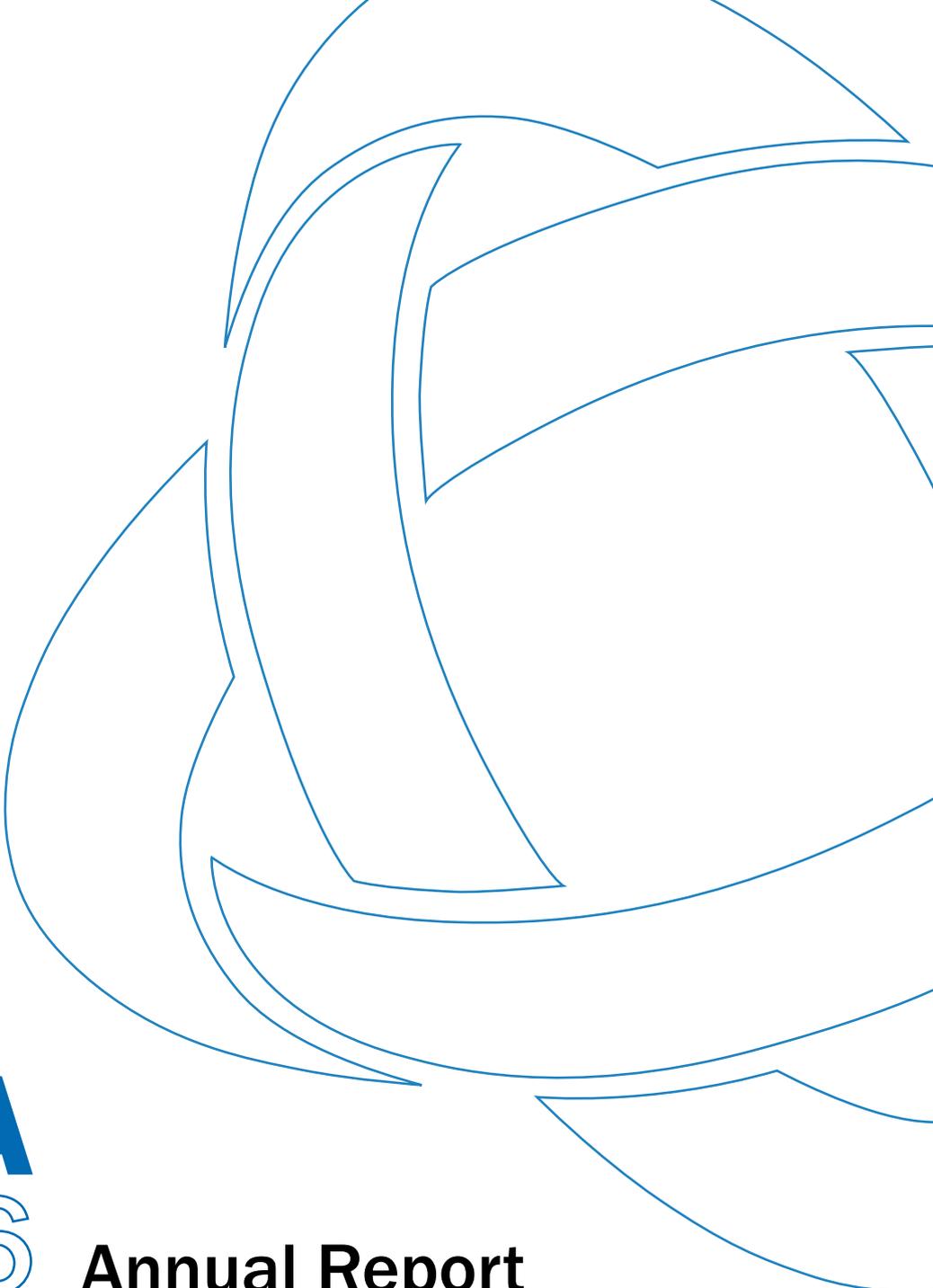


NEA

2006

Annual Report





NEA
2006

Annual Report

NUCLEAR • ENERGY • AGENCY

Organisation for Economic Co-operation and Development

The NEA in Brief

	Governing body: the Steering Committee for Nuclear Energy
28	members countries (22 in the Data Bank)
48	years of international service
7	standing technical committees
18	international joint projects funded by participants
69	professional and support staff (NEA and the Data Bank combined)
500	national experts participating in NEA committees
3 600	experts participating annually, on average, in policy and technical meetings organised at OECD headquarters
€ 10.2	million budget for the NEA in 2006, supplemented by voluntary contributions
€ 2.8	million budget for the Data Bank in 2006, supplemented by voluntary contributions
69	publications produced in 2006

The NEA and its Mission

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 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.

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The European Commission (EC) takes part in the work of the NEA. A co-operative agreement is in force with the International Atomic Energy Agency (IAEA). The NEA also maintains contacts with several non-member countries as well as the nuclear industry and a number of civil society organisations.



Message from the Director-General

Events in 2006 were marked not only by a growing interest in nuclear energy, but also by clear commitments to increase generating capacity in the years to come. Security of supply issues, global warming and high fossil fuel prices weighed heavily in the decision-making balance. But at the same time, it can reassure decision makers, stakeholders and the public at large that such decisions are being accompanied by tangible actions to make sure that the next generation of nuclear power plants is safer, more economical and more respectful of the environment than ever before.

The NEA programme of work covers a very full range of topics, with nuclear safety and regulation as the top priority in the Agency's 2005-2009 Strategic Plan. In addition, 15 international joint projects (see page 28 for details) are conducted under NEA auspices on nuclear safety matters. In a longer-term perspective, the Generation IV International Forum (GIF) continues to pursue its activities with far-reaching goals in mind, while also paying close attention to non-proliferation issues.

An important new development in 2006 was when the NEA was requested to provide the Technical Secretariat functions of Stage 2 of the Multinational Design Evaluation Programme (MDEP). The MDEP was set up to share the resources and knowledge accumulated by national nuclear regulatory authorities during their assessment of new reactor designs, with the aim of improving both the efficiency and the effectiveness of the process. The main objective of Stage 2 is to identify common regulatory practices and regulations that enhance the safety of new nuclear reactor designs. Ultimately this is expected to lead to a convergence of codes, standards and safety goals in the participating countries. Such convergence would help streamline many of the steps involved in bringing new plants online in the context of competitive markets worldwide, while at the same time maintaining the highest levels of safety.

The NEA membership is confident that many aspects of nuclear energy will be even further enhanced by the strengthened co-operation between the member countries and the Russian Federation which has recently been put in place. At the end of 2006, the OECD Council approved the Joint Declaration on Co-operation between the NEA and the Government of the Russian Federation in the Field of the Peaceful Uses of Nuclear Energy. As part of the planned forms of co-operation, starting on 1 January 2007, the Russian Federation was granted regular observer status in all the NEA standing technical committees (see page 42) and their working groups. This should provide ample opportunities for exchanges of knowledge and experience between NEA member country experts and their Russian counterparts, as well as to provide scope for enhanced safety in design, operation and decommissioning of nuclear power plants.

The Agency looks forward to continue contributing to the safe, environmentally friendly and economical use of nuclear energy for peaceful purposes in the years to come.



Luis E. Echávarri
NEA Director-General



Nuclear Power in 2006

Nuclear energy development

At the end of 2006, 346 reactors were connected to the grid in OECD countries constituting some 83.6% of the world's total nuclear electricity generating capacity and about 23.1% of the total electricity supply in the OECD area. During 2006, one reactor was started up in Japan and six reactors were shut down in other OECD countries (four in the United Kingdom and one in the Slovak Republic, all on 31 December 2006, and one in Spain earlier in the year).

Although OECD countries continue to have different approaches to the production and use of nuclear energy, including in some cases official moratoria or phase-out policies (Austria, Belgium, Germany, Italy, Spain and Sweden), growing concern about energy security, rising prices of fossil fuels and carbon-dioxide emissions have stimulated new debates on the role of nuclear power throughout the OECD area and around the world. Major events that exemplify this renewed global interest in 2006 include the G8 endorsement of nuclear energy following the St. Petersburg meeting; a majority of European Union (EU) leaders giving strong backing to a revival of nuclear power at an EU summit; the government of Australia recommending to give consideration to building new nuclear power plants and that of the United Kingdom to replacing ageing plants; an energy policy review commissioned by the government of Belgium recommending reconsideration of the country's nuclear phase-out policy; and the government of the Netherlands

establishing the conditions under which it would be possible to build new nuclear power plants. Plans to increase nuclear capacity were also announced in 2006 in several OECD countries:

- In Canada, the government of Ontario confirmed that nuclear power will be an important part of its plan to address looming energy shortages. Two new reactors are expected to be built and feasibility studies on refurbishing the Darlington and Pickering nuclear power plants are to be initiated. Both Ontario Power Generation and Bruce Power applied for Canadian Nuclear Safety Commission licences to prepare sites for the construction of new reactors.
- In France, the Board of *Électricité de France*, the primarily state-owned electricity utility, approved construction of a 1 630 MWe European pressurised water reactor (EPR) near Flamanville in the Basse-Normandie region.
- In Japan, a second unit at the Shika nuclear power plant (a 1 300 MWe advanced boiling water reactor) started commercial operation, while construction of a third unit at the Tomari nuclear power plant continued. Current plans include the construction of additional units.
- In the Republic of Korea, construction of the Shin Kori nuclear power reactors began in June and preparation of the Shin Wolsong site continues. Korea Hydro and Nuclear Power placed a USD 1.2 billion order with Doosan Heavy Industries for the first pair of third-generation APR-1400 PWRs (Shin Kori units 3 and 4).

2006 Nuclear Data Summary (as of the end of 31 December 2006)

	Operational reactors	Installed capacity (GWe net)	2006 uranium requirements (tonnes U)	Nuclear share of 2006 electricity production (%)
Belgium	7	5.8	880	54.4
Canada*	20	12.5	1 600	15.6
Czech Republic	6	3.5	664	31.5
Finland	4	2.7	467	28.4
France	59	63.3	7 184	78.1
Germany	17	20.3	3 400	27.0
Hungary	4	1.8	379	38.3
Japan	55	47.1	8 352	34.2
Mexico	2	1.4	200	4.7
Netherlands**	1	0.5	65	3.7
Republic of Korea	20	16.8	3 600	39.0
Slovak Republic	5	2.0	491	57.6
Spain	8	7.3	1 726	19.8
Sweden**	10	8.9	1 600	44.9
Switzerland**	5	3.2	270	37.9
United Kingdom	19	10.9	2 165	18.9
United States	104	99.9	22 890	19.4
Total (OECD)	346	307.9	55 933	23.1

* Estimates. ** 2005 data.

- In the United States, the Nuclear Regulatory Commission (NRC) proceeded to review four applications for early site permits for new reactor construction, and renewed operating licences for five nuclear power plants for 20 years, bringing the total number of US licence renewals to 47. The NRC also approved six power uprate applications in 2006, amounting to a total of 1 057 MWe of electricity generating capacity.

In non-OECD countries, three new units came on line in 2006 and construction of another three began. Plans for robust expansion of nuclear electricity generating capacity in China, India and the Russian Federation were initiated, and consideration is being given to either increasing existing capacity or to introducing nuclear energy in a number of other countries (e.g., Argentina, Bulgaria, Egypt, Indonesia, Romania, South Africa and Vietnam).

On a global level, plans for the development of international nuclear fuel cycle programmes were announced in 2006 by the governments of the United States (the Global Nuclear Energy Partnership) and the Russian Federation (the Global Nuclear Infrastructure Initiative). Although both programmes are in the early stages of development and differ somewhat in detail, they are both directed at elements of security of supply and include possible used nuclear fuel take-back and reprocessing components. The governments of France, Japan and the Russian Federation also placed priority in 2006 on the development of fast reactors. Successful deployment of fast reactors in the coming years could lead to significant changes in global nuclear development and nuclear fuel cycle activities.

Uranium production, conversion and enrichment

Preliminary data indicate that in 2005 uranium was produced in just five OECD countries, one of which produced only small amounts as part of mine remediation. However, Canada (28%) and Australia (23%) accounted for slightly

more than half of world production. Production in OECD countries amounted to approximately 22 000 tonnes of uranium (tU) in 2005 and is expected to decrease slightly in 2006. This production accounted for only about 40% of the uranium requirements in the OECD area, with the remainder being met by secondary sources (for example, excess commercial inventories). For a complete picture of the uranium market see *Uranium 2005: Resources, Production and Demand*.

Since late 2001, the price of uranium has been rising, with the spot price nearly doubling in 2006 alone. This increase in price, coming after nearly two decades of sustained low prices, has stimulated a considerable increase in exploration activities and the initiation of significant new production programmes. Although production is estimated to have declined slightly in 2006 compared to 2005, increased investment will help meet the expected increased demand in the years to come as secondary sources diminish and reactor requirements need to be increasingly met by primary production. However, increasing primary production may take some years as uranium mine development times are lengthy in many jurisdictions.

During 2006, uranium conversion facilities continued to operate in Canada, France, the United Kingdom and the United States. In France, detailed design of a new large-capacity conversion facility was under way in 2006 and could lead to first production by 2010.

In terms of uranium enrichment, the worldwide trend towards the use of centrifuge technology continued in 2006. In the United States, the Louisiana Energy Services National Enrichment Facility (NEF) received an NRC construction and operating licence for its new facility in New Mexico, and development of the American centrifuge by the US Enrichment Corporation continued. In France, AREVA began development of the Georges Besse II facility, which will add significant centrifuge enrichment capacity beginning in 2009. Both NEF and Georges Besse II will employ URENCO enrichment technology.



AREVA, France

Above: Uranium "yellow cake".
Right: Aerial view of the JEB mill and the JEB tailings management facility, McClean Lake, Canada.



Cogema, Canada

Nuclear safety and regulation

Overall, the safety performance of nuclear power plants in OECD countries continues to be excellent, as reflected in a number of published performance indicators. The current safety record is built upon a mature industry, a robust regulatory system and a strong foundation of research. There is a general consensus that safety assessment and research can improve the efficiency and effectiveness of a regulatory system by helping to identify the items most important to safety and by anticipating future regulatory challenges, thus allowing resources to be focused on the most significant concerns.

Licensing new technologies and designs is now being recognised as a short-term challenge given recent developments in energy policies. OECD countries are promoting several initiatives to improve the efficiency of the design review of new nuclear power plants. The initiatives seek to enhance nuclear safety worldwide, by promoting convergence on safety practices and by combining the expertise of participating regulatory authorities. The aim is to achieve consensus on safety matters, which will support national regulatory decisions while expediting and improving the safety review of new designs and technologies.

In the meantime, the number of nuclear power plants reaching their initial design life is increasing and license renewal continues to be adopted in many countries. OECD countries have implemented ageing management based on state-of-the-art technology, and for regulatory authorities, it is important to review the adequacy of ageing management methods applied by the operators, based on reliable technical evidence. These countries have taken initiatives to establish databases and knowledge bases on the most important ageing mechanisms, with the goal of continuing to improve practices for ageing management.

Other safety issues are also being closely monitored. In 2006, a small number of significant events took place, drawing attention to failures on electrical and protection systems. These failures illustrate the continuing need to respond to operating experience and to implement an appropriate and timely corrective action programme. Nuclear regulatory authorities and nuclear safety institutions have been active in revealing and resolving issues in this field.

Radiological protection

Many countries are considering the construction of new nuclear reactors and much can be learnt from experience with the current generation of power plants, including the identification of trends and good practice in the radiological protection of workers and the public. These experiences can, in turn, be translated into various types of design targets for such things as occupational exposure from operation and maintenance activities, and public exposure from operation and effluent releases. These design targets will influence not only the physical design of new plants, but the processes and procedures that they will use for operation, maintenance and eventually decommissioning activities. As such, the assessment of current trends and experience, with new build in mind, is increasingly being considered at the utility/operational level and at the regulatory/policy level as well. This will have an effect on



Cogema, Canada

Radiation measurements. Above: at McClean Lake, Canada. Below: at Saclay, France.



A. Gonin, CEA, France

designs and plans for Generation III+ and Generation IV reactors.

Assessing experience and establishing design targets are also strongly influenced by another current trend in radiological protection: that of stakeholder involvement in radiological protection decision making. As governments have increasingly recognised their citizens' desire to become actively involved in decisions affecting the management of public and environmental risks, there has been an increasing need to assess how decisions are taken, and to find appropriate mechanisms for the governance of such risks in our modern, information-driven society. In many cases, this has required the modification of organisational structures and procedures to accommodate input from stakeholders. A key example is the process that has been used to develop new general recommendations from the International Commission on Radiological Protection (ICRP). Until 1999, the development of ICRP recommendations was done in a very closed fashion, with experts discussing and developing among themselves "the best approaches" to radiological protection. This process was opened up to broad public consultation in 1999, and although this has somewhat prolonged the development stage of the Commission's new recommendations (now due to be finalised in early 2007), there is consensus that this new process will lead to more broadly understood, accepted and applicable ICRP recommendations than in the past. This process seems to have opened in an irreversible way, and may well become a "procedural benchmark" for the development of other international and national standards and regulations.

