H Skeet: Does the Secretary of State agree that the amount of radiation is likely to be within international standards and that only a fraction of the natural radiation will be in either area? Does he also agree that the Bedfordshire water table will not be polluted nor will any untreated effluence be allowed to enter the river Ouse? Will he also ensure that there are two meaningful planning inquiries before either of the procedures goes ahead; and is 1990 the possible completion date of such a project?

Mr Jenkin: I am grateful to my Hon Friend who has the advantage of great knowledge in this area, which I respect. I confirm the Government's intention and that of the industry is to operate well within the international standards laid down by the International Commission on Radiological Protection.

As to the inquiries, an initial preliminary inquiry would be appropriate only if the investigatory works were such as to require planning permission. If not, there appears to be no reason why any obstacle should be put in the way of further investigation. It is important to state that if it is subsequently decided, in the light of those investigations, to use the site for the disposal of radioactive wastes, that proposal would then be the subject of a full public inquiry.

My Hon Friend referred to the water table. It is not appropriate for me to answer questions of that type, but NIREX and, subsequently, the public inquiry would need to have the fullest evidence to ensure that there is no possible risk of pollution of the water table through the escape of nuclear radioactivity.

My Hon Friend also asked when this project would come to fruition. I believe that we must have these facilities by the end of the decade, but it would be rash to try to forecast precisely how long these complex but necessary procedures will take.

Mr John Cartwright: However skilled the public relations campaign might be, or however expert the scientific advice available, does the Secretary of State realise that ordinary people will take a lot of persuading that nuclear waste can safely be stored on land for long periods? Is it not, therefore, extremely unwise to propose the storage of highly radioactive waste in areas of concentrated housing such as Billingham?

Mr Jenkin: That matter will have to be considered in the greatest of detail. I remind the Hon Gentleman that at the Trades Union Congress this year, in a debate in which objections were raised to the use of sea dumping, Mr Ray Buckton on behalf of the General Council asked the Government to accelerate action on land-based methods of dealing with waste.

The Government believe that land-based disposal of intermediate wastes is the safest and the best method, provided that a site can be found with sufficient geological certainty and stability which will remain safe for the necessary period of time.

I understand the difficulty of persuading ordinary people of the safety aspect of this matter. I can say that no stone will be left unturned. I remind the Hon. Gentleman that the Radioactive Waste Management Advisory Committee includes trade union members nominated by the TUC. I am sure that that organisation will be well placed to advise NIREX and the Government as to the best way of approaching the public in these difficult matters.

Mr David Madel: Will my Right Hon Friend remember that land suitable for industrial development in Bedfordshire should be used quickly to create long-term jobs rather than for the dumping of radioactive waste? Will he also remember that Bedford already takes a great deal of domestic and industrial waste which adds to the traffic congestion within the county? Will he also remember that there is a great deal of public unease about the future of the nuclear industry? The Government have a considerable task in allaying public anxiety. I do not think they make the job any easier by choosing an area such as Elstow which is near an industrial and highly developed part of Bedfordshire. Will the Secretary of State ensure that a relatively small county is not asked to do too much for too many too quickly?

Mr Jenkin: I fully understand my Hon Friend's anxiety. The actual quantities of intermediate waste that would need to be stored in the site currently envisaged for the location in his constituency are tiny compared with the volumes of normal waste to which he referred. The relevant site, a former brick clay pit, was earmarked some years ago for the building of a power station which, in the event, has not taken place. There is some development on the site at present and if it is decided after a public inquiry to proceed with the use of the site for radioactive disposal the existing users will need to be relocated. The question of immediate jobs—I understand my Hon Friend's point on this matter—must be subordinated to the need to ensure the most rigorous safety procedures and standards for a course of action that is essential, bearing in mind the quantities of intermediate waste that already exist as a result of past generation of power by nuclear means.

Mr Ted Leadbitter: May I draw the attention of the Secretary of State to the third paragraph of his statement? After dealing with the "high-level, heat-generating wastes from nuclear fuel" he concludes "However there is no scientific reason for deferring the disposal of other categories of waste." It appears from those words that the Secretary of State has pre-empted the situation and that on those grounds he has come to a conclusion.

Then in the eighth paragraph of his statement he said: "planning permission will be necessary"? In the light of those two references and of his kind comments earlier that he would be available for discussion, does he accept that if the planning authority of Cleveland county concludes that because of the already high proportion of overhazardous industries in the area it cannot give planning permission, he will give way to that consideration?

Finally, in view of the Right Hon Gentleman's invitation to consult, will he agree at the earliest possible moment to receive a deputation of Hon Members from the area, including the representative of the Cleveland County Council?

