



ACTIVITIES IN 1996



**Twenty-Fifth Annual Report
of the OECD Nuclear Energy Agency**

Paris 1997

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HIGHLIGHTS

ENLARGEMENT OF NEA MEMBERSHIP

On 27 June 1996, the OECD Council approved the membership of the Czech Republic and Hungary in the OECD Nuclear Energy Agency (NEA) and its Data Bank. The membership of these two countries brought the membership of the NEA to 27 and that of the Data Bank to 21.

This enlargement of the NEA was particularly significant as the Czech Republic and Hungary were the first countries from the former Soviet Bloc to join the Agency, and the first NEA Members whose nuclear power programmes involve only Soviet-designed reactors. The Czech Republic's nuclear power programme presently provides 20 per cent of the country's electricity. In Hungary the nuclear share reaches 41 per cent.

NUCLEAR DEVELOPMENT AND THE FUEL CYCLE

Although in 1996 nuclear power's share of total electricity generation in NEA Member countries remained stable at around 25 per cent, nuclear electricity generation in NEA countries, excluding the two new Members (the Czech Republic and Hungary), increased by about 3 per cent over 1995. This increase is the result, in part, of additional capacity connected to the grid in 1996, totalling 7.8 GWe. However, due to retiring capacity and an anticipated lower rate of capacity additions, the nuclear share of total electricity generation in NEA countries is expected to decline to about 22 per cent by the year 2010.

In the event that governments wish to mitigate the impact of energy supply and transformation on global climate change, it will be necessary to undertake a wide variety of measures. One option would be to increase reliance on nuclear energy. During 1996 (the Nuclear Energy Agency sponsored a study of the different options for nuclear power development that could be called for as part of a mitigation strategy, looking at the potential impediments to increased use of nuclear power. The study should help to promote an objective exchange of views on the extent to which nuclear energy could assist governments in addressing the issue of global climate change. Results from this work have been utilised in connection with the NEA's continuing co-operation with the International Energy Agency (IEA) and the OECD Environment Directorate.

For the nuclear option to continue to be available, one must ensure a sufficiently robust infrastructure of industry and services to support the safe and economic use of nuclear energy. Currently there are doubts as to whether enough effort is being put into updating facilities and transferring expertise and know-how to succeeding generations of designers, engineers and regulators. A number of studies focusing on particular aspects of this problem have been undertaken in various parts of the NEA. As part of its efforts to develop a framework to help identify further needs for specific studies and gauge the extent to which governments might be able to act to preserve options for the future, the NEA organised a workshop on infrastructure for nuclear energy deployment.

A current concern is the management of stocks of separated plutonium, Press and public attention has focused on the need to cope with excess plutonium from military use. Many of the technical developments for using separated plutonium in the civil nuclear industry would be applicable to ex-military plutonium, The NEA report on *Management of Separated Plutonium. The Technical Options* was made available to the participants in a meeting of the

G-7 nuclear safety group held in Paris in October, which was also attended by Belgium, Switzerland, Russia and the International Atomic Energy Agency (IAEA).

NUCLEAR SAFETY AND REGULATION

The NEA nuclear safety and regulation programme is intended to add value to the national programmes of its Member countries by bringing together the best experts to identify issues of current concern and develop common positions. In addition, safety-related operating experience is collected and analysed, and international research projects and studies are carried out, thereby maximising the contribution of each partner. In 1996, some 28 reports were issued and ten major workshops were held on a wide range of topics relevant to reactor safety and regulation. The workshops addressed issues such as the technical basis for licensing computer-based safety systems, safety issues relevant to fuel and control rods, the desirable attributes of future thermal hydraulic codes, and the implementation of hydrogen mitigation in nuclear containments.

The Committee on the Safety of Nuclear Installations (CSNI) issued a collective opinion on nuclear safety research and a group of senior experts formulated a number of recommendations on how to maintain capabilities and facilities in this field in the Member countries.

During 1996, the first large-scale test involving the melting of real core material and its interaction with the lower head of a reactor pressure vessel was performed successfully as part of the RASPLAV project.

RADIATION PROTECTION

Following the preparation of the *Basic Safety Standards for Protection against Ionising Radiation and the Safety of Radiation Sources*, jointly with other international organisations in 1996, the NEA contributed to the formulation of detailed guidance for the application of these international standards, and continued to provide a forum for the exchange of information and experience between national radiation protection authorities through its Committee on Radiation Protection and Public Health (CRPPH).

During 1996 work was initiated in a number of new areas including science and technology developments affecting radiation protection, particularly in radiobiology and dosimetry; societal aspects of radiation protection; and new approaches to the integrated management of risk. In addition to these new activities, the Agency continued to sponsor and co-ordinate the international Information System on Occupational Exposure (ISOE), whose membership and scope of activities continued to expand in 1996.

Finally, in the area of management of nuclear accidents, substantial progress was made in the organisation of the second phase of the International Nuclear Emergency Exercises (INEX); the first regional exercise of the INEX-2 series was held in Switzerland in 1996.

RADIOACTIVE WASTE MANAGEMENT

International co-operation plays a major role in the orientation of national strategies and R&D activities in the field of radioactive waste management, and the NEA is closely associated with many of these activities. In particular, the Agency continues to promote a broad debate on disposal strategies, integrating technical as well as non-technical aspects, in line with the agreed principles of ethics and environmental protection which are especially

relevant when considering long-lived waste disposal issues. Given the progress made in the gradual implementation of radioactive waste disposal systems, there is increasing emphasis on regulatory and licensing aspects, which concern not only the scientific community, but also policy-makers, local and regional authorities, and the general public.

On a more technical and scientific level, considerable R&D is being devoted to the safety and engineering aspects of deep underground repositories. The geological characteristics of potential disposal sites have to be evaluated in order to provide a firm basis for long-term safety studies, and geoscientists need to work with safety assessment specialists to prepare convincing "safety cases". A great deal of attention is therefore given to the integration of activities in various disciplines in order to build confidence in the long-term capacity of each specific disposal project to isolate radioactive waste from the biosphere, and to limit future risks to what could be acceptable to current generations. This is the ultimate objective of all NEA activities in the area of radioactive waste management.

NUCLEAR SCIENCE AND THE DATA BANK

In 1996, the Agency's Nuclear Science Committee (NSC) entered its fifth year of operation. Its programme has been developed during a period when Member country resources for research in nuclear science and technology have been severely reduced. These cuts have in many cases reduced the size of research groups to a level where the most effective use of resources lies in international collaboration. The NSC is ideally placed to choose research topics of interest to Member countries on the basis of consensus between scientific delegates influential in determining national programmes.

Two projects which were initiated in 1996 were Long-Term Irradiation of Materials, and Actinide Separation Chemistry, both of which resulted in publications. A new working party on nuclear criticality safety was formed to bring together different projects in this important area, while that on the physics of plutonium recycling completed a first cycle of "benchmark" calculation exercises. On-going, long-term projects are the development under quality assurance procedures of a new version of the JEF* evaluated nuclear reaction data library; to be known as JEFF-3, and the collection, compilation and verification of nuclear data and computer programs for nuclear technology. This information is made available directly to individual scientists and laboratories in Member countries.

The Internet offers the possibility of making scientific information available simply and rapidly with few restrictions. The Data Bank has now 1 000 accredited users authorised to download information from its Worldwide Web site. A total of 5.1 Gigabytes of information were retrieved via Internet in 1996.

*Joint Evaluated File

LEGAL AFFAIRS

NEA work in this area has concentrated on three principle areas: the modernisation of the international nuclear civil liability regime; the update of the Agency's study of the general regulatory and institutional framework for nuclear activities in OECD countries; and assistance in the development of nuclear legislation in Central and Eastern Europe, combining the direct provision of consulting services with training activities in nuclear law.

PUBLIC INFORMATION AND PUBLICATIONS

The NEA aims to serve as a reliable source of information available to national authorities, decision-makers and opinion leaders, and more generally, to the interested, non-specialist public.

In 1996, a large selection of scientific and technical publications was published, reflecting the entire scope of the NEA programme. As regards publications devoted to informing large sections of the public, preparations were completed for *Radiation in Perspective: Applications, Risks and Protection*. The NEA's best-seller for 1996 was *Informing the Public About Radioactive Waste Management*, a new report which summarises the findings of an international seminar on this subject.

RELATIONS WITH NON-MEMBER COUNTRIES

During 1996 the main focus of relations with non-member countries was again on Central and Eastern European countries (CEEC) and the New Independent States (NIS). Co-operation with these countries was mainly in the areas of nuclear safety and regulation, radiation protection and nuclear law.

Planning, development and execution of safety research programmes in CEEC/NIS benefitted from NEA assistance through the work of four support groups, which evaluated technical proposals, shared experience gained in Member countries, and arranged for training researchers. A major study on safety research needs of soviet-designed reactors was completed, leading to the identification of research topics which should receive priority over the next few years. This study will be published in 1997.

Several CEEC/NIS were involved in NEA work on nuclear emergency planning, preparedness and management. Seven of them participated in a regional emergency exercise organised by the NEA in which a nuclear plant in Switzerland was the site of a simulated accident.

Training activities in nuclear law for the benefit of CEEC/NIS continued, notably through the organisation of an international seminar in Romania. Assistance was provided to Belarus and the Ukraine in preparing their nuclear legislation, and international efforts to resolve liability issues raised by nuclear safety assistance programmes in CEEC/NIS were pursued.

I. TRENDS IN NUCLEAR POWER

NUCLEAR DEVELOPMENT AND THE FUEL CYCLE

The focus of nuclear construction activity continued to be in the Far East in 1996, accompanied by increasing indigenous capabilities to design and manufacture nuclear plants. A desire to secure energy supplies appears to be the driving force, a factor that is also evident in Turkey's decision to invite tenders for the construction of a nuclear power plant.

The short-term outlook for nuclear energy in most OECD countries continues to be dominated by the availability of adequate amounts of base-load generation and the low prices of fossil fuels. For countries that do not fear supply disruptions, there is currently little incentive to consider the longer-term picture and the possible role of nuclear energy in providing diversity and thus adding to security of supply.

In several countries the trend towards introducing more active competition into the electricity markets is seen as having a further dampening effect on the prospects for investment in nuclear power plants, as the returns take longer to materialise than in the case of fossil-fuelled plants. Nevertheless, the future for nuclear plants operating with high load factors and low operating costs should be secure for as long as plant life can be extended economically and in conformity with safety requirements. In recent years there have been significant improvements in the costs of nuclear-generated electricity arising in large part from increases in availability factors.

Where privatisation of the nuclear operating utility is at issue, the availability of funds to meet back-end and decommissioning liabilities continues to be debated. However, experience with decommissioning is growing, with evidence accumulating that dismantlement is not as costly as previously thought.

The front end of the nuclear fuel cycle is generally stable, with incremental process development. With the drawdown of uranium stockpiles over the last few years, some mining companies are preparing to expand operations, but for the moment there has been no sustained movement in spot prices for uranium. One of the factors brought into commercial calculations is the growing availability of mixed oxide (MOX) fuel from European fuel manufacturers.

A number of Member countries believe that in the long term, and perhaps in the medium term, there will need to be a resurgence of investment in nuclear power production, if only to help meet policy goals and commitments in relation to climate change. There has, however, been little debate at government level about the potential relevance of nuclear energy in preparation for the third Conference of Parties to the UN Framework Convention on Climate Change (FCCC).

The availability of the nuclear option in the longer term is, however, not to be taken for granted. There has been a continued decline in government expenditure on nuclear R&D, which has been rather more severe than for government expenditure on energy R&D in general. There is no evidence that the commercial sector is compensating by increasing its investment in nuclear energy research.

NUCLEAR SAFETY AND REGULATION

Although the safety performance of nuclear power plants operating in NEA Member countries continues to be satisfactory, there are several areas where additional work is needed and where international co-operation has been particularly productive. Areas of continuing interest include: the ageing of structures and components; the application of probabilistic techniques to nuclear plant licensing and operation; the safety margins of modern fuels - high burnup fuel in particular; safety criticality software; emergency preparedness; and accident management. In addition, issues such as maintaining capabilities and key experimental facilities, and the potential impact on safety culture from increased competition and industry restructuring are receiving increased attention.

The regulatory aspects of radioactive waste management, high-level waste in particular, are also the focus of intense international debate and activities.

RADIATION PROTECTION

The final publication, in 1996, of the new basic standards for radiation protection marked the beginning of a new phase of consolidation of radiation protection concepts and regulations. The international organisations involved initiated programmes for the preparation of detailed guidance for the practical application of the new standards, while Member countries began to prepare, issue or revise regulations to implement the international standards. The scientific debate concerning the validity and the limitations of the current epidemiological and theoretical base for the definition of radiation risk factors and the International Commission on Radiological Protection (ICRP) System of Radiological Protection continued in 1996. New data generated by the epidemiological study of Hiroshima and Nagasaki survivors appeared to support the hypothesis of the linear, no-threshold, dose-effect relationship adopted by the United Nations Scientific Committee on the Effects of Atomic Radiations (UNSCEAR), the ICRP and other international organisations as the basis for the current regime of radiation protection.

The tenth anniversary of the Chernobyl accident gave rise to a number of important international meetings to review its consequences. At these meetings the results of the large number of studies on the radiological, health, psychological and socio-economic impacts of the accident, organised by national and international organisations, were integrated to provide a coherent picture of the situation. It was confirmed that the negative impacts of the Chernobyl accident are far from eliminated, that affected populations are still subject to harmful health effects and psychological stress, and that the authorities of the countries concerned still must deal with social and economic difficulties.

