2010 NEA Annual Report

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NUCLEAR ENERGY AGENCY

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NUCLEAR ENERGY AGENCY
Organisation for Economic Co-operation and Development

The NEA in Brief

Governing body:
the Steering Committee for Nuclear Energy

29	member countries (22 in the Data Bank)
52	years of international service
7	standing technical committees
18	international joint projects funded by participants
61	professional and support staff (NEA and the Data Bank combined)
665	national experts participating in NEA committees
3 500	experts participating annually, on average, in policy and technical meetings organised at OECD headquarters
€ 10.4	million budget for the NEA in 2010, supplemented by voluntary contributions
€ 3.0	million budget for the Data Bank in 2010, supplemented by voluntary contributions
66	publications produced in 2010

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.

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.

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Note: Readers are kindly invited to bear in mind that the main body of this report covers activities and events in 2010 and does not preclude any outcomes or decisions that may be made subsequently in connection with events taking place at a later date.

Message from the Director-General

Safety must remain the top priority

Just recently, on 11 March 2011, Japan experienced a major earthquake followed by a tsunami of cataclysmic magnitude. On behalf of the OECD Nuclear Energy Agency, I wish to express my condolences to the Japanese people who are being affected by one of the worst natural disasters of the century. The combined effects of the earthquake and tsunami have led to the loss of thousands of lives and to the destruction of the main infrastructures in north-eastern Japan. At the time of writing, the Fukushima nuclear power plant accident and its various developments and repercussions continue to unfold, but one conclusion is already clear: safety must always remain the top priority of the nuclear energy sector. Severe accidents are thankfully rare, and considerable work has been and is being done worldwide to avoid their occurrence.

The NEA has a long history of international co-operation and research on nuclear safety, through its regular programmes of work of the Committee on the Safety of Nuclear Installations (CSNI) and the Committee on Nuclear Regulatory Activities (CNRA) (see pages 14-17), as well as the numerous joint projects it organises at the international level (details of current projects dealing *inter alia* with fuel failure, melt coolability, steam explosions, loss-of-coolant accident tests and validation of severe accident codes are provided on pages 28-33). Several studies and projects provide useful information for the current crisis, and all contribute to making nuclear power plants safer. The human dimension is also not to be forgotten, whether in terms of accounting for possible human error, strengthening safety culture or crisis communication and public information.

NEA work in 2011 will include specific analyses of the accident as well as identification and dissemination of lessons learnt. External events such as earthquakes, tsunamis, floods, fires and missiles will be considered as well as design reviews in relation to a number of issues such as multiple common-cause failures, containment integrity, emergency core cooling systems, diesel generators, emergency power supply, hydrogen and spent fuel pools.

Radiological protection is also a very important aspect of providing for the health and safety of man and the environment when nuclear power is used. Again, the NEA has studied numerous issues in-depth and published a wide array of reports and analyses in this field. Of particular note in the current context are the International Nuclear Emergency Exercise (INEX) series (see page 20) and the recent publication on *Occupational Radiological Protection Principles and Criteria for Designing New Nuclear Power Plants.* Lessons from the past will be put to best use, and further investigations will be carried out for emergency management, alert systems, evacuation measures, radiation dose limits, steam releases, radiation plume models, monitoring and decontamination.

Of course, work in other areas of NEA expertise continues as well and contributes to the strengthening of the scientific, technological and legal bases on which the nuclear industry is built. As readers will discover in the pages that follow, 2010 was a record year in terms of activities and outputs, covering in addition to the subjects above, nuclear development and the fuel cycle, the security of supply of medical radioisotopes, radioactive waste management, nuclear science, nuclear data and legal affairs. The NEA also carried forward its functions as Technical Secretariat of the Generation IV International Forum (GIF) and the Multinational Design Evaluation Programme (MDEP) (see pages 36-37 for further details).

In conclusion, the activities of the NEA have never been so pertinent and needed, and the Agency will continue to play its instrumental role in conducting state-of-the-art research and analyses, and sharing its results for the benefit of member countries and beyond.

Luis E. Echávarri
NEA Director-General

Nuclear Power in 2010

Nuclear energy development

At the end of 2010, a total of 342 reactors were connected to the grid in NEA countries (not including three reactors under refurbishment in Canada), constituting about 83% of the world's total nuclear electricity generating capacity and about 22% of the total electricity supply in NEA countries. During 2010, one new reactor was connected to NEA country grids (Shin Kori-1 in the Republic of Korea), none were shut down and construction was initiated (first concrete poured) for one reactor (Ohma in Japan).

Significant developments that occurred in NEA member countries in 2010 included:

- In the Czech Republic, the state power company ČEZ received bids from companies competing to build and to operate two additional reactors at the Temelin site and as many as three other new reactors on other sites; a decision is expected in 2011.
- In Finland, the parliament approved decisions in principle for two new reactor projects, clearing the way for Teollisuuden Voima (TVO) and Fennovoima to build new nuclear generating capacity.
- In Germany, the government amended the Atomic Energy Act to extend the operating lives of nuclear power plants by 8 years (for plants having begun operation before 1980) or 14 years (for plants connected to the grid after 1980).
- In Japan, the revised energy plan (produced as part of a mandatory review every three years) called for the construction of 9 reactors by 2020 and more than 14 by 2030 in order to meet both CO_2 reduction targets and electricity demand and to increase security of energy supply.
- In the Netherlands, the Dutch public utility Delta and Électricité de France (EDF) signed a Memorandum of Understanding, the first step towards the construction of a proposed second reactor at Borssele.
- In the Republic of Korea, the government was considering plans to construct up to 14 new reactors by 2024 in order to reduce dependence on fossil fuels and to meet increasing demand for electricity.
- In Spain, the government approved the continued operation of unit 2 of the Vandellós nuclear power plant and the two-unit Almaraz nuclear power station for an additional ten years following approval of such continued operation by the Spanish nuclear regulator.
- In Sweden, the parliament passed a bill that allows Swedish firms to replace the existing ten reactors, in effect reversing the referendum decision 30 years ago to phase out nuclear power.
- In Turkey, an agreement signed with Rosatom set the stage for the construction of the country's first nuclear power station, with the proposed four units at the Akkuyu site on the Mediterranean coast to be built, operated and financed by the Russian Federation.

2010 Nuclear Data Summary (as of 31 December 2010)

	Operational reactors	Installed capacity (GWe net)	Uranium requirements (tonnes U)	Nuclear share of electricity production (%)
Belgium	7	5.9	925	51.2
Canada	17	12.1	1 600*	15.1
Czech Republic	6	3.7	885	35.9
Finland	4	2.7	455	28.4
France	58	63.1	8 000	74.1
Germany	17	20.5	2 650*	27.3
Hungary	4	1.9	435	43.8
Japan	54	47.4*	8 870*	29.2
Mexico	2	1.4	405	3.1
Netherlands	1	0.5	60	3.2
Republic of Korea	21	18.7	4 200	32.2
Slovak Republic	4	1.8	365*	51.8
Slovenia	1	0.7	230*	37.3
Spain	8	7.5	1 390	20.1
Sweden	10	9.3	1 550*	38.1
Switzerland	5	3.3	245*	38.0
United Kingdom	19	10.1	1 500*	17.9*
United States	104	100.7	15 995*	20.2*
Total (OECD)	**342**	**311.3**	**49 760**	**22.0***

* 2009 data. Operational = connected to grid.

Shares of uranium resources and production			
	Resources (%)*	Production (%)**	Production (tU)**
Australia	31.0	11	6 000
Canada	9.0	18	9 750
United States	3.8	3	1 630
Namibia	5.3	9	4 500
Niger	5.0	6	3 300
South Africa	5.5	1	600
Kazakhstan	12.1	34	17 800
Russian Federation	8.9	7	3 700
Uzbekistan	2.1	5	2 500
Ukraine	1.9	2	830
Others	15.4	4	2 260
Total	**100.0**	**100**	**52 870**

* Identified resources recoverable at less than USD 130/kgU (2009 data). ** 2010 estimates.

- In the United States, pre-construction activities for new reactors began at Vogtle and Virgil C. Summer, while completion of the construction of the Watts Bar-2 reactor (initially suspended in 1988) continued.

While all these developments pointed towards increased nuclear generating capacity in NEA member countries, the continuing economic downturn and low natural gas prices delayed firm commitments for new build activities. Concerns about the electricity market structure in the United Kingdom and the loan guarantee programme in the United States were also cited as reasons for delayed construction commitments. In addition, in some cases the continued operation of nuclear power plants comes with a cost in terms of fuel tax and payments to support the development of renewable energy technologies (Germany), or simply compensation paid to operate the facilities (Sweden).

Although only one firm new build commitment was announced in NEA member countries in 2010, activity increased sharply in other parts of the world, particularly in China. In non-NEA countries, a total of four reactors were connected to the grid (two in China and one each in India and the Russian Federation), and construction was initiated on a total of 12 reactors (eight in China, two in the Russian Federation and one each in Brazil and India), while no reactors were shut down. These developments brought the total number of reactors under construction in the world to 65, of which 14 are located in NEA member countries.

Uranium production, conversion and enrichment

Preliminary, unofficial data indicate that global uranium production rose by about 4% in 2010, compared to 2009, once again principally owing to increased output in Kazakhstan. Uranium was produced in seven NEA member countries in 2010. France, Germany and Hungary contributed only very small amounts as part of mine remediation activities, whereas Australia (11%), Canada (18%), the Czech Republic (<1%) and the United States (3%) together accounted for a significant share of world production. Production in NEA countries amounted to approximately 17 700 tonnes of uranium (tU) in 2010 (a decrease of over 10% from 2009) accounting for roughly 35% of their uranium requirements. Remaining requirements were met by non-NEA country production and secondary sources (material derived from dismantling warheads, excess commercial inventories and reprocessed uranium).

After the uranium spot price reached a peak of USD 354/kgU in June 2007, it declined to a low of about USD 108/kgU in June 2010 before increasing to USD 160/kgU in November 2010, principally due to purchases by China as the country began to accumulate inventory for the operation of its rapidly expanding fleet of nuclear power plants. Long-term price indicators declined to about USD 158/kgU in mid-2010 before rising slightly to USD 169/kgU in late 2010. Global uranium exploration and mine development activity continued in many countries although at a somewhat reduced pace compared to earlier years due to challenging financial conditions as well as technical and licensing issues, in particular in NEA member countries.

Uranium conversion facilities continued to operate in Canada, France, the United Kingdom and the United States in 2010. Construction of additional conversion capacity continued in France with first production of 15 000 tU/yr expected in 2012, as well as a subsequent increase in capacity to 21 000 tU/yr at the modernised and expanded Comurhex II facility.

Construction of two new uranium centrifuge enrichment plants [AREVA's Georges Besse II facility in France and Louisiana Energy Services' National Enrichment Facility (NEF) in the United States] was completed, and both began operation in 2010. These high-efficiency plants will significantly reduce electricity consumption during this phase of fuel production for light water reactors. The US Enrichment Corporation resumed development of the American centrifuge design for the American Enrichment Plant and submitted an update to its application for a US Department of Energy (DOE) loan guarantee after securing investment from Toshiba Corporation and the Babcock & Wilcox Investment Company. The GE-Hitachi Global Laser Enrichment project continued with the construction of a test loop intended to scale up process equipment, gather process information and validate efficiencies of the process.

Nuclear safety and regulation

In 2010, the safety performance of nuclear power plants in NEA member countries remained at a very high level, as in previous years. The safety of operating installations depends on a number of factors such as plant configuration, the ageing of materials and components, safety culture and human performance in maintenance, engineering and operation. Regulatory oversight through the use of inspection and performance assessment ensures that safety margins necessary for adequate protection are maintained. As more installations move to long-term operation and increased power levels, it is critical to understand the safety implications of changes in plant configuration, operational modes and the maintenance of ageing components. NEA member countries believe that safety can be maintained, and even enhanced, through the use of operating experience, analysis, research and various tools such as probabilistic safety assessments (PSA) to gain insights that are not available from deterministic analyses. They also agree 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.

In striving to improve, regulatory authorities have come to acknowledge that public perception of the regulatory body is based, in part, on the latter's ability to communicate its activities to stakeholders. Transparency in activities and routine engagement with stakeholders increases public confidence in the regulatory authority. Accordingly, NEA countries have been seeking to refine the role of the regulatory authority in public engagement.

As the number of existing nuclear power plants that are entering or preparing for long-term operation is increasing, the NEA continues to support regulatory authorities in their review of the adequacy of long-term operation and ageing management methods. Additionally, related issues such as component obsolescence during the lifetime of a facility and the oversight of contractors and subcontractors are challenges that regulatory authorities are addressing through international efforts.

At the same time that many countries are addressing long-term operation, several are also licensing and constructing new reactors. NEA countries have supported a number of initiatives, including the establishment of multinational undertakings such as the Multinational Design Evaluation Programme (MDEP), to improve the efficiency of the design review of new nuclear power plants and to share experience related to the regulation of new reactors. Recent new design and construction experience has already highlighted new challenges with a global workforce and suppliers. International collaborative efforts can yield improvements in regulatory practices and enhanced knowledge and understanding of new technology. The initiatives seek to reinforce nuclear safety worldwide, by promoting convergence on safety practices and by combining the expertise of participating regulatory authorities, while improving and expediting the safety review of new designs.

New approaches, new concepts and new technology often present new issues for safety. The development and validation of new analytical tools and research is necessary to support the identification and resolution of new or unique safety issues based on the technology of advanced designs. Regulatory and safety practices for advanced designs have the greatest potential for international harmonisation and should be pursued to the extent practical. Likewise, international collaborative projects and cost-sharing have significant potential for mutual gains.

TVO 2010, Finland

SNMPC 2010, China

The EPR (above) and the AP1000 (below) which are being addressed by the MDEP.

Radioactive waste management

The future of the Yucca Mountain project and the review of US policy regarding radioactive waste management in general have been questions of concern for many actors internationally in this field. Initial hopes of some observers that the Yucca Mountain project might go forward, albeit with some delay, have not been realised. While the regulatory review of the application continues to be pursued, focus has shifted to the work of the Blue Ribbon Commission and the results of its deliberations, expected for the end of 2011. The repercussions of the US disposal programme being blocked and fundamentally reviewed have nonetheless been limited at the international level, particularly as there are indications that the Blue Ribbon Commission may not challenge geological disposal as the end point for managing highly radioactive waste.

The geological disposal programmes in Sweden, Finland and France, considered as the most advanced programmes by experts in the field, have been moving forward according to schedule. The Swedish implementer decided to pursue a license application for a deep geological repository at the Forsmark site in Östhammar, while the spent fuel conditioning facility that is part of the overall waste disposal concept will be constructed in Oskarshamn, a municipality that was also a candidate for the repository.

In Germany, exploratory work at the Gorleben site was restarted, and the safety institutions began preparing a preliminary safety case for the site, which could be used as a basis for further decision-making on a spent nuclear fuel repository in Germany. In Canada and in the United Kingdom important milestones were reached in siting procedures. After agreeing through broad stakeholder involvement processes on general procedures for siting, both countries began a voluntary nomination process offering an open dialogue with interested communities as a first step. That such a process based on voluntarism and active application from interested municipalities is not always simple and can prove a lengthy process was shown by the Japanese programme for which its siting and dialogue process was reorganised and intensified after more than two years of unsuccessful calls for interest.

