NEA NEWSLETTER

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THE OECD NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 20th April 1972, replacing the OECD's European Nuclear Energy Agency (ENEA).

NEA now groups all the European Member countries of OECD with Australia, Canada, Japan and the United States. The Commission of the European Communities and the International Atomic Energy Agency take part in the Agency's work.

The main aims of the NEA are to promote cooperation between Member governments in the safety and regulatory aspects of nuclear power and in the development of nuclear energy as a contributor to economic progress.

This is achieved by:

- *encouraging the harmonisation of governments' regulatory policies and practices;*
- *reviewing technical and economic aspects of the nuclear fuel cycle;*
- *assessing demand and supply, and forecasting the potential contribution of nuclear power to energy demand;*
- *exchanging scientific and technical information; and*
- *coordinating and supporting research and development programmes, notably through the setting up of joint projects.*

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Foreword

In carrying out its basic task of helping Member countries identify and resolve the important issues facing their nuclear energy programmes, the Nuclear Energy Agency prepares and publishes a great deal of material intended for specialists and policy makers in government and elsewhere.

Despite the scope of this material, and other general publications like the annual activity report which goes to an extensive readership, there still seems to be a definite need for an additional link between the Agency and what we see as a large potential audience in parliaments, government departments, industry, research bodies, and other groups in the community which are interested in, or involved with, the further development of nuclear power.

Hence this Newsletter, which we hope will become a regular feature of our publications programme, providing up-to-date information on the Agency's activities and policies and also news about many other aspects of nuclear power. The regular coverage will include reviews of NEA reports and summaries of key speeches, meetings and topical events.

From time to time the Newsletter will give space to discussions of the major issues confronting nuclear power development in the OECD area. This first issue leads with two such topics. We also hope to be able to feature other articles of special interest.

The Newsletter will be published twice a year. We naturally welcome any comments and contributions which will help it to become a genuine two-way channel of communication, reflecting the NEA's commitment to the free exchange of information at the international level.

The Role of the Severe Accident in Nuclear Safety*

The question of severe accidents poses perhaps one of the biggest challenges to the nuclear industry and efficient international cooperation is needed to tackle this problem. This article describes some of the basic changes that have been taking place in safety philosophy and the contribution of the NEA in this field.

The application of any technology incurs certain risks. Early technology posed risks primarily to its workers and rarely, if ever, involved the public at large - with the possible exception of transport risks. Only with the advent of large modern projects, such as hydro dams and large chemical complexes have people totally unconnected with the enterprise been threatened by accidents in these facilities.

As people have become more aware of this risk they have demanded more say in the continuing debate on what levels of risk are acceptable, a decision that has higherto been left to the wisdom of technical experts representing both industry and government, which normally regulates the use of technology.

Unfortunately, as we know, risk acceptance is not a strictly rational process and public attitudes to risk are affected by many powerful influences, including questions of utility and psychological factors. As far as the latter is concerned, we must also recognise differences between voluntary and involuntary risks.

If we take, for example, the case of the quite staggering figures of the road toll (a voluntary risk) in the industrial countries, (more than 120,000 killed every year in the OECD countries), we see that public perception of the dangers of motoring have had very little effect on car ownership. When we look at the reverse side of the coin, taking the example of nuclear power (an involuntary

* By Klaus Stadie, Deputy Director, Safety and Regulation, NEA.

risk), we notice that public opinion in many Western countries is completely mesmerised by the ultimate potential for damage posed by a nuclear reactor, despite the evidence that a catastrophic accident is not in the least likely. This attitude showed up clearly in the aftermath to Three Mile Island (TMI) which - we must recall - did not kill a single person.

Defence in Depth

This is not to play down the small, but very real, possibility that a nuclear power reactor could fail, with serious effects on people, even some distance away. But it may help to explain the difficulties the regulatory authorities are faced with when attempting to decide acceptable and rational levels of protection. In fact the risks inherent in exploiting nuclear power have been known from the outset and safety considerations have always played a major role in nuclear development, bringing it to the point today where it can be described as perhaps the safest industry. Not a single person of the general public has yet been killed as a result of an accident in a nuclear power reactor in the OECD area.
It is therefore doubtful whether it is wise to go a great deal further to provide costly devices designed to mitigate the consequence of extremely rare accidents. The economic penalty to the industry of following this course would be enormous compared with the very small reduction in risk accrued and it would be difficult - if not impossible - to verify the proper functioning of these devices during such an accident.
This argument has to be seen in the light of the fact that everything humanly possible has already been done in the nuclear safety field to cope with human fallibility through a defence in depth system, consisting of several layers of redundant and diverse safety devices. These different layers give assurance that we can limit the progression of any accident, the initiation of which in the first place is made at the very least unlikely by a vast quality assurance programme.

Safety approaches

So why raise the question of acceptable risk levels ? The answer can be seen in the way safety thought has developed since the 1950s. Up to now the fundamental safety approach for the most common reactor type in the OECD area - the light water reactor - developed in the United States where the type originated. This approach was - and is - based on the definition of a maximum credible accident and the demonstration that its consequences can be contained. Anything worse than this type of accident is considered so unlikely that it is classed "incredible", which in turn means that there is no need to take precautions against these events or their consequences. This concept, or a similar one, has been adopted in all OECD countries with water reactor power programmes.
In 1967 Mr. Farmer publicly challenged for the first time this black and white approach to nuclear safety. He pointed out that the mere fact of using nuclear reactors implied the acceptance of some finite degree of risk and, since no technology was entirely risk free, there was no logical way of differentiating between credible and incredible accidents. The 1975 Reactor Safety Study took this further and made the first quantitative estimates of the risks associated with nuclear power production in light water reactors. Later on many similar studies in other OECD countries have followed the WASH-1400 lead.
Finally there was the Three Mile Island accident which, depending on the way you look at it, was a credible or incredible event, according to the twenty year old definition of the design basis accident (DBA). TMI therefore gave additional impetus to the search for a new policy.

