NEA
1999 Annual Report

N U C L E A R • E N E R G Y • A G E N C Y

Organisation for Economic Co-operation and Development

The NEA in Brief

27 Member countries (21 in the Data Bank)

41 years of international service

7 standing technical committees

11 joint projects and information exchange programmes

72 professional and support staff

540 national experts participating in NEA committees

4 400 experts participating in policy and technical meetings organised at OECD headquarters

FF 57 million budget for the NEA in 1999, supplemented by voluntary contributions

FF 16 million budget for the Data Bank in 1999, supplemented by voluntary contributions

56 publications in 1999

Governing body: the Steering Committee for Nuclear Energy

The Nuclear Energy Agency (NEA) is a semi-autonomous body within the Organisation for Economic Co-operation and Development (OECD), located in the Paris area in France. The objective of the Agency is to contribute to the development of nuclear energy as a safe, environmentally acceptable and economical energy source through co-operation among its participating countries.

The European Commission (EC) takes part in the work of the NEA. A co-operation agreement is in force with the International Atomic Energy Agency (IAEA). The NEA also co-operates with non-member countries of Central and Eastern Europe (CEEC) and the former Soviet Union (NIS).

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Mr. Luis Echávarri
Director-General of the NEA

1999 In Perspective

International co-operation on nuclear energy started almost half a century ago when President Eisenhower launched the "Atoms for Peace Programme", and was followed in the latter part of the 1950s by the creation of international organisations such as the OECD Nuclear Energy Agency, the International Atomic Energy Agency and Euratom.

While the original objectives – fostering cost-effective technological development, establishing and maintaining efficient and independent regulatory systems, protecting man and the biosphere from radiation effects, and preventing diversion of nuclear material to non-peaceful purposes – remain the main pillars of international co-operation, today's efforts need to adjust to a rapidly changing worldwide environment.

Electricity market deregulation, privatisation of the nuclear industry, disengagement of public agencies from nuclear R&D funding, slim prospects for new nuclear plant construction in the near term in many countries, and slow progress in demonstrating acceptable solutions for disposing of spent nuclear fuel and radioactive waste, are among the major challenges which governments face today in dealing with nuclear energy.

At the same time, certain challenges facing governments may tend to work in favour of nuclear power. Governments are increasingly looking at future energy needs in terms of sustainable development and meeting Kyoto greenhouse gas reduction targets, which will be difficult to accomplish without nuclear power. By progressively integrating sustainable development principles into their overall energy policies, Member countries are becoming more committed to – or at least more conscious of – the link between the resource, environment, economic and social aspects of energy production and use by present and future generations.

EDF, France

Switchyard at Chavigny, France.

Against this backdrop, if nuclear energy is to continue to form a part of countries' energy mixes, assurances must be given that it is:

Economically competitive. Most operating nuclear power plants are already competitive, even in a deregulated electricity market. Future plants must also compete favourably, taking into account that other energy sources have not yet integrated their externalities in cost calculations.

Environmentally friendly. Technical and institutional measures are already in place in OECD countries to ensure that the use of nuclear energy will not harm the natural environment significantly. It is essential to maintain a robust technical and regulatory framework in order to alleviate related social and environmental concerns.

Acceptable to the public. Addressing public concerns about nuclear risks and involving stakeholders in a transparent and democratic decision-making process is key to public confidence. It is important to allow the public to put social, ethical and political issues related to nuclear energy in perspective with issues raised by alternative energy sources. Excellent nuclear safety records are, of course, a prerequisite to this process.

The resources of international co-operation, notably through the Nuclear Energy Agency, can substantially help "keep the nuclear option open" in a sustainable development perspective, for example by helping preserve and develop scientific and technical know-how, maintaining adequate human resources both in quantity and quality, contributing to greater cost-effectiveness of nuclear operations, and improving stakeholder confidence in radioactive waste management solutions.

The 1999 Annual Report of the Nuclear Energy Agency illustrates various facets of the international co-operation made available to Member governments which assists them in rising to these challenges.

Trends in Nuclear Power

Nuclear energy development

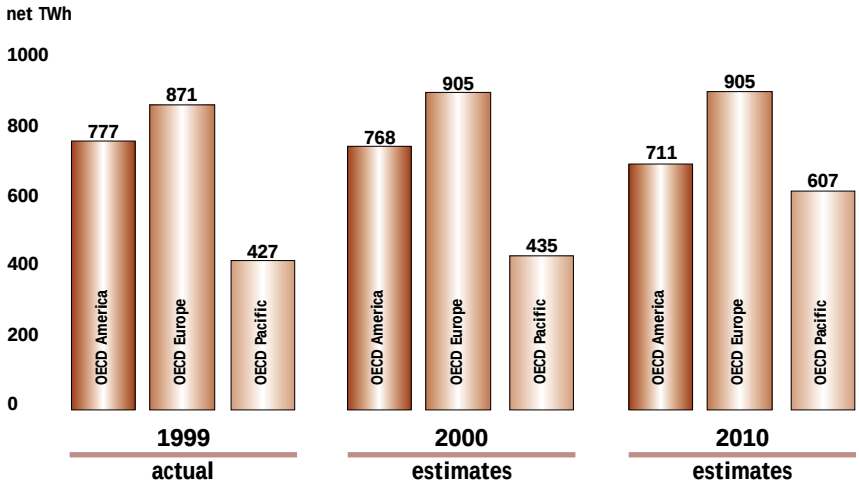
The decision-making landscape in the energy and electricity sectors is evolving along two main axes: addressing environmental concerns, and more broadly sustainable development issues; and moving towards deregulated markets and private enterprises. The explicit integration of the sustainable development concept in energy policies is calling for strategies that preserve natural resources and the environment, reduce regional disparities and give equal opportunities to present and future generations worldwide. The introduction of competition in electricity markets is expected to yield higher economic efficiency, as costs previously supported by taxpayers or captive consumers will be borne by shareholders and by consumers who will be able to choose between alternative suppliers.

Against this broad background, in 1999 nuclear energy continued to be acknowledged as a valuable component of the energy mix of many OECD countries. In some countries, however, it was the subject of controversy and a matter for public debate, in two cases leading to the decision to begin phasing out its production.

Nuclear power generation will remain fairly constant over the next ten years, but will represent a decreasing proportion of total electricity production as demand increases. Beyond the next decade the position is unclear and will depend on a number of technical, environmental, economic and political factors that are country-specific and may change over time.

In 1999 a total of 348 nuclear power units were in operation in OECD countries, providing some 24% of the electricity supply. Two new units were connected to the grid in the Republic of Korea and one in France, while one unit was shut down in Sweden. In Spain, the installed nuclear capacity increased by some 100 MWe owing to the upgrade of two nuclear units. Ten units were under construction: two in the Czech Republic, four in Japan and four in Korea. Two additional units were firmly committed in Korea.

Nuclear power production in the OECD area (1999-2010)



Nuclear safety and regulation

The safety performance of the nuclear power plants operating in OECD countries continued to be very good in 1999. However, the criticality accident which took place at a uranium processing plant in Japan, resulting in one fatality and two severely injured workers, came as a reminder that continuing vigilance over operating procedures and enhancement of safety culture remain of paramount importance for the nuclear industry. This accident prompted the Japanese government

to implement several improvements in the regulations governing the handling of nuclear materials and to strengthen emergency preparedness. The international community is analysing the lessons learned from this event.

Deregulation of the electricity market raises a number of potential concerns with respect to the safety and regulation of nuclear power plants. Concerns that need to be addressed include ownership and organisational issues, economic pressure on licensees and the regulatory body, the adequacy of the nuclear infrastructure, and, possibly, electrical grid stability.

The transition to the year 2000 was smooth and uneventful. Some 300 nuclear power plants reported to the NEA Y2K Early Warning System (YEWS) a mere 14 minor events – none of which had any safety significance.

Assuring nuclear competence into the 21st century in both industry and regulatory bodies is an issue of rising concern in many countries, as a considerable number of experienced specialists will be leaving the nuclear field over the next decade or so and will be difficult to replace. Nuclear energy careers are losing attraction and nuclear engineering schools are disappearing rapidly. The issues of effectiveness of the regulatory body and communication between the regulator and the public are also receiving more attention.

Carl Lindhe, Barsebäck Kraft AB, Sweden

Contamination control at Unit 2 of the Barsebäck nuclear power plant in Sweden.

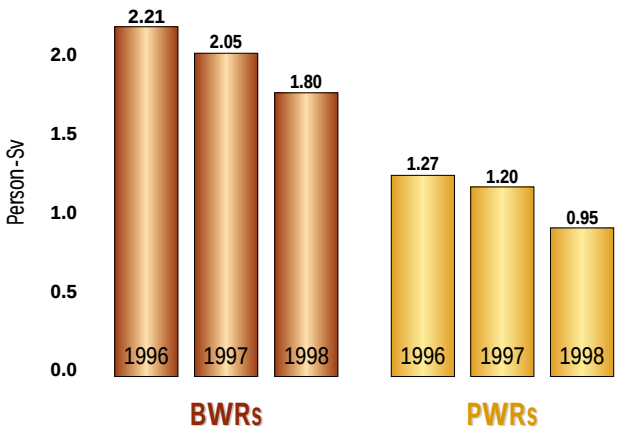
Radiation protection

Society is increasingly demanding a participatory role in decision-making processes involving radioactivity, and requiring more transparency in political, regulatory and administrative decisions. One such area of concern is the release of slightly contaminated materials from the decommissioning of nuclear plants (scrap metals for recycling for example). Many issues involving the transportation and storage of radioactive waste are also on the public agenda. Governments and regulatory authorities are working to address these concerns, and to adapt their processes to this new framework.

Current data show clear reductions in occupational exposures at commercial nuclear power reactors of all types. This reduction is most likely the consequence of competitive pressures from deregulation, which drive utilities to perform work more efficiently, often resulting in less exposure.

In the field of nuclear emergency planning, preparedness and management, there is a clear trend towards using modern data and information exchange technology to improve the effectiveness and efficiency of these exchanges. Electronic means are being developed and tested for sending the first notification of an accident situation to other countries, and for exchanging information as the situation evolves. This helps to answer calls for greater transparency in the increasingly global context in which we work. International co-ordination is considered to be particularly important regarding countermeasures and relevant criteria, as well as for information to the public and the media.

Annual occupational exposure trends
for two reactor types in OECD countries



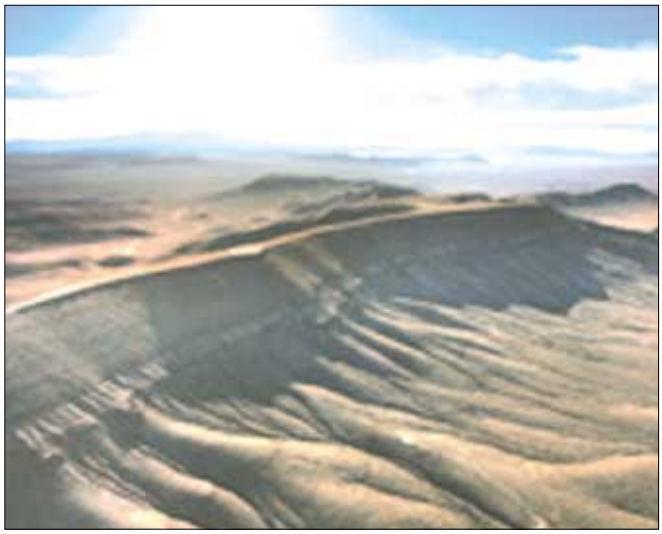
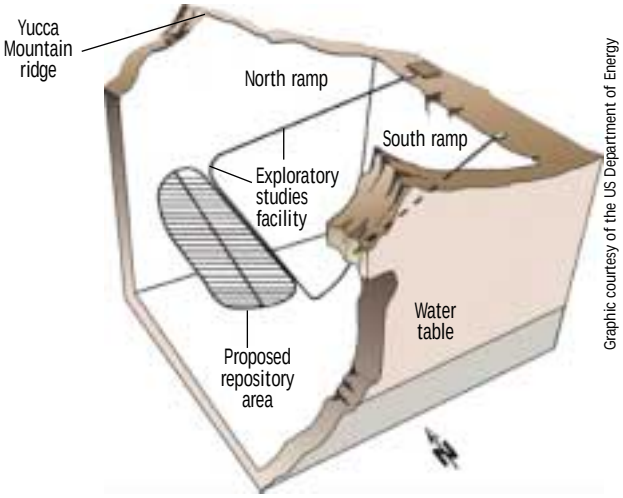


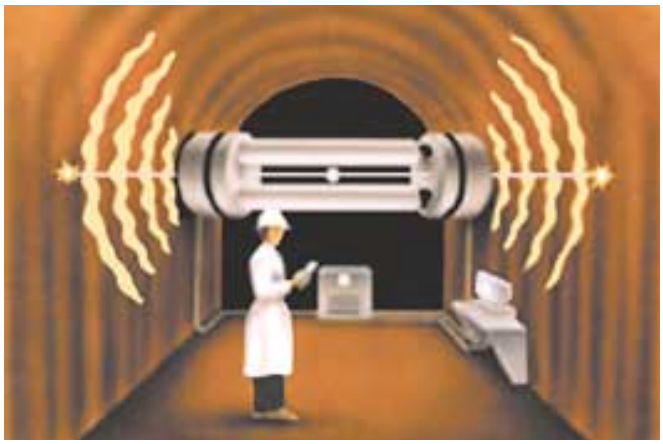
Photo courtesy of the US Department of Energy

Yucca Mountain, site of a potential geologic repository.



Graphic courtesy of the US Department of Energy

Subsurface layout of the site.



Graphic courtesy of the US Department of Energy

The rock's response to stress:
movement, cracking and other changes could affect the rock's suitability for housing a repository. This test, conducted at several locations, measures how Yucca Mountain rock responds. Aluminium jacks set horizontally inside a test alcove apply force to rock walls. Instruments monitor movement of the walls and compression of the rock beyond the walls. Measuring the squeezing of the rock provides scientists with data they can use to predict how stresses will affect the rock.

Radioactive waste management

While waste management programmes continued to be strategically focused on the development of deep repository systems for long-lived radioactive wastes, the dialogue with stakeholders during the decision-making process gained increased attention. Government and industry began to make specific provisions for public involvement, notably in Canada, Finland, France, Switzerland and the United Kingdom. By way of example, the Government of Canada recommended that a comprehensive public participation programme and the development of an ethical and social assessment framework form part of a future approach to deep repository development.