On the European level, new impetus can be expected from the planned directive for waste safety which the European Commission submitted to the Council of the European Union for approval as a legally binding text. The directive will require all 27 EU Member States to present national programmes that indicate *inter alia* when, where and how they will construct and manage final repositories. Also, internationally agreed safety standards will become legally binding and enforceable in the European Union.

The need for sustainable decision-making on all aspects of radioactive waste management, not only repositories, was demonstrated *inter alia* in Spain, where a decision among several candidate sites to host a centralised, intermediate spent fuel storage facility was postponed due to political considerations. By this and other examples, it has become very clear that inclusive decision-making in this area, which involves governmental stakeholders and institutional and non-institutional stakeholders, takes time and should be pursued from the very onset of repository programmes. With this in mind, a new process of dialogue was undertaken in the Czech Republic, even if a repository is not foreseen to be constructed before 2050.

Radiological protection

Two years after the finalisation of new general recommendations by the International Commission on Radiological Protection (ICRP), radiological protection professionals continue to work on their interpretation and practical implementation. These efforts can most clearly be seen in the development of both the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources and the European Commission's Basic Safety Standards Directive.

In practical terms, the ICRP's new recommendations are much more clearly focused on the optimisation of protection than previously, and more extensively recommend the use of dose constraints as an integral tool in the optimisation process (for example as a planning benchmark for screening protection options). The detailed understanding of dose constraints continues, however, to be a subject of some controversy, and this can be seen in the relatively light coverage they receive in both sets of safety standards cited above. The interpretations of dose constraints that may emerge in national regulations could thus have an impact on radiological protection implementation, and as such have been a subject of great interest to practitioners, particularly those in the nuclear power industry. Although it appears that the practical definition of dose constraints and the fixing of any numerical values to be used will remain the responsibility of the users and licensees, the current lack of practical clarity continues to fuel significant discussions and work in this area.

Another important aspect of the new ICRP recommendations concerns the radiological protection of the environment. In its most recent recommendations the ICRP indicated that it would be developing a framework to include the radiological protection of non-human species into its overall framework for human protection. The ICRP continues to work in this area and significant thinking and discussion have begun. Both BSS documents mention the radiological protection of the environment, but do not refer to requirements. NEA member countries generally find that their existing environmental protection regulations provide sufficient levels of protection against the effects of ionising radiation, and that environmental impact assessment regulations provide a firm basis for judging the adequacy of protective measures. Here again, radiological protection practitioners are discussing these issues, and await further recommendations from the ICRP for assessment and appropriate implementation.

Another subject of discussion and concern in 2010 related to the fight against terrorism and the decision whether to use full-body imaging as part of airport passenger screening efforts. Many governments have addressed the question of whether the use of such devices is justified, and although the radiation exposure that these devices can cause has not been a central issue in decisions, it has systematically been considered. Currently, while there are many standards for the proper manufacture and use of such imaging devices, there is no common governmental view with regard to the justification of their use in NEA member countries. While individual exposures from such scans are extremely small, an international pilots' union has recommended that its members insist on alternative search methods rather than scans to avoid the exposure from the potentially large number of scans they could receive. Considerations of the use of such scanning devices has already led to their imaging being less revealing of an individual's body, and stakeholder input will most probably continue to affect how such devices are designed, deployed and used.

Nuclear science

Many of the scientific challenges associated with the maintenance of the current fleet of nuclear power systems relate to the drive for increased fuel burn-up and/or extended plant lifetime. Increased fuel burn-up for current reactor designs implies an increase in the initial enrichment, which is now starting to pose a challenge to the 5% ^{235}U enrichment "threshold" applied to criticality safety cases for many existing light water reactor (LWR) fuel fabrication, transport and storage operations. More generally, increased burn-up and extended plant lifetimes would stimulate the development and validation of modelling methods for fuel and structural materials performance assessment.

For future reactor systems, there has been a continued trend towards the study and development of systems and fuel designs which help minimise waste arisings. Many future fuel designs include the presence of significant quantities of minor actinides as part of transmutation strategies. Given the expectation of significant changes to the fuel matrix, and noting the economic incentives to maximise burn-up, it is anticipated that fuel and material performance will be a key issue for future as well as current nuclear power systems. With the closure of many of the world's high fluence irradiation facilities, there may be increasing reliance on detailed computer modelling of material performance, including the application of multi-scale modelling methods.

Minimisation of waste is one of the incentives for developing a closed fuel cycle, and the compatibility of new fuel designs with existing and potential reprocessing methods is seen as an important element of current research. It is also recognised that the transition from today's mainly LWR fleet to a closed-cycle system based on fast reactors would present challenges in the area of waste minimisation. Research continues on various operating scenarios involving combinations of thermal and fast reactors to optimise waste minimisation while meeting production demands.

Research activities in support of plans to construct a full-scale demonstration of sodium-cooled fast reactor systems have been undertaken in recent years. In 2010, these projects were still at the design concept stage, but there has already been significant interest in the development and validation of modelling methods for design and safety analyses.

Given the trend to extend computer modelling methods into new application domains and the closure of many experimental facilities, there has been growing use of sensitivity/uncertainty analysis as part of the demonstration of the accuracy of such predictive methods. This growth has also been linked to increased computer speed and memory capability which allows the application of more rigorous techniques, such as the use of Monte Carlo sampling for the treatment of uncertainty.

Nuclear law

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 remains a primary concern of NEA member countries. Those which signed the 2004 Protocols to amend the Paris Convention and the Brussels Supplementary Convention are actively working to implement the provisions of those protocols into their national legislation, provisions that significantly increase the amount of compensation to be made available, broaden the scope of damage for which compensation may be granted and ensure that more victims will be entitled to compensation than ever before. A majority of the signatories to both protocols are now ready to deposit their instruments of ratification of these protocols. Sweden, for example, passed a new Act on Liability and Compensation for Nuclear Damage in June 2010 which implements both protocols, and Slovenia and Portugal each adopted ratification and implementing legislation in 2010 enabling them to deposit their instruments of ratification.

In addition, member countries which are not signatories to the above-mentioned conventions continue to modernise their third party liability regimes. Increasing the liability amounts of nuclear operators is a significant step in this process. This past year, for example, Poland ratified the 1997 Protocol to amend the 1963 Vienna Convention on Civil Liability for Nuclear Damage, thereby significantly raising its operator liability amount.

On a regional level, a workshop organised jointly by the Brussels Nuclear Law Association and the European Commission was held on the impact of the different nuclear liability regimes in Europe. The principal focus of this initiative was to determine whether a uniform European Union liability and compensation regime is both feasible and desirable, and whether the European Atomic Energy Community should accede to the Paris Convention.

Efforts to establish a global regime for nuclear liability and compensation have continued despite the fact that the number of contracting parties to the respective conventions did not increase in 2010. The 1988 Joint Protocol, which establishes a link between the Paris and Vienna Conventions, still counts 26 contracting parties, and the 1997 Convention on Supplementary Compensation for Nuclear Damage has only been ratified by four countries (Argentina, Morocco, Romania and the United States). However, an important nuclear power generating country, India, signed this latter instrument in October 2010 and is expected to ratify it in the near future. That convention will enter into force 90 days after the date on which at least five states with a minimum of 400 000 "units" of installed nuclear capacity (or roughly 400 000 MWth of installed capacity as defined in the convention) have done the same.

Following the adoption in 2009 of the Council Directive establishing a Community framework for the nuclear safety of nuclear installations by the Council of the European Union, on 3 November 2010 the European Commission proposed a directive on the management of spent fuel and radioactive waste. The objective of the proposal is to set up an EU legal framework for the management of spent fuel and radioactive waste as an integral part of the safe use of nuclear energy for electricity production and of ionising radiation in medicine, industry, agriculture, research and education.

In 2010, certain member countries were taking steps to relaunch their nuclear power programmes, and to that end began preparing new or revised legal frameworks. In 2010, the Swedish Act on the phasing out of nuclear energy was abolished and with amendments entering into force on 1 January 2011, the construction of new nuclear power plants became possible in view of gradually replacing existing reactors. Also of note was Italy's adoption of an implementing decree for the siting, construction and operation of nuclear installations and its establishment of a new nuclear regulatory body, the *Agenzia per la sicurezza nucleare*. In December 2010, an amendment to the German Atomic Energy Act entered into force allowing nuclear power plants built before 1980 to continue to operate for approximately 8 years longer, and newer reactors to operate approximately 14 years longer than envisaged in the "phase-out law" of 2002.

Technical Programmes

Nuclear Development and the Fuel Cycle

Nuclear Development Committee (NDC)

The NDC continues to support member countries in economic assessments of nuclear energy, including system costs of power generation and the economics of the nuclear fuel cycle, as well as the reliable application of nuclear technology and examination of the potential of nuclear power to mitigate greenhouse gas emissions.

Highlights

- The 2010 edition of *Projected Costs of Generating Electricity*, published in collaboration with the International Energy Agency (IEA), provides levelised costs of electricity per MWh for almost 200 plants in 21 countries.
- The latest edition of *Uranium: Resources, Production and Demand* was published, providing readers with information on key aspects of global uranium resources, including supply-demand projections to 2035.
- Three reports were released under the new series on *The Supply of Medical Radioisotopes*, and important progress was made in addressing shortage problems.
- A report on *The Security of Energy Supply and the Contribution of Nuclear Energy* was published.
- A "Nuclear Energy Technology Roadmap" to 2050 was issued in co-operation with the IEA.
- Other titles published included *Public Attitudes to Nuclear Power* and *Radioactive Waste in Perspective*.

Policy and strategic issues

Nuclear power has been attracting interest from governments due to its ability to contribute to security of electricity supply in a low carbon-emitting environment, as well as its increasing economic attractiveness as carbon pricing becomes the main driver for changing emission profiles in many countries. The Ad hoc Expert Group on Climate Change and Nuclear Energy Build Rates worked towards completion of its report on this subject. In parallel, the "Nuclear Energy Technology Roadmap" produced in co-operation with the IEA set out the necessary steps to achieve the nuclear expansion envisaged in the IEA *Energy Technology Perspectives* 2008 "Blue Map" scenario (1 250 GWe by 2050), covering technology development, policy measures and resources. The study on *The Security of Energy Supply and the Contribution of Nuclear Energy* was published, highlighting the significant contribution that nuclear energy has made over the past 40 years in terms of energy diversification and enhanced energy supply security in many NEA countries.

NEA staff members also participated in the IEA in-depth energy policy reviews of Hungary, Poland and the Slovak Republic in 2010. NEA involvement brings expertise on nuclear energy to the teams conducting the reviews, thus ensuring that they are as comprehensive as possible.

To support requests from member countries for advice on advances in the use of nuclear technology, the NEA has been examining progress towards sustainability of the nuclear fuel cycle from both technical and policy perspectives. The report on *Trends in the Nuclear Fuel Cycle*, to be published in 2011, will explore recent developments and likely future trends that may improve this sustainability.

To address concerns about current levels of nuclear energy education and training as well as knowledge preservation, the NEA has been considering changes that have taken place since the publication of its previous reports on this subject. With the age profile of the nuclear workforce showing a substantial proportion of professionals who have already reached or are approaching retirement age, there is a real risk of losing much of the collective knowledge and experience of the industry over the next few years. A new report under preparation will analyse the response of countries and the industry over the last ten years, consider the role of research facilities in supporting education and training and, for the first time, outline a job taxonomy focusing on the nuclear training component of workforce competence.

Security of supply of medical radioisotopes

The NEA continued its efforts related to improving the security of supply of molybdenum-99 (^{99}Mo) and its decay product, technetium-99m (^{99m}Tc), the most widely used medical radioisotope. The NEA became actively involved in international efforts in 2009 following the unexpected, extended shutdown of Canada's research reactor which produces approximately 35% of world ^{99}Mo supply. The NEA established the High-level Group on the Security of Supply of Medical Radioisotopes (HLG-MR), which at the end of 2010 was comprised of 22 experts representing 13 countries, the European Commission and the International Atomic Energy Agency (IAEA).

Throughout the first year and a half of its two-year mandate, the HLG-MR examined the major issues that affect the short-, medium- and long-term reliability of ^{99}Mo/^{99m}Tc supply. The collective efforts of HLG-MR members and nuclear medicine stakeholders have allowed for a

Covidien, United States

Nuclear medicine scanner using technetium-99m.

comprehensive assessment of the key areas of vulnerability in the supply chain and an identification of the issues that need to be addressed. Significant progress has already been achieved on improving the supply situation through increased communication, co-ordination of reactor schedules and a better understanding of demand-management opportunities. Continued action is required on the part of all stakeholders.

The NEA has released three reports under the series *The Supply of Medical Radioisotopes*. The first, subtitled *An Economic Study of the Molybdenum-99 Supply Chain,* offers a unique analysis of the ^{99}Mo/^{99m}Tc supply chain, finding that the recent shortages are linked to insufficient capital investment, brought about by an economic structure that does not provide sufficient remuneration for producing ^{99}Mo or support for developing additional production and processing infrastructure. To assist decision makers in their efforts to ensure long-term, reliable ^{99}Mo/^{99m}Tc supply, the study presents options for creating a sustainable economic structure.

The second report, subtitled "Interim Report of the OECD/NEA High-level Group on the Security of Supply of Medical Radioisotopes", presents findings related to the main issues affecting security of supply including reactor and processing capacity constraints, transport, demand management, communications and other supply chain problems. The report makes key recommendations, including on the need to continue the improved communications between suppliers and end users, offers suggestions to streamline and harmonise transport approvals by the industry and regulator, and highlights the importance of understanding future demand.

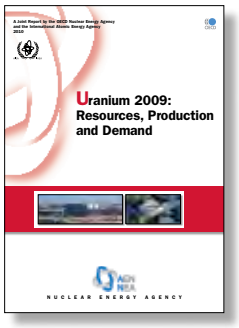
The third report, subtitled "Review of Potential Molybdenum-99/Technetium-99m Production Technologies", reviews potential alternatives for the production of ^{99}Mo and ^{99m}Tc. It provides criteria for objectively assessing alternative technologies and an assessment of the technical and economic merits of available technologies. Based on this work, the NEA Secretariat and the HLG-MR have started to develop a policy approach and recommendations for governments, industry and other stakeholders that will outline the foundation for ensuring the long-term supply of ^{99}Mo/^{99m}Tc.

Economics and financing

Following the publication of the report on *The Financing of Nuclear Power Plants*, there was considerable interest in looking at financing models and various innovative models have been used globally, including long-term contracts, loan guarantees and "build, own, operate" approaches. Nevertheless, financing remains a crucial issue and was the subject of a debate at the NEA Steering Committee for Nuclear Energy, following which the NEA was asked *inter alia* to explore the positions of the international financial institutions concerning the financing of nuclear energy projects.