RADIOACTIVE WASTE MANAGEMENT

National programmes in the field of radioactive waste management continued to be characterised by careful, step-by-step progress in the further development and implementation of disposal systems. As a result of increasingly open discussions involving the scientific community, represented by the agencies responsible for the implementation of disposal solutions, and by regulatory authorities, policy-makers and the general public, progress was made in many technical and non-technical areas. Indeed, radioactive waste management issues need to be addressed from a broad perspective, taking full account of socio-political issues. In fact, public or parliamentary debates are currently taking place in

several countries, with a view to defining acceptable, long-term disposal strategies, integrating the protection of the public and the environment and other associated concerns. This is the case, notably, in Canada and the United Kingdom, where the results of such consultations are expected to be available in 1997. In several other countries, activities related to the identification and selection of potential disposal sites have encountered a number of difficulties arising from political and public acceptance issues. On the other hand, from a technical, safety perspective, specialists have increasing confidence in their ability to design and construct containment facilities for long-lived radioactive waste capable of meeting extremely stringent standards.

NUCLEAR SCIENCE AND THE DATA BANK

The general trend of decreasing resources for nuclear R&D continued in 1996 in most of the NEA Member countries. However, a large number of these countries have recognised the interest of keeping the nuclear option open to meet more general goals, such as security of energy supply and preservation of the environment. Therefore, the challenge will be to maintain a sufficient nuclear R&D infrastructure with less public and private funds available. In many areas of nuclear science, this challenge is met through enhanced co-operation between countries, especially within an international framework such as the NEA.

In this context, Member countries have expressed needs for the documentation of existing scientific knowledge and for safeguarding it, as well as for the development of internationally validated calculation tools in the field of nuclear science. Consequently, the NEA science section has, in close co-operation with the NEA Data Bank, enhanced its efforts to develop and maintain internationally agreed reference databases, for example in the fields of nuclear fuel performance, criticality safety and radiation shielding. These databases are widely used to validate commonly used and newly developed computer codes in international comparison exercises, conducted within the NEA science programme.

In addition to the traditional reactor physics part of the NEA Nuclear Science programme, Member countries have shown an increased interest in nuclear fuel cycle physics and chemistry, materials science and criticality safety activities. The corresponding applications areas are related to the management of the nuclear fuel cycle (high burnup fuel, new fuel concepts and actinide separation), to lifetime extension of nuclear power plants and to the storage and transport of spent fuel.

LEGAL AFFAIRS

The past year was marked by the intensification of efforts aimed at completing negotiations on the revision of the Vienna Convention on nuclear civil liability, and a new global convention on supplementary funding for the compensation of nuclear damage, with public financing. The NEA and its Member countries were active participants in this work, which will ultimately require a revision of the Paris Convention, as well as a re-examination of the Brussels Supplementary Convention. The other important trend was the reinforcement of the institutional and legislative framework for the peaceful use of nuclear energy in Central and Eastern European countries and the New Independent States. These activities were aimed at achieving wider participation by these countries in international nuclear law conventions, as well as their adoption of modern domestic legislation.

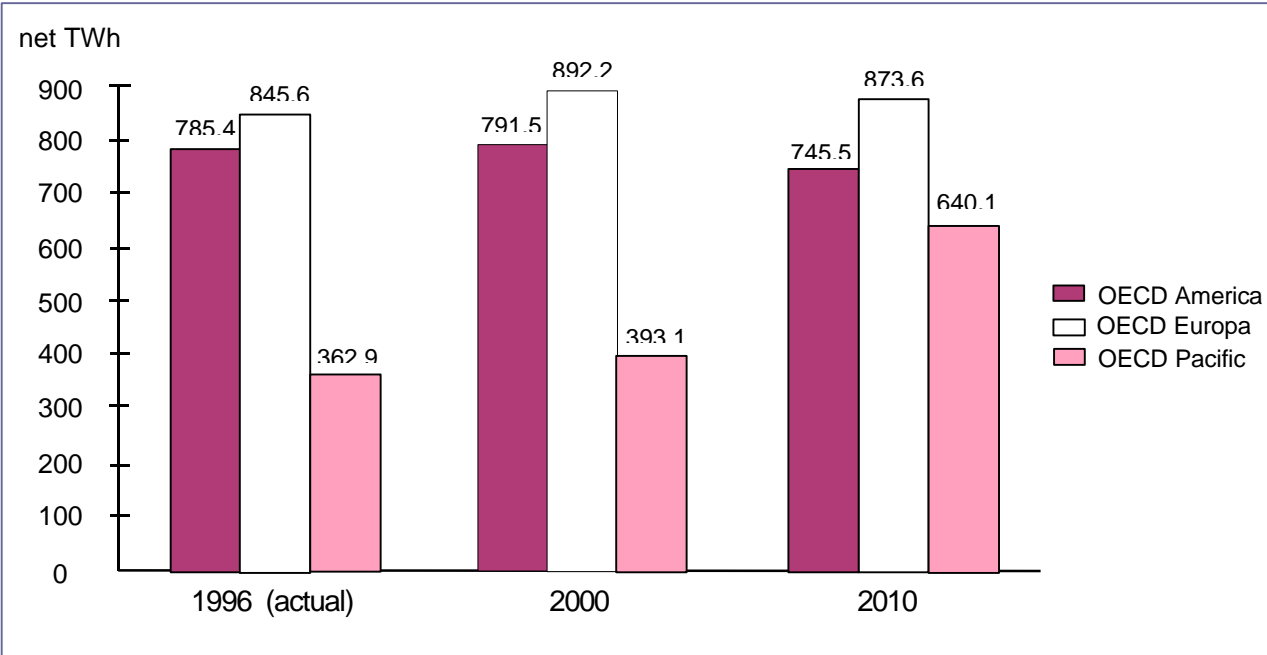
II. NUCLEAR DEVELOPMENT AND THE FUEL CYCLE

DATA, TOOLS AND METHODOLOGIES

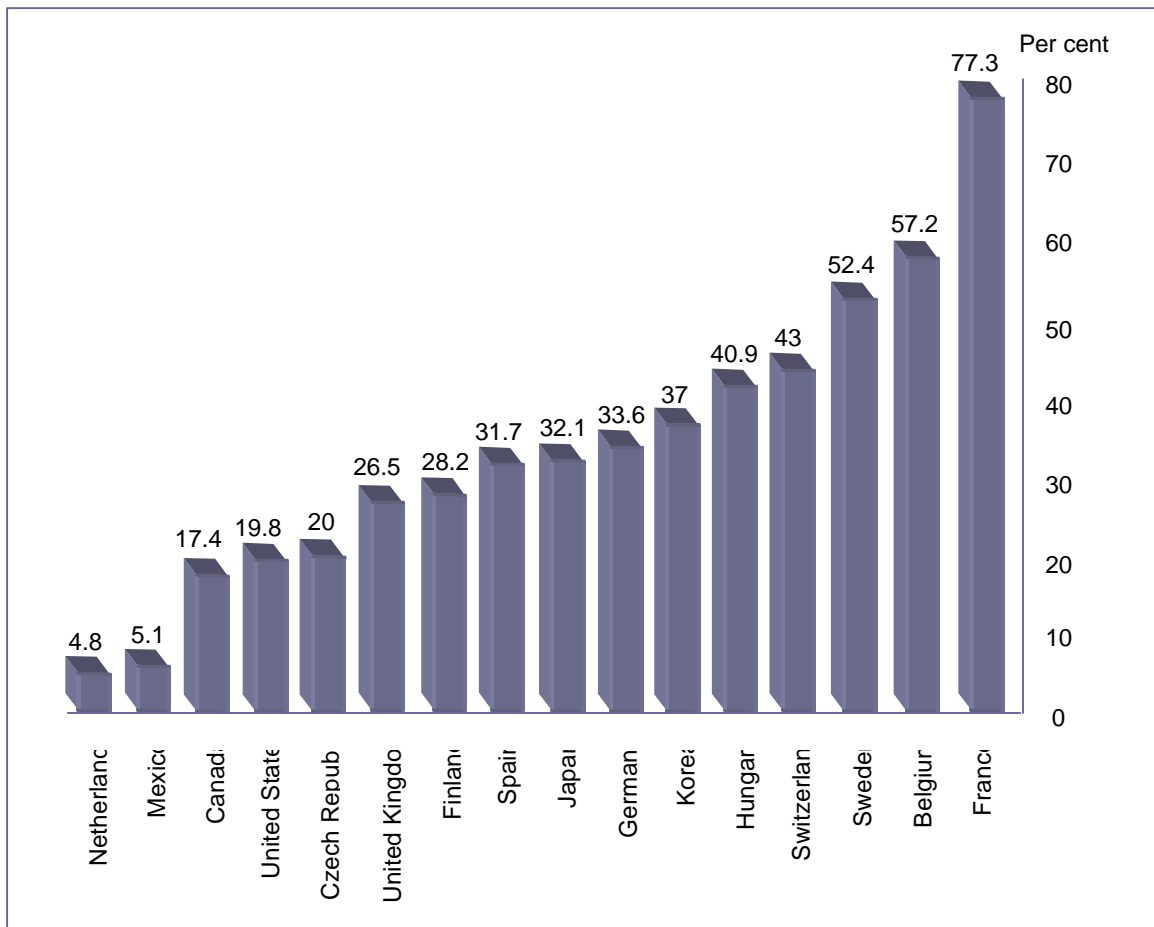
OECD Nuclear Data

The NEA collects and publishes data annually on nuclear power and the fuel cycle in Member countries. The report entitled OECD Nuclear Data, also known as the “Brown Book”, contains historical data and estimates of nuclear power capacity, electricity generation and fuel cycle supply and demand in Member countries for the period up to 2015. For the first time, the “Brown Book” contained data on the Czech Republic and Hungary, which joined the NEA in May 1996. At the end of 1996, the total capacity provided by the 357 reactors now installed in Member countries was 297.5 gigawatts (GWe), Another 14 reactors totalling 14.6 GWe were under construction and four reactors totalling 3.9 GWe were firmly committed. The total capacity of nuclear power plants in the year 2000 and 2010 is projected to be 306.5 and 331.9 GWe, respectively. The 1.7 GWe of capacity that is expected to be retired by the year 2000 is already deducted from these projections.

**Nuclear Power Production
In the OECD Area (1996-2010)**



Nuclear Power Share of Total Electricity Production in the OECD Area (1996)



Uranium: Resources, Production and Demand

NEA activities in the field of uranium continued in 1996 with the publication of *Uranium 1995: Resources, Production and Demand*, and the reconstitution of the joint NEA-IAEA Uranium Group. The latest update of the uranium publication, also known as the “Red Book”, contains statistical data and trend analysis in the field of uranium geology, exploration, production, and demand for 54 countries. In addition, the report presents worldwide projections on nuclear electricity generation, uranium requirements and uranium production capacity, as well as an analysis of supply and demand in the short and medium terms. It points out that low production levels and inventory drawdowns experienced in the last few years might reverse the over-supply market conditions and induce not only a price increase, but also a revival of production activities. On the other hand, the report stresses that the increasing availability of new sources from countries of the former Soviet Union, and from the dismantling of nuclear weapons, might limit the possibility of a uranium market recovery in the short term.

The October 1996 meeting of the Uranium Group represented the first official convening of the reconstituted joint NEA-IAEA Uranium Group. The reconstitution of the group illustrates the strengthening of the co-operation between the two agencies, both in research activities and in the preparation of publications such as the “Red Book”. The meeting included 36 participants from 24 countries. The participation of experts from all interested

countries in future meetings of a fully integrated Uranium Group will ensure the broadening of the scope of information collected and analysed, and will facilitate exchanges of know-how between NEA Member and non-member countries.

Assessment of the Economic Consequences of Nuclear Reactor Accidents

Estimates in past studies of external costs of severe nuclear accidents indicate that for Western plants, in general, severe accidents contribute only a relatively small amount to the external costs of nuclear power. However, such studies show large discrepancies and are often considered controversial. One source of the large differences in the cost estimates is that the risks are strongly plant and site-specific; but even allowing for this factor there are relatively large differences between the various published applications.

In taking decisions on the management of the consequences of any future severe accident with off-site consequences, it would be useful to have a more precise and detailed evaluation of the economic consequences stemming from such decisions. Certain accident cost elements need to be better assessed, In this connection, one element of particular concern is health effects, the costs of which are dominant in the case of large accidents with long-term impacts. More effort is needed to develop existing accident assessment codes so as to integrate medium and long-term impacts at the macro-economic level.

The calculation of external costs associated with rare severe accidents requires some input from probabilistic safety assessment (PSA). However, the extent to which the PSA results have been used and the consistency of the application have varied significantly, and a number of limitations to currently applied methodologies have been identified. In addition to certain limitations, PSA techniques are mainly associated with relatively primitive economic models and a lack of consensus on a possible role of risk aversion.

Global Climate Change

The NEA is carrying out a study on the impact on nuclear policies of environmental concerns and especially climate change risks. This study will use analysis, carried out in co-operation with the International Atomic Energy Agency (IAEA), of the nuclear component of energy demand/supply scenarios that have been published by other international organisations. A projection of nuclear capacity and electricity generation in OECD countries and worldwide up to 2050 will be completed in the first quarter of 1997. The opportunities and challenges that the implementation of nuclear programmes will raise for governments and nuclear industries will be investigated.

The NEA participated in the OECD Forum on Climate Change and Energy organised by the Environment Directorate with the support of the International Energy Agency (IEA). It was noted that the "Climate Technology Inventory" developed by the IEA in the context of the Framework Convention on Climate Change (FCCC) did not include nuclear technologies. Based on its previous studies, the NEA is drawing up an inventory of actions, strategies and policies of governments and the nuclear industry in OECD countries that aim to preserve nuclear energy as an option for providing electricity. This inventory will be used in assessing the scenarios of the NEA and other institutions for the future use of nuclear energy, but could be adapted to complement IEA input to the FCCC.

The NEA participated in the review of the summary for policy-makers of the *Second Assessment Report* of the Intergovernmental Panel on Climate Change (IPCC) that was prepared by the IPCC Secretariat. This summary points out the potential role of nuclear power in alleviating the risk of global climate change.

