

NEA

Annual Report



2007

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)
49	years of international service
7	standing technical committees
21	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
€ 10.3	million budget for the NEA in 2007, supplemented by voluntary contributions
€ 2.9	million budget for the Data Bank in 2007, supplemented by voluntary contributions
61	publications produced in 2007

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-operation 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

As nuclear energy continues to make its comeback in many countries as a secure, affordable and virtually CO₂-free energy source, international co-operation becomes an increasingly attractive approach for all sectors concerned.

Safety is one of the areas in which there is the widest consensus that international co-operation can provide significant benefit, for government agencies, for industry as well as for the public at large. The Agency has a full programme on nuclear safety, with its activities being piloted by the NEA Committee on Nuclear Regulatory Activities (CNRA) and the NEA Committee on the Safety of Nuclear Installations (CSNI). In addition, in 2007, 18 multinational joint projects were being conducted under NEA auspices on specific aspects of nuclear safety (see page 28 for further details). Joint projects were also being carried out in the fields of radioactive waste management and radiological protection.

In order to respond to growing demand for electricity, but also to growing environmental concerns, member countries have entrusted the NEA with carrying out a number of studies and co-operative activities. These range from economic studies covering the full range of the fuel cycle and such topics as the financing of new nuclear power plants, to technical studies on material science, decommissioning and radioactive waste management, to name just a few. The Agency is also acting as Technical Secretariat for the Generation IV International Forum (GIF) and Stage 2 of the Multinational Design Evaluation Programme (MDEP), two international initiatives that are seeking to pave the way for nuclear energy use in the future. Safety, security, efficiency, economy and sustainable development are among the initiatives' driving forces.

Progress continues to be made in the area of radioactive waste management, where consensus has largely been reached at the international level in support of deep geological disposal for the management of high-level and long-lived waste. Support at the political level and among key stakeholders is also more forthcoming than in the past, as readers will see in the pages that follow. Greater experience in steering radioactive waste management programmes, and the sharing of this experience, are having a clear impact.

International co-operation has brought very positive, concrete results in 2007 in the form of new general recommendations from the International Commission on Radiological Protection. For nearly a decade, the NEA played an active role in helping to develop the new recommendations, notably by providing a forum and opportunities for interaction with interested authorities of member countries as well as a dialogue with other stakeholders.

Finally, the development and strengthening of nuclear legislation governing the peaceful use of nuclear energy, which provides the legislative backbone for operations in the field, would not be possible without the dedicated participation of experts from across the NEA membership.

Building upon its successes, and looking forward to a challenging future, the NEA will continue to promote international co-operation in order to provide the greatest value added for its member countries.



Luis E. Echávarri
NEA Director-General



Nuclear Power in 2007

Nuclear energy development

At the end of 2007, a total of 346 reactors were connected to the grid in OECD countries constituting some 83% of the world's total nuclear electricity generating capacity, and about 23% of the total electricity supply in the OECD area. During 2007, one reactor was restarted in the United States and none were shut down. Construction was initiated on three reactors (one in France and two in the Republic of Korea), and construction resumed on one reactor in the United States.

There are significant differences in nuclear energy policy in OECD countries, some of which (e.g. Austria, Belgium, Germany, Italy, Spain and Sweden) have official moratoria or phase-out policies. However, the fact that nuclear power can produce competitively priced, base-load electricity that is essentially free of greenhouse gas emissions and can enhance security of energy supply has led several governments to conclude that nuclear energy is a necessary part of the energy mix. This is perhaps best exemplified by the October 2007 Resolution of the European Parliament which characterised nuclear energy as "...indispensable if basic energy needs are to be met in Europe in the medium term." In 2007, plans to increase nuclear capacity gained momentum in several OECD countries:

- In Canada, an Environmental Assessment of Bruce Power's proposal to build new reactors (approximately 4 000 MWe in total) in Ontario was initiated. A feasibility study was undertaken for building a 1 085 MWe

advanced CANDU reactor in the province of New Brunswick. In Alberta, the construction of two advanced CANDU reactors was proposed to help extract oil from the tar sands.

- In Finland, construction of the Olkiluoto-3 European pressurised water reactor (EPR) continues. Environmental impact assessments of plans to build an additional unit at Olkiluoto and at Loviisa were initiated, and intentions to build another reactor at an as yet undetermined location were announced.
- In France, construction of a 1 630 MWe EPR began near Flamanville in the Basse-Normandie region in December 2007. *Électricité de France* (EdF) intends to replace its present reactors with EPRs beginning in 2020, based on experience with the EPR unit under construction in Flamanville.
- In Japan, construction of the Tomari-3 and Shimane-3 reactors continued, as did preparations to restart the Monju fast reactor. In parallel, the government approved a long-term plan to enhance security of energy supply by placing greater importance on developing nuclear power, a nuclear fuel recycling system and fast breeder reactors.
- In the Republic of Korea, construction of the Shin Wolsong-1 reactor officially began and construction of the first of two reactors (APR-1400s) at Shin Kori continued. Current plans call for the construction of an additional two APR-1400 units at Shin Ulchin beginning in 2015.

2007 Nuclear Data Summary (as of 31 December 2007)

	Operational reactors	Installed capacity (GWe net)	Uranium requirements (tonnes U)	Nuclear share of electricity production (%)
Belgium	7	5.8	906	54.1
Canada*	20	12.5	1 700	15.6
Czech Republic*	6	3.5	664	31.5
Finland	4	2.7	489	29.0
France	59	63.3	7 184	76.8
Germany	17	20.4	3 400	23.2
Hungary	4	1.8	407	37.2
Japan*	55	47.1	8 792	34.2
Mexico	2	1.4	356	4.4
Netherlands*	1	0.4	65	3.1
Republic of Korea*	20	16.8	3 600	38.9
Slovak Republic	5	2.0	475	54.9
Spain	8	7.5	1 283	17.8
Sweden*	10	9.0	1 600	50.3
Switzerland	5	3.2	318	40.6
United Kingdom*	19 ^a	10.2 ^a	2 165	19.5
United States*	104	100.0	22 890	19.4
Total (OECD)	346	307.6	56 294	22.7

* 2006 data. a) 2007 estimates.

- In the Slovak Republic, the completion of the construction of two reactors, stopped in 1992, has been confirmed and consideration is being given to building additional units.
- In Switzerland, three energy companies announced the creation of the Resun joint venture which intends to replace the Beznau and Muhleberg reactors with plants of up to 1 600 MWe by 2020.
- In the United States, the Tennessee Valley Authority restarted the Browns Ferry-1 plant (shut down in 1985) and announced that it would complete construction of the Watts Bar-2 nuclear power plant (construction suspended in 1988). The Nuclear Regulatory Commission (NRC) accepted for review the South Texas Nuclear Project (two advanced boiling water units with a combined capacity of 2 700 MWe), the first of several anticipated combined construction and operating licences.

More generally, the governments of the Czech Republic, Hungary and Mexico are considering building new units, and the governments of Poland and Turkey are moving forward with plans to introduce nuclear power. The government of the United Kingdom conducted a national consultation on the role of nuclear power in a low carbon economy.

In non-OECD countries, three new units came on line in 2007 and construction of another four began. Plans were initiated for robust expansion of nuclear electricity generating capacity in China, India, the Russian Federation and South Africa, and consideration is being given to either increasing existing capacity or to introducing nuclear energy in a growing number of countries, including Argentina, Bulgaria, Indonesia, Kazakhstan, Lithuania, some of the Persian Gulf States, Romania and Vietnam.

Initiatives to develop international nuclear fuel cycle programmes also made headway in 2007. The Global Nuclear Energy Partnership (GNEP) proposed by the United States and designed to aid the expansion of the peaceful uses of nuclear energy through enhanced safeguards, international fuel services and advanced technologies (including reprocessing and fast reactors) grew to 19 members in late 2007 (Australia, Bulgaria, Canada, China, France, Ghana, Hungary, Italy, Japan, Jordan, Kazakhstan, Lithuania, Poland, the Republic of Korea, Romania, the Russian Federation, Slovenia, Ukraine and the United States). The International Enrichment Centre initiative, a partnership between the Russian Federation and Kazakhstan under International Atomic Energy Agency (IAEA) supervision, also aims to enhance non-proliferation by allowing international partners access to enriched nuclear fuel services without having to deploy the technology locally. Armenia joined the partnership in late 2007. Successful deployment of these programmes and fast reactors could lead to significant changes in global nuclear power development and nuclear fuel cycle activities.

Uranium production, conversion and enrichment

Preliminary data indicate that in 2006 uranium was produced in just five OECD countries, one of which produced only small amounts as part of mine remediation activities. However, Canada (25%), Australia (19%) and the United

States (5%) accounted for almost half of world production. Production in OECD countries amounted to approximately 19 700 tonnes of uranium (tU) in 2006 and is expected to increase slightly in 2007. Production in OECD countries accounted for only about 30% of the uranium requirements in the OECD area, with the remainder being met by imports and secondary sources (excess commercial inventories for example). A complete picture of the uranium market will be available in 2008 when *Uranium 2007: Resources, Production and Demand* is published jointly by the NEA and the IAEA.

Beginning in 2001, the spot price of uranium began to rebound from historic lows of about USD 18/kgU to levels not seen since the 1980s. In 2007, the spot price rose dramatically to a high of USD 354/kgU in June before declining to USD 235/kgU in December. High prices have stimulated increased exploration that has already resulted in significant new discoveries, but temporary difficulties at operating mines have resulted in reduced output. Increasing demand combined with reduced production and dwindling inventories have all contributed to strengthening the market. Purchases by speculators are also considered to have been an important factor, particularly in the swift rise in price in early 2007. The spot market price has gone through more rapid and significant changes in 2007 than it has in decades, creating great interest in the market and injecting much-needed investment into the industry.

During 2007, uranium conversion facilities continued to operate in Canada, France, the United Kingdom and the United States. CoverDyn completed upgrades and expanded capacity at its plant in the United States; AREVA invested in a new, large-capacity conversion facility in France that is expected to begin production by 2010; and Cameco signed an agreement with Kazatomprom that could lead to the development of a new conversion facility in Kazakhstan.

In terms of uranium enrichment, in 2007 construction progressed at two new centrifuge plants using URENCO technology: AREVA's Georges Besse II facility in France and Louisiana Energy Services' National Enrichment Facility (NEF) in the United States. The US Enrichment Corporation received a licence from the NRC and is progressing on its demonstration of the American centrifuge design. AREVA announced plans to apply for a licence and to build a centrifuge facility in the United States. GE-Hitachi Nuclear Energy continued development of the Australian SILEX laser enrichment technology while China and Japan continued development of domestic centrifuge enrichment facilities.

Nuclear safety and regulation

In 2007, the safety performance of nuclear power plants in OECD countries remained at a very high level, as in previous years. The main elements of this achievement are 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.

The number of nuclear power plants reaching their initial design life is increasing and licence renewal continues to be an approach adopted in many OECD countries. The NEA continues to support regulatory authorities in their review of the adequacy of ageing management methods applied by the operators, based on state-of-the-art technology and reliable technical evidence.

In 2007, a significant earthquake took place in Japan near the 7-unit Kashiwazaki Kariwa nuclear power plant. Though the impact on plant safety has been negligible, the plant will remain shut down until exhaustive examinations are completed. The lessons learnt from this analysis will be addressed by the international community to discuss potential improvements to face external events. This event illustrates the continuing need to respond to operating experience and to implement an appropriate and timely corrective action programme. Nuclear regulatory authorities and nuclear safety research institutions have been active in revealing and resolving issues in this field.

Licensing new technologies and designs is now being recognised as a priority 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 and to share experience related to the regulation of new reactors. 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 improving and expediting the safety review of new designs and technologies.

Radioactive waste management

After phases of reorientation and extensive consultancy processes on radioactive waste management options, important decisions have been taken in some OECD countries, providing new stable direction for further developments.

The government of Canada formally selected Adaptive Phased Management as Canada's approach for the long-term stewardship of its used nuclear fuel. By this decision, the government followed the recommendation of the Canadian Nuclear Waste Management Organisation (NWMO), which proposed this plan in November 2005 after a three-year study which engaged thousands of citizens in every province and territory of Canada. In accordance with the Canadian Nuclear Fuel Waste Act, the NWMO is now responsible for implementing the government's decision.

In the United Kingdom, the government had sought advice from an independent group, the Committee on Radioactive Waste Management (CoRWM), on its future waste management policy. Following the publication of the CoRWM report in 2006, the government launched a public consultation on how to manage higher-level radioactive waste safely. The summary and analysis of responses to this broad public consultation process, which was meant to ensure that final decisions reflected all interests, concerns and best practice, have been published. The consultation responses indicate support for managing higher-activity radioactive waste in the long term through

geological disposal, as recommended by the CoRWM as the best available option.

The European Union Council also gave new momentum to the waste management efforts of its members by launching a High-level Group on Nuclear Safety and Waste Management and a European Nuclear Energy Forum. Addressing waste management issues will be a major activity of both institutions.