International co-operation through the NEA

The need for a common policy on accidents was perceived some time ago by the NEA Committee on the Safety of Nuclear Installations. This Committee directs a broad and comprehensive international programme in nuclear safety technology and licensing. In 1980 the Committee established a group of senior experts from a number of Member countries to study the potential response of existing water reactor safety systems to class 9 accidents (accidents beyond the DBA) and to examine the implications for current safety research and development.
It soon became clear that there was no common understanding of what constituted a class 9 accident - a term which in any

case dates back to the time when the DBA was defined. Our experts finally decided to use the term "Severe Accident" instead, defining this as an event in which there is a failure of structures, materials, systems, etc., without which core cooling cannot be properly assured by normal means.

The Senior Group agreed unanimously on a number of questions. In general there was a consensus that the capability of PWRs to protect the public was far greater than the DBA approach implied. It was agreed that the first priority in safety should be accident prevention and then its progression thereafter to successive stages. At the same time the undoubted ability of plants to function safely beyond the DBA should be turned to account so as to maintain maximum control over events and thus keep the potential hazard to a minimum.

The most important area of concern for the experts was accident management, extending throughout the sequence of events making up a severe accident. Highest priority was placed on improving the ability of plant personnel to cope with severe accidents. It was felt that under this heading of accident management, a number of actions called for urgent attention: research aimed at producing best estimates of accident sequences, identification of key parameters in accident progression to enable appropriate instrumentation to be developed, the training of operators to diagnose severe accidents in terms of physical phenomena not scenarios, and more study of long-term accident management.

This work continues. We see as a priority task the need to develop a safety rationale which adequately takes into account accidents which have very low probability and at the same time potentially high consequences, without requiring absolute evidence that these events do little or no harm.

Much more work still needs to be done to arrive at a common policy. The OECD, and in particular its Committee on the Safety of Nuclear Installations, is pursuing this question vigorously, because we are clearly aware of the difficulties Member countries will encounter in their nuclear power programmes if we do not reach a consensus on how to treat severe accidents.

Trends in the Control of Occupational Exposure in Nuclear Facilities*

There has been a significant evolution in radiation protection concepts and practices, which aims at an optimal balance between the cost for a given level of protection and the minimization of radiation hazards obtained through such measures. Practical problems arise notably for the control of occupational exposure in some areas of the nuclear fuel cycle.

During nuclear energy's early years the main concern was the protection of workers and great efforts were made then to minimise occupational exposure. The result of this pressure on nuclear plant designers and operators was the achievement of generally satisfactory working conditions and the reduction of the exposure of workers to levels which are, by and large, well below the authorised dose limits. There remain, however, a few groups of nuclear workers whose working conditions and levels of exposure give cause for concern, and renewed efforts are needed to give these groups better protection.

By the 1960's and 1970's, as the nuclear industry got into its stride, nuclear operators and regulatory bodies began to shift the emphasis of their concerns towards minimising radiological risks to the public. This new emphasis was prompted by the then rapid expansion of the nuclear industry in the OECD countries, especially the growth in the number and size of power stations, and the consequent rise in public concern about real or perceived radiation hazards.

During these years increasingly strict requirements were introduced at all nuclear plants to prevent accidents and to ensure a safe treatment and containment of radioactive wastes. As a result of these efforts, the general level of safety at nuclear plants has considerably improved and the elaborate new systems for waste management have reduced the discharge of radioactive effluents to

* By Osvaldo Ilari, Deputy Head, Radiation Protection and Waste Management Division, NEA.

trivial levels. Taken together, these two aspects have lessened the radiological risks to members of the public associated with potential accidents and their radiation exposure in normal operating conditions to below any value of concern.

Risks to nuclear workers

However, these achievements were made at the cost of increasing the radiation exposure to the group that was initially the focus of attention, that is the workers employed in the industry. The new plant safety requirements include inspection and maintenance procedures, as well as plant modifications and backfit, and because of these measures plant operational staff are now exposed to radiation doses additional to those produced from the normal running of the plants. In the same way, the high priority given to the safe treatment and storage of radioactive wastes requires increasing involvement of workers in waste management operations and thus results in their increased exposure to radiations.
This is confirmed by a number of studies carried out by the NEA and by other international and national organisations. In particular, these studies show that the maintenance and inspection personnel in nuclear power plants are being increasingly exposed to higher levels of dose compared with all other categories of nuclear workers. This exposure of workers is a real fact. It has to be set against its trade-off which is a decrease of potential harm to the public due to the possible decrease of the probabilities of accidents and their radiological consequences. In other words, it has to be weighed against a hypothetical rather than a real advantage.

A lack of balance

There is a growing feeling among experts that this situation may be out of balance, both in the way different levels of radiological risk are tolerated for two separate groups (the workers and the population) and in the varied responses to different requirements (the safety of nuclear plants, protection of workers and protection of the public) which in the final analysis all have the same regulatory value.