Another area affected by stakeholder participation is emergency planning and preparedness. Since the Chernobyl accident, significant efforts have been made, both nationally and internationally, to improve response capabilities to accidents. Broadly, this work has focused on the urgent phase of such accidents, addressing for example communications and data management strategies to best serve the needs of decision makers. More recently, and based on 20 years of experience addressing the effects of the Chernobyl accident, governments have begun focusing on planning for later phases of accident situations. Growing experience from all of the Chernobyl-contaminated areas has indicated that the complexity of these situations can only be addressed through pluralistic discussions and actions directly involving affected stakeholders. These lessons are beginning to affect aspects of emergency planning and preparedness for nuclear and radiological incidents, as well as for malevolent acts.

Radioactive waste management

In May 2006 the second review conference of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management took place in Vienna, Austria under International Atomic Energy Agency (IAEA) auspices, and closely examined the waste management programmes of 41 countries worldwide. It was agreed that progress had been made in all areas of radioactive waste management, including the management of spent fuel, decommissioning waste and disused sealed sources.

In terms of geological disposal, public attention is still focused on the Yucca Mountain project in the United States and on the ONKALO Facility in Finland, which are both progressing, albeit with some delays in the case of Yucca Mountain. However, at the same time there has

also been considerable progress on other, less advanced programmes.

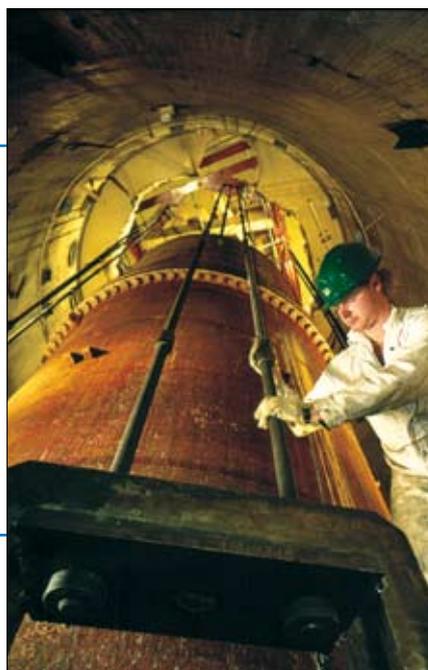
In France, the Planning Act Concerning the Sustainable Management of Radioactive Materials and Waste was issued, updating the 1991 Bataille law which had provided for research to be carried out along three axes (long-term storage, transmutation and geological disposal) over a 15-year time frame. The Act requires an application for a deep geological repository to be submitted by 2015 and for the repository to be commissioned by 2025. Retrievability is a key feature of this repository. The new law also institutes a formal national radioactive waste management plan and prescribes that by 2013 a decision should be made for graphite and radium-bearing waste, a category of low-level, but long-lived waste.

The Belgian programme made an important step forward when the Belgian government decided in June that low- and intermediate-level, short-lived waste will be disposed of in a surface repository in Dessel. This municipality – as well as the other candidate municipality of Mol – had been engaged in a participatory process with the Belgian waste agency ONDRAF/NIRAS and had expressed its willingness to host such a facility. The partnership arrangements will be maintained throughout the process of repository design.

Following the publication by the UK Committee on Radioactive Waste Management (CoRWM) of its final report and recommendations for the long-term management of long-lived waste in June, the UK Environment Minister outlined the government's policy in this area in October, closely echoing the findings of the CoRWM. The government confirmed that geological disposal should be the end-point for such wastes and that any siting decisions should be taken based upon open and transparent partnerships with potential host communities. An important change to institutional arrangements will be the transfer of the implementer's responsibility from UK



UKAEA, United Kingdom



Examples of decommissioning activities carried out in the United Kingdom.

NIREX to the Nuclear Decommissioning Authority (NDA). A successor body to the CoRWM will provide independent scrutiny and advice to the government.

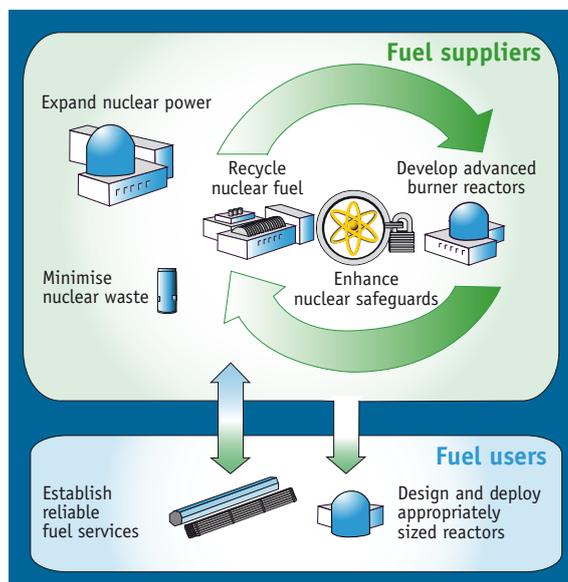
Finally, important legal decisions have been taken which strengthen the waste management programmes in Germany and Switzerland. For the Konrad repository in Germany, the Lower Saxony administrative court denied the request for an injunction, thus opening the door for the utilisation of the Konrad mine as a repository for non-heat-generating waste. In Switzerland, the Federal Council approved the findings of the *Entsorgungsnachweis* project, thus confirming that construction of a deep geological repository for high-level waste, spent fuel and long-lived, intermediate-level waste is in principle feasible in Switzerland. This decision paves the way to begin site selection once the related criteria have been specified.

The only operating geological repository worldwide, the WIPP (Waste Isolation Pilot Plant) in New Mexico, which has been receiving long-lived transuranic radioactive waste for five years, was recertified by the US Environmental Protection Agency (US-EPA). The recertification is a mandatory review of the WIPP's long-term safety and performance to ensure that it continues to meet safety requirements based on the most accurate and up-to-date information available. The US-EPA reviewed information from operational changes and emplacement experience, site characterisation data, and updated estimates of the waste inventory. The decision also took into consideration an updated performance assessment provided by the US Department of Energy.

Nuclear science

One of the key issues in the development of advanced nuclear systems is the choice of materials. This is true for structural materials as well as for materials used in the development of advanced nuclear fuels. Many different aspects have to be taken into account, for example temperature, radiation and corrosion resistance, as well as radiation activation concerns. As a complement to experimental activities, there are currently a number of national and international scientific projects devoted to the development of computer models simulating the behaviour of structural and fuel materials under different conditions. The computer models aim at developing multi-scale numerical tools to simulate the effects of irradiation on mechanical and corrosion properties of materials, starting from basic physics principles.

Recent initiatives, such as the US Global Nuclear Energy Partnership (GNEP), have generated renewed interest and subsequent scientific studies in, for example, areas related to the back end of the fuel cycle and to the development of smaller or modular nuclear reactors. Different types of nuclear fuel recycling schemes are being studied with the goal of developing a more efficient fuel cycle with improved proliferation resistance. Another advantage of advanced recycling schemes is that they produce less nuclear waste. The studies involve both the chemistry of the fuel separation processes and the potential to burn (transmute) transuranic elements in fast reactors or in dedicated, accelerator-driven, sub-critical reactors.



The Global Nuclear Energy Partnership focuses on expanding nuclear power and establishing partnerships between fuel suppliers and fuel users.

Nuclear law

NEA members are striving to minimise legal impediments to the safe use of nuclear energy and to develop and harmonise legislation governing the peaceful uses of nuclear energy. To that end, they continue to search for solutions to overcome nuclear operators' inability to obtain private insurance coverage for certain third party liability and material damage risks they are legally obliged to assume; to determine whether the risks associated with radioactive sources and nuclear fusion installations should be covered by special nuclear liability and compensation regimes; to ensure that the use or transport of small quantities of nuclear substances are not subject to an overly burdensome liability and compensation regime; to assess the impact of international conventions outside the nuclear field on nuclear activities; to facilitate the development and implementation of nuclear safety assistance programmes with non-members and to assist selected non-members in adopting domestic nuclear legislation based upon internationally accepted principles.

They are also striving to ensure that adequate and equitable compensation is made available to victims who suffer injury or damage as a result of a nuclear incident. Those members who adopted the Protocols to amend the Paris and Brussels Supplementary Conventions in 2004 continue to work actively towards their ratification and implementation into national legislation. Other members are on their way to ratifying the 1997 Convention on Supplementary Compensation for Nuclear Damage, while still others are examining the benefits of adhering to the 1997 Protocol to Amend the Vienna Convention or are considering amending their national legislation to reflect the provisions of these instruments.

Technical Programmes



Nuclear Development and the Fuel Cycle

Nuclear Development Committee (NDC)

The NDC continues to support member countries in the field of nuclear energy policy, addressing issues of relevance for governments and the industry at a time of nuclear technology renaissance and sustained government interest in ensuring long-term security of energy supply, reducing the risk of global climate change and pursuing sustainable development.

Nuclear policy issues

The NDC study on innovation in the nuclear energy sector was completed in 2006 and prepared for publication early in 2007. It is based on data and information from 11 countries and 23 case studies. The study examined the special characteristics of nuclear innovation systems and investigated feedback from experience in the nuclear sector to delineate policy recommendations for enhancing their effectiveness.

In the framework of the project on nuclear energy risks and benefits in perspective, the Secretariat organised a seminar at the annual meeting of the NDC. A background document based upon a broad survey of literature on health and environmental impacts, economics and social aspects of alternative electricity generation technologies was presented and discussed by the Committee. Some

Highlights

- A 40-year retrospective of statistical data and analyses on uranium resources, production and demand was published.
- The first international study on innovation in the nuclear energy sector, based on a comprehensive set of country reports and case studies, was completed for publication early in 2007.
- Co-operation with the International Energy Agency (IEA) was strengthened, leading to a better integration of nuclear energy issues in the global energy analyses carried out under OECD auspices. In particular, the NEA contributed to two IEA flagship publications: *Energy Technology Perspectives 2006* and the *World Energy Outlook 2006*.

members highlighted national viewpoints. The findings of the seminar will be reflected in a report for policy makers to be issued in 2007.

The study on licensing processes and nuclear energy in a competitive electricity market progressed in 2006 and received input from the NEA Committee on Nuclear Regulatory Activities (CNRA). The report is being finalised for publication early in 2007. The main objective of the project was to investigate the regulatory processes in place in various NEA countries from the viewpoint of their effectiveness in deregulated markets. The key findings from a review of regulatory experience in selected countries include: recognition/awareness by stakeholders of the challenges raised by combining effectiveness and efficiency in regulations and their implementation, and willingness to minimise potential undue regulatory

Shares of uranium resources and production (in %)

	Resources*	Production**
Australia	24.0	23
Canada	9.4	28
United States	7.2	2
Namibia	2.1	8
Niger	4.8	7
South Africa	7.2	2
Kazakhstan	17.2	10
Russian Federation	3.6	8
Uzbekistan	1.6	6
Ukraine	1.9	2
Others	21.0	4

* Identified resources recoverable at less than USD 130/kgU; ** in 2005.

burdens by means of advanced regulatory methods such as risk-informed regulation.

Strengthening its co-operation with the International Energy Agency (IEA), the NEA contributed to the drafting and review of nuclear energy sections in two major IEA books: *Energy Technology Perspectives 2006* and the *World Energy Outlook 2006*. The relative emphasis on nuclear energy in those publications reflects the renewed interest in the nuclear option in policy-making circles. The inputs from the NEA, based on the main findings from its activities and publications, help ensure that nuclear energy issues are assessed on a level playing field and integrated within the global energy analysis landscape.

The NEA also participated in the IEA in-depth energy policy reviews of Hungary, the Republic of Korea and the United Kingdom. This participation brings nuclear energy expertise to the review team and ensures that those issues are addressed in a comprehensive way in the context of the national energy policies under review.

Economics

A study on market competition in the nuclear industry was initiated towards the end of the year. It aims to examine competition in the supply of nuclear energy goods, materials and services for the whole nuclear fuel cycle, including the construction of new nuclear power plants. Some key markets will likely be selected for more in-depth analysis. In particular, given the anticipated increase in demand for new nuclear power plants and associated materials and services over the coming decade, the study will examine possible constraints on expansion of supply.

Technology

At the request of the French authorities, an international peer review of the results of the French R&D programme on partitioning and transmutation was organised by the NEA. The main findings, conclusions and recommendations of the review were presented to the French authorities and published. The peer review covers a number of topics of general relevance for member countries interested in sustainable approaches to the back end of the fuel cycle.

Nuclear power plant lifetime extension is becoming a routine operation and has proven to be a cost-effective way to maintain or increase the contribution of nuclear energy to electricity generation in many NEA countries. The study on *Nuclear Power Plant Life Management and Longer-term Operation*, published in 2006, builds on previous work carried out under NDC auspices. Based on the information provided by eleven member countries and two international organisations, the study presents statistics and current trends relating to the extended, longer-term operation of nuclear power plants. Findings from the study include the recognition of ageing phenomena and their potential impacts on safety, but it concludes that the extended operation of existing nuclear power plants offers significant economic advantages, contributes to security and stability of electricity supply, maintains the diversity of energy resources and reduces the risk of climate change. Finally, the report highlights the potential role of longer-term operation as a bridge between the present and future generations of reactors.

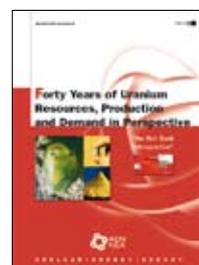
With the renewed interest for nuclear energy and the perspective of significantly expanding the installed nuclear capacity in the coming decades, recycling fissile and fertile material inventories is attracting increasing attention from policy makers. A study carried out under NDC auspices during 2005-2006 and to be published in 2007 covers strategic and policy issues associated with the management of recyclable materials. It provides an overview of the amounts of materials available, their state-of-the-art management options, through recycling or direct disposal, their potential value and the challenges raised by the implementation of advanced nuclear systems which could enhance the effectiveness of recycling.

Data and resource assessment

In the area of uranium resource assessment, the Joint NEA/IAEA Uranium Group continued its activities by completing the 2005 update of *Uranium: Resources, Production and Demand*, the "Red Book", and beginning preparations for the 2007 edition. Published in June 2006, the 2005 "Red Book" highlighted increased exploration and mine development efforts in many countries in response to recent increases in the spot market price for uranium. It concluded that sufficient uranium resources and production capability exist to meet future requirements, but cautioned that the long lead times needed to bring resources into production (typically in the order of ten years or more) mean that there is a potential for uranium supply shortfalls and continued upward pressure on prices, in particular if mine developments do not proceed as planned.

The Secretariat, under the leadership of past Uranium Group members, published the "Red Book Retrospective" in September 2006. The Retrospective was undertaken to compile, analyse and publish all of the key information collected in the 20 editions of the Red Book published between 1965 and 2004. It provides the most complete record of the uranium industry publicly available, along with new insights into costs of discovery, resource to production ratios and time to reach production after discovery.

The annual edition of the "Brown Book", *Nuclear Energy Data*, provides statistical data on nuclear electricity capacity and generation, as well as nuclear material and fuel cycle service production and demand in member countries. The 2006 edition offers projections to 2025 and country reports highlighting key events in the nuclear energy field.



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Nuclear Safety and Regulation

Highlights

- The CSNI and the CNRA have prepared and approved their respective Operating Plans, which develop the main challenges identified by the Joint CSNI/CNRA Strategic Plan into specific activities within the programme of work of the committees. The Operating Plans will provide a very useful tool to assign priorities and to ensure efficiency and adequate supervision of the committees' activities.
- Both committees organised several workshops, most notable were those on Improving Nuclear Safety Through Operational Experience Feedback; Regulatory Inspection Practices; Seismic Probabilistic Safety Assessment of Nuclear Facilities; and Benchmarking of CFD Codes for Application to Nuclear Reactor Safety.
- Knowledge management has become a growing concern in many countries, and both safety committees agreed to participate in an NEA pilot project on boron dilution, which will provide the key elements for the establishment of an NEA policy on data preservation and information access.
- In 2006 two new multilateral "Joint Projects" were started on fire safety assessment (PRISME) and on ageing issues (SCAP). See page 28 for further details on these and other joint projects under way. One project was completed (MASCA-2).

Committee on Nuclear Regulatory Activities (CNRA)

The CNRA contributes to developing a consistent and effective regulatory response to current and future challenges. These challenges include operational experience feedback, increased public expectations concerning safety in the use of nuclear energy, industry initiatives to improve economics and inspection practices, the necessity to ensure safety over a plant's entire life cycle, and new reactors and technology.

Operating experience

The joint NEA/IAEA Incident Reporting System (IRS) is the only international system providing regulators and government bodies with information about lessons learnt from safety-significant events at nuclear power plants. The IRS co-ordinators exchange information about recent events during their annual meetings and jointly define topics of interest for further work.

In 2006, a report was published on *Regulatory Challenges in Using Nuclear Operating Experience*. The report focuses on how regulatory bodies can ensure that operating experience is used effectively to promote the safety of nuclear power plants.

The Working Group on Operating Experience organised a major conference on operating experience feedback in May. Senior regulators and researchers along with managers and technical-level experts discussed ways to improve nuclear safety through operating experience feedback and developed a number of recommendations.

Several issues are currently being studied by the working group, including the safety analysis of fire operating events, loss of heat sink events and international networks for nuclear facility operating experience feedback.

The regulatory goal of ensuring nuclear safety

A senior-level task group was set up to address the fundamental question, "How can the regulator judge whether its actions are actually ensuring an acceptable level of safety at nuclear facilities?" The group's findings will be published.