With several countries now firmly committed to geological disposal of the higher-activity and longer-lived wastes, the outlook for progress in the disposal area is now much stronger than in the past. This was confirmed at the International Conference on Geological Repositories (ICGR07), held in Berne, Switzerland, on 15-17 October 2007. Participants discussed the current status of affairs in long-term waste management on a high political level and showed a clear commitment from all major waste programmes to geological disposal. They noted that there has been progress in recent years and that some programmes have become more mature, refocused or legally tied to clear schedules. While safety remains the first priority, local acceptance of the site and national acceptance of the programme are key, and both need to be secured for the long term.

On the technical and project levels, tangible progress has been made in some of the most advanced geological repository programmes. The construction of underground exploratory facilities on repository sites – or at least at designated areas – has moved forward in France at the Bure site and in Finland at the Olkiluoto site. Following the final rejection of lawsuits by the highest administrative court in Germany, the construction and operating licence for the Konrad geological repository for low- and intermediate-level waste has been confirmed and technical work started to convert the former iron ore mine into an active repository. In Sweden, SKB submitted its latest research programme which should lead to site selection of a final repository in 2009. For its part, the US Department of Energy is preparing to submit the Yucca Mountain license application to the regulatory authorities in mid-2008.

Radiological protection

Important changes in the nuclear field are beginning to take shape, and radiological protection is no exception. A major step forward was taken with the approval in March of the new general recommendations of the International Commission on Radiological Protection (ICRP), which have been published as ICRP Publication 103. The revision of the international Basic Safety Standards, in which eight international organisations are participating, are now well under way. Finally, though outside the production of nuclear energy, there are radiological protection challenges associated with the increasing use of medical exposures.

In terms of new developments, the general recommendations of the ICRP adopted in 2007 cover all exposures to radiation, from both natural and artificial sources. Based on the excellent experience with the "as low as reasonably achievable" (ALARA) approach to managing occupational exposures and effluent releases, and further driven by increasing participation of stakeholders in risk-



Monitoring radioactivity.

related decision-making processes, approaches to managing what the ICRP now calls "Emergency and Existing Exposure Situations" has increasingly moved towards optimisation. This brings a certain harmony to the management of any type of exposure, which currently are not all managed by focusing on the optimisation of protection. This means that, following the precautionary principle, there is no pre-determined end-point or level below which it is generically seen as inappropriate to further reduce exposures. Instead, situation-specific aspects are assessed in order to identify and implement the most effective protection for the circumstances at hand. The new recommendations do, however, continue to propose using dose limits to ensure that individuals, either workers or members of the public, are not overly exposed. Governments have begun looking into how Publication 103 may affect national regulation and are developing plans to implement changes where appropriate.

The revision of the 1996 International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources (BSS) has been undertaken by eight international organisations: the International Atomic Energy Agency (IAEA, which has overall responsibility for the BSS revision), the OECD Nuclear Energy Agency (NEA), the International Labour Organisation (ILO), the World Health Organisation (WHO), the Pan-American Health Organisation (PAHO), the Food and Agriculture Organisation (FAO), the European Commission (EC) and the UN Development Programme (UNDP). In addition to the overall revision of the standards, the participating organisations will also be looking into how the recently adopted ICRP general recommendations may impact the BSS. The target approval date of the revised BSS by the IAEA Board of Governors is September 2009; approval by the co-sponsoring organisations is planned to take place in parallel.

Under social pressure and rapid technical evolution, the medical use of radiation is growing and is the largest man-made source of radiation exposure. The increasing use of medical radiation applications, and the availability of rapidly changing new technologies in medical imaging and radiotherapy have resulted in radioprotection issues not always being fully taken into account during the introduction or planning of apparatus or procedures. This has increased the risk of serious accidental radiation overexposure of patients due to human, organisational or technological failures, which are reported. While arrangements are being put in place to minimise the risk of such accidents, there will be an ongoing need to devote resources to ensure that radiation protection requirements and optimisation proceed in parallel with technology

development and implementation, and that tools for preventing unplanned medical overexposures are upgraded.

Nuclear science

Demand continues to increase from the nuclear research, industry, safety and regulation communities to obtain good knowledge of the uncertainties associated with different calculated/modelled reactor parameters such as criticality, radiation load on the main reactor components and neutron/gamma ray flux. This information is especially important for the estimation of safety margins as a better understanding of, and confidence in, these margins could have a significant economic impact.

To help meet the demand for a better estimation of modelling and simulation uncertainties, nuclear data library producers are making efforts to include uncertainty information in their data libraries in the form of covariance matrices. Methodologies have also been developed and/or are under development in many countries to quantify computational biases and their associated uncertainties. The methods used are mainly based on linear perturbation theory to calculate the sensitivity coefficients and to propagate these sensitivities, using the basic data covariance matrices, to the final reactor parameters.

Nuclear law

OECD countries continue to strive to minimise legal impediments to the safe use of nuclear energy and to develop and harmonise legislation governing the peaceful uses of nuclear energy. Ensuring that adequate and equitable compensation is made available to victims who suffer injury or damage as a result of a nuclear incident occurring at a nuclear installation or during the transport of nuclear substances is still a primary aim. Those member countries which adopted the Protocols to amend the Paris and Brussels Supplementary Conventions in 2004 are actively working to implement the provisions of these protocols in their national legislation. Other OECD member countries are examining the benefits of adhering to the 1997 Protocol to amend the Vienna Convention, and still others are evaluating the advantages of adhering to the 1997 Convention on Supplementary Compensation for Nuclear Damage. Several of these countries are searching for solutions to overcome nuclear operators' inability to obtain private insurance coverage for certain third party liability risks that they are legally obliged to assume under these conventions.

Other important issues concern the impact of international conventions outside the nuclear field on nuclear activities; ensuring that the use or transport of small quantities of nuclear substances are not subject to an overly burdensome liability and compensation regime; identifying legal and economic factors that may impact nuclear emergency decision making; facilitating the development and implementation of nuclear safety assistance programmes with non-members; and assisting selected non-members in adopting domestic nuclear legislation based upon internationally accepted principles.



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.

Highlights

- A study on *Risks and Benefits of Nuclear Energy* was completed and published. Based on a comprehensive survey of authoritative published literature and research results, the study provides insights into the advantages and drawbacks of the nuclear option as compared with alternatives.
- Co-operation with the International Energy Agency (IEA) continued with the NEA providing significant contributions to the IEA publication *Energy Technology Perspectives 2008*, as well as expertise for the in-depth reviews of energy policy of several IEA member countries.

Nuclear policy issues

Nuclear energy is attracting increasing interest from decision makers in the context of policies aiming at security of energy supply, reduction of fossil fuel dependency and mitigation of global climate change. The study on *Risks and Benefits of Nuclear Energy* provides a wealth of information and data that policy makers may use to assess the potential role of nuclear energy in their national energy policies. The study

was completed in 2007 and was widely presented in international conferences and scientific journals. Based upon a broad survey of literature and results from research on life cycle analysis of electricity generation chains, it offers illustrative examples of quantitative and qualitative indicators concerning economic, environmental and social aspects of electricity generation. It also provides insights into methodologies and decision-aiding tools of interest to policy makers responsible for assessing alternative options for energy supply mixes.

Security of supply is a cornerstone of energy policy and has become more prominent on the agenda of policy makers following increasing tensions in oil and gas markets and rising prices of hydrocarbons. The role of nuclear energy in enhancing national security of supply has been recognised by several OECD countries. There is, however, little analytical work providing quantitative assessments of nuclear energy's contribution to ensure secure access to electricity. The objective of the NDC study on this topic is to identify relevant quantitative approaches for measuring the contribution of nuclear energy to security of supply and to provide decision makers with robust, authoritative information to support technology choices for electricity generation aiming at enhancing security of supply.

Shares of uranium resources and production

	Resources (%)*	Production (%)**	Production (tU)**
Australia	24.0	21	8 575
Canada	9.4	23	9 465
United States	7.2	4	1 700
Namibia	2.1	7	2 875
Niger	4.8	8	3 154
South Africa	7.2	1	535
Kazakhstan	17.2	16	6 655
Russian Federation	3.6	8	3 415
Uzbekistan	1.6	6	2 305
Ukraine	1.9	2	845
Others	21.0	4	1 676
Total	100.0	100	41 200

* Identified resources recoverable at less than USD 130/kgU (2005 data).

** 2007 estimates.

In order to ensure that nuclear energy issues are addressed on a level playing field with alternatives, the NEA strengthened its collaboration with other parts of the OECD and in particular with the IEA. In this connection, the NEA contributed a nuclear energy chapter to the IEA publication on *Energy Technology Perspectives 2008*, drawing primarily from the outcomes of past and ongoing studies carried out under the auspices of the NDC.

NEA staff members participated in the IEA in-depth energy policy reviews of Finland, Japan, Sweden, Switzerland and the United States. NEA involvement brings nuclear energy expertise to the teams in charge of the reviews, thereby contributing to a comprehensive approach to the overall analysis.

Economics

Recognising the growing importance of competitiveness in liberalised electricity markets, the NDC decided to create a Working Party on Nuclear Energy Economics. The working party will provide guidance to the NDC on key economic issues that could be investigated from an international perspective for the benefit of member countries. At its first meeting in November, the working party developed proposals for activities on economic databases and models, and selected high priority topics for consideration by the NDC within its 2009–2010 programme of work. It is expected that the working party will play an essential role in reinforcing the relevance and quality of the economic analyses issued by the NEA.

The study on market competition in the nuclear industry has been completed and its outcomes will be published early in 2008. The report covers the state of competition in each of the major nuclear industry sectors, including the supply of new nuclear power plants and each stage of the front and back ends of the fuel cycle, as well as the industry's outlook for the coming years. One of the findings of the study is that competition, while present in all sectors of the nuclear industry, is limited in some sectors and in some geographic regions. The study concludes that efforts should be made by governments to maintain, and where possible increase, the level of competition in all nuclear market sectors as the industry expands to meet growing demand over the next decade and beyond.

Technology

The report on *Management of Recyclable Fissile and Fertile Materials* published early in 2007 provides an overview of inventories of recyclable materials and the options available for managing those materials. It highlights the relevance of exploiting the energy content of recyclable materials in the context of renewed interest in nuclear energy in many countries. The report also includes a comprehensive review of the advantages and drawbacks of alternative options for the back end of the fuel cycle, ranging from direct disposal of spent fuel to recycling of plutonium, partitioning and transmutation and full recycling of minor actinides. The main findings of the study were presented at various international conferences, including Global 2007.

The renewed interest in recycling, triggered in part by the perspective of a nuclear energy renaissance and also by increasing uranium prices, has led the NDC to launch a study on transition scenarios from thermal to fast neutron reactors. The study, initiated in mid-2007, will focus on strategic and policy issues associated with the deployment of fast neutron reactors and analyse the role of governments in ensuring an adequate framework for the implementation of synergetic strategies to optimise the use of fissile materials and minimise the environmental and social impacts of nuclear energy programmes.

The project on the timing of high-level waste (HLW) disposal was completed by the end of 2007 and the report summarising the main findings and conclusions will be published early in 2008. The study identifies key factors influencing the timing of HLW disposal and examines how social, technical, environmental and economic aspects impact national strategies in the field. It confirms the importance of informing all stakeholders and involving them in the decision-making process in order to achieve a successful implementation of those strategies. The study underlines the need for support and a clear, long-term commitment on behalf of government regarding the design and implementation of a national policy for the management and timely disposal of radioactive waste.

In the context of strong, anticipated growth in nuclear energy, policy makers, industrial stakeholders and civil society are enquiring into the adequacy of natural resources to support a broad revival of nuclear programmes. A new project has been initiated by the NDC to define any raw material limitations that could arise from a hypothetical tenfold expansion of global nuclear generating capacity. Such growth would increase the demand not only for nuclear fuel, but also for a number of natural resources required to support nuclear power plant construction, operation, decommissioning and the disposal (or reprocessing) of used nuclear fuel. The study is also investigating ways and means of overcoming the limits identified through policy measures and/or technical progress. The scope of the study includes all natural resources necessary to support nuclear energy development, including uranium and other mineral resources (e.g. zirconium and gadolinium), as well as land requirements for siting all nuclear facilities.

Data and resource assessment

The annual edition of *Nuclear Energy Data* (or the "Brown Book") 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 2007 edition offers projections to 2025 and country reports highlighting key events in the nuclear energy field.

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Nuclear Safety and Regulation

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.

The Working Group on Operating Experience (WGOE) completed its report on "The Use of International Operating Experience Feedback for Improving Nuclear Safety", providing several recommendations to improve the system to collect, assess and define corrective measures resulting from operational events.

The WGOE co-organised an International Workshop on Defence-in-Depth Aspects in Electrical Systems of Importance for Safety, held in September in Sweden. Senior regulators and researchers along with industry managers and technical-level experts discussed lessons learnt from the event that took place at the Forsmark nuclear power plant in 2006, as well as ways to improve system design and operation.

Other issues being studied by the working group include the safety analysis of fire operating events and the improvement of international networks for nuclear facility operating experience feedback.

The regulatory goal of assuring nuclear safety

The senior-level task group formed to address this subject completed its report which sought to answer the fundamental question, "How can the regulatory body judge whether its actions are actually assuring an acceptable level of safety at nuclear facilities?" The report noted that

there are many sources of information available to the regulator pertaining to safety at any given nuclear facility, such as inspection reports, operating experience reports, research results, periodic safety reviews, probabilistic safety analysis (PSA) results, insights from IAEA reviews and other similar information. The major challenge, and hence the primary focus of this report, is how can the regulatory body systematically collect the safety-relevant information and make an integrated safety assessment of that information to arrive at a sound judgement of the acceptability of a facility's level of safety.