Significant progress has been made towards implementing geologic repositories in Member countries. Two such facilities – the Waste Isolation Pilot Plant (WIPP) in New Mexico, USA, and the Hindalen facility in Norway – started routine operation in 1999. For the Yucca Mountain repository in Nevada, USA, a draft environmental impact statement was released and the development of a detailed regulatory framework progressed through the publication of site-specific environmental standards proposed by the US Environmental Protection Agency. In Finland, an application for a "Decision in Principle" (DIP) was submitted to the Government, in which Olkiluoto was proposed as a disposal site. The council of the host municipality endorsed the DIP.

In some Member countries, R&D programmes constitute an important part of the decision-making process for implementing a geologic repository. In this respect the "H-12" report was submitted to the Japanese authorities to demonstrate the technical reliability of the specific geologic disposal plan in Japan, and to provide the scientific and technical basis for both the siting procedure and the development of an appropriate regulatory framework. In Sweden, a new analysis of the long-term safety concept (KBS/3) for spent fuel disposal was delivered to the government authorities. This report forms part of the information basis required to select two sites for further site investigation out of six Swedish communities for which feasibility studies are presently being carried out.

Nuclear science

This year increased attention was paid to new and advanced nuclear applications, in comparison to the more traditional items such as the utilisation of mixed-oxide (MOX) fuel, high burn-up fuel, and the lifetime extension of power plants. New topics in the field included high-temperature engineering, pyrochemistry applications and scientific issues related to the production of hydrogen using nuclear processes. The interest in physics aspects of waste transmutation and the chemistry of waste separation remained high.

The spectacular development in computing power is having a strong impact on the modelling and predictive calculations of various reactor and fuel cycle physics parameters. Monte Carlo methods are being increasingly used, as compared to deterministic methods. In addition, calculations of full three-dimensional models are now being performed regularly, improving the accuracy of the results by eliminating the approximations associated with two-dimensional methods. The trend is to use 3D best-estimate methods in a growing number of applications, for example to detect radiation damage of reactor pressure vessel walls.

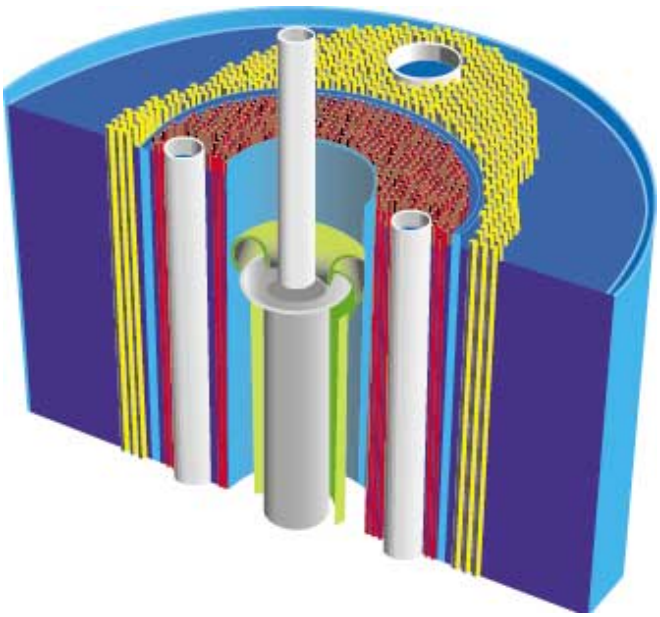
Nuclear data and software

Nuclear data and software activities in OECD Member countries concentrate on developing computer programs and associated data for the simulation and accurate prediction of different nuclear phenomena, needed for research and testing in various nuclear fields (the nuclear fuel cycle, nuclear safety, radioactive waste management...).

In terms of nuclear data, interests focused in 1999 on the scientific aspects of actinide partitioning and transmutation, which seeks to reduce the intensity and duration of the radioactivity of nuclear waste. The need for additional intermediate-energy nuclear data for accelerator-driven transmutation systems has been confirmed, triggering new data measurements and evaluation activities. More accurate nuclear data are also required for better evaluating the safety margins and improving the economics of nuclear power plants.

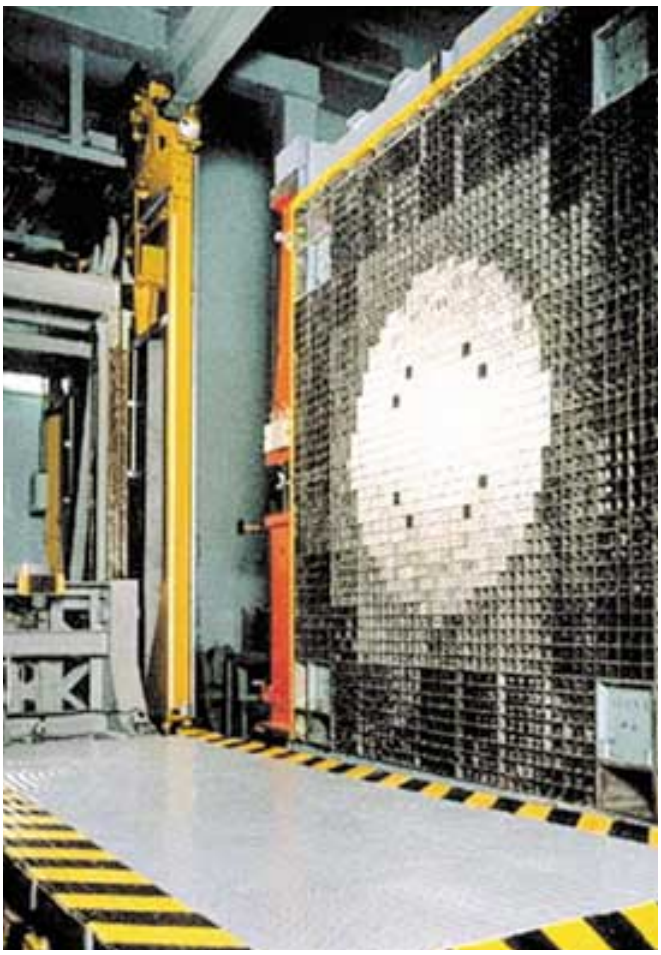
The need to transfer knowledge from the scientists approaching retirement age to the new generation of researchers requires careful attention, including the organisation of training courses on the applicability and correct use of certain important computer programs and the preservation of data. In the latter case, there is presently strong support for the preservation of so-called "integral data", measured at research reactor facilities.

Concept of a neutron spallation source surrounded by a sub-critical transmutation system



SCK•CEN Mol, Belgium

Fast Critical Assembly (FCA) at JAERI, Japan.



JAERI, Japan

Nuclear law

Sound national and international legal frameworks are essential to the safe use of nuclear power worldwide. More particularly, modernising and encouraging adherence to the international conventions on nuclear liability will help ensure the equitable compensation of nuclear damage in the event of a nuclear incident, while at the same time facilitating international trade of nuclear materials and equipment. In response to efforts made by the international community in 1997 to reform the nuclear liability regime established by the Vienna Convention, the Contracting Parties to the Paris Convention have been actively negotiating a revision of the latter instrument, and the Contracting Parties to the Brussels Supplementary Convention have just begun deliberations on revising theirs as well. Major reasons for undertaking these revisions are to ensure, to the greatest degree possible, compatibility with, and accessibility to, other existing international nuclear liability instruments that provide for either extended geographical coverage, supplementary funding for compensating victims, or both.

The trend to strengthen the institutional and legislative framework in the field of nuclear energy in the countries of Central and Eastern Europe and the New Independent States continued. Countries from these areas pursued their adherence to international conventions in the field of nuclear law, as well as the process of modifying and modernising their national legislation accordingly.

Nuclear Development and the Fuel Cycle

Nuclear Development Committee (NDC)

Mission

■ To provide authoritative, reliable information on nuclear technologies, economics, strategies, and resources to governments for use in policy analyses and decision making, including on the future role of nuclear energy within the context of energy policies that contribute to sustainable development.

Nuclear policy issues

Energy and electricity market deregulation and sustainable development issues, particularly the environment, were high on the agenda in 1999, and several NEA activities investigated how they are affecting nuclear energy policies. A meeting for energy policy makers, organised jointly by the IEA and the NEA, addressed issues raised by the current trends in nuclear power in OECD countries. The meeting, called "Business as Usual and Nuclear Power", offered opportunities for senior governmental officials and representatives from the nuclear industry to present their respective views and policies. The proceedings will be published early in 2000.

The study on educational programmes in the nuclear field undertaken in 1998 was completed. The report, which will be finalised in 2000, highlights concerns expressed by the scientific community about a potential shortfall in nuclear expertise in the medium and long term, and recommends that governments and industry consider measures to ensure the implementation of adequate educational programmes. (See also related work described in "Nuclear Safety and Regulation" on assuring nuclear safety competence into the 21st century.)

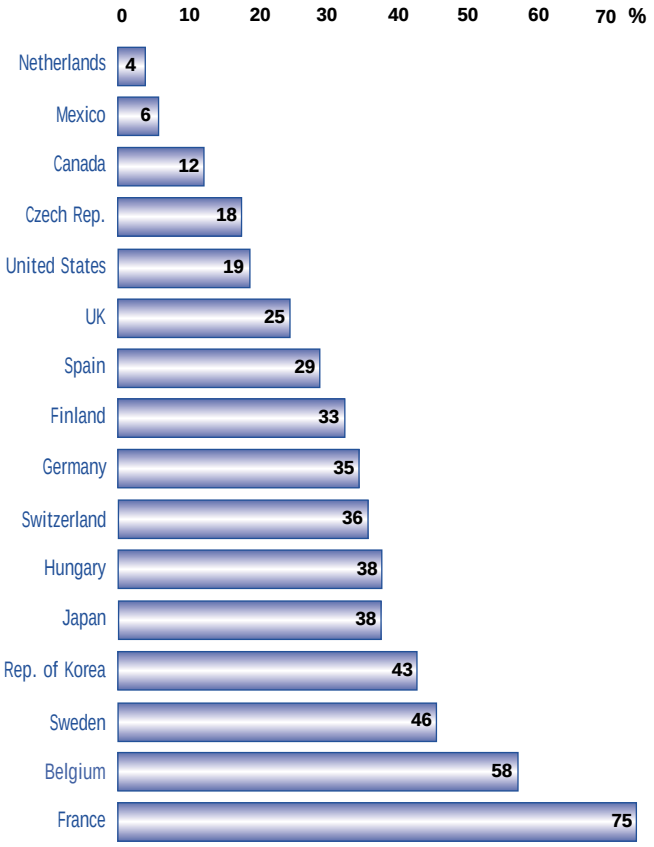
Plant life management (PLIM) is an important topic in OECD countries, where nuclear units are ageing and decisions have to be taken on refurbishment or retirement and decommissioning. In 1999, the NEA published a five-language glossary of PLIM terminology in order to provide utility operators, regulators and policy makers with a common set of terms that have uniform, industry-wide meanings, and to facilitate discussion between experts from different countries.

Economics

In response to priorities identified by Member countries, activities in the field of economics focused on analyses of capital costs of nuclear power plants, and ways and means to reduce those costs, as well as the impacts of electricity market deregulation on nuclear power competitiveness.

The study on *Reduction of Capital Costs of Nuclear Power Plants* concluded that significant economic gains could be obtained through technological progress, enhanced project management and policy measures. The report, to be published early in 2000, highlights possible improvements in design and construction, and illustrates through

Nuclear power share of total electricity production in OECD countries (1999)



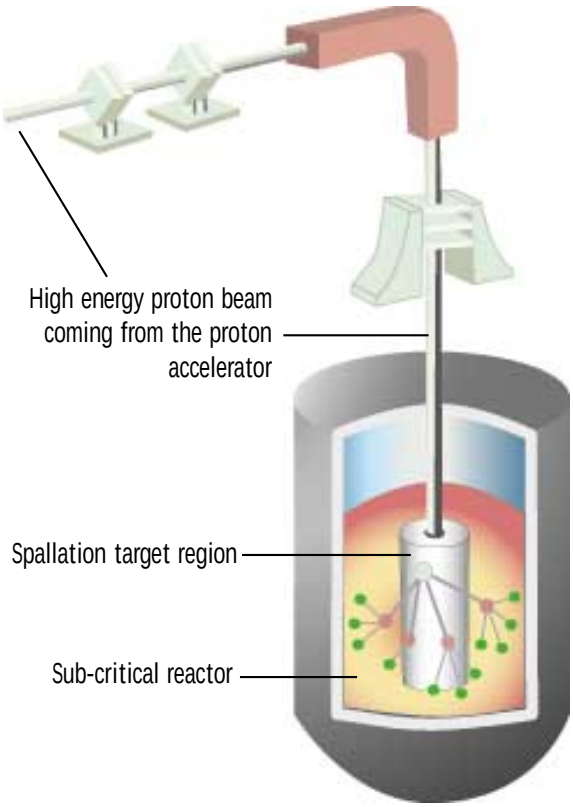
examples provided by various countries and manufacturers the expected achievements in terms of capital cost reduction.

In the area of economic deregulation, a study was undertaken to cover such topics as the impact of market deregulation on competitiveness, guaranteeing funds for financing future liabilities and restructuring the nuclear industry. It is expected to be completed in the first quarter of 2000. A workshop will be held in 2000 in order to review technological and policy issues related to nuclear plant life extension in a deregulated electricity market. The workshop will aim at drawing conclusions of interest to decision makers.

Technology

Several nuclear fuel cycle studies were under way in 1999, including a review of trends and analyses of various aspects of the back-end of the nuclear fuel cycle, with emphasis on actinide and fission product partitioning and transmutation. The studies in this field will be pursued in 2000 and are expected to be completed by 2001. Key milestones and findings from the activities on partitioning and transmutation are published on a continuing basis on the NEA web site.