According to the present radiation protection doctrine, which requires that the protection of people be brought to an optimum, an attempt is made to strike a balance between the costs needed to achieve given levels of protection and the radiation risks that can be prevented by the introduction of these protection measures. The most recent developments in this field go further along this line by suggesting that the protection of people should be guaranteed through an overall optimisation of all the various parameters involved.
There is, therefore, a need for a rational approach to the question of optimisation of protection to produce an equitable balance between the requirements of plant safety and those of protection of workers and the community.

International co-operation

The NEA is contributing to work in this vital area through the activities of a Group of Experts who have the task of reviewing dosimetric data on occupational exposure in the nuclear industry, identifying those aspects which involve problems of balance between plant safety and radiation protection and developing a conceptual approach and methodology to decide the optimum balance.
The results of these studies will eventually form the basis for the important decisions, which will have to be made soon, on the systems and procedures to improve the dosimetric situation of workers in the nuclear industry in the context of the high level of technological safety already achieved in nuclear plants.

The special case of uranium mining

A particular group of nuclear workers which has been coming in for special attention from the experts in recent years has been the miners in the uranium mining industry. All uranium miners, and especially those working in underground mines, are exposed to natural radioactivity which emanates from uranium and thorium minerals and is breathed in at the workplace. These miners receive relatively large doses of radiation to their lungs, and a number of epidemiological studies seem to confirm that they are perhaps the only homogeneous group of workers which are showing the occurrence

of some cases of health damage, in particular lung cancers, caused by radiation.
These consequences of working in a uranium mine are exacerbated by the synergism, or interaction, of radiation effects with smoking habits, and the effects of other pollutants in the working environment such as dust, fumes and so on.
To raise the protection standards of uranium mines to the satisfactory levels achieved in other areas of the nuclear fuel cycle plant designs, particularly ventilation systems need to be improved; also operational procedures must be tightened up; more accurate systems for dose evaluations developed and advanced instrumentation must be made available for the personal dosimetry of workers and the monitoring of contamination levels in the work-place.
In the past few years the NEA has been making a significant contribution to work in these areas through the promotion of studies, exchanges of information and the preparation of technical guidance. Expert Groups working for the Agency have prepared technical reports on radon and thoron dosimetry and on the metrology and monitoring of these radionuclides.
As correct dosimetry and monitoring can only be obtained from accurate and reliable instruments, great emphasis has been placed on studies in this area. For example, an important intercalibration and intercomparison exercise for dosimetry and monitoring equipment, covering the whole OECD area, is being launched at present by the NEA in collaboration with the Commission of the European Communities (CEC).
Other, more specific and detailed questions are also being tackled by those responsible for the radiation protection of workers. But the issues summarised above have a broader impact and it seems likely that their satisfactory solution will represent a very important step for the nuclear industry.

The Meaning of "Demonstration" in the Long Term Management of Radioactive Waste*

There are often calls for a demonstration of the safe management of high level radioactive waste as a prerequisite for the further development of nuclear energy programmes. These calls have even been reflected in national legislation on nuclear energy deployment. We should therefore be clear about what we mean by the term demonstration and its practical realisation.
The NEA has just published a document* which describes an international agreement on what would constitute a valid demonstration programme. This statement will help to promote a better understanding of the issues, and will put the national and international research and development activities in their proper context.

* This article is taken from *Long Term Management of High-Level Radioactive Waste - The Meaning of a Demonstration*, a new, 23 pp. booklet which is available free of charge from the NEA.

Short and long term activities

In the complex sequence of operations for the safe management of high level waste we distinguish between operations which are intended to solve short term problems and others which involve the very long term. Short term activities can be directly demonstrated in the sense that the successful running of facilities is itself adequate proof of their feasibility and safety.
For all practical purposes, this has already been achieved, notably in France, through the successful operation over the past five years of the AVM industrial solidification plant and its associated storage facility at Marcoule.
For longer term activities, such as the isolation of radioactive waste in deep underground structures, demonstration must be indirect. Direct demonstration of such a disposal system would call for practical experience over an impossibly long period, far longer than a human lifetime. Proof of the safety of high

level waste disposal must therefore be based on a different approach.
The demonstration of deep underground disposal for high level radioactive waste involves two steps:

- Firstly, to prove that a disposal system could be built, operated and closed safely at acceptable costs, using available mining and engineering experience. This may involve designing and building one or more experimental facilities.
- Secondly, to make a convincing evaluation of the system's performance and long term safety on the basis of predictive analyses confirmed by a body of varied technical and scientific data, much of it derived from experimental work.

Support from experience and research

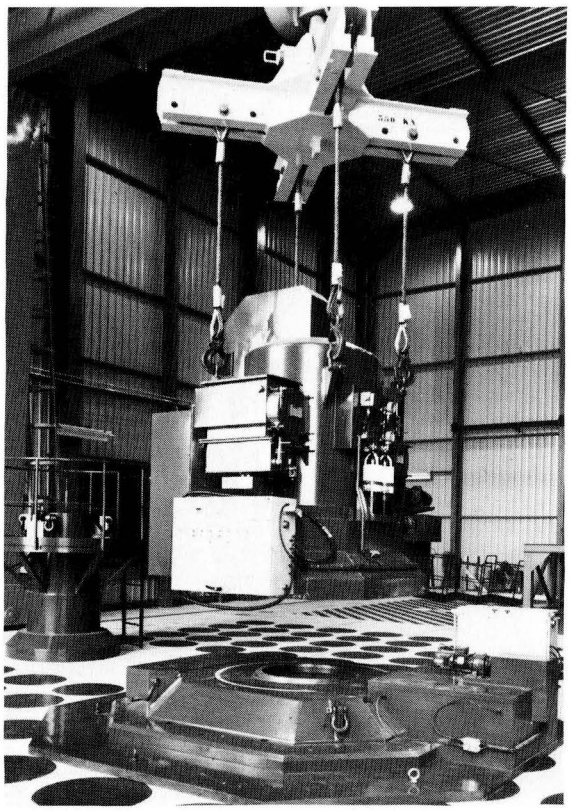
There is already considerable experience available from conventional drilling, mining and engineeering, which is directly relevant to the design and construction of deep underground repositories located several hundred metres underground. In addition specific research and development activities should be, and are being, carried out to complement this experience.
So far the information available suggests that there is no major obstacle, either from the geotechnical or the economic standpoint, to the proper emplacement of solidified high level waste in suitable geological environments at the required depth.
The second, indirect step, involves the collection of supporting evidence and preparation of a predictive safety assessment that can provide a sufficient degree of confidence in the security of this form of disposal.