The NEA also organised, in France in June, a Regulatory Forum on Assuring Nuclear Safety involving high-level participants from regulatory authorities, government agencies, nuclear industry leaders and other stakeholders. The forum addressed different perspectives for assuring nuclear safety and the principal challenges in arriving at an integrated assessment. Several subjects were discussed:

- maintaining safety focus on operating plants in a changing nuclear setting;
- operators' challenges in assuring nuclear safety in operating plants;
- essential safety topics for assuring nuclear safety;
- the integrated safety assessment;
- the regulatory challenges in communicating safety.

The findings from the forum were used by the senior-level task group to finalise its report on *The Regulatory Goal of Assuring Nuclear Safety*, which will be published early in 2008.

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 International Workshop on Inspection of Digital Instrumentation and Control (I&C) Systems Important to Safety was held in September in Germany. Nuclear inspectors met with experts to discuss methods to improve inspection programmes for these systems, which are being put into service in many power plants. Planning also began for the 9th international workshop, to be held in 2008 and to address the training and qualification of inspectors, the integration of inspection findings and the inspection of new plants under construction.

Highlights

- The main challenges identified by the Joint CSNI/CNRA Strategic Plan have been addressed in the committees' respective Operating Plans in order to assign priorities and to ensure efficiency within their programmes of work.
- In 2007 the CNRA and the CSNI organised several workshops, most notable were those on the Transparency of Nuclear Regulatory Activities; Regulatory Approaches to Licensee Safety Culture;

Fuel Cycle Safety: Past, Present and Future; Use of CFD Codes in Nuclear Reactor Safety; Defence-in-Depth Aspects in Electrical Systems of Importance for Safety; and the Role of Research in a Regulatory Context.

- Three new multilateral "Joint Projects" were started on containment thermal-hydraulics (THAI), on iodine chemistry (BIP) and on steam explosion (SERENA). See page 28 for further details on these and other joint projects under way.

Other issues being studied by the working group include regulatory inspection philosophy, inspection organisation and inspection of fire protection systems.

Nuclear regulators and public communication

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.

The group's main activity in 2007 was the organisation of a workshop on the Transparency of Regulatory Activities, which was held in Japan in May. This workshop attracted communicators and technical staff of the nuclear regulatory organisations together with a number of top regulators. The workshop addressed the understanding of transparency; stakeholders' expectations regarding transparency; the conditions for ensuring the transparency of regulatory activities; changes in 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

Regarding the analysis and management of accidents, work in this area has primarily focused on the thermal-hydraulics of the reactor coolant system; in-vessel behaviour of degraded cores; containment behaviour and protection; computational fluid dynamics (CFD); and fission product release, transport, deposition and retention. According to CSNI recommendations, in the future additional efforts will be made in other areas, notably as related to new and advanced reactors.

The main objective regarding thermal-hydraulics of the reactor coolant system and related safety and auxiliary systems is to improve and to expand the application of

best-estimate codes in nuclear power plant safety and design evaluations, including uncertainty evaluations. During 2007, further progress was made on the uncertainty and sensitivity evaluation of best-estimate methods (BEMUSE). Following an assessment based on calculations from an integral test, work continued on an analysis of a commercially operating nuclear power plant. This work will be completed during 2008.

Activities in the area of CFD code utilisation include best practice guidelines, completed in 2006, a CFD code assessment and validation database for single-phase applications in the area of nuclear reactor safety, completed in 2007, and multi-phase applications, which will be completed in 2008. A pilot project to keep the CFD code assessment database up-to-date using a web-based portal will start in 2008. Preparations have also begun to hold a second workshop on validation and benchmarking of CFD codes for application to nuclear reactor safety. This workshop, to be held in September 2008, will focus on multi-phase applications.

The International Standard Problem (ISP) No. 47 on predictability of containment atmosphere was completed in 2007. Work continues on in-vessel behaviour of degraded cores, including the preparation of a report on predicting in-vessel accident progression (covering beyond-design-basis accident code capabilities), a state-of-the-art

report on in-containment behaviour of aerosols and the containment code validation matrix.

Regarding the transfer of knowledge to young engineers and scientists, the organisation of two courses is under way: one on severe accidents, to be held in co-operation with the Severe Accident Research Network (SARNET) in Hungary in April 2008, and one in the area of thermal-hydraulics, to be held in Italy in May 2008.

Ageing and structural integrity of reactor components

The main topics investigated in this area include the integrity of metal components, the integrity of concrete structures and the seismic behaviour of structures and components. Maintenance, in-service inspections and the 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 inspection personnel's exposure to radiation.

Current activities in this area include a benchmark on risk-informed, in-service inspection methodologies (RISMET), a synthesis report concerning the ageing of nuclear power plant concrete containment structures, and a joint IAEA/NEA survey of nuclear facilities that have experienced an earthquake. During 2007, work was also carried out on finalising the second phase of the Probabilistic Structural Integrity of a PWR Reactor Pressure Vessel Benchmark (PROSIR), and preparing PROSIR phase 3 on probability of crack arrest.

During 2007, preparations began for a workshop on recent findings and developments in Probabilistic Seismic Hazard Assessment Methodologies and Applications, to be held in April 2008 in France. Preparatory work was also undertaken in 2007 to organise an NEA/JRC Workshop on Risk-informed Piping Integrity Management, aimed at discussing the final results of RISMET and the applications and uses of the OPDE database (see page 33 for further details on the OPDE Project). This workshop will take place in June 2008 in Spain.

Similarly, progress was made in organising a workshop on ageing management of thick-walled concrete structures, which will address in-service inspection, maintenance and repair as well as instrumentation, methods and safety assessment in view of long-term plant operation. The workshop will be held in October 2008 in the Czech Republic.

A second expert meeting was held in 2007 to pursue discussions on the establishment of a co-operative research project on ex-plant materials from the José Cabrera nuclear power plant. The project is intended 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; preparing a technical note on the use of risk information in the regulatory process; and writing a technical opinion paper on level-2 PSA and severe accident management.

The group has begun work on PSA of off-site external hazards other than earthquakes, where the focus is on off-site external events, including 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.

Based on a CSNI request, the group also initiated discussions on current experience with reliability modelling and qualifications of digital systems in the context of PSA applications. A meeting was held on this subject in October. The group launched an activity aimed at creating an information base and preparing a state-of-the-art report on risk analysis methods for addressing low-power and shut-down practices.

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. The main focus of the group remains on reviewing data from reactivity-induced accident (RIA) and loss-of-coolant accident (LOCA) experiments, and assessing how these data affect fuel safety criteria, in particular at increasing burn-up, notably because these two design basis accidents and the establishment of their safety limits continue to be the centre of regulatory attention.

The WGFS is continuing its work to update the 1986 CSNI state-of-the-art report on RIA and LOCA, although this time the two issues will be separated into two reports. Final drafts of these reports were prepared in 2007 and will be submitted to the CSNI for approval in 2008.

The adequacy of existing fuel performance codes for the simulation of high burn-up fuel behaviour under accident conditions was assessed by benchmarking against an irradiated LOCA test performed at the Halden reactor. The benchmark was successfully completed in 2006 and showed that further effort was needed to better model and validate high burn-up phenomena. It was therefore decided to continue the benchmarking with two additional Halden LOCA tests, in co-operation with the Halden



T. Thompson, NEI, United States

Inspecting a new fuel shipment at the Brunswick nuclear power plant.

Reactor Project (see page 28), to address in particular the effects from ballooning and related fuel blockage. Ongoing national and international fuel safety research programmes are expected to provide additional experimental data on irradiated fuel claddings for further code assessment and improvement.

Human and organisational factors

The Working Group on Human and Organisational Factors (WGHOF) constitutes a unique international forum for addressing safety management, human and organisational factors, and human performance in nuclear facilities. A technical opinion paper about human factors in nuclear power plant modifications was finalised in 2007, with publication foreseen early in 2008. Other activities include writing technical opinion papers about human performance issues in the safety of nuclear power plant maintenance, and about the role of human factors in advanced control room developments. A workshop on Maintaining Oversight of Licensee Safety Culture – Methods and Approaches was organised in co-operation with the CNRA, the IAEA and WANO in May in the United Kingdom.

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 introduction of the new, web-based FINAS has suffered some delays, but is expected to be operational in 2008.

A successful international workshop was held in October, addressing the questions of 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 also addressed potential future issues based on preliminary results of the survey conducted on fuel cycle safety issues such as fires, 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 Action Plan's Final Report, presenting the methodology with two examples of application, was approved by the CSNI in June 2007. At that time, the CSNI agreed to test the methodology, beginning in 2008, by evaluating the change in safety margins which would result from implementing the newly proposed US NRC rules on performing LOCA analyses. Overall, it is intended that the methodology will be able to be used to quantify the change in margins due to combinations of plant modifications occurring together, as well as in support of setting safety limits for advanced reactor designs.

Research facilities for existing and advanced reactors

Following several years of work on the subject, in December the CSNI adopted a Collective Statement on the Support Facilities for Existing and Advanced Reactors. The statement places particular emphasis on CSNI experience in acting as an efficient co-ordinator of international reactor safety research projects involving both regulators and industry, and on preparing for the next generation of reactors.

A joint CSNI/CNRA workshop was held in France in December on the Role of Research in a Regulatory Context (RRRC-2). The workshop concluded that the CSNI should define a long-term strategy and approach for joint efforts aiming at developing infrastructure for advanced reactors (Generation IV). In particular, it was agreed that the CSNI should identify the key safety and risk issues and the data needs for specific Generation IV design concepts, or the infrastructure needs for producing the required data, and the role of the regulator, industry and R&D institutions in the development of such infrastructure.

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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.

Highlights

- The RWMC played an important role in co-organising the International Conference on Geological Repositories: A Common Goal, A Variety of Paths held in Switzerland in October.
- An international symposium organised by the NEA on "Safety Cases for the Deep Disposal of Radioactive Waste: Where Do We Stand?" reviewed progress made on safety cases over the last decade.
- The RWMC Forum on Stakeholder Confidence (FSC) finalised a report on what contributes to *Fostering a Durable Relationship Between a Waste Management Facility and Its Host Community*.
- The RWMC Working Party on Decommissioning and Dismantling (WPDD) reviewed regulatory arrangements during the decommissioning of nuclear facilities by analysing operators' and regulators' experience.

Waste management policy and regulatory issues

The RWMC was instrumental in co-organising the International Conference on Geological Repositories, which was held in Berne, Switzerland in October. As during the previous conferences in this series, held in Denver in 1999 and in Stockholm in 2003, the Berne Conference gave high-level decision makers and opinion leaders an opportunity to discuss at the highest political and regulatory levels ongoing and planned activities to develop geological repositories. In line with the conference's subtitle "A Common Goal, A Variety of Paths", high-level politicians, top regulators and heads of waste agencies discussed in plenary presentations and panel discussions the various political frameworks and factors influencing the decision-making process. The NEA will publish the proceedings of the conference.

Regulatory criteria are paramount in evaluating the safety of waste management facilities. However, the extremely long timescales over which the regulations are meant to apply make the framing of regulation especially difficult. The RWMC has addressed these issues in a new report on *Regulating the Long-term Safety of Geological Disposal*, which builds on the outcomes of several initiatives, including a 2006 workshop in which specialists in sociology and

philosophy participated alongside technical experts. The report stresses that it is important that differences in national approaches be understood and explained in order to establish confidence in national repository programmes. It also upholds that developing a common understanding of obligations to future generations and of how to integrate these obligations in regulatory criteria for long-lived radioactive waste would make comparisons of regulatory approaches in national and international contexts more meaningful and useful.

Safety case for geological disposal

The NEA hosted an international symposium on "Safety Cases for the Deep Disposal of Radioactive Waste: Where Do We Stand?" in Paris in January. The symposium, co-sponsored by the IAEA and the EC, provided an opportunity to review progress and to identify emerging trends and challenges. It brought together experts in the field of radioactive waste disposal from 16 NEA member countries, international organisations and the Russian Federation. The symposium showed that there has been significant evolution in terms of the analytical tools, lines of evidence, range of performance indicators and communication of the safety case.

Through its Integration Group for the Safety Case (IGSC), the RWMC continues to further define trends and best practices in developing and presenting safety cases. Building on the success of the international symposium held on this topic, a workshop in early October explored safety case issues in depth. The results will support a state-of-the-art report.

Another workshop held in the United Kingdom in November addressed Stability and Buffering Capacity of the Geosphere for Long-term Isolation of Radioactive Waste: Application to Crystalline Rock. Using specific examples from relevant national programmes, the workshop explored the key processes affecting such rocks as host environments for geological disposal; the lines of evidence to support their stability and robustness over long timescales; and their resilience to natural disruptive forces.

Finally, the IGSC updated its programme of work to ensure that the NEA will continue to effectively support safety and scientific understanding of disposal programmes in member countries.

Forum on Stakeholder Confidence

The RWMC Forum on Stakeholder Confidence (FSC) summarised six years of learning by the FSC and the WPPD in *Stakeholder Involvement in Decommissioning Nuclear Facilities*, a report that reviews stakeholder concerns and best practice in addressing them. The lessons learnt can contribute *inter alia* to better foresight in siting and building new facilities.