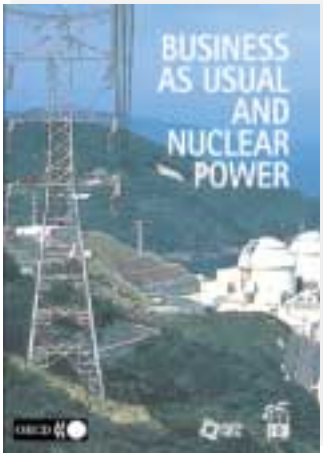
Schematic diagram of
an accelerator-driven system



In co-operation with the International Energy Agency and the International Atomic Energy Agency, the NEA is carrying out a study on R&D programmes on innovative reactor designs. The main objectives of the study are to review ongoing activities in the field of R&D focusing on innovative reactor designs and to identify the potential role of international co-operation in enhancing the efficiency of national R&D programmes.

Highlights

- A joint NEA/IEA meeting was convened in October to discuss the future of nuclear power in OECD countries and assess the long-range implications of the current trends in nuclear power for energy policy and the nuclear industry.
- The Joint NEA-IAEA Uranium Group undertook a review of environmental activities in the uranium mining and milling sectors that led to the publication of a report covering 29 countries.
- Co-operation with other OECD bodies was strengthened through active participation in horizontal projects, such as the preparation of the 2001 OECD Ministerial meeting on sustainable development.



Data and resource assessment

The 1999 update of *OECD Nuclear Energy Data* provided key figures on nuclear power programmes and fuel cycle activities in Member countries.

A report on environmental activities in uranium mining and milling was published under the auspices of the Joint NEA/IAEA Uranium Group. The study provides an overview of activities related to environmental protection during mining and milling operations, and restoration and reclamation measures taken after the closing of old sites. The survey covers activities reported by 29 countries.

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Nuclear Safety and Regulation

Committee on the Safety of Nuclear Installations (CSNI)
Committee on Nuclear Regulatory Activities (CNRA)

Mission

To assist Member countries in maintaining and further developing:

- the scientific and technical knowledge required to assess the safety of nuclear reactors and other nuclear installations;
- efficient and effective regulation that is based on current scientific and technical knowledge and gives priority to factors most important to the safety of nuclear power reactors and other nuclear installations.

Primary coolant system behaviour

Work in this area focuses on thermal-hydraulic phenomena of the primary cooling system, degraded core cooling and safety aspects of fuel behaviour. One of the most important issues is the evaluation of existing thermal-hydraulic safety margins. A number of activities are in progress, such as the international standard problem (ISP) benchmark exercises of various best-estimate thermal-hydraulic codes, their experimental validation and verification, and related methodological studies dealing with uncertainties, aimed at evaluating these margins.

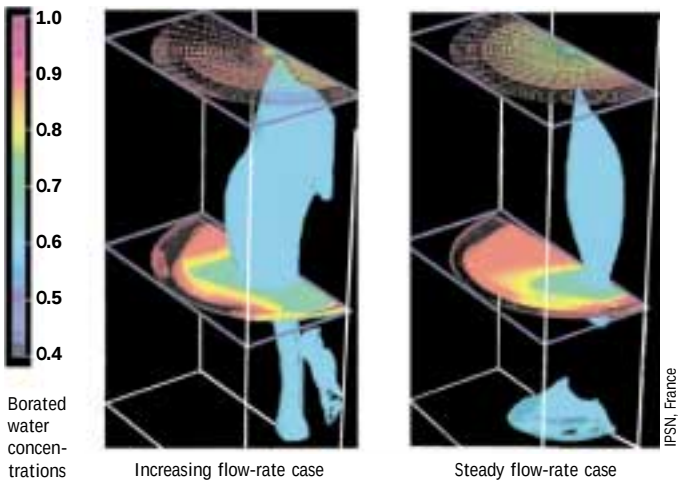
The interaction of the reactor core molten material with water, known as fuel-coolant interaction (FCI), is one of the most complex technical issues involving a number of thermal-hydraulic and chemical phenomena. This issue and its potential impact on reactor vessel and containment integrity have been studied and discussed in detail. A technical opinion paper on FCI was prepared, containing a brief summary of current views of the leading NEA experts, based on the characteristics of modern, western-style power plants. It concludes that the probability of in-vessel FCI causing containment failure is very low and therefore of little or no significance to overall risk.

A special effort has been made to address the safety issues of fuel performance. Various types of fuels and core designs, including under high burn-up conditions, were investigated from the safety point of view. The ensuing report, *Fuel Safety Criteria Technical Review*, was completed and will be published in early 2000.

International Standard Problem No. 42, based on a special experiment carried out at the PANDA facility, Paul Scherrer Institute, Switzerland is an ongoing, complex exercise involving various phases of design basis accident (DBA) and beyond DBA scenarios. It is designed to investigate the behaviour of primary coolant systems and passive safety systems performance under a variety of conditions. The exercise provides the opportunity to test capabilities of primary coolant system codes, containment codes (lumped parameter and 3D), computational fluid dynamics (CFD) codes and possibly severe accident codes. The exercise will be completed in the year 2000.

Ongoing International Standard Problem No. 43 on boron dilution is based on experiments being conducted at the University of Maryland test facility. The purpose of this ISP is to check how the existing CFD codes are able to predict transport and mixing of a boron slug in the primary circuit. The first workshop was held in October 1998. The final workshop and the final draft report are planned for the first half of the year 2000.

Test results from experiments on the mixing of borated water in the reactor core



In blue: borated water concentration lower than 0.6.
Time: 18.1s for an 8m³ inlet plug.

Ageing and structural integrity of reactors

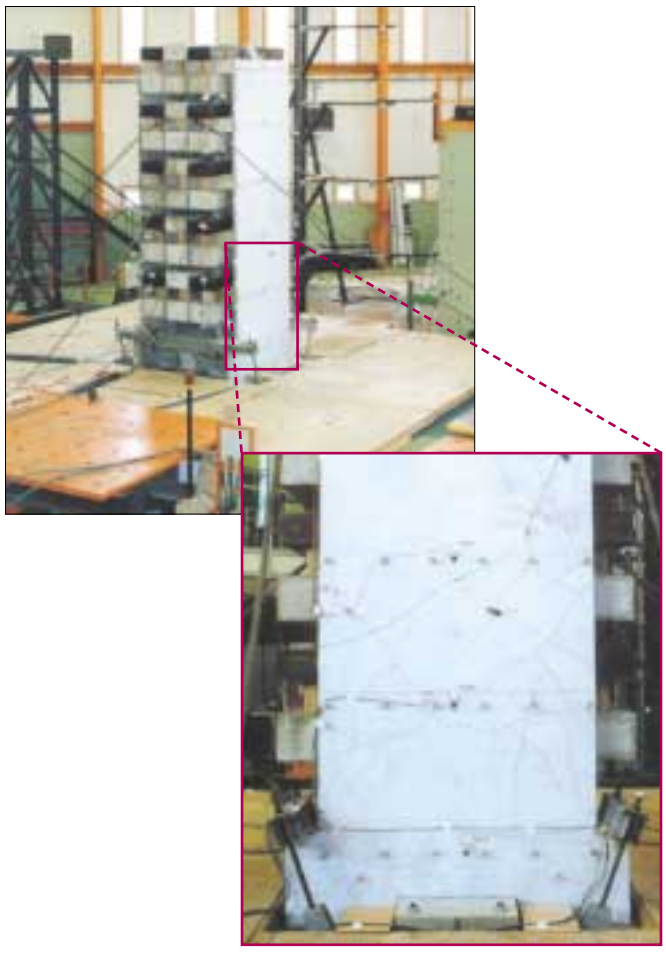
The main topics investigated in this area include metal components, concrete structures and seismic behaviour. Two workshops were held and three reports issued.

In the area of metal components, a comparison report was issued from a benchmark exercise on reactor pressure vessel pressurised thermal shock analysis. This exercise combined deterministic and probabilistic fracture mechanics analyses and thermal hydraulics mixing analyses. The exercise attracted many participants and went a step beyond previous exercises that only considered fracture mechanics aspects.

Regarding concrete structures, the proceedings were issued of a workshop held in November 1998 on the static and dynamic finite element analysis of degraded concrete structures. Unresolved questions were identified regarding the modelling of material behaviour in such circumstances. Leaktightness of containment continues to be studied closely.

In the field of seismic engineering, a workshop was held on the engineering characterisation of seismic input. Experience with recent earthquakes in Japan, Turkey and Chinese Taipei will be used to validate and improve present methods. A workshop was also held on seismic risk, in conjunction with performance safety assessment work.

CAMUS 1 seismic engineering tests on a 5m-high, reinforced concrete model weighing 36 tons.



CEA, France

Highlights

- The CSNI produced 35 reports and technical opinion papers this year, organised seven major workshops and provided support to five international projects.

- The CNRA produced a selection of reports, including *The Role of the Nuclear Regulator in Promoting and Evaluating Safety Culture and Regulatory Response Strategies for Safety Culture Problems*.

- To minimise potential safety-related problems associated with the "millennium bug", an NEA worldwide information exchange system, the Y2K Early Warning System (YEWS), based on a US Nuclear Regulatory Commission initiative, was tested and made operational in time for the transition to the year 2000.

Confinement of accidental radioactive releases

Work in this field continued to focus on the exchange of information and joint activities in the areas of severe accident phenomena in the reactor containment and containment aspects of severe accident management. An important component of these activities concerns fission product phenomena in the containment and the primary circuit. A computer code comparison in the framework of an international standard problem (ISP) benchmark exercise based on an experiment performed at the Whiteshell Laboratories of AECL in Canada (ISP-41) was completed. A state-of-the-art report on *Flame Acceleration and Deflagration-to-Detonation Transition in Nuclear Safety* was completed, as well as reports on the impact of short-term severe accident management actions on long-term severe accident management; accident management aspects of the control of fission products in the containment during a severe accident; and carbon monoxide/hydrogen interactions in the containment.

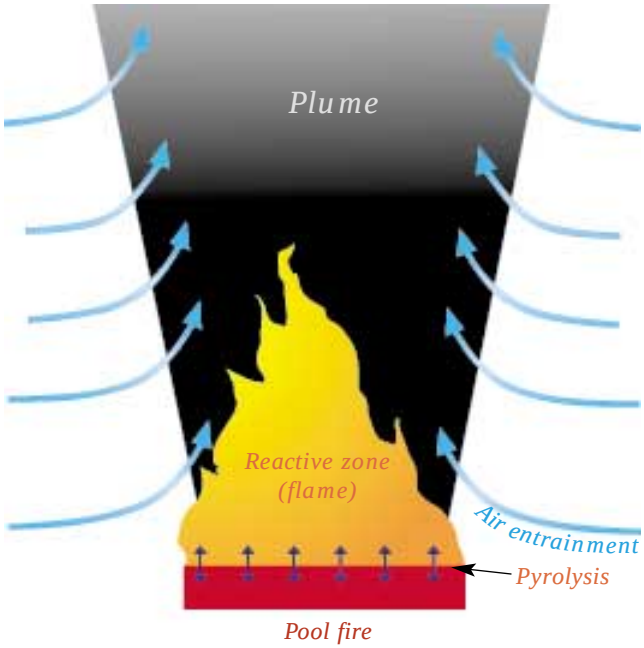
Two specialist workshops were held during the year. The first was devoted to iodine aspects of severe accident management. Its main aim was to provide a link between iodine research and the application of its results in nuclear power plants, with particular emphasis on severe accident management. The topic of the second workshop was ex-vessel core debris coolability. Its primary objective was to review the current situation in this field and identify areas where knowledge is adequate for plant application.

Risk assessment

The main mission of the working group on risk assessment is to advance the understanding and utilisation of probabilistic safety assessment (PSA) in order to ensure the continued safety of nuclear installations in Member countries. PSA methodology has matured greatly over the past years, but further work is still required, especially in such areas as human and software reliability. In order to remain abreast of current perspectives, the group collaborates with other CSNI working groups (in particular on operating experience and human and organisational factors) and other international organisations.

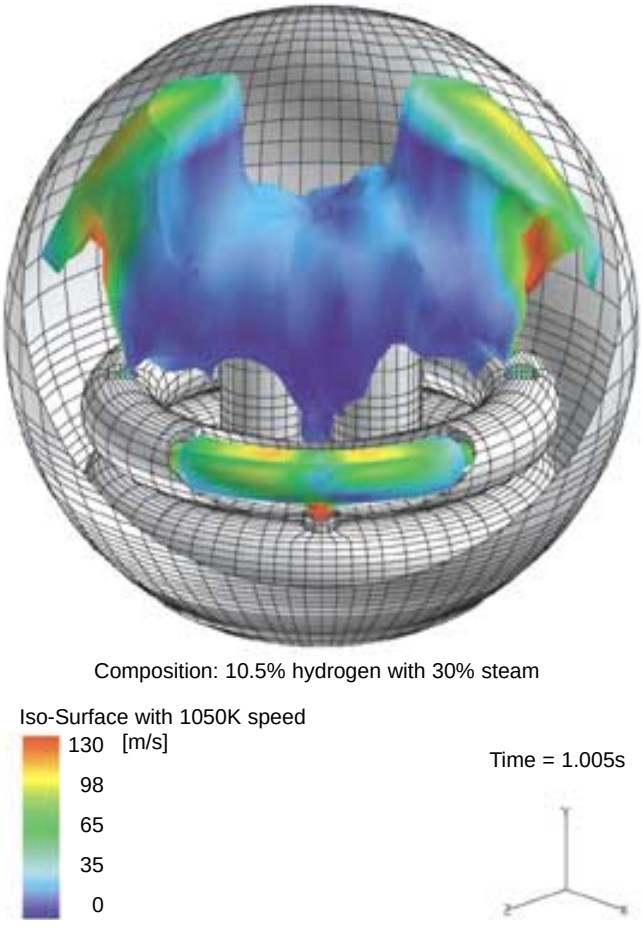
Major state-of-the-art reports were completed on *Errors of Commission in Probabilistic Safety Assessment and Fire Risk Analysis*, *Fire Simulation, Fire Spreading and the Impact of Smoke and Heat on Instrumentation Electronics*. Proceedings of two workshops were also issued on seismic PSA and fire risk assessment. In addition to the task initiated last year on software reliability, the working group will begin updating past reports on low power and shutdown PSA; risk monitor applications; passive systems PSA; and possibly level-2 PSA (assessing the frequency of releases of molten material in the reactor containment).