The NEA Working Party on Nuclear Energy Economics (WPNE) continued to provide advice on key economic issues that merit investigation on an international level. Efforts focused on preparing, in co-operation with the IEA, the 2010 edition of *Projected Costs of Generating Electricity.* Extending and deepening the analysis undertaken in that study, two new projects have been initiated: one on the competitiveness of nuclear power under different carbon pricing regimes and another on the system effects of nuclear power. The latter is being carried out in co-operation with the IEA and the IAEA.

Data and resource assessment



The longstanding publication, *Uranium: Resources, Production and Demand* (the "Red Book") is released biennially in co-operation with the IAEA. The 2009 edition of this series, published in July 2010, shows that total identified resources increased by about 15% compared to 2007, including those reported in the high-cost category (<USD 260/kgU). These resources, amounting to over 6 000 000 tU are sufficient for 100 years of supply at the 2008 rate of consumption. The high cost category was reintroduced for the first time since the 1980s in response to the generally increased market prices for uranium in recent years (despite the decline from the mid-2007 peak), expectations of increasing demand as new nuclear power plants are planned and built, and increased mining costs.

The 2010 edition of *Nuclear Energy Data* (the "Brown Book") provides readers with data on all aspects of the nuclear fuel cycle and information on nuclear policy development and other issues. It reports *inter alia* that a total of 14 reactors were under construction and 24 firmly committed for construction in NEA countries in 2010.

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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, addressing in particular operational experience feedback, inspection practices, the regulation of new reactors and public engagement concerning safety in the use of nuclear energy.

Highlights

- **The CNRA and the CSNI maintained their focus on the safety of existing plants, as well as activities supporting the technology and science of new reactors and advanced designs. Other key topics addressed during the year included the efficiency and effectiveness of activities related to safety, and the availability of adequate nuclear skills and technical infrastructure.**
- **In 2010, the CSNI organised several workshops and conferences, most notable were those on human performance and the operation of new nuclear power plant technologies, stress corrosion cracking and cable ageing, computational fluid dynamics, soil-structure interactions, and seismic observation in deep boreholes and their applications.**

Operating experience

The joint NEA/IAEA International Incident Reporting System for Operational Experience (IRS) is the only international system providing regulators with information about lessons learnt from safety-significant events at nuclear power plants (NPPs). The Working Group on Operating Experience (WGOE) focuses its activities on follow-up actions regarding IRS and national information which also includes trends, responses and measures taken, and lessons learnt. The group completed reports on the regulatory activities resulting from the 2006 Forsmark-1 event and the recommendations by the CSNI DIDELSYS task group, and on identifying trends from the international event database. The WGOE held a meeting on Maintaining and Transferring Knowledge in Operating Experience. Representatives from regulatory authorities, technical support organisations and industry presented current strategies and tools and a report is being prepared. Additionally, the WGOE chose several topics for future in-depth discussions. Event reports are under development that reflect discussions related to anchor bolts, transformers, and counterfeit, suspect and fraudulent items.

Regulation of new reactors

The Working Group on the Regulation of New Reactors (WGRNR) is reviewing regulatory activities concerning siting, licensing and oversight of new commercial NPPs. Given that sharing information about the licensing process, construction experience and inspection practices will be helpful to all countries, a construction experience programme (ConEx) is being developed. The ConEx objectives are to identify major deficiencies associated with NPP design and construction, to assess the adequacy of, and to supplement if necessary, regulatory activities to detect and correct such events, and to disseminate information to ensure appropriate regulatory attention is given to lessons learnt from past events. A web-based interface was developed in 2010 with a procedure that describes the roles, responsibilities and means to promptly share the lessons learnt. A report on the regulation of site selection and preparation aimed at reviewing the various practices used by regulators was finalised. The report is based on a survey covering different aspects of the regulation of nuclear sites. The WGRNR is discussing potential follow-up activities related to new plant siting. An activity was initiated on recent regulatory experiences describing licensing structures, the resources and skills needed to perform reviews, assessments and construction oversight, the types of training needed for these activities and the various licensing processes. The first phase covers general aspects, including the licensing process, safety assessment, public participation, construction and operating oversight. A survey was taken and the report is under preparation. The second phase will be launched in 2011 on the different aspects of the design reviews performed by regulatory authorities.

Regulatory inspection practices

In 2010, the Working Group on Inspection Practices (WGIP) focused its efforts on the inspection of licensee maintenance programmes and licensee emergency arrangements. It finished the report on "Inspection of the Licensee's Corrective Action Programme". The tenth international workshop on inspection practices held in May in the Netherlands addressed experiences from the inspection of safety culture and of management systems, and the effectiveness of regulatory inspection processes. Following the workshop, several countries reported that they had applied the conclusions from all three topics.

Nuclear regulators and public communication

The activities of the Working Group on Public Communication of Nuclear Regulatory Organisations (WGPC) focused

on the transparency of regulatory activities, local public information, the use of public perception surveys and crisis communication. A survey and discussions on transparency considered the nuclear safety information that should be given to the public regarding the safety level of nuclear installations, regulatory decisions and general issues of concern to the public. A report on commendable practices for regulatory transparency was drafted. Discussions on local public information dealt more specifically with the information to be provided to persons living in the vicinity of a nuclear facility; a technical note on practical approaches to local meetings was issued. Group members debated the use of public perception surveys by nuclear regulatory organisations (NRO) to correct and improve its public image as an independent body in charge of protecting the population; a technical note on main features of the opinion survey was issued. Crisis communication concerns NRO communication when events have a media impact. A guidance report is under preparation.

The regulator's role in licensee oversight of vendor and other contracted services

The senior-level expert group addressing the regulator's role in assessing licensee oversight of contractors completed its mandate with the finalisation of a regulatory guidance booklet. Contracted services are an integral part of the design, construction and operation of a nuclear facility. However, changes in the nuclear industry have tended to increase the licensee's use of contracted services. The regulator must address the changes to provide assurance that the licensee maintains its responsibility for the safety of the facility, regardless of who provides the goods and services for the facility or where the activities involved in the supply chain take place. The group has provided guidance to address challenges regarding the retention of nuclear expertise, the interface between the licensees and the contractors, multinational contracting and manufacturing new technologies and processes. The booklet includes sample questions to consider when assessing the adequacy of the licensee's oversight of contractors. It provides recommendations aimed at regulatory authorities, with equal applicability to operating facilities and new construction as well as to any nuclear installation and even other industries.

Long-term operation

A senior-level expert group was formed in 2010 to produce a guidance document on the challenges of long-term operation (LTO) of nuclear power plants, primarily addressing the implications for regulatory bodies and focusing on policy issues. The objectives are to review the different approaches for long-term operation in member countries, including regulatory activities related to licensing and supervision of LTO, challenges with ageing management issues, design improvements and compliance with newer design requirements, as well as severe accident policies. The senior-level task group met for the first time in September 2010 and established the outline of the document. An NEA forum on LTO challenges will be held in June 2011 to inform the final report.

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 accidents and their management, ageing and structural integrity, fuel and fuel cycle safety, contributors to risk and human factors. The committee also facilitates the establishment of international joint research projects when useful.

Analysis and management of accidents

The activities of the Working Group on Analysis and Management of Accidents (WGAMA) have 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. Work has also been undertaken on new and advanced reactors.

During 2010, further progress was made on the uncertainty and sensitivity evaluation of best-estimate methods (BEMUSE), with the related synthesis report completed and approved by the CSNI in December. This report provides information about the applied methods, and summarises the conclusions and recommendations of the BEMUSE programme.

Regarding computational fluid dynamics (CFD), work is progressing on the development of best practice guidelines for CFD application to nuclear reactor safety (NRS) problems, CFD code assessment for NRS problems, CFD extension to two-phase flow problems, benchmarking activities and the organisation of workshops. The CFD benchmark on a customised T-junction experiment was completed as scheduled, and the report will be issued in 2011. The workshop on Experimental Validation and Application of CFD and Computational Multi-fluid Dynamics (CMFD) Codes to Nuclear Reactor Safety issues (CFD4NRS-3) was hosted by the US Nuclear Regulatory Commission (NRC) and co-organised by the NEA and the IAEA on 14-16 September 2010. Some 190 participants from 20 countries contributed.

In order to assess safety analysis code capabilities, two international standard problems (ISP) continued on thermal-hydraulics of the reactor coolant system (ISP-50 on the Korean ATLAS facility) and on hydrogen combustion (ISP-49 based on the French ENACCEF and German THAI facilities). The latter is close to completion.

Work also continued on in-vessel behaviour of degraded cores. The report on core exit temperature (CET) effectiveness in accident management and the proceedings of the Workshop on Implementation of Severe Accident Management Measures were issued. Those of the Workshop

on In-vessel Coolability are due to be issued shortly. A new activity was launched on code benchmarking to assess the ability of computer codes to simulate in-vessel core melt progression and degraded core coolability on the basis of three severe accident sequences involving safety systems failure or delayed operation.

Ageing and structural integrity of reactor components

The main topics addressed by the Working Group on Integrity and Ageing of Components and Structures (WGIAGE) concern the integrity and ageing of metal components and concrete structures, and the seismic behaviour of structures and components.

A report documenting the results and conclusions of the benchmark on risk-informed, in-service inspection methodologies (RISMET) was finalised. Workshops were organised on Soil-Structure Interaction (SSI) Knowledge and Effect on the Seismic Assessment of NPP Structures and Components in co-operation with the International Atomic Energy Agency (IAEA), as well as on Seismic Observation in Deep Boreholes and their Applications, hosted by the Japan Nuclear Energy Safety Organization (JNES) and embedded in the 1st Kashiwazaki International Symposium on Seismic Safety of Nuclear Installations. Proceedings are being prepared.

In 2009, the WGIAGE initiated an activity aimed at improving the robustness of assessment methodologies for structures impacted by missiles by means of a benchmark involving 28 teams. The purpose is to develop guidance that outlines effective methods of evaluating the integrity of structures in such circumstances. The benchmark was launched in February and its results were compiled in September. A workshop was organised in December to review the results, models and assumptions made by the different teams.

Component fatigue is a key issue for the safety of nuclear power plants. During the last WGIAGE annual meetings, member countries reported leaks and deep cracks where fatigue appeared to be the active degradation mechanism. The group has initiated an activity to assess fatigue data transferability practices in member countries. During 2010, an initial identification was made of existing or ongoing fatigue tests on components.

In view of the increasing interest in safe, long-term operation of existing nuclear power plants, an activity was initiated to identify technical areas of common interest concerning age-related degradation of materials in safety-related systems, structures and components (SSCs) during NPP long-term operation (>60 years) and to capture operating experience associated with degradation in buried tanks and piping.

An activity was also launched to identify technical areas related to the structural integrity evaluation of piping systems using deterministic and/or probabilistic methods and the demonstration that flaws in piping systems will exhibit leaks prior to failure.

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 nuclear safety decision-making in member countries. The activity on PSA knowledge transfer is progressing as scheduled, with the objective of developing an understanding of the current needs and ongoing activities in member countries on PSA knowledge transfer, including related international activities, and supporting the dissemination of lessons learnt and best practices. A comprehensive questionnaire was circulated to WGRISK members, the IAEA and the EC, and the resulting report is expected to be submitted for approval in spring 2011.

The activity on PSA for the design and commissioning of new NPPs seeks to identify and characterise current practices in this area and to identify key technical issues, current approaches to address these issues and associated lessons learnt as well as issues requiring further work. In addition, in order to extend the audience and the discussion, a joint workshop including PSA for advanced reactors will be organised in Paris on 20-24 June 2011.

The development of best practice guidelines on failure modes taxonomy for reliability assessment of digital instrumentation and control (I&C) systems for PSA was approved by the CSNI in June with the aim of developing technically sound and feasible failure mode taxonomy for such reliability assessments, and providing best practice guidelines on the use of taxonomy in modelling, data collection and qualification of digital I&C reliability. The guidelines are expected to be submitted for approval in 2013.

Finally, regarding information exchange on the use and development of PSA in member and non-member countries, an activity was launched to update the report on "The Use and Development of PSA in NEA member countries".

Fuel safety

The Working Group on Fuel Safety (WGFS) is concerned with 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 report on *Nuclear Fuel Behaviour in Loss-of-coolant Accident (LOCA) Conditions* was published in June 2009 and *Nuclear Fuel Behaviour under Reactivity-initiated Accident (RIA) Conditions* was published in March 2010.

The adequacy of existing fuel performance codes for the simulation of high burn-up fuel behaviour under accident conditions was assessed by benchmarking against irradiated LOCA tests performed at the Halden reactor. The exercise consisted of two benchmarks, with pre- and post-test calculations being carried out; a report was issued in late 2010.

Two tasks on the safety significance of the Halden IFA-650 LOCA test results and on the LOCA criteria basis and test methodology were completed. Both reports concluding the tasks provided recommendations to the international community.

Regarding progress in the testing and modelling of nuclear fuel behaviour during RIAs, participants at a 2009 workshop concluded that further development of analytical codes would be needed and that the transposition of separate effect mechanical tests carried out in laboratories on the reactor case remains an open question. Based on those findings, two new activities were started.

In parallel, the group has been reviewing the current status of light water reactor fuel safety criteria, which in some areas has developed rapidly, in order to update a report published over ten years ago.

Human and organisational factors

The Working Group on Human and Organisational Factors (WGHOF) constitutes a unique international forum for addressing safety management including safety culture, human and organisational factors, and human performance in nuclear facilities. A specialists meeting on Human Performance and the Operation of New Nuclear Plant Technology was held in Washington DC in March. The objectives of this workshop and an earlier survey were to prioritise and to pursue a set of research topics to enhance the state of knowledge regarding human and organisational factors related to new nuclear power plant technologies. This activity brought together specialists from 16 countries.

Two new tasks were also undertaken: one involved a follow-up activity on approaches to maintaining oversight of leadership, managing for safety and safety culture, and the other aims to investigate key attributes of human reliability analysis (HRA) in nuclear risk assessments. Both activities will seek to provide valuable insights for international specialists on human and organisational factors.

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, and fire protection.

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. A FINAS user manual was finalised and uploaded into the FINAS database.

A workshop on Safety Assessment of Fuel Cycle Facilities – Regulatory Approaches and Industry Perspectives will be organised by the group in Canada in September 2011, where various approaches of national regulators in the safety assessment of fuel cycle facilities and industry experience in providing safety justification for their facilities will be presented and discussed.

Integrated assessment of safety margins

Factors such as power uprates, longer operating cycles, new fuel designs and increased fuel burn-up, combined with plant ageing and plant life extensions require a comprehensive, integrated assessment in order to evaluate their potential cumulative safety impact. The Task Group on Safety Margin Applications and Assessment (SM2A) is validating the methodology agreed in 2007 by evaluating the change in safety margins which would result from implementing the newly proposed rules on performing LOCA analyses. Ultimately, it is intended that the methodology will be able to be used to quantify the change in margins due to combinations of plant modifications, as well as in support of setting safety limits for advanced reactor designs. A base case, with a hypothetical 10% power uprate applied to a commercial NPP, was considered. The activity was successfully completed with its report approved in December.

Defence in depth of electrical systems and grid interaction

Following the July 2006 Forsmark-1 event which identified a number of design deficiencies related to electrical power supply to systems and components important to safety in NPPs, a Task Group on Defence in Depth of Electrical Systems and Grid Interaction (DIDELSYS) was established.