Projected Costs of Generating Electricity

The fifth study on the projected costs of generating electricity was initiated in October. Like its predecessors, this study is being carried out jointly with the IEA, and in co-operation with the IAEA and the International Union of Producers and Distributors of Electrical Energy (UNIPEDE). At its first meeting, an expert group discussed and agreed upon the objectives, scope and table of contents of the report, which is expected to be published by the end of 1997. A questionnaire on the projected costs of generating electricity by power plants to be commissioned by 2005-2010 was sent to representatives of OECD countries, and to experts from non-OECD countries invited by the IAEA to participate in the study. The study will address specific issues which define the new economic landscape within which electricity policies are being designed, such as deregulation and privatisation of the electricity sector, globalisation of the world economy and growing environmental concerns.

THE NUCLEAR INDUSTRY AND ITS CONTEXT

Plant Life Management

Plant life management (PLIM) is becoming an increasingly prominent issue as plants get older, and as the prospects for opening new sites are poor. Understandably, there is concern about both the technical and the safety aspects of this issue. However, the approach developed under the NEA Nuclear Development Committee (NDC) was to analyse the issue as related to business decisions driven by economics. The NEA Secretariat undertook a preliminary analysis of experience in major refurbishment costs at nuclear power plants as an aid to gauging the outlook for extending plant life, and hence the available nuclear capacity early in the next century.

The preparation of a glossary of PLIM terminology in five languages (English, French, German, Spanish and Russian) is nearly complete. The Agency benefited from co-operation with the Electric Power Research Institute (EPRI), the Commission of the European Communities (CEC) and the IAEA.

Nuclear Infrastructure

Nuclear power programmes in most NEA Member countries are no longer expanding, which has resulted in less procurement from utilities, and also a reduction in nuclear research activities. Questions have been raised as to whether these trends could limit the possibility of an expanded nuclear construction programme early in the next century. This problem could affect not only the nuclear industry, but also research institutes and regulatory bodies that ensure nuclear safety. Furthermore, all sectors of the nuclear community could be affected by reductions in the supply of appropriately educated graduates.

In order to explore the substance of these concerns, and potential roles for governments in responding to them, the NEA held an international workshop on infrastructure for nuclear energy deployment, in June 1996 in Paris. It was generally agreed that there were grounds for concern, even if it was not possible to identify threshold levels for infrastructure below which future nuclear programmes might be in jeopardy. A number of actions have already been undertaken by governments and industry in order to maintain some elements of the infrastructure. The NEA was encouraged to continue working on this topic, with the aim of clarifying concerns and suggesting areas of responsibility for government and industry.

Beneficial Use of Isotopes

The NEA undertook a study on the role of governments in the production and supply of isotopes for various applications in medicine, industry and agriculture. This study is being carried out in co-operation with the IAEA. A questionnaire on isotope production capabilities, and issues related to the support of those facilities by governments has been sent to both OECD Member countries and non-member countries through the IAEA Secretariat. The results will be compiled and analysed in 1997.

Economic Analysis of Repositories for Low-Level Radioactive Waste

In some Member countries, low-level radioactive waste (LLW) repositories have been operated for a considerable period of time. In addition to wastes generated by the daily operation of nuclear power plants, the increasing numbers of ageing nuclear plants will result in a growing amount of low-level waste from their refurbishment and/or decommissioning. Although the cost of LLW disposal is generally a small part of the total cost of nuclear power generation, the total costs of investment in, and operation of, repositories, together with long-term surveillance, are by no means small. The NEA's analysis of the cost elements, which are affected by the different types, sizes and geological conditions of the repositories, aims to provide a better understanding of these factors as one step toward reducing costs.

THE FUEL CYCLE

Nuclear Power Development and Fuel Cycle Strategies

The NEA participated in the preparation of an international symposium on nuclear reactor and fuel cycle strategies to be organised by the IAEA in 1997. Drawing from its background expertise and on-going studies, the NEA Secretariat has contributed to key issues papers that will be presented at the symposium, covering current and potential technologies for the use or disposal of separated plutonium, and a range of scenarios for the deployment of nuclear electricity generation.

Plutonium

One of the traditional tasks of the NDC has been to study the choice of fuel cycles, the technologies associated with them, and their economics, including, among others, plutonium recycling aspects.

Past NEA work on plutonium has targeted mainly the economic and scientific issues, and the need to identify suitable technical solutions, despite the political uncertainties associated with their implementation. It has also addressed questions influencing the choice of fuel options and illustrated how economic and logistic assessments of the alternatives could be undertaken.

National programmes and policies concerning the civil use of plutonium are quite diverse, being influenced by a number of complex factors and by different evaluations of the benefits arising from plutonium, seen as a quasi-indigenous energy source. In any case, the management of plutonium, including any that may become available from retired nuclear weapons, is of great interest to governments and the public alike. Moreover, interest on the

part of governments does not depend on their having separated plutonium in stock or, indeed, any intention of using plutonium.

In early 1994, the NEA assembled an international ad hoc expert group, with membership drawn from fifteen OECD countries, the Russian Federation and three international organisations, with the task of identifying, reviewing and evaluating the broad technical questions related to plutonium management. The expert group was concerned with the technical options for managing civil plutonium, including any that may become available from ex-military uses, and their work, which has now been completed, focused on the following two topics:

- Existing technologies related to medium-term storage of plutonium or plutonium recycling in reactors. Experience gained from them was reviewed and their potential deployment over the next twenty years or so was examined.
- Other technologies may become available in the longer term. A technical review was made of these additional options.

Partitioning and Transmutation

The NEA has been involved, since 1989, in various activities concerning actinide and fission product partitioning and transmutation (P&T), and has provided a forum for technical discussions on such activities and national programmes.

Although during the last few years interest in P&T has grown in a number of countries, it cannot be seen as an alternative to the established policies concerning the back-end of the fuel cycle. The NEA has stressed that P&T requires long-term scientific and technological development, and international co-operation is therefore essential in order to facilitate progress, guarantee the quality of the results, and ensure proper co-ordination and optimal resource utilisation.

Under the aegis of the NDC and the guidance of liaison officers nominated by Member countries, three international information exchange meetings were previously held: at Mito City (Japan), Argonne National Laboratory (United States) and Cadarache (France) in 1990, 1992 and 1994, respectively. The fourth NEA exchange meeting was hosted by Japan's Science and Technology Agency (STA), the Japan Atomic Energy Research Institute (JAERI), the Power Reactor and Nuclear Fuel Development Corporation (PNC), and the Central Research Institute of the Electric Power Industry (CRIEPI) in Mito City, Japan, in September 1996. More than 100 participants from 11 countries, together with Russia, the IAEA and the CEC attended the meeting, which, like the previous one held in Cadarache, primarily focused on P&T strategic systems studies. A total of 40 papers was presented.

This meeting provided further insight into, and basic elements for pursuing comparative studies on, the overall balance of costs and benefits of adding P&T to the nuclear fuel cycle. Work presented constituted valuable input to the activities of the newly formed NEA P&T Expert Group, which has been set up to bring together what has been achieved in national research programmes and, in particular, by P&T systems studies.

ENERGY POLICY REVIEWS

Members of the Secretariat took part in IEA in-depth reviews of energy policy, and assisted the IEA in preparing reports on Belgium, Canada, Sweden and the Ukraine.

III. REACTOR SAFETY AND REGULATION

NUCLEAR SAFETY RESEARCH

The aim of nuclear safety research is to provide information to plant designers, operators and regulators to assist in the resolution of safety issues, and also to anticipate problems of potential significance. A report completed in 1995 showed that, although the safety level of nuclear power plants in Member countries is fully satisfactory and the basic technologies necessary to resolve safety issues have advanced considerably, the international community believes that there is the potential for further improvement, and that continued safety research work is necessary to address many of these concerns and to support the safe operation of nuclear power plants.

In this connection, the NEA Committee on the Safety of Nuclear Installations (CSNI) noted in a collective opinion issued in 1996 that the funding levels of government safety research programmes have been reduced during recent years in several Member countries. It stressed that care is needed to ensure that this funding reduction does not have an adverse impact on the ability of government agencies to fulfil their safety responsibilities. Moreover, the Committee expressed concern about the ability of Member countries to sustain an adequate level of nuclear safety research, notwithstanding the international consensus on research needs and objectives.

In particular, the Committee expressed concern with regard to the lack of international support for important new experimental facilities at a time when existing facilities are being decommissioned and their experienced research teams disbanded. It emphasised that the untimely shutdown of large facilities and the break-up of experienced research and analytical teams inevitably leads to a loss of competence, and a reduced ability to deal quickly and efficiently with future safety problems. The lack of large research facilities will make it more difficult to understand complex severe accident phenomena, to verify and validate computer codes, to clarify uncertainties, and to demonstrate the validity of severe accident management strategies. In turn, there will be an adverse impact on the ability to regulate and support operating reactors and the development of new designs adequately.

Following completion of the 1995 report, a group of senior experts reflected further on the issues of nuclear research capability and facilities and proposed practical means to address the concerns; their findings are to be published in a report entitled *Nuclear Safety Research in OECD Countries: Capabilities and Facilities*. In general terms, and with respect to current needs, technical programmes and facilities exist, or are planned, which will meet the majority of the research needs identified in previous reviews. In most areas, however, some additional effort appears to be justified. Co-operative programmes are not likely to be able to meet Member countries' immediate needs for safety research; it should therefore be the responsibility of each country to adequately support its own short-term needs.

The experts also evaluated longer-term research needs, and identified specific areas and facilities able to meet those needs. The conclusion was that there is potential for useful long-term international co-operation in many of these areas. It was recommended that the CSNI take a pro-active role in organising and implementing co-operative projects to provide key safety-related facilities in the future.

OPERATING EXPERIENCE AND HUMAN FACTORS

The agreement reached in 1995 between the NEA and the IAEA for joint management of the Incident Reporting System (IRS) has, so far, met the expectations of NEA Member countries. A joint guidelines document is being prepared, and increased emphasis will be placed on reporting the human-factor aspects of incidents.

During 1996 a study on undetected failures of safety-related systems was completed. A survey of operating experience indicates that a significant number of latent failures remained undetected during long periods of commercial operation due to deficiencies in the quality control during design, and in the surveillance procedures during operation. The study provides guidance on how to implement corrective and preventive actions. Studies are also being conducted on the role of simulators in operator training, on operating experience with computer-based systems, and on equipment requalification following an outage.

ACCIDENT PREVENTION ACTIVITIES

Accident prevention continued to receive considerable attention and resources in 1996. Activities were carried out in the area of core degradation phenomena, in the application and further development of thermal-hydraulic codes, and in the area of fuel behaviour.

A status report on the rapid cooling of a degraded core has been finalised and several activities aimed at better understanding and modelling the mechanisms related to fuel-coolant interaction have continued. The latter activities will culminate in a major specialist meeting, to be held in Japan in 1997.

With respect to thermal-hydraulic codes and their application, activities carried out include the use of "best estimate" methods, comparison of methods to quantify uncertainties and development of possible procedures to control and minimise the "user effect". A workshop was organised to review the state of the art on thermal-hydraulic and neutronic codes and to develop the desirable attributes of future codes.

An ad hoc group reviewed the issue of accident behaviour of high burnup fuel and recommended the establishment of an international project to carry out tests aimed at achieving a better understanding of the behaviour of reactor fuel when subjected to rapid power transients.

SEVERE ACCIDENT PHENOMENOLOGY AND MANAGEMENT

The overall objective of severe accident management is to reduce the risk of large radioactive releases from a nuclear power plant damaged by such an accident. It consists of those actions that are taken by the plant staff during the course of an accident to prevent damage to the reactor core, terminate progress of core damage and retain the core within the vessel, maintain integrity of the containment, and minimise off-site releases. It also involves pre-planning and preparatory measures, guidelines and procedures, equipment modifications to facilitate implementation and severe accident training.

New initiatives are being taken in several Member countries to implement hydrogen mitigation measures in large, dry, pressurised water reactor containment. The NEA organised a workshop on the implementation of hydrogen mitigation techniques in Winnipeg, Manitoba, Canada. The workshop demonstrated support for the installation of passive

autocatalytic recombines, possibly supplemented by other measures (igniters or post-accident dilution).

A workshop on the chemistry of iodine in reactor safety was held in Würenlingen, Switzerland. Substantial progress has been made in this area in the last few years, and although additional research is still needed, it has now become possible to prioritise remaining issues that have an impact on accident management strategies.

Work has progressed in several areas where more information is necessary to define accident management guidelines and procedures. These areas include the ex-vessel coolability of molten core debris, as well as the control of iodine, cesium, strontium and other fission products in the containment during a severe accident.

A state-of-the-art report on *High-Pressure Melt Ejection and Direct Containment Heating* was completed. It showed that the level of knowledge is extensive in this area and covers those essential elements of the accident sequence and inherent physical phenomena that could limit the containment loads, the combination of which is necessary to provide the defence-in-depth background knowledge needed to resolve issues. Substantial progress has been made on the preparation of another report on *Containment Thermal Hydraulics and Hydrogen Distribution*.

International Standard Problem (ISP) exercises have continued to be one of the key components of the programme of work concerning severe accidents. An ISP exercise based on the German experiment VANAM M3 on the coupling of thermal-hydraulic and aerosol behaviour in a reactor containment was completed. It demonstrated that the computer codes compared in the exercise could calculate the general thermal-hydraulic behaviour with sufficient accuracy. However, it would be desirable to improve accuracies both in experiments and calculations, with respect to aerosol behaviour.

AGEING AND STRUCTURAL INTEGRITY

In the area of structural integrity, the scope of activities was widened and more emphasis was put on ageing. Previously only steel structures had been considered, but new groups were set up to study the ageing of concrete structures (primarily, but not exclusively, the containment), and the seismic behaviour of structures.