Preparations also began for an NEA forum which will be held in June 2007 and involve top-level participants from regulatory authorities and government agencies, nuclear industry leaders and other stakeholders. The forum will examine how regulatory bodies can systematically collect and analyse all of the safety-related information available to arrive at an integrated judgement on the acceptability of the level of safety of the nuclear facilities that they regulate. The forum will seek regulatory body perspectives, industry perspectives, governmental perspectives and other stakeholder perspectives on this question.

Regulatory inspection practices

As part of the activities of the Working Group on Inspection Practices (WGIP), inspectors from regulatory bodies meet periodically to exchange information and experience related to regulatory safety inspection processes and to carry out related studies. The WGIP mandate notes the important relationship between inspection practices and operating experience and how regulatory inspections must be supplemented by reviews and by other regulatory controls to yield an integrated assessment of safety and to provide a basis for enforcement, an essential part of the regulatory oversight process.

An internal report was completed on inspection efforts. The basis for this work was to study more in-depth how much effort member countries expend on nuclear regulatory inspections. Sharing this information could help the regulatory bodies in NEA member countries to better understand the effort required to support the different

inspection approaches and to consider opportunities for improving the effectiveness of their regulatory strategies.

The 8th International Workshop on Nuclear Regulatory Inspection Activities was held in May and hosted by the Canadian Nuclear Safety Commission. Topics addressed included how regulatory inspections can promote, or not promote, good safety culture, interactions between the licensee and its contractors, and future challenges for inspectors.

Other issues being studied by the working group include regulatory inspection philosophy, inspection organisation and inspection practices, inspection of fire protection systems and digital instrumentation and control (I&C) inspections.

Nuclear regulators and the public

Transparency is one of the keys to public acceptance of nuclear energy. Information officers from regulatory bodies meet once a year to exchange information and experience related to communication with the

public and to carry out related studies. The mandate of the Working Group on Public Communication of Nuclear Regulatory Organisations (WGPC), as revised in 2005, includes the preparation of reports addressing developments, tools, procedures and achievements in the area of nuclear regulatory communication with the public and stakeholders. Two such reports were issued in 2006 which address the challenges associated with public communication during abnormal situations and with the publicity given to regulatory decisions.

The group's main activity in 2006 was the preparation of a workshop on the Transparency of Regulatory Activities, to be held in Japan in May 2007. This workshop will bring together communicators and technical staff of the nuclear regulatory organisations and senior regulators. The workshop includes five topical sessions: Understanding transparency; Stakeholders' expectations regarding transparency; Conditions for ensuring the transparency of regulatory activities; Changing regulatory practices for ensuring transparency; and Methods for evaluating transparency.

Committee on the Safety of Nuclear Installations (CSNI)

The CSNI contributes to maintaining a high level of safety performance and safety competence by identifying emerging safety issues through the analysis of operating experience and research results, contributing to their resolution and, when needed, establishing international research projects.

Analysis and management of accidents

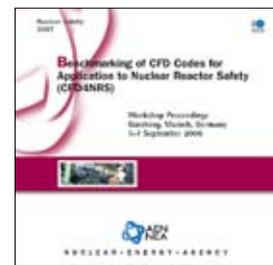
Current CSNI activities on the analysis and management of accidents primarily concern the thermal-hydraulics of the reactor coolant system and related safety and auxiliary systems; in-vessel behaviour of degraded cores and in-vessel protection; containment behaviour and containment protection; and fission product release, transport, deposition and retention. According to CSNI recommendations, additional efforts will need to be made in other areas, notably in the fire safety area.

The main objective regarding thermal-hydraulics of the reactor coolant system and related safety and auxiliary systems is to improve and expand the application of best-estimate codes, including uncertainty analysis, in nuclear power plant safety and design evaluations. During 2006, progress was made on the quantification and application of best-estimate methods including uncertainty and sensitivity (BEMUSE). The study addresses thermal-hydraulic, best-estimate calculations from an integral test

facility with a nuclear core (Phases 2 and 3) and is planned to continue for a nuclear power plant (Phases 4 and 5) in 2007-2008.

Activities in the area of computerised fluid dynamics (CFD) code utilisation include best practice guidelines, completed in 2006, and multi-phase applications, most of which will be completed in 2007. For CFD codes nodalisation is still a challenge and there is a lack of good experimental data suitable for two-phase code validation.

A workshop on Benchmarking of CFD Codes for Application to Nuclear Reactor Safety was held in September. Clear recommendations were made at the workshop relating to best-practice guidelines, experimental data and measurement uncertainties, and interaction with experimenters involved in producing data. The workshop proceedings will be released on CD-ROM and the NEA website in the beginning of 2007. Also soon to be released are the recommendations from the workshop on evaluation of uncertainties in relation to probabilistic safety assessment (PSA).



Work continued on in-vessel behaviour of degraded cores, notably the report on predicting in-vessel accident progression, covering beyond-design-basis accident code capabilities, the state-of-the-art report on in-containment behaviour of aerosols, the International Standard Problem (ISP) 47 on predictability of containment atmosphere, and the containment code validation matrix. The status report on iodine chemistry was completed.

Ageing and structural integrity of reactor components

The main topics investigated in this area include metal components, concrete structures, and the seismic behaviour of structures and components. Maintenance, in-service inspection and testing of structures, systems and components important to safety need to be of such a standard and frequency as to ensure that levels of reliability and effectiveness remain in accordance with the design assumptions. The concept of risk-informed, in-service inspection (RI-ISI) has been successfully implemented in several NEA countries and is now, along with non-destructive testing qualification, providing improved in-service inspection, reducing both plant risks and radiation exposure to inspection personnel.

Current activities in this area include a benchmark on risk-informed, in-service inspections methodologies (RISMET), a synthesis report concerning the ageing of nuclear power plant concrete containment structures, and a joint IAEA/NEA survey on nuclear facilities that have experienced an earthquake. During 2006, work was also carried out on the Probabilistic Structural Integrity of a PWR Reactor Pressure Vessel Benchmark (PROSIR). The reports on Differences in approach between nuclear and conventional seismic standards with regard to hazard definition and on the Survey of primary water stress corrosion cracking (PWSCC) in Ni-based alloys were approved for release.

A workshop on Structural Reliability Evaluation and Mechanical Probabilistic Approaches of NPP Components was organised in September in France. Workshop recommendations pruned the continuing use of mechanical probabilistic approaches since they give more information than deterministic evaluations and constitute an essential tool for highlighting effects of uncertainties surrounding the deterministic criteria for structural integrity of safety-class components.

An expert meeting was held to discuss the Spanish proposal to set up a co-operative research project on ex-plant materials from the José Cabrera nuclear power plant. The project aims to focus on assessing properties of extended operation and in-plant irradiated materials from the José Cabrera reactor vessel core internals.

Risk assessment

The main mission of the Working Group on Risk Assessment (WGRisk) is to advance the understanding and utilisation of probabilistic safety assessment (PSA) as a tool to support decision making in member countries on matters related to nuclear safety. While PSA has matured greatly over the past decades, further work is still required to refine methods and to apply PSA methodology to new areas.

Current tasks include establishing a framework for human reliability data exchange; analysing the uses and developments of PSA in member countries; organising an international experts' meeting in the area of seismic PSA; work on using risk information in the regulatory process; and writing a technical opinion paper on recent developments in level-2 PSA.

A specialist meeting was organised on the Seismic Probabilistic Safety Assessment of Nuclear Facilities in

November in the Republic of Korea. The meeting resulted in a new set of findings and recommendations to guide future national and international work on effective ways of using seismic PSA. The group also started to work on PSA of off-site external hazards other than earthquakes, where the focus is on off-site external events, including (external) floods. PSA in several member countries indicates that external off-site events such as extreme weather conditions or high temperatures are important risk contributors. In addition, work has begun on the status of and experience with the technical basis and use of probabilistic risk criteria.

Fuel safety

The Working Group on Fuel Safety (WGFS) addresses the systematic assessment of the technical basis for current safety criteria and their applicability to high burn-up, as well as to the new fuel designs and materials being introduced in nuclear power plants. A concise review of existing data resulting from reactivity-induced accident (RIA) and loss-of-coolant accident (LOCA) experiments was carried out. The group also assessed how these data affect fuel safety criteria at increasing burn-up.

In 2006, the WGFS continued to review the adequacy of existing codes for the simulation of high burn-up fuel behaviour under accident conditions. A benchmark for the Halden irradiated LOCA test was organised in co-operation with the OECD Halden Reactor Project. The benchmark showed that further effort is needed to better model and validate high burn-up phenomena as related to internal pressure; transient fission gas release; collapse of the fuel column after ballooning of the cladding; oxidation and related hydriding; ballooning and related fuel blockage. The experimental database on actual irradiated fuel claddings requires additional data. Ongoing national and international fuel safety research programmes are expected to fill the existing gaps.

A meeting was organised in Paris to review the status of LOCA analyses and tests as well as plans for future activities. The meeting addressed the current development of burn-up dependent LOCA criteria and aimed to identify areas where data might be needed.

The Review of High Burn-up and LOCA Database and Criteria was issued as a CSNI report. The Technical Note on LOCA Fuel Cladding Test Methodology was completed.

Human and organisational factors

The Working Group on Human and Organisational Factors (WGHO) constitutes a unique international forum for addressing safety management, human and organisational factors, and human performance in nuclear facilities. Current activities include writing technical opinion papers about human performance in the safety of NPP maintenance and about the role of human factors in NPP modifications. An activity on maintaining oversight of licensee safety culture and the technical bases for philosophies, methods and approaches was started in 2006 to accommodate a request from the CNRA, including the organisation of a workshop in 2007. A workshop on future control room designs and human performance issues and work practices was organised in Norway in May.

Fuel cycle safety

The Working Group on Fuel Cycle Safety (WGFCS) brings together regulatory and industry specialists to address a broad range of interests, including safety assessments, nuclear criticality safety, probabilistic safety assessment, safety management, decommissioning and site remediation, fire protection and human factors.

The joint NEA/IAEA Fuel Incident Notification and Analysis System (FINAS) is the only international system providing regulators and government bodies with information about lessons learnt from safety-significant events at fuel cycle facilities. The new web-based FINAS is scheduled to go into operation early in 2007.

Planning continued on an international workshop to be held in October 2007 which will address how to ensure the safety of current and new fuel cycle facilities, legacy waste concerns (including facilities and waste), the reprocessing of nuclear fuel and the recycling of waste. The workshop will also address potential future issues based on preliminary results of the survey on fuel cycle safety issues such as fire, human factors and ageing in relation to fuel cycle safety.

Integrated assessment of safety margins

Factors such as ongoing power uprates, longer operating cycles, new fuel designs and increased fuel burn-up, combined with plant ageing and plant life extension require a comprehensive, integrated assessment in order to evaluate their potential cumulative safety impact. An extensive Action Plan on Integrated Assessment of Safety Margins (SMAP) began in 2004, aiming to develop a methodology for the assessment of synergistic safety margin reductions. The methodology derived can be used to quantify the change in margins due to combinations of plant modifications occurring together. It could also be used as support for setting safety limits for advanced reactor designs. The Action Plan and the Final Guidance document are expected to be completed early in 2007.

Research facilities for existing and advanced reactors

Following a CSNI recommendation, a group of senior research managers was constituted with the aim of providing the necessary input and elaborating elements of strategy for maintaining key safety research facilities and possibly expanding their use. Its main task was to revise an earlier CSNI report on the subject, and to address a number of technical disciplines and related facilities, aiming to define priorities for possible joint international initiatives or programmes in the future. Extensive consultations and report revisions took place during 2005 and 2006, including consultation with industry. The final report was completed and approved in June.

The report concludes that the CSNI should adopt a strategy for preserving a research facility infrastructure for the long term (past 2008), based on maintaining unique, versatile and hard-to-replace facilities. These facilities are identified in the Executive Summary of the report. Factors to be considered for initiatives include:

facility operating and replacement cost; ability to define a useful programme; industry participation; and host-country commitment. In the thermal-hydraulics area, the report recommends in the short term to support a co-operative research programme at the PANDA facility. It should be noted that CSNI actions stemming from an earlier report played a major role in the preservation of the PANDA facility over the past five years. Regarding severe accidents, facilities supporting the resolution of pre-core melt conditions, combustible gas control and coolability of overheated cores are in danger in the short term. The report recommends that action be taken to preserve the MISTRA facility in light of its 3-D containment simulation and instrumentation capabilities. The CSNI will be following up the report by defining the Committee's responsibilities in the long-term strategy and the implementation of the long-term recommendations.

Industry participation in CSNI activities

Both the NEA Strategic Plan and the Joint CNRA/CSNI Strategic Plan recognise the importance of co-operation with industry, including in the area of nuclear safety. Following a CSNI debate on the subject, it was concluded that the benefits of co-operation include a better understanding of the technical issues, a pooling of expertise and improved programme design in terms of access to information and greater confidence that the focus of research will be realistic and practical. The debate also found that, while maintaining and encouraging adequate co-operation with industry:

- The regulator should maintain independence and, at all times, be able to demonstrate its independence.
- There is a long tradition of industry participation in joint research projects in several countries, especially in projects devised to address operational issues. For generic, long-term issues, public funding is perhaps more appropriate.
- There should be a gradual approach to industry participation, where co-operation first occurs in joint projects and in working group activities. Industry involvement in working groups would also facilitate industry participation in new joint projects as they are first discussed in the pertinent working group.
- CSNI work on high burn-up fuel is a good example of industry involvement with positive results. In a research framework where both plant safety and efficiency are addressed, industry participation will occur naturally.

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Radioactive Waste Management

Radioactive Waste Management Committee (RWMC)

The RWMC is assisting member countries in the area of management of radioactive waste and materials, focusing on the development of strategies for the safe, sustainable and broadly acceptable management of all types of radioactive waste, in particular long-lived waste and spent fuel.

Waste management policy and governance issues

The safety case is a key input to decision making throughout the repository implementation process, which has evolved over the last decade from a numerical, performance-focused assessment to a collation of the broader range of evidence that supports and gives context to the safety argument. The Integration Group for the Safety Case (IGSC) prepared a symposium on Safety Cases for Deep Disposal: Where Do We Stand? to share practical experience on preparing a safety case and to highlight progress made since 1989, when a similar symposium was held. The symposium, scheduled for January 2007 and co-sponsored by the IAEA and the EC, will provide an international basis for the further development of safety cases and will indicate directions for future work programmes of the NEA and other international organisations in this area.

Complementing the symposium, the International Experiences in Safety Cases (INTESC) initiative aims to provide a comprehensive overview of state-of-the-art practices in existing and developing safety cases to identify key concepts, including points of consensus and divergence. Information from 15 member organisations has been collected. The report, to be published in 2007, will help clarify actual differences and similarities in safety cases.

The handling of issues related to timescales has also been revisited by the IGSC. The report finds that three broad areas in the regulation and practice of repository planning and implementation are affected by timescales issues, and it draws conclusions in light of recent international experience.

Regulatory and policy aspects of long-term safety

Regulatory acceptance criteria, and in particular radiological protection criteria for humans and the environment over long timescales, are a prerequisite to the realisation

Highlights

- A workshop of the RWMC Regulators' Forum discussed Practical Issues and Challenges in the Regulation of Geological Disposal of Long-lived Radioactive Waste in order to better understand policies, principles and objectives underlying different national long-term safety criteria.
- The RWMC Working Party on Decommissioning and Dismantling (WPDD) organised a topical session on Emerging Issues and Trends in Regulatory Practices During Decommissioning of Nuclear Power Plants
- The role of modelling engineered barrier systems (EBS) in the framework of the safety case was the topic of the fourth NEA/EC EBS workshop, held in Tokyo, Japan.
- The Forum on Stakeholder Confidence (FSC) organised a workshop in national context in Hungary to discuss the social and economic context of waste management facility siting.

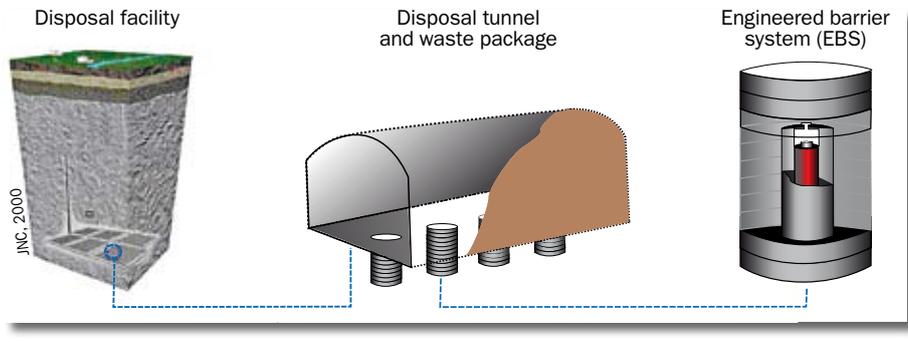
of any underground repository for long-lived radioactive wastes. A number of countries have established such regulatory criteria, while others are now discussing what constitutes a proper regulatory test and suitable time frame. These criteria are meant to ensure protection and safety for periods of time that are extremely long, even atypical, and in advance of regulation for other hazardous materials.

It has been recognised for many years that differences in criteria between countries may make it difficult to establish the necessary levels of acceptance of national repository proposals. Yet, a review of the long-term radiological protection criteria for disposal of long-lived waste, and an examination of their consistency internationally reveals a broad range of differing criteria and practices, and it is important that the differences be understood and explained. This work is being carried out by the Long-term Safety Criteria Group of the RWMC Regulators' Forum.