Physical phenomena
in an open atmosphere fire



IPSN, France

NUPEC large-scale hydrogen combustion test used in the framework of severe accident research



GRS, Köln, Germany

Safety research

The Group of Senior Experts on Nuclear Safety Research Facilities and Programmes continued to investigate the implications of the decrease in nuclear safety research funding and the untimely shutdown of important research facilities and capabilities. It prepared a short list of essential and unique facilities for thermal hydraulics and severe accident research that were under threat of immediate closure, and made recommendations for their preservation and future use through international collaboration. It also identified areas where essential capabilities were in danger of disappearing or being dispersed soon, and made recommendations regarding the organisation of Centres of Excellence where facilities and teams of experts could be maintained in order to ensure the continued availability of advanced knowledge necessary for future nuclear safety programmes. The group also made recommendations regarding the setting-up of data banks, the establishment of networks of experts and research facilities, and other forms of international collaboration. Follow-up to the recommendations is being organised by the CSNI.

Assuring nuclear safety competence into the 21st century

A workshop was held to consider the issue of assuring nuclear safety competence into the 21st century. The purpose of the meeting was to exchange views on the most efficient approach to recruiting, training, and retaining safety staff, and preserving a critical mass of knowledge in both industry and regulatory bodies. In its 1998 report on *Future Nuclear Regulatory Challenges*, the CNRA identified the human element as one of the most critical aspects of maintaining regulatory effectiveness, efficiency and quality of work; and emphasised that there is a need to preserve among staff a collective knowledge in all relevant technical disciplines with sufficient depth to permit adequate

independent assessment of safety issues. In most Member countries the majority of experienced experts will be leaving the nuclear field over the next decade or so and will not be replaced by younger specialists, as nuclear energy careers are not very attractive any more and nuclear engineering schools are disappearing rapidly. The issues are of concern not only for the nuclear industry, but also for governments, as safety must be ensured into the future. The workshop examined the current situation as well as future trends and challenges, and discussed possible solutions. Recommendations were made and are being considered by the CNRA.

Co-operation with the CEEC and the NIS

A programme of co-operation with both the central and eastern European countries (CEEC) and the New Independent States (NIS) of the former Soviet Union is being carried out in the safety area. The aim of the programme is to assist the CEEC/NIS in the planning, development and execution of safety research programmes with a view to building up local capabilities in safety technology and safety analysis, in particular with respect to VVER reactors. In 1999, work continued in collaboration with CEEC/NIS experts on the development of a VVER code validation matrix, i.e. identifying specific tests and facilities necessary to validate the computer codes used to simulate the thermal-hydraulic behaviour of VVER-type reactors, and the performance of their safety systems following postulated accidents. NEA experts also continued to provide technical support for verifying the ability of the bubbler condenser containment system of VVER-440/213 reactors to maintain its integrity following certain postulated accidents, and thus limit the release of radioactive material to the environment. CEEC and

NIS experts attend meetings of the CSNI, the CNRA, NEA workshops and specialist meetings, and participate in international standard problem exercises. At the request of the Russian authorities, NEA experts performed a review of the MINATOM Safety Research Strategic Plan for Russian Nuclear Power Plants.

Safety culture

Two short reports were completed during the year: *The Role of the Regulator in Promoting and Evaluating Safety Culture* and *Regulatory Response Strategies for Safety Culture Problems*. The first report gives general guidance on how to recognise early signs of declining safety performance. The latter provides a general framework for step-wise regulatory attention once early signs of declining safety performance have been observed.

Regulatory effectiveness

A workshop was held on developing and measuring regulatory effectiveness in the nuclear energy field. Regulators were the main participants, with some representatives from the nuclear industry and government participating too. Following that workshop, and in order to take the discussions a step further, a small strategy group was established to examine case studies on regulatory effectiveness models as well as the use of internal QA and indicators of effectiveness.

Operating experience and human factors

The joint NEA and International Atomic Energy Agency (IAEA) Incident Reporting System (IRS) is the only international system of its kind providing regulators and governmental organisations with an assessment of safety-significant events. The system contains some 2 800 reports, and is increasing by more than 100 reports per year. The IRS database is distributed on CD-ROM and is used in all Member countries.

Examples of work carried out in the areas of operating experience and human factors are given below:

- A database on operational experience related to computer-based systems important to reactor safety was initiated for a trial period.
- An international common-cause failure data exchange was established as an OECD project to provide qualitative understanding of common-cause failure events, their basic causes and possible remedies. Data collection guidelines and a report on centrifugal pumps were prepared, while data collection on diesel generators and motor-operated valves progressed.
- A state-of-the-art report on the identification and assessment of organisational factors for safety in nuclear power plants was finalised.
- Workshops were held on human factor aspects of upgrading and refurbishment of control rooms as well as the transition period from operation to decommissioning.

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Radiation Protection

Committee on Radiation Protection and Public Health (CRPPH)

Mission

To assist Member countries in the regulation and application of the system of radiation protection by identifying and addressing conceptual, scientific, policy, operational and societal issues in a timely and prospective fashion, as well as clarifying their implications.

Controllable dose and the use of collective dose

In recent years, broad discussions of various aspects of the system of radiation protection, as recommended by the International Commission on Radiological Protection (ICRP), have intensified, and have also been taken up by a technical community somewhat beyond traditional radiation protection specialists. Specifically, it has been suggested that the "apparent incoherence" of the system of radiation protection should be addressed, particularly in light of the increased pressure by civil society to limit risks to human beings and to become more involved in radiation protection decision making. The CRPPH is contributing to this discussion by carrying out a critical review of the system of radiation protection.

One very important aspect of this review concerns the nature and use of the concept of collective dose (estimating the number of expected health effects in an exposed population based on the sum of individual doses to the population). Important aspects of the discussion include: When is collective dose a relevant concept? When could and should it be used? What are the limitations and pitfalls? How should it be used, if at all? What are the experiences in Member countries?

The CRPPH discussed these issues and prepared a draft review paper which will be finalised during the Committee's April 2000 meeting. The main headings of this paper, to be published in 2000, include:

- Transparency of the radiation protection framework;
- Terminology and presentational issues;
- Risk versus dose;
- The practical application of optimisation;
- The concept of triviality;
- The use of collective dose.

This work is intended to contribute to ongoing debates concerning the system of radiation protection. It is assumed that these debates will eventually result in consensus and form the basis for the next round of ICRP general recommendations, probably in the 2005 to 2010 timeframe.

Stakeholder involvement in the assessment and management of radiological risks

One of the aspects of the "modernisation" of the system of radiation protection is the increasing involvement of various stakeholders in the decision-making processes. This is particularly true in situations involving public exposure to radiation. In cases such as the siting of radioactive waste repositories, or addressing the concerns of populations living in contaminated areas, new decision-making and conflict-resolution approaches are necessary to arrive at solutions acceptable to all.

To investigate these approaches, a workshop will be organised in the fall of 2000 that will include discussions of illustrative case studies, conflict-resolution theories, mechanisms for their implementation, and practical examples thereof. This work will draw not only on input from previous CRPPH workshops on decision making, but also on the Committee's work in the area of comparative risk assessment and management.

Measuring radioactivity near a fuel storage facility at the Cadarache centre in France.

Gamma/Le Corre, CEA, France

Comparative risk assessment and management

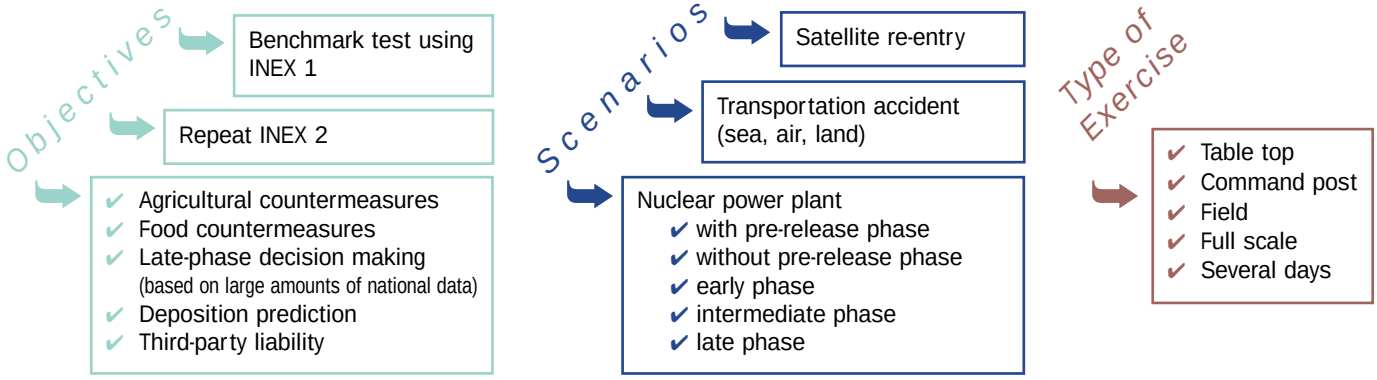
Work on comparative risk assessment and management culminated in the completion of a report on this subject in April 1999. Risks from public and worker exposure to radiation, asbestos and nickel aerosols from the petrochemical industry were addressed.

The report concluded that the management and assessment of risks in the three cases discussed appear to be very similar. In the case of ionising radiation, the dose-effect relationship is based on the follow-up of survivors of Hiroshima and Nagasaki. This relationship is comparable to those established for asbestos and certain nickel compounds, which are also based on the epidemiological study of various situations involving occupational exposure. Thus for all three carcinogenic hazards, it is considered appropriate to assume that effects at low levels of exposure can be presented based on measured effects at high exposures. Subject to some limitations, optimisation (as used in radiation protection) can be applied to protective actions preventing exposures to both asbestos and nickel. In addition, protective actions against all three hazards are not aimed at achieving zero risk. Other similarities as well as some differences in the assessment and management of these three risks are detailed in "A Comparison of Methods for Assessing and Managing the Carcinogenic Risks Associated with Asbestos, Nickel (and Nickel Compounds) and Ionising Radiation".

Highlights

- A broad dialogue was initiated on and directions were proposed for the future evolution of the internationally accepted system of radiation protection.
- A study showed similarities in the approaches used to assess and manage risks from radiation, asbestos and nickel aerosols.
- A workshop discussed and summarised the lessons learned from the series of four international nuclear emergency exercises in Switzerland, Finland, Hungary and Canada (INEX 2), and discussed future exercises.
- The membership of the Information System on Occupational Exposure (ISOE) grew to 429 reactors owned by 79 utilities in 28 countries and included regulatory authorities from 23 countries.

Future generation of INEX exercises



INEX

As part of the second series of International Nuclear Emergency Exercises (INEX 2), an exercise was organised in 1999 simulating an accident at the Darlington nuclear power plant in Canada. This was the final exercise in the INEX 2 series, which included earlier exercises in Switzerland, Finland and Hungary. A meeting summarising the lessons learned from these four exercises was organised by the NEA in late November, and a discussion on future exercises was held. The lessons learned regarding nuclear emergency management policy, together with a long-term strategy for future International Nuclear Emergency Exercises, will be published in 2000. The INEX 2 exercises have also been successful in identifying areas in which data and information management could be improved, and in testing possible mechanisms for this purpose. The report, entitled *Monitoring and Data Management Strategies for Nuclear Emergencies*, was prepared for publication in early 2000.

A new exercise, INEX 2000, similar in size and scope to those of the INEX 2 series, will be held with the objective to test the ability of modern data and information exchange technology to improve the effectiveness and efficiency of exchanges, and to serve the needs of decision makers better. In addition, INEX 2000 will be the first series to address civil liability questions in the early phase following a nuclear emergency.

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Radioactive Waste Management

Radioactive Waste Management Committee (RWMC)

Mission

■ To assist Member countries in developing safe management strategies and technologies for spent fuel, long-lived waste and waste from the decommissioning of nuclear facilities.

Geologic disposal

A major review was completed of recent developments in the field of deep geologic disposal of long-lived radioactive waste. The full report, entitled *Geological Disposal of Radioactive Waste: Review of Developments in the Last Decade*, covers the scientific and technical bases for deep geologic disposal, safety assessment, legal and regulatory developments, and communication with the public. The primary sources of input to the study were the answers to a questionnaire provided by NEA Member countries, as well as by the EC and the IAEA, and evaluations of literature, workshops and reports from Member countries and international organisations. In addition to the full report, a summary report was published under the title *Progress Towards Geologic Disposal of Radioactive Waste: Where Do We Stand?*

Peer reviews

The Japan Nuclear Cycle Development Institute (JNC) submitted a request to the NEA to organise an international peer review of the just-released "H-12 study". This major R&D study provides a decision-making basis for moving the Japanese waste disposal programme from the present R&D phase to a new phase in which siting and regulatory procedures would be formulated. The NEA review provided valuable input in the areas of geology, repository technology and safety assessment.

The international peer review *NIREX Methodology for Scenario and Conceptual Model Development* was completed during 1999. The primary purpose of the review was to judge whether the NIREX methodology provided an adequate framework to support the building of a future licensing safety case. Another objective was to determine whether the methodology could aid in establishing a better understanding, and, ideally, enhance acceptance of a repository among stakeholders (the scientific community, policy makers and the public). The report is available free of charge at http://www.nea.fr.

Retrievability

Retrievability of disposed waste and reversibility of disposal actions taken are currently being considered in many radioactive waste management programmes worldwide. The concepts span technical, regulatory and ethical issues and it is important that a broadly based understanding is developed of their strategic value and implications. The RWMC has begun preparing a document intended to provide a comprehensive yet concise overview of the issues concerned.

Integrated performance assessments

In every radioactive waste management programme, integrated performance assessments (IPAs) of radioactive waste repositories are at the core of the safety case. After having evaluated the lessons learnt from the conduct of IPAs, a second study, which analyses IPA review experiences of ten implementers and seven regulatory organisations, was prepared for publication under the title *Regulatory Reviews of Assessments of Deep Geologic Repositories: Lessons Learnt*. In order to draw additional lessons from preparing, presenting and reviewing IPAs, a follow-up project was initiated which will focus on the approaches and arguments used to establish confidence in the overall results of IPAs.