A workshop was held on probabilistic structural integrity analysis and its relationship to deterministic analysis, which was a continuation of previous activities on metal components. The main themes of this meeting were probabilistic fracture mechanics, risk-based in-service inspection, and the relationship of integrity analysis and probabilistic safety assessment (PSA). The second phase of the Fracture Analysis of Large-Scale International Reference Experiments (FALSIRE) project was completed, and the final comparison report issued. A continuation project was started, combining the thermal-hydraulic and mechanical analysis aspects. This project is purely analytical, involving the analysis of a reactor pressure vessel (RPV) nozzle under thermal shock conditions. An exercise on fatigue crack growth was also started. Work continued to complete the steam generator tube inspection action of Plate Inspection Steering Committee (PISC III), the last action remaining.

In the area of concrete structures, work began on highest priority proposals contained in a 1995 report, including specific issues of concern to containment integrity, and non-destructive examination of thick or inaccessible sections. In the area of seismic behaviour of structures, an analogous status report was prepared and issued, with proposals for a future programme of work in the area. Piping analysis and design, and engineering characterisation of seismic input were identified as particularly timely topics, with ageing effects, validation of analysis methods and re-evaluation of existing facilities and assessment beyond the design

basis also being identified as high priority issues, An International Standard Problem exercise analysing a seismic, shear-wall model was completed, and the comparison report issued. This exercise attracted wide participation.

PROBABILISTIC SAFETY ASSESSMENT

The application of probabilistic safety assessments (PSAS) to the resolution of safety issues is increasing. Extending the use of PSAS to decision-making intensifies the need for consistency of methods and data. Both the CSNI and the Committee on Nuclear Regulatory Activities (CNRA) continue to be very active in the area of PSA.

Specific PSA issues such as treatment of human interaction and methodology for PSA level 2 were pursued. A review of plant modifications, the need for which was identified as a result of PSA, was completed. In addition, major studies were undertaken on fire risk analysis and on human reliability, concentrating on the potential causes and consequences of errors of commission. An ad hoc group collected and analysed data on the application of PSA to the regulatory process in preparation of a special discussion which will take place in the CNRA in 1997.

FUEL CYCLE SAFETY

The nuclear fuel cycle covers the procurement and preparation of nuclear fuel for nuclear power reactors, its recovery and recycling after use, and the safe storage of all waste generated through these operations. During the past year discussions continued on safety research programmes being performed in Member countries. A working group will be formed to identify issues related to such programmes and to facilitate awareness of existing and future programmes.

Operation of the Fuel Incident and Notification Analysis System (FINAS) continued to expand during the year as more reports were received from nuclear fuel cycle facilities, and further development of the database is planned to make possible better analysis of lessons learned. A topical meeting is being planned for the coming year which will consider safety in intermediate storage facilities.

INSPECTION PRACTICES

The working group on regulatory inspection practices, which provides a forum for exchanging information and experience on safety inspection practices in Member countries, met twice in 1996.

An international workshop on regulatory inspection practices related to inspection planning, plant maintenance and assessment of safety, was held in 1996, Inspectors from NEA Member countries and from non-member countries met and exchanged information on these topics.

As part of an ongoing effort relative to methods for evaluating the safety performance of licensees, two studies are under way to review the application of performance indicators and on combining individual assessments in inspection findings, Work also continued in the area of inspection of fuel and core management practices and on-site emergency preparedness at nuclear power plants. Another study is being prepared on inspection practices in relation to control room operators.

Work on an expanded and updated report on inspection practices and philosophy is nearing completion. This report provides descriptions of different inspection practices, as well as the organisational setup and basic inspection philosophies of regulatory bodies and organisations in both NEA Member and non-member countries.

IV. RADIATION PROTECTION

As a follow-up to its substantial contribution to the development of international radiation protection recommendations, the NEA Committee on Radiation Protection and Public Health (CRPPH) focused in 1996 on the preparation of guidance for the application of specific aspects of the new standards in areas such as the control of potential exposures and the use of dose constraints. The Committee also began to focus on the study of new scientific and policy developments which may lead to novel regulatory and operational approaches to radiation protection. Finally, the CRPPH continued its traditional role of being a forum for the exchange of information and experience between national authorities as well as on-going programmes on the optimisation of occupational radiation protection (the ISOE Programme) and the assessment and management of the consequences of nuclear accidents (the INEX Programmes).

RADIATION PROTECTION POLICY AND DEVELOPMENTS

The completion, in 1994, of the *Basic Safety Standards for Protection against Ionising Radiation and the Safety of Radiation Sources* (BSS), gave way to a new phase, namely the preparation of detailed guidance to assist Member countries in their concrete application. The IAEA took the major burden of this responsibility by launching a broad programme of safety guides addressing specific aspects of the BSS. As part of its traditional function of generating authoritative reference documents on issues of interest to Member countries, the NEA provided guidance on a particularly sensitive issue introduced by the BSS, namely, the criteria for interpreting and using the new concepts of potential exposure and dose constraints. Expert group reports on these two concepts were published in December 1995 and May 1996 respectively.

The other major activity of the CRPPH in 1996 was the initiation of work on emerging issues of concern to the international radiation protection community and national authorities that could have a significant impact on the practice and the regulation of radiation protection. As a first step, the CRPPH developed a “monitoring” function for scientific and technological developments, and other events and trends which may affect radiation protection, in order to be able to give an early warning to national authorities of the potential implications of these developments for their practices and regulatory approaches. This monitoring function was entrusted to a new Working Group on Science and Technology Affecting Radiation Protection, which started its work in the autumn of 1996.

Moreover, in its review of forthcoming issues and challenges, the CRPPH had also specifically identified two areas where problems were already being experienced. First, there was a growing understanding that societal factors and public concerns needed to be integrated into the decision-making process concerning major radiation protection and safety issues, particularly with respect to radioactive waste disposal and the management of the consequences of nuclear accidents. A Working Group on Societal Aspects of Radiation Protection was set up to study these problems. The second area where new work was initiated concerns the problems that national authorities are increasingly experiencing when they have to establish criteria for balanced management of the large variety of today's technological risks. The new Working Group on Integrated Risk Management, constituted in the autumn of 1996, initiated a study on the ways and means to address the need for “global” optimisation of radiation protection and for an integrated approach to the management of radiological risks in the context of technological risks in general.

PROTECTION OF WORKERS

Throughout the world, occupational exposures at nuclear power plants have been steadily decreasing over the past decade. This trend is partly due to regulatory pressures arising from the issuance of ICRP Publication 60 in 1991, the BSS, and the European Union's Council Directive on the Basic Safety Standards for the Protection of the Health of Workers and the General Public Against the Dangers Arising from Ionizing Radiation in 1996. It is also due to technological advances, improved plant designs, and improved water chemistry and plant operational procedures, as well as other factors. However, with the ageing of the world's nuclear power plants, it will become more difficult to maintain occupational exposures at today's levels, in spite of compliance with the principle of optimisation. In addition, economic pressures have led plant managers to streamline refueling and maintenance operations as much as possible, thus adding scheduling and budgetary pressure to the task of reducing operational exposures.

The NEA prepared a good practice manual for the application of work management concepts in the nuclear industry (see Chapter IX). Such concepts make it possible to reduce the number of hours of work, and thus to reduce occupational exposures, as well as to reduce costs.

INTERNATIONAL EMERGENCY EXERCISES

During 1996 the INEX 2 series of regional nuclear emergency exercises began. The results and lessons learned from the previous international exercise, INEX 1, and its three follow-up, NEA-sponsored workshops (Short-Term Countermeasures, 1994; Agricultural Aspects of Radiological and/or Nuclear Emergency Situations, 1995; and Emergency Data Management, 1995) contributed to the development of INEX 2, which is a series of regional command-post exercises, taking place between 1996 and 1998, and involving simultaneous, real-time participation of many countries.

The structure of INEX 2 for each regional exercise is based on an "accident-host" country which will superimpose the INEX 2 objectives and requirements on a previously planned and scheduled national-level command-post exercise. Bordering countries participate simultaneously, activating their own emergency command posts and utilising existing bilateral and multilateral notification and communication agreements, including agreements sponsored by the IAEA and the CEC, to receive and transmit information. Countries not bordering the accident host ("far-field countries") also participate simultaneously, either with full or partial command-post exercises. Each exercise lasts one day, and only the pre-release, release and immediate post-release phases are addressed. The World Meteorological Organisation also participates, in real-time, supplying weather information and predicted radioactive release plume trajectories.

Currently, four regional INEX 2 exercises are scheduled. The first, in Switzerland, took place in November 1996. Others will follow in Finland (April 1997), Canada (April 1998) and Hungary (summer/fall 1998). The INEX 2 Programme has received wide support. A total of 30 countries participated in the Swiss regional INEX 2 exercise and 28 were scheduled to participate in the Finnish exercise. Because INEX 2 will be repeated in several regions, countries may choose to participate in the exercise in more than one region, playing "accident-host country", "border country", or "far-field country", depending upon their geographical relationship to the accident-host country.

The objectives of the INEX 2 series of exercises are expected to evolve somewhat with experience, but initially INEX 2 is focusing on real-time exchange of information, decision-making based on uncertain plant conditions, and communications with the public and media.

V. RADIOACTIVE WASTE MANAGEMENT

Radioactive waste management is a key and controversial aspect of nuclear power. The NEA contributes to promoting a broad approach internationally to this topic, through systematic exchanges of information and experience, the definition of safe disposal policies, the analysis of R&D results, the integration of technical and non-technical aspects in repository concepts in line with environmental and ethical principles, and international peer reviews of specific elements of national programmes. Most of these activities are focused on the disposal of long-lived radioactive waste, which remains a major challenge due to the need to ensure its safe containment for unusually long time periods.

THE GENERAL STRATEGIES

The most favoured approach among experts to the management of long-lived radioactive waste is disposal in deep and stable geological formations in relatively passive multi-barrier systems. The main objective of this approach, which is based on fundamental ethical and environmental protection principles, is the long-term protection of humans and the environment at a level which is at least equivalent to the level acceptable to current generations. Furthermore, while this approach is still under development, and will not be proposed for practical implementation in most countries until the beginning of the next century, it relies on available technology and does not call for a major breakthrough in scientific research.

The NEA programme focuses on the geological disposal strategy and its gradual implementation in a series of steps, which include siting activities, construction and operation of repositories and, finally, closure and sealing. The step-by-step process has to be accompanied by safety studies which, prior to any decision to proceed to the next step, have to be submitted to and approved by national regulatory authorities. Within the NEA Radioactive Waste Management Committee (RWMC), this process is the subject of regular discussions involving representatives from regulatory authorities and agencies in charge of the implementation of practical disposal solutions. The discussions cover many aspects of disposal, such as the basic criteria and timescales to be considered and the role of institutional control measures, e.g. records and surveillance activities, the minimisation of the risks of inadvertent human actions at disposal sites, and the licensing process. Co-operation with other NEA Committees takes place on specific subjects. The NEA's objective in this field is to promote a continuing debate on all the essential elements of the disposal issue, therefore helping Member countries to adopt well-based strategies, in line with current international thinking.

In 1996, the NEA addressed for the first time the management of very low-level waste, which represents large volumes of very slightly contaminated or even only suspect materials. These materials, mostly generated by the dismantling of nuclear facilities, do not necessarily require disposal in disposal facilities for low-level, short-lived waste, which may be overdesigned in view of the limited hazard they represent. However, there is no clear consensus yet on the strategy to be followed for these wastes and further work is required, in particular to promote the identification of appropriate disposal solutions. Co-operation with the International Atomic Energy Agency is taking place in this area.

LONG-TERM SAFETY AND SITE EVALUATION STUDIES

Technical activities in these two related areas continued to enjoy high priority in 1996. They consist of the development of suitable methodologies to assist in understanding and assessing the long-term behaviour of deep geological disposal systems, notably the engineered barriers and the host rocks. In this respect, a great deal of progress is being made in advanced countries. In 1996, three NEA activities achieved new momentum and are described below. The experience gained is of significant interest to national programme because it provides them a broader basis for their respective safety studies.

INTEGRATED PERFORMANCE ASSESSMENTS

Performance assessment (PA) studies will provide the main support to decision-making for licensing the siting, operation, and closure of deep repositories for long-lived nuclear wastes. In 1995 the NEA set up the Working Group on Integrated Performance Assessments of Deep Repositories (IPAG) with the following goals:

- analyse existing PA studies and learn about what has been produced to date;
- shed light on what can and should be done in future studies.

Participating organisations and their integrated PA studies	
Organisation	Integrated PA study submitted to IPAG
AECL, Canada	The disposal of Canada's nuclear fuel waste: Postclosure assessment of a reference system (1994)
GRS, Germany	Analysis of the long-term safety of disposal concepts with heat-producing radioactive wastes (1991) (in German)
NAGRA, Switzerland	Kristallin-I Safety Assessment Report (1994)
PNC, Japan	Research and development on geological disposal of high-level radioactive waste, first progress report (1992)
SKB, Sweden	SKB-91 Final disposal of spent nuclear fuel. Importance of the bedrock for safety (1991)
SKI, Sweden	The SKI deep repository performance assessment research project SITE-94
POSIVA, Finland	TVO-92 safety analysis of spent fuel disposal
US DOE/WIPP	Draft 40 CFR 191 Compliance Certification Application for the Waste Isolation Pilot Plant (1995)
US NRC	NRC Iterative Performance Assessment Phase 2: Development of capabilities for review of a performance assessment for a high-level waste repository (1995)
US DOE/YMP	Total-System Performance Assessment - 1995: An evaluation of the potential Yucca Mountain repository (1995)

Ten organisations representing safety authorities, research bodies, and agencies for the development of waste management facilities participated in the IPAG during 1996. The mix of several types of waste management programmes and disposal concepts, including different geologies and different types and amount of waste, offered a unique opportunity for the exchange of information and discussion.