Mr Jenkin: I assure the Hon Gentleman that I am always happy to receive a deputation of which he is a member. I shall of course be happy to do that.

In answer to what the Hon Gentleman said about planning, I have made it clear that I intend to call in any application which it would not be fair to leave to the local planning authority. I should call it in so that there might be a public inquiry, and at that, of course, the County Council would be a key witness. The fact that Cleveland—and the Billingham area in particular—has been the centre for the chemical industry, particularly the organic chemical industry, for a number of years, is scarcely relevant to the use of the anhydrite mine for the storage of radioactive waste. There is no conceivable risk of anything such as an explosion. That is not the concern. The concern is about whether the site is safe to contain the radioactinides and nuclides which might damage health and poison the environment. The fact that there are chemicals on the surface, as the Hon Member for Stockton, North (Mr Cook) said, is not a factor in that connection, but no doubt these matters will be explored thoroughly in any public inquiry that is held.

Mr Richard Holt: Will the Secretary of State consider the fact that he might well have made a similar statement a few decades ago in a scientific manner when the subject of asbestos was first brought to attention? At that time the Secretary of State would have got up, as he has done today, and said that full scientific advice had told him that it was perfectly safe. Can the Secretary of State guarantee today that it is perfectly safe, or that it will be in the future? You state that there is to be a public inquiry. Will you say what alternative sites you have if the public inquiry turns you down?

Will the Secretary of State kindly advise those of us who have not yet had the benefit of reading the paper of the difference between a deep cavity and a deep hole, because it seems that one of the scientific reasons for choosing my constituency of Cleveland is that a hole already exists there which someone thinks should be filled in? That is the worst scientific reason for putting radioactive waste there.

Mr Jenkin: I assure my Hon Friend that that factor would not weigh with me in the choice of site. If I may put the subject in layman's language, the difference is that some substances have a fairly high radioactivity—I am talking about intermediate-level waste—where the half-life is short and the radioactivity declines fairly rapidly, and in those circumstances it is sufficient—so we are advised by the advisory committee—for them to be stored in relatively shallow—about 30 m deep—in appropriate pits of that nature and covered in. For substances that have a longer half-life, and when there needs to be a much more permanent safeguard against the escape of radioactivity, it is considered that a deep pit, a mine or something of that nature, is the best place. Of course, the geological stability and the other conditions in the mine are critical in this connection.

I understand my Hon Friend's difficulty about scientific advice, but I firmly believe that Governments should always seek to act on the best scientific advice that is available. Of course, no one can say that that is infallible for all time. No one would be so foolish as to say that. However, we have a problem. We have intermediate waste, and it is important for us to make permanent arrangements for its suitable and safe disposal. That is what my statement is intended to lead to, and that is why I have spelt out the procedures, and they are very stringent procedures, to ensure that the waste is as safe as we could possibly make it.

Mr John Evans: Will the Secretary of State accept that his statement today is of great significance to every citizen in this country and that there is enormous public interest in the matter? Is he aware, on the subject of the public inquiries, which we on these Benches naturally applaud, that the utilities—the CEGB, the Atomic Energy Authority, and so on—have enormous funds at their disposal and a large number of experts to present their case, but there is a terrible feeling that the objectors have to scrape around for pennies to present their objections? In view of the tremendous importance of this issue, will the Right Hon Gentleman take this opportunity to state that the objectors to the proposals will have state finance to present their case to the public inquiry?

Mr Jenkin: I entirely accept the importance that the Hon Gentleman rightly attaches to my statement and to this whole subject. The matter of funds for objectors at public inquires has been considered many times by successive Governments, and in particular has been raised many times in connection with the Sizewell inquiry. I do not believe that it would be right for me to give any fresh undertakings on that at this stage. However, local authorities themselves are powerful bodies which can command considerable resources and I am sure that the local authorities, whether in Cleveland County or the District Councils in the area or, indeed in Bedfordshire, will be well able to represent the views of their residents effectively and thoroughly at the public inquiry.

Mr Anthony Steen: While people at Billingham and in Bedfordshire will understandably be concerned, is my Right Hon Friend aware that a fair amount of nuclear waste is being transported by rail through Totnes railway station nearly every night? Is the handling of that nuclear material safe and are the wagons which carry it safe? Will my Right Hon Friend assure my constituents in South Hams that they are safe?

Mr Jenkin: I think that my Hon Friend is referring to the transfer of irradiated fuel by techniques that are now well established. That is a matter for my Right Hon Friend the Secretary of State for Transport, but it is the Government's intention and that of all the protective agencies that we have to ensure that all those operations are as safe as they possible can be.