In another activity, the FSC explored what contributes to *Fostering a Durable Relationship Between a Waste Management Facility and Its Host Community*, noting that the societal durability of an agreed solution is essential for the success of any long-term RWM project. The report shows how technical and architectural design can contribute to the quality of life of the host community, and how the process of deliberating about the facility can also bring added value. Finally, a report on *Cultural and Organisational Changes in Radioactive Waste Management Organisations* was issued based on a survey of 17 FSC members in 11 countries, case histories and theoretical input. Set in a framework which helps to understand the different environments in which waste management organisations work, the report sheds light on changes observed in mission, values, culture and structure, and identifies the triggers and main agents of change as well as ways of overcoming resistance.

To better define and gain new momentum for the next phase of its work, the Forum on Stakeholder Confidence held a brainstorming workshop in December to discuss possible new themes for investigation and to further improve its modus operandi and outreach. The workshop was also an excellent occasion to strengthen ties with FSC constituencies, for example with municipal stakeholder organisations, government task forces, other stakeholder-based study groups and academia.

Decommissioning

Following a seminar organised by the Working Party on Decommissioning and Dismantling (WPDD) in late 2006, a report on "Regulatory Arrangements during the Decommissioning of Nuclear Facilities" has been prepared to assist regulators in adapting regulation from the plant operation phase to that of decommissioning. The report, to be published in 2008, draws conclusions on emerging issues, such as an increasing emphasis on conventional industrial hazards and environmental matters and managing the changing nature of work patterns. The WPDD is also currently finalising a state-of-the art report on the regulatory release of buildings and materials, which will review international criteria for clearance and analyse national approaches to this issue. This report complements an earlier published report on releasing the sites of nuclear installations.

At its annual meeting in November, the WPDD hosted a special topical session on Human and Organisational Factors, addressing organisational arrangements, planning and contracting schemes, project management and personnel issues, skills assessment and training, safety culture and knowledge management. The meeting also included a special session on strategies, regulation and practices



Decommissioning at Windscale, United Kingdom.

adopted in the United Kingdom in the field of decommissioning. Next steps for the WPDD include conducting a study on cost estimates and exploring the scope for more standardisation in their reporting.

The Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects (CPD) expanded its basis for information exchange by including two new decommissioning projects. It also established two specialised task groups to analyse the experience gathered with the use of robotics in decommissioning and with various techniques for the decontamination and dismantling of concrete. (See page 34 for further details on this programme.)

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.

The CLAYTRAC Project, a major NEA Clay Club undertaking, has analysed data on natural tracer elements to improve understanding of transport processes and their implications for the performance of deep geological disposal systems. Preliminary results provide convincing evidence that diffusion is the dominant transport process over geological timescales for the formations studied. The project was highlighted in the opening session of a recent international conference on clays in France. A final report will be available in 2008.

The Clay Club is also continuing its investigation of processes that lead to self-sealing of fractures in clays, which could have important implications for the performance of deep geological repository systems because of the possibility to reduce or eliminate preferential pathways. An expert team completed a comprehensive review of the topic and confirmed that there are recent important laboratory results and field tests that reinforce empirical observations of self-sealing. A full technical report, synthesising and interpreting the conclusions in the context of geological disposal, will be prepared in 2008.

Work continued on the Thermochemical Database (TDB) Project, which moved into phase IV covering the years 2008-2012. This NEA-sponsored joint project is described on page 34.

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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.

Highlights

- Based on the CRPPH 50th Anniversary discussions in May with national regulatory authorities and international organisations involved in radiological protection, and on two forward-looking reports on emerging social and scientific challenges to radiological protection, the CRPPH has identified its strategic direction for the coming years.
- With the approval of the new ICRP general recommendations in March, and following seven years of collaborative discussions, the CRPPH began to consider aspects of the recommendations' implementation.
- Preparations were made for a workshop to be held in January 2008 to discuss how science and values contribute to the formation of policy judgements, to elaborate the scientific and policy processes involved in decision making and to identify priority science areas needed to support policy decisions.
- Several expert groups were established to address identified needs in post-accident management based on the results of the INEX-3 emergency exercises series.

Evolution of the international system of radiological protection

In March 2007 the International Commission on Radiological Protection (ICRP) approved its new general recommendations, which will replace those contained in ICRP Publication 60 issued in 1990. This draws to a conclusion the efforts that were begun in 1999, and to which the CRPPH has significantly contributed. The NEA actively participated in the process by providing a forum and opportunities for interaction with interested authorities of member countries as well as a dialogue with other stakeholders. Since 1999, the CRPPH has organised eight international workshops, performed four detailed assessments of ICRP draft texts, and has issued, in addition to conference proceedings, seven expert group reports proposing innovative approaches to the evolution of the ICRP's system of radiological protection. These actions have been complemented by direct interactions with the ICRP. The final report on CRPPH work in this area will be published in 2008. The CRPPH will also continue its engagement with the ICRP in developing supplemental recommendations.

In terms of the application of the system of radiological protection, the NEA, as a co-sponsoring organisation of the International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources (BSS) has been working with the other co-sponsoring organisations to revise the BSS. This work is expected to continue for two to three years, and the CRPPH, taking the lead in this work on behalf of the NEA, will continue to actively contribute the expertise of its members and its Secretariat to this work.

Stakeholders and radiological protection

The CRPPH has long been at the forefront of developing stakeholder involvement in radiological protection issues. Given the evolution that has taken place, the Committee decided to take stock of current practice and tasked a scoping group with examining how radiological protection institutes have adjusted their activities to working with stakeholders. Based on eight case studies in member countries and one outside, the group concluded that an increasing number of activities were engaging stakeholders beyond the usual players (typically public authorities and industry), and highlighted the real gains being made by both the institutes and stakeholders. This work will be disseminated as an NEA publication. The group and the CRPPH nevertheless felt that more effort on consolidating good practices is required and therefore, over the coming year, the newly formed Expert Group on Stakeholder Involvement and Organisational Structure will investigate concrete changes in the activities of radiological protection institutes. The CRPPH will subsequently support the development of a guidance document for radiological protection professionals by the International Radiation Protection Association (IRPA), the global association of professional radiological protection societies.

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 common ground among the approaches taken to risk assessment and risk management. To address the related

issues, the CRPPH created the Expert Group on the Public Health Perspective in Radiological Protection (EGPH) in 2006 and began studies and exchanges of national experience. The group's ongoing activities and proposals for topics that could usefully be explored in more depth were reported to the CRPPH during its 2007 annual meeting. The CRPPH agreed that the EGPB shall develop case studies in four areas: 1) radon, 2) justification of medical exposure, 3) public health judgement in decision making based on new scientific evidence, and 4) management of individual differences.

Operational radiological protection from a policy perspective

In order to explore operational aspects of radiological protection that have or could have policy and regulatory implications, and to facilitate better interaction with the Information System on Occupational Exposure (ISOE), the Expert Group on Occupational Exposure (EGOE) was formed in 2006 and its programme and list of studies were approved in 2007. These studies shall explore in stepwise manner: 1) criteria for new build, 2) implementation of the ICRP recommendations, and 3) radiological protection policy and operational issues. The formal involvement of the ISOE programme in this activity has allowed it to take advantage of the operational experience of the ISOE membership.

Radiological protection science and policy judgement

The recent CRPPH assessment of ongoing research in radiation biology has indicated that there could be significant impact on the current system of radiological protection should research outcomes challenging current radiological protection assumptions continue to emerge. While none of these outcomes is at this point certain, regulatory authorities appreciate being kept informed of possible outcomes so that their practical implications can be assessed and preparations undertaken where appropriate. As such, the CRPPH, in co-operation with the Radiation and Nuclear Safety Authority (STUK) of Finland, will be organising the International Workshop on Science and Values in Radiological Protection, to be held on 15-17 January 2008 in Helsinki. This workshop will discuss how regulatory and policy judgements can best be made in the context of emerging scientific challenges and continuing scientific uncertainties. It will also help radiological protection (RP) policy makers, regulators and practitioners to better understand developments coming from RP science, and will help the scientists to better understand the broad processes of RP decision making, thereby leading to better interaction overall.

Radiological protection of the environment

The Secretariat's desk study reviewing national regulations and international instruments related to the radiological protection of the environment was published in early 2007. Following this, the CRPPH released a parallel study of national regulations and international instruments related to protection of the environment from chemical toxins, which assessed the regulatory implications of different approaches. The CRPPH also approved a paper discussing approaches

to integrating radiological protection of non-human biota into the current system of radiological protection that was subsequently published in the December issue of the *Journal of Radiological Protection*. In order to further develop thinking on radiological protection of the environment, the CRPPH is organising a session on environmental protection, covering regulatory and policy issues as well as current practice, at the International Conference on Radioecology and Environmental Radioactivity to be held in Bergen, Norway in June 2008.

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) by using a common scenario to examine 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 this exercise series, the CRPPH Working Party on Nuclear Emergency Matters (WPNEM) held a workshop on the INEX 3 consequence management exercises in 2006. 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. They also identified issues needing additional examination at the international level. The NEA finalised a synthesis report of the exercise series, workshop and follow-up activities in 2007. The WPNEM established several expert groups to address key needs in consequence management and recovery arising from the exercise series, particularly in the areas of post-accident countermeasures, impacts of nuclear indemnification and good practices in decision making.

Occupational exposure at nuclear plants

Occupational exposure at nuclear power plants continues to be an important issue for the CRPPH. The sharing of operational lessons and experience, as well as the collection, analysis and exchange of occupational exposure data continues to be addressed by the NEA joint project: the Information System on Occupational Exposure (ISOE). In support of CRPPH efforts to facilitate improvement of members' operational radiological protection capabilities, ISOE continued to collect, evaluate and disseminate occupational exposure data and trends, and to share operational experience through its information exchange network and international symposia. Important enhancements in ISOE value were undertaken in 2007 through ongoing improvements to the ISOE web-based information exchange system, and the creation of a new Expert Group on Work Management looking at optimisation of radiological protection in the nuclear power industry. Further details on the ISOE programme are provided on page 34.

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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.

Highlights

- A comprehensive *Handbook on Lead and Lead-bismuth Eutectic Technologies* was published.
- The results of two scientific studies relevant to the physics of plutonium recycling were issued.
- The International Conference on Nuclear Data for Science and Technology (ND2007) was held in France in April.
- The International Conference on Nuclear Criticality Safety (ICNC'07) was organised on 28 May-1 June in Russia.

Material science was introduced as a new activity in the NEA nuclear science programme in 2007 in addition to the habitual activities which comprise reactor physics, fuel cycle physics and chemistry, criticality safety and radiation shielding. The detailed work programme of this new activity will be further developed in 2008.

Fuel cycle physics and chemistry



A comprehensive *Handbook on Lead and Lead-bismuth Technologies*, including for example materials compatibility and thermal-hydraulics, has been published. The handbook contains some 700 pages of reference materials for these heavy liquid metals. In addition,

a specific benchmark exercise has been launched on a thermal-hydraulic loop for lead-alloy-cooled advanced nuclear systems.

The Expert Group on Chemical Partitioning is writing a report on national programmes in partitioning and is also studying different aqueous and pyrochemical fuel cycle flowsheets, including the calculation of waste products generated within each individual flowsheet. Recently, the group also launched an activity on curium separation and management. This activity will cover available strategies (transmutation or interim storage), separation methods, storage and disposal requirements, and handling experiences.

A state-of-the-art report on fuel cycle transition scenarios, including issues on country-dependent scenarios and key technologies for implementing future scenarios, has been completed. As a complement to this report, the expert group is also pursuing two benchmark exercises, one to compare the performance of different scenario codes and one to study a regional European transition scenario. It is also planned to initiate a global transition scenario study.

Reactor physics

The results of two benchmark studies relevant to the physics of plutonium recycling were issued in 2007. One of the studies concerned a pebble bed modular reactor (PBMR) fuelled with reactor-grade plutonium, whereas the second study involved an evaluation and analysis of reactor period measurements carried out in the CROCUS reactor in Switzerland for different delayed super-critical conditions.

A number of reactor physics benchmarks involving mixed-oxide (MOX) fuels are being conducted. A report containing the results from a MOX fuel modelling code benchmark exercise, using irradiated fuel rod data from the OECD/NEA Halden Reactor Project in Norway, was published in 2007. In addition, three MOX benchmarks,



IFE, Norway

At the Halden reactor in Norway.

based on experimental data from the VENUS reactor in Belgium, are under way.

The NEA nuclear science programme also comprises a series of benchmark exercises related to transients in different reactor types with special focus on coupled neutronics and thermal-hydraulics. The series covers BWR fuel bundle tests, based on unique experimental data from Japan, VVER-1000 coolant transient benchmarks and a PBMR-400 coupled neutronics/thermal-hydraulics transient study.

Considering the importance of a correct treatment of model and data uncertainties in the analysis of different reactor parameters, an expert group was established to develop best-estimate simulation methods with systematic uncertainty analysis across different phenomena (multi-physics) and different scales.

An Expert Group on Minor Actinide Burning in Thermal Reactors was established and will hold its first meeting in early 2008.