Scenario methodologies

A workshop on scenario development for evaluating the safety of radioactive waste repositories was organised in Madrid, Spain on 10-12 May 1999 to review recent developments and practical experience in scenario methodologies, and to prepare an update of the 1992 report summarising the status in this field, identifying where sufficient methods exist and flagging any outstanding problem areas. Participants discussed methodologies and best practice, based on a

The Tono Geoscience Center in Toki, Gifu Prefecture, Japan.

JNC, Japan

questionnaire circulated before the workshop. The report is in preparation for publication in 2000.

Sorption

Sorption is a combination of physical and chemical processes by which the migration of radionuclides in the geosphere (and possibly from a radioactive waste repository) can be slowed down under certain conditions. Better understanding of the sorption phenomena in radionuclide migration is important for reducing uncertainties and increasing confidence in assessments of the performance of waste repositories. The NEA seeks to enhance scientific understanding in this area through its sorption project.

The first phase of the sorption project ran from 1997 to 1998, with a workshop being held in Oxford in May 1997. A report updating relevant information on the use of important parameters describing sorption processes is in preparation.

A second phase of the sorption project was initiated. It will take the form of a benchmarking exercise for the different modelling approaches in use at various waste management organisations. By applying these various approaches in a systematic way to the same measured data, an evaluation of their merits and limitations will be possible, as will recommendations on their use.

These projects help to improve modelling processes and their respective data form part of the TDB Project (see "Joint Projects").

Clay Club

Defining the chemical and isotopic composition of groundwater present in argillaceous formations is a crucial part in the assessment of the long-term performance of barriers for waste repository systems in such geologic media. The NEA "Clay Club" produced a critical review, for publication in 2000, of the relevant literature on current methods used to extract water and solutes from all types of argillaceous media considered for waste disposal, and on the various approaches to the interpretation of their results. An ongoing initiative is aimed at providing a detailed catalogue of "features, events and processes" (FEPs) specific to the disposal of long-lived waste in argillaceous formations.

GEOTRAP

The NEA GEOTRAP Project on Radionuclide Migration in Geologic, Heterogeneous Media published the proceedings of its third workshop and organised its fourth workshop in Carlsbad, New Mexico in June at the invitation of the United States Department of Energy (USDOE). While the third workshop addressed the roles of water-conducting features of geologic structures in radionuclide migration, the fourth examined the technical confidence in current models used to calculate site-specific performance assessment. Proceedings of the latter are in preparation. The fifth GEOTRAP workshop will be hosted by SKB in Äspö, Sweden in 2000, and will address the theoretical basis for and geologic evidence of retention processes in heterogeneous geologic media.

Gas generation and migration

A substantive body of multidisciplinary experimental and modelling work related to the potential impacts of gas generation, accumulation and migration on the performance and long-term safety of underground repositories has been developed. The recently published joint EC/NEA report, *Gas Migration and Two-Phase Flow through Engineered and Geological Barriers for a Deep Repository for Radioactive Waste*, presents a synthesis of this material, which will help national and international programmes better focus future work. This state-of-the-art report will be complemented by a workshop aimed at examining future requirements for an adequate consideration of the gas issue in safety cases. It will be jointly organised by the NEA, the EC and the French radioactive waste management organisation ANDRA, the host of the workshop.

Highlights

- An RWMC study reviewed the developments in the area of geologic disposal over the last decade. The study found that the technology is mature enough for deployment, but that progress still needs to be made in building confidence and addressing the ethical and political dimensions of the issue.
- Integrated performance assessments (IPA) are at the core of the safety case. The RWMC analysed experience from regulator's reviews of IPAs conducted in eight countries.
- Gas generation from waste, its accumulation and migration are important safety issues for geologic repositories. A recently published joint NEA/EC report analysed the state of the art.
- The NEA completed two peer reviews: one of the Japanese "H-12 study", which forms a major decision-making basis for advancing to the next phase of the Japanese waste management programme, and one of the UK NIREX methodology for assessing the long-term safety of a deep geologic repository.

Decommissioning

The RWMC and several NEA committees, jointly with the IAEA and the EC, organised a workshop in Rome, Italy, in May 1999 to examine the regulatory aspects of decommissioning nuclear facilities. The workshop was hosted by the Italian National Environmental Protection Agency (ANPA) and identified various issues that require additional dialogue among regulators, implementers and waste handling organisations. Several topics have been identified that will be addressed in a series of cross-committee collaborative projects within the NEA framework. (See "Joint Projects" for further information regarding decommissioning activities.)

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Nuclear Science

Nuclear Science Committee (NSC)

Mission

■ To help Member countries identify, collate, develop and disseminate scientific and technical knowledge used to ensure the safe, reliable and economic operation of current nuclear systems and to develop next generation technologies.

During 1999, the main emphasis of the NEA in the field of nuclear science was on reactor and fuel cycle physics, fuel cycle chemistry, criticality safety and radiation shielding and dosimetry. In these and other related areas, the Agency examined international comparison exercises and benchmark studies in order to validate computational models and data used in Member countries for predicting the behaviour and performance of different nuclear systems. In addition, the Agency sponsored specialist meetings and workshops and co-ordinated the preparation of state-of-the-art reports.

Reactor physics

The main goal of the reactor physics programme is to establish with what precision different reactor parameters can be predicted in computational models through comparison with experiment. In 1999, special emphasis was given to the validation of methods used in the calculation of a main steam line break in a pressurised water reactor (PWR). The codes tested were three-dimensional, coupled neutronic/thermal-hydraulic codes. The final results will be published in 2000.

Another international comparison exercise related to reactor transients (power variations) was initiated in 1999. It concerned the consequences of a turbine shutdown in a boiling water reactor (BWR) and tested the coupling between reactor system dynamics and core phenomena.

Both of the above-mentioned activities were organised in close co-operation with the CSNI.

A workshop on "Core Monitoring for Commercial Reactors: Improvements in Systems and Methods" was held in Stockholm, Sweden in October 1999. The main objective was to discuss how instrumentation, methods and models used to monitor the core of a reactor could be validated, improved and further developed to provide more detailed information on the local power in the reactor core. The proceedings were prepared for publication in early 2000.

K. Niederau, KKB/NIK, Switzerland

Change of fuel elements at Beznau nuclear power plant in Switzerland. The reactor core consists of 121 fuel elements, each with 179 fuel rods 11mm in diameter and about 3m long.

Fuel cycle physics

The use of new fuel types in reactors and the extension of existing fuels to higher burn-up require refined knowledge of basic physics phenomena in order to maintain adequate safety margins. NEA activities in this area include the updating and maintenance of a database of nuclear fuel behaviour experiments under normal operating conditions. Data are constantly being added to this public domain database and it contained, at the end of 1999, data from some 380 well-documented experiments.

The utilisation of mixed-oxide (MOX) fuel in reactors was addressed in the two following activities:

- An international benchmark programme was put in place to examine studies of MOX fuel in a BWR and a MOX experiment performed at the VENUS zero power critical facility at SCK-CEN Mol, Belgium.
- An expert group on reactor-based plutonium disposition established a programme to review issues that must be addressed when switching from standard fuel to weapon-grade MOX fuel. Two meetings of this group were held in 1999.

Fuel cycle chemistry

A workshop was organised in Japan in October 1999 to review recent progress and applications of speciation technology to actinide and fission product elements in nuclear fuel cycle chemistry in order to develop optimal strategies for managing spent fuel and radioactive waste. The need, advantages, disadvantages and limitations of various speciation methods were discussed and recommendations for future R&D in this field were made. The NEA will publish the proceedings.

Nuclear criticality safety

The nuclear criticality safety programme deals with physics issues of relevance mainly to the transport and storage of nuclear fuel.

The joint USDOE and NEA project on International Criticality Safety Benchmark Experiments (ICSBEP) published a new edition of its handbook, which contains well-characterised data from about 2 500 critical configurations. The handbook was issued on CD-ROM in September 1999 and is available from the NEA.

A series of international benchmarks devoted to burn-up credit criticality have been carried out. Burn-up credit is a term used to describe the reduction in reactivity of the fuel due to the change in its composition during irradiation. Studies of PWRs have been completed and published. During 1999, results from studies on BWRs and MOX-fuelled reactors were analysed.

Partitioning and transmutation

Partitioning and transmutation (P&T) consists of separating the long-lived radionuclides contained in spent nuclear fuel and to transmute those to shorter-lived or even stable radionuclides using fast reactors or accelerator-driven systems. P&T is intended to allow a better use of natural resources, and to reduce the amount of high-level waste that needs to be disposed of as well as the possible impacts of such waste on the environment.

The second workshop on "Utilisation and Reliability of High Power Accelerators" was held in Aix-en-Provence, France in November 1999. The workshop brought together accelerator and reactor physics experts to discuss the performance of accelerator-driven nuclear energy systems (ADS) and their dependence on the reliability of the particle accelerator.

An international benchmark exercise to compare different transmutation concepts (PWR, fast reactor and accelerator-driven system) was finalised in 1999. The part of the benchmark devoted to accelerator-driven systems (ADS) was followed up at the end of 1999 by a new benchmark specification for a simplified ADS, where participants were asked to calculate different neutronic parameters (criticality level, fuel burn-up reactivity and safety parameters) at start-up and after five years of irradiation.

Highlights

- The results from a study on the calculation methods used and accuracies obtained in the prediction of reactor pressure vessel embrittlement due to neutron irradiation were published.
- A new edition of the nuclear criticality benchmark handbook, containing data from criticality safety experiments, was released.
- A first information exchange meeting was organised on the survey of basic studies in the field of high-temperature engineering.
- A workshop was organised on the evaluation of speciation technology.
- A programme was launched on transferring competencies gained from the use of mixed-oxide (MOX) fuel to programmes dealing with burning surplus weapon-grade plutonium in reactors.

Radiation shielding and dosimetry

The radiation shielding experiments database (SINBAD), maintained jointly by the NEA and the Radiation Safety Information Computational Center (RSICC), USA, contains peer-reviewed compilations from shielding experiments, with special emphasis on pressure vessel irradiation studies. About ten new or revised compilations of experiments were included in 1999. A new release of the database was issued and copies can be obtained on CD-ROM from the NEA.

It is essential to calculate the number of neutrons accurately in order to assess and predict reactor pressure vessel embrittlement and thereby ensure the safe operation of nuclear power plants. The NEA launched a programme to verify the expected accuracy in such calculations, using experiments performed at SCK-CEN Mol, Belgium as a basis. The results from this exercise show that full three-dimensional calculations give decisive improvements in the prediction of reactor pressure vessel embrittlement due to neutron irradiation.

A programme to validate computational algorithms used in three-dimensional radiation transport codes was carried out by the NEA. The results from a first series of benchmarks were circulated for peer review, before being published.

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Data Bank

Mission

To be the international centre of reference for its Member countries with respect to basic nuclear tools, such as validated computer codes and nuclear data, and to provide a direct service to its users by developing, improving and validating these tools and making them available as requested.

In line with its general mission, the Data Bank acts, in most of its Member countries, as the national reference centre for scientific nuclear data and computer programs. In addition, a project that aims to provide recommended chemical thermodynamic data, mainly for use in the safety assessment of radioactive waste repositories, is conducted in close co-operation with the NEA radioactive waste management programme (see "Joint Projects" for further details).

In order to provide a rapid and reliable service to its Member countries, the Data Bank needs to stay in the forefront of computer technology and electronic communication techniques. The large amount of information handled by the Data Bank is kept in modern database systems, stored on a network of fast workstations. To provide a quick response to direct on-line database retrievals, the Data Bank recently installed a second, separate, high-speed Internet line.

Close to 2 500 registered users with individual passwords can directly access the Data Bank services. The on-line databases containing scientific nuclear data were accessed by users more than 20 000 times during 1999. The Data Bank distributes, on request, about 2 000 computer programs per year, covering all areas of nuclear applications. The main users of the Data Bank services are national laboratories (50%); nuclear industry, vendors and utilities (25%); and universities (25%).

Nuclear data services

The availability of accurate nuclear data is of fundamental importance in the modelling and simulation of all nuclear applications. This concerns both the efforts to improve the safety margins and the economics of existing nuclear power plants and the design and optimisation of advanced or new concepts, as well as non-energy applications such as nuclear medicine and astrophysics.

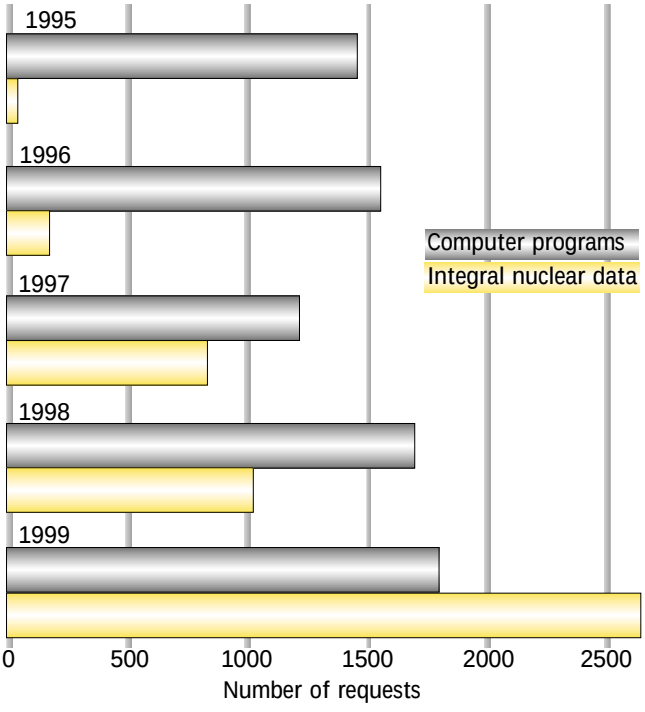
The Data Bank continued the collection and exchange of basic experimental and bibliographic scientific nuclear data in 1999 according to the international agreement between a network of data centres. Bibliographic references were entered into the CINDA (Computer Index for Neutron Data) database, and experimental reaction data were compiled into the EXFOR (Exchange Format) database (see below).

The compilation and verification of the new, improved version of the Joint Evaluated Fission and Fusion (JEFF) data library continued throughout 1999. A preliminary version of the general-purpose library was released to laboratories in Member countries in charge of testing the data for different application areas. The work to produce a new JEFF library for radioactive decay and fission yield data was begun.