Dr M S Miller: The Right Hon. Gentleman is right to pay attention to the TUC's wish for a permanent method of disposal to be found, and I am glad that the Government are proceeding along those lines. However, the Right Hon. Gentleman is being a little premature in giving assurances that cannot yet be claimed to be 100 per cent effective. This matter is of great concern, as I am sure the Right Hon Gentleman knows.

Will the Right Hon Gentleman expand on the first aspect of his statement. He rightly divided radioactive wastes into two—high-level and intermediate and low-level waste. The Right Hon Gentleman said that the high-level waste would be solidified. Does he mean that it will be vitrified, and when will it be done?

I am partly responsible for a parliamentary hearing through the Council of Europe's sub-committee on nuclear energy of the Committee on Science and Technology in Stockholm on this subject. The most important aspect of the problem is to try to prevent the scientists from adopting the lofty attitude that they know all the answers. Radioactive waste can be made safe, but there must be dialogue between the people involved and the scientists. It is not good enough to lay down the law and say that it will be safe. Will the Right Hon Gentleman take that on board and ensure that every effort is made to bring the public into this so that they can be reasssured?

Mr Jenkin: I am grateful to the Hon Gentleman for his view that nuclear waste can be safely stored. I am sure that he is right, and is is our intention that is should be.

I am looking forward to meeting representatives of the TUC general council to discuss those matters in the near future. We shall want to maintain a dialogue on this.

The Hon Gentleman's final point is important. I spent two years as a shadow spokesman on energy in the 1970s and I met many scientists. One quality of that distinguised profession that struck me was their ability to communicate their science to the public. Had they not done so they would never have been allowed to do anything. Nuclear scientists understand better than scientists in some other fields the need to explain things to the public.

Mr John Carlisle: I endorse the comment of my Hon Friend the Member for Bedfordshire, South-West (Mr Madel) that Bedfordshire has had its fair share of waste over the past few years.

Why was this extraordinary decision—as I believe it to be—made to put waste in such a heavily populated area? What transportation will be used to bring that waste into Elstow?

Mr Jenkin: It would be inappropriate for me to hazard a guess as to how that might be done. These are clearly matters that require further investigation and that will be thoroughly aired at any public inquiry. The site in question is close to a railway and has road access to motorway networks. Several options therefore exist.

I understand the anxiety of my Hon Friend and his constituents. It will be the intention of all concerned, not least myself, to ensure that as the various procedures are carried through every opportunity is taken to explain what is involved to the public and to seek to allay their anxiety.

The choice of the site as one for possible investigation is for NIREX and I commend the statement that it has issued today which explains why it has picked on this as one of the two sites.

Mr Simon Hughes: While I welcome the Right Hon Gentleman's statement that intermediate level waste should be stored on land rather than at sea, does he accept that his responsibility as Secretary of State for the Environment is to ensure that Britain sees less and less nuclear waste, not more and more? Will he use his influence to ensure that Government policy is to decrease rather than increase nuclear waste?

Will the Right Hon Gentleman give an undertaking to publish the shortlist of sites as suggested by the management advisory committee? Will he make known the criteria for the selection of the two proposed sites so that we can be sure that the selection was made on scientific not political or quasi-political grounds?

Mr Jenkin: There has never been any question of disposing of intermediate waste at sea, only low level waste, and that we believe will be safe on scientific evidence.

On questions of nuclear policy and the generation of more waste I must defer to my Right Hon Friend the Secretary of State for Energy who is responsible for such matters.

The Hon Gentleman asks whether we ought to publish a shortlist of the sites from which the two that I have mentioned were drawn. That would not serve any useful purpose at this stage. If and when NIREX decides to go ahead with proposals for developing disposal facilities I shall hold a public inquiry and NIREX will have to justify its choice of site to the independent inspector in the light of the assessment principles which are the subject of the consultation document that I have put in the Library. I prefer to leave the matter there.

Mr Stuart Bell: A constituent of my Hon Friend the Member for Stockton, North (Mr Cook) said that if this waste is deposited 400 ft below his house it will be like living above a nuclear time bomb. That is the kind of dangerous feeling that exists in my area of Cleveland as a result of these announcements. We welcome the fact that there will be a public inquiry, that planning permission will have to be granted and that the decisions will have to be taken by the Department of the Environment along with the Ministry of Agriculture, Fisheries and Food. However, have the mine owners been consulted? What would happen if they refused to give permission for such deposits to take place? Will the Right Hon Gentleman give an assurance at the end of the day that he will take note of the views of the people of Cleveland and not seek to impose a solution by making these deposits in Cleveland?