Ultimately, it is hoped that work in this area will help provide guidance and information to those programmes still developing criteria, and assist national programmes in communicating the context and meaning of regulatory standards for long-term disposal. A workshop was held in November on Practical Issues and Challenges in the Regulation of Geological Disposal of Long-lived Radioactive Waste: Towards a Common Understanding of Policies, Principles and Objectives. Participants represented regulators, implementers, consultancies, research centres and academic institutions. The workshop helped develop the groundwork for a "common understanding" and a way to carry this initiative forward.

Repository safety and integration of science

In the series of workshops on the role of engineered barrier systems (EBS), the fourth and final workshop was held in Tokyo, Japan, to address the topic of EBS design confirmation and demonstration. The workshop aimed to promote common understanding of approaches to demonstrate



EBS: the reference concept for the geological disposal system in Japan.

that EBS can be manufactured, constructed and installed satisfactorily. The workshop examined specific examples of EBS testing and demonstration programmes; feedback to modelling and safety; assessment and design optimisation; and refinement processes to help build confidence in the safety case.

Forum on Stakeholder Confidence

The Forum on Stakeholder Confidence (FSC) organised its sixth workshop in national context in Tengelic, Hungary. The workshop offered a unique opportunity to hear from, and interact with, Hungarian stakeholders – amongst whom 11 mayors – one year after Parliament gave the green light to construct a low- and intermediate-level, short-lived radioactive waste repository in the township of Bátaapáti. The workshop provided international delegates and Hungarian stakeholders with a chance to explore the social and economic context of waste management and facility siting, and the opportunity to discuss the important work of the Public Oversight and Information Associations in Hungary. The FSC also used the workshop to test the main messages of its study on building a sustainable relationship between a facility and the host community. Positive feedback was received and the FSC decided to proceed with the study's publication in 2007. The study reviews the value added that waste storage or repository projects can bring to the hosting communities, focusing on cultural and amenity aspects.

In order to better understand recent cultural and structural changes taking place within RWMC organisations, and thereby to better address stakeholder concerns, the Forum is preparing a desk study to extract lessons learnt from member institutions' experience. Another study, also close to being finalised, reviews stakeholder aspects of decommissioning nuclear facilities. The study was carried out in co-operation with the NEA Working Party on Decommissioning and Dismantling. During 2006, the Forum also addressed organisational changes and aspects of e-communications (see page 38 for further details).

Decommissioning

The Working Party on Decommissioning and Dismantling (WPDD) organised a topical session on Emerging Issues and Trends in Regulatory Practices During Decommissioning of Nuclear Power Plants to discuss the challenges of setting up a decommissioning regulatory regime, and to explore the need to strike a balance between harmonisation and flexibility.

Releasing the site of a nuclear installation from radiological control is usually one of the last steps of decommissioning and to date has been practised in a limited number of cases only. The WPDD completed a status report describing the basic considerations which must be taken into account when deciding on the release of a site. The WPDD also finalised a status report on strategy selection for decommissioning that reviews factors influencing decommissioning strategies and addresses the challenges associated with balancing these factors in the process of strategy selection. Finally, the WPDD issued a status report on decommissioning funding that offers, in a concise form, an overview of relevant considerations on decommissioning funding mechanisms with regard to ethics, implementation and uncertainties. These three reports are available on the NEA website.

Regarding the release of radioactive materials from regulatory control, adequate methods of measurement must be available to demonstrate or verify that the activity levels are lower than regulatory values. The WPDD published a study on objectives and methodology for radiological characterisation drawing on experience gathered within the NEA Co-operative Programme on Decommissioning (CPD) and collected by a CPD task group.

Understanding the scientific basis

To secure the scientific basis of its work, the RWMC continued to support the development and maintenance of quality-assured databases and models for use in the implementation of repositories. Work continued on the Thermochemical Database (TDB). The Working Group on the Characterisation, Understanding and the Performance of Argillaceous Rocks as Repository Host Formations (the "Clay Club") continued its studies on specific clay properties, notably on long-term natural tracer profiles (CLAYTRAC) and on the self-sealing capacities of clays. Finally, the NEA International Database of Features, Events and Processes (FEPs) was updated and expanded to continue providing an internationally accepted reference point to compile and cross-check for national programmes' assessments of which FEPs can affect repository evolution and safety.

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Radiological Protection

Committee on Radiation Protection and Public Health (CRPPH)

The CRPPH is contributing to the definition of new directions and approaches for the international system of radiological protection in order to achieve a clearer and more streamlined framework. The ultimate objective is to achieve a system that will better address regulator and practitioner needs, and will more appropriately position scientific radiological protection considerations within the broader context of social judgement and risk governance.

Evolution of the International System of Radiological Protection

Since the International Commission on Radiological Protection (ICRP) began to develop new general recommendations in 1999, the CRPPH has led the NEA standing technical committees in providing input and suggestions to the process. When the ICRP issued the third major draft of its general recommendations in 2006, the NEA organised three international workshops in Tokyo, Washington DC and Prague to discuss the draft. A line-by-line assessment of the draft was performed, resulting in 50 pages of detailed comments on the text. Although the ICRP did not revise its draft text during these workshops, the ICRP Chair's presentations of its principles during the workshops evolved significantly along the lines suggested by workshop discussions.

It is expected that the ICRP will issue one more draft of its general recommendations before their approval by the Commission in 2007. The CRPPH will again perform a detailed assessment of the last draft and provide well-supported suggestions for changes in the hope that the final ICRP recommendations will best address their policy, regulatory and applicational needs.

Stakeholders and radiological protection

Twenty years after the major accident at the Chernobyl nuclear power plant, the radioactive contamination continues to have an important impact on lives in the vicinity, and to a lesser extent in areas such as Western Europe and beyond. The CRPPH produced a report entitled *Stakeholders and Radiological Protection: Lessons from Chernobyl 20 Years After* which focuses on the role of radiological protection and how this discipline has been deployed to help people in the affected areas to manage their lives. Although the topic of this report concerns radioactivity and nuclear energy, it can also be very useful

Highlights

- In order to enable a review of the 2006 draft of the recommendations of the International Commission on Radiological Protection (ICRP) by stakeholders, the CRPPH organised three workshops in Tokyo, Washington DC and Prague. Detailed comments on the draft were provided through an expert group.
- The CRPPH produced a report on *Stakeholders and Radiological Protection: Lessons from Chernobyl 20 Years After* focusing on how radiological protection has been deployed to help people in the affected areas.
- A workshop was held in Paris in May to evaluate the results of the INEX 3 emergency exercises series.

to policy makers and experts who may be forced to deal with the aftermath of wide-scale disasters, regardless of their causes (natural, accidental or malicious).

Radiological protection and public health

In a very broad sense, the notion of public health is inherently all-inclusive, not focusing on any single risk or group of risks. In this context, questions of risk prioritisation and resource allocation are important. In a more technical sense, however, this broad perspective suggests that there should be some common elements among the approaches taken to risk assessment and risk management. If radiological protection is increasingly viewed as "just another aspect of public health decision making", will this have any impact on the structures and processes of the institutions currently dedicated to only radiological protection? To address these and other related issues, the CRPPH created an expert group in 2006 and began studies and exchanges of national experience. The group will report to the CRPPH in 2007 and propose topics that can usefully be explored in greater depth.

Operational radiological protection from a policy perspective

The influence of radiological protection policy on operational protection, and the feedback from operational protection to the formulation of protection policy are growing. For example, policy, regulatory and operational lessons can be drawn from a review of the regulatory assessment of "ALARA" (as low as reasonably achievable) programmes. New ICRP recommendations will need to be applied at the operational level, including such concepts as dose constraints and optimisation. An expert group was created to identify and discuss such issues in a preliminary fashion, and to present a report to the May 2007 meeting



M. Durisova



AVN



Cogema



EDF

The multiple facets of radiological protection concern both people and the environment.

of the CRPPH. Opportunities to leverage the operational experience of the ISOE programme will be sought.

Radiological protection science and policy judgement

The recent CRPPH assessment of ongoing research in radiation biology has indicated that there could be a significant impact on the current system of radiological protection should the outcomes of research challenging current radiological protection assumptions continue to emerge. While none of these outcomes are at this point certain, regulatory authorities are working to remain abreast of developments in order to assess potential practical implications and to prepare for them. In this light, the CRPPH has begun preparing an international workshop to explore how policy judgements can best be made in the context of emerging scientific challenges and continuing scientific uncertainties that are often quite large. This workshop will help RP policy makers, regulators and practitioners to better understand developments, as well as possible developments, coming from RP science. At the same time, it will help RP scientists to better understand the broad processes of RP decision making, and to better interact with these processes in terms of providing input stemming from their research.

Scoping studies

The CRPPH has identified several topics that require scoping studies before a decision for further, in-depth studies can be taken. To assist member countries in preparing for the possibility of building new nuclear power plants, a scoping study was established to explore justification and optimisation of new build and, specifically, to investigate how the concept of "best available techniques" could be relevantly applied. Using a case-study approach, another scoping group will report on how RP organisations are handling the challenge and opportunity of stakeholder involvement. Finally, following a 2005 desk study reviewing national regulations and international instruments related to the radiological protection of the environment, the NEA is producing a parallel study of national regulations and international instruments related to protection of the environment from chemical toxins to assess regulatory implications of different approaches.

Nuclear emergency and recovery management

During 2005 and 2006, fifteen countries investigated the later-phase, decision-making processes in International Nuclear Emergency Exercises (the INEX 3 table-top exercises), examining how they might, in the wake of a contamination, implement agricultural countermeasures and food restrictions, adopt "soft" countermeasures such as travel, trade and tourism controls, communicate with the public and move towards recovery. To evaluate the results of these exercises, the Working Party on Nuclear Emergency Matters (WPNEM) held a workshop during which participants from 22 countries shared their national experiences of the exercise, collectively analysed their approaches to consequence management and the implications of any differences on decision makers, and identified issues needing additional examination at the international level. The WPNEM subsequently launched a series of initiatives to address key needs in consequence management and recovery as identified during the workshop. A synthesis report of the exercise series, workshop and follow-up activities is in preparation.

Occupational exposure at nuclear power plants

Occupational exposure at nuclear power plants continues to be an important issue. The sharing of operational lessons and experience, as well as the collection, analysis and exchange of occupational exposure data continues to be achieved through the joint Information System on Occupational Exposure (ISOE) (see page 33 for further details). Important steps in enhancing ISOE value through a more strategic approach to meeting ISOE members' operational needs were initiated in 2006.

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Nuclear Science

Nuclear Science Committee (NSC)

The aim of the NEA nuclear science programme is to help member countries identify, pool, develop and disseminate basic scientific and technical knowledge used to ensure safe and reliable operation of current nuclear systems, as well as to develop next-generation technologies. The main areas covered are reactor physics, fuel behaviour, fuel cycle physics and chemistry, criticality safety and radiation shielding.

The principal areas covered by the NEA nuclear science programme are reactor physics, fuel cycle physics and chemistry, criticality safety and radiation shielding. A large part of the work is based on international benchmark exercises, employed to validate models and data used in member countries for predicting the behaviour and performance of different nuclear systems. In addition, the nuclear science programme sponsors specialist meetings and workshops, as well as the preparation of state-of-the-art reports as necessary.

Reactor physics

Activities related to current reactor systems comprise studies of nuclear reactor stability and transient issues, as well as the possibility to burn weapons-grade plutonium in existing light water reactors. The work on reactor stability includes, among others, a benchmark on coupled neutronics and thermal-hydraulics transients in a pebble bed modular reactor (PBMR) and a benchmark on the detailed void distribution inside a boiling water reactor (BWR) fuel bundle, based on experimental data provided by NUPEC, Japan. A number of benchmarks concerning physics and fuel behaviour are being conducted to validate the modelling tools used in simulating the use of weapons-grade plutonium, in the form of mixed-oxide fuel, in current light water reactors.

In the area of advanced reactors, the emphasis has recently been on high-temperature reactors (HTRs). A benchmark designed to investigate the use of plutonium and thorium fuels in HTR systems was completed and the results will be published in early 2007. Another benchmark, based on experimental data from the Swiss PROTEUS research reactor, is being devoted to a study of low-enriched uranium HTR configurations, with the objective of reducing the design and licensing uncertainties for small and medium-sized, helium-cooled reactors using low enriched uranium and graphite high-temperature fuel.

Work was also recently started to review the current status and needs of sensitivity and uncertainty analysis in

Highlights

- A report was published on the technical feasibility of extending the average fuel discharge burn-up in current light water reactors (LWRs).
- A report assessing the possibility of burning weapons-grade plutonium in the form of mixed-oxide (MOX) fuel in Russian-designed VVER-1000 reactors was issued.
- The 8th Workshop on Shielding Aspects of Accelerators, Targets and Irradiation Facilities (SATIF-8) was held in May in the Republic of Korea.
- The 9th Information Exchange Meeting on Actinide and Fission Product Partitioning & Transmutation was held in September in France.



PSI, Switzerland

The PROTEUS research reactor at the Paul Scherrer Institute, Switzerland.

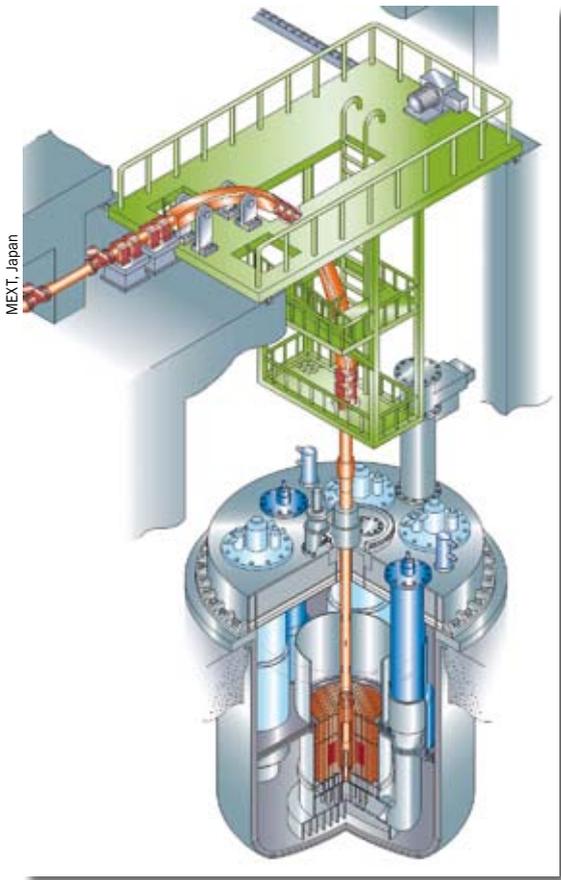
modelling exercises, with special emphasis on multi-physics and multi-scale simulations.

Fuel cycle physics and chemistry

A report assessing the scientific and technological limits to very high burn-up fuel cycles (up to 100 GWd/t) in current light water reactors (LWRs) was published during the year. The study reviews the repercussions for the fuel cycle, for reactor operation and safety, as well as for fuel cycle economics, and provides recommendations regarding scientific and technological areas in which further development would be required to achieve these very high burn-ups.

An expert group on chemical partitioning is finalising a status report describing the aqueous and pyrochemical processes being used or developed for the reprocessing of irradiated fuel in different countries. This group is also reviewing fuel separation criteria influencing future nuclear waste repositories and a methodology for evaluating the impact of existing repository projects on current and advanced fuel cycle scenarios.

The 9th Information Exchange Meeting on Actinide and Fission Product Partitioning & Transmutation (P&T) was



Development of an accelerator-driven nuclear transmutation system in Japan.

organised on 25-29 September 2006 in Nîmes, France. The meeting was attended by 170 scientists who reviewed progress in national and international programmes as well as in different areas of P&T, such as fuels and targets, chemical partitioning and waste forms, spallation targets, dedicated transmutation systems, coolants, physics and nuclear data.

A study of the technical information needed to fully understand the transition from current nuclear fuel cycles to long-term sustainable fuel cycles has been undertaken. An overview report is being finalised and two specific scenario benchmarks are being conducted: one benchmark to compare three different transition scenarios (once-through, limited plutonium recycling in LWRs, and plutonium and minor actinide recycling in fast reactors), and another benchmark to study a theoretical regional European approach involving a sharing of facilities and fuel inventories to optimise the use of resources.

Nuclear criticality safety

A report assessing the ability of computer codes to handle slow convergence in calculating problems relevant to a fission source was issued. Four different test problems, which could be used to develop test cases for criticality safety codes, were investigated. It was concluded that although advanced source convergence methods are normally worth using in difficult problems, there are presently no substitutes for a sound understanding of the physics of the individual system and a carefully applied, appropriate computational technique.

A workshop on the Need for Post-irradiation Experiments to Validate Fuel Depletion Calculation Methodologies was held on 11-12 May 2006 in Řež, Czech Republic to review the need for and availability of fuel post-irradiation experiment (PIE) data, especially for VVER reactors. It was concluded that the status of PIE data for all light water reactors needs to be further investigated and that all available data should be entered into the NEA Spent Fuel Isotopic Composition Database (SFCOMPO). The NEA has established the Expert Group on Assay Data of Spent Nuclear Fuel to co-ordinate this activity.

Radiation shielding and reactor dosimetry

The 8th Workshop on Shielding Aspects of Accelerators, Targets and Irradiation Facilities (SATIF-8) was held on 22-24 May 2006 in Pohang, Republic of Korea. The workshop participants reviewed progress in areas such as dosimetry, shielding of high-energy accelerators, induced radioactivity, status of computer codes, and shielding data libraries and shielding in medical and industrial accelerator applications. The proceedings will be published in early 2007.