Nuclear criticality safety

A new edition of the *International Handbook of Evaluated Criticality Safety Benchmark Experiments* was issued in September. The new edition contains 491 evaluations describing about 4 500 critical, near-critical or sub-critical configurations, as well as five criticality alarm placement/shielding evaluations and three fundamental physics measurements relevant to criticality safety applications.

A new Expert Group on Uncertainty Analysis for Criticality Safety Assessment has been established. The group will formalise a procedure for the validation of codes used in criticality computation with one of the goals being, for example, to investigate the potential reduction in costs related to the redundant safety margins employed in the handling of fissile materials.

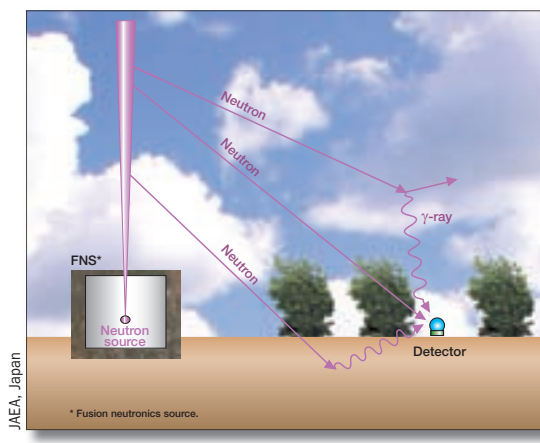
An activity has been started to systematically obtain and document new isotopic composition data from post-irradiation experiments. The data will be stored in the NEA Spent Fuel Isotopic Composition Database (SFCOMPO).

The Expert Group on Burn-up Credit has launched an exercise to study the performance of the depletion calculations codes for long-term geological disposal applications. The study will be undertaken in close co-ordination with the NEA radioactive waste management programme.

Radiation shielding and reactor dosimetry

A computational radiation transport benchmark exercise is under way. The benchmark is designed to elucidate important issues necessary to judge the quality of numerical solutions obtained with particle transport software. The results from deterministic solutions will be compared to a reference solution based on Monte Carlo calculations.

A study of radiation skyshine effects, based on experimental data from a reactor in Kazakhstan, is also being conducted as part of the NEA radiation shielding programme.



Schematic diagram of a skyshine experiment.

R&D facilities in nuclear science

A review of the needs for research and test facilities in the area of nuclear science is being undertaken. The outputs of this activity will be a status report and a database containing information about existing R&D facilities. The database, which will be publicly released in the beginning of 2008 on the NEA website, contains information on over 750 scientific research facilities. The report will be published later in 2008.

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 nuclear application areas. Data from integral experiments have been collected in the areas of reactor physics (IRPhE), fuel behaviour (IFPE) and radiation shielding (SINBAD). The NEA is also co-operating with the US Department of Energy in the compilation of data for the *International Handbook of Evaluated Criticality Safety Benchmark Experiments* (ICSBEP). All the collected data are made available through the Data Bank to the nuclear community in a comprehensive and structured format for use in computer model and benchmark validation exercises.

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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 upon request.

Highlights

- Some 1 800 computer codes and 2 000 sets of integral data were distributed to 620 authorised establishments.
- A complete CINDA archive was published in seven volumes, comprising 55 000 references from 1935 to 2006.
- A new version of the data display program JANIS-3 was released in June with reinforced plotting capabilities.
- A revised decay data library, JEFF-3.1.1/RDD, was released in November.
- A new phase of the Thermochemical Database (TDB) Project was approved towards the end of the year and will begin its activities in February 2008.

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 and engineers in member countries. The collection of codes covers many different areas, ranging from reactor design, dynamics, safety and radiation shielding to material behaviour and nuclear waste applications.

During 2007, a total of 94 new or revised versions of computer codes were acquired and 54 were verified, tested and master-filed. The special co-operative agreement in place between the NEA Data Bank and the International Atomic Energy Agency (IAEA) has enabled the NEA Data Bank to receive 25 computer codes from non-OECD countries. Nineteen new or revised sets of integral experiment compilations (such as SINBAD, IFPE and IRPhE) were acquired and integrated during the same period.

The Data Bank answered requests for 1 843 programs in 2007, of which 103 were sent to non-OECD countries. With regard to integral data experiments in support of computer code validation, 1 958 sets were distributed, of which 257 were sent to authorised users in the non-OECD area.

Knowledge transfer and preservation

As part of the Data Bank services, training courses on the utilisation of the most popular computer programs were

organised. The areas covered were: computational radiation physics, radiation transport using Monte Carlo codes and data visualisation, radioisotope build-up and depletion during irradiation and cooling, uncertainty analysis in dosimetry and in coupled neutronics/thermal-hydraulics, and evaluated nuclear data processing. Approximately 250 participants attended in all.

In June, the NEA participated in the International Conference on Knowledge Management in Nuclear Facilities organised by the IAEA. Senior staff presented an overview of the work contributed by the NEA and its Data Bank to this field.

The Data Bank's knowledge preservation activities include the development of the IFPE (fuel performance experiments), SINBAD (shielding and dosimetry experiments) and the IRPhE (International Handbook of Evaluated Reactor Physics Benchmark Experiments) databases. Numerous copies of these databases were distributed upon request.

In the field of radiation transport and reactor physics, important "legacy" books were released to the Data Bank after publishers reverted the copyrights to the authors. The following have been released so far by professors MMR. Williams and J. Lewins: *The Slowing Down and Thermalisation of Neutrons*; *Mathematical Methods in Particle Transport Theory*; *Random Processes in Nuclear Reactors*; *Nuclear Reactor Kinetics and Control*; and *Importance: The Adjoint Function*. The OECD/NEA Data Bank is now authorised to distribute them in PDF format at no cost to requesters, and in particular to students.

Nuclear data services

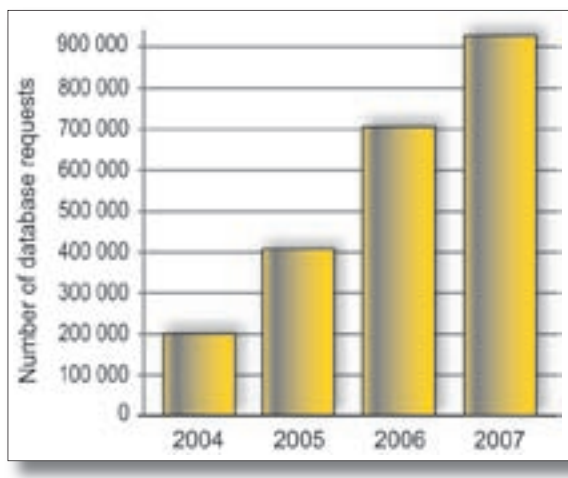
The Data Bank maintains large databases containing bibliographic (CINDA), experimental (EXFOR) and evaluated (EVA) nuclear data and makes these databases available online to scientists and engineers in member countries. In 2007, the evaluated nuclear data libraries ENDF/B-VII.0, IRDF-2002, PADF-2007 and JEFF-3.11/RDD were added to the EVA database. The NEA contributed over 80 experiments on neutron-induced data and over 110 experiments on charged-particle reactions to the EXFOR database.

These databases are maintained in close co-operation with other nuclear data centres and cover most types of data needed in nuclear energy applications. In 2007, the Data Bank published a complete version of the CINDA

database that includes over 55 000 references to neutron- and charged-particle data including references to EXFOR. The publication was printed in seven volumes and distributed to approximately 300 libraries and research facilities around the world.



A new version of the nuclear data display software, JANIS-3, was released in June to respond to users' feedback and needs. The main improvements include coverage of the EXFOR database, the EXFOR and CINDA search panels and the plotting features. 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. JANIS users access the NEA online databases more than 40 000 times per month. Users request the new program mainly for fission applications, but also for basic research and educational purposes. The program is free of charge and can be downloaded or launched from the JANIS web page at www.nea.fr/janis.



JANIS usage. The latest version (JANIS-3.0) was released in June 2007.

In April, the NEA co-sponsored the International Conference on Nuclear Data for Science and Technology, ND2007, in Nice, France. Senior staff gave welcoming addresses and several presentations were made on NEA work. The next conference on nuclear data is planned to be held in the Republic of Korea in 2010.

The JEFF project

The Joint Evaluated Fission and Fusion (JEFF) project has revised its decay data library. The new version, JEFF-3.1.1/RDD, was released in November and is available on the

NEA website. A full report on the decay data library is planned to be published in 2008.

The outline of a JEFF-3.1 validation report has been established. The report will contain sections on: 1) Thermal systems, 2) Fast systems, 3) Fuel cycle, storage and reprocessing, 4) Fusion systems, and 5) Other applications.

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 countries (Russia, BROND; China, CENDL; and the IAEA-based FENDL). In 2007, a publication (Vol. 25) was issued on the *Assessment of Fission Product Decay Data for Decay Heat Calculations*. Two new activities have also been launched, one on ²³⁵U Capture Cross-section in the keV to MeV Energy Region, and the other on Improvement of Accessibility and Quality of the EXFOR Database.

The High Priority Request List (HPRL) is based on requests from data users and provides a guide for scientists planning measurements and developing nuclear theory and data evaluation programs. The content is reviewed on a regular basis by external referees. New requests are expected from different WPEC subgroups during 2008, for example on cross-section uncertainties for advanced reactors.

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 34).

In-house computer services

The Data Bank's in-house computer services provide a highly available network, data storage and servers. The web cluster connected by two internet links has served one million visitors in 2007, who browsed 2.5 million web pages and downloaded 2.7 million documents amounting to a total of two terabytes (2 000 gigabytes).

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Nuclear Law Committee (NLC)

The NLC promotes the development, strengthening and harmonisation of nuclear legislation governing the peaceful uses of nuclear energy in member countries and selected non-member countries. It supports the application and modernisation 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.

Highlights

- A colloquium on the past, present and future of the NLC was held at OECD headquarters to celebrate the Committee's 50th anniversary.
- Member countries which are party to the Paris and Brussels Supplementary Conventions on Nuclear Third Party Liability continued to work towards implementing in their national legislation the Protocols to amend those conventions, which were adopted in 2004. The NLC actively sought to help those countries resolve the problem of financial security for operator liability which ensued.
- The NLC finalised a draft Steering Committee Decision to ensure that an overly burdensome regime would not apply to small quantities of nuclear substances which are in transport or in use outside a nuclear installation.
- The NLC established a joint ad hoc working group together with the Committee on Radiation Protection and Public Health (CRPPH) in order to study the impact of legal and economic factors on nuclear emergency decision making.
- The seventh session of the International School of Nuclear Law was held at the University of Montpellier 1.

Development and harmonisation of nuclear legislation

To mark its 50th anniversary, the NLC organised a colloquium on its past, present and future in conjunction with the committee's regular meeting in Paris, France. The committee was founded on 24 January 1957 as the Group of Governmental Experts on Third Party Liability in the Field of Nuclear Energy. Over its five decades of work, it has made a significant contribution to the safe and responsible use of nuclear energy, notably by participating in the drafting of international conventions in the field of civil liability for nuclear damage. Those attending the colloquium included nearly all former NLC chairs and former heads of NEA Legal Affairs. Copies of the speeches can be found on the NEA website at www.nea.fr/html/law/colloquium/welcome.html.



Participants at the Nuclear Law Committee's 50th anniversary.



50th anniversary colloquium.
From left to right: N. Pelzer, L. Echávarri,
J. Schwartz, R. Dussart-Desart, M. Léger.

Member countries which are party to the Paris and Brussels Supplementary Conventions on Nuclear Third Party Liability continued to work towards implementing in their national legislation the Protocols to amend those conventions, which were adopted in 2004. Their provisions require nuclear operators to make more money available to compensate more victims for more types of damage than ever before. Nuclear operators are obliged to provide financial security to cover their risks under the revised nuclear liability regimes. Several countries are facing delays in implementation because the private

nuclear risk insurance industry has made it clear that it is unable or unwilling to provide full coverage for certain risks which nuclear operators are obliged to assume under the revised or newly adopted international nuclear liability conventions (risks such as the costs of certain preventive measures, environmental damage and prescription periods which exceed ten years). The NLC actively sought to help those countries find adequate, alternative financial security.

The NLC finalised a draft Steering Committee Decision to ensure that nuclear operators are not overly burdened by the application of the Paris Convention on Nuclear Third Party Liability to small quantities of nuclear substances used or transported outside of a nuclear installation. The NLC co-ordinated its actions with relevant counterparts at the International Atomic Energy Agency to ensure consistency with an almost identical decision relating to the 1963 Vienna Convention on Civil Liability for Nuclear Damage, the 1997 Protocol to amend that Convention and the Convention on Supplementary Compensation for Nuclear Damage. The Decision was adopted by the Steering Committee for Nuclear Energy in October.

The NLC continued its study of the impact on the nuclear energy sector of the Aarhus Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters. The Convention will impact the management of nuclear energy information by public authorities and the decision-making process for nuclear energy projects. The committee examined several national court decisions that relate to the subject matter of the Aarhus Convention and invited an expert to speak about the role of the Aarhus Compliance Committee.

The NLC established an ad hoc working group together with the Working Party on Nuclear Emergency Management of the Committee on Radiation Protection and Public Health (CRPPH) to study the impact of legal and economic factors on nuclear emergency decision making.