Leaving room for interpretation and judgement

Predictive analyses are increasingly used as scientific tools to foresee the long term behaviour of complex engineered systems. They can be used just as well to assess the long term behaviour of radioactive waste disposal systems. Backed by results obtained from field experiments and other areas of science such as geology, hydrology, the study of natural historical evidence and archeology, such "system performance assessments" have the potential to provide an indirect proof of the suitability and long term integrity of the systems proposed.
However, predictive analyses call for highly sophisticated scientific techniques and the results obtained will always leave room for interpretation and judgement because of uncertainties and unexpected events in the far future.
The competent national authorities have a duty to critically examine the scientific and technical evidence provided in support of proposed disposal systems. They will have to satisfy themselves that this evidence shows a sufficiently deep understanding of the problems involved, and that the proposed systems can meet the long term safety objectives. As in other endeavours, absolute safety does not exist and safety goals must be seen in the context of other human activities.

Further assurance on safety

The combination of a short term direct demonstration of mining and civil engineering capabilities and an indirect

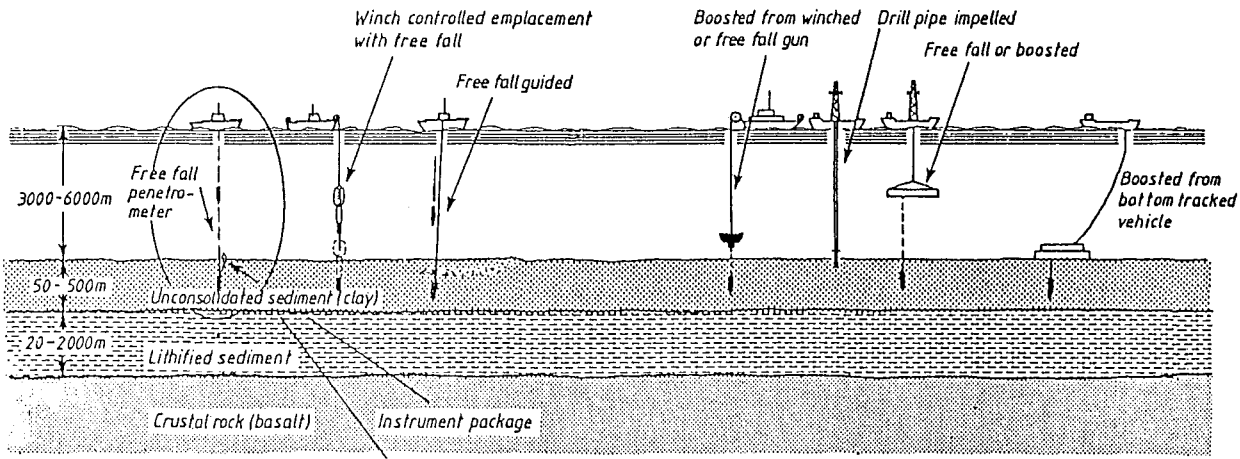


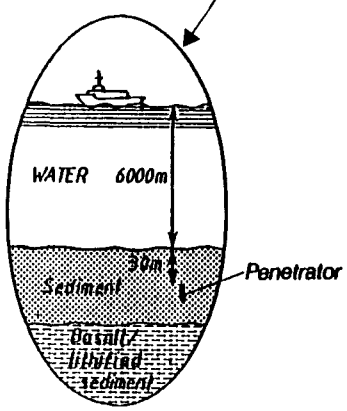
Storage of vitrified high-level waste

demonstration of long term safety through predictive analyses can provide a valid response to regulatory and public concern about the long term management of radioactive waste. A great deal of progress has already been made in this direction and there is every reason to believe that such a demonstration will become increasingly convincing as further research and development activities are carried out.

Disposal of Radioactive Waste Beneath the Seabed

The technical feasibility and long term safety of using the sediment layers under the seabed for the isolation of high-level radioactive waste is being investigated at the international level under NEA sponsorship.
Disposal of high-level radioactive waste in stable geological formations underlying the ocean floor is conceptually similar to disposal in geological formations on land, as the aim is the isolation of long-lived radionuclides in a geological medium which provides the main containment barrier.





Seabed Disposal Concepts - Atkins planning May 1981 DOE/RW/82.015 cited in the forthcoming status reports 1983 on seabed working group OECD NEA

The NEA programme

The aims of the research programme of the NEA Seabed Working Group are to provide information for a complete assessment, including long term safety, of the emplacement, of high-level radioactive waste in suitable containers in the sedimentary geologic formations of the deep ocean floor.