Mr Jenkin: As the Hon Gentleman obviously understands these matters I am sure that he will do his best to seek to allay the exaggerated fears of his constituents. There is no conceivable question that these wastes will constitute anything remotely approaching a bomb. That is part of the danger that comes simply from using the word "nuclear" which people associate with explosions, and it is not the case. We must bend every endeavour to try to allay such anxieties.

Of course we shall take account of other people's views. That is precisely why I have outlined the complex procedures and safeguards that exist.

I am not sure whether the question of where the waste would be put if the owner of the mine did not consent would arise in the case of the anhydrite mine at Billingham. I understand that the owner, ICI, has been informed about this and that it has said that if it is in the national interest it would be prepared to allow its facility to be used for this purpose, subject to all the necessary safeguards.

Whether I would impose any decision is a hypothetical question that does not arise at this stage.

Dr Jeremy Bray: Is the Right Hon Gentleman aware that the anhydrite mine at Billingham is a very big hole indeed and that at the rates of depositing which NIREX is proposing, by the end of the century only 1 per cent of the available space will have been filled up? Is it wise to go through all the hazards of preparing public opinion to accept a facility which will be grossly problematic, and could not the geology have been explored at a much less sensitive site?

Mr Jenkin: I am sure that the criterion that was uppermost in the mind of NIREX was to find a site that would provide the most suitable and safest storage for the intermediate waste with which it is concerned. The area of this mine is, I am told, about one mile by one mile by 15 feet, which is a vast volume, and the Hon Gentleman is right to say that it would provide storage facilities for many years, if that should be necessary. That is a matter for NIREX. My concern is to see that if its investigations lead it to conclude that it is a place where it would wish to store the categories of intermediate waste, I must be satisfied that all the criteria, particularly those spelled out in the consultation document, are fully complied with before there is any question of consent being given.

Nuclear waste disposal

25 October 1983

Mr Hardy asked the Secretary of State for the Environment if he has any plans for the dumping of plutonium of high or medium-level nuclear waste at sea; and if he will make a statement.

Mr Waldegrave: The planning of operations to dispose of radioactive waste at sea is a matter for the Nuclear Industry Radioactive Waste Executive. However, such operations have to be authorised and licensed by my Right Hon Friends the Secretary of State for the Environment and the Minister of Agriculture, Fisheries and Food. Because the disposal of high-level radioactive waste, as currently defined by the International Atomic Energy Agency, is not permitted under the terms of the London convention, no operation involving such waste would be authorised or licensed. However, radioactive waste, including plutonium-contaminated material, which falls outside the IAEA definition of high-level waste may be legitimately disposed of at sea. In the absence of authoritative scientific advice that sea disposal within the terms of the London convention poses a real risk to human health, or is likely to cause significant and permanent damage to the environment, this disposal method continues to form part of the national strategy for radioactive waste management.

British Nuclear Fuels Ltd

26 October 1983

Mr Jackson asked the Secretary of State of Energy if he will publish in the *Official Report* a statement showing the profits earned and dividends paid to the Government by British Nuclear Fuels Ltd annually since its incorporation; and if he will make a statement as to its financial prospects for the current year.

Mr Giles Shaw: The following table gives BNFL's profits available for distribution and dividends paid from these to the Government since the company's creation in 1971.

BNFL group— summarised financial results

Year	Profit available for distribution £million	Dividends £ million
1971-72	0·6	–
1972-73	2·7	–
1973-74	1·3	–
1974-75	3·6	–
1975-76	5·6	–
1976-77	1·4	0·3
1977-78	4·7	1·3
1978-79	15·7	2·2
1979-80	16·0	2·7
1980-81	12·9	2·7
1981-82	29·8	4·0
1982-83	44·9	12·4
	139·2	25·6

Hunterston power station

27 October 1983

Mr Foulkes asked the Secretary of State for Scotland when he was informed about the recent radioactive leak from Hunterston nuclear power station; when the leak took place; what were the details of the report; and what action he is taking as a result.

Mr Allan Stewart: On 13 October the South of Scotland Electricity Board reported that a radiological survey on 10 October at Hunterston A nuclear power station had revealed some low-level contamination in the vicinity of the liquid effluent pipeline. The board took the affected pipeline out of service immediately and is installing a temporary bypass line. Access has been restricted to the contaminated area which is well clear of the site boundary. The Nuclear Installation Inspectorate (NII) has been notified but the incident is not considered to have a significant radiological impact. The matter is now in the hands of NII, which is investigating and action is being taken to prevent a recurrence.