Nuclear law publication programme

Volumes No. 79 and 80 of the *Nuclear Law Bulletin* were published in June and December respectively. This periodical provides up-to-date information on national and international developments in legislation, regulations and case law in the field of nuclear law. It also includes articles and studies analysing recent developments. The *Nuclear Law Bulletin* is a unique international publication in nuclear law and has proved to be an invaluable tool for both professionals and academics working in this field. Back issues (except for the latest three) are available for free download at www.nea.fr/html/law/nlb.

Country files on nuclear legislation in OECD member countries, comprising the regulatory and institutional framework for nuclear activities, are also available online at www.nea.fr/html/law/legislation/welcome.html. In 2007, several country files were updated. It is intended to update the country files on a regular basis and to include reproductions of new nuclear legislation.

Nuclear law educational programme

The seventh session of the International School of Nuclear Law (ISNL) was held from 27 August to 7 September in Montpellier, France, with 57 people from 35 countries and the European Commission participating. Established in 2001 by the NEA and the University of Montpellier 1, the ISNL aims to provide high-quality education in international 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 2008 session will take place from 25 August to 5 September. Further information may be obtained at www.nea.fr/html/law/isnl/index.html.



Participants at the 2007 session of the ISNL, Montpellier, France.

The third Summer Institute of the World Nuclear University (WNU) took place in the Republic of Korea in July. This six-week training programme covered a broad spectrum of nuclear energy issues, mainly in the field of nuclear science and technology. The four-day nuclear law module was co-organised by the NEA and the IAEA, and focused on general nuclear law subjects, third party liability and environmental law, and on non-proliferation and safeguards. The 2008 WNU Summer Institute will be held at Ottawa University, Canada from 5 July to 15 August.

The WNU also organised its first regional session in China in July 2007. This session aimed to inform an audience of Chinese graduate students and nuclear professionals of the key issues facing the nuclear energy sector. The NEA participated and delivered a lecture on international nuclear law.

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Joint Projects and Other Co-operative Projects

NUCLEAR SAFETY RESEARCH

The Halden Reactor Project

The Halden Reactor Project is operated by the Norwegian Institute for Energy Technology (IFE). It has been in operation since 1958 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 prototype developments and analyses carried out at the Halden establishment in Norway. It is supported by approximately 100 organisations in 18 countries. The Halden Project benefits from stable and well-experienced organisation and a technical infrastructure that has undergone substantial developments throughout the years. The project objectives have been continuously adapted to users' needs.

The 2006-2007 work scope in the fuel area 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 have provided valuable insights, which have been confirmed in hot cell post-irradiation examinations. Properties of UO_2 , 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 materials in BWRs and PWRs continued, with the aim of characterising the effect of water chemistry and material ageing. The work on cable ageing has resulted in a technique that is being used for assessing insulation damage and in those cases to determine the extent and location of the damage.

The programme on human factors has focused on experiments in the Halden man-machine laboratory, related data analyses, new control station designs, evaluations of human-system interfaces, process and instrumentation optimisation and digital instrumentation and control (I&C). This involves *inter alia* the use of the Halden Virtual Reality Facility. Progress has been made in the area of human reliability assessment (HRA), aiming to provide data suitable for probabilistic safety assessments and to improve validity of HRA methods.

An Enlarged Halden Programme Group meeting (bringing together both programme representatives and participating country experts) was held in March. The main results of the programme were reported on that occasion.

A number of international workshops, such as those on Advanced Control Systems Designs, Irradiation Assisted Stress-cracking Corrosion and LOCA tests were organised in 2007, mainly to discuss the outcomes of ongoing programme items. Another Programme Group meeting was held in the Czech Republic in September. The Halden Board also met twice in 2007.

The BIP Project

The Behaviour of Iodine Project (BIP), which is supported by 13 member countries, began in 2007. The work consists of separate effect and modelling studies that will augment and complement larger national and international experimental programmes. In addition, it will provide data and interpretation from three Radioiodine Test Facility (RTF) experiments. The proposed project for iodine experiments, to be hosted by Atomic Energy of Canada Limited (AECL), will combine international resources to achieve a consolidated understanding of the behaviour of iodine and other fission products in post-accident nuclear reactor containment buildings. This will be accomplished by:

- addressing technical issues and scientific gaps;
- optimising the use of existing data and test results to support common tools for predicting fission product behaviour.

Specific technical objectives that this programme hopes to achieve are:

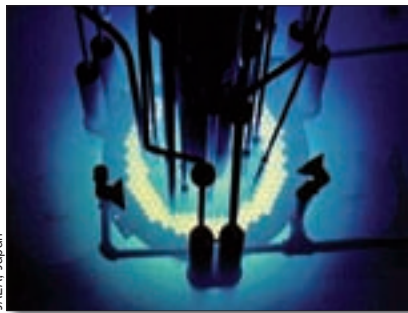
- quantification of the relative contributions of homogeneous bulk aqueous phase processes, homogeneous aqueous phase processes in paint pores and heterogeneous processes on surfaces to organic iodine formation;
- the measurement of adsorption/desorption rate constants on containment surfaces as a function of temperature, relative humidity and carrier-gas composition;
- the provision of RTF data to participants, for use in collaborative model development and validation.

One meeting of the project steering bodies was held in 2007 and was mainly devoted to discussing the parameters and boundary conditions to be chosen for the test matrix.

The Cabri Water Loop Project

The Cabri Water Loop Project, which began in 2000 for an eight-year period, is investigating the ability of high burn-up fuel to withstand the sharp power peaks that can occur in power reactors due to postulated rapid reactivity insertions in the core (RIA accidents). The project participants, from 13 member countries, intend to determine the limits for fuel failure and the potential consequences of possible ejection of fuel into the coolant environment. Different cladding materials and fuel types are being studied. Project execution involves substantial facility modifications and upgrades,

and consists of 12 experiments with fuel retrieved from power reactors and refabricated to suitable length. The experimental work is being carried out at the *Institut de radioprotection et de sûreté nucléaire* (IRSN) in Cadarache, France, where the Cabri reactor is located. Programme execution can, however, involve laboratories in participating organisations, for instance, in relation to fuel fabrication and characterisation and instrumentation. Recently, the Japan Atomic Energy Agency (JAEA) has joined the project, bringing additional high burn-up experiments carried out in the JAEA nuclear safety research pulse reactor.



Top view of the JAEA nuclear safety research reactor (NSRR).

JAEA, Japan

Two tests (still using the sodium loop) were carried out with high burn-up fuel having zirconium-niobium cladding material. Fuel that had been in service in Spanish and French reactors, respectively with ZIRLO and M5 cladding, and with burn-up in excess of 70 MWd/kg, was subjected to a ~100 cal/g energy injection during the transients. No fuel failure was registered. Appreciable progress has occurred in the design of the water loop test facility and in the production of related components. It will take about three years for the water loop to be in place. The Cabri tests are being complemented by additional reactivity-induced accident (RIA) tests performed in Japan. These tests, which constitute the in-kind contribution from JAEA for its participation in the Cabri Project, will be carried out at both cold and hot coolant conditions and with both BWR and PWR fuel.

A meeting of the Cabri Technical Advisory Group was held in January. A meeting of the Project Steering Committee was held in October in the United States.

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, which was 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 also sought 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 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, but did not result in a concrete proposal. The final report of the project was issued in June, and a concluding workshop was held in France in October, where the main outcomes were presented and discussed among project partners. This completes the MASCA-2 Project.

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 was organised in France in October 2007.

A new three-year programme (MCCI-2) has been adopted by participants, which started in 2006. Emphasis is 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. Two meetings of the project steering bodies were held in 2007. On these occasions, the first tests results and the test conditions for the remaining programme were discussed. The next meeting is planned for April 2008 to review new results and to specify the end of the project tests' matrix.

The PKL Project

This project started in 2004 and consisted 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 participated.

The PKL experiments focused on the following PWR issues that have been 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.

The last tests were carried out in 2006. Their outcomes were extensively discussed at the final meetings of the project steering bodies, which took place in May 2007. Although the project was officially completed in November 2007 with the publication of the final report, a proposal was distributed at the end of the year for a follow-up project to address heat transfer in steam generators and remaining issues on boron precipitation.

The PRISME Project

Fire is a significant contributor to overall core damage frequency for both new and old plant designs. Questions of fire probabilistic safety analysis (PSA) that remain open are the following:

- the propagation of heat and smoke from the room in which the fire is located to other rooms;
- the impact of heat and smoke on safety critical systems;
- the role of the ventilation network in limiting smoke and heat propagation.

The objective of the PRISME Project, which began in 2006 and in which ten member countries participate, 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 regarding the failure time for equipment situated in nearby rooms and the effect of conditions such as room-to-room communication and the configuration of the ventilation network. The results obtained for the experimentally studied scenarios will be used as a basis for qualifying fire codes (either simplified zone model codes or computational fluid dynamics codes). After qualification, these codes could be applied for simulating other fire propagation scenarios in various room configurations with a good degree of confidence.

Tests were carried out and reported upon as scheduled in 2007. Two meetings of the project steering bodies were held in April and October. The conditions for the entire test series were addressed in the meetings, including ways to support the experimental projects with analyses and code assessments. As requested by the project members, the French IRSN also prepared and submitted the plans and conditions for the four tests to be carried out in 2008, which were circulated among participants and subsequently revised accord-

ing to the input received. These tests will also involve facility modifications to meet specific members' requirements.

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 will be completed in 2008. 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 which has been rescheduled to take place early in 2008.

The ROSA Project

The ROSA Project is to address issues in thermal-hydraulics analyses relevant to LWR safety using the ROSA (Rig-of-safety assessment) large-scale test facility of the Japan Atomic Energy Agency (JAEA). In particular, it is intended to focus 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 in 14 countries, and will be conducted between April 2005 and December 2009. The overall objectives of the ROSA Project are to provide an integral and separate-effect experimental database to validate the code predictive capability and accuracy of models. In particular, phenomena coupled with multi-dimensional mixing, stratification, parallel flows, oscillatory flows and non-condensable gas flows are to be studied.

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;
- open tests: upper-head break and bottom break LOCA.

The programme includes a total of twelve tests, of which eight have been carried out so far. Four tests were performed in 2007, one on temperature stratification, one

on water hammer and two on primary cooling through depressurisation. The remaining four tests were discussed by the project steering bodies, which defined the tests' initial and boundary conditions. They will be conducted in 2008 and in the first part of 2009. Project members also discussed the issues to be addressed in a possible follow-up project. Two project meetings were held in 2007, in May in France, and in November in Japan.

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;
- 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.



OECD Halden Reactor Project

Cable ageing specimen.

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 Management Board held its second meeting in May and approved the programme of work for 2007 and 2008, as proposed by the two working groups on SCC and cables. The scopes and structures of the databases have been defined, and their formats have been finalised.

The SCIP Project

The Studsvik Cladding Integrity Project (SCIP) started in July 2004 and aims to utilise the hot cell facilities and expertise available at the Swedish Studsvik establishment in order to assess material properties and determine conditions that can lead to fuel failures. The project, in which 11 countries participate, has the main objective of improving the general understanding of cladding reliability at high burn-up through advanced studies on phenomena and processes that can impair fuel integrity during operation in power plants and during handling or storage. The project aims to achieve results of general applicability (i.e. not restricted to a particular fuel design, fabrication specification or operating condition). The results can consequently be used in solving a wider spectrum of problems and applied to dif-

ferent cases. It also aims to achieve experimental efficiency through the judicious use of a combination of experimental and theoretical techniques and approaches.

The SCIP Project has so far focused on the execution of several power ramps and on defining a hot cell programme addressing the various failure mechanisms which will be studied in the project. These are as follows:

- pellet-clad interaction (PCI): stress corrosion cracking initiated at the cladding inner surface under the combined effect of the mechanical loading and chemical environment caused by an increase in the fuel pellet temperature following a power increase;
- hydride embrittlement: time-independent fracture of existing hydrides;
- delayed hydride cracking (DHC): time-dependent crack initiation and propagation through fracture of hydrides that can form ahead of the crack tip.

The programme has been progressing very satisfactorily, producing evidence that is relevant for understanding the factors leading to cladding brittleness and the methods for reproducing in hot cell tests the stress-strain conditions that prevail in fuel power ramps. Two meetings of the project steering bodies took place with NEA support in 2007.

The SERENA Project

The Steam Explosion Resolution for Nuclear Application (SERENA) Project was launched in 2007 with nine member countries participating. Its predecessor programme sought to evaluate the capabilities of the current generation of fuel-coolant interaction (FCI) computer codes in predicting steam-explosion-induced loads in reactor situations, and to identify confirmatory research that would be needed to bring predictability of FCI energetics to required levels for risk management. The programme concluded that in-vessel FCI would not challenge the integrity of the containment whereas this cannot be excluded for ex-vessel FCI. However, the large scatter of the predictions indicated lack of understanding in some areas, which makes it difficult to quantify containment safety margins to ex-vessel steam explosion. The results clearly indicated that uncertainties on the role of void (gas content and distribution) and corium melt properties on initial conditions (pre-mixing) and propagation of the explosion were the key issues to be resolved to reduce the scatter of the predictions to acceptable levels. Past experimental data does not have the required level of details to answer the question.