In 2009, the group issued its final technical report which provides information on the state of the art regarding the robustness of safety-related electrical systems (SRES), taking into account their interaction with other electrical equipment, the use of new technologies and the problems encountered when modernising existing NPPs. It will also provide guidelines for improving communication and coordination among grid operators, nuclear safety authorities and licensees.

A follow-up activity was initiated to identify elements in a methodology on how to periodically carry out a systematic hazard review of possible voltage/frequency transients which could occur from the grid and in NPPs, and to convene a workshop in May 2011 to discuss progress made since the publication of the technical report.

Research facilities for existing and advanced reactors

Following a *CSNI Collective Statement on Support Facilities for Existing and Advanced Reactors,* a Task Group on Advanced Reactor Experimental Facilities (TAREF) was established with a mandate to examine gas-cooled reactors and sodium fast reactors in a first phase. In 2009, the activity on gas-cooled reactors was completed and the corresponding report entitled *Experimental Facilities for Gas-cooled Reactor Safety Studies* was published. The activity on experimental facilities for sodium fast reactor safety studies was completed in 2010 and the related report was approved for publication. The report identifies safety issues relevant to sodium fast reactors and experimental facilities to address them, and provides recommendations on strategies for facilities and international programmes in support of such safety assessments. The findings of this activity are expected to trigger internationally funded OECD projects on relevant safety issues at the identified key facilities.

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Radioactive Waste Management

Radioactive Waste Management Committee (RWMC)

The RWMC is assisting member countries in the development of safe, sustainable and broadly acceptable strategies for the long-term management of all types of radioactive waste, in particular long-lived waste and spent fuel considered as waste, and for the decommissioning of obsolete nuclear facilities.

Highlights

- An International Conference and Dialogue on Reversibility and Retrievability (R&R) was held in December to collect stakeholder views and examine strategy and policy implications of R&R.
- The Forum on Stakeholder Confidence (FSC) reviewed its work and discussed its impact with stakeholders at a symposium commemorating the FSC 10th anniversary.
- The Integration Group for the Safety Case (IGSC) reviewed methods for safety assessment at a workshop held in May.
- The Working Party on Decommissioning and Dismantling (WPDD) analysed decommissioning cost elements, estimation practices and reporting requirements in various countries.

Waste management policy and regulatory issues

In addition to its activities on the disposal safety case, stakeholder involvement and decommissioning, the RWMC continued to pursue projects on reversibility and retrievability (R&R) and memory preservation. The committee took up new tasks in preparing for the next International Conference on Geological Repositories (ICGR-11) scheduled to be held in October 2011 under the theme of "National Commitment – Regional and Local Confidence". Also, preparations have begun to conduct an international peer review of the Swedish licence application to construct a deep geological disposal facility for high-level waste.

Addressing very long timescales is an important aspect of confidence building in the disposal of high-level radioactive waste. In this context, the RWMC examined radiological protection principles and criteria for geological disposal and reviewed, in close dialogue with the radiological protection community, their meaning and use over very long timescales. On a related issue, the RWMC Regulators' Forum prepared a compilation of documents reviewing the development of relevant regulation over the last decade and discussing the subject of optimisation.

The RWMC project on retrievability and reversibility (R&R) continued to develop a guidance report on this topic, addressing experience with retrieval and lessons learnt; limitations on retrievability; the implications of the concept for regulation, monitoring and institutional control; ethics and values; and decision-making processes. It organised the International Conference and Dialogue on Reversibility and Retrievability in Planning Geological Repositories in December in Reims, France, in co-operation with the International Atomic Energy Agency and the European Commission, and with the support of a range of governance institutions from France, Germany, Japan, Sweden, the United Kingdom and the United States. The conference was the first in a decade on this subject and the first ever to propose a dialogue among such a wide range of stakeholders. Participants discussed lessons learnt so far and the various roles R&R can have in repository implementation.

As many radioactive waste disposal programmes approach the siting and operational stages, preservation of records, knowledge and memory (RK&M) across generations is one of the pillars of confidence in safety and security, as well as a foundation for robust decisions by future generations. The RWMC has laid the groundwork for a new project on RK&M, observing that preservation of knowledge and memory needs to be addressed from early on in the national programmes.

Safety case for geological disposal

The RWMC Integration Group for the Safety Case (IGSC) has finalised its multi-year project on engineered barrier systems (EBS) by examining how to design, characterise, model and assess the performance of EBS, and how to integrate these aspects within the safety case for geological disposal. The final report presenting the project's main results and findings was prepared jointly with the EC. Building on this project and on the Approaches and Methods for Integrating Geologic Information in the Safety Case (AMIGO) project, the IGSC is initiating a series of workshops on cross-cutting issues involving interactions between the geosphere and engineered barriers. Lessons learnt in a first workshop on the topic of cementitious materials in geological repositories were summarised in a report.

The IGSC also initiated the second phase of its project on advances in methods for safety assessment (MeSA). A workshop was organised in May 2010 to review state-of-the-art and current practice and to consolidate the methodological understanding of safety calculations, which form the technical core of a safety case. Based on the workshop and additional input, the IGSC proceeded to prepare a synthesis report addressing *inter alia* the context of the safety case, assessment strategy, scenarios, modelling strategy and treatment of uncertainties.

At its annual meeting, the IGSC dedicated a topical session to organisational aspects of developing safety cases. This session demonstrated a growing recognition that factors such as knowledge management, or broader issues such as organisational structure and inter-disciplinary co-ordination which have sometimes been viewed as peripheral, have direct bearing on the quality of, and confidence in, the safety case.

Forum on Stakeholder Confidence

The RWMC Forum on Stakeholder Confidence (FSC) celebrated its ten-year anniversary by organising a colloquium with more than 100 participants from 20 countries and international organisations, including FSC members and other representatives of civil society and RWM institutions. Beyond taking stock of change and progress in the governance of RWM over the past decade, academic researchers from French and UK universities reviewed the FSC learning methods and the large body of reports made available. The quality of FSC reports was acknowledged and the seven FSC national workshops and community visits organised over the last ten years emerged as the most popular and effective means of joint learning.

The FSC also shed new light on the issue of *Partnering for Long-term Management of Radioactive Waste*, illustrating experience of creating and maintaining relationships in 13 countries, and providing detailed information on such aspects as collaboration formats and compensation rules. Another FSC study provided insight into the symbolic dimension of radioactive waste management, showing that key concepts of radioactive waste management, like safety or reversibility, carry different meanings for different stakeholders or societal groups, and that better understanding can be developed through dialogue.

Decommissioning

The RWMC Working Party on Decommissioning and Dismantling (WPDD) worked on the application of lessons from decommissioning to the design and operation of new reactor systems, concluding that, although many design provisions aiming at improved operation and maintenance will also be beneficial for decommissioning, designers still need to consider issues that are specific to decommissioning such as developing sequential dismantling sequences and providing adequate waste management strategies.

Large components constitute a specific challenge for decommissioning and have a systemic impact on the whole process. To provide guidance to decision makers, the WPDD launched a study that will provide a methodology to assess different options for the long-term management of large components from decommissioning. The group is also evaluating R&D needs for decommissioning, analysing the innovation needs for decommissioning and assigning broad priorities to these; in a later stage the project will aim to define relevant R&D projects that might be undertaken on a collaborative or jointly funded basis.

The WPDD Decommissioning Cost Estimation Group (DCEG) analysed decommissioning cost elements, estimation practices and reporting requirements in various countries. Its findings suggest that cost methodologies need to be updated continuously, using cost data from actual decommissioning projects, and systematic approaches need to be implemented to collect these data. It also notes that more needs to be done to facilitate comparison of estimates. As a practical contribution, the group began updating the listing of standardised cost items for decommissioning, commonly known as the "Yellow Book", in a joint undertaking with the European Commission and the IAEA.

The International Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects (CPD) continued to expand its working base, bringing the number of active decommissioning projects in the programme to 59, including 13 nuclear power plants (see page 34 for more information).

Understanding the scientific basis

The RWMC continued to support the development and maintenance of quality-assured databases and models for use in the implementation of repositories and to generally secure the scientific basis of its work.

In 2010, the NEA Clay Club commemorated 20 years of successful work on improving the understanding of argillaceous rocks as repository host formations, and organised a special session at its annual meeting to share knowledge on anomalous heads in sedimentary formations. As a result of earlier work, it also prepared a substantial review on the *Self-sealing of Fractures in Argillaceous Formations in the Context of Geological Disposal of Radioactive Waste*. The report examines the evidence, mechanisms and time frames for self-sealing.

The Thermochemical Database (TDB) Project, which is run by the NEA Data Bank under the scientific guidance of the RWMC, continued to develop its database of recommended chemical thermodynamic data for the safety assessment of radioactive waste repositories (see page 34 for further details).

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Radiological Protection

Committee on Radiation Protection and Public Health (CRPPH)

The objective of the CRPPH is to facilitate the understanding and implementation of a system of radiological protection that addresses regulator and practitioner needs, and more appropriately positions scientific radiological protection considerations within the broader context of social judgment and risk governance.

Highlights

- The CRPPH continued its active participation in the development of the new international Basic Safety Standards (BSS), led by the International Atomic Energy Agency (IAEA) and co-sponsored by the NEA and several other international organisations. It is expected that the new BSS will be adopted during 2011.
- The report on *Occupational Radiological Protection Principles and Criteria for Designing New Nuclear Power Plants* was published.
- The INEX-4 exercise, focusing on consequence management and transition to recovery, began in September 2010 and is being held in 23 countries, including 5 non-NEA member countries, until March 2011.
- A workshop on Practices and Experiences in Stakeholder Involvement for Post-nuclear Emergency Management was held in October 2010, hosted by the US NRC.

Evolution of the international system of radiological protection

During 2010 the technical development of the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* (BSS) was broadly completed through the work of the eight sponsoring organisations (EC, FAO, IAEA, ILO, NEA, PAHO, UNEP, WHO). An extensive NEA analysis of draft version 3.0 was carried out during meetings in Paris and Tokyo. The final step of this technical development was the approval in Autumn 2010 by the IAEA Safety Standards Committees and endorsement by the sponsoring organisations to send the draft document to the IAEA Commission on Safety Standards for review and approval in view of submission to the IAEA Board of Governors for final adoption. After this, the provisional BSS will be sent to all sponsoring organisations, including the NEA, for approval through their own internal processes.

Radiological protection science and policy judgment

Studies of significant aspects of radiological protection decision-making have been an important aspect of CRPPH work over the years, and this continued to be the case during 2010. A report presenting the results of the first two Science and Values in Radiological Protection workshops (Helsinki, January 2008 and Vaux de Cernay, December 2009) was finalised for publication. It summarises discussions of how the bases for decisions, whether scientific and/or value judgments, can be more transparently expressed by deciders. Plans were made to hold the third science and values workshop in November 2011.

The CRPPH also addressed a very practical aspect of decision-making by endorsing the work by the NEA Secretariat on the radiological protection questions to be considered by governments when deciding whether to justify the use of airport body scanners employing ionising radiation. While recognising this as clearly a governmental decision involving many considerations beyond radiological protection, the short report prepared by the Secretariat, jointly with seven other international organisations which are members of the Inter-Agency Committee on Radiation Safety (IACRS: EC, FAO, IAEA, ILO, NEA, PAHO, UNEP and WHO), outlined the radiological protection issues that should be considered by governments in making such decisions.

Stakeholders and radiological protection

Key lessons in nuclear and radiological emergency preparedness and response identified through events and exercises have led to improvements in emergency arrangements nationally and internationally. Among these lessons has been the recognition that effective management of complex situations such as those during emergencies requires the involvement of a broad range of stakeholders. To be effective, such involvement must be organised as part of preparedness. In order to further examine this issue and to share national experience, the NEA organised a workshop on Practices and Experiences in Stakeholder Involvement for Post-nuclear Emergency Management, which was held in October in Washington DC and hosted by the US Nuclear Regulatory Commission. A report summarising the results of these discussions will be published in early 2011 (see page 42 on Nuclear Energy and Civil Society for further details).

Operational radiological protection from a policy perspective

Following the publication of *Occupational Radiological Protection Principles and Criteria for Designing New Nuclear Power Plants,* the CRPPH Expert Group on Occupational Exposure is working to complete its second report, on dose constraints, for CRPPH review and approval in May 2011. This work focuses on collecting operational experience with the use of dose constraints in optimising protection, and is aimed at developing a practical understanding of dose constraints. It will provide valuable information that may be used in setting dose constraints for the radiological protection of workers.

The CRPPH Expert Group on Best Available Techniques is examining practical approaches to the management of effluents for new reactors, with the objective of developing an understanding of good practice among regulatory authorities, utilities and reactor vendors. Detailed plans for a workshop on effluent management techniques, to be held in early 2012, have been developed.

In order to assist NEA member countries with their implementation of new International Commission on Radiological Protection (ICRP) recommendations, the CRPPH launched a study on the resources needed to implement the ICRP recommendations of 1990. This study consists of a questionnaire and a series of interviews with regulatory authorities, nuclear utilities, hospitals/doctors and industrial radiography organisations, in order to capture their experience and to extrapolate what resources may be needed to implement the 2007 recommendations. This work is partly based on an earlier report that characterised the policy and regulatory changes that took place from ICRP Publication 26 (1976) to Publication 60 (1990), and again the changes that may be brought about in the evolution from ICRP Publication 60 to Publication 103 (2007).

The NEA Nuclear Law Committee (NLC) asked the CRPPH to provide a technical opinion concerning the exclusion of nuclear installations being decommissioned from the application of the Paris Convention. In 1990, the CRPPH had recommended criteria for such exclusions, and the NEA Steering Committee had agreed to allow such exclusions using the CRPPH recommended criteria. However, since then the numerical standards used to develop the criteria have become outdated, and the German Delegation to the NLC proposed that the criteria be updated. Starting with a proposal developed at the IAEA regarding the exclusion of nuclear installations being decommissioned from the application of the Vienna Convention, the CRPPH developed a new set of criteria that are broadly consistent with those being proposed by the IAEA. The final proposed criteria will be submitted to the NLC and the NEA Steering Committee for approval.

Another area addressed by the CRPPH in 2010 was consumer products containing radioactive materials. In the 1970s and 1980s, the NEA had issued standards and guides on the manufacture and use of several types of consumer products containing radioactive materials (for example tritium light sources and pacemakers). These have since become out of date but continue to be referred to by experts needing advice. The EC has published an update and work on a global, internationally accepted guide has begun with the intention of issuing a jointly sponsored (EC, IAEA, ISO and NEA) IAEA safety series document. A draft of this material was prepared by the CRPPH during 2010, and has been proposed to the IAEA for further development.

Radiological protection of the environment

An ad hoc expert group has been tasked with identifying, if possible, areas in which the CRPPH could usefully contribute to discussions on radiological protection of the environment. The group has noted that some NEA member countries are considering some level of regulatory consolidation with respect to the management of chemical and radiological effluents, and is conducting a survey of experience and intentions in this area. The group's final report will be presented to the CRPPH for review and approval in May 2011.