Mr Foulkes asked the Secretary of State for Scotland what incidents involving any kind or degree of leakage or discharge of radioactive substances from the nuclear power station at Hunterston have been reported to him since the start of operation of the station.

Mr Allan Stewart: Under the agreed procedure by which the Secretary of State is notified of accidents involving leakages of, or discharges of, radioactive substances the Health and Safety Executive published a summary of all such reported occurrences in its quarterly statements of nuclear incidents. These statements include details of any such incidents at Hunterston. The information is made generally available to the media and the public and copies of the appropriate press notices are already available in the Library of both Houses. There have been no incidents at Hunterston which have resulted in significant releases of radiation on or offsite.

Sellafield

2 November 1983

Dr Cunningham asked the Secretary of State for the Environment if he will make a statement about recent allegations concerning radioactive material emanating from the British Nuclear Fuels plant at Sellafield and its possible connection with public health in west Cumbria.

Mr Patrick Jenkin: Recent media reports, including a Yorkshire Television programme last night, have discussed the levels of radioactivity in the neighbourhood of the BNFL works at Sellafield and in particular have drawn attention to an apparently high incidence of cancer among children and young people. The reports have linked this with the discharges of radioactive substances from the Sellafield works.

I appreciate the natural concern aroused by these reports. They have not indicated levels of radioactivity out of line with those recorded in previous monitoring and the radiological significance of the levels quoted has been exaggerated. It is none the less right that we should take seriously any evidence of an abnormally high rate of cancer even though such evidence is difficult to assess.

The National Radiological Protection Board is working closely with Oxford University on studies into the incidence of leukaemia clusters and other cancers. This may well contribute to our evaluation of the situation at Seascale. In addition, my Right Hon Friend the Secretary of State for Social Services has invited the distinguished medical scientist Sir Douglas Black, who is a former president of the Royal College of Physicians, to consider the evidence concerning the alleged cluster in the neighbourhood of Sellafield and its causation, to determine the need for any further research and to make recommendations.

The discharges at Sellafield are subject to regular monitoring and stringent control. Authorisation issued by my Department and the Ministry of Agriculture, Fisheries and Food under the Radioactive Substances Act 1960 impose definite limits on the amount of radioactivity in discharges and control the most significant individual substances. It has for some time been an aim of the authorising Departments to reduce the discharges of the most significant substances. At their instigation, BNFL is constructing SIXEP, a site ion exchange effluent treatment plant. This plant, which is likely to cost over £80 million, is planned to come into operation in 1984 and will bring about a reduction of caesium discharged to the sea to one tenth of the maximum released in recent years. Meanwhile, caesium discharges have already been halved as a result of interim measures. The new authorisation issued when the plant is ready will oblige the company to limit discharges of caesium and certain other substances to levels as low as reasonably achievable within the limits set.

It has also been our aim to secure big reductions in discharges of plutonium and other alpha emitters. Over the past 10 years BNFL has achieved a reduction of 80 per cent in these discharges. Last year authorising Departments informed BNFL and it accepted that recent levels of discharge of these substances which accumulate in sea bed sediments should be further reduced as soon as practicable. The Departments have put forward a draft authorisation which would have the effect of reducing the actual level of such discharges to about 200 curies a year. That is about one quarter of the amount released last year and one thirtieth of the total at present authorised. The aim is to have the necessary plant in operation in 1985.

My Right Hon Friend the Minister of Agriculture, Fisheries and Food and I will continue to ensure that all necessary action is taken to keep discharges within the recognised safety limits. In addition, we will be considering in the light of technological developments whether yet further reductions should be sought. In this we will take full account of authoritative independent advice from the Radioactive Waste Management Advisory Committee.

Incidence of cancer in children

2 November 1983

Mr Austin Mitchell asked the Secretary of State for Social Services to carry out surveys of the incidence of cancer in children in villages around Windscale; and whether he will make a comparison of the local statistics with national figures.

Mr Kenneth Clarke: The National Radiological Protection Board, in conjunction with a member of the Medical Research Council External Scientific Staff, is already undertaking a study of cancer (including leukaemia) in the neighbourhood of nuclear plants in England. In addition the Office of Population Censuses and Surveys are conducting an analysis of cancer incidence and mortality comparing national figures with those in local authority areas in the vicinity of nuclear sites operating before 1955.

We have now asked a distinguished medical scientist, Sir Douglas Black, to consider the evidence concerning the alleged cluster of cancer cases in Seascale and advise us as quickly as possible whether further research is needed and to make recommendations as to what form if any, the research should take.