All organisations submitted their most recent integrated PA study for analysis and discussion, including written answers to over 70 specific questions. This enabled the group to assess progress in the field of PA since 1990 and to identify present trends. All answers were compiled and rationalised into a report representing the most complete review to date of PA studies of deep repositories. A set of recommendations was also prepared for those who do and for those who review PAs. In particular, although the PA studies submitted were carried out at different times and with different objectives and levels of resources, they all have a number of elements in common, which allowed the IPAG to propose a list of recommended elements in a safety assessment report.

Although new PA studies are under way in several organisations, the final IPAG report should remain a valuable reservoir of information and source material. This report will be published in 1997.

GEOTRAP THE OECD/NEA INTERNATIONAL PROJECT ON RADIONUCLIDE MIGRATION IN GEOLOGIC, HETEROGENEOUS MEDIA

This new NEA project, launched in April 1996, is designed to serve the needs of waste disposal organisations as they move from research to a phase of development and demonstration of disposal concepts of long-lived radioactive waste in deep geologic formations. Within the project, specialists in the characterisation of disposal sites and experts in the assessment of long-term safety interact with each other in a structured fashion, and discuss approaches to acquiring field data and testing and modelling transport of radionuclides in actual geologic formations. Membership in GEOTRAP is open to all organisations represented in the safety-analysis and site-characterisation groups of the NEA, i.e. the Performance Assessment Advisory Group (PAAG) and the Co-ordinating Group on Site Evaluation and Design of Experiments (SEDE).

The new project is organised as a series of forum-like workshops whose sequence over the next three years has been established and is fully integrated within the current programmes of work of PAAG and SEDE. The NEA will publish the proceedings of each workshop, along with a status report reflecting the materials that were presented, the discussions that took place, and the final conclusions and recommendations.

The first workshop, "Field Tracer Transport Experiments: Design, Modelling, Interpretation, and Role in the Prediction of Radionuclide Migration", was held in Cologne (Germany), 28-30 August 1996. It was co-organised with the European Commission and hosted by the *Gesellschaft für Anlagen und Reaktorsicherheit (GRS) mbH*. The technical presentations provided an overview of on-going studies of radionuclide migration phenomena and the characterisation of relevant properties of geologic media. Discussions took place on the extent to which it is possible to resolve migration problems using field tracer transport experiments, and to define the role of tracer tests in safety assessments of deep radioactive waste repositories. These discussions ultimately led to the conclusion that field tracer tests are an important element in the general understanding of the system, but do not eliminate the need for complementary approaches. Constructive ideas were also provided on future experimental programmes.

THE NEA “CLAY CLUB”

A wide spectrum of argillaceous media is being considered in NEA Member countries as potential host rock for the final, safe, near-surface or at-depth disposal of radioactive waste, and/or as a major constituent of repository systems. These media have a number of favorable generic properties, including homogeneity, low groundwater flow, chemical buffering, propensity for plastic deformation and self-healing of fractures by swelling, and a marked capacity to chemically retard the migration of radionuclides.

To evaluate these media, and notably to assess quantitatively the potential migration of radionuclides to the environment, a sound general understanding of the basic physical and chemical processes that govern groundwater, gas and solute transport through them is required. In this context, the NEA established, in 1991, a Working Group on Measurement and Physical Understanding of Groundwater Flow Through Argillaceous Media (informally named the “Clay Club”), to help demonstrate the capability of geoscientists to understand and characterise fluid flow in clay-rich media and build confidence in performance of clays as barriers to radionuclide migration.

To achieve these objectives, the “Clay Club” promotes a continuing intercomparison of the properties of the different argillaceous media, an exchange of technical and scientific information on clay properties and behaviour and on ongoing testing carried out in underground research facilities, and a detailed review of the available and most promising investigation techniques for site characterisation. These activities are focused on the findings and the perceived needs of the national radioactive waste disposal programmes but also tend to promote a cross-fertilisation of ideas from other industrial sectors (oil and gas, geothermal energy and minerals).

In 1996, a state-of-the-art report on the basic concepts and mechanisms which control water, solute and gas movement through the whole spectrum of argillaceous media was published. In addition, a workshop was jointly organised with the Commission of the European Communities on fluid flow through faults and fractures in argillaceous media. Future activities will deal with a series of detailed topics (e.g. rock-water interactions, water sampling...), but also with an assessment of the remaining issues related to the Performance of argillaceous media as a barrier to flow and radionuclide transport, them. and the ways to address them.

OTHER WASTE MANAGEMENT ACTIVITIES

The NEA also completed or pursued other activities in 1996, notably:

- the publication of a final report from the Co-ordinated Research and Environmental Surveillance Programme Related to Sea Disposal of Radioactive Waste (CRESP), summarizing the knowledge accumulated within CRESP over its fifteen years of existence;
- the setting up of an international database on Features, Events and Processes (FEPs) as a relatively comprehensive list of all the elements to be considered in the construction of scenarios used to assess the long-term safety of waste repositories;
- the setting up of a sorption modelling project to investigate the potential for “mechanistic” sorption models to improve confidence in performance assessment calculations;
- the continuation of joint projects on natural analogue studies and the decommissioning of nuclear facilities (see Chapter IX).

VI. NUCLEAR SCIENCE AND THE DATA BANK

The Agency's Nuclear Science programme is aimed at reinforcing co-operation basic and applied scientific research in Member countries, and making the results available" to nuclear scientists and technologists in those countries. Within the wide scope of science relevant to nuclear energy, the NEA Nuclear Science Committee (NSC) identifies topics for shared research that will most benefit from co-ordination within the NSC and from the scientific support of the NEA Data Bank.

Scientific work is a prerequisite for technical progress. An important part of the NSC'S work is the collaborative assessment of the state of knowledge in areas of growing importance, and the preliminary investigation of outstanding problems. Two projects passed through this preliminary stage in 1996: the Long-Term Irradiation of Materials, and Actinide Separation Chemistry. Work also continued on longer-term projects, such as Nuclear Criticality Safety and development of the Joint Evaluated Fission and Fusion Data File (JEFF-3).

While new technology may be applied to produce a near-term economic gain, new scientific results must be applied to the solution of technical problems before their value becomes apparent. For this reason it is particularly important that technologists and scientists have access to recent and reliable data and calculation tools. The NEA Data Bank's function is to provide nuclear reaction data and computer programs covering a wide field of nuclear energy technology to users in participating countries. During 1996, important changes were made to the Data Bank's computer installation, which now provides browsing access to Internet users on all aspects of the Agency's work, as well as access to nuclear physics data and, for accredited users, access to computer programs.

SCIENTIFIC STUDIES

Nuclear Criticality Safety

A decision was made in 1996 to form a new Working Party on Nuclear Criticality Safety (WPNCS) to bring together different projects in this important area of research. These projects cover criticality safety issues of storage, dissolution and transport of nuclear materials, and the *International Handbook on Nuclear Criticality Safety Benchmarks*.

The topic which has received the most attention during the last four years is "burnup credit". This term refers to the reduction in reactivity of spent nuclear fuel (as compared to fresh fuel) due to the change in isotopic composition during irradiation. In principle, spent fuel can safely be packed in containers with closer spacing because of its reduced reactivity. However, calculation methods must be developed and proven to be reliable, to guarantee that the packing configuration chosen is safe for the fuel concerned. The use of burnup credit calculation techniques will result in radiologically safer and more economic transport of spent fuel. Four studies on pressurised water reactor (PWR) fuel have been completed, while work will continue on boiling water reactor (BWR) and MOX fuel.

International Evaluation Co-operation

National programmes in nuclear data measurement and the evaluation of nuclear reaction data have been steadily reduced, increasing the importance of international co-operation. The NEA provides the Secretariat for collaboration between evaluation groups worldwide and for the smaller group of institutes engaged in high-precision, nuclear data measurements. The working parties on International Evaluation Co-operation (WPEC) and Nuclear Data Measurement Activities (WPMA) met at Argonne National Laboratory in June 1996 to review progress on measurements and evaluation.

Progress in evaluation in 1996 included the benchmark testing of the JENDL-3.2 library (Japan), and the development of a joint fission and fusion JEFF-3 library within the NEA (JEFF-3 compilation was started in 1996). The Russian MENDL-I library for proton-induced reactions up to 100 MeV was released in ENDF format with the assistance of the NEA. In addition to co-ordinating work and exchanging results between the major evaluation projects, WPEC brings together several small-scale collaborations between groups and individuals in different laboratories on specific problems. Twelve such groups were active in 1996.

Work is oriented through a joint High Priority Request List for nuclear data, defined in consultation with end-users in the different countries. The list aims to improve transparency and communication between producers and users so as to focus the available resources more accurately. It is planned to present the list on the NEA Web site.

High-Performance Computing in Nuclear Applications

The NSC Task Force on Advanced Computing continued its investigation of the need for high-performance computing in nuclear energy, the impact of new computer architectures on the performance of existing software, and the need to develop new algorithms for more efficient computation using massively parallel computers. In a demonstration exercise carried out during 1996, the group partially adapted a complex existing program for determining the atmospheric dispersion of radioactivity from a fixed source and succeeded in reducing computing time from about one hour to a few minutes (see box).

The Physics of Plutonium Recycling and Actinide Transmutation

Following publication in 1995 of the results of a series of international standard benchmark exercises, further progress was made in 1996 on multiple recycling in advanced PWRS. The study covered five recycle generations, with the aim of evaluating the potential use of PWRS to reduce and stabilise the plutonium stockpile. At the same time, it was a test of the nuclear data libraries and the calculation models. The study suggests that multiple recycling will be feasible, in realistic scenarios. The results will be published in 1997.

The Evolution of High-Performance Computing in Nuclear Applications

The computer programs used for the design, assessment and -operation of current nuclear reactors may be used today on workstations, and perhaps run faster than on supercomputers a few years ago. Cheaper microprocessors may soon reach the speeds of today's powerful workstations. The conclusion may seem straightforward: nuclear industry will calculate with commercial workstations and existing software packages.

Calculating the power distribution during one full cycle of a power reactor would take weeks on a present-day powerful workstation, but using the refined methods suitable for advanced parallel computers, the computing time would be measured in hours. These parallel computers deliver very high computing power, in particular when used with appropriate mathematical algorithms. Currently, they are applied mainly to problems which cannot be solved on the previous generation of supercomputers, such as climate modelling and molecular dynamics, referred to as "grand challenge" problems. Similar problems exist for nuclear reactors, notably turbulence calculations in fluid flow, and radiation transport calculations taking full account of reactor geometry.

A complementary study related to the transmutation of actinides was undertaken. It concerns a calculation benchmark on the recycling of MOX fuel in a PWR reactor, followed by a transmutation stage, consisting of either a PWR, a special actinide burner reactor or an accelerator. The objective is to calculate the activity of individual radioisotopes at the end of the recycling and transmutation stages. The benchmark specifications were issued in 1995 and the final results are expected in 1997.

The Long-Term Irradiation of Materials

Adequate knowledge of cumulative radiation doses, or fluence, is an essential step in developing and validating more effective models for the prediction of radiation damage to reactor components. An NSC report, completed in 1996, reviews the computation techniques used in twelve NEA countries for calculating long-term cumulative radiation doses to reactor pressure vessels and other components, and concludes that at present no firm judgement can be made on international levels of accuracy. In order to establish an essential baseline for future work on improving methods for fluence calculation and predicting radiation damage, the NEA began an international, "blind" benchmark exercise based on unpublished data from the Belgian VENUS test reactor.

Other Projects in Nuclear Science

These included:

- publication of a review report on the different chemical thermodynamics databases;
- publication of the results of the SMORN-7 benchmark study on Neural Networks for Reactor Diagnostics;
- continuation of work on the compilation of data from fuel performance experiments (of which there were 157 in the database at the end of 1996); and
- publication of the proceedings of the second “Specialist Meeting Shielding Aspects of Accelerators, Targets and Irradiation Facilities”.

The NEA DATA BANK

The basic nuclear data and calculation methods used in nuclear energy technology are very largely in the public domain, and new work is regularly presented in scientific journals and conferences. It is the mission of the NEA Data Bank, which is supervised by the NSC and supported by 21 of the Agency’s Member countries, to collect, verify and store in a common computer format these programs and data, for distribution to nuclear scientists and technologists in participating countries.

The Data Bank exchanges compiled data from nuclear measurements with the IAEA and national centres in the United States and Russia; together these centres provide worldwide service coverage. Under separate arrangements (which impose some restrictions) with the US Department of Energy (USDOE) and the IAEA, computer programs are exchanged with US software centres, while the Data Bank provides a computer program service on behalf of the IAEA to accredited users in IAEA member states.

The relevance of the Data Bank’s work is reinforced by the link with the NSC, which is the only international body covering the wide scope of science specific to nuclear technology. Thus, many projects co-ordinated by the NSC include validation of calculation methods, wherein the Data Bank is active in supplying computer programs to participants, co-ordinating the study, collating the results and assisting in the analysis and final publication. For nuclear data evaluations within the Joint Evaluated Fission and Fusion File (JEFF) project (formerly JEF), assembly and maintenance of the files, quality control and distribution are the responsibility of the Data Bank.

Preparations for the JEFF- 3 File

Work started in 1996 with the selection and initial loading of data for the new version of the Joint Evaluated File, incorporating the European Fusion File (EFF) previously maintained separately by ECN Petten. The combined library will be known as the Joint Evaluated Fission and Fusion File (JEFF). The baseline for the preparation and quality assurance of the new JEFF-3 file will be the current standard version JEF-2.2, which has been widely adopted and assessed in participating countries since its release in 1992. Nuclear data compilation continued, with a particular effort to include recent experiments.

Formal procedures were developed during 1996 for quality assurance (QA) of the JEFF-3 starter file and its subsequent versions, based on the ISO-9000 family of international standards. These “non-prescriptive” standards require the user to define QA standards

appropriate to its product, document the processes involved and prove that both are consistently followed.