Work is also currently under way on the preparation of a handbook which will contain benchmarks related to neutron slowing and neutron transport theory.

R&D facilities in nuclear science

In follow-up to the report on *Research and Development Needs for Current and Future Nuclear Energy Systems*, an expert group has been established to review the needs of research and test facilities in nuclear science. A database containing information on more than 700 facilities is being established, and a status report identifying future needs of nuclear science research facilities is being drafted.

Knowledge preservation

The NEA science programme is, in close collaboration with the Data Bank, pursuing the preservation of information from important and well-documented experiments in many application areas. Databases have been established in the areas of reactor physics (IRPhE), fuel behaviour (IFPE) and radiation shielding (SINBAD). The NEA is also co-ordinating the compilation of data into the International Handbook of Evaluated Criticality Safety Benchmark Experiments (ICSBEP). The data are made available to the nuclear community in a comprehensive and structured format for use in computer model and benchmark validation exercises. In addition, the NEA science programme is contributing to the Agency's pilot project on boron dilution (see page 14).

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Data Bank

The Data Bank operates as an international centre of reference for its member countries with respect to basic nuclear tools, such as computer codes and nuclear data, used for the analysis and prediction of phenomena in the nuclear field. It provides a direct service to its users by acquiring, developing, improving and validating these tools and making them available as requested.

The US Department of Energy and the NEA have agreed to continue to exchange nuclear data and computer programs and a five year co-operative arrangement to that effect was signed by the NEA Director-General, Luis Echávarri, and the US Acting Under Secretary of Energy, Dennis Spurgeon, in April 2006.



Dennis Spurgeon (left) and Luis Echávarri (right).

Computer program services

The NEA Data Bank plays a central role in the collection, validation and dissemination of computer codes and associated application data libraries used by scientists/engineers in member countries. The collection of codes covers many different areas, from reactor design, dynamics, safety and radiation shielding to material behaviour and nuclear waste applications.

In 2006, the Data Bank acquired 65 new or new versions of computer codes. Of these, 22 were received from non-OECD countries through the special co-operative agreement in place between the NEA Data Bank and the International Atomic Energy Agency (IAEA).

Highlights

- An arrangement between the United States Department of Energy and the NEA to co-operate in the field of nuclear data and computer programs was signed on 10 April 2006 in Washington DC.
- The first edition of the International Handbook of Evaluated Reactor Physics Benchmark Experiments (IRPhE), containing detailed information on measured and evaluated reactor physics parameters, was issued on CD-ROM.
- The documentation of the latest version of the Joint Evaluated Fission and Fusion data library (JEFF-3.1) was issued, and a new processed data library, based on JEFF-3.1 and for use in Monte Carlo (MCNP) applications, was released.

The Data Bank answered requests for 1 781 programs in 2006, of which 118 were sent to non-OECD countries. Requests for data from integral experiments in support of computer code validation were in high demand: 3 796 sets of experiments were distributed, of which 604 were sent to authorised users in the non-OECD area.

Special efforts have been devoted to sensitivity and uncertainty analysis studies. A new covariance data library was published containing cross-section uncertainties for different application areas.

Computer program training courses

As part of the computer program services, the Data Bank organises training courses on the utilisation of the most popular computer programs. The following courses were organised or co-sponsored in 2006:

Organised by the NEA:

- NJOY Users Group Meeting, NEA Headquarters, Issy-les-Moulineaux, France, 20 November 2006.
- Training Course on PENELOPE-2006 for Electron-photon Transport, University of Barcelona, Barcelona, Spain, 4-7 July 2006.

Co-sponsored by the NEA:

- *Journées codes de calcul en radioprotection, radio-physique et dosimétrie*, INSTN Saclay, France, 28-29 November 2006.
- Training Course on Monte Carlo Simulation, *Universidad Internacional de Andalucía*, Baeza (Jaén), Spain, 15-17 November 2006.
- Workshop on Use of Monte Carlo Techniques for Design and Analysis of Radiation Detectors, University of Coimbra, Coimbra, Portugal, 15-17 September 2006.
- TOUGH (Unsaturated Groundwater Transport and Heat Transport Simulation) Symposium 2006, Lawrence

Berkeley National Laboratory, Berkeley, California, USA, 15-17 May 2006.

- Training Course on Neutron Spectra Unfolding, Cape Town, South Africa, 7-8 April 2006.
- Seminar and Training on Scaling, Uncertainty and 3D Coupled Code Calculations in Nuclear Technology (3D.S.UNCOP-2005), School of Nuclear Engineering, Barcelona, Spain, 23 January-10 February 2006.

Preservation of information from integral experiments

The Data Bank continues to compile integral experimental data under the supervision of the Nuclear Science Committee. Well-documented information and data from reactor physics, fuel behaviour, radiation shielding and criticality safety integral experiments are collected, verified, evaluated and made available to scientists and engineers.

The IFPE (fuel performance experiments) database was updated in April and October 2006, including newly compiled experiments. Two revisions of SINBAD (shielding and dosimetry experiments) were made in April and September 2006. Nine new benchmark experiments were added to the SINBAD collection and seven benchmarks were updated. The first edition of the IRPhE (International Handbook of Evaluated Reactor Physics Benchmark Experiments) containing detailed information on measured reactor physics parameters and their evaluation, exceeding 4 000 pages, was issued on CD-ROM in March 2006. More than 200 copies were distributed on request.



Nuclear data services

The Data Bank maintains large databases containing bibliographic (CINDA), experimental (EXFOR) and evaluated (EVA) nuclear data and makes these databases available online to scientists and engineers in member countries. The number of retrievals from the NEA website averages about 1 200 per month for bibliographic and experimental data, and about the same number for evaluated data libraries. The databases are maintained in close co-operation with other nuclear data centres and cover most types of data needed in nuclear energy applications. In 2006, the Data Bank produced a new version of the CINDA database, with an improved coverage of references to neutron- and charged-particle data including references to EXFOR.

A new version of nuclear data display software, JANIS-2.2.2, was released in November 2006 to respond to users' feedback and needs. The popularity of the program has increased steadily and is now also being used in many university courses around the world as an easy introduction to nuclear data manipulation. The JANIS users access the NEA online databases more than 25 000 times per month. The program is free of charge and can be downloaded or launched from the JANIS home page at www.nea.fr/janis, where the complete manual can also be found.

The JEFF project

In 2006, the Joint Evaluated Fission and Fusion (JEFF) community began to validate the latest version of the evaluated data library (JEFF-3.1). Users are providing feedback to a dedicated webpage and updated, evaluated files are posted on the website following review and approval by the JEFF management committee. A revised version of the radioactive decay data library is under preparation and, together with the corresponding documentation, will be released in 2007.

The Data Bank released a processed library based on JEFF-3.1 for use with the Monte Carlo code MCNP. This library will assist engineers and/or scientists wishing to use the JEFF-3.1 general purpose library in application calculations. Processed, multi-group, cross-section libraries are being prepared for release in 2007.

International nuclear data evaluation co-operation

The NEA Working Party on International Nuclear Data Evaluation Co-operation (WPEC) provides a framework for co-operative activities between the participating projects in Japan (JENDL), the United States (ENDF), Western Europe (JEFF) and non-OECD member countries (Russia, BROND; China, CENDL; and the IAEA-based FENDL). In 2006, the Working Party issued three reports on covariance matrix evaluation and processing in the resolved/unresolved resonance region; nuclear data standards; and nuclear data for improved low-enriched uranium (LEU)-LWR reactivity predictions. Two new activities on prompt photon production from fission products and on processing of covariance data were started.

A High Priority Request List (HPRL) for nuclear data continues to be maintained. The list, which is based on requests from data users, provides a guide for scientists planning measurements and developing nuclear theory and data evaluation programs. An entirely new list is available on the NEA website and the content is being reviewed on a regular basis by external referees.

The Thermochemical Database (TDB) Project

The Data Bank continues to develop its database of recommended chemical thermodynamic data for the safety assessment of radioactive waste repositories. This work is performed under the scientific guidance of the NEA Radioactive Waste Management Committee. Details are provided in the section on Joint Projects and Other Co-operative Projects (see page 33).

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Legal Affairs

Nuclear Law Committee (NLC)

The NLC promotes the harmonisation of nuclear legislation governing the peaceful uses of nuclear energy in member countries and selected non-member countries. It supports the modernisation and strengthening of national and international nuclear liability regimes. In addition, under its supervision the NEA compiles, analyses and disseminates information on nuclear law through a regular publications programme and organises the International School of Nuclear Law educational programme.

Development and harmonisation of nuclear legislation

The NLC continued to look for solutions to problems encountered by nuclear operators unable to obtain private insurance coverage for third party liability and material damage resulting from a nuclear accident caused by terrorist acts. After reviewing additional information on lifetime insurance requirements, the availability of coverage more than ten years after an incident and coverage of damage caused by simultaneous attacks on several nuclear facilities, the Committee finalised its report on the matter, which was published in *Nuclear Law Bulletin No. 78*.

The Committee also studied the issue of whether nuclear fusion installations should be included within the scope of the Paris Convention. Recent scientific reports confirm that the radiological risks created by fusion reactors are relatively low and that the risk of transboundary damage resulting from their operation is extremely small. There seems little justification for including such facilities within the scope of the Convention at the moment, but should that situation change, the insurance industry confirmed its ability to resolve any related financial security issues.

In parallel, the Committee examined the best method for ensuring that operators are not burdened by the application of the Paris Convention to small quantities of nuclear substances used or transported outside of a nuclear installation, in keeping with current international regulations. It will consider the amendment of a 1977 Decision of the Steering Committee for Nuclear Energy in this regard.

Highlights

- Member countries party to the Paris and Brussels Supplementary Conventions continued to work actively to implement into their national legislation the Protocols to amend those conventions which were adopted in 2004.
- The NLC continued the detailed examination of liability and compensation regimes for damage caused by a nuclear incident resulting from terrorist acts; the need to include nuclear fusion installations in a comprehensive, international liability regime; and the best way to ensure that an overly burdensome regime does not apply to small quantities of nuclear substances outside a nuclear installation.
- The NLC examined the impact of the Aarhus Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters on the nuclear energy sector.
- The sixth session of the International School of Nuclear Law was held at the University of Montpellier 1.
- The inaugural session of the eighth term of office of the European Nuclear Energy Tribunal was held at OECD Headquarters.

NLC members also assessed how to implement the Aarhus Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters in the nuclear energy sector. The Convention will most probably change the way in which governments manage nuclear energy information and make decisions on nuclear energy projects.

International nuclear liability regime

Member countries which adopted the 2004 Protocols to amend the Paris and Brussels Supplementary Conventions worked actively to ratify and implement those Protocols into their national legislation. Once in force, the Protocols will require nuclear operators to make more money available to compensate more victims for more types of damage than ever before. A few countries have already adopted the necessary legislation, but most reported delays due to difficulties in obtaining operator financial security for newly assumed risks.

European Nuclear Energy Tribunal

The European Nuclear Energy Tribunal was initially established in 1957 pursuant to the Convention on the Establishment of a Security Control in the Field of Nuclear Energy. Its jurisdiction is now limited to resolving disputes over the interpretation or application of the 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy and the 1963 Brussels Convention Supplementary to the Paris Convention.

On 24 May 2006, the OECD Council adopted a Resolution appointing the judges of the Tribunal for its eighth term of office and the Tribunal held its Inaugural Session on 27 October 2006.



The European Nuclear Energy Tribunal and members of the NEA Legal Affairs section.

The following judges will hold office for a five-year term: Dr. Peter Baumann (Austria), Ms. Mia Wouters (Belgium), Mr. Olivier Talevski (Denmark), Ms. Marie-Claire Guyader (France), Prof. Armin von Bogdandy (Germany), Mr. Bert Maan (Netherlands) and Prof. Vaughan Lowe (United Kingdom). At that session, Professor von Bogdandy was elected President, and Ms. Julia Schwartz, NEA Head of Legal Affairs, was appointed Registrar of the Tribunal.

Nuclear law information programme

Issues No. 77 and 78 of the *Nuclear Law Bulletin* were published in June and December 2006 respectively. This periodical provides up-to-date information on developments in legislation, regulations, case law and institutional structures in the field of nuclear law at national and international levels, and has proved to be an invaluable tool for those working on nuclear law issues. More information is available on the NEA website at www.nea.fr/html/law.

In April, the NEA jointly published with the IAEA *International Nuclear Law in the Post-Chernobyl Period*. This compendium of articles on international nuclear law initiatives taken since the Chernobyl accident demonstrates how that event heightened awareness of the need to improve the international legal regime governing the peaceful uses of nuclear energy. The full text of the report is available at www.nea.fr/html/law/chernobyl/welcome.html.

In May, the proceedings of the Second International Workshop on Indemnification of Damage in the Event of a Nuclear Accident were published. This workshop, co-organised by the NEA and the nuclear regulatory authority of the Slovak Republic in 2005, assessed the liability and compensation mechanisms that would be implemented by participating countries affected by a nuclear incident occurring within or near their borders.

The *Regulatory and Institutional Framework for Nuclear Activities* was made available online for free downloading in 2006. It is intended to update the country profiles on a regular basis and to include reproductions of relevant legislation in the member countries concerned.

Nuclear law educational programme

The sixth session of the International School of Nuclear Law (ISNL) was held from 21 August to 1 September in Montpellier, France, with 60 people from 30 countries and the European Commission participating. Established in 2000 by the NEA and the University of Montpellier 1, the ISNL aims to provide high-quality education in nuclear law to students and legal professionals through an intensive training course. It benefits from the support of the IAEA and the International Nuclear Law Association, and from professional expertise provided by the European Commission services. The 2007 session will take place from 27 August to 7 September. Further information may be obtained at www.nea.fr/html/law/isnl/index.html.



Participants at the sixth session of the ISNL, Montpellier, France.

The second session of the World Nuclear University (WNU) Summer Institute took place in July-August in Stockholm, Sweden. This six-week training programme covered a broad spectrum of nuclear energy issues, with the nuclear law module co-organised by the NEA and the IAEA focusing on general nuclear law subjects as well as on non-proliferation and nuclear security. The 2007 WNU Summer Institute will be hosted by the Korea Atomic Energy Research Institute and Korea Hydro & Nuclear Power Co.

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Joint Projects and Other Co-operative Projects

NUCLEAR SAFETY RESEARCH

The Halden Reactor Project

The Halden Reactor Project has been in operation for 48 years and is the largest NEA project. It brings together an important international technical network in the areas of nuclear fuel reliability, integrity of reactor internals, plant control/monitoring and human factors. The programme is primarily based on experiments, product development and analyses. It is carried out at the Halden establishment in Norway supported by approximately 100 organisations in 20 countries.

Work in the fuel area in 2006 included important loss-of-coolant accident (LOCA) tests carried out with high burn-up fuel. These are the only LOCA tests that are currently performed in-pile worldwide, and complement the work done at laboratory scale in other institutions, notably in France, Japan and the United States. The tests carried out in 2006 have provided valuable insights which need to find confirmatory evidence in hot cell post-irradiation examinations. Properties of UO₂, gadolinia and MOX fuels in a variety of conditions relevant to operation and licensing were investigated. Long-term irradiations have been carried out with advanced and standard nuclear fuel at high initial rating conditions. Corrosion and creep behaviour of various alloys were studied. The experimental programme on the effect of water chemistry variants on fuel and reactor internals materials has been expanded. Tests to investigate the cracking behaviour of reactor internals material in BWRs and PWRs continued, with the aim of characterising the effect of water chemistry and material ageing. The programme on human factors focused on tests and data analyses carried out in the Halden man-machine laboratory, encompassing new designs and evaluations of human-system interfaces and control rooms. This involves *inter alia* the use of the Halden Virtual Reality Facility. Progress has been made in the area of human reliability assessment, aiming to provide data suitable for probabilistic safety assessments. The work on cable ageing has resulted in a technique that is being used at industrial level for assessing whether cable insulation is damaged, and in those cases to determine the extent and location of the damage.

An Enlarged Halden Programme Group Meeting (bringing together both programme representatives and participating country experts) is planned for March 2007. The main results of the joint programme will be reported on that occasion. A number of international workshops, such as those on Advanced Control Systems Designs, Irradiation-Assisted Stress Corrosion Cracking, and LOCA tests were organised in 2006, mainly with the purpose of discussing the outcomes of ongoing programme items.

The Halden Reactor Project operates by way of three-year renewable mandates. The current programme will be carried out during 2006-2008. Preparations are being

made for the programme's continuation in the longer term, including renewal of the Halden reactor licence.

The Cabri Water Loop Project

The Cabri Water Loop Project is investigating the ability of high burn-up fuel to withstand the sharp power peaks that can occur in power reactors due to rapid reactivity insertion in the core (RIA accidents). It involves substantial facility modifications and upgrades and consists of 12 experiments to be performed with fuel retrieved from power reactors and refabricated to suitable length. The project began in 2000 and will run for eight years. The experimental work is being carried out at the Institute for Radiological Protection and Nuclear Safety (IRSN) in Cadarache, France, where the Cabri reactor is located. Programme execution also involves laboratories in participating organisations for fuel preparation, post-irradiation examinations and test channel instrumentation. Organisations in 12 countries, including regulators, industry and research organisations, participate in the project.