Three questions need to be asked about such a proposal:

- Are there any locations in the ocean floor with the right sediment properties and other characteristics?
- Is it possible to emplace packaged waste in the seabed sediments and what effect would this have on the sediment barrier?
- What are the radiological consequences of seabed disposal?

Some studies envisage the vitrification of high-level radioactive waste contained in stainless steel canisters. The canisters would then be stored on land for a period varying from 5 to 50 years before they were buried in the seabed.
The minimum burial depth would depend on long term containment considerations, so that the sediment barrier would be able to prevent unacceptable radionuclide migration into the ocean. To date most studies have indicated that burial at a few tens of metres would satisfy radiation protection requirements. The burial depth would also depend on local sediment properties.

Methods of emplacement

Two emplacement techniques are being studied. The penetrator emplacement concept can be described as the loading of one or more waste canisters into a torpedo shaped device which is dropped from a ship above the disposal area. The penetrator comes to rest in the ocean sediment at a depth depending on the penetrator geometry and the sediment properties. During the first phase of field trials, in March 1983 in the Atlantic Ocean, embedment of 30 metres was achieved with a reduced size free-fall penetrator, corresponding to about 100 metres embedment for a full size device.
The drilled emplacement method currently being considered requires the drilling of a borehole from a ship into the sediment. The hole would be backfilled in a controlled manner after emplacement of a large number of waste canisters. It is expected that drilling equipment could be built to drill holes 0.5 metres diameter, down 900 metres below the seabed, at 4000 metres depth.
Since radiological acceptability is one of the major factors to be considered in deciding whether seabed disposal options for high-level waste are feasible, assessments of the radiological impacts of these options are an important part of the research programme.
Preliminary calculations and sensitivity analysis showed that the factor which has the greatest influence on potential doses to man is the rate of migration of radionuclides upwards through the sediments and into the ocean.
Work to produce more comprehensive radiological assessments is already underway. In order to be able to quantify in detail the long-term radiological consequences of seabed burial it is necessary to build predictive models to describe each component of the barrier system and of the pathways back to man.

Research programme only

The NEA co-ordinated research programme is essentially an R & D programme and there are therefore no plans to implant high-level radioactive waste in any site in either the Pacific or the Atlantic Oceans. One of the main questions indeed is whether a suitable site even exists for such a repository.
The Programme is organised by the Seabed Working Group, with representatives from a number of countries with active R and D in this area*. A comprehensive state-of-the-art report about the findings of this group is being prepared and will be published by NEA soon.

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* Members of NEA Seabed Working Group are: Canada, F.R. of Germany, France, Japan, the Netherlands, Switzerland, United Kingdom, United States and the Commission of European Communities. Belgium and Italy have observer status.

The Joint Evaluated File Project at the NEA Data Bank

The world economic recession over the past few years has tended to concentrate limited scientific resources, and to encourage international cooperation. This is the case with the joint Evaluated File (JEF) which will be built up in cooperation between countries participating in this exercise, and the NEA Data Bank itself. Release of the first fully-tested version of the JEF-1 file is planned for 1985.

The need for evaluated nuclear data

An important feature of nuclear energy technology is its dependence on the interactions with nuclei of such an elusive

particle as the neutron. As a result of the difficulty of following the behaviour of individual neutrons, the values of most of the nuclear constants required for design calculations are known only to an accuracy of a few percent, rather than to the much higher accuracy with which engineers in other disciplines are able to work.
Conservative design of reactors and shielding then requires that neutronics calculations should assume the least favourable cross-section values, resulting in a less than optimal final design. A one percent improvement in the certainty with which key cross-sections are known could yield savings of millions of dollars per reactor. These potential savings supply the justification for continuing long-term national and international programmes to generate better nuclear data by new measurements and by careful "evaluation" of the sum of measured data already available.
The evaluation process involves the study of all available measurements of the cross-section concerned, re-assessment of the error estimates and possible re-calibration of the curves to take account of improvements in the measurement standards used. Sections of the energy range in which little measured data is available can be filled in by theoretical calculation. Finally, the validity of the evaluation can be tested by comparing the values measured for macroscopic effects (easier to measure to high accuracy) with the predictions obtained from calculations, simulating the same experiment, and using the (microscopic) evaluated cross-section data.

The joint evaluated file project (JEF)

The proposal to co-ordinate the evaluation work carried out in several of the countries in the NEA Data Bank and to combine the output in a single file, to be compiled and maintained at the Data Bank, originated in the 1980 meeting of the NEA Committee on Reactor Physics. These data are needed to replace the much older national evaluated data files on which most reactor physics calculations in Europe are currently based. Use of a concise and newly selected set of evaluations by many of the Data Bank countries will give not only improved accuracy in calculations, but also much improved possibilities for intercomparison of the results.
During 1982 the Data Bank assembled a JEF-1 "starter file" of all the principal elements and isotopes currently important in reactor design and shielding. Evaluations for inclusion in the file were chosen by experts in Member countries. By the end of the year the file contained data for nearly 270 different materials, and simple integral comparisons with data measured in standard neutron spectra had provided a preliminary check on their validity. Progress with the assembly and simple validation of the file was sufficient to justify a new proposal for a second phase of the JEF project covering the period 1983-1985.