CEA Cadarache, France

Environmental monitoring and sample analyses.

Nuclear emergency and recovery management

The INEX-4 exercise is focusing on consequence management and transition to recovery in response to malicious acts involving the release of radioactive materials in an urban setting. The exercise began in September 2010 with 23 countries (including 5 non-NEA countries) participating. The exercise will continue until March 2011 and be followed by an evaluation workshop in December 2011.

Occupational exposure at nuclear power plants

The sharing of operational lessons and experience, as well as the collection, analysis and exchange of occupational exposure data continue to be addressed by the Information System on Occupational Exposure (ISOE), an NEA joint project which is sponsored by the IAEA. The ISOE continued its efforts to better meet end-user needs by providing online data collection and analytical resources. 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 cycle physics and chemistry, criticality safety and material science.

Highlights

- The 1st NEA Workshop on Technology and Components of Accelerator-driven Systems (TCADS) was held in Karlsruhe, Germany on 15-17 March.
- The 10th NEA Workshop on Shielding Aspects of Accelerators, Targets and Irradiation Facilities was held in Geneva, Switzerland on 2-4 June.
- The 2nd NEA International Workshop on Structural Materials for Innovative Nuclear Systems (SMINS) was held in Daejeon, Korea on 31 August-3 September.
- The 11th NEA Information Exchange Meeting on Actinide and Fission Product Partitioning and Transmutation (P&T) was held in San Francisco, California, USA on 1-4 November.
- A report on *National Programmes in Chemical Partitioning* was published.
- The final report of an international benchmark to model the effects of a turbine trip in a boiling water reactor (BWR) was published.

The main objective of the NEA nuclear science programme is to validate models and data used in member countries for predicting the behaviour and performance of different nuclear systems by comparing calculated and experimental results in international benchmark exercises. In addition, it organises specialists' meetings and workshops and produces state-of-the-art reports as necessary.

Reactor physics

A significant part of NEA work related to reactor physics is devoted to the propagation of uncertainties in the modelling of coupled core neutronics/thermal hydraulics effects in a reactor. A number of benchmarks based on measured data, such as the Russian-designed reactor (VVER-1000) coolant transient benchmark and the pressurised water reactor (PWR) sub-channel bundle test benchmark, are used to validate the models.

Several benchmark exercises devoted to advanced reactor systems are also underway, covering reactor transient calculations, for example in a pebble bed modular reactor (PBMR) and a sodium-cooled fast reactor, and fuel depletion calculations in a high-temperature, gas-cooled reactor (HTGR).

In addition to the above-mentioned activities, work in this area also comprises fuel performance as well as radiation transport and shielding activities. In both these areas, the NEA has established databases containing experimental data which are being used extensively in member countries to validate modelling codes and associated data.

Bohunice NPP, Slovak Rep.

View of a VVER steam generator.

Fuel cycle physics and chemistry

Following the publication in 2009 of the status report on *Nuclear Fuel Cycle Transition Scenarios Studies* as well as the study on *Nuclear Fuel Cycle Synergies and Regional Scenarios for Europe*, work continues on a review of a global scenario. The performance of the computer programs used to calculate these scenarios is also being compared in depletion and transition benchmarks.

A report is being prepared on the characteristics and performance of fuels bearing minor actinides, such as metal, oxide, nitride, dispersion and sphere-pac fuels, for advanced nuclear systems, as is a report on the development status of structural materials to be used in advanced nuclear systems.

A comparative study of homogeneous versus heterogeneous recycling of transuranic (TRU) isotopes in fast reactors has been undertaken, and the report from the study will be published in 2011.

KAERI, Korea

Pyropartitioning through electrorefining.

In the area of fuel cycle chemistry, a study is being carried out on progress in separation chemistry, specifically minor actinide separation, and a review is being prepared on scientific issues related to the management of curium. The report on *National Programmes in Chemical Partitioning* was published.

Nuclear criticality safety

A large number of studies related to burn-up credit criticality safety, i.e. a safety approach that accounts for the reduction in reactivity of configurations with spent nuclear fuel due to the change in their composition after irradiation, have been undertaken and published. A summary report on lessons learnt in burn-up credit is being finalised for publication in 2011.

An activity was started in 2010 to review the development of advanced Monte Carlo calculation techniques used in the area of nuclear criticality safety, with special emphasis on depletion and perturbation methods. Plans are to produce a guidance report for users of relevant computer programs.

A state-of-the-art report on assay data for spent nuclear fuel is scheduled to be issued in early 2011. It is strongly linked to the NEA database on spent fuel isotopic composition (SFCOMPO), which is being continuously maintained and updated.

Material science

NEA work in the area of material science is mainly devoted to multi-scale modelling of fuels and structural materials for nuclear systems. The following three state-of-the-art reports are being prepared:

- an assessment of the possibilities and limits of numerical methods applied to multi-scale modelling of materials and the means to link them;
- a critical review of recent progress and bottlenecks for future development of fuels;
- an assessment of the use of a multi-scale modelling approach to describe the changes induced by irradiations in structural nuclear materials.

In addition, efforts will be made to define a protocol and a standard test for each modelling tool and, based on the results of the tests, to recommend improvements.

A proposal to address primary damage issues is under consideration. The activity would include a report on the state of the art in primary damage characterisation and the limitations of the NRT-dpa standard.

Integral experiments for minor actinide management

The main objectives of this activity are to assess the availability of minor actinide nuclear data, to evaluate the target accuracies of these data in applications such as transmutation in light water, fast and accelerator-driven subcritical reactors, and, if appropriate, to make recommendations on additional differential and integral experiments needed to meet the target accuracies.

A review of existing nuclear data and integral experiments for minor actinide management has been performed, as well as an assessment of the accuracy of the available data. A discussion of the need for further measurements is ongoing, with the final report due to be issued in 2011.

Knowledge preservation

In order to assist member countries in the development of new nuclear facilities, and in the context of marked change in the composition of their skills base as a generation of highly experienced nuclear scientists and engineers retires, the NEA Nuclear Science Committee launched, some years ago, a programme of establishing well-structured and highly accessible databases to preserve and evaluate information from reactor physics (IRPhE), criticality safety (ICSBEP), shielding (SINBAD), fuel performance (IFPE) and isotopic composition of spent fuel (SFCOMPO). The maintenance and updating of these databases are performed in close collaboration with the NEA Data Bank.

The contents of the 2010 editions of the above-mentioned databases were as follows:

- the IRPhE handbook, published in June 2010, contains 43 series of reactor physics experiments performed at 24 reactor facilities;
- the ICSBEP handbook, published in December 2010, contains nearly 4 416 critical or subcritical configurations;
- the SINBAD database contains 44 radiation shielding, 30 fusion neutronic shielding and 23 accelerator shielding experiments;
- the IFPE database contains 1 445 rods/samples from various sources, comprising BWR, AGR, PHWR, PWR and VVER reactor systems;
- the SFCOMPO database contains 246 samples from 14 commercial reactors.

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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

- The fifth edition of the International Handbook of Evaluated Reactor Physics Benchmark Experiments was published on DVD in June. This edition contains 43 series of reactor physics experiments performed at 24 reactor facilities.
- Seven workshops and training courses were organised on the utilisation of the most popular computer codes as part of knowledge management activities.
- A new version of the data display program, JANIS 3.2, was made available on DVD together with its main databases, including the latest evaluated nuclear data files: JENDL-4.0, RUSFOND-2010 and CENDL-3.1.
- Two reports from the Working Party on International Nuclear Data Evaluation Co-operation (WPEC) were issued: one on methods to produce covariance data in the fast neutron region and the other on improvement of the quality of the EXFOR database.

Computer program services

The collection of computer codes distributed by the NEA Data Bank covers most areas of importance to nuclear development, especially reactor design, dynamics and safety, as well as radiation shielding, material behaviour and nuclear waste applications. After collecting and validating the computer codes and associated libraries, the Data Bank disseminates these codes on request to scientists and engineers in member countries. Authorised non-OECD member countries also have access to these services through a co-operative agreement between the NEA Data Bank and the International Atomic Energy Agency (IAEA). In addition, the current co-operative arrangement between the US Department of Energy (DOE) and the NEA, signed in 2006, authorises the Data Bank to issue user licenses and to distribute US computer codes to Data Bank member countries.

In 2010, the Data Bank responded to more than 1 000 requests for computer programs and about 2 700 requests for compilations of integral experiments (such as SINBAD, IFPE, IRPhE and CCVM). The requests originated from 425 national and international research centres, laboratories, universities and software and engineering companies from the member countries and from 52 non-OECD member countries. During the same period, 51 new computer program packages, including 4 originating from non-OECD member countries, were added to the Data Bank's collection.

Knowledge management: data – information – knowledge – understanding

The preservation and transfer of data and information are central to the role of the Data Bank. One of its key functions is to provide a comprehensive set of evaluated experiments against which computer codes and their associated nuclear data libraries can be validated. These data are evaluated by teams of experts and stored in well-structured, readily accessible databases. Databases are maintained on behalf of the NEA Nuclear Science, Radiological Protection and Radioactive Waste Management, and Nuclear Safety Divisions.

Furthermore, the following databases are developed and maintained in co-operation with the NEA Nuclear Science Committee: IFPE (fuel performance experiments for over 1 500 rods, including fission product gas release and fuel/clad interaction data), SINBAD (over 100 shielding and dosimetry experiments from fission, fusion and accelerator facilities), IRPhE (reactor physics experiments relevant to the main types of current power reactor designs and for several of the design concepts for advanced reactor systems) and ICSBEP (experiments on over 4 000 critical or sub-critical configurations).

In co-operation with the NEA Nuclear Safety Division, the Data Bank stores experimental data from several international joint projects. These include CSNI Code Validation Matrix (CCVM) integral test data and separate effects test data for thermo-hydraulic transient experiments which are used to validate large thermo-hydraulic computer codes for the safety analysis of reactor transients.

Seven workshops or training courses on the utilisation of the most popular computer programs were organised during 2010 as part of the Data Bank knowledge management activities. The subjects covered during these training sessions, attended by more than 100 participants, addressed many different areas including computational radiation physics, criticality safety and radiation shielding, radiation transport using Monte-Carlo codes and sensitivity/uncertainty analysis, and analytical benchmarks.

A computer program training workshop organised by the Data Bank.

Nuclear data services

The nuclear data services are to a very large extent provided through direct online access to the EVA, EXFOR and CINDA databases containing evaluated, experimental and bibliographic data respectively. Users can also access these data using the Java-based nuclear information software called JANIS, which facilitates the visualisation, comparison and manipulation of such data.

As part of the international network of Nuclear Reaction Data Centres (NRDC), the Data Bank is responsible for the compilation in the EXFOR database of experimental reaction data measured in member countries. In 2010, the NEA contributed over 128 new entries on neutron- and charged-particle-induced reaction data. Moreover, 269 additional entries were updated with new or revised information.

The Data Bank also develops JANIS-based tools to help verify the format of EXFOR files. These tools are used at the Data Bank to peer review EXFOR files submitted to the NRDC.

The new JANIS 3.2 version allows users to access major evaluated libraries, including the latest releases: JENDL-4.0, RUSFOND-2010 and CENDL-3.1. It also contains new features to display data uncertainties and their correlation in both ENDF and NJOY formats. JANIS 3.2, together with its main databases, is available online and on DVD.

The JEFF Project

The latest version of the JEFF library, JEFF-3.1.1, was adopted by the French nuclear industry to simulate its fleet of reactors across the world. The next JEFF release, under development, should maintain JEFF-3.1.1 performance and respond to additional users' needs for both fission and fusion applications, notably covariance data and photon production.

The Data Bank also offers a set of processed libraries for use with the Monte Carlo neutron-particle extended [MCNP(X)] code, based on JEFF-3.1.1, to assist scientists using JEFF data in application calculations.

International nuclear data evaluation co-operation

The NEA Working Party on International Nuclear Data Evaluation Co-operation (WPEC) provides a worldwide framework for co-operative activities between major nuclear data evaluation projects.

In 2010, two WPEC subgroups completed their reports, which will be issued early in 2011. The first one, Subgroup 24 (Sg24), was established to develop methodology for production of covariance data in the fast neutron region. The report describes the different approaches and compares results obtained with existing nuclear reaction codes. The second one, Subgroup 30 (Sg30), focused on the improvement of the accessibility and the quality of the EXFOR database. The report describes the translation process from EXFOR into more user-friendly tabulated data files, as well as the various methods developed to verify and to correct the contents of the database.

In addition to maintaining the High Priority Request List (HPRL) for nuclear data, the WPEC has launched three new subgroups on "Co-ordinated evaluation of ^{239}Pu in the resonance region" (Sg34), "Scattering angular distribution in the fast energy range" (Sg35), and "Reporting and usage of experimental data for evaluation in the resolved resonance region" (Sg36).

The Thermochemical Database (TDB) Project

The Data Bank works together with the NEA Radiological Protection and Radioactive Waste Management Division on a thermochemical database project examining the key elements required for geochemical modelling. Teams of international experts are carrying out critical reviews of bibliographic references and have set up a quality-assured database. Further details are provided in the section on Joint Projects and Other Co-operative Projects (see page 34).

In-house computer services

The Data Bank is responsible for NEA in-house computer services comprising internet and data servers connected to a fast network. In 2010, the NEA internet server registered 1.2 million visits, during which 3.3 million web pages were browsed and some 4.3 terabytes were downloaded.

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Legal Affairs

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 adoption, implementation and modernisation of national and international nuclear liability regimes. Under its supervision, the NEA analyses and disseminates information on nuclear law through a regular publications programme and conducts annual sessions of the International School of Nuclear Law.

Highlights

- Signatories to the 2004 protocols to revise the Paris Convention and the Brussels Supplementary Convention made good progress towards implementing the provisions of those protocols into their national legislation, including finding ways to financially secure those nuclear risks for which operators are unable to obtain private insurance.
- The NLC held a special session addressing legal aspects related to the long-term operation of nuclear power plants.
- Two issues of the *Nuclear Law Bulletin* (NLB) were published including topical articles on the European Union Directive on nuclear safety, competition law and the nuclear sector, the notion of environmental damage, nuclear third party liability jurisdiction and enforcement rules in the European Union and the Treaty on the Non-proliferation of Nuclear Weapons following the 2010 review conference.
- The tenth session of the International School of Nuclear Law (ISNL) was held at the University of Montpellier 1. A special anniversary publication, comprising scholarly papers on the history, evolution and future of international nuclear law, was widely disseminated and dedicated to ISNL alumni.

Development and harmonisation of nuclear legislation

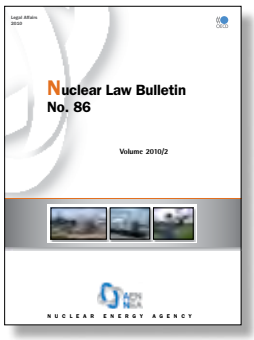
Ensuring adequate and equitable compensation for third party damage caused by a nuclear incident continued to attract the highest level of attention amongst member countries. Those which are party to the Paris and Brussels Supplementary Conventions on nuclear third party liability worked towards implementing the 2004 protocols amending those conventions. A few are still facing delays in implementation because private nuclear risk insurers are unable to provide full coverage for certain risks which nuclear operators are obliged to assume under the newly revised conventions; such risks include the cost of reinstating an impaired environment and claims instituted more than ten years after the occurrence of a nuclear incident.