The first two tests (still in the sodium loop) were carried out with high burn-up fuel having zirconium niobium cladding material. Fuel of Spanish and French origins, with ZIRLO and M5 cladding respectively, and burn-up in excess of 70 MWd/kg, was subjected to a ~100 cal/g energy injection during the transients. From the evaluation of the in-reactor signals during the tests and from the non-destructive examination it appeared that neither the M5 nor the ZIRLO fuel failed.

Appreciable progress has been made in the design of the water loop test facility and in the production of related components. Almost three years will be required to put the water loop in place. In the future, the Cabri tests will be complemented by additional RIA tests that will be performed in the NSRR reactor in Japan. These tests constitute the in-kind contribution from the Japan Atomic Energy Agency (JAEA) for its participation in the Cabri Project.

A meeting of the Cabri Technical Advisory Group was held in April 2006. A meeting of the Project Steering Committee was held in October in Spain.

The MASCA-2 Project

The first phase of the Material Scaling (MASCA) Project investigated the consequences of a severe accident involving core melt. It started in mid-2000 and was completed in July 2003. The second phase of the project started thereafter, upon request of the member countries and recommendation of the CSNI. The programme, to last three years, was supported by organisations in 17 countries. It was based on experiments that were mainly carried out at the Kurchatov Institute in the Russian Federation, and that made use of a variety of facilities in which corium compositions prototypical of power reactors could be tested.

The tests in the first phase of the programme were primarily associated with scaling effects and coupling between thermal-hydraulic and chemical behaviour of the melt. The tests of the second phase provided experimental information on the phase equilibrium for the different corium mixture compositions that can occur in water reactors. This determines the configuration of materials in the case of stratified pools, and thus the thermal loads on the vessel. In order to extend the application of MASCA results to reactor cases, the influence of an oxidising atmosphere and the impact of non-uniform temperatures (presence of crusts or solid debris) was addressed in addition to scaling effects. The programme was also intended to generate data on relevant physical properties of mixtures and alloys that are important for the development of qualified mechanistic models.

The final meeting of the project steering bodies was held in 2006 during which the results obtained to date and plans for the final report were reviewed. Discussions were also held to assess the possible need for a new programme at the Kurchatov Institute facilities following completion of the MASCA-2 Project, but did not result in a concrete proposal. After publication of the final report early in 2007, a workshop will be held in Cadarache, France in October 2007 to discuss among project partners the application of the results obtained.

The MCCI-2 Project

The aim of the Melt Coolability and Concrete Interaction (MCCI) Project is to provide experimental data on relevant severe accident phenomena and to resolve two important accident management issues. The first one concerns the verification that the molten debris that has spread on the base of the containment can be stabilised and cooled by water flooding from the top. The second issue concerns the two dimensional, long-term interaction of the molten mass with the concrete structure of the containment, as the kinetics of such interaction is essential for assessing the consequences of a severe accident. The programme utilises the unique expertise and infrastructure that have been developed at Argonne National Laboratory (ANL) for conducting large-scale, high-temperature reactor materials experiments. The US Nuclear Regulatory Commission (NRC) acts as the project Operating Agent.

The first phase of the programme (MCCI-1) was completed in 2005. The experiments on water ingress mechanisms showed that cooling of the melt by water is reduced at increasing concrete content, implying that water flooding is more effective in the early phase of the melt-concrete interaction. The effect of concrete type, i.e. siliceous and limestone types (used respectively in Europe and the United States), was also addressed in the first phase of the programme. Material properties such as porosity and permeability were derived. Tests also showed appreciable differences in ablation rate for siliceous and limestone concrete, which is a relevant finding that requires confirmation. A workshop on the results of MCCI-1 is planned to take place in October 2007.

A new three-year programme (MCCI-2) has been adopted by participants. Emphasis will be placed on 2D core-concrete interaction experiments, as they provide the integrated effect of many processes. The MCCI-2

Project involves organisations from 12 member countries. A meeting of the project steering bodies was held in Paris in April 2006. On this occasion, the test conditions for the three-year programme were discussed. A meeting is planned for early 2007 to review the status of the first project tests.

The PKL Project

This project started in 2004 and consists of experiments carried out in the *Primär Kreislauf* (PKL) thermal-hydraulic facility, which is operated by AREVA NP in its establishment at Erlangen, Germany. Organisations from 14 countries participate.

The PKL experiments focus on the following PWR issues that are currently receiving great attention within the international reactor safety community:

- boron dilution events after small-break, loss-of-coolant accidents (LOCAs);
- loss of residual heat removal during mid-loop operation with a closed reactor coolant system in context with boron dilution;
- loss of residual heat removal during mid-loop operation with an open reactor coolant system;
- an additional test to be defined in agreement with the project partners according to the state of open issues such as:
 - boron precipitation during large-break LOCAs, or
 - boron dilution after steam generator tube rupture.

Three tests were carried out in 2006. Their preparation and the first test outcomes were extensively discussed at the two meetings of the project steering bodies that took place during the year. A workshop covering an analytical exercise with code predictions related to the PKL tests was also held in 2006. The project is set to continue until May 2007 to enable completion of the final report.



PKL test facility in Erlangen, Germany.

The PRISME Project

Fire is a significant contributor to the overall core damage frequency for both new and old plant designs. The objective of the PRISME Project is to answer questions concerning smoke and heat propagation inside a plant by means of experiments tailored for code validation purposes. In particular, the project aims to provide answers to the following:

- What is, for a given fire scenario, the failure time for equipment situated in the nearby rooms that communicate with the fire room by the ventilation network and/or by a door (which is open before the fire or opens during the fire)?
- Is it valid to assume that no propagation occurs beyond the second room from the fire room when the rooms communicate through doors, and beyond the first room when rooms communicate only by the ventilation network?
- What are the safety consequences of the damper or door failing to close, or of an intervention delay which is too long?
- What is the best way to operate the ventilation network in order to limit pressure-driven phenomena and releases to nearby rooms? Is it the admission damper closing following fire detection? Is it the extraction damper closing when the temperature threshold of filters has been reached or when the filters are plugged?

The results obtained for the experimentally studied scenarios will be used as a basis for qualifying fire codes (either simplified zone model codes or CFD codes). After qualification, these codes could be applied for simulating other fire propagation scenarios in various room configurations with a good degree of confidence. The information will be useful for designers in order to select the best fire protection strategy. For the operators, these data could be useful for establishing the suitable driving for the plant, such as the driving of the ventilation network (closing dampers, to reduce the ventilation flow rate or to stop the ventilation) in case of a fire event.

Two meetings of the Programme Review Group and Management Board were held in April and October 2006. During the last meeting, the outcome of the first test and the progress made on the accompanying analytical exercise were discussed.

The PSB-VVER Project

The objective of the PSB-VVER Project is to provide experimental data of relevance to the validation of safety codes in the field of VVER-1000 thermal-hydraulics. The project, in which seven countries participate, started in 2003 and should have been completed at the end of 2006. It consists of five PSB-VVER experiments addressing:

- scaling effects;
- natural circulation;
- small, cold leg break LOCAs;
- primary to secondary leaks;
- 100% double-ended, cold leg break.

Extensive pre- and post-test analyses are accompanying the experimental programme throughout the experimental series.

Four project tests have been successfully carried out and reported upon thus far. The features of the final test were discussed and revised by members. This test will simulate thermal-hydraulic conditions arising after a large-break LOCA in a VVER-1000 reactor, and will be the first one run under these very demanding conditions. Difficulties encountered by the Operating Agent led to the postponement of the last test until April 2007.

The ROSA Project

The ROSA Project was launched in 2005 to resolve issues in thermal-hydraulics analyses relevant to LWR safety, and makes use of the ROSA (Rig-of-safety assessment) large-scale test facility of the Japan Atomic Energy Agency (JAEA, formerly JAERI). The project is focusing on the validation of simulation models and methods for complex phenomena that may occur during safety transients. The project is supported by safety organisations, research laboratories and industry from 13 countries and is set to run from April 2005 to December 2009. The overall objectives of the ROSA Project are:

- To provide an integral and separate-effect experimental database to validate code predictive capability and accuracy of models. Phenomena coupled with multi-dimensional mixing, stratification, parallel flows, oscillatory flows and non-condensable gas flows are to be studied in particular.
- To clarify the predictability of codes currently used for thermal-hydraulic safety analyses as well as of advanced codes presently under development, thus creating a group among member countries who share the need to maintain or improve technical competence in thermal-hydraulics for nuclear reactor safety evaluations.

The project consists of the following six types of ROSA large-scale experiments:

- temperature stratification and coolant mixing during emergency coolant injection;
- unstable and disruptive phenomena such as water hammer;
- natural circulation under high core power conditions;
- natural circulation with superheated steam;
- primary cooling through steam generator secondary depressurisation;
- two open tests defined by participants (one on pressure vessel upper-head break LOCA and another on pressure vessel bottom break LOCA, combined with accident management measures with symptom-oriented operator actions).

The first two tests were carried out as scheduled in 2005. In 2006, two tests were carried out addressing temperature stratification and high-power natural circulation. Two meetings of the project steering bodies were held.

The SCAP Project

The Stress Corrosion Cracking and Cable Ageing Project (SCAP), which is supported by 14 NEA member countries, began in 2006. The International Atomic Energy Agency (IAEA) and the European Commission also participate as observers. The project's main objectives are to:

- establish two complete databases with regard to major ageing phenomena for stress corrosion cracking (SCC) and degradation of cable insulation respectively, through collective efforts by OECD/NEA member countries;
- establish a knowledge base by compiling and evaluating collected data and information systematically;

- perform an assessment of the data and identify the basis for commendable practices which would help regulators and operators to enhance ageing management.

The project has been designed to last for four years and is being funded by a Japanese voluntary contribution. It is anticipated that the database definition and the collection of a representative amount of data for starting the assessment will take approximately two years. The assessment phase and the commendable practice report are expected to take one year each.

The first meeting of the Management Board was held in June 2006. The Board approved the project's Terms of Reference and nominated the representatives in the two working groups on SCC and cable ageing. The first working group meetings were held in September (on cable ageing) and in October (on SCC), where the scope and organisation of the databases were discussed. The databases will be set up with the support of technical institutions as clearing houses.

The SCIP Project

The Studsvik Cladding Integrity Project (SCIP) aims to clarify mechanisms and reproduce conditions that can lead to cladding failure. To achieve this objective, it utilises the hot cell facilities and expertise available at the Swedish Studsvik establishment in order to carry out the necessary testing. The project has the following overall goals:

- to improve the general understanding of cladding integrity at high burn-up;
- to study both BWR and PWR/VVER fuel cladding integrity;
- to complement two large international projects (Cabri and ALPS), which focus on fuel behaviour in design-basis accidents (notably RIA), where some of the mechanisms are similar to those that may occur during normal operational transients or anticipated transients;
- to achieve results of general applicability (i.e. not restricted to a particular fuel design, fabrication specification or operating condition), so that they can consequently be used in solving a wider spectrum of problems and be applied to different cases;
- to achieve experimental efficiency through the judicious use of a combination of experimental and theoretical techniques and approaches.

Although the primary concern of this project is the integrity of LWR cladding during reactor operation, a number of closely related areas of relevance to water reactors in general are also addressed. New types of fuel designs and cladding materials, as well as more demanding operational modes have been introduced or are being considered in order to enhance fuel utilisation and plant efficiency, through for instance higher operating power

and higher discharge burn-up. These new fuel designs need to be verified with respect to relevant performance and safety aspects, notably resistance to corrosion and resistance to pellet-clad mechanical interaction (PCMI) under normal operation conditions and during transients. Assessments should also cover conditions such as those prevailing during fuel handling and storage.

Organisations from ten member countries participate in the project. As recommended by the CSNI, there is also comprehensive industry participation. Two meetings of the project steering bodies were held with NEA support in 2006.

The SETH Project

The SESAR Thermal-hydraulics (SETH) Project, which is supported by 14 NEA member countries, began in 2001. It consists of thermal-hydraulic experiments in support of accident management, which are carried out at facilities identified by the CSNI as those requiring international collaboration to sponsor their continued operation. The tests carried out at AREVA's *Primär Kreislauf* (PKL) in Germany, which were completed in 2003, investigated boron dilution accidents that can arise from a small-break, loss-of-coolant accident (LOCA) during mid-loop operation (shutdown conditions) in PWRs. The final report of the PKL tests was completed in 2004.

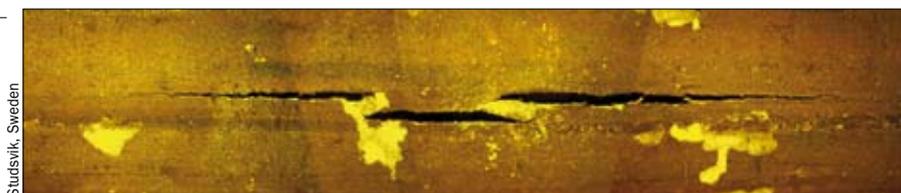
The experiments being carried out at the Paul Scherrer Institute (PSI) PANDA facility in Switzerland are to provide data on containment three-dimensional gas flow and distribution issues that are important for code prediction capability improvements, accident management and design of mitigating measures. After an extensive preparation phase, the experimental series started in 2004 and continued in 2005. Due to the complexity of the PANDA experiments, some delays were encountered and the Project Board therefore decided to extend the programme's duration to the end of 2006, after completion of the last three tests. The final report should be completed by the spring of 2007. A follow-up to the project, called SETH-2, will be launched in 2007 and make use of the PANDA facility and the MISTRA facility of the French *Commissariat à l'énergie atomique* (CEA). The project will aim to resolve key computational issues for the simulation of thermal-hydraulic conditions in reactor containments.

NUCLEAR SAFETY DATABASES

The COMPSIS Project

The Computer-based Systems Important to Safety (COMPSIS) Project was undertaken in 2005 by ten member countries with an initial mandate of three years. To the

Failed, high burn-up fuel cladding after exposure to a power ramp



Studsvik, Sweden

extent that analogue control systems are being replaced by software-based control systems in nuclear power plants worldwide, and that the failure modes of both hardware and software in these new systems are rare, there is a considerable advantage in bringing the experience of several countries together. By doing so, it is hoped to contribute to the improvement of safety management and to the quality of software risk analysis for software-based equipment.

Work during the first part of the project has concentrated on the development of the COMPSIS data collection guidelines, quality assurance and data exchange interface. Two meetings of the COMPSIS steering body were held in 2006 with NEA support.

The FIRE Project

The Fire Incidents Records Exchange (FIRE) Project started in 2002 and its mandate was renewed for another three-year period starting in January 2006. Eleven countries participate. The main purpose of the project is to collect and analyse data related to fire events in nuclear environments, on an international scale. The specific objectives are to:

- define the format for, and collect fire event experience (by international exchange) in, a quality-assured and consistent database;
- collect and analyse fire events data over the long term so as to better understand such events, their causes and their prevention;
- generate qualitative insights into the root causes of fire events that can then be used to derive approaches or mechanisms for their prevention or for mitigating their consequences;
- establish a mechanism for the efficient feedback of experience gained in connection with fire events, including the development of defences against their occurrence, such as indicators for risk-based inspections;
- record event attributes to enable quantification of fire frequencies and risk analysis.

The structure of the database is now well-defined and arrangements have been made in all participating countries to collect and validate data. Similar to the OPDE Project, the group is reviewing and collecting past events in addition to events having taken place during the year. The quality-assurance process is in place and has proved to be efficient on the first set of data provided. An updated version of the database is given to participants every year. Two meetings of the project steering body were held during 2006.

The ICDE Project

The International Common-cause Data Exchange (ICDE) Project collects and analyses operating data related to common-cause failures (CCF) that have the potential to affect several systems, including safety systems. The project has been in operation since 1998, and a new agreement covering the period April 2005-March 2008 has come into force. Eleven countries participate.

The ICDE Project comprises complete, partial and incipient common-cause failure events. The project currently covers the key components of the main safety



BWR piping at the Brunbuettel NPP in Germany after a hydrogen explosion.

systems, such as centrifugal pumps, diesel generators, motor-operated valves, power-operated relief valves, safety relief valves, check valves, control rod drive mechanisms, reactor protection system circuit breakers, batteries and transmitters. These components have been selected because several probabilistic safety assessments have identified them as major risk contributors in the case of common-cause failures.

Qualitative insights from data will help reduce the number of CCF events that are risk contributors, and the member countries use the data for their national risk analyses. More activities in the area of quantification are under discussion and an internal seminar about the topic will take place in 2007. Reports have been produced for pumps, diesel generators, motor-operated valves, safety and relief valves, check valves and batteries. Data exchange for switchgear and breakers, reactor-level measurement and control rod drive component exchange is ongoing.

Two project meetings were held in 2006. The next ICDE steering group meeting will take place in April 2007 in Sweden.

The OPDE Project

The Piping Failure Data Exchange (OPDE) Project started in 2002. The first phase of the project period was successfully completed in mid-2005. The project was then renewed for another three-year period until mid-2008. Currently, 12 countries participate. The project goals are to:

- collect and analyse piping failure event data to promote a better understanding of underlying causes, impact on operations and safety, and prevention;
- generate qualitative insights into the root causes of piping failure events;
- establish a mechanism for efficient feedback of experience gained in connection with piping failure phenomena, including the development of defence against their occurrence;
- collect information on piping reliability attributes and factors of influence to facilitate estimation of piping failure frequencies.