The NEA Data Bank maintains and provides a service from the following databases:

- Experimental nuclear reaction data: Measured data for neutron-, charged particle- and photon-induced reactions up to 1.5 GeV (EXFOR database).
- Bibliography: the CINDA database giving references to measurements, evaluations and other literature on neutron-induced reaction data, with cross-references to the EXFOR database.
- Evaluated data libraries: the current standard version of the Data Bank's JEFF data library; and other complete, evaluated nuclear data libraries, such as ENDF/B, EFF, JENDL, BROND and CENDL.

Requests for NEA Data Bank computer codes and integral data



- Nuclear structure data (linked to NNDC at Brookhaven National Laboratory, USA): complete nuclear structure evaluations (ENSDF); the nuclear science reference database (NSR); nuclear properties and selected integral data (NUDAT).

Computer program services

Following the reduction of nuclear R&D budgets in Member countries and the subsequent decrease in the number of experimental facilities, the need for high-quality computer codes to model and simulate different nuclear energy applications has increased. The spectacular increase in computing power has also made it possible to perform more accurate calculations, for example by using Monte Carlo techniques.

The Data Bank maintains a database containing more than 2 000 documented program packages and group cross-section data sets, covering all civil application areas of nuclear energy. The program packages (the program itself, the user manual and suitable test cases) are distributed on CD-ROM or sent via Internet on request. Newly acquired program packages are now stored in a full, computer-readable form. In addition, work has begun to prepare electronic files of the documentation of older packages.

The Data Bank distributed, upon request, close to 1 900 program packages in 1999. This was the highest demand so far and represented an increase of about 110 programs (6%) compared to 1998.

As part of the services, the Data Bank also organises training courses on the utilisation of the most popular computer programs. The following courses were held during 1999:

- NJOY User Group Meeting in connection with the JEFF Meeting, at NEA Headquarters, 12-14 April 1999;
- MCNP Introductory Training Course at NRG Petten, the Netherlands 19-23 April 1999;
- MCNP Advanced Training Course at Imperial College London, UK, 5-9 July 1999;
- Workshop on the theory of neutron-induced cross-sections in the resonance range and on the analysis code SAMMY, 27 September-1 October 1999 at NEA headquarters;
- Course on applications of the TOUGH2/T2VOC codes to subsurface multiphase flow and remediation modeling at the International Ground Water Modeling Center, Colorado, USA, 28-30 October 1999.

Experimental integral data

The Data Bank has, under the direction of the NEA Nuclear Science Committee (NSC), continued the compilation of integral experimental data. These data are extremely important for validating the predictive capacity of a computer program in a specific nuclear application. Safeguarding these data is an important part of preserving the scientific knowledge needed to maintain and develop nuclear technology as a safe and economic energy option. Integral data relevant to nuclear fuel behaviour, radiation shielding and nuclear criticality safety have been collected. The interest in Member countries for these data is increasing. Close to 2 800 data sets were requested from the Data Bank in 1999, compared to about 1 100 in 1998 (see figure).

Highlights

- The Data Bank has close to 2 500 registered users of the on-line computer program, nuclear and chemical data services.
- The number of requests for integral experimental data was almost three times higher than in 1998.
- The new version of the Joint Evaluated Fission and Fusion (JEFF) data library was released for testing.
- The book on recommended chemical thermodynamic data of technetium (Tc) was published.

J. Mihalczo, ORNL, USA

Critical experiment with metallic fuel used for validating calculation codes.

The following databases are maintained at the Data Bank:

- International Criticality Safety Benchmark Experiments (ICSBEP): data from about 2 500 critical configurations (available on CD-ROM);
- International Fuel Performance Experiments (IFPE): experimental data from more than 300, well-characterised fuel rod experiments (available on CD-ROM);
- Radiation Shielding Experiments (SINBAD): data from 35 shielding experiments, with particular emphasis on pressure vessel fluence (available on CD-ROM);
- Code Validation Matrix of Thermal-Hydraulic Codes (CCVM) (on behalf of the CSNI): reactor transient and loss-of-coolant accident integral test data (available on CD-ROM).

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Legal Affairs

Group of Governmental Experts on Third-Party Liability in the Field of Nuclear Energy

Mission

- To foster progress towards a global regime addressing liability and compensation for nuclear damage.
- To contribute to the modernisation of the Paris Convention and the Brussels Supplementary Convention on nuclear third-party liability and compensation.
- To promote the harmonisation of Member countries' nuclear legislation and to assist selected non-member countries in the field of nuclear law.
- To analyse and disseminate information on nuclear law issues for the benefit of both Member and non-member countries.

Civil liability for nuclear damage

Through its legal affairs programme, the NEA continues to serve as a forum for the examination of legal issues in the nuclear field, with special emphasis on civil liability and compensation for nuclear damage. It supports the work of the Group of Governmental Experts on Nuclear Third-Party Liability aimed at establishing an adequate legal framework for the safe use of nuclear energy and at encouraging the development of provisions for equitable compensation of nuclear damage in the event of a nuclear incident. More particularly, it assists the Experts in analysing issues related to the emergence of a global nuclear liability regime and in addressing problems associated with the interpretation and application of the various international nuclear liability instruments in which they are interested.

The NEA also supports the specific work undertaken by the Paris Convention States and the Brussels Supplementary Convention States to revise their respective conventions, a matter of particular importance in light of the operation of the 1988 Joint Protocol on the application of the Paris and Vienna Conventions, the recent amendment of the Vienna Convention and the adoption of a new global Convention on Supplementary Compensation for Nuclear Damage.

Assisting certain central and eastern European countries (CEEC) and New Independent States (NIS) to develop nuclear legislation that reflects internationally accepted principles for the peaceful utilisation of nuclear energy is also a major focus for the legal affairs programme. This assistance places particular emphasis upon encouraging nuclear liability and compensation provisions that will permit membership in a global regime addressing such matters. Most of this work is undertaken within the ambit of the NEA Contact Group on Liability Questions Raised by Nuclear Safety Assistance Programmes for Eastern Europe or, in the particular case of Ukraine, a Joint Task Force on Nuclear Legislation. As a result of these initiatives, many of the CEEC/NIS have adopted such legislation and adhered to one or more of the international nuclear liability instruments.

International symposium on the reform of civil nuclear liability

In the context of continuing efforts by the international community to improve the nuclear liability regimes established by the Paris and Vienna Conventions, the NEA organised an International Symposium on the Reform of Civil Nuclear Liability in Budapest, Hungary from 31 May to 3 June 1999. The symposium was co-hosted by the Hungarian Atomic Energy Authority and the Hungarian Academy of Sciences, and benefited from the co-operation of the IAEA and the European Commission.

The focus of the symposium was twofold: first, to address issues associated with the practical implementation of the reforms adopted

Meeting of the Contracting Parties to the Paris Convention, Berlin, Germany, July 1998.

under both the 1997 Protocol to Amend the Vienna Convention and the new Convention on Supplementary Compensation for Nuclear Damage; and secondly, to evaluate and proffer solutions for those reform challenges that still lie ahead, including the amendment of the Paris and Brussels Supplementary Conventions. Within this context, the symposium also took a close look at the complexities of international transport of nuclear substances, the practical problems involved in claims settlement and administration of awards, and the particular difficulties facing certain countries from Eastern Europe in joining an international nuclear liability regime. Approximately 225 participants attended, including government experts, nuclear industry representatives, nuclear risk insurers, specialists from international organisations and academics.

Sam Farr, Nuclear Electric plc, United Kingdom

Fuel flask transporter at Hinkley Point A nuclear power plant in the United Kingdom.

Highlights

- With four meetings convened in 1999, Contracting Parties made considerable progress in their negotiations to revise the Paris Convention.
- The States party to the Brussels Supplementary Convention initiated their deliberations on its revision.
- The NEA organised an International Symposium on the Reform of Civil Nuclear Liability in Budapest, Hungary, and the proceedings were prepared for publication in English and French.
- A new edition of the Analytical Study on the Regulatory and Institutional Framework for Nuclear Activities in OECD Member countries was published.

Seminar on nuclear law and liability

In conjunction with the Turkish Atomic Energy Authority, the NEA also organised a Seminar on Nuclear Law and Liability, which was held in Ankara on 8-9 September 1999. The seminar was co-sponsored by the IAEA and attracted close to 150 participants. It addressed a wide variety of legislative issues ranging from establishing regulatory and other nuclear-related institutions to implementing the provisions of international nuclear liability conventions into domestic legislation. A compendium of papers, texts and other supporting documents distributed during the seminar was prepared by the NEA following the event.

Information on nuclear law

The *Nuclear Law Bulletin*, issued twice a year, provides up-to-date information on recent developments in the field of nuclear law at the national and international levels. This publication has proved to be an invaluable tool over the past thirty years for persons in government, regulatory, academic, industry and international circles who work closely with nuclear law. In 1999, back issues of the *Nuclear Law Bulletin* were made available in both English and French on the NEA web site (http://www.nea.fr/html/law/pub.html).

A completely new edition of *Nuclear Legislation: Analytical Study, Regulatory and Institutional Framework for Nuclear Activities* in OECD Member countries was prepared. This loose-leaf publication, which provides a systematic analysis of nuclear legislation and nuclear institutions in 29 countries, is a useful reference tool for those interested in the regulation of nuclear activities. As with the original publication in 1995 and its subsequent updates, this new edition is organised on the basis of a standardised format for all countries, thus facilitating the search for and comparison of information.

A new edition of the *Overview of Nuclear Legislation in Central and Eastern Europe and the NIS* was prepared for publication in 2000. This publication updates the information provided in the 1998 edition on the institutional and legal frameworks which have been established in the CEEC and NIS, while also expanding the geographical scope of this Overview to countries not previously covered.

The Proceedings of the Budapest International Symposium on the *Reform of Civil Nuclear Liability* were also prepared for publication. These proceedings reproduce all papers submitted by speakers at the symposium in their original language (English or French) accompanied by an abstract in the other language. Also published in the proceedings are the transcripts of all of the discussion periods organised during the five working sessions, as well as the transcript of the round-table debate on the new global regime of nuclear liability. Finally, in light of the focus upon CEEC and NIS joining an international regime on civil nuclear liability, the reports submitted by participants from these countries have also been included.

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Joint Projects and Other Co-operative Projects

NUCLEAR SAFETY

The RASPLAV Project

The second phase of the NEA-sponsored RASPLAV Project started in mid-1997 and will finish in mid-2000. It brings together 16 OECD Member countries and the Federation of Russia for the purpose of advancing the necessary knowledge for dealing with the retention of molten core material inside the reactor pressure vessel during an accident. As part of the project, a number of integral tests with prototypical core materials, molten salt simulant tests, and several smaller-scale separate effects tests are being conducted at the Kurchatov Institute in Moscow. The aim is to measure material properties and to understand the relevant phenomena. In 1999, the fourth and last integral test using 200 kg of corium was carried out, using partially metallic, carbon-free corium. Previous tests had shown the influence of small amounts of carbon on stratification of the core melt and had investigated oxidic compositions.

A computer model has been developed to analyse the tests, and has proved essential in carrying out the test design successfully. This analytical work is carried out at the Institute of Nuclear Safety of the Russian Academy of Sciences.

The Sandia Lower Head Failure Project

This new, three-year project began in 1999, bringing together eight Member countries for the purpose of studying the creep rupture behaviour of light water reactor (LWR) lower heads. The information obtained is useful for developing severe accident management strategies for coping with ex-vessel behaviour of molten core debris. Five steel models of a lower head will be tested to failure. The project is the continuation of a similar project previously carried out by the US Nuclear Regulatory Commission at Sandia National Laboratories.

The Halden Reactor Project

The programme of work for 1999 completed the three-year programme as envisaged in the Agreement for the period 1997-1999. The experimental work in the fuel area addressed those high burn-up issues that are key for fuel safety and reliability assessments. They include the degradation of thermal conductivity and the increase of fission gas release and swelling with burn-up for UO_2, gadolinia and MOX fuel types. The experiments dedicated to the issue of cladding lift-off due to enhanced fission gas release at high burn-up were completed. The comparative testing of different PWR cladding alloys progressed, providing valuable on-line and inspection data.

The programme dedicated to in-vessel materials included tests on irradiation-assisted stress corrosion cracking (IASCC) susceptibility in a variety of BWR-relevant conditions. The effect of neutron fluence and stress intensity on the crack propagation of different stainless steel alloys has been elucidated. The work on the annealing and re-embrittlement of pressure vessel materials proceeded according to schedule.

Sandia National Laboratories, USA

View of the instrumented lower head tested in the framework of the Sandia Lower Head Failure Project.

Vattenfall AB, Sweden

Control room operations at Ringhals Unit 3 in Sweden.

Stephan Zaubitzer, EDF, France

The effect of shiftwork on operator performance is being studied within the framework of the Halden Reactor Project. Pictured here: two workers at the Nogent-sur-Seine plant in France.

The programme on man-machine systems generated, *inter alia*, various software tools in support of control room operation. This included the signal validation toolbox PEANO, the process event classification system ALADDIN, the computerised alarm system toolbox COAST and the upgrade of the computerised procedure system COPMA. The work on the upgrade of the Halden Man-Machine Laboratory was brought close to completion with the acquisition of two new simulators, one for PWRs and one for BWRs. Studies dedicated to human-centred automation and human factor experiments concerned with the effect of shiftwork on operator performance were conducted. Methods for quantitative evaluations of human factor experiments were also implemented. The virtual reality laboratory was actively used in support of human factors/control room studies and in a number of collaborations with Project participants. The activities on software validation and verification progressed as planned and included the use of formal methods, Petri nets and algebraic specifications.

Project results were presented in a number of papers and progress reports. An executive summary of achievements for the period 1997-1999 was also produced. As confirmed by all participants, the Halden Project will be continued over the next three-year period (from 2000 to 2002), on the basis of the framework programme presented to the Halden Board of Management in 1998.

The OECD-IPSN CABRI Water Loop Project

This project is intended to address the issue of reactivity-initiated accidents (RIAs) for high burn-up fuel. It stems from previous Japanese and French tests conducted on high burn-up PWR fuel that exhibited failure (in a few instances) at relatively moderate energy deposition levels. The CABRI Project aims to extend the database for high burn-up fuel performance in RIA conditions and, more importantly, to perform relevant tests under coolant conditions representative of PWRs. To this end, the CABRI facility, which is located at the Cadarache centre (France) will be modified to include a water-cooled loop. Coolant conditions representative of PWRs are essential in order to derive validated fuel safety criteria from this type of test.