The present programme has been formulated to resolve the remaining uncertainties by performing a limited number of focused tests with advanced instrumentation reflecting a large spectrum of ex-vessel melt compositions and conditions, as well as the required analytical work to bring the code capabilities to a sufficient level for use in reactor case analyses. The objective of the SERENA experimental programme is threefold:

- to provide experimental data to clarify the explosion behaviour of prototypic corium melts;
- to provide experimental data for validation of explosion models for prototypic materials, including spatial distribution of fuel and void during the premixing and at the time of explosion, and explosion dynamics;

- to provide experimental data for the steam explosion in more reactor-like situations to verify the geometrical extrapolation capabilities of the codes.

These goals will be achieved by using the complementary features of the TROI (Korea Atomic Energy Research Institute) and KROTOS (*Commissariat à l'énergie atomique*) corium facilities, including analytical activities. The KROTOS facility is more suited for investigating the intrinsic FCI characteristics in a one-dimensional geometry. The TROI facility is better suited for testing the FCI behaviour of these materials in reactor-like conditions by having more mass and multi-dimensional, melt-water interaction geometry. The validation of models against KROTOS data and the verification of code capabilities to calculate more reactor-oriented situations simulated in TROI will strengthen confidence in code applicability to reactor FCI scenarios. The first operational meeting of this project will be held in January 2008.

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 was completed in May 2007. A workshop was organised in June 2007, during which participants discussed the application of the results for benchmarking codes used for reactor applications.

A follow-up to the project, called SETH-2, was launched in 2007 and will make use of the PANDA facility and the MISTRA facility of the French *Commissariat à l'énergie atomique* (CEA). Nine countries are participating. The project aims to resolve key computational issues for the simulation of thermal-hydraulic conditions in reactor containments and will benefit from the complementarity of the two facilities. Two meetings of the project steering bodies were held in 2007 and were mainly devoted to discussing the parameters and boundary conditions to be chosen for the test matrix. The operating Agent has made the preparatory arrangements for performing the tests in 2008.

The THAI Project

The Thermal-hydraulics, aerosols and iodine (THAI) Project, is supported by eight member countries and began in 2007. It consists of thermal-hydraulic experiments aiming at resolving uncertainties related to combustible hydrogen and to the behaviour of fission products, in particular iodine and aerosols. The proposed experiments are designed to fill knowledge gaps by delivering suitable data for the evaluation and simulation of the hydrogen and fission product interactions mentioned above, thus supporting the validation of accident simulation codes and models. The experiments are conducted in the THAI facility, which is operated by Becker Technologies GmbH in Germany. The *Gesellschaft für Anlagen- und Reaktorsicherheit* (GRS) and AREVA NP GmbH also support the programme.



Becker Technologies GmbH, Germany

Schematic view of the THAI facility.

In the case of hydrogen, uncertainties mainly arise in relation to determining conditions for the occurrence of deflagration flames, and the performance of devices, such as passive autocatalytic recombiners, designed to reduce the concentration of hydrogen gas developed in a hypothetical accident. Some concern also exists regarding the applicability of several previous experiments where helium was used to simulate hydrogen. The relevance to reactor safety is connected with the destructive potential of fast deflagrations.

In the case of fission products, a number of transport processes have not yet been investigated to a level of detail sufficient to establish reliable transport models. Such processes include iodine exchange between turbulent atmospheres and walls, relocation by wash-down (washing the walls with condensate water), airborne chemical reaction of iodine with radiolytic ozone, and aerosol re-suspension from a boiling sump. The control of volatile radioactive species is relevant to the potential accident source term and the radioactivity management.

In 2007 two meetings of the project steering bodies were held to discuss the parameters for the tests to be performed in 2008. Tests performed in 2007 are also being used to support a blind benchmark exercise, being conducted as a complementary study by a number of project participants.

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

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. Recently, countries have begun submitting data. Two meetings of the COMPSIS steering body were held in 2007 with NEA support. A new three-year phase of the project will start in January 2008.

The FIRE Project

The Fire Incidents Records Exchange (FIRE) Project started in 2002 and its current mandate runs until the end of 2009. Twelve 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, which now contains more than 300 records, is provided to participants every year. One meeting of the project steering body was held during 2007.

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 was extended with

a new agreement covering the period April 2005–March 2008. 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 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 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 took 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. The next report to be produced will be on water level measurement.

Two project meetings were held in 2007. The next ICDE steering group meeting will take place in April 2008 in Germany. A new three-year phase is planned to follow the current one.

The OPDE Project

The Piping Failure Data Exchange (OPDE) Project started in 2002. The first phase of the project 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 scope of the OPDE Project includes all possible events of interest with regard to piping failures in the main safety systems. It also covers 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 2007 with NEA support. One of the subjects discussed was the terms and

conditions for the third phase of the project (June 2008-May 2011).

RADIOACTIVE WASTE MANAGEMENT

The CPD Programme

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 22 organisations actively executing or planning the decommissioning of nuclear facilities. It has operated under Article 5 of the NEA Statute since its inception in 1985, and 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. Two new organisations joined the programme during 2007: Barsebäck Kraft AB and Studsvik Nuclear AB (both located in Sweden).

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 44 decommissioning projects (28 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 began two studies during 2007, one on Remote Dismantling Techniques and one on Decontamination and Dismantling of Concrete Structures. The reports from the task groups undertaking these studies are scheduled to be published in 2009.

The 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 series edited by the Data Bank. The current Phase III of the TDB Project runs until the end of January 2008. The 17 scientific institutions and technical authorities from 13 NEA member countries participating in the TDB Project decided to extend the project (TDB Phase IV) to 2012.

During 2007, a state-of-the-art report on the chemical thermodynamics of solid solutions was published. Work on the reviews of thorium, tin and iron data continued. The thorium report will be published in early 2008. The tin and

iron reports are scheduled for peer review during 2008. TDB Phase IV will begin in February 2008 and will include a review of auxiliary data, an update of the selected value database accrued during earlier phases of the project, a review of molybdenum data and a review of additional iron data.

RADIOLOGICAL PROTECTION

The ISOE System

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 (RP) at nuclear power plants worldwide. Sponsored jointly with the IAEA, the ISOE programme has a membership of 71 participating 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 utility and regulatory authority RP experts. 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 481 reactor units (401 in operation and 80 in cold-shutdown or some stage of decommissioning) in 29 countries, thus covering 91% of the world's operating commercial power reactors. 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.

In 2007, 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 continued through the successful organisation and hosting of the 2007 international and regional ISOE ALARA symposia, in the United States and the Republic of Korea respectively.

The ISOE Network web-based information portal, formally launched in 2006, was considerably enhanced during 2007. The portal provides members with a "one-stop" website for ISOE information and experience exchange. In 2008, members will be able to enter their occupational exposure data into the ISOE database directly through the website.

In 2007, the ISOE Steering Group approved the programme's new Terms and Conditions for the period 2008-2011.

General Information



Information and Communications

Nuclear energy decision making and stakeholder participation need to be based on knowledge and 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.

Highlights

- A Statement by the NEA Steering Committee for Nuclear Energy regarding a government role in ensuring qualified human resources in the nuclear field was widely communicated, including to ministers in all member countries.
- The Agency produced 61 publications, of which 19 were put on sale and 42 were distributed free of charge.
- Contacts with the media continued at a steady pace, and a press briefing was organised in conjunction with the publication of *Risks and Benefits of Nuclear Energy*.
- NEA information and publications stands were organised at 11 international conferences.

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 these activities are reflected in the Agency's large selection of publications and reports.

Public affairs and relations with the press

A Statement by the NEA Steering Committee for Nuclear Energy regarding a government role in ensuring qualified human resources in the nuclear field was adopted in October. This statement was subsequently disseminated to a very wide and high-level audience, including ministers in all member countries. The Statement generated considerable interest and is being followed up with a number of practical measures. Further information is available in the Press Room of the NEA website.

The Agency responded to a steady volume of media inquiries and organised a number of interviews. Journalists'

subjects of interest included the future of nuclear energy, uranium resources, costs, safety, the impact of the UK decision on nuclear energy and qualified human resources. In addition to these regular contacts with the press, the Agency organised a press briefing in conjunction with the publication of *Risks and Benefits of Nuclear Energy*. Several press releases were also issued on important aspects of the Agency's work. A particularly significant development concerned the signing of a Joint Declaration on Co-operation between the NEA and the Russian Federation in March. The joint declaration has opened the way for the Russian Federation to participate as an observer in all the Agency's standing technical committees and their working groups.



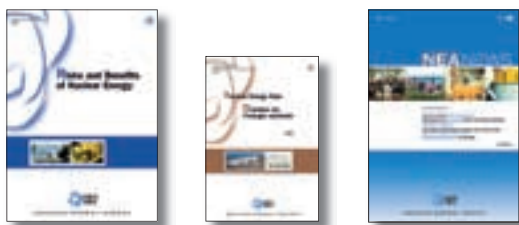
Signature of the Joint Declaration by K. Pulikovskiy, Russian Federation, and L. Echávarri, OECD/NEA.

The NEA Director-General, Luis Echávarri, presented the work of the Agency, including highlights of *Risks and Benefits of Nuclear Energy*, in various fora. His paper on "What Role for Nuclear Energy?" was published as part of the Heiligendamm G8 summit documentation.

Publications

In 2007, the Agency produced 61 publications, of which 19 were put on sale and 42 were distributed free of charge. The list of these publications is provided on page 44. Best sellers included *Nuclear Energy Data 2007* and *Risks and Benefits of Nuclear Energy*. All free reports published by the NEA are made available in pdf format on the NEA website.

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 was brisk during 2007 with, on average, over 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 nuclear safety sections. The most accessed reports in the course of 2007 concerned Chernobyl, with the three NEA reports published on the subject accounting for well over 27 000 downloads among them.

Online interaction with NEA delegates continues to grow. Most NEA committees and their working groups use some form of electronic communication, such as dedicated download areas, e-mail discussion lists or online collaborative work spaces ("wikis") to support their work; many now use several. The streamlining of NEA internal procedures to support these activities during 2007 brought increased efficiency and higher traffic to these parts of the website.

The number of individual subscriptions to the Agency's monthly electronic bulletin continued its ascent in 2007, topping 7 500 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.

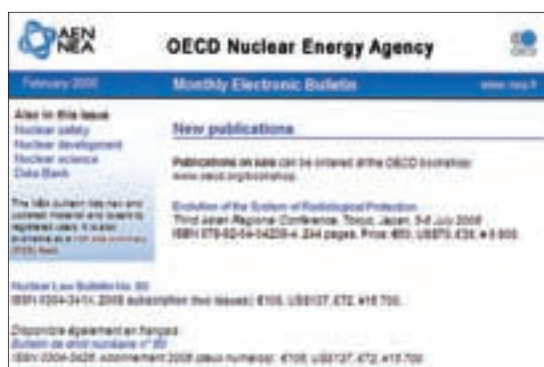
The Delegates' Area on the NEA website also continues to provide an important service for many NEA committees and working groups. This section of the website provides authorised users with OECD official documents, information on forthcoming NEA meetings, contact details for other committee members, as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

NEA visibility in international fora

NEA information and publications stands were organised at 11 international conferences in 2007. These included:

- PIME 2007 (February, Milan, Italy);
- International Conference on Nuclear Data for Science and Technology, ND-2007 (April, Nice, France);
- 15th Session of the Commission on Sustainable Development (April-May, New York, NY, USA);
- International Congress on Advances in Nuclear Power Plants – ICAPP (May, Nice, France);
- 11th International Conference on Environmental Remediation and Radioactive Waste Management – ICEM'07 (September, Bruges, Belgium);
- European Nuclear Congress – ENC (September, Brussels, Belgium);
- American Nuclear Society (ANS) Winter Meeting (November, Washington DC, USA);
- 20th World Energy Congress (November, Rome, Italy);
- International Conference on Geological Repositories: A Common Goal, A Variety of Paths (October, Berne, Switzerland);
- 2nd International Symposium on Nuclear Power Plant Life Management (October, Shanghai, China);
- UN Framework Convention on Climate Change, 13th Conference of the Parties (December, Bali, Indonesia; displays in co-operation with the International Energy Agency).

Some 2 500 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 the International Conference on Nuclear Data for Science and Technology, ND-2007, held in April in France and the International Conference on Geological Repositories: A Common Goal, A Variety of Paths, held in October in Switzerland.



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Nuclear Energy and Civil Society

RADIOACTIVE WASTE MANAGEMENT

Waste agencies and the repository host communities

The Forum on Stakeholder Confidence (FSC) published two major reports in 2007 (both available in English and in French at www.nea.fr). The first was *Fostering a*



Durable Relationship Between a Waste Management Facility and Its Host Community. Any long-term radioactive waste management project is likely to be operated and monitored for decades to centuries. It requires a physical site and will impact in many ways the surrounding community over that whole period. The societal durability of an agreed solution is essential to success. The report

shows that a durable relationship between the facility and its host community can be achieved by improving prospects for quality of life across generations. This may be as straightforward and relatively inexpensive as providing a special coat of paint (as at the Vandellós site in Spain), or as complex and rich as engaging community processes to design an integrated radioactive waste management project (as in the "local partnership" approach created in Belgium). A number of basic design elements that would favour building a durable relationship between the facility



ENRESA, Spain

The "special coat of paint" at the Vandellós site in Spain.

and its host community are identified in the report based on the analysis of numerous stakeholders' input and FSC experience. These design elements include functional, cultural and physical features.