The OPDE Project is envisaged to include all possible events of interest with regard to piping failures in the main safety systems. It will also cover non-safety piping systems that, if leaking, could lead to common-cause

initiating events such as internal flooding of vital plant areas. Steam generator tubes are excluded from the OPDE Project scope. Specific items may be added or deleted upon decision of the Project Review Group. An updated version of the database is provided to participants every six months. Two Project Review Group meetings were held in 2006 with NEA support.

RADIOACTIVE WASTE MANAGEMENT

The Co-operative Programme on Decommissioning (CPD)

The NEA Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects (CPD) is a joint undertaking which functions within the framework of an agreement between 21 organisations actively executing or planning the decommissioning of nuclear facilities. Operating under Article 5 of the NEA Statute since its inception in 1985, a revised Agreement between participants came into force on 1 January 2004 for a period of five years. The objective of the CPD is to acquire and share information from operational experience in the decommissioning of nuclear installations that is useful for future projects.

The information exchange also ensures that best international practice is made widely available and encourages the application of safe, environmentally friendly and cost-effective methods in all decommissioning projects. It is based on biannual meetings of the Technical Advisory Group (TAG), during which the site of one of the participating projects is visited, and positive and less positive examples of decommissioning experience are openly exchanged for the benefit of all. Currently 42 decommissioning projects (26 reactors, 8 reprocessing plants and 8 fuel facilities) are included in the information exchange.

Although part of the information exchanged within the CPD is confidential and restricted to programme participants, experience of general interest gained under the programme's auspices is released for broader use. In this context, the CPD collected information amongst its members for a state-of-the-art report on measuring contamination levels of materials designated to be released from regulatory control and prepared a status report of the CPD programme, describing the progress made and the main results obtained by the CPD during 1995-2005. Both reports have been issued by the RWMC Working Party on Decommissioning and Dismantling to encourage relevant NEA member organisations to consider joining the CPD.

The Thermochemical Database (TDB) Project

The Thermochemical Database (TDB) project aims at meeting the specialised modelling requirements for safety assessments of radioactive waste disposal sites. Chemical thermodynamic data are collected and critically evaluated by expert review teams and the results are published in a book series edited by the Data Bank. The French *Commissariat à l'énergie atomique* joined the TDB project in 2006, bringing the number of TDB participants to 17 organisations in 12 member countries.

During 2006, work continued on the reviews of thorium, tin and iron. The thorium report is under peer review and is scheduled for publication in 2007. The tin and iron reports are scheduled for peer review during 2007. A state-of-the-art report on chemical thermodynamics of solid solutions will be published in the first part of 2007.

RADIOLOGICAL PROTECTION

The Information System on Occupational Exposure (ISOE)

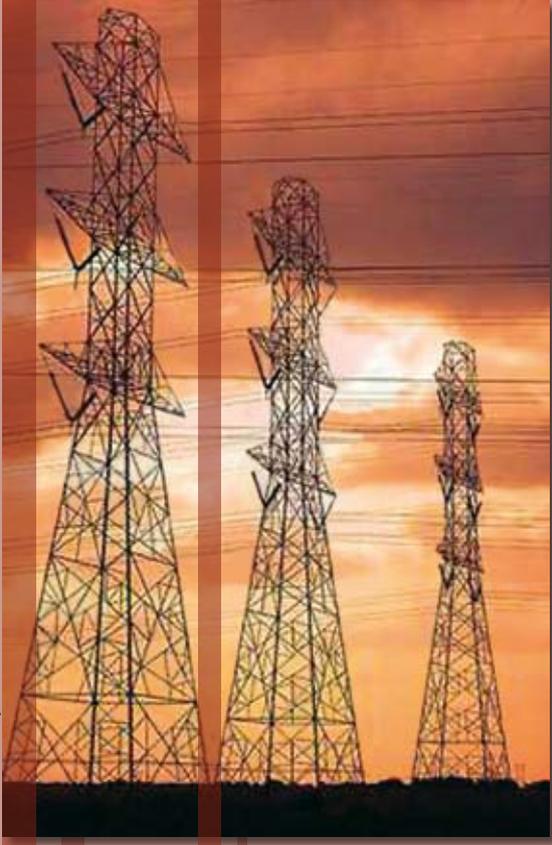
Since its creation in 1992, the Information System on Occupational Exposure (ISOE) has been facilitating the exchange of data, analysis, lessons and experience in occupational radiological protection at nuclear power plants worldwide. The ISOE programme is co-sponsored by the IAEA. Its membership includes 69 utilities in 29 countries, as well as the regulatory authorities of 25 countries.

The ISOE programme maintains the world's largest occupational exposure database and a network of radiological protection experts from utilities and regulatory authorities. Four supporting ISOE Technical Centres (Europe, North America, Asia and IAEA) manage the programme's day-to-day technical operations of analysis and exchange of information and experience. The ISOE occupational exposure database itself contains information on occupational exposure levels and trends at 480 reactor units (403 in operation and 77 in cold-shutdown or some stage of decommissioning) in 29 countries. This represents 91% of the world's operating commercial power reactors (442). Since its inception, ISOE participants have used this dual system of databases and communications networks to exchange occupational exposure data and information for dose trend analyses, technique comparisons, and cost-benefit and other analyses promoting the application of the as low as reasonably achievable (ALARA) principle in local radiological protection programmes.

Whereas the database and information exchange mechanism used initially was the floppy disk, then the CD, the data viewing and analysis component was successfully transferred to the web as part of the new ISOE Network information portal, formally launched in 2006. The ISOE Network currently has about 400 registered users from utilities and regulatory authorities who use the network to access the full range of ISOE products and share their operational radiological protection experience. In 2007, Network services will be further enhanced through the implementation of online data entry modules, and optimised functionality based on direct user feedback. The databases will continue to be maintained on CD for those with specific national requirements or without access to the web.

In 2006, the ISOE programme continued to concentrate on the exchange of data, analysis, good practice and experience in the area of occupational exposure reduction at nuclear power plants. The four regional ISOE Technical Centres continued to support their regional members through specialised data analyses and benchmarking visits. ISOE information and experience exchange largely benefited from the 2006 international and regional ISOE ALARA symposia, held in Germany and Japan respectively.

South Texas Gallery, USA



General Information

Information and Communications

Nuclear energy decision making and stakeholder participation need to be based on understanding. The NEA seeks to provide member governments and other interested parties with a large array of information resulting from the Agency's activities, thereby enhancing awareness and understanding of the scientific, technical and economic aspects of the nuclear option.

The NEA is an intergovernmental agency specialised in studying the scientific, technical and economic aspects of nuclear energy. It strives to provide high-quality, factual information in a timely manner to member countries, as a complement to national energy analyses. Through a varied information and communications programme, this information is also made available to other interested parties wishing to learn about nuclear energy's multiple aspects and the results of the Agency's work. NEA activities cover the full range of the fuel cycle and consider future technological developments. All of these activities are reflected in the Agency's large selection of publications and reports.

Public affairs and relations with the press

In 2006, media interest in nuclear issues grew as did interest in the public at large. The Agency received over 60 enquiries from television and print media on subjects such as the future of nuclear energy in NEA countries, uranium resources, Chernobyl, radioactive waste management and nuclear safety.

Highlights

- The Agency produced 69 publications in 2006, of which 18 were put on sale and 51 were distributed free of charge.
- Two press briefings were organised: one concerning follow-up activities to the Chernobyl accident, and the other reviewing uranium resources, production and demand.
- NEA information and publications stands were organised at 12 international conferences.

The NEA hosted two press briefings during the year, in April and June. The first was organised in conjunction with the release of two publications related to the Chernobyl accident: *Stakeholders and Radiological Protection: Lessons from Chernobyl 20 Years After*, and *International Nuclear Law in the Post-Chernobyl Period*. The second press briefing was organised in co-operation with the IAEA on the occasion of the release of the "Red Book", *Uranium 2005: Resources, Production and Demand*. Several press releases were also issued throughout the year on important aspects of the Agency's work.

The NEA Director-General, Luis Echávarri, presented the work of the Agency, including the findings of the Red Book, in various fora. These included the G8 Conference on Energy Security in Moscow, the European Nuclear Assembly in Brussels, the Conference of the Institution of Engineers of Ireland in Dublin, in the presence of Irish Prime Minister Ahern, and the International Nuclear Youth Congress held in Stockholm. L. Echávarri's article on "Nuclear Energy: Towards Sustainable Development" published in the *OECD Observer* also brought key information about nuclear energy to wide audiences across member countries.



Foratom, Belgium



www.g8russia.ru

Left: Luis Echávarri speaking at the European Nuclear Assembly in Brussels.

Right: the conference room of the G8 International Conference on Energy Security in Moscow.

Publications

In 2006, the Agency produced 69 publications, of which 18 were put on sale and 51 were distributed free of charge. The list of these publications is provided on page 44. Best sellers included *Uranium 2005: Resources, Production and Demand*, *Nuclear Energy Data 2006* and the German edition of *Nuclear Energy Today*. All free reports published by the NEA are made available in pdf format on the NEA website. The most highly accessed reports in 2006 concerned Chernobyl (see further details below).

In order to keep NEA correspondents and other interested professionals abreast of significant findings and advances in the Agency's programme of work, *NEA News* continues to be published twice a year in English and French. It provides feature articles on the latest developments in the nuclear energy field, as well as updates on NEA work, news briefs, and information about NEA publications and forthcoming events. *NEA News* is also available free of charge on the Agency's website at www.nea.fr/html/pub.



Internet-based communication

The NEA website is an important part of the Agency's information programme and has proved effective in raising the profile of the Agency's work. Website traffic remained healthy during 2006 with, on average, nearly 3 000 people using the site's services each day. The content areas that attracted the most visitors were the Data Bank, nuclear science and radiological protection. The most accessed reports in the course of 2006 concerned Chernobyl, with the two new reports published to coincide with the 20th anniversary and *Chernobyl: Assessment of Radiological and Health Impacts - 2002 Update* accounting for well over 11 000 downloads amongst them.

Individual subscriptions to the Agency's monthly electronic bulletin continued to grow during 2006, topping 7 000 subscribers by year-end. Distributed free of charge, the bulletin includes monthly updates on important NEA activities and newly released reports. Subscription requests can be made at www.nea.fr/html/signon.html.

The Delegates' Area on the NEA website also continues to provide an important service for many NEA committees and working groups. This section of the website provides authorised users with OECD official documents, information on forthcoming NEA meetings, contact details for other committee members, as well as access to the presentations and background notes prepared for the Steering Committee policy debates.

Over the summer, a comprehensive review of the NEA website's information structure and user-friendliness was carried out. The review consisted of interviews with typical users of the service and an assessment by a usability expert. Conclusions were drawn and improvements implemented in September and October. Further feedback from NEA committee members and other website visitors is always welcome.

NEA visibility in international fora

NEA information and publications stands were organised at 12 international conferences in 2006. These included:

- *Recherches sur la gestion des déchets radioactifs à haute activité et à vie longue - Axe 2 : Stockage géologique* (January 2006, Paris, France);
- PIME (February 2006, Vienna, Austria);
- ISOE International Symposium (March 2006, Essen, Germany);
- European Nuclear Assembly (March 2006, Brussels, Belgium);
- Engineers Ireland Conference (April 2006, Dublin, Ireland);
- OECD Forum (May 2006, Paris, France);
- INEX 3 (May 2006, Paris, France);
- NEA/ICRP Forum on Radiological Protection (August 2006, Washington DC, USA);
- PHYSOR 2006 (September 2006, Vancouver, Canada);
- 9th P&T Information Exchange Meeting (September 2006, Nîmes, France).
- ANS Winter Meeting (November 2006, Albuquerque, NM, USA);
- IAEA International Conference on Lessons Learned from Decommissioning of Nuclear Facilities and the Safe Termination of Nuclear Activities (December 2006, Athens, Greece).

Over 2 000 reports were distributed in conjunction with these events. The NEA has also been active in co-sponsoring a number of international conferences. Of particular note were PHYSOR-2006, Advances in Nuclear Analysis and Simulation held in Vancouver, BC, Canada in September, and the IAEA International Conference on Lessons Learned from Decommissioning of Nuclear Facilities and the Safe Termination of Nuclear Activities held in Athens, Greece in December.

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Nuclear Energy and Civil Society

RADIOACTIVE WASTE MANAGEMENT

FSC workshop in Hungary

The integration of waste management programmes into wider socio-political considerations is a major challenge for all waste management programmes. Through its Forum on Stakeholder Confidence (FSC), the RWMC provides member countries with opportunities to exchange information in this area as well as to exchange views with relevant stakeholders. The FSC continues to organise workshops in national context to provide a basis for helping the national stakeholder dialogue programmes and to gain insight into both country-specific and general aspects of the political, cultural and socio-economic framework. Six FSC workshops in national context have been organised thus far: in Finland (2001), Canada (2002), Belgium (2003), Germany (2004), Spain (2005) and Hungary (2006).

The sixth FSC workshop was held near Bataapáti, Hungary, the site where an underground repository for short-lived, low- and intermediate-level waste (LILW) will be built. Workshop participants observed an outstanding demonstration of trustful co-operation among stakeholders as well as the great trust the communities have in the implementing waste managing organisation, which has

been built up over 16 years of active engagement. The workshop proceedings will be published in due course.

FSC "value added" project

Traditionally, local benefits to be drawn from a radioactive waste management (RWM) facility are discussed in terms of hosting fees and socio-economic development packages (employment and infrastructure, for example). However, communities do not gain added value and sustainability through financial compensation and development opportunities only. Whilst those economic means are important, RWM projects also offer opportunities to improve well-being, consolidate knowledge, fulfil value ideals, elaborate community identity and image, and develop social relationships.

Based on the analysis of numerous stakeholders' input and FSC experience, an FSC report on "Added Value and Sustainability from a Radioactive Waste Management Facility" identified a number of basic elements for designing a facility that would favour building a sustainable relationship with a local community. The design elements include functional, cultural and physical features. The very process of working out the desired features of an RWM facility and site can also bring added value to the community. Social capital – networks, norms and trust – is built up, equipping the community to face other decisions and issues. Local stakeholders may also focus their work on community identity, image and profile. Even when not favourable to hosting an RWM facility, communities can use the opportunity to develop quality-of-life indicators and reflect on the direction they wish to take in coming years.

FSC project on organisational changes

Institutions with responsibilities for radioactive waste management must be able to accommodate organisational changes in order to carry out the long-term projects for which they are responsible. Institutions capable of achieving and maintaining stakeholder confidence will need focused efforts in the three main areas of organisational aspects, mission and behaviour. For the purpose of better understanding recent cultural and structural changes taking place within RWM organisations, the FSC launched a survey.

The survey indicates that important changes have recently taken place in the vast majority of the queried organisations. Changes in mission and main goals were observed in a few organisations, and changes in values and culture in most of them. Similar changes have been reported by implementers, regulators and policy makers. There are, however, remarkable variations among countries. These differences reflect not only idiosyncratic cultural and political traditions, but also variations regarding the stage of RWM programmes. Further investigations are necessary to determine the extent to which various factors, such as cultural context, political and social environment, legal



PURAM, Hungary

Above: Participants at the sixth FSC workshop, held near Bataapáti, Hungary.
Below: The site of the Bataapáti waste repository.



Attila Nagy, Index.hu, Hungary

and policy changes, and local aspects influence changes in RWM organisations.

Internet and e-communication

RWM organisations themselves seek to create trust and stable relations with various parts of society and therefore need to be proactive in their information and communication strategies towards stakeholders. In this respect, internet technologies appear to be a prime tool, and interactivity a major asset of web technology.

As part of the FSC meeting held in June 2006, member organisations' experience in the use of Internet-based communication has been addressed. This experience highlights the diversity of stakeholders and their perceptions and needs – media, institutions or local associations, young people, other individuals or groups of different generations and different locations – but also the diversity of communication objectives RWM organisations seek to achieve: publicising their corporate identity and area of expertise, informing the public at large as well as the media, and seeking to establish a dialogue with identified stakeholders on a specific issue.

Stakeholder confidence can be strengthened by making all relevant information available on the website in a transparent, open and clear manner. This requires trade-offs between exhaustive and complex information and oversimplification, but in any case socially contentious issues must be addressed. Electronic communication technologies can be a tool, among a range of others, to sustain strategies and to achieve broad-ranging objectives. However, building stakeholder confidence depends upon many communication practices among which the web and electronic platforms can play a very useful role, but cannot entirely replace people-to-people exchanges.

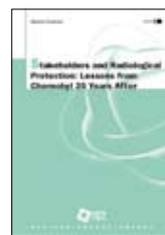
STAKEHOLDERS AND RADIOLICAL PROTECTION

The recognition of the need for and usefulness of stakeholder involvement in decision making has enlarged the focus of radiological protection in recent years. The CRPPH has for some time devoted a significant part of its programme of work to stakeholder involvement, primarily through the series of workshops held in 1998, 2001 and 2003 in Villigen, Switzerland. A key result of these workshops suggests that when stakeholders are involved in radiological risk assessment and management, and science is brought to the service of "inclusive" decision-making processes, the resulting decisions can be of higher quality and greater sustainability than had stakeholders, radiological protection scientists and other professionals not worked together with decision makers towards a solution.

A key area of application of the stakeholder involvement knowledge developed through the above-mentioned work is that of rehabilitation of contaminated lands and facilities, which often involves significant stakeholder concerns. Work to rebuild the lives of those living in the areas affected by the Chernobyl accident is a prime example of this, and with 2006 marking 20 years since the accident, the CRPPH revisited this case publishing a new

report entitled *Stakeholders and Radiological Protection: Lessons from Chernobyl 20 Years After*. While clearly not all of this experience is applicable to other circumstances in other countries, much can be gained by studying its stakeholder involvement aspects.