Gaining acceptance for JEF

By September 1983, the file contained data for a total of 297 isotopes and natural elements, and a start had been made on the simplest "benchmark" tests of parts of the file against standard experimental results. Calculations have been made at Harwell, Karlsruhe and Winfrith, and to a lesser extent at the NEA Data Bank itself. While results are re-assuring, they represent only the first step in testing the data under circumstances closer to those of operating reactors.
Validation work will continue over the next two years, largely in national laboratories, and in parallel with improvements to the file where these are considered urgent. The aim is to release, late in 1985, a well benchmarked JEF-1 file, whose strengths and weaknesses in representing integral measurements and the behaviour of critical assemblies are adequately understood. In parallel, new evaluations are being undertaken by participating countries, and these improvements will be incorporated in a revised version of the file, JEF-2, to be released at the end of 1985.
The further life of the project will depend on the confidence of scientists and engineers in the reliability of the data. It is hoped that the JEF file will provide the physics basis for a new round of refinements in existing reactor types. Continued JEF development and extension to higher energies could make this file a suitable basis for early fusion reactor designs.

Supercomputers: The Next Generation

Over the 40 years of their development the speed of computers has increased by something like seven orders of magnitude; or to put it another way, a calculation which would have taken a year to run in 1940, or a full day in 1950, can now be done in one second. And there seems to be a strong push to produce even faster machines: some thinking in U.S. circles suggests an increase in speed by a factor of 200. The reason for this speed up, according to Mr. Jack Worlton of the Los Alamos National Laboratory, is that there are still many problems which cannot be attempted because of the computing time required. On a super-fast computer a job which now consumes an unattainable 1000 hours of working time could conceivably be completed during an overnight routine.

However, computer architects are up against the problem that the rate of increase in the speed of calculation of computers is slowing down, and a new approach is needed if a 200 times speed-up is to be attained in the next decade or so. The suggestion is that a future generation of supercomputers would achieve only part of their increased speed by improved electronics, and designers would be forced into radical architectural changes, such as the introduction of parallel processing, to make up the difference.

Mr. Worlton made these predictions during the course of two lectures at the OECD headquarters, Paris on 27 September, when he surveyed the origins of mass storage systems and reviewed and evaluated the generic characteristics of the new generation of super computers this process has spawned.

He said the Japanese initiative to become the world number one in supercomputing had caused United States manufacturers to look to their products and research effort and that the competition between these two leaders was certain to intensify in the next few years, with the outcome depending on the US's ability to counter several Japanese advantages, especially in hardware.

According to Dr. Worlton the Japanese "fifth generation" computer proposals probably covered two almost distinct lines of development: the use of the power of their vertically integrated computer industry to fill a gap in the world market for an IBM-compatible supercomputer, and the application of artificial intelligence concepts to improve human communication with these extremely complex machines.

CRAY 1 super-computer

Nuclear Inter Jura Congress '83

About 200 delegates were welcomed to the 6th Congress of the International Nuclear Law Association (INLA) held in San Franciso, 11th to 15th September. The Congress was the biennial meeting of members of this non-government Association, which is mainly concerned with promoting the study and exchange of information on nuclear law. Members of the Association are drawn from more than 30 countries, although most come from the OECD area.

The 1983 Congress considered international trade in nuclear plant and materials and the progress of regulation of nuclear installations, with particular emphasis being placed on problems of radioactive waste management and public attitudes to nuclear energy. Also on the Agenda was the question of the legal status of operations to decommission nuclear power stations.

One session was given to examining the basic principles of the nuclear third party liability regime in the light of recent revisions of the Paris and Brussels Conventions undertaken within the OECD. There was also discussion of problems caused by insufficient harmonization of liability and indemnity in the Member countries, as well as the subject of the introduction of justifications for limiting the liability of the nuclear operator.

Uranium Programmes

One of the major economic advantages of nuclear power over the other major systems used in electricity power generation is its low fuel cost. This advantage will only remain while uranium production can cover the requirements of the nuclear industry and while resources of uranium are sufficiently large to ensure such supply well into the future.

The NEA has several programmes relating to work in the different areas of the front end of the fuel cycle. One of these, IUREP, is concerned with supply in the next century.

IUREP

The International Uranium Resources Evaluation Project (IUREP) started in 1977 with a review of the uranium potential of 185 countries. From this review, estimates were made of the amount of "Speculative Resources" existing in the world.

While, as the name implies, the existence of these resources is speculative, they are very important. Resources which have already been discovered can be used to supply uranium to meet the needs of the nuclear energy programmes in the short-term but in the longer-term (i.e. in the next century) uranium will need to be produced from resources which have not yet been discovered. Estimates of the magnitude of such resources are vital to energy planners.

The work, known as Phase 1 of IUREP, was published in 1978 in the report "World Uranium Potential: An International Evaluation" and has been summarized in recent editions of the Red Book.

Since then missions, usually consisting of two uranium geologists, have been sent to selected countries to make a better assessment of the Speculative Resources of these countries. During this exercise, known as the IUREP Orientation Phase, twenty countries have been visited. Reports on five of the missions have so far been released, and the remaining reports will be published during the next few months (copies of summaries of these reports are available, on request, from the NEA). The Orientation Phase, which started in 1979, will finish at the end of 1983.

A review of the IUREP Speculative Resources data base was completed in June 1983. The review resulted in some minor changes to the resource estimates and a clearer indication of the confidence that can be placed in these data. The new estimates will be reported in the next edition of the Red Book.

IUREP and other studies concerned with possible supply from Speculative Resources are continuing in the NEA.