The second report concerned *Cultural and Structural Changes in Radioactive Waste Management Organisations: Lessons Learnt*. In recent years the socio-political environment of radioactive waste management has been changing in a significant way. Stakeholder dialogue has become a lead principle. The FSC surveyed members to learn how radioactive waste management organisations have adapted to this societal transition. How do they balance the requirement of openness and the increasing concerns over the security of facilities? Are there organisations that have successfully changed from a technical to a customer-focused culture? What resistance was met? Which tools and instruments helped organisations evolve? The report documents the changes observed by managers and sets them in an organisational sciences framework. All those who are intent on learning about the changes that have taken place in the field of radioactive waste management, or whose own organisations in any sector must adapt to societal demand, will be interested by the experience and insights reported here.

Stakeholders and decommissioning

The expectation that significant numbers of nuclear power plants will reach the end of their operating lives in the coming decade or so, or will be shut down for economic or other reasons, is resulting in increasing emphasis being given in member countries to the involvement of stakeholders in the associated decision procedures. The NEA Working Party on Decommissioning and Dismantling (WPDD) in cooperation with the Forum on Stakeholder Confidence (FSC) completed a study on this issue in 2007, resulting in the publication of a report entitled *Stakeholder Involvement in Decommissioning Nuclear Facilities: International Lessons Learnt*.



The study concluded that, although those likely to be most affected by a decision to shut down a nuclear facility are those living nearby, such decisions will sometimes have wider consequences, perhaps even at a national level (for example in the event that alternative sources of electricity need to be found to replace that from the shut-down plant). In these situations, there is also a need to consider the views of stakeholders, which represent local and national interests. As the decision process moves

from issues concerned with the shutdown of the plant to strategies for its dismantling, the importance of purely local interests becomes greater. For this reason, it is necessary to develop dialogue and co-operation among regulators, implementers and local stakeholders as early as practicable. The host municipalities for nuclear facilities tend to focus their attention on the day-to-day issues arising from the activities at the plant and, as regards decommissioning, will generally favour the early reuse of the site for economic or cultural purposes.

RADIOLOGICAL 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. In keeping abreast of experience in this evolving field, the NEA Committee on Radiation Protection and Public Health (CRPPH) has worked to remain involved in key discussions. On the specific item of promoting stakeholder engagement among radiological protection professionals, the CRPPH and the NEA Secretariat actively participated in three meetings organised by the national radiological protection societies of Spain (2005), France (2006) and the United Kingdom (2007) to develop a "Code of Conduct" for stakeholder involvement and 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 group preparing the Code of Conduct aims to produce a draft in time for circulation and discussion at the May 2008 meeting of the CRPPH. This involvement will complement other work by the Committee focusing on consolidation of a more open and interactive approach by radiological protection institutes with respect to stakeholders, particularly beyond the stakeholders traditionally involved in radiological protection.



A. Gonin, CEA, France

Radiological protection at Saclay, France.

The CRPPH Working Party on Nuclear Emergency Matters is now planning a workshop on stakeholder involvement aspects in consequence management, modelled on the successful Villigen series which addressed stakeholder participation in radiological decision making. As noted earlier, the CRPPH is also carrying out a scoping study to look into how various national radiological protection organisations are managing to incorporate stakeholder involvement the most effectively in their processes, and what, if any, structural implications this may have.

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 main activity in 2007 was the organisation of a workshop on the transparency of regulatory activities which was held in Japan in May. This workshop attracted



JNES, Japan

Workshop on the transparency of regulatory activities, Tokyo and Tokai-Mura, Japan.

communicators and technical staff of the nuclear regulatory organisations together with a number of top regulators. The workshop addressed the understanding of transparency; stakeholders' expectations regarding transparency; the conditions for ensuring the transparency of regulatory activities; changes in regulatory practices for ensuring transparency; and methods for evaluating transparency. The proceedings of the workshop have been published.

OECD Headquarters, OECD



NEA Headquarters, B. Baudouin, 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 members of **the Bureau of the Steering Committee** for Nuclear Energy are (as at its autumn 2007 meeting):

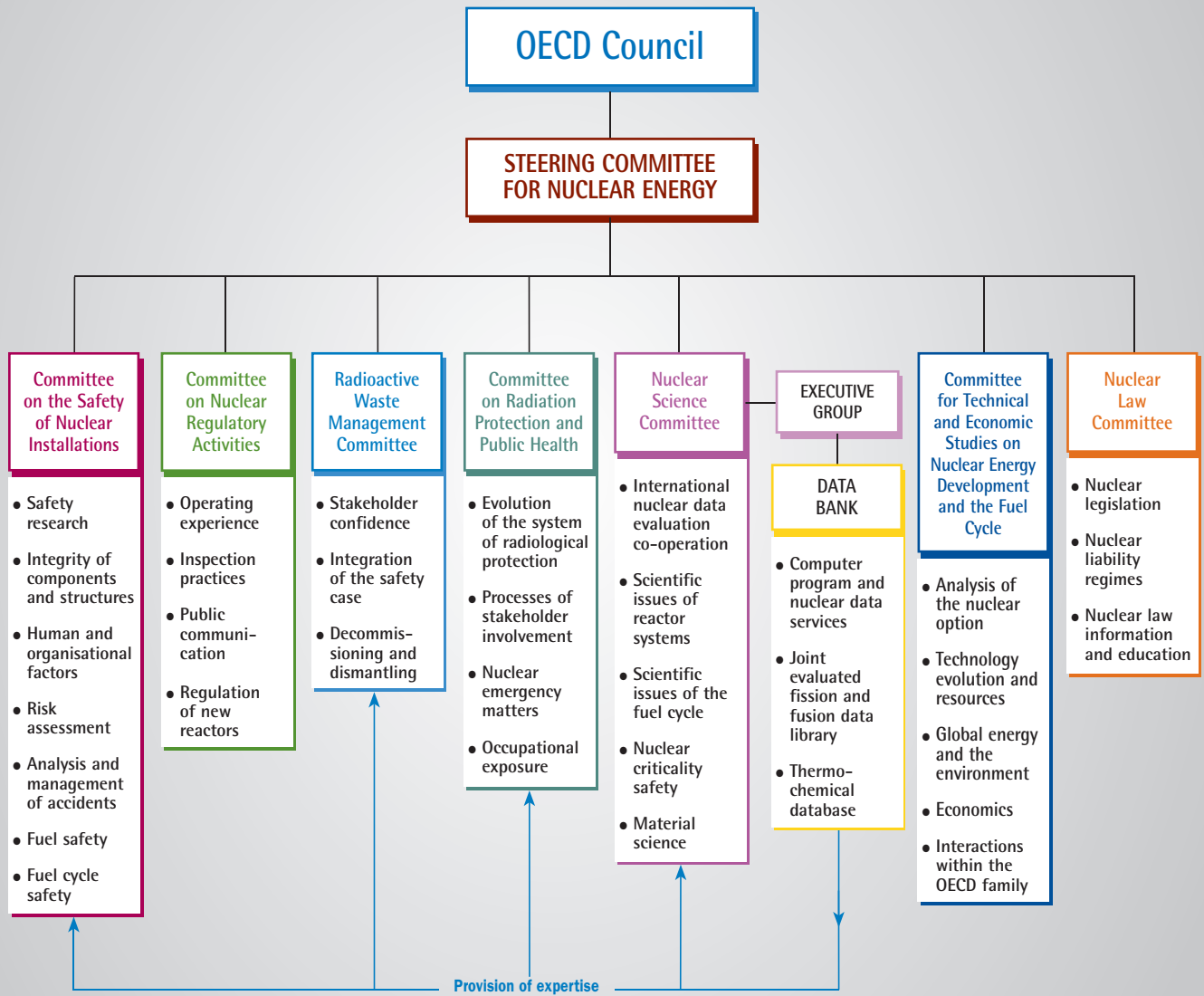
Mr. Richard STRATFORD (United States), Chair
Mr. Olivier CARON (France), Vice-Chair
Dr. Walter SANDTNER (Germany), Vice-Chair
Mr. Kenji SEYAMA (Japan), Vice-Chair
Dr. József RÓNAKY (Hungary), Vice-Chair

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.

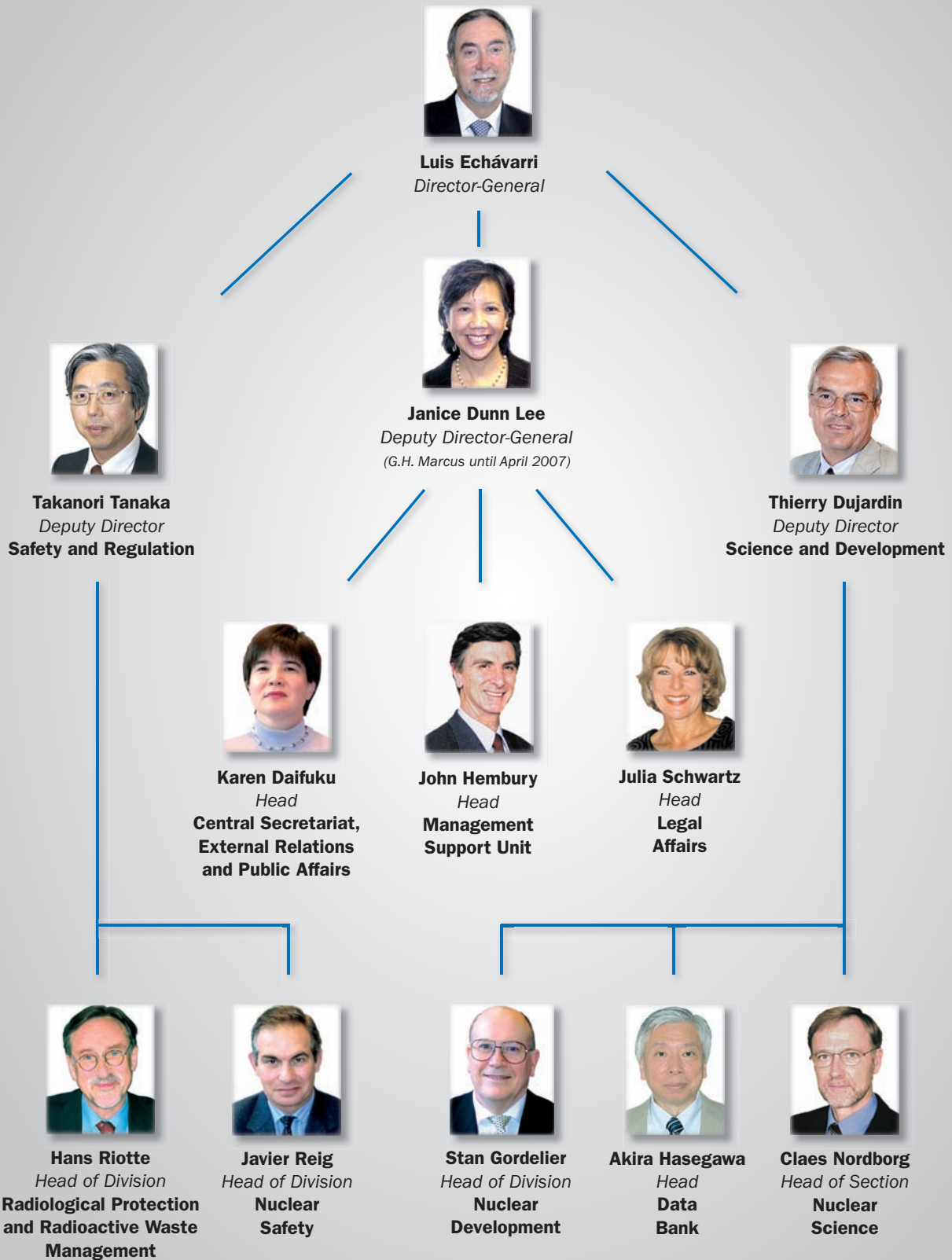
The Steering Committee for Nuclear Energy and the Agency's seven standing technical committees are serviced by **the NEA Secretariat**, composed in 2007 of 69 professional and support staff from 19 countries. Professional staff are often specialists from national administrations and research institutes, 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. The Russian Federation holds regular observer status in all the Agency's standing technical committees and their working groups. Slovenia participates as a regular observer in the seven standing technical committees. Selected other countries take part in NEA activities on a more ad hoc basis.

NEA Committees in 2007



NEA Secretariat in 2007



NEA Publications Produced in 2007



General Interest

Annual Report 2006

ISBN 978-92-64-99003-6, Free: paper or web.

NEA News, Vol. 25, Nos. 1 and 2

ISSN 1605-9581, Free: paper or web.



Innovation in Nuclear Energy Technology

ISBN 978-92-64-00644-7, Price: € 45, US\$ 60, £ 32, ¥ 6 200.

Management of Recyclable Fissile and Fertile Materials

ISBN 978-92-64-03255-2, Price: € 30, US\$ 39, £ 21, ¥ 4 100.

Nuclear Energy Data 2007 – Données sur l'énergie nucléaire 2007

Bilingual

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