The NLC held a special session addressing legal aspects related to long-term operation of nuclear power plants. Particular attention was given to the national situations in Canada, Finland, Japan and the United States. The main issues pinpointed by the committee were the identification of the authority in charge of decision-making on long-term operation, the participation of the public and other stakeholders in the decision-making process, the various legal consequences of conducting periodic safety reviews as opposed to fixed-term operating licenses and the possibility to appeal refusals of long-term operation applications.

The NLC also discussed the new third party liability legislation in India. In 2010, for the first time, the Indian parliament adopted comprehensive nuclear liability legislation. The main principles of the 2010 Civil Liability Act for Nuclear Damage have been inspired by the international nuclear liability conventions, especially the 1997 Vienna Convention and the Convention on Supplementary Compensation, including liability limited in amount and time, exclusive jurisdiction, strict liability of the operator and the financial security obligation. However, the new legislation does contain two controversial elements: the operator's right of recourse against suppliers for supply of equipment/material with patent/latent defects or sub-standard services, and the possibility of bringing claims for indemnification of nuclear damage on legal grounds other than the 2010 Civil Liability Act for Nuclear Damage.

Both the NLC and the NEA Legal Affairs Section were active in providing legal input to the NEA Committee on Radiation Protection and Public Health (CRPPH) and its Working Party on Nuclear Emergency Matters (WPNEM). The Legal Affairs Section participated in the WPNEM workshop on Practices and Experiences in Stakeholder Involvement for Post-nuclear Emergency Management and gave a presentation on legal frameworks in stakeholder involvement. It will continue its co-operation with the WPNEM for the Fourth International Nuclear Emergency Exercise (INEX-4).

Nuclear law publication programme



The 85th and 86th issues of the *Nuclear Law Bulletin* (NLB) were published in June and December 2010 respectively. The *Nuclear Law Bulletin* is a unique international publication for both professionals and academics in the field of nuclear law. It provides subscribers with authoritative and comprehensive information on nuclear law developments. Published twice a year in both English and French, it features topical articles written by renowned legal experts, covers legislative developments worldwide and reports on relevant case law, bilateral and international agreements as well as regulatory activities of international organisations. All but the latest three editions of the NLB are freely available online at www.oecd-nea.org/law/nlb. The most recent editions are available on subscription through the OECD bookshop at www.oecdbookshop.org.

Country profiles on the regulatory and institutional framework for nuclear activities in OECD member countries are available at www.oecd-nea.org/law/legislation/. Several country profiles were revised in 2010 such that a large majority of the chapters are now entirely up-to-date. The NEA website also proposes a listing of "Latest legislative developments", which tracks recent nuclear legislative events prior to their publication in the *Nuclear Law Bulletin;* the listing can be found at www.oecd-nea.org/law/legislation/updates.html.

Nuclear law educational programme

A very successful 10th anniversary session of the International School of Nuclear Law (ISNL) was held in August-September in co-operation with the University of Montpellier 1, France. Established in 2001, 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 professional expertise provided by the OECD/NEA and the International Atomic Energy Agency (IAEA). In celebration of the 10th anniversary of the ISNL, the NEA widely disseminated a special publication dedicated to ISNL alumni entitled *International Nuclear Law: History, Evolution and Outlook.* The publication was also made available online free of charge. During the past ten sessions, the ISNL has trained more than 550 participants from all around the world. The 2011 session is scheduled to be held from 22 August to 2 September. Further information may be obtained at www.oecd-nea.org/law/isnl/.

Over 20 renowned lecturers taught at the 2010 session, including senior NEA staff.

Some 55 participants from around the world participated in the 2010 session.

Given strong demand for education in nuclear disciplines, including nuclear law, the NEA also began preparations to launch a new programme called International Nuclear Law Essentials (INLE). The INLE will be a one-week, comprehensive course in international nuclear law geared towards professionals with a busy schedule. The first session of the INLE will take place in October 2011.

The sixth Summer Institute of the World Nuclear University (WNU), an intensive six-week programme aimed at building future leadership in nuclear science and technology, took place at Oxford University in the United Kingdom. NEA Legal Affairs and the IAEA Office of Legal Affairs co-ordinated the nuclear law component.

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NUCLEAR SAFETY RESEARCH

The Halden Reactor Project

The Halden Reactor Project, operated by the Norwegian Institute for Energy Technology (IFE), was established in 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 experienced organisation and a technical infrastructure that has undergone substantial developments over the years. The project objectives have been continuously adapted to users' needs.

IFE, Norway

View of the Halden reactor hall.

In 2010, work in the fuel area included continued testing of high burn-up fuel under loss-of-coolant accident (LOCA) conditions. These are the only LOCA tests that are currently being performed in-pile worldwide, and complement the work done at laboratory scale in other institutions, notably in Japan and the United States. The tests carried out thus far have provided valuable insights and have been the basis for benchmarking exercises carried out by the Working Group on Fuel Safety Properties of UO_2, gadolinia and MOX fuels under a variety of conditions relevant to operation and licensing. 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 boiling and pressurised water reactors continued, with the aim of characterising the effect of water chemistry and material ageing.

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 Centre. Progress has been made in the area of human reliability assessment (HRA), aiming to provide data suitable for probabilistic safety assessments and to improve the validity of HRA methods.

The main results of the programme were reported at 35th Enlarged Halden Programme Group meeting, where about 160 participants from all the project's member countries met with about 130 members of Halden staff. There were also a regular meeting of the Halden Programme Group in Belgium in November, and two meetings of the Halden Board in 2010.

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 project for iodine experiments, hosted by Atomic Energy of Canada Limited (AECL), pools international resources to achieve a consolidated understanding of the behaviour of iodine and other fission products in post-accident nuclear reactor containment buildings. 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 2010 and was devoted to discussing the test results as well as the parameters and boundary conditions to be chosen for the remaining tests. Analytical work performed by participants enabled progress in model qualification for iodine behaviour in the containment, and in understanding containment paint behaviour. A follow-up project is planned to start in 2011.

The Cabri Water Loop Project

The Cabri Water Loop Project, which began in 2000, 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.

Two tests (still using the sodium loop) were carried out with high burn-up fuel cladded with zirconium-niobium 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 was made on the reconstruction of the reactor and the construction of the water loop test facility, with the new core envelope and the security tube of the pressurised water loop being implemented. In July 2009, a regulation hydrotest of the pressurised water loop was successfully carried out. The resumption of the tests in the framework of the Cabri Water Loop Project is expected in 2012.

The Cabri tests are being complemented by additional reactivity-initiated accident (RIA) tests performed in Japan. These tests, which constitute the in-kind contribution from the Japan Atomic Energy Agency (JAEA) for its participation in the Cabri Project, will be carried out under both cold and hot coolant conditions, and with both BWR and PWR fuel.

A meeting of the Cabri Technical Advisory Group was held in March 2010. A meeting of the Project Steering Committee was postponed to February 2011 in Paris.

The MCCI-2 Project

The aim of the recently completed Melt Coolability and Concrete Interaction (MCCI) Project was to provide experimental data on relevant severe accident phenomena and to resolve two important accident management issues. The first one concerned 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 concerned 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 utilised the unique expertise and infrastructure developed at Argonne National Laboratory (ANL) for conducting large-scale, high-temperature reactor materials experiments. The US Nuclear Regulatory Commission (NRC) acted 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, a relevant finding that required confirmation. A workshop on the results of MCCI-1 was organised in France in October 2007.

The second phase of the programme (MCCI-2) was completed in 2010. Emphasis was placed on 2D core-concrete interaction experiments, as they provide the integrated effect of many processes. The MCCI-2 Project involved organisations from 12 member countries. The last meeting of the project steering bodies was held in 2010 during which the test results on core-concrete interaction and the test conditions for the molten core cooling test were discussed. A concluding workshop was organised in November 2010 to draw lessons learnt from the project and to consider their application to reactor scale.

The PKL-2 Project

A first PKL Project was performed from 2004 to 2007 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. These 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; and loss of residual heat removal during mid-loop operation with an open reactor coolant system.

A second phase of the project, using the same PKL loop together with the PMK loop in Hungary and the ROCOM facility at Dresden-Rossendorf (FZD), started in 2008 with the support of 14 countries. The PKL-2 tests are investigating safety issues relevant for current PWR plants as well as for new PWR design concepts. They are focusing on complex heat transfer mechanisms in the steam generators and boron precipitation processes under postulated accident situations.

Two meetings of the steering bodies were held in 2010 during which the results of the new tests were presented and the test conditions for the last series of tests were discussed. A complementary test with the ROSA-2 project was defined to study the scaling effects between both facilities.

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 still 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 Fire Propagation in Elementary, Multi-room Scenarios (PRISME) Project (from the French *Propagation d'un incendie pour des scénarios multi-locaux élémentaires)* began in 2006 and has 13 participating countries. The project's objective 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 2010. Two meetings of the project steering bodies were held in April and October. The PRISME integral tests were successfully carried out as per the project schedule, and a series of benchmark exercises were carried out by the analytical working group to conduct cross-comparisons and validations of code modelling approaches. The PRISME test campaigns will conclude during the first half of 2011. A PRISME-2 follow-up project is currently being discussed among interested parties and is expected to commence in July 2011.

The ROSA-2 Project

A first Rig-of-safety Assessment (ROSA) Project was carried out from 2005 to 2009 to address issues in thermal-hydraulics analyses relevant to LWR safety using the ROSA large-scale test facility of the Japan Atomic Energy Agency (JAEA). In particular, it focused on the validation of simulation models and methods for complex phenomena that may occur during transients/accidents. The project was supported by safety organisations, research laboratories and industry in 14 countries, and provided an integral and separate-effect experimental database to validate the code predictive capability and accuracy of models. In particular, 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, and upper-head break and bottom break LOCA were addressed by the 12 tests carried out in the first phase. The project was successfully completed and the final report was released on DVD.

A second phase of the project, called ROSA-2 and using the same large-scale test facility, started in April 2009 with the support of 14 countries. The ROSA-2 programme is to last for three years and will consist of six tests. The subjects will be:

- intermediate break LOCAs (for risk-informed, break-size definition and verification of safety analysis codes);
- steam generator tube rupture (SGTR) and SGTR with steam line break (for improvement and new proposals regarding accident management and mitigation/emergency operation).

These tests will benefit from the utilisation of instruments newly acquired during the first phase of the ROSA Project.

The SCIP-2 Project

The Studsvik Cladding Integrity Project (SCIP) started in July 2004 and completed its first five-year mandate in 2009, when several power ramps and a hot cell programme addressing the various failure mechanisms were executed. The nuclear fuel failure mechanisms studied in the first phase of the project were:

- pellet-cladding 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.

In December 2008, all members of the project steering bodies indicated their interest in continuing the project for another five-year period. SCIP-2 thus began in July 2009 with the participation of 13 countries (two more than in the first phase). The main objective of SCIP-2 is to generate the high-quality experimental data needed for improving the understanding of dominant failure mechanisms for water reactor fuels and to devise means for reducing fuel failures. The major focus will be on cladding failures caused by pellet-cladding mechanical interaction, especially stress corrosion and hydrogen-assisted fracture mechanisms, as well as on the propagation of cladding cracks. Improved understanding based on experiments and analyses is needed in order to reduce the occurrence, or the risk of occurrence, of fuel failures. This understanding is to be applicable to pellet-cladding interaction conditions that can arise during normal operation or anticipated transients, as well as during long-term fuel storage. The proposed programme is intended to complement other international projects in the fuel area. Extensive analyses and theoretical modelling of the fracture mechanisms are to accompany the experimental programme.

In addition to reviewing existing Studsvik ramp data, the project will study the following fuel failure mechanisms:

- pellet-cladding mechanical interaction (PCMI), the mechanical driving force for PCI and hydrogen-induced failures;
- pellet-cladding interaction (PCI), notably when cladding fails due to stress corrosion cracking;
- hydrogen-induced failures: in particular as regards zirconium alloys, classical hydride embrittlement (HE) and delayed hydrogen cracking (DHC).

Two meetings of the project steering bodies took place in 2010, as well as a workshop on pellet-cladding interaction.

The SERENA Project

The Steam Explosion Resolution for Nuclear Applications (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 do not have the required level of detail 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 pre-mixing 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 (French *Commissariat à l'énergie atomique*) corium facilities, including analytical activities. The KROTOS facility is more suited for investigating the intrinsic FCI characteristics in 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.

Two meetings of the project steering bodies were held in 2010. The results of two new tests were presented and discussed, enabling a better specification of the test configurations for the last three tests to be performed. In parallel, analytical activities were undertaken to prepare and to assess these tests. A benchmark on a reactor case is under preparation.

The SETH-2 Project

The first phase of the SESAR Thermal-hydraulics (SETH) Project, supported by 14 member countries, was conducted from 2001 to 2007. It consisted of thermal-hydraulic experiments in support of accident management, which were carried out at facilities identified by the CSNI as those requiring international collaboration to sponsor their continued operation. The experiments carried out at the Paul Scherrer Institute (PSI) PANDA facility in Switzerland provided 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.

A follow-up to the project, called SETH-2, was launched in 2007 and made use of the PANDA facility and the MISTRA facility of the French *Commissariat à l'énergie atomique* (CEA). Nine countries participated. The project aimed to resolve key computational issues for the simulation of thermal-hydraulic conditions in reactor containments and benefited from the complementarity of the two facilities.

The project was completed in December 2010, with two meetings of the project steering bodies having been held in 2010 to present the last test results. A concluding seminar will be organised in 2011 to draw the lessons learnt from this project, including the application to reactor scale.

Installation of refined instrumentation in the PANDA facility.

The SFP Project

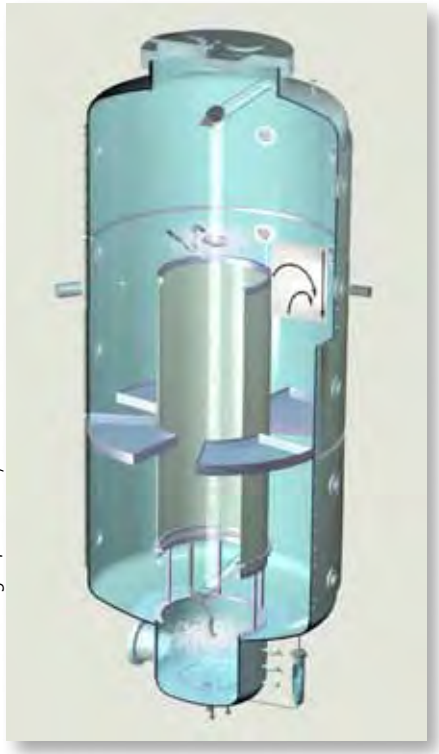
The Sandia Fuel Project (SFP), supported by 13 member countries, began in 2009. The objective of the project is to perform a highly detailed thermal-hydraulic characterisation of full-length, commercial fuel assembly mock-ups to provide data for the direct validation of severe accident codes. Code predictions based on previous results indicate that fuel assemblies can ignite and radially propagate in a complete loss-of-coolant accident. Hence, there is a need for qualified data obtained under representative fuel configurations. The experiments should focus on thermal-hydraulic and ignition phenomena in PWR 17x17 assemblies and supplement earlier results obtained for BWR assemblies. Code validations based on both the PWR and BWR experimental results will considerably enhance the code applicability to other fuel assembly designs and configurations.