QA procedures will be enforced through a new database system for the JEFF-3 library, with associated applications programs controlling the storage, maintenance and retrieval of the data. The database has been installed and is in the final stage of testing. Procedures include the use of standard test cases, to be run in case of future modifications to the database or to the application programs, and are comprehensively documented.

Intermediate Energy Nuclear Data (IEND)

Interest in accelerator-driven subcritical reactors, either for power production or for transmutation of the higher actinides and fission products isolated during reprocessing of nuclear fuel, has resulted in the decision to build a compilation of IEND measurement data, and a pilot data library for sensitivity studies with the assistance of the Kurchatov Institute in Russia and Hanover University in Germany.

User Services

Demand for computer programs, and related integral experiments data, was high and a total of 1 800 program packages were dispatched to users. Program acquisition (114 packages) was at a lower level than usual. Work continued on the development of a new integrated database for the storage and management of all information related to program services. In particular, uniform dispatch procedures are being developed for the different media requested by program users: PC diskettes, tape cassettes, CD-ROM and Internet.

The transfer of the nuclear reaction databases to Worldwide Web access, and the availability of some provisional information about the work of different parts of the Agency, caused a further rise in browsing access to the open section of the NEA Web site. At the end of the year, 1 000 users were registered for access to the Data Bank's scientific services.

About 2 500 megabytes of nuclear reaction data were retrieved, most directly via the Web. The CD-ROM edition of the Computer Program Abstracts, the JEF-PC data access package and the International Handbook of Criticality Safety Benchmark Experiments, in hard copy and on CD-ROM, were in high demand. A joint NEA-ECN Petten home page on partitioning and transmutation is included in the Data Bank Web site.

Training in the Use of Complex Calculation Tools

Several large and widely used computer programs in the area of reactor physics have become standard tools in their field of application. They are, however, complex, and must be well understood if they are to be used correctly. In collaboration with universities and research institutes, the Data Bank organised five training courses in 1996 covering the following programs: Monte Carlo MCNP (three courses), EGS4 and SCALE. It is planned to maintain and diversify this collaboration in future years.

Projects in Support of Other NEA Programmes

The NEA Data Bank assists other parts of the Nuclear Energy Agency in specific scientific projects and with expertise in the field of computing and database management. The main part of these services is provided in the areas of nuclear science, radioactive waste management and nuclear safety. The Data Bank's considerable experience in providing computer on-line services is also being used to assist the NEA to develop its Web site on the Internet.

Nuclear Science

The Data Bank works in close co-operation with the Nuclear Science Section, especially in the field of international computer code comparisons and integral experiments. Results from international "benchmark" comparisons are incorporated in the Data Bank's documentation of the computer programs and nuclear data concerned and are supplied to users on request. The Data Bank also stores information about experimental data used in validating different types of computer programs. Databases are currently held for radiation shielding experiments (SINBAD), criticality safety benchmark experiments (ICSBEP), fuel performance experiments, and atmospheric dispersion tracer experiments.

Waste Management

The Data Bank works with the NEA Radioactive Waste Management Division on a thermochemical database project for key elements required for geochemical modelling. The database, which contains bibliographic references and numerical data, is developed and maintained by the Data Bank, and an on-line service is provided.

Following the publication in 1995 of Chemical Thermodynamics of Americium, the Data Bank is finalising three new reports: one on technetium data, one on neptunium and plutonium data, and a book containing special guidelines for the users of these thermochemical data. Discussions began in 1996 on the priorities and establishment of a second phase of this project, to follow the publication of the above volumes.

Reactor Safety

In 1996, the Data Bank developed a www-based reporting system for the Fuel Incident Notification and Analysis System (FINAS). A detailed set of nuclear plant design characteristics and diagrams for units in OECD Member countries was also compiled.

The NEA Data Bank continued to maintain a high-quality database of simulated reactor transient experiments (CCVM) to be used in validating the large thermal-hydraulic computer codes for the safety analysis of reactor transients.

VII. LEGAL AFFAIRS

NUCLEAR CIVIL LIABILITY REGIME

The NEA serves as a framework for studies on the civil liability regime for damage caused by nuclear accidents, both within the general context of the ongoing modernisation of international conventions, and, more specifically, in the area of liability for damage connected with the longer-term management of radioactive waste.

The NEA Group of Governmental Experts on Nuclear Third Party Liability continues to follow closely the ongoing negotiations concerning the revision of the 1963 Vienna Convention, as well as those regarding the adoption of a new, worldwide convention, aimed at providing supplementary funding to finance compensation for nuclear damage beyond the financial guarantees by the operators. The result of these negotiations on the Vienna Convention will affect the future of the Paris Convention of 1960. A favorable conclusion would mean that the Paris Convention will probably have to be revised in order to maintain the harmonisation of the provisions of the two conventions. This latter objective is particularly important for the countries who ratified the 1988 Joint Protocol concerning the application of the Vienna and Paris Conventions. The outcome of the negotiations concerning the draft convention on supplementary funding will also have an effect on the advisability of amending the Brussels Convention supplementary to the Paris Convention - a regional mechanism by which the participating countries agree to provide additional means for the compensation of damages covered by the Paris Convention.

The problem of liability for nuclear damage resulting from radioactive waste disposal facilities has been studied in detail by the NEA Group of Governmental Experts during the past two years. In 1996, after drawing lessons from a questionnaire dealing with the application of the Paris Convention to the storage or disposal of radioactive waste, sent out by the Secretariat to Member countries, experts concluded that the Paris Convention should apply to nuclear damage resulting from an accident occurring in a radioactive waste storage facility, and the Convention should apply to damage caused by waste after its disposal. However, still to be determined more precisely, taking account of the technical aspects, is the point at which the radioactive waste storage facility post-closure phase begins, as well as the period during which the special regime of nuclear liability should continue to apply to this particular risk.

INFORMATION ON NUCLEAR LAW

The sharing of information on nuclear law is one of the traditional activities of the NEA. This activity primarily involves producing publications concerning the major aspects of legislation on nuclear energy, prepared in close collaboration with the national authorities of the countries concerned. In 1996, the NEA continued the publication of its *Nuclear Law Bulletin*. This review, published twice a year since 1960 and distributed by subscription all over the world, contains information on current events in nuclear law in the form of articles, analyses of legal texts and recently adopted national regulations, studies of case law, etc.

The analytical study entitled *Regulatory and Institutional Framework for Nuclear Activities*, covering NEA countries, was updated during the year. This study, a completely new version of which was published in 1995, is updated annually in order to include modifications made to national legislation and regulations during the preceding year. The

publication has been designed to facilitate comparative analysis of different national legislation.

Finally, the NEA updated and distributed an *Overview of Nuclear Legislation in Central and Eastern Europe and the NIS*, a study covering 16 countries that was produced for the first time in 1995. Its purpose is to provide an overview of the legal nuclear framework in this rapidly evolving region. This work was made possible by the network of contacts created by the Agency during the last few years in the course of its co-operation and assistance activities involving countries in that region. These contacts enable the NEA to receive regular and reliable information on the contents of such legislation, and on the progress made in its adoption.

VIII. INFORMATION PROGRAMME

INFORMATION AND PUBLICATIONS PROGRAMME

The availability of high-quality information on nuclear energy issues is key for decision-making in this field. The NEA has consistently sought to contribute to this objective by providing accurate and reliable information to the national authorities of its Member countries and, through them, to specialists, policy-makers, opinion formers and, in general, to all those with a need to know. NEA publications are an important tool for conveying the results of international co-operation and the significance of NEA work.

In 1996, a total of 32 publications (38 volumes), 16 “OECD documents” (mainly NEA technical reports), and 3 periodicals were published. The NEA also produced 14 free publications. (See Annex IV).

NEA BEST-SELLERS IN 1996

The NEA’s best-seller in 1996 was *Informing the Public about Radioactive Waste Management*, which contains the proceedings of an international seminar held by the NEA in Finland. Other publications which sold particularly well were the following:

- *Eurochemic 1956-90: 35 Years of International Experience in the Field of Nuclear Techniques;*
- *Implementing Severe Accident Management in Nuclear Power Plants;*
- *Infrastructure for Nuclear Energy Deployment;*
- *Nuclear Safety Research in OECD Countries - Areas of Agreement, Areas for Further Action, Increasing Need for Collaboration;*
- *OECD Nuclear Energy Data 1996;*
- *Uranium 1995: Resources, Production and Demand.*

The *NEA Newsletter* a bi-annual magazine with articles on a range of key nuclear energy issues, as well as updates on the work of the Agency, was substantially modernised and improved in terms of layout and content.

As part of the NEA series *Nuclear Energy and Information*, the report entitled *Radiation in Perspective: Applications, Risks and Protection* was finalised for publication. The report, intended for the non-specialist reader, seeks to enlighten debate on this subject by presenting the most up-to-date and authoritative material on the sources, uses and effects of radiation, and on the ways in which people are protected from its risks. It discusses, *inter alia*, the development of radiation protection measures, internationally agreed principles, and such social and economic issues as ethical questions, risk perceptions, risk comparisons, public participation in decision-making, and the cost of protection.

A new public information file *Radioactive Waste Management Programmes in OECD/NEA Countries* was also prepared for publication. It consists of standardised fact-sheets describing the programmes of 17 Member countries, covering the sources, types and quantities of waste, the main lines of the national radioactive waste management programme, the competent bodies, the financing of waste management, research and development, transport, and public information.

In parallel, the Agency increased its marketing efforts in Member countries and elsewhere. In particular, the NEA provided an information booth at the American Nuclear Society (ANS) 1996 Winter Meeting. The Agency also made a greater effort to display its publications at other major international nuclear meetings.

During the year, the NEA undertook several measures to enhance its Internet/Web site, which is intended to help raise the visibility of the NEA and its work. Improvements are being introduced to make the site more user-friendly and more comprehensive. The full NEA catalogue of publications is already available on the Web; electronic order forms are provided.

IX. JOINT PROJECTS AND OTHER CO-OPERATIVE PROJECTS

THE RASPLAV PROJECT

The RASPLAV project was established in July 1994. It brings together 16 OECD Member countries and Russia for the purpose of advancing the knowledge necessary to establish effective strategies for dealing with the retention of a molten core inside the reactor pressure vessel (RPV) during an accident. A number of integral tests with prototypic core materials, a number of molten salt tests as well as several smaller-scale, separate effects tests are being conducted at the Kurchatov Institute as part of the RASPLAV project with the aim of measuring material properties and understanding the relevant phenomena. In 1996 the first test, with 200 kg of corium, was successfully carried out, with a maximum corium temperature of 2 800°C and the establishment of convection in the molten pool.

The technical progress achieved to date has major significance in reducing uncertainties and confirming the validity of using ex-vessel flooding as a means of retaining a molten core in the reactor pressure vessel, The significance of the technical achievements include:

- Obtaining heat transfer data based on measurements with real materials at high temperatures.
- Experience in working with real materials so as to uncover any new phenomena that may not have been uncovered in previous experiments with simulant materials.
- Experience in working with real materials so as to determine the extent, if any, of chemical interactions between corium and the RPV. Such chemical interactions can only be obtained with real materials at prototypic temperatures.
- Direct comparison of the heat transfer rate obtained from corium experiments with that obtained from salt experiments, so as to extrapolate data to full-size reactor conditions.

The success of the initial experiments, together with the development of successful melt technology, provides a good basis for moving on to more complex experiments involving, for instance, melt stratification, The current project will terminate in June 1997, and it is envisaged that a second phase addressing such aspects will start in July 1997 and last for three years.

THE HALDEN REACTOR PROJECT

The research programmes at the OECD Halden Reactor project are concerned with nuclear fuel and material performance and man-machine systems development. Approximately 100 organisations are involved.

Fuel and core material reliability and safety continued to be the prime motivation for the Halden project's experimental and analytical activities in 1996. Potential performance limiting parameters were studied during normal operation and in response to operational transients. The programme encompassed current and advanced designs with specific emphasis on high burnup performance. Particular attention was focused on fuel rod thermal behaviour, fission product release and phenomena related to the effect of waterside corrosion.

The man-machine systems research programme continued to focus on software verification and validation, man-machine interaction research, surveillance and support systems development, and control room development during 1996. The overall objective of the programme was to provide information supporting the design and licensing of upgraded, computer-based control rooms, and to demonstrate the envisaged improvements through validation tests in the project's experimental control-room facility, as well as through pilot installations in nuclear power plants.

THE INFORMATION SYSTEM ON OCCUPATIONAL EXPOSURE (ISOE)

After five years of successful operation, the ISOE Programme continues to grow. At the end of 1996, this programme involved 63 participating utilities from 23 countries, as well as national regulatory authorities from 20 countries. In total, annual occupational exposure information from 360 operating commercial nuclear power reactors, as well as from 35 commercial nuclear power reactors in cold shutdown or in decommissioning, are included in the ISOE databases. New participants are the Korean Utility KEPCO (Korea Electric Power Corporation) and Korean authorities MOST (Ministry of Science and Technology) and KINS (Korea Institute of Nuclear Safety), as well as the French authorities OPRI (*Office de protection contre les rayonnements ionisants*) and IPSN (*Institut de protection et de sûreté nucléaire*) and the Mexican authority, the *Comisión Nacional de Seguridad Nuclear y Salvaguardias*.

The ISOE Steering Group was concerned with two major issues during 1996: the finalisation of the report by the Expert Group on the Impact of Work Management on Occupational Exposures; and the structure, format and relational database system used to manage the occupational exposure data collected annually. The final report of the ISOE expert group will be published in early 1997, and is entitled *Work Management in the Nuclear Power Industry*. Many radiation protection practices must be justified, often in monetary terms, in order to gain management support. This report describes what is currently considered to be good practice in the application of work management principles, and illustrates the application of these principles with actual case studies and examples. One of the main objectives of this report is to provide the radiation protection manager with examples of work management techniques and approaches to assist in the justification of their application. Another of the report's objectives is to show plant managers, maintenance managers, and outage schedulers that the use of work management techniques will save time and money and reduce occupational exposure. The areas which are covered by the report include: regulatory issues; work management policy; worker involvement; work selection, planning and scheduling; work preparation; work implementation; and assessment and feedback. The work of the expert group was supplemented by comments provided during an NEA-sponsored workshop on the subject, held in Paris in November 1995.