The Role of Governments in Promoting a Realistic Public Understanding of the Potentialities of Nuclear Power

*This article is based on an edited version of a paper given by Howard K. Shapar, Director General, OECD Nuclear Energy Agency, at the Uranium Institute, London, 25th August 1983**

There is no question that adverse public attitudes towards nuclear power translated into action by opponents has been, and continues to be, a significant obstacle in the way of nuclear power growth. We all recognise that public anxieties about nuclear power are real even if they are not well founded.
An analysis of the problem could start with an examination of the background to the anti-nuclear protest movements. The proper setting for these protests is surely the broader societal issues of the 1970s:

a) increasing concern about the environment;
b) discussions about the role of energy in social and economic development;
c) questioning of the purpose of economic growth;
d) greater interest in science on the one hand and disillusionment with many scientific achievements on the other;
e) lack of trust in institutions and governments;
f) the issue of non-proliferation of nuclear weapons;
g) mistrust for "large" industrial projects.

Public opinion polls

Public opinion polls show that a significant share of the population in many of the industrialised countries are either directly opposed to further deployment of nuclear power or are worried or confused about reactor safety or waste disposal. Some polls which have carried the same questions for a number of years claim to show a marked deterioration in public support for nuclear power since the mid 1970s.

Among the many interesting features of these polls are the anomalies thrown up, such as figures which show that more people would like to stop the construction of new plants than close down the plants that are presently operating. This might suggest that economic realities are being increasingly recognised.
Another point is that some polls in some countries have shown public confidence in nuclear power slipping steadily away at the very time when some governments are intensifying their efforts to keep communities informed and when progress is being made in the technical aspects of safety and waste disposal systems.
If the polls are to be believed it seems that the relatively small number of anti-nuclear activists in the OECD area reflect a broader distrust of nuclear power in our communities.
Those with a positive view towards nuclear power are often in the minority. That leaves a large share of the public who "don't know", are indifferent or uncommitted and their support needs to be won over.

The main public issues

When we come to examine the issues that seem to cause the most public disquiet, we need to remember that the boundaries of these issues are frequently as uncertain as the concerns of these people who discuss them and that there is overlap and interaction between subjects. However, safety of nuclear reactors is obviously a leading issue and under that subject the fear of radiation is a focus of concern for those people who are unable to be more specific about plant safety.
As far as it is possible to classify the main areas of concern in most countries, the list would read something like this:

a) <u>Safety</u>

Are the risks too great? How safe is safe enough? Was Three Mile Island the proof of the underlying weakness of the

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* *Uranium and Nuclear Energy* : the 1983 Proceedings of the Eighth International Symposium of the Uranium Institute will be published by the Institute in December.

system, or an accident that proved the system worked?

b) Waste Management

How can we prove that long-lived, high-level radioactive waste can be kept safe? What problems are we creating for future generations?

c) Non-proliferation

An issue which touches foreign policy, trade and (through the NPT) disarmament.

d) Transport of nuclear materials

With the growth in nuclear traffic, concerns in some countries about safety have increased. Transport through densely populated areas provides a handy cause for those who want to question the potential dangers to populations of nuclear waste or nuclear materials.

Government reaction to anti-nuclear attitudes

The way governments have faced the nuclear opposition in the past decade, as might be expected, reflects the national economic and political situations in each case but it also points up the diversity of approaches dictated by national attitudes and traditions.
These approaches have varied from deliberately including the electorate in the decision-making process through a range of measures such as national referenda, public inquiries, and parliamentary debate, to making decisions at the top with the minimum of public consultation.
The obvious conclusion to be drawn from the application of these methods is that there is no single self-evident government response to nuclear opposition that would be as suitable, say, in Spain as in Canada. Governments must work in the context of their own institutions and their own political imperatives and the way the elements of the response are mixed is unique to the situation. That is not to say that some of those elements that have been successfully employed in one country may not be successfully employed in others.
There are three main ways, I believe, in which governments can help to promote public understanding of nuclear power:

a) by carrying out effectively their traditional tasks of deciding priorities, funding research, encouraging information exchange with other countries, and regulating - that is to say by performing their tasks well;
b) by providing basic information about the need for nuclear power and its economic importance, and providing appropriate opportunities for changes in policies. This is the government explaining its position;
c) by judgement and decision, that is to say by leadership, particularly when no clear course is offered.

If governments followed more closely the priorities they have set themselves in these areas, they would find that they were going a long way to answering many of the doubts and uncertainties surrounding nuclear power today.

Some general observations

When one looks at the public acceptance situation in OECD countries, one is struck by the differences in government responses. The similarities are less obvious, but they are present, and sufficiently noticeable to allow some preliminary conclusions:

a) In the democratic tradition governments accept the fact that the public has a right to be informed on issues in the public interest - and nuclear energy is one of these issues.
b) Some governments are less forthcoming than others; other governments go to very great lengths to provide information on nuclear power and opportunities to discuss the question.
c) Those who support the more forthcoming approach argue that the benefits of this policy outweigh the difficulties and costs of implementing it as well as the embarrassing lapses and failures which are sometimes uncovered by it.
d) There are clear advantages, if only from the standpoint of public acceptance, to consistent and decisive leadership on the nuclear issue on the part of governments.
e) The best advertisement for nuclear power is trouble-free operation. Governmental efforts to produce quality performance, when otherwise lacking, is a necessary ingredient.

f) There should be free and continuing international consultation on operating experience so that countries can share the experience of the large number of reactors now in operation.
g) International co-operation in reactor safety research and waste management should continue to be encouraged. Such co-operation in major aspects of the fuel cycle contributes to greater public confidence.

Conclusion

In the present harsh economic climate, there is an even greater incentive for reasoned and timely decision making on nuclear issues. Some governments have in the past been able, through a variety of techniques, to explain their decisions convincingly and thereby facilitate the public acceptance of nuclear power that is so crucial to its future progress. Nuclear's continuing economic and environmental advantages are the linchpins for such successes. Silence in the face of a divisive issue means that only one side of the argument will be heard. That there is an appropriate role for governments here is clear. That successful results can be obtained, notwithstanding the difficulties, is also clear.