In 1999, a revised programme was worked out by the French Nuclear Safety and Radiation Protection Institute (IPSN), including plant retrofitting, fuel acquisition and test execution. Twelve experiments are to be conducted over a period of eight years. Preliminary indications of interest were received in June 1999. The legal and operational framework of the Project was then drawn up by the NEA and the IPSN, and resulted in draft agreements that were presented to potential participants for review. The international nuclear community (both safety organisations and industry) showed great interest in the proposed programme, as it addresses a very important safety issue and CABRI is the only facility where RIA tests can be carried out under representative coolant conditions. The international Agreement should be ready early in 2000.

The PLASMA Project

The OECD-sponsored project on the implementation of a plant safety monitoring and assessment (PLASMA) system for VVER reactors proceeded according to plans and was nearly completed. The PLASMA system was installed at the Paks nuclear power plant full-scope simulator for its site acceptance test (SAT). The test was performed for a single-version server of the system. The simulator version of PLASMA was used in connection with the validation test for the new, symptom-based, emergency operation procedures introduced at Paks. By the end of the year, the whole system configuration was being transferred to the Paks station, where it would be operated in parallel with the existing plant computer on Unit 2. The installation of the new reactor protection system on Unit 2 was planned to take place in March 2000, so that the final SAT of the entire system could take place in April 2000.

Miklos Beregnyei, PAKS Nuclear Power Plant Ltd., Hungary

Partial view of the PAKS nuclear power plant, pilot site for the PLASMA Project.

This project has been realised through the collaboration of Japanese (JAERI), Hungarian (KFKI and Paks NPP) and Norwegian (IFE/HRP) organisations, within the OECD/NEA project framework.

RADIATION PROTECTION

ISOE: The Information System on Occupational Exposure

The ISOE Programme, launched in 1992 by the NEA, has since grown apace, both in number of participants and in the scope of its work. The objectives of the programme are to promote and co-ordinate international co-operative undertakings in the area of protection of workers at nuclear power plants; to collect annual occupational exposure data from commercial nuclear power plants and to analyse them for general trends; and to provide a forum for communication among radiation protection experts. Since 1998, the programme is administered by a joint NEA/IAEA Secretariat.

As of December 1999, the programme enjoyed the participation of 422 reactors (in operation, cold shutdown or some stage of decommissioning), owned by 77 utilities in 26 countries. National regulatory authorities from 23 countries also participate in the ISOE programme. The participation of 88% of the world's operating commercial nuclear reactors makes ISOE the largest occupational exposure database in the world.

Regarding the average collective dose per reactor for operating reactors included in the ISOE database, a clear downward trend can be observed over the last decade (1987-1998). This decrease in dose has been attributed to the reduction in outage duration achieved through better work selection and management. More information and trends can be found in *Occupational Exposures at Nuclear Power Plants: Eighth Annual Report of the ISOE Programme, 1998*.

Marc Morceau, SODEL-EDF, France

Collecting samples for radioactivity controls near the Blayais nuclear power plant in France.

DECOMMISSIONING

Nuclear Installation Decommissioning

In October 1999, three additional decommissioning programmes, from Italy, Sweden and France, were accepted into the Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects. This brought the total number of projects in the programme to 38, including 26 reactors, 9 reprocessing plants, 2 fuel material plants, and 1 isotope handling facility.

In 1999, the programme published the results of its work on the costing of decommissioning projects and decontamination techniques. The future programme of work will concentrate on policy issues as well as on communication and acceptability issues. It is within this framework that a series of "position papers" will be developed on such subjects as the authorised release of materials and sites, the reuse of material, costs and funding, and the safety and acceptability of decommissioning programmes.

ONDRAF, Belgium

Remotely controlled chipping hammer being used to remove the contaminated layer of concrete from the floor of the Eurochemic plant.

RADIOACTIVE WASTE MANAGEMENT AND DATA

The Thermochemical Database (TDB) Project

The second phase of the NEA Thermochemical Database (TDB) Project was started in 1998 as a semi-autonomous, separately funded project. Seventeen organisations from 13 countries participate. The main objective of the project is to make available an internationally recognised and quality-assured chemical thermodynamic database of selected chemical elements for use in the safety assessment of nuclear waste repositories. The NEA Data Bank acts as project co-ordinator and is responsible for the maintenance and updating of the database, for providing bibliographic and data services to Member countries and for the publication of the recommended thermochemical data.

The work programme of the second phase of the TDB project, covering the period 1998-2001, is well under way and includes the following activities:

- updating and maintenance of the computer on-line service of the database for the users of thermodynamic data in Member countries;
- updating, maintenance and, if necessary, re-evaluation of the data reviewed during Phase I (U, Am, Np, Pu and Tc);
- evaluation of relevant inorganic compounds of nickel and selenium;
- evaluation of simple organic complexes for the most important elements (U, Am, Np, Pu, Tc and Ni);
- compilation and evaluation of zirconium data.

COMPUTER CODES AND NUCLEAR DATA

The International Co-operative Programme on Computer Code and Nuclear Data Dissemination and Exchange

The NEA Data Bank's computer program and nuclear data services are provided within a framework of international co-operative agreements. In the case of the computer program services, the Data Bank has a co-operative arrangement with the IAEA, where the NEA provides services to the non-OECD members of the IAEA. In exchange, the IAEA has placed one person at the Data Bank to administer these services. During 1999, the non-OECD part represented about 10% of total computer program distribution.

The NEA computer program services to non-OECD members consist in:

- providing computer programs upon request;
- acquiring programs developed in non-OECD member countries;
- distributing publications concerning computer programs and their use;
- providing advice to users on specific applications.

Successful co-operation among data centres has been established for the co-ordination, collection, compilation and dissemination of nuclear data on an international scale. The data centres cover nuclear physics data required both for energy and non-energy nuclear technology applications, as well as data for the basic sciences, and provide an essential link between the producers and users of nuclear data. The co-operative agreement between the data centres is reviewed at annual meetings to reflect recent developments in the different centres. The Nuclear Data Centres Network consists of five core centres:

- the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory, USA;
- the Nuclear Energy Agency (NEA) Data Bank, Issy-les-Moulineaux, France;
- the International Atomic Energy Agency (IAEA), Vienna, Austria;
- the Institute of Physics and Power Engineering (IPPE), Obninsk, Russia;
- the Kurchatov Institute, Moscow, Russia.

Other data centres provide an essential complement to the core centres by assuming responsibility for the collection and compilation of nuclear data for specific application areas.

BNL, USA

Brookhaven National Laboratory, USA.

Frédérique Dubosq

NEA headquarters, France.

IAEA, Austria

IAEA headquarters, Austria.

Kurchatov Institute, Russia

Experimental facilities at the Kurchatov Institute, Russia.

Information Programme

Mission

The main goal of the NEA in the area of information and communication is:

- to provide Member governments and other interested parties with information resulting from the activities of the NEA, and
- to enhance awareness and understanding of the scientific, technical and economic aspects of the nuclear option as well as awareness of the NEA itself.

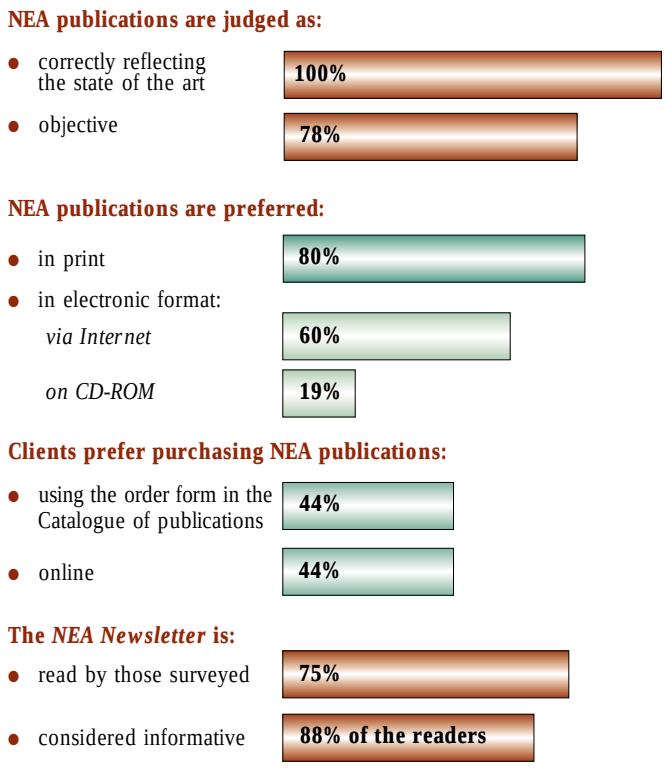
A major task during the year was the conduct of an international marketing survey to back up the development of an NEA information strategy that would improve the communication of the results of the Agency's work and better serve the Agency's stakeholders. The survey confirmed that there were two main groups of stakeholders: scientists and researchers with a need for detailed, technical information, and decision makers in the nuclear field and in broader circles with a need for short, policy-oriented reports.

The first group tends to be very well served with the large range of technical material produced by the Agency. In the second group, policy-oriented material is in high demand, and the Agency will endeavour to produce more material adapted to these needs. It is planned, in particular, to launch a "policy statements" page on the web site and to provide policy-oriented reports or summaries of longer technical publications on a semestrial basis. This will also help fulfil some of the objectives set out in the Agency's new *Strategic Plan*, notably that of providing authoritative assessments on key issues, as input to government decisions on nuclear energy policy.

A few of the interesting figures produced by the survey include the following:

- 78% of those surveyed feel that NEA publications are objective;
- 100% feel that NEA publications correctly reflect the state of the art;
- 80% of readers prefer publications in print, while Internet access is preferred over CD-ROM for electronic versions;
- 44% of clients prefer purchasing NEA publications with paper order forms, and 44% prefer purchasing online;
- 75% of those surveyed read the bi-annual *NEA Newsletter* and 88% find it informative.

The international marketing survey



Publications

In 1999 the Agency published 56 books, of which 30 were on sale and 26 were for free distribution. The list of these publications is given on page 32. Marketing efforts for these books included:

- monthly electronic notices of new publications sent to an e-mail list of approximately 3 900 subscribers;
- the organisation of publications and information stands at seven international conferences (see details below);
- the systematic dissemination of publicity flyers for all new publications, as from August;
- advertising (through purchase and exchange agreements) in specialist journals.

Best sellers for the Agency included *Nuclear Energy Data 1999* (or the "Brown Book"), *Advanced Reactors with Innovative Fuels*, *Use of Hydrogeochemical Information in Testing Groundwater Flow Models* and *Utilisation and Reliability of High Power Proton Accelerators*.

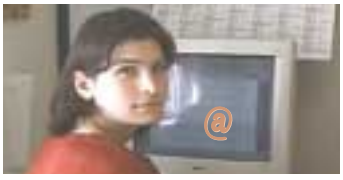
Communicating electronically

The NEA web site was used extensively for conveying substantive information about the Agency's work, as well as for publicising books on sale. Over 2 000 full reports were available on the site by the end of the year, including all of the past issues of the *Nuclear Law Bulletin* from 1968 to 1998. New publications were highlighted on the home page (http://www.nea.fr) as they came out, with detailed information being provided on the publications pages (http://www.nea.fr/html/pub/). An electronic catalogue of publications, updated daily, is also available on these pages.

Work was begun to replace the automatic generation of an order form with a more user-friendly and efficient link to the OECD online bookshop (http://www.oecd.org/publications/), which allows for the actual order to be placed online with secure payment facilities. The OECD online bookshop is also beginning to offer .pdf files of publications so that customers may either buy an electronic copy of the book, or receive a free electronic copy while waiting for the paper copy to arrive. In the coming months, the bookshop will also provide a service that allows potential customers to browse the full contents of a publication, much as one would do in a traditional book store, before actually purchasing it.

The Agency's Extranet continued to serve committee members with official reports and meeting documents. This has helped to get information to Delegates more quickly and less expensively. The electronic delivery of press releases was also developed to save time and costs.

Communicating electronically around the world.



Highlights

- A total of 56 publications was produced in 1999 covering the entire range of NEA activities.
- A major marketing survey was carried out to learn more about the profile of customers and their interest in the work of the NEA.
- NEA information and publications stands were organised at seven major international conferences.
- The NEA co-sponsored 20 international conferences during 1999.

International co-operation

NEA information and publications stands were organised at seven major international conferences:

- the Seoul Nuclear Exhibition in conjunction with the 14th KAIF/KNS Annual Conference, Seoul, Korea (7-9 April);
- the International Symposium on Technologies for the Management of Radwaste from NPPs and Back-End of the Nuclear Fuel Cycle Activities, Taejon, Korea (30 August-3 September);
- the TOPFUEL '99 Conference, Avignon, France (13-15 September);
- the International Conference on Nuclear Criticality (ICNC) '99 Conference, Versailles, France (20-23 September);
- the 7th International Conference on Radioactive Waste Management and Environmental Remediation (ICEM '99), Nagoya, Japan (26-30 September);
- the TOPSEAL '99 Conference on Radioactive Waste Management, Antwerpen, Belgium (10-13 October);
- the American Nuclear Society "Winter Meeting", California, USA (14-16 November).

Co-sponsorship of 20 international conferences was organised in 1999, largely in connection with the co-operation agreements that are in place with the International Atomic Energy Agency (IAEA) and the American Nuclear Society (ANS). Such co-sponsorship has helped to raise awareness of the NEA. Through NEA participation in programme committees and in the conferences themselves, it also helps the NEA to contribute its results internationally and to benefit from the most up-to-date exchange of opinions and experience in technical areas.

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NEA Publications Produced in 1999

Publications of General Interest

NEA Newsletter
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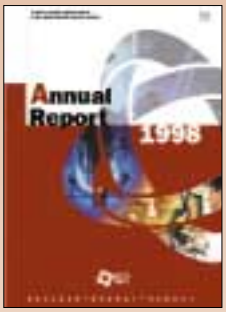

NEA Annual Report – 1998
Free: paper or Web.

Catalogue of publications – 1999
Free: paper or Web.

The Strategic Plan of the Nuclear Energy Agency – 1999
Free: paper or Web.