The most important issue addressed by the ISOE Programme during 1996, however, was the structure and format of the NEA 1 database. This database contains the annual occupational exposure information supplied by the ISOE participating utilities (total annual collective dose, total collective outage dose, total collective normal operation dose, individual dose distributions for exposures received at the plant during the year, annual collective dose for specific tasks or work on specific systems, etc.). To assure that the database is compatible with the needs of its users, it was decided at the end of 1995 to update its structure, format and operating system. This work was brought close to completion during 1996, and the new database and accompanying user manuals will be provided to the ISOE participating utilities in the spring of 1997.

A topical session was held in conjunction with the annual meeting of the ISOE Steering Group. This year's topics were primary water chemistry and its effect on occupational exposures, and ALARA tools. An informal proceedings document, containing the 12 papers from the topical session, was prepared and distributed to all ISOE participants.

THE INTERNATIONAL CO-OPERATIVE PROGRAMME ON DECOMMISSIONING

The International Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Programmes began in 1985. Initially consisting of ten decommissioning projects in eight countries, the programme has since grown to the present number of 31 projects in 13 countries, including 21 reactors, seven reprocessing plants, two fuel material plants, and one isotope handling facility. Two projects are located in non-member countries (the Bohunice A-1 reactor decommissioning project in the Slovak Republic, and the Paldiski submarine training reactor decommissioning project in Estonia).

Since membership in the Co-operative Programme is voluntary, continued growth is the best proof of its success. Indeed, the programme is the only international forum for this type of data and experience exchange involving such a wide range of countries and projects. It is hoped that in the future, a large-scale, commercial nuclear power plant will be added to the programme. In addition, recent interest by the Russian Federation in participating in NEA activities is expected to lead to talks between the NEA and Russian officials to identify specific areas of common interest where Russian participation might be possible, and the Co-operative Programme is one such area.

The forum offered by the Co-operative Programme for the exchange of technical information and experience is valuable in ensuring the employment of options that are best from the standpoint of safety, economics and the environment. For some members, with less experience in this area, the benefit in not having to go through an expensive learning and development programme is invaluable. Of particular importance in this period is not just the increase in membership and projects from OECD countries, but the recent inclusion of non-OECD countries and the active participation of the CEC and other international organisations such as the IAEA and the UNIPED, This growth demonstrates that the increasing importance of decommissioning for the future of the nuclear industry is now recognised.

At the end of 1996 two documents prepared by the programme were published. The first was a summary report of the first ten years of the NEA Co-operative Programme on Decommissioning, and the second document was a summary of the work performed by the Task Group on Recycling and Reuse of Scrap Metals resulting from decommissioning. The first publication, a compilation of the experience gained during the programme's ten years of existence, discusses the "state of the art" in various areas of interest to decommissioning (assessment of activity inventories, cutting techniques, remote operations, decontamination, melting, radioactive waste management, and health and safety aspects), presenting summaries of the work performed by the various task groups and finally, examining work to be addressed by the programme in the future.

The report entitled *Recycling and Reuse of Scrap Metals* is a detailed description of an integrated risk management approach to establishing clearance criteria for metals resulting from decommissioning activities. In view of other work published in this area by the IAEA and by the CEC, the Task Group felt that it was important to contribute the point of view of decommissioners to the ongoing debate over the regulatory establishment of clearance levels.

ANALOGUE STUDIES IN THE ALLIGATORS RIVERS REGION (ASARR): THE OECD/NEA-SPONSORED PROJECT IN THE FIELD OF NATURAL ANALOGUE STUDIES FOR NUCLEAR WASTE DISPOSAL

In order to support the safety analyses of nuclear waste repositories, it is important to gather qualitative and quantitative evidence on the long-term, in-situ performance of the materials that will be disposed of. While some information can be collected directly at the disposal site, other information will require extrapolation from similar conditions occurring elsewhere in nature. For example, uraninite, *i.e.* naturally occurring uranium dioxide, is an analogue material to UO₂ fuel. Thus, several aspects of the dissolution of spent nuclear fuel in natural groundwaters, and the mobilisation and migration of uranium can be studied at existing uraninite deposits.

The NEA and other organisations are involved in this field because of the need for natural analogue studies, as well as the potential difficulties associated with them. One NEA initiative is the ASARR project - Analogue Studies in the Alligators Rivers Region - on the mobilisation and migration of uranium in the oxygen-rich groundwaters surrounding the Koongarra uranium ore body in the Alligators Rivers Region of the Northern Territory of Australia. The oxygenated conditions of the groundwater at this site reproduce its normal conditions at shallow-land repositories, and abnormal conditions in deep geologic repositories. Abnormal conditions at depth could arise, in some scenarios, from the mixing of surface waters with the groundwater.

The Koongarra studies were included in the NEA programme of work since 1987 under the acronym of ARAP (Alligators Rivers Analogue Project). ASARR started in January 1995 and will end in January 1998, Specific focus areas are:

- the testing of models for the uptake of uranium and other species on the surface of natural substrates (sorption studies);
- the elucidation of previously identified mechanisms for the fixation of uranium within uranium-bearing minerals (mineralisation studies);
- the correlation between amounts of uranium in solution and the local mineralogy (volubility studies);
- the determination of the isotopic distribution of the uranium in the rock in order to test, amongst other things, the ability of fractured rocks to take up uranium and other actinides by matrix diffusion (U-disequilibrium studies).

The ASARR project is being jointly undertaken by the Australian Nuclear Science and Technology Organisation (ANSTO), the Japan Atomic Energy Research Institute (JAERI), the Korea Atomic Energy Research Institute (KAERI), and the United States Nuclear Regulatory Commission (USNRC), under the aegis of the NEA. ANSTO serves as the managing organisation, while the NEA is the project co-ordinator.

X. RELATIONS WITH NON-MEMBER COUNTRIES

The major component of NEA activities with non-member countries has been co-operation with, and assistance to, Central and Eastern European Countries (CEEC) and the New Independent States (NIS) of the former USSR, under the auspices of the OECD Centre for Co-operation with Economies in Transition (CCET), in the areas of nuclear safety, radiation protection and nuclear law and liability

NUCLEAR SAFETY AND REGULATION

Enhancement of Nuclear Safety Research Capabilities

The NEA has been assisting the CEEC/NIS in the planning, development and execution of safety research programmes with a view to building up capabilities in safety technology and safety analysis, in particular with respect to WER reactors. In co-ordination with OECD Member countries and other international organisations, co-operative programmes continued to be pursued in order to complete or improve existing research facilities and to train staff. In 1996 four OECD support groups continued their work on evaluating technical proposals, sharing experience accumulated in Member countries, and arranging for training of CEEC/NIS researchers in laboratories of OECD Member countries, as well as assisting in identifying sources of funding. These four support groups were concerned, respectively, with:

- research on WER-440/213 bubbler condenser containment;
- WER code-validation matrix;
- WER-1000 large-scale test facility (PSB); and
- safety research needs for Russian-designed reactors.

In addition, co-operation with the CEEC and the NIS continued on two of the Agency's autonomous projects: the RASPIAV project, simulating a hypothetical severe accident, and the OECD Halden Reactor project, studying man-machine interface and fuel behaviour (see Chapter IX). An additional project, SCORPIO-VVER, was started during the year. The aim of this project is to adapt a core surveillance system previously developed for LWRS of Western design to WERS.

Provision of Nuclear Safety Information

CEEC/NIS experts continued to be invited to attend NEA workshops and specialist meetings and to participate in International Standard Problem (ISP) exercises. In 1996, some 50 CEEC/NIS experts were invited to attend five workshops and 19 specialist meetings sponsored by the NEA. In addition CEEC/NIS specialists participated in three ISP exercises. This participation provides an effective way for experts to gain international experience, establish links with their peers, and demonstrate the degree of sophistication and development of the computer codes used in accident analysis.

Strengthening Safety Authorities

The NEA Committee on Nuclear Regulatory Activities (CNRA) has established a link with the association of nuclear regulatory bodies of countries operating WER-type reactors. Regulators from this association were invited to CNRA annual meetings in an observer capacity. Such a link with the CNRA was considered necessary in order to strengthen the authority and stature of the CEEC/NIS regulatory bodies.

Safety Research Needs of Russian-Designed Reactors

A group of senior technical experts from Russia and NEA Member countries completed a study of the safety research needs of Russian-designed reactors. The study considered all the technical areas of interest: reactor safety manuals, thermal hydraulics, integrity of plant equipment and structures, severe accidents, and operational safety. For each area it addressed three basic questions:

- What is the safety concern?
- What are the open safety issues?
- What are the safety research needs?

The study led to the identification of a number of research topics which should receive priority over the next few years if the risk level is to be reduced. A number of recommendations, concerning the development of a safety research strategic plan and increased international co-operation, were also made.

NUCLEAR EMERGENCY MATTERS

(see also Chapter IV)

During 1996 several CEEC/NIS countries participated in NEA work in the area of nuclear emergency planning, preparedness and management, specifically in conjunction with the INEX programme. Based on experience gained during the INEX 1 exercise in 1993, the NEA has developed a series of regional exercises called INEX 2. The first of these regional exercises took place on 7 November 1996 in Leibstadt, Switzerland, using the Leibstadt plant as the site of the simulated accident. Thirty countries, including the host country, Switzerland, and two international organisations took part in this exercise. Of the 30 participants, seven Eastern European countries participated: Belarus, Bulgaria, Estonia, Lithuania, Romania, the Slovak Republic and Slovenia. Experts from five of these countries participated in the meeting of the Programme Committee in Zurich in June 1996, and were funded by the NEA. The exercise itself was carried out by experts in their countries, and did not involve any travel or funding.

The Finnish regional INEX 2 exercise will take place in April 1997, with the Programme Committee for this exercise meeting in Helsinki in December 1996. This exercise involves the participation of 18 countries, including six CEEC/NIS (Estonia, Latvia, Lithuania, Russia, the Slovak Republic and Slovenia). Experts from Lithuania and the Slovak Republic were given financial assistance for their participation in the December Programme Committee meeting.

NUCLEAR LAW AND LIABILITY

Training Activities in Nuclear Law

During the last few years, the CEEC and the NIS have undertaken a considerable effort to develop and modernise their nuclear law, with a view to attaining a level of legislation comparable to that of Western countries. The countries concerned have requested the assistance of competent international organisations in this process, and the NEA is particularly active in this area.

Within the framework of the co-operation and assistance programmes set up by the NEA, advanced training seminars are particularly important. These seminars, to which the IAEA and the CEC also contribute, have been organised each year since 1993, and deal, successively, with specific aspects of this branch of law. Subjects considered so far include, for example, nuclear civil liability, the safety of nuclear installations and the legal aspects of radioactive waste management and decommissioning.

The most recent seminar was held in Romania on 26-30 August 1996 at the Cernavoda nuclear facility, at the invitation of the National Commission for the Control of Nuclear Activities and the Romanian electricity utility, RENEL. The seminar brought together more than 50 specialists on radioactive waste management questions from 15 countries, as well as Western experts. From the perspective of developing legislation in these countries, the questions that received the most attention concerned the procedures for consulting the public and for studying the impact on the environment during the selection of a site for the construction of a storage facility, the mechanisms for financing decommissioning and waste disposal activities, and international law in this area (in particular the draft convention on the safety of radioactive waste management, presently in negotiation). The NEA undertook to put together written contributions made at the seminar and to distribute them to all participants.

The Agency also runs other training activities in the field of nuclear law. Researchers are accepted for limited periods and are provided with assistance in their legal work. Moreover, the Agency contributes to the training of specialists from non-member countries by inviting them as observers to meetings of Western legal experts as well as to working sessions of the NEA Group of Governmental Experts on Nuclear Third Party Liability.

The NEA is also responsible for several bilateral co-operative programmes with Eastern countries, with the aim of assisting them in the preparation of legislation or nuclear regulations. It was through this channel that international working groups on nuclear legislation for Belarus and the Ukraine were setup in 1996.