NEA Estimates of Nuclear Power Capacity in OECD Countries to 2000 (October 1983)

The annual NEA Summary of Nuclear Power and Fuel Cycle Data was first published for general use in March this year and since then the estimates of Nuclear Power Capacity in OECD countries have been revised. Copies of the Summary are available, free of charge, from the NEA.

GWe

Country	1981	1982	1985	1990	1995	2000
Australia	0.0	0.0	0.0	0.0	0.0	0.0
Austria*	0.0	0.0	0.0	0.0	0.0	0.0
Belgium	1.7	3.5	5.5	5.5	5.5	5.5
Canada	5.25	7.0	10.1	13.9	15.6	17.3
Denmark	0.0	0.0	0.0	0.0	0.0	0.0
Finland	2.2	2.2	2.2	2.2	3.2	3.2
France	22.0	23.8	36.3	54.8	67.2	82.4
Germany, F.R.	9.9	9.9	16.5	23.1	28.2	30.0
Greece	0.0	0.0	0.0	0.0	0.0	1.0
Iceland	0.0	0.0	0.0	0.0	0.0	0.0
Ireland	0.0	0.0	0.0	0.0	0.0	0.0
Italy	1.3	1.3	1.3	3.3	13.3	17.5
Japan	15.5	17.3	25.7	35.0	49.0	70.0
Luxembourg	0.0	0.0	0.0	0.0	0.0	0.0
Netherlands	0.5	0.5	0.5	0.5	0.5	0.5
New Zealand	0.0	0.0	0.0	0.0	0.0	0.0
Norway	0.0	0.0	0.0	0.0	0.0	0.0
Portugal	0.0	0.0	0.0	0.0	1.0	2.9
Spain	2.0	2.0	4.7	6.7	9.0	13.0
Sweden	6.4	7.3	8.4	9.4	9.4	9.4
Switzerland	1.9	1.9	2.9	2.9	2.9	3.9
Turkey	0.0	0.0	0.0	0.0	1.0	3.0
U.K.	6.1	6.1	9.0	10.7	16.4	22.7
U.S.	5.2	63.7	80.3	114.0	122.7	130.0
OECD Total rounded	131	147	204	282	345	412

* Excluding Zwentendorf, 700 MWe.

New NEA Reports

Nuclear safety reports

Just before the summer break the NEA released two reports which are bound to have implications for nuclear safety research in two important areas: human reliability and fast breeder safety technology. A third report, on aspects of spent fuel transport, is to be released early next year.

Assessing Human Reliability in Nuclear Power Plants describes work carried out from 1978 to 1982 by the CSNI Group of Experts on Human Error Data and Assessment set up under the NEA Committee on the Safety of Nuclear Installations (CSNI). Over 31 experts from 11 countries and the Commission of the European Communities contributed to the several studies reported.

The Group's main aim was to study techniques for analysing human tasks in nuclear plants and for quantifying the importance of the errors that people occasionally make in performing them. The report proposes a classification scheme for systematic collection of human reliability data through incident reporting schemes, and discusses the use of control room simulators as a way of collecting this data.

Status of LMFBR Safety Technology - No. 3 Improving the Performance and Reliability of Protection and Shutdown Systems reviews the status of LMFBR protection and shutdown system performance and reliability. It describes the devices installed or planned for both existing and projected fast breeder reactors, and also highly innovative systems under development or consideration.

The report which was prepared for the NEA by the Commissariat à l'Energie Atomique (CEA) France, was published in June 1983. Among a number of conclusions is the view that LMFBR protection and shutdown systems may be considered to have reached a very high degree of reliability. Depending on the degree of fast breeder reactor development, the review suggests that in future it may no longer be necessary to take into account a Containment Design Accident resulting from complete failure of the shutdown system.

Standard Problem Exercise on Criticality Codes for Large Arrays of Packages of Fissile Materials which will be published on behalf of the NEA by the Oak Ridge National Laboratory in February 1984, presents the results obtained for large arrays of model fissile materials, packages and binary mixtures.

The report examines the accuracy of criticality computational methods for computing arrays of Class II fissile transport packages. These calculations are important in regulating international shipments of fuel cycle materials.

Copies of these nuclear safety reports are available only through official channels. Inquiries should be made to:

Nuclear Safety Division
OECD Nuclear Energy Agency
38 Boulevard Suchet
75016 Paris
France

New publication on electricity generation costs

A report entitled: "The Costs of Generating Electricity in Nuclear and Coal-fired Power Stations" will be published shortly by the OECD Nuclear Energy Agency.

Experts from twelve Member countries, the International Energy Agency (IEA), the International Atomic Energy Agency (IAEA) and the Commission of the European Communities (CEC) took part in the work of the group which produced the report.

This presents in simple terms the applied methodology, i.e., the lifetime discounted levelised cost method, and compares the cost of generating electricity in the participating countries. A comparison is made between nuclear and coal-fired power stations to be commissioned in the 1990s with common as well as national assumptions.

The main conclusion of the report is that no uniform set of data exists for nuclear and coal-fired power stations because assumptions on basic parameters differ from country to country. However, in spite of these differences, it is possible to show that nuclear energy is cheaper than coal in all participating countries except in some parts of the United States and Canada.

Uranium: resources, production and demand

Since 1965 the Agency has periodically published reports on uranium resources