Mr Mitchell also asked whether surveys had been carried out on the presence of plutonium and other radioactive elements in household dust in villages round Windscale.

Mr Clarke: The National Radiological Protection Board at present monitors the level of radioactivity in the air which, they consider, provides more relevant information. We will ask them to consider again whether there would be any worthwhile purpose to be served by investigating levels of household dust in addition to their present work.

Energy conservation

7 November 1983

Mr Burt asked the Secretary of State for Energy what the estimated maximum savings per year arising from the energy efficiency campaign announced by his Department are.

Mr Buchanan-Smith: It has been estimated that 20 per cent of the nation's energy bill could be saved by cost-effective efficiency measures by the late 1990s. The aim of the campaign is to achieve this as soon as possible.

Mr Burt also asked whether bearing in mind the complaints by industry about the Government's failure to get the message across and the consequent failure by industry to apply for grants that it may need to fulfil the aims of the conservation campaign, will the Minister outline what steps he intends to take to publicise the campaign throughout the country?

Mr Buchanan-Smith: As my Right Hon Friend announced last week, an energy efficiency office has been established in my Department with the particular task of carrying the campaign forward. We do not intend the campaign to run only centrally. Ministers hope to visit cities and other centres throughout the United Kingdom in the next few months. We believe that enormous savings can be made. I am grateful to my Hon Friend for his support.

Mr Hanley asked that the extent of the publicity that is planned through advertising on television and in newspapers be set out?

Mr Buchanan-Smith: I cannot give the detailed expenditure figures. However, every means possible will be used to bring the campaign home to the public and industry. If savings of 20 per cent at present prices can be achieved by the end of the 1990s, a potential saving of £7 billion a year is possible. That is a worthwhile prize to work for.

Fuels policy

7 November 1983

Mr Rogers asked the Secretary of State for Energy what proposals his Department has for a balanced fuels policy.

Mr Giles Shaw: It remains the Government's aim that all economic forms of energy should be exploited, supplied and used efficiently.

Mr Rogers also asked the Minister to disclose what role he sees the coal industry playing in any future balanced fuel programme? Will he also elevate the coal industry in his general accounting procedures so that it can play a truly effective role?

Mr Shaw: I welcome the Hon. Gentleman's question. The Government's aim is to ensure that the coal industry plays a major and viable part in our energy policy. I hope that the Hon Gentleman will agree that it is essential, in that achievement, to produce coal at a price at which the market is willing to buy.

Mr Wilson asked whether the Minister believes in a market and balanced energy policy. Had he examined the figures in today's *Glasgow Herald* which show that the South of Scotland Electricity Board will be buying about 4 million tonnes of coal from the National Coal Board next year compared with about 8 million tonnes three years ago? Does the Minister realise that if that continues, a catastrophic loss of jobs, beyond the industry's current position, will occur? Does he accept his responsibility for trying to retain a share of the coal industry for Scotland?

Mr Shaw: I am aware of the position. I understand that a large portion of the problem is due to the Peterhead power station now using natural gas liquid in addition to coal. I understand that that is for a temporary period. Overall, the loss to the coal board in Scotland is about 25 per cent of the volume compared with last year. We must remember that there has been a large drop in demand.

Dr McDonald: If the Government are committed to a balanced fuel policy, will the Minister prove that commitment by reversing the CEGB's decision not to use the fifth unit at the Isle of Grain oil-fired power station which is being built by one of our best teams of construction workers?

Mr Shaw: It is for the CEGB to determine where its major capital investments should be realised.

Plutonium dust

7 November 1983

Mrs Dunwoody asked the Secretary of State for the Environment if he will start an urgent inquiry into the origins of plutonium dust found on Cumbrian coastal areas.

Mr Waldegrave: The origins of plutonium in the environment are fall-out from weapon tests and discharges from nuclear installations. The environmental effect of the latter is carefully monitored and the results published. Exposures to the public are well within the limits recommended by the International Commission on Radiological Protection.

In addition my Department already part-funds a programme of research in Cumbria into the distribution and behaviour of radioactive substances in the environment and the pathways by which they could lead to radiation exposure of man. The work is carried out by British Nuclear Fuels Limited, the United Kingdom Atomic Energy Authority, and the Institute of Terrestrial Ecology of the Natural Environment Research Council; budgeted expenditure this year is £180 000.

A description of the programme appears in chapter 8 of the Progress Report on Sponsored Research on Radioactive Waste Management January 1981-March 1982, published by the Department earlier this year, which is in the Library of the House. The detailed reports of findings mentioned there are deposited in the British Library lending division.