Liability Issues Raised by Nuclear Safety Assistance Programmes

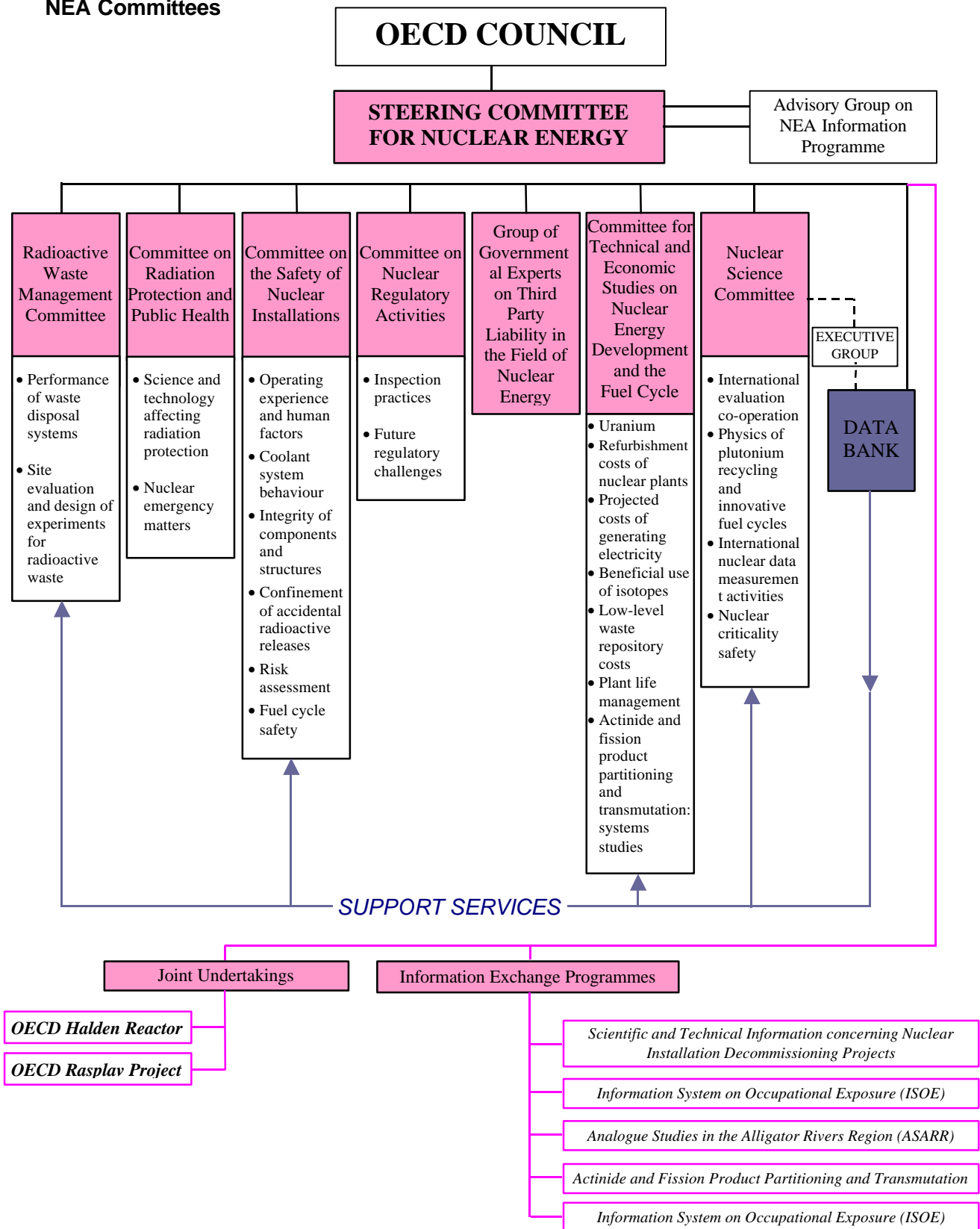
A "Contact Group" was established in 1994 to study the means by which nuclear contractors might be protected from liability arising in connection with the provision of goods and services pursuant to nuclear safety assistance programmes in place with certain CEEC/NIS. The group focuses, in particular, on bilateral and multilateral agreements intended to put into place guarantees of indemnification for Western contractors where legal action could be taken against them following a nuclear incident. The aim of the group is also to encourage CEEC/NIS which are not yet parties to accede to the regime established by the international conventions on nuclear liability and to incorporate the principles of this regime into their domestic legislation.

In addition to consultations amongst its members, the Contact Group may make recommendations to the 19-23 May Secretariat regarding specific actions; an example is the creation by the NEA, during 1996, at the request of the Government of the Ukraine, of a Joint Task Force on nuclear legislation in that country. This task force, which consists of a small group of Ukrainian and Western legal specialists, is presently working on the amendment of the basic nuclear legislation in the Ukraine and on various other issues proposed by the Ukrainian authorities. The EBRD, the CEC and the IAEA are also participating in this group. The possibility of establishing a similar body with Russia is being considered.

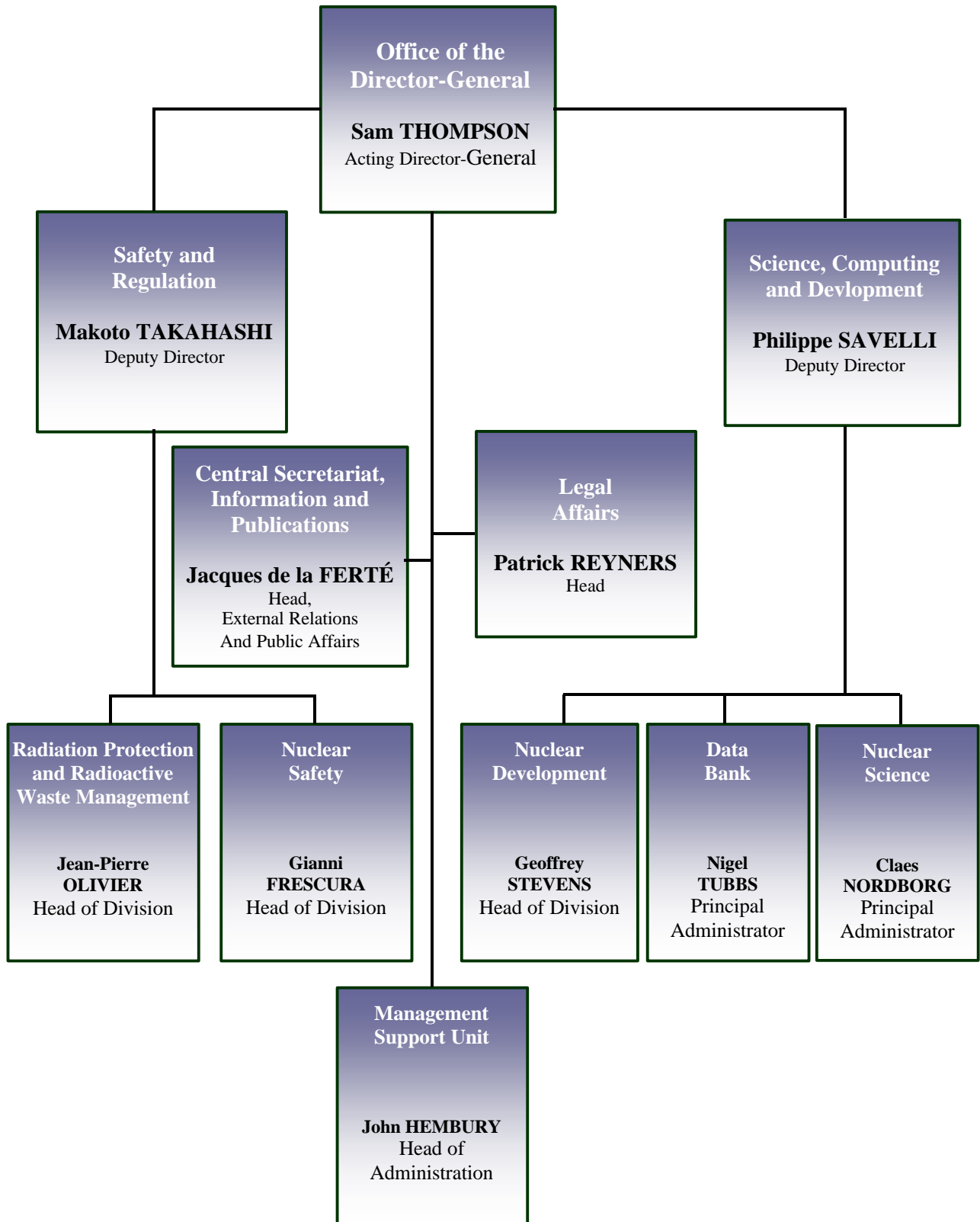
ANNEX I

Organisation Charts of the NEA

NEA Committees



NEA Secretariat Structure in 1996



ANNEX II

ADMINISTRATION AND STAFF

The personnel establishment in 1996 was 80 (including 41 professional staff). The total appropriation for the Agency for 1996, including the Data Bank, was 81.4 million French francs.

ANNEX III

LIST OF WORKSHOPS, SPECIALIST MEETINGS AND SYMPOSIA IN 1996

28-29 February	Comparison Workshop of International Standard Problem No.37 (VANAM M3 test) - Cologne, Germany
28 February-1 March	Workshop on Probabilistic Structural Integrity Analysis - Stockholm, Sweden
5-7 March	Workshop on Technical Support for Licensing of Computer-Based Systems Important to Safety - Munich, Germany
25-29 March	Introductory Training Seminar on the Monte Carlo Code MCNP for Radiation Transport and Criticality - Stuttgart, Germany
13-16 May	Workshop on Seismic Shear Wall ISP -Yokohama, Japan Training Seminar on the Use of MCNP in Radiation Protection and Dosimetry - Bologna, Italy
13-17 May	Workshop on the Implementation of Hydrogen Mitigation Techniques - Whiteshell, Canada
19-23 May	International Workshop on Regulatory Inspection Activities Related to Inspection, Planning, Plant Maintenance and Assessment of Safety - Chester, United Kingdom
10-11 June	International Workshop on Infrastructure for Nuclear Energy Deployment - OECD, Paris, France
10-12 June	Workshop on Fluid Flow through Faults and Fractures in Argillaceous Formations - Bern, Switzerland
10-13 June	Training Seminar on Electron-Photon Radiation Transport Calculations Using EGS4 - Montpellier, France
10-13 June	Workshop on the Chemistry of Iodine in Reactor Safety - Würenlingen Switzerland

1-5 July	Training Seminar on Criticality and Shielding Calculations for Spent Nuclear Fuel Packages using SCALE - Stuttgart, Germany
26-30 August	Training Seminar on Nuclear Law - Cernavoda, Romania
28-30 August	Workshop on Field Tracer Transport Experiments: Design, Modelling, Interpretation and Role in the Prediction of Radionuclide Migration - Cologne, Germany
2-6 September	Introductory Training Seminar on the Monte Carlo Code MCNP for Radiation Transport and Criticality - Stuttgart, Germany
11-13 September	4th International Information Exchange Meeting on Actinide and Fission Product Separation and Transmutation - Mito City, Japan
26-27 September	Specialist Meeting on Advanced Instrumentation and Measurement Techniques - NEA, Issy-les-Moulineaux, France
14-17 October	Specialist Meeting on In-Core Instrumentation and Reactor Core Assessment - Mito City, Japan
4-7 November	Specialist Meeting on Safety Issues Related to Fuel Elements and Control Rods - Madrid, Spain
4-8 November	Workshop on Thermal-Hydraulic and Neutronic Codes - Annapolis, United States
13-15 November	Specialist Meeting on the Optical Model Above 20 MeV -CEA, Bruyères-le-Châtel, France
18-19 November	Special Meeting on In-Vessel Debris Coolability and Lower Head Integrity - OECD and Western European Union, Paris, France
2-3 December	Seminar on 3D Deterministic Radiation Transport Computer Programs - OECD, Paris, France

ANNEX IV

LIST OF PUBLICATIONS PRODUCED IN 1996

Publications of General Interest

NEA ACTIVITY REPORT 1995

Free on request.

CATALOGUE OF PUBLICATIONS 1996-97

Free on request.

NEA NEWSLETTER, VOL. 14, NOS. 1 AND 2

ISSN 1016-5398

Annual subscription price: FF 160 US\$ 32 DM 52 f 20 ¥ 3600

EUROCHEMIC 1956-1990

Thirty-five years of international co-operation in the field of nuclear engineering: The chemical processing of irradiated fuels and the management of radioactive wastes

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INFORMING THE PUBLIC ABOUT RADIOACTIVE WASTE MANAGEMENT

Proceedings of an NEA International Seminar - Rauma, Finland, 13-15 June 1995

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Price: FF 250 US\$ 45 DM 67 £30 ¥ 4850

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ISBN 92-64-14795-0

Price: FF 210 US\$ 42 DM 60 £27

INFRASTRUCTURE FOR NUCLEAR ENERGY DEPLOYMENT

Proceedings of an NEA Workshop - Paris, France, 10-11 June 1996

ISBN 92-64-15361-6

Price: FF 235 US\$ 46 DM 69 £30 ¥ 4950

OECD NUCLEAR ENERGY DATA 1996

(Bilingual) ISBN 92-64-04840-5

Price: FF 125 US\$ 24 DM 36 £16 68

TRENDS IN NUCLEAR RESEARCH INSTITUTES

ISBN 92-64-14781-0

Price: FF 340 US\$ 68 DM 98 £44

URANIUM 1995: RESOURCES, PRODUCTION AND DEMAND

A Joint Report by the OECD/NEA and the IAEA

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A Report by a Joint Group of Experts from the OECD/NEA and the EC

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THE NEA CO-OPERATIVE PROGRAMME ON DECOMMISSIONING - THE FIRST TEN YEARS 1985-95

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RECYCLING AND REUSE OF SCRAP METALS

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Radioactive Waste Management

CHARACTERISATION OF LONG-TERM GEOLOGICAL CHANGES FOR DISPOSAL SITES

Proceedings of an NEA Workshop - Paris, France, 19-21 September 1994

ISBN 92-64-14829-9

Price: FF 200 US\$ 40 DM 59 £26

CO-ORDINATED RESEARCH AND ENVIRONMENTAL SURVEILLANCE PROGRAMME RELATED TO SEA DISPOSAL OF RADIOACTIVE WASTE - CRESP FINAL REPORT, 1981-1995

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THE INTERNATIONAL INTRAVAL PROJECT

Final Results

Working Group 2 Report: Finnsjön, Stripa and WIPP 2

Working Group 4 Report: The Analyses of the Alligator Rivers Natural Analogue

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WATER, GAS AND SOLUTE MOVEMENT THROUGH ARGILLACEOUS MEDIA

A Report by the NEA Working Group on Measurement and Physical Understanding of Groundwater Flow Through Argillaceous Media ("Clay Club")
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NUCLEAR WASTE BULLETIN, NO. 11, JUNE 1996

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Nuclear Safety

IMPLEMENTING SEVERE ACCIDENT MANAGEMENT IN NUCLEAR POWER PLANTS

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Price: FF 100 US\$ 20 DM 29 £13 ¥2100

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NUCLEAR LAW BULLETIN, NOS. 57 AND 58 PLUS SUPPLEMENTS, JUNE AND DECEMBER 1996

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