Nuclear Regulation

The Role of the Nuclear Regulator in Promoting and Evaluating Safety Culture
Free: paper or Web.

Economic and Technical Aspects of the Nuclear Fuel Cycle

Environmental Activities in Uranium Mining and Milling
A Joint NEA/IAEA Report
ISBN 92-64-17064-2
Price: FF 280 US$ 47 DM 84 £ 29 ¥ 5 550

Glossary of Nuclear Power Plant Ageing
(English-French-German-Spanish-Russian)
ISBN 92-64-95842-7
Price: FF 300 US$ 52 DM 89 £ 32 ¥ 6 050

OECD Nuclear Energy Data – 1999
ISBN 92-64-05856-7
Price: FF 120 US$ 21 DM 36 £ 13 ¥ 2 400

Actinide and Fission Product Partitioning and Transmutation
Status and Assessment Report
Free on request.

Actinide and Fission Product Partitioning and Transmutation
Proceedings of the Fifth International Information Exchange Meeting, Mol, Belgium, 25-27 November 1998
Free on request.

Back-end of the Fuel Cycle in a 1 000 GWe Nuclear Scenario
Workshop Proceedings, Avignon, France, 6-7 October 1998
ISBN 92-64-17116-9
Price: FF 210 US$ 34 DM 63 £ 21 ¥ 4 050

Nuclear Safety

Russian Minatom Nuclear Safety Research Strategic Plan
An International Review
Free: paper or Web.

Radioactive Waste Management

Geological Disposal of Radioactive Waste
Review of Developments in the Last Decade
ISBN 92-64-17194-0
Price: FF 190 US$ 31 DM 57 £ 19 ¥ 3 300

Nuclear Decommissioning: A Proposed Standardised List of Items for Costing Purposes
Free : paper or Web.

Water-conducting Features in Radionuclide Migration
Workshop Proceedings, Barcelona, Spain, 10-12 June 1998
ISBN 92-64-17124-X
Price: FF 600 US$ 96 DM 180 £ 60 ¥ 11 600

Decontamination Techniques Used in Decommissioning Activities
Free: paper or Web.

Nirex Methodology for Scenario and Conceptual Model Development
An International Peer Review
Free : paper or Web.

Strategic Areas in Radioactive Waste Management
The Viewpoint and Work Orientations of the NEA Radioactive Waste Management Committee
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Confidence in the Long-term Safety of Deep Geological Repositories
Its Development and Communication
Free: paper or Web.

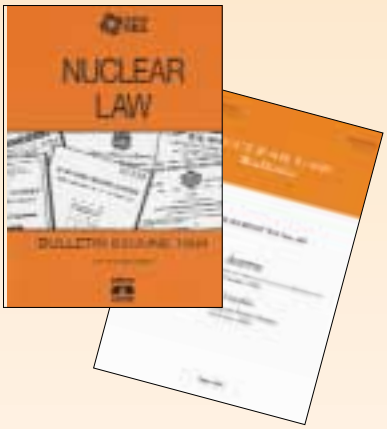
Progress Towards Geologic Disposal of Radioactive Waste: Where Do We Stand?
An International Assessment
Free: paper or Web.

Radiation Protection

ISOE – Occupational Exposures at Nuclear Power Plants
1997 – *Free on request.*
1998 – *Free: paper or Web.*

Second International Nuclear Emergency Exercise INEX 2
Final Report of the Swiss Regional INEX 2 Exercise
ISBN 92-64-06760-4
Price: FF 500 US$ 88 DM 149 £ 53 ¥ 11 600

Nuclear Legislation



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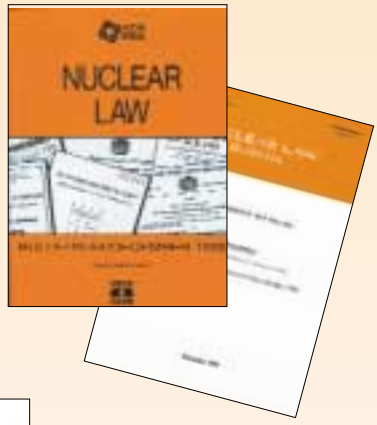
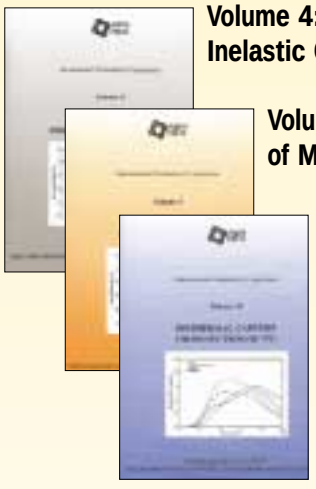


Nuclear Legislation – Analytical Study
Regulatory and Institutional Framework for
Nuclear Activities – 1998 Update
ISBN 92-64-17024-3
Price: FF 150 US$ 27 DM 45 £ 16 ¥ 3 200

The Data Bank

International Evaluation Co-operation
Free: paper or Web.



Volume 4: ^{238}U Capture and Inelastic Cross-sections

Volume 8: Present Status of Minor Actinide Data

Volume 18: Epithermal Capture Cross-section of ^{235}U

Light Water Reactor (LWR) Pin Cell Benchmark Intercomparisons
JEFF Report 15
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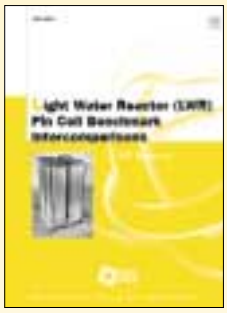

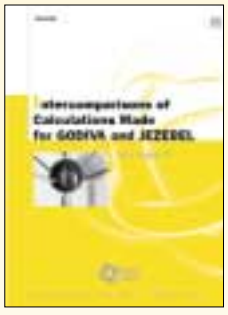

Intercomparisons of Calculations Made for GODIVA and JEZEBEL
JEFF Report 16
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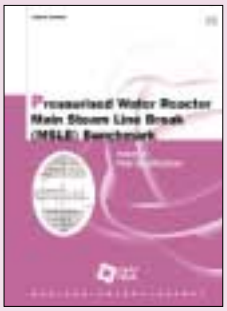
Computer Program Abstracts *Free: CD-ROM.*

Radiation Shielding Experiments (SINBAD) Database *Free: CD-ROM.*

Nuclear Science

SATIF-4: Shielding Aspects of Accelerators Targets and Irradiation Facilities
Workshop Proceedings,
Knoxville, Tennessee, USA,
17-18 September 1998
ISBN 92-64-17044-8
Price: FF 500 US$ 88 DM 149 £ 53 ¥ 10 300

Ion and Slow Positron Beam Utilisation
Workshop Proceedings, Costa da Caparica,
Portugal, 15-17 September 1998
ISBN 92-64-17025-1
Price: FF 400 US$ 72 DM 119 £ 43 ¥ 8 500



Pressurised Water Reactor Main Steam Line Break (MSLB) Benchmark
Volume 1 : Final Specifications
Free: paper or Web.

Speciation, Techniques and Facilities for Radioactive Materials at Synchrotron Light Sources
Workshop Proceedings, Grenoble, France, 4-6 October 1998
Free: paper or Web.

Advanced Reactors with Innovative Fuels
Workshop Proceedings, Villigen, Switzerland, 21-23 October 1998
ISBN 92-64-17117-7
Price: FF 730 US$ 117 DM 218 £ 73 ¥ 14 100

International Fuel Performance Experiments Database

Handbook on International Criticality Safety Benchmark Experiments Database
Free: CD-ROM.

Physics and Fuel Performance of Reactor-based Plutonium Disposition
Workshop Proceedings,
Paris, France, 28-30 September 1998
ISBN 92-64-17050-2
Price: FF 400 US$ 70 DM 119 £ 43 ¥ 8 200

Utilisation and Reliability of High Power Proton Accelerators
Workshop Proceedings,
Mito, Japan, 13-15 October 1998
ISBN 92-64-17068-5
Price: FF 650 US$ 113 DM 194 £ 69 ¥ 13 100

Main Workshops and Seminars Held in 1999

February

08-10 International Workshop: Impact of the Year 2000 on the Nuclear Industry – Ottawa, Canada.

March

22-23 Third Workshop on PWR Main Steam Line Break (MSLB) Benchmark – Garching, Germany.

May

10-12 Workshop on Scenario Development for Evaluating the Safety of Radioactive Waste Repositories – Madrid, Spain.

17-18 Workshop on Nuclear Power Plant Transition from Operation into Decommissioning – Rome, Italy.

18-20 Workshop on Iodine Aspects of Severe Accident Management – Vantaa (Helsinki), Finland.

19-21 Joint NEA/IAEA/EC Workshop on the Regulatory Aspects of Decommissioning – Rome, Italy.

31-03 International Symposium: Reform of Civil Nuclear Liability – Challenges and Opportunities – Budapest, Hungary.

June

14-17 Fourth GEOTRAP Workshop on Confidence in Models of Radionuclide Transport for Site-Specific Performance Assessment – Carlsbad, New Mexico, USA.

21-23 Workshop on Developing and Measuring Nuclear Regulatory Effectiveness – Paris, France.

29-01 International Workshop on Fire Risk Assessment – Helsinki, Finland.

August

10-12 Seismic Risk Workshop – Tokyo, Japan.

23-25 Workshop on Approaches for the Integration of Human Factors into the Upgrading and Refurbishment of Control Rooms – Halden, Norway.

September

20-24 International Conference on Nuclear Criticality Safety (ICNC '99) – Versailles, France.

27-29 Information Exchange Meeting on the Survey of Basic Studies in the Field of High-Temperature Engineering – Paris, France.

October

04-05 Workshop on Core Monitoring for Commercial Reactors: Improvements in Systems and Methods – Stockholm, Sweden.

12-14 Workshop on Assuring Nuclear Safety Competence into the 21st Century – Budapest, Hungary.

18-22 9th International Conference on Radiation Shielding (ICRS-9) – Tsukuba, Japan.

26-28 Workshop on Evaluation of Speciation Technology – Tokai-Mura, Japan.

November

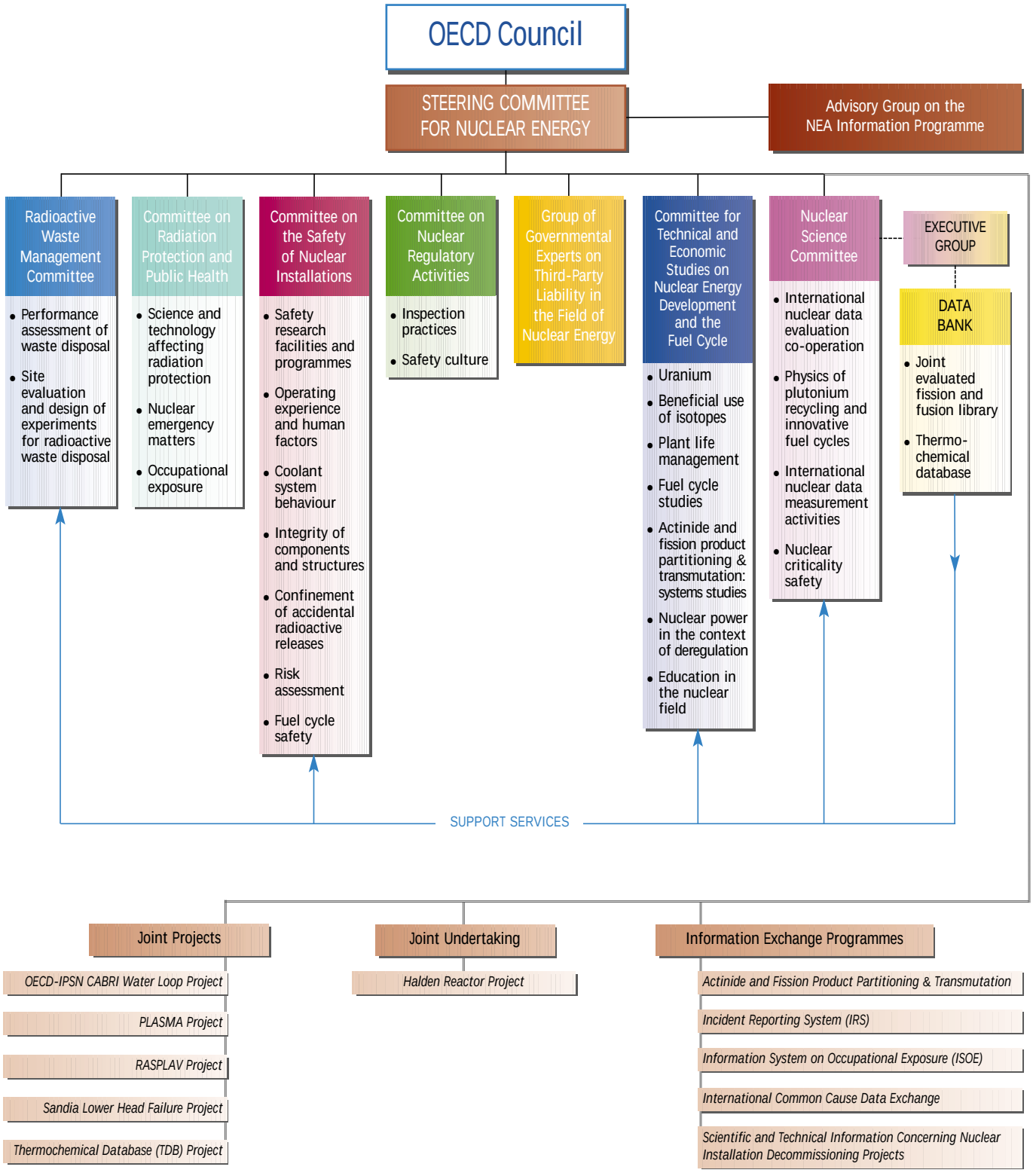
15-17 Workshop on Engineering Characterisation of Seismic Input – Long Island, New York, USA.

15-18 Workshop on Ex-Vessel Debris Coolability – Karlsruhe, Germany.

22-24 Second Workshop on Utilisation and Reliability of High Power Proton Accelerators – Aix-en-Provence, France.

29-01 INEX 2 Series Workshop – Paris, France.

Organisation Charts of the NEA



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Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996) and the Republic of Korea (12th December 1996). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

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The mission of the NEA is:

- to assist its Member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

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