Nuclear waste transport

8 November 1983

Mr Cohen asked the Secretary of State for Transport what are the reasons which led to the introduction of new containers for the transport of spent nuclear fuel by rail.

Mr Ridley: I understand that the Central Electricity Generating Board has, since 1979, been renewing its fleet of flasks used for transporting spent fuel from first generation—Magnox—reactors.

Each flask design is subject to rigorous assessment and must be certified on my behalf as complying with stringent safety standards formulated by the International Atomic Energy Agency before the flasks can be put into use.

The board has informed me that, in the course of a continuing programme of research, it has carried out tests on a reduced scale model of a now obsolete type of flask. These tests suggested that under extreme impact in one particular attitude, a seal weld of flasks of that type could have been capable of suffering some minor cracks. This conclusion is not directly relevant to the types currently being phased out but the board, although satisfied there is no significant risk to the public, has informed me that it is accelerating their withdrawal.

In the light of this information I am cancelling the relevant certificates from 14 November.

In view of the Hon Member's question, I have asked the Central Electricity Generating Board to make a statement. I will arrange for copies to be placed in the Library of the House.

Nuclear waste in sea

9 November 1983

Mr Norman Atkinson asked the Secretary of State for the Environment what is the total discharge into the sea per annum of plutonium, ruthenium and caesium from each United Kingdom nuclear establishment; and what progress has been made in the design of filtering techniques to avoid the need for open sea liquid discharge.

Mr Waldegrave: The table shows discharges to the sea in 1982 from United Kingdom nuclear establishments of isotopes of these substances.

Site	Radionuclide	Annual Discharges (Curies) 1982
British Nuclear Fuels Ltd.		
Sellafield	Ruthenium-103	458
	Ruthenium-106	11 316
	Caesium-134	3 736
	Caesium-137	54 060
	Plutonium-238	127
	Plutonium-239 +240	434
	Plutonium-241	13 105
Chapelcross	Ruthenium-106	0·21
	Caesium-134	2·4
	Caesium-137	29·4
United Kingdom Atomic Energy Authority		
Winfrith	Ruthenium-106	4·9
Dounreay	Ruthenium-106	110
	Caesium-137	336
Central Electricity Generating Board (CEGB) and South of Scotland Electricity Board (SSEB)		
Berkeley	Ruthenium-106	<0·5
	Caesium-134	6
	Caesium-137	55
Bradwell	Ruthenium-106	<0·5
	Caesium-134	10
	Caesium-137	64
Hinkley Point 'A'	Ruthenium-106	5
	Caesium-134	4
	Caesium-137	24
Hinkley Point 'B'	Ruthenium-106	3
	Caesium-134	2
	Caesium-137	3
Dungeness 'A'	Ruthenium-106	<0·05
	Caesium-134	3
	Caesium-137	53
Sizewell	Ruthenium-106	<0·5
	Caesium-134	4
	Caesium-137	72
Oldbury	Ruthenium-106	<0·5
	Caesium-134	3
	Caesium-137	46
Wylfa	Ruthenium-106	1
	Caesium-134	1
	Caesium-137	18
Hunterston 'A'	Ruthenium-106	2·9
	Caesium-134	17·4
	Caesium-137	53·6
Hunterston 'B'	Ruthenium-106	3·9
	Caesium-134	3·1
	Caesium-137	4

Figures for earlier years are contained in the additional tables to my Department's annual Digest of Environmental Pollution and Water Statistics, which are obtainable from the Department and are in the Library of the House. At the Sellafield works of British Nuclear Fuels Ltd which is the source of the most significant discharges, considerable progress is being made in effluent treatment. Measures utilising an ion exchange procedure have halved caesium discharges and a major new plant, involving expenditure of more than £80 million, will reduce such discharges to one tenth of their peak level in recent years. Discharges of plutonium and its daughter products have also been reduced, and a further 15 per cent reduction should be achieved by the use of filters which were installed this year. New plant and procedures are to be introduced progressively so that by 1985 discharges of all alpha bearing wastes should be reduced by at least four fifths of their current level.

Fast Breeder Reactors

9 November 1983

Mr Norman Atkinson asked the Secretary of State for Energy if the international development of the fast breeder reactor would obviate much of the plutonium and americium now being discharged into the sea by Sellafield and other nuclear establishments; and if he will initiate further international discussion as to the commercial development of fast breeder design.

Mr Giles Shaw: The levels of discharges from the sites are established by the relevant authorising Departments taking into account the health and environmental considerations and the nature of the existing nuclear generating and reprocessing plants. It would be premature to specify at this stage what discharges would be authorised following the international development of the fast reactor. My Right Hon Friend announced on 5 September that the Government had decided to open formal negotiations to seek agreement on the joint development of fast reactors with other European countries; these discussions are still in progress.