The project is scheduled to last three years and to be conducted in two phases. Phase 1 will focus on axial heating and burn propagation. Phase 2 will address radial heating and burn propagation, and will include effects of fuel rod ballooning. The second meeting of the project steering bodies was held in May 2010 during which the programme of work for 2010 and 2011 was approved.

The THAI Project

The Thermal-hydraulics, Hydrogen, Aerosols and Iodine (THAI) Project, supported by eight member countries was completed in 2009. It consisted 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 were 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 were successfully conducted in the THAI facility, which is operated by Becker Technologies GmbH in Germany. The *Gesellschaft für Anlagen- und Reaktorsicherheit* (GRS) and AREVA NP also support the programme.

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 (PARs), 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.



Becker Technologies, Germany

Diagram of the THAI containment vessel.

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 resuspension from a boiling sump. The control of volatile radioactive species is relevant to the potential accident source term and the radioactivity management.

In 2010, a concluding seminar was organised to draw the lessons learnt from this project and to discuss their application to reactor scale. A follow-up project has been proposed with a three-year mandate to address dust transport in advanced gas-cooled reactors, hydrogen mitigation and iodine or aerosol behaviour in specific containment conditions.

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. A new three-year mandate began in January 2008. 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 concentrated on the development of the COMPSIS data collection guidelines, quality assurance and data exchange interface. Countries began submitting data in 2006; however, the total number of event records in the database is still very low and available funds allow the extension of this phase until the end of 2011. Two meetings of the COMPSIS steering body were held in 2010.

The FIRE Project

The Fire Incidents Records Exchange (FIRE) Project started in 2002. A third phase of the project began in January 2010 for an additional four years. Twelve countries participate. The main purpose of the project is to collect and to 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 well-defined and arrangements have been made in all participating countries to collect and to validate data. 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 370 records, is provided to participants every year. One meeting of the project steering body was held during 2010.

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 2008-March 2011. It has also been agreed that a new project phase will start in April 2011 and last until December 2014. 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. Additional activities in the area of quantification are under discussion. Reports have been produced for pumps, diesel generators, motor-operated valves, safety and relief valves, check valves, batteries, switchgear and breakers, and reactor-level measurement. Data exchange for heat exchangers and control-rod drive component exchange is ongoing, and reports are planned for 2011. Two project meetings were held in 2010.

The OPDE Project

The Piping Failure Data Exchange (OPDE) Project started in 2002. A new three-year phase of the project was started in June 2008. Currently, 11 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 2010.

The SCAP Project

The Stress Corrosion Cracking and Cable Ageing Project (SCAP), which was conducted from 2006 to 2010, was supported by 15 member countries. The International Atomic Energy Agency (IAEA) and the European Commission also participated as observers. The project's main objectives were 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.

The project was successfully completed and its assessment report provides the technical basis for commendable practices in support of regulatory activities in the fields of SCC and cable insulation. A final workshop on Commendable Practices for Safe, Long-term Operation of Nuclear Reactors – OECD/NEA Stress Corrosion Cracking and Cable Ageing Project (SCAP) took place on 25-26 May 2010 in Tokyo, Japan.

Following the completion of the SCAP project, SCC-module participants were interested in some form of continuation and discussions were initiated to explore possibilities. It was recognised that there are many aspects very similar to those of the OPDE Project, and it was therefore envisaged to combine the two. As a result, two joint OPDE and SCAP SCC meetings were held in 2010 to define the scope and objectives of a new project called Component Operational Experience, Degradation and Ageing Exchange Programme (CODAP), which is expected to start by June 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 among 25 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 among participants came into force on 1 January 2009 for a period of five years. The objective of the CPD is to acquire and to share information from operational experience in the decommissioning of nuclear installations that is useful for future projects.

The information exchange also ensures that best international practice is made widely available and encourages the application of safe, environmentally friendly and cost-effective methods in all decommissioning projects. It is based on biannual meetings of the Technical Advisory Group (TAG), during which the site of one of the participating projects is visited, and positive and less positive examples of decommissioning experience are openly exchanged for the benefit of all. Currently 59 projects under active decommissioning (35 reactors and 24 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 provided an important analysis of experience in the use of remote handling procedures and equipment, as well as the decontamination of concrete structures.

The Sorption-3 Project

Radionuclide sorption is one of the most important processes with regard to the prevention or retardation of radionuclide migration from a geological repository to the biosphere. It is the overriding objective of the Sorption Project to demonstrate the potential of thermodynamic sorption models to improve confidence in the representation of radionuclide sorption in the context of radioactive waste disposal. After a first phase of the Sorption Project (1997-1998) investigating the potential of thermodynamic models for improving the presentation of sorption in performance assessments for geological repositories, a second phase demonstrating the consistency and applicability of different thermodynamic models was organised from 2000 to 2004. The current third phase of the Sorption Project was started in November 2007 to produce guidelines on thermodynamic sorption model development and the use of such models in building a safety case.

In 2010, Sorption Project participants discussed key challenges in applying thermodynamic models and the use of underlying databases at a workshop entitled From Thermodynamics to the Safety Case which was jointly organised with the NEA Thermochemical Database (TDB) Project. Taking into account the feedback from this workshop, the Sorption Project participants finalised their draft guidelines.

The TDB Project

The Thermochemical Database (TDB) Project aims to make available a high-quality thermodynamic database to meet the needs of those performing safety assessments for the disposal of radioactive waste. The project has been responsible for the publication of reviews of chemical thermodynamic data for the major actinides as well as those elements present in fission or activation products. The project's current mandate runs to 2013, following an extension of one year decided by the TDB Management Board. Sixteen organisations from 14 countries participate.

The reviews on chemical thermodynamic data for inorganic compounds and complexes of iron (Fe) and tin (Sn) were finalised in 2010 with the goal of issuing the results in the first half of 2011. A study of inorganic species and compounds of molybdenum (Mo) and a complementary review of iron (Fe) continued to be pursued in 2010, as was a review of ancillary data used by the project. These studies will be conducted for another two years, with the results planned for publication in late 2012 or in 2013.

RADIOLOGICAL PROTECTION

The ISOE System

Since its creation in 1992, the Information System on Occupational Exposure (ISOE), jointly sponsored by the IAEA, has been facilitating the exchange of data, analysis, lessons and experience in occupational radiological protection (RP) at nuclear power plants worldwide. The ISOE programme maintains the world's largest occupational exposure database and a network of utility and regulatory authority RP experts. As of December 2010, membership included 66 participating utilities from 26 countries, and the regulatory authorities of 24 countries.

Four supporting ISOE Technical Centres (Europe, North America, Asia and the 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 472 reactor units in 29 countries (397 operating units and 75 under decommissioning), thus covering about 90% of the world's operating commercial power reactors. The ISOE database, publications and annual symposia, along with the ISOE Network website, facilitate the exchange among participants of operational experience and lessons learnt in the optimisation of occupational radiological protection.

In 2010, 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, on improving the quality of its occupational exposure database and on migrating ISOE resources to the ISOE Network website (www.isoe-network.net). The four regional ISOE Technical Centres continued to support their regional members through specialised data analyses and benchmarking visits. ISOE information and experience exchange also continued in 2010 through the International Symposium held in Cambridge, United Kingdom, and the regional ALARA symposia held in the United States and the Republic of Korea.

Technical Secretariat

Generation IV International Forum (GIF)

Fourth generation nuclear power plants are the next step in the development of nuclear energy. They will succeed the early prototypes from the 1950s (first generation), the first commercial reactors developed in the 1970s (second generation), and their direct descendants such as the advanced boiling water reactor (ABWR), the AP1000 or the European pressurised reactor (EPR) (all third generation). The goals of fourth generation plants are to improve sustainability (including effective fuel utilisation and minimisation of waste), economics (competitiveness with respect to other energy sources), safety and reliability (for example, no need for offsite emergency response), as well as proliferation resistance and physical protection.

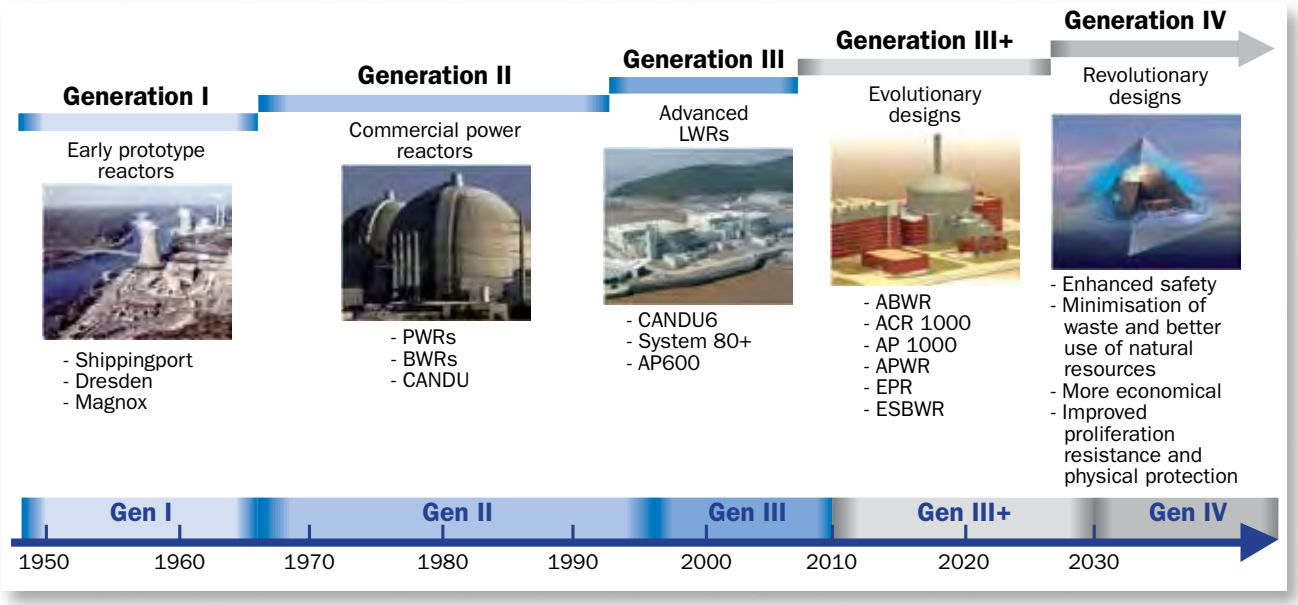
After a thorough review of roughly 100 concepts in 2002, Generation IV International Forum (GIF) members selected six systems for further R&D: the gas-cooled fast reactor (GFR), the lead-cooled fast reactor (LFR), the molten salt reactor (MSR), the sodium-cooled fast reactor (SFR), the supercritical-water-cooled reactor (SCWR) and the very-high-temperature reactor (VHTR). Detailed information on these systems can be found in the "Technology Roadmap for Generation IV Nuclear Energy Systems" (2002) and in its update entitled "GIF R&D Outlook for Generation IV Energy Systems" (2009), both available on the GIF public website (www.gen-4.org/).

In 2003, the GIF governing body asked the NEA to provide Technical Secretariat support to the technical bodies in charge of the development of the six systems and the three methodology working groups. The NEA Steering Committee acknowledged that this role was consistent with the NEA mission, and since then is regularly kept informed of GIF activities. The NEA is fully compensated for its support to the GIF through voluntary, financial and in-kind contributions made by individual GIF members. In 2010, the GIF had ten active members: Canada, China, Euratom, France, Japan, the Republic of Korea, the Russian Federation, South Africa, Switzerland and the United States.

Out of the six systems selected, two appear to be advancing more quickly as they are driven by near-term projects (~2025) connected to practical targets: improvement of resource utilisation (including waste management) with the sodium-cooled fast reactor, and co-generation of electricity and process heat with the very-high-temperature reactor. Regarding sodium technology in GIF member countries, the year 2010 was marked by the restart of the Monju reactor in Japan and first criticality of China's Experimental Fast Reactor (CEFR). For the very-high-temperature reactors, the situation was contrasted by the closure of Pebble Bed Modular Reactor (Pty) Limited (PBMR) in South Africa on the one hand, and the successful operation of the high-temperature test reactor (HTTR) at 950°C in Japan on the other.

Two memoranda of understanding were signed on lead-cooled fast reactors and molten salt reactors in 2010, thus allowing the signatories to start collaboration despite the fact that no formal system arrangement has been signed for those systems to date. In addition to the signature of two additional Project Arrangements (PA) during the year on VHTR materials and SCWR materials and chemistry, GIF members also agreed on the text for the System Integration and Assessment Project Arrangement for the SFR system, a first of its kind in the GIF. This project, considered as the final goal of collaboration for each system, uses the results from the other project arrangements. It will serve as a basis for similar projects for other systems.

In parallel, GIF members developed common methodologies addressing cross-cutting activities related to the GIF goals: risk and safety, proliferation resistance and physical protection, and economics. The current status of these methodologies is available on the GIF website, and software for cost estimates (G4Econs) is available upon request to the Technical Secretariat (emwg@gen-4.org).



Multinational Design Evaluation Programme (MDEP)

The MDEP is a unique multinational initiative undertaken by the nuclear regulators of Canada, China, Finland, France, Japan, the Republic of Korea, the Russian Federation, South Africa, the United Kingdom and the United States to co-operate on safety design reviews of new reactors and to identify opportunities for possible harmonisation and convergence of safety licensing review practices and requirements. The International Atomic Energy Agency (IAEA) participates in many of the MDEP activities, including the harmonisation efforts. In 2010, the third year of the MDEP, representatives from these ten national regulatory authorities continued their co-operative efforts as described below.