This report describes how radiological protection has been adapted to meet the needs of people still affected by the accident or, in some cases, the lessons learnt from this. The report strives to demonstrate how a technical discipline, such as radiological protection, can adjust to be more effective in meeting the needs of ordinary people forced to live in extraordinary circumstances. As such, the report goes beyond supporting the work of the CRPPH, and is stimulating reading for anyone with an interest in planning for emergencies involving widespread contamination and their aftermath.



The CRPPH also remains involved in other key discussions. Following the International Radiological Protection Association (IRPA) session on stakeholder involvement in May 2004, the Spanish Society for Radiological Protection (SERP) consulted the French and the UK Societies to explore opportunities for organising a follow-up international workshop aiming at promoting stakeholder engagement among radiological protection professionals. The three societies agreed to hold three workshops on this important issue in 2005 (in Spain), 2006 (in France) and 2007 (in the United Kingdom). The CRPPH and the NEA Secretariat have actively participated in the first two of these meetings, and plan to attend the third. One of the general conclusions from these two meetings is that the radiological protection community, under the auspices of the IRPA, should develop a "Code of Ethics" for stakeholder involvement, or a "declaration of commitment" from radiological protection experts entering into stakeholder discussions describing the processes and rules to which they are willing to commit. The CRPPH is strongly placed to contribute to this work.

As noted earlier, the CRPPH is also carrying out a study to see how various national radiological protection organisations are managing to incorporate stakeholder involvement most effectively in their processes, and what, if any, structural implications this may have. This study will provide useful elements for debating the way forward at the 50th anniversary meeting of the CRPPH in May 2007.

NUCLEAR REGULATORS AND THE PUBLIC

Information officers from regulatory bodies meet once a year under the auspices of the Working Group on Public Communication of Nuclear Regulatory Organisations (WGPC) to exchange information and experience related to communication with the public and to carry out related studies. The two main topics discussed in 2006 were the challenges associated with public communication during abnormal situations and the publicity given to regulatory decisions, together with the preparation of a workshop on the transparency of regulatory activities to be held in Japan in May 2007. For further information regarding the activities of the WGPC, see page 15.

OECD Headquarters, OECD



NEA Headquarters, Benjamin Baudoin, OECD/NEA



Organisational Structure of the NEA

The Nuclear Energy Agency (NEA) is a semi-autonomous body of the Organisation for Economic Co-operation and Development. OECD member countries wishing to participate in the activities of the Agency must make a formal request to join. Of the 30 OECD member countries, 28 are members of the NEA:

Australia	France	Japan	Slovak Republic
Austria	Germany	Luxembourg	Spain
Belgium	Greece	Mexico	Sweden
Canada	Hungary	Netherlands	Switzerland
Czech Republic	Iceland	Norway	Turkey
Denmark	Ireland	Portugal	United Kingdom
Finland	Italy	Republic of Korea	United States

The NEA is governed by the **Steering Committee for Nuclear Energy**. This committee is primarily made up of senior officials from national atomic energy authorities and associated ministries. It oversees and shapes the work of the Agency to ensure its responsiveness to member countries' needs, notably in establishing the biennial programmes of work and budgets. It approves the mandates of the seven standing technical committees.

The current members of the **Bureau of the Steering Committee** for Nuclear Energy are (as of its autumn 2006 meeting):

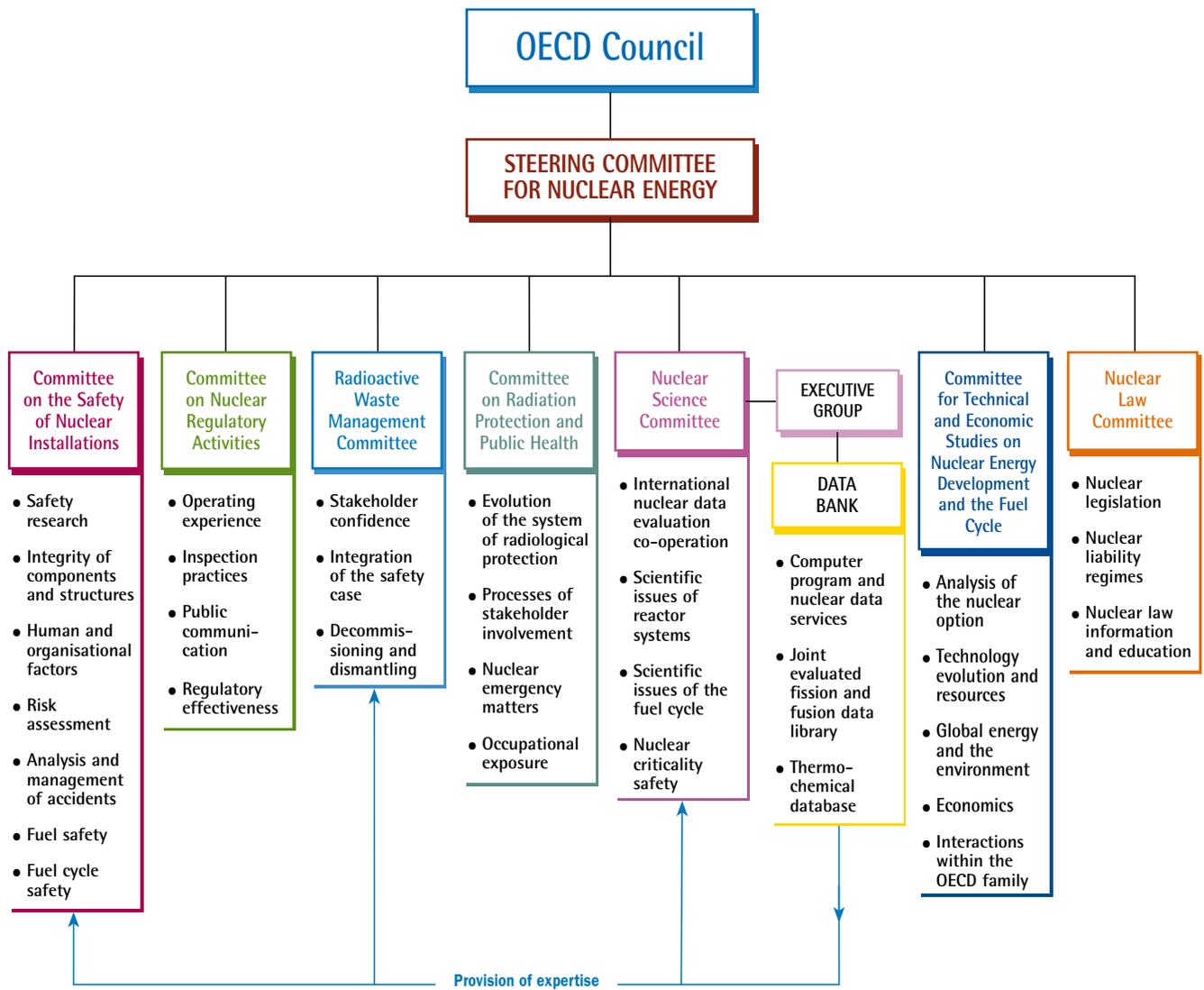
Mr. Richard STRATFORD (United States), Chair
Ms. Sylvana GUINDON (Canada), Vice-Chair
Dr. Walter SANDTNER (Germany), Vice-Chair
Mr. Kenji SEYAMA (Japan), Vice-Chair
Dr. József RÓNAKY (Hungary), Vice-Chair

The **standing technical committees** are primarily composed of member country experts and technical specialists. These committees constitute a unique feature and important strength of the NEA, providing flexibility for adapting to new issues and helping to achieve consensus rapidly. Their main areas of work are listed in the chart.

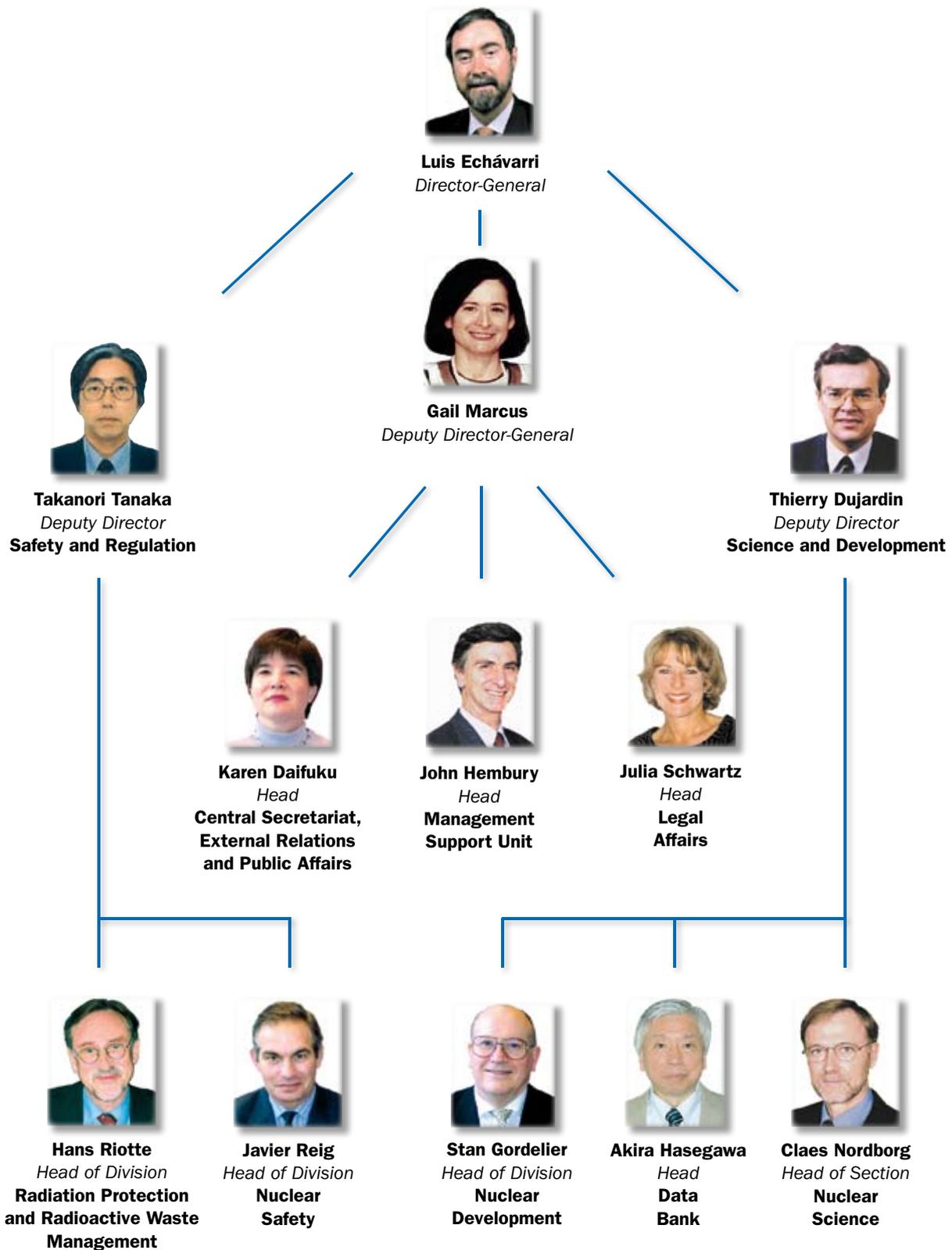
The Steering Committee for Nuclear Energy and the Agency's seven standing technical committees are serviced by the **NEA Secretariat**, composed in 2006 of 69 professional and support staff from 19 countries. Professional staff are often specialists from national administrations and research institutes, bringing their experience to the Agency for two to five years on average.

Participation in the work of the Agency by **non-member countries** is an established practice. At the end of 2006, the Steering Committee for Nuclear Energy and subsequently the OECD Council approved the text of a Joint Declaration on Co-operation between the Government of the Russian Federation and the OECD Nuclear Energy Agency in the Field of the Peaceful Uses of Nuclear Energy. Starting on 1 January 2007, the Russian Federation will hold regular observer status in all of the Agency's standing technical committees and their working groups, after having participated in the NEA nuclear safety committees for roughly a decade. Slovenia participates as a regular observer in all seven standing technical committees. Selected other countries take part in NEA activities on a more ad hoc basis.

NEA Committees in 2006



NEA Secretariat in 2006



NEA Publications Produced in 2006

General Interest

Annual Report 2005

ISBN 92-64-01089-0 *Free: paper or web.*

NEA News, Vol. 24, Nos. 1 and 2

ISSN 1605-9581 *Free: paper or web.*



Nuclear Development and the Fuel Cycle

Advanced Nuclear Fuel Cycles and Radioactive Waste Management

ISBN 92-64-002485-9 *Price: € 50, US\$ 67, £ 36, ¥ 6 900.*

Forty Years of Uranium Resources, Production and Demand in Perspective

"The Red Book Retrospective"

ISBN 92-64-02806-4 *Price: € 92, US\$ 111, £ 60, ¥ 12 200.*

French R&D on the Partitioning and Transmutation of Long-lived Radionuclides

An International Peer Review of the 2005 CEA Report

ISBN 92-64-02296-1 *Free: paper or web.*

Kernenergie heute

(German version of *Nuclear Energy Today*)

ISBN 92-64-02653-3 *Price: € 25, US\$ 32, £ 16, ¥ 3 200.*

Nuclear Energy Data – 2006

ISBN 92-64-02489-1 *Price: € 30, US\$ 40, £ 21, ¥ 4 100.*

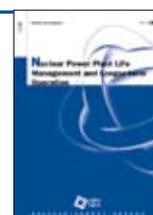
Nuclear Power Plant Life Management and Longer-term Operation

ISBN 92-64-02924-9 *Price: € 30, US\$ 40, £ 21, ¥ 4 100.*

Uranium 2005: Resources, Production and Demand

A Joint Report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency

ISBN 92-64-02425-5 *Price: € 120, US\$ 150, £ 82, ¥ 16 700.*



Nuclear Safety and Regulation

Building, Measuring and Improving Public Confidence in the Nuclear Regulator

Workshop Proceedings, Ottawa, Canada, 18-20 May 2004
ISBN 92-64-02590-1 Price: € 47, US\$ 59, £ 32, ¥ 6 500.



Learning from Nuclear Regulatory Self-assessment

International Peer Review of the CSN Report on Lessons Learnt from the Essential Service Water System Degradation Event at the Vandellós Nuclear Power Plant
ISBN 92-64-02310-0 Free: paper or web.

Nuclear Power Plant Operating Experiences from the IAEA/NEA Incident Reporting System – 2002-2005

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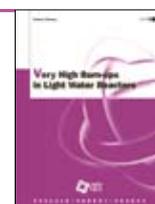
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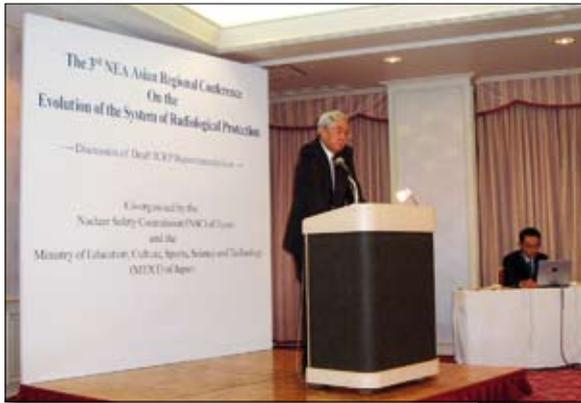
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Yoshiko Ichihara, OECD/NEA



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Main Workshops and Seminars Held in 2006

May

- 01-03 8th International Regulatory Inspection Workshop, Toronto, Canada.
- 11-12 The Need for Post-irradiation Experiments to Validate Fuel Depletion Calculation Methodologies, Řež, Czech Republic.
- 22-24 8th Workshop on Shielding Aspects of Accelerators, Targets and Irradiation Facilities (SATIF-8), Pohang, Republic of Korea.
- 29-31 Improving Nuclear Safety Through Operating Experience Feedback, Cologne, Germany.

July

- 05-06 3rd Asian Regional Conference on the Evolution of the System of Radiological Protection, Tokyo, Japan.

August

- 28-29 North American Regional Conference on the Evolution of the System of Radiological Protection, Washington, DC, United States.

September

- 05-07 Benchmarking of CFD Codes for Application to Nuclear Reactor Safety, Garching, Germany.
- 13-15 4th EC/NEA EBS Workshop on Integration of Engineered Barrier Systems in the Safety Case: Design Confirmation and Demonstration, Tokyo, Japan.
- 25-29 9th Information Exchange Meeting on Actinide and Fission Product Partitioning and Transmutation, Nîmes, France.

October

- 24-25 3rd NEA/ICRP Forum on the Evolution of the System of Radiological Protection, Prague, Czech Republic.

November

- 06-08 Seismic Probabilistic Safety Assessment of Nuclear Facilities, Jeju Island, Republic of Korea.
- 14-17 Regional Development and Community Support Aspects of Radioactive Waste Management Programmes, FSC National Workshop and Community Visit, Tengelic, Hungary.
- 28-30 Regulating for the Long-term Safety of Geological Disposal of Radioactive Waste: Practical Issues and Challenges, Paris, France.

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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.

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