Radioactive Waste Management Advisory Committee

15 November 1983

Mr Simon Hughes asked the Secretary of State for the Environment what consultations he has had recently with the Radioactive Waste Management Advisory Committee.

Mr Patrick Jenkin: My Department has regular and useful consultations with the Radioactive Waste Management Advisory Committee, which continues to be the major source of independent and objective advice to the Government in this controversial and important field. The Under-Secretary of State will attend part of tomorrow's meeting of the committee.

My colleagues and I are grateful to Sir Denys Wilkinson FRS, vice-chancellor of the University of Sussex, for his distinguished and widely appreciated contribution as chairman of the committee since it was set up in 1978. It was with regret that I accepted Sir Denys's wish to give up the chairmanship at a suitable opportunity, in order to devote more time to his other commitments.

I am today appointing Professor Paul T Matthews CBE, FRS, who has expressed to my Right Hon Friends the Secretaries of State for Scotland and Wales and myself his willingness to serve, as chairman of the committee for a term of three and a half years beginning in January. Professor Matthews is a distinguished physicist who recently retired as vice-chancellor of the University of Bath and is currently working in the department of applied mathematics and theoretical physics at Cambridge.

Atomic Energy Authority

16 November 1983

Mr Skinner asked the Secretary of State for Energy what was the cost to public funds of the study undertaken by the accountants Peat Marwick Mitchell into the operation of the Atomic Energy Authority.

Mr Giles Shaw: The payment made for the first stage mentioned in the reply by my Hon Friend the Member for Croydon, Central (Mr Moore) of 30 November 1982 was £20 193. The second stage mentioned in that reply, also being carried out by Peat Marwick and Mitchell, is expected to cost some £121 000, of which £79 000 has been paid.

Radioactive material in Whitehall

17 November 1983

Mr Skinner asked the Secretary of State for the Home Department if he will make a statement about the handling by the police of the radioactive material deposited in Whitehall on Saturday 12 November; what was the radioactive level of the material; where it was taken for analysis; and what precautions were used by the persons dealing with the material.

Mr Hurd: The Commissioner of Police of the Metropolis tells me that on 12 November some people taking part in a demonstration emptied a dustbin of mud at the junction of Whitehall and Richmond Terrace and claimed that it was highly radioactive. The police cordoned off the area and called for assistance from the chemical incident unit of the London Fire Brigade. As the unit was arriving, the police learnt that the demonstrators had brought the material with them some distance by train. The inference was that they would have been most unlikely to have exposed themselves to dangerous material. The police took the material in a plastic bag to Westminster Hospital, and confirmed that it was not dangerous. Arrangements are being made to test the precise level of radioactivity of the material.

Water supplies on Merseyside

18 November 1983

Mr Terry Fields asked the Secretary of State for the Environment what measures are taken to test supplies of water on Merseyside for pollution; what measures are taken to test for radioactivity; what are the permitted levels of radioactivity in public water supplies; what recent levels have been recorded on Merseyside; and if he will make a statement.

Mr Waldegrave: The North West Water Authority tests the Merseyside water supplies every day, and regularly analyses samples for a wide range of possible pollutants. The Department's radiochemical inspectorate has recently completed a comprehensive analysis programme of River Dee water, which is used to supply Merseyside, and regularly analyses water from a typical impounding reservoir in north Wales. The radioactive content of the samples has been found to be well within the WHO guideline levels, which have been adopted in the United Kingdom.

East Anglian water

22 November 1983

Mr T H H Skeet asked the Secretary of State for the Environment, whether he has consulted the Minister for Agriculture, Fisheries and Food; and whether there have been joint consultations with the Anglian Water Authority about the disposal of nuclear waste in Bedfordshire and its effect on the water table in the area pursuant to section 8 of the Radioactive Substances Act 1960.

Mr William Waldegrave: My Department works closely with the Ministry of Agriculture, Fisheries and Food, with which it would act jointly in authorising any repository proposed by the Nuclear Industry Radioactive Waste Executive (NIREX).

The Anglian Water Authority is one of the bodies invited to comment on the draft principles for the protection of the human environment published by the authorising Departments on 25 October. NIREX will now be investigating the possible effect on the water table of a repository at Elstow, along with other relevant factors. If it subsequently decides to put forward a specific proposal, that proposal will be assessed against the final version of principles mentioned above and the consultation provisions of the Radioactive Substances Act 1960 will be observed.