2010 highlights

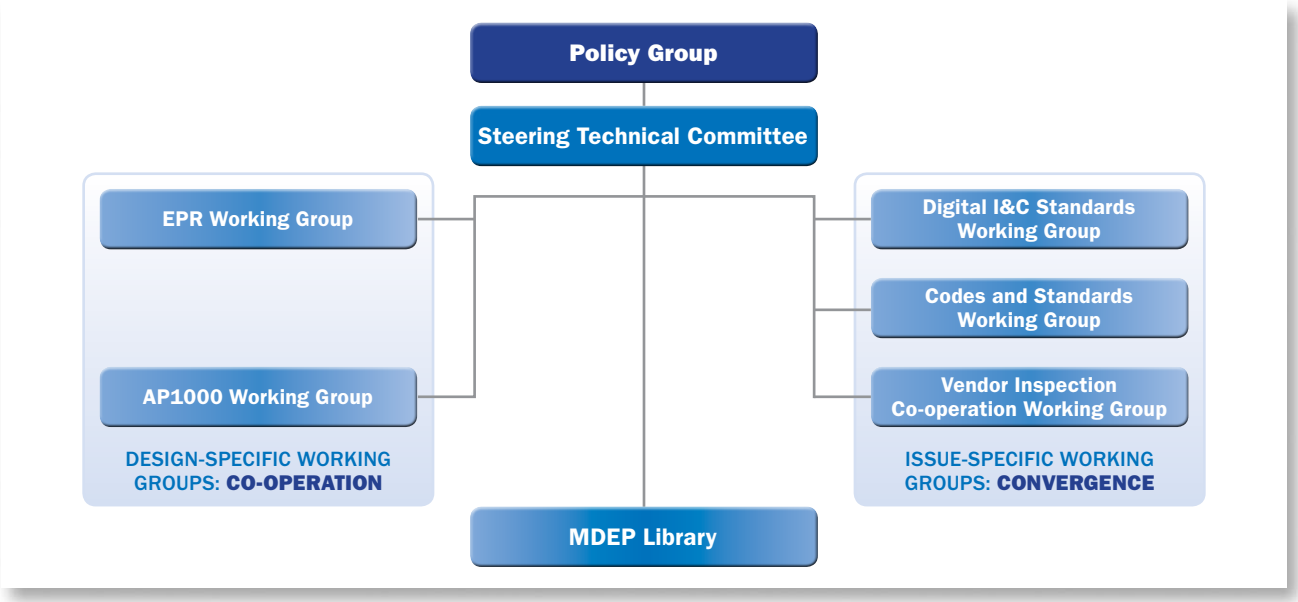
At its March 2010 annual meeting, the MDEP Policy Group, which is comprised of the heads of the ten participating national regulatory bodies, approved the conversion of the MDEP into a long-term programme that should, however, focus on specific interim results. It also agreed to communicate the results and achievements of MDEP activities to other stakeholders, for example non-MDEP regulators, standards development organisations, industry organisations such as the World Nuclear Association, vendors, applicants, licensees and other interested organisations. In organisational terms, in addition to the Policy Group (PG) which provides overall objectives and guidance for the programme, the MDEP Steering Technical Committee (STC) implements MDEP activities and directs the various working groups (two design-specific and three issue-specific groups).

Each MDEP working group is carrying out its respective programme, including completing and revising products such as Common Positions that may be useful both inside and outside the MDEP. The working groups also continue striving to obtain input from important stakeholders such as standards development organisations and industry representatives that are knowledgeable about the regulatory and technical issues being addressed.

The design-specific working groups include the EPR Working Group and the AP1000 Working Group, which co-operate on the safety reviews of AREVA's European pressurised reactor (EPR) and Westinghouse's AP1000 designs. The EPR Working Group includes regulators from China, Canada, Finland, France, the United Kingdom and the United States. In 2010, the EPR Working Group travelled to China to take advantage of discussing technical issues with members of China's National Nuclear Security Administration (NNSA) and its safety reviewers, as well as visiting the construction site at Taishan where the world's third and fourth EPRs are under construction. The AP1000 Working Group involves regulators carrying out reviews of that design such as Canada, China, the United Kingdom and the United States.

The issue-specific working groups have been tasked with studying the similarities and differences in regulatory requirements and practices in MDEP countries. For instance, in the Mechanical Codes and Standards Working Group, the MDEP regulators are working with the various mechanical codes standards development organisations to study why and how the codes differ between their countries. Similar efforts are being undertaken by the Digital Instrumentation and Control Working Group on digital control and safety systems. The Vendor Inspection Co-operation Working Group is co-ordinating inspections of reactor parts manufacturers among interested MDEP countries.

Overall, the MDEP continued to make progress in 2010 on sharing design review information with the objective of ensuring the safety of new reactors. MDEP activities are proving to be key to understanding the differences and similarities among regulatory review and licensing requirements and practices, and are helping to identify opportunities for harmonisation and convergence of licensing approaches.



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

- The Agency produced 66 publications in 2010, of which 16 were put on sale and 50 were distributed free of charge. Overall dissemination, downloads and sales were at record highs.
- The International Conference on Access to Civil Nuclear Energy, co-organised by the French Government and the OECD/NEA in March 2010, significantly enhanced NEA visibility among the 63 countries that participated, many of which at ministerial level. At this event, the NEA Director-General moderated the session on how to finance a nuclear programme.
- Nine press releases were issued on a diverse range of topics, including on the releases of *Projected Costs of Generating Electricity: 2010 Edition*, the *Nuclear Energy Technology Roadmap* and *Uranium 2009: Resources, Production and Demand*, the accession of Poland to NEA membership and nuclear energy's role in the security of electricity supply.
- A number of new information products were made available for wide distribution, including separately printed executive summaries of the *Projected Costs of Generating Electricity: 2010 Edition* and *The Supply of Medical Radioisotopes: An Economic Study of the Molybdenum-99 Supply Chain*, as well as a new NEA brochure.
- The NEA website underwent a major redesign, and a new website address was adopted to better reflect the international nature of NEA work and to highlight its contribution to the overall mission of the OECD.
- An NEA Facebook page was created to provide an additional channel of communication for the Agency's latest news and events.

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 its member countries as well as to other interested parties wishing to learn about nuclear energy's multiple aspects and the results of the Agency's work.

Public affairs and relations with the media

Contacts with the media were very strong in 2010, especially in relation to the International Conference on Access to Civil Nuclear Energy. Another highlight was the 25 March press conference of NEA Director-General Luis Echávarri and IEA Executive Director Nobuo Tanaka on *Projected Costs of Generating Electricity: 2010 Edition*, which also raised the visibility of the NEA with a number of articles in the press. On 18 November, a press conference was organised with Minister Hanna Trojanowska, Commissioner for Nuclear Energy of the Government of Poland, and NEA Director-General Luis Echávarri to announce the OECD Council's decision to accept Poland as the NEA's 29th member country. Press coverage was particularly significant in the Polish media.

Nine press releases were issued in 2010, covering the releases of *Projected Costs of Generating Electricity: 2010 Edition*, the *Nuclear Energy Technology Roadmap* and *Uranium 2009: Resources, Production and Demand*, the 10th anniversary of the International School of Nuclear Law, the 10th anniversary of the Forum on Stakeholder Confidence, the 20th anniversary of the International Nuclear and Radiological Event Scale (INES), the underlying explanation for the shortage in the medical radioisotope supply chain, the accession of Poland to NEA membership and nuclear energy's role in the security of energy supply.

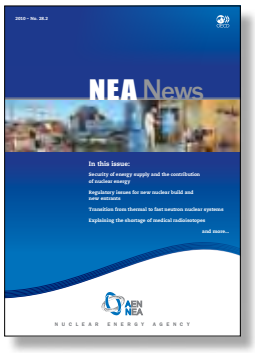
Director-General Echávarri and Minister Trojanowska.

Publications

In 2010, the Agency produced 66 publications, of which 16 were put on sale and 50 were distributed free of charge.

The list of these publications is provided on page 46. Best sellers included Projected *Costs of Generating Electricity: 2010 Edition, Uranium 2009: Resources, Production and Demand* and the *Nuclear Law Bulletin*. NEA publications on sale are also being made widely available via Google Books and the OECD/NEA Nuclear Energy iLibrary.

All free NEA reports are made available in pdf format on the NEA website. The most accessed reports during the course of the year were *PENELOPE-2008: A Code System for Monte Carlo Simulation of Electron and Photon Transport* (67 000 downloads), *Actinide and Fission Product Partitioning and Transmutation: Tenth Information Exchange Meeting* (35 000 downloads), *Nuclear Fuel Behaviour in Loss-of-coolant Accident (LOCA) Conditions* (34 000 downloads) and the *Executive Summary* of *Projected Costs of Generating Electricity: 2010 Edition* (29 000 downloads).



NEA News is the Agency's specialised journal, published twice a year in English and French, which endeavours to keep NEA correspondents and other interested professionals abreast of significant findings and advances in the Agency's programme of work. 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. The journal is available free of charge on the Agency's website at www.oecd-nea.org/nea-news/.

Internet-based communication

The NEA website plays a key role in communicating the work and accomplishments of the Agency. Website traffic was consistently strong in 2010 with an average of roughly 3 300 visitors per day. The website sections that attracted the most visitors were, in order of magnitude: the Data Bank (computer programs and abstracts), nuclear science, nuclear safety, publications and radioactive waste management.

The NEA website was significantly modernised and restructured in 2010. In addition, the Agency adopted a new website address – www.oecd-nea.org – to better reflect the international nature of NEA work and to highlight its contribution to the overall mission of the OECD. This change of address coincided with the beginning of the OECD's 50th anniversary celebrations and the launch of a new OECD website. The NEA has also created a Facebook page where visitors can browse photos, view video clips and keep up-to-date on the Agency's latest news. The page is available at www.facebook.com/OECDNuclearEnergyAgency.

The number of individual subscriptions to the *NEA Monthly News Bulletin* increased by 10%, with over 22 000 subscribers by the end of 2010. Distributed free of charge, the bulletin includes monthly updates on important NEA activities and newly released reports. A sign-up form is available at www.oecd-nea.org/general/register.

Online interaction with NEA delegates continues to expand. Most NEA committees and their working groups rely extensively on electronic communication such as password-protected extranet pages, e-mail discussion lists or online collaborative work spaces to support their work.

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 official OECD 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

The main event for the NEA in 2010 was the International Conference on Access to Civil Nuclear Energy which took place at the OECD Conference Centre in Paris on 8-9 March. This conference was organised by the French Government in collaboration with the OECD and the NEA, and with the support of the International Atomic Energy Agency (IAEA). The OECD and the NEA were key in providing technical support for the preparation of the conference programme and the necessary infrastructure.

The purpose of the conference was to facilitate dialogue between the countries seeking access to nuclear power for the first time and the countries exporting this technology. More than 1 100 representatives from 63 countries, of which 40 at ministerial level, attended the conference. The French President, the President of the European Commission, the IAEA Director-General and the OECD Secretary-General delivered keynote speeches at the opening session, and the French Prime Minister gave the closing speech. As it was the first time that the French President visited the OECD, he offered a plaque dedicated to co-operation and solidarity between nations for a stronger, cleaner, fairer world economy. NEA Director-General Luis Echávarri was the moderator of the session on how to finance a nuclear programme. This major international conference offered many opportunities for the NEA to highlight its work, in particular its publication on *The Financing of Nuclear Power Plants*, and to raise its visibility among a considerable number of member and non-member countries, as well as within the OECD itself.

The NEA was also active in co-sponsoring several other international conferences. Of particular note were the Technical Meeting on the Application of Advanced Safety Assessment Methods held in Slovenia in June, the 17th Pacific Basin Nuclear Conference on Nuclear Energy: An Environmentally Sound Option held in Mexico in October, the 3rd East Asia Forum on Radwaste Management held in Korea in early November, and the 7th International Topical Meeting on Nuclear Plant Instrumentation, Control and Human-machine Interface Technologies organised in the United States in November.

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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. In 2010, the main activity of the WGPC consisted of finalising the report on commendable practices for the transparency of regulatory activities and the technical notes on local public information and on the use of public perception surveys. Surveys were conducted among regulators on crisis communication in the case of high media interest. Answers are being analysed and compiled into WGPC guidance reports.

Radioactive Waste Management Committee (RWMC) Forum on Stakeholder Confidence (FSC)

The FSC celebrated its 10th anniversary with a colloquium in Paris on 15 September 2010. Over 100 Forum members, community representatives, academics, politicians and journalists attended from NEA member countries and beyond. They discussed lessons learnt regarding partnership arrangements between radioactive waste management institutions and local communities, and ways to increase the value of waste repositories to civil society. The colloquium produced numerous suggestions for themes and activities to be considered by the FSC in the future. Academic researchers from French and UK universities reviewed FSC learning methods and the large body of reports made available online (www.oecd-nea.org/fsc). These external observers noted the care with which the FSC has formed practices broadly inclusive of many types of stakeholders as well as the quality of the resulting publications. FSC lessons were also found to apply to other fields, from nanotechnologies and GMOs to new nuclear build. Based on an online evaluation, national workshops and community visits emerged as the most popular and effective means of joint learning; the FSC has organised seven such workshops.

Over the past decade, the FSC has issued several reports analysing the societal aspects of radioactive waste management. They are available on the FSC pages of the NEA website, along with summary flyers in several languages. In 2010, the FSC published *Partnering for Long-term Management of Radioactive Waste* which illustrates experience in 13 countries with decision-making in collaboration between waste management institutions and local or regional stakeholders. It provides detailed information on legal arrangements and compensation rules, among others. The 2010 report *More Than Just Concrete Realities: The Symbolic Dimension of Radioactive Waste Management* shows that key concepts such as "safety" or "reversibility" carry different meanings for different stakeholders or societal groups. Opinions and attitudes are shaped not only by actual events, but also by values, norms, knowledge, beliefs and cultural tradition. Better understanding of different underlying interpretations can contribute to taking more robust decisions; the FSC points out that such understanding is developed through dialogue.

Radiological protection

The NEA Workshop on Practices and Experiences in Stakeholder Involvement for Post-nuclear Emergency Management was held in October 2010 in Washington DC, and hosted by the US Nuclear Regulatory Commission. The workshop provided a forum for over 70 experts representing organisations from 16 countries to exchange information and experience on approaches to, and issues in, stakeholder involvement in post-nuclear emergency management, to identify areas where enhancements in stakeholder involvement in post-nuclear emergency management could be achieved nationally and internationally, and to recommend approaches to address these areas. The workshop's conclusions will be published as an NEA report. The key collective views of the international experts participating at the workshop identified *inter alia* that:

- preparedness for stakeholder involvement should be a top priority;
- use of existing networks and communication systems increases efficiency and enhances interactions;
- incentives for participation enhance stakeholder involvement;
- agreement on rules, procedures and processes improves stakeholder interactions;
- a broad spectrum of stakeholders is essential in emergency exercise planning.

In support of this workshop, the NEA Expert Group on Stakeholder Involvement and Organisational Structures investigated how emergency management organisations have adapted to the opportunities and challenges presented by stakeholder involvement in post-nuclear emergency preparedness and response. Five NEA member countries were surveyed (Finland, France, Norway, the United Kingdom and the United States), and present a wide variety of political, institutional and cultural contexts, and approaches to post-emergency management. The mandate and role of national emergency management organisations in different countries vary greatly. Legal and regulatory obligations assigned to the different types of stakeholders concerned by post-emergency management also vary considerably from one country to another. The survey reveals a general trend among emergency management organisations to address longer-term issues beyond the early or crisis phase, to pursue a multitude of objectives, and to use a diversity of tools and methods for stakeholder involvement. The results of this work were issued under the title "Survey on Organisational Adaptation to Stakeholder Involvement in Post-nuclear Emergency Management" [NEA/CRPPH(2010)5].

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 34 OECD member countries, 29 are members of the NEA:

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

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 2010 meeting):

- Mr. Richard STRATFORD (United States), Chair
- Ms. Marie-Elise HOEDEMAKERS (Netherlands), Vice-Chair
- Mr. Frédéric MONDOLONI (France), Vice-Chair
- Dr. József RÓNAKY (Hungary), Vice-Chair
- Mr. Kazuo SHIMOMURA (Japan), 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 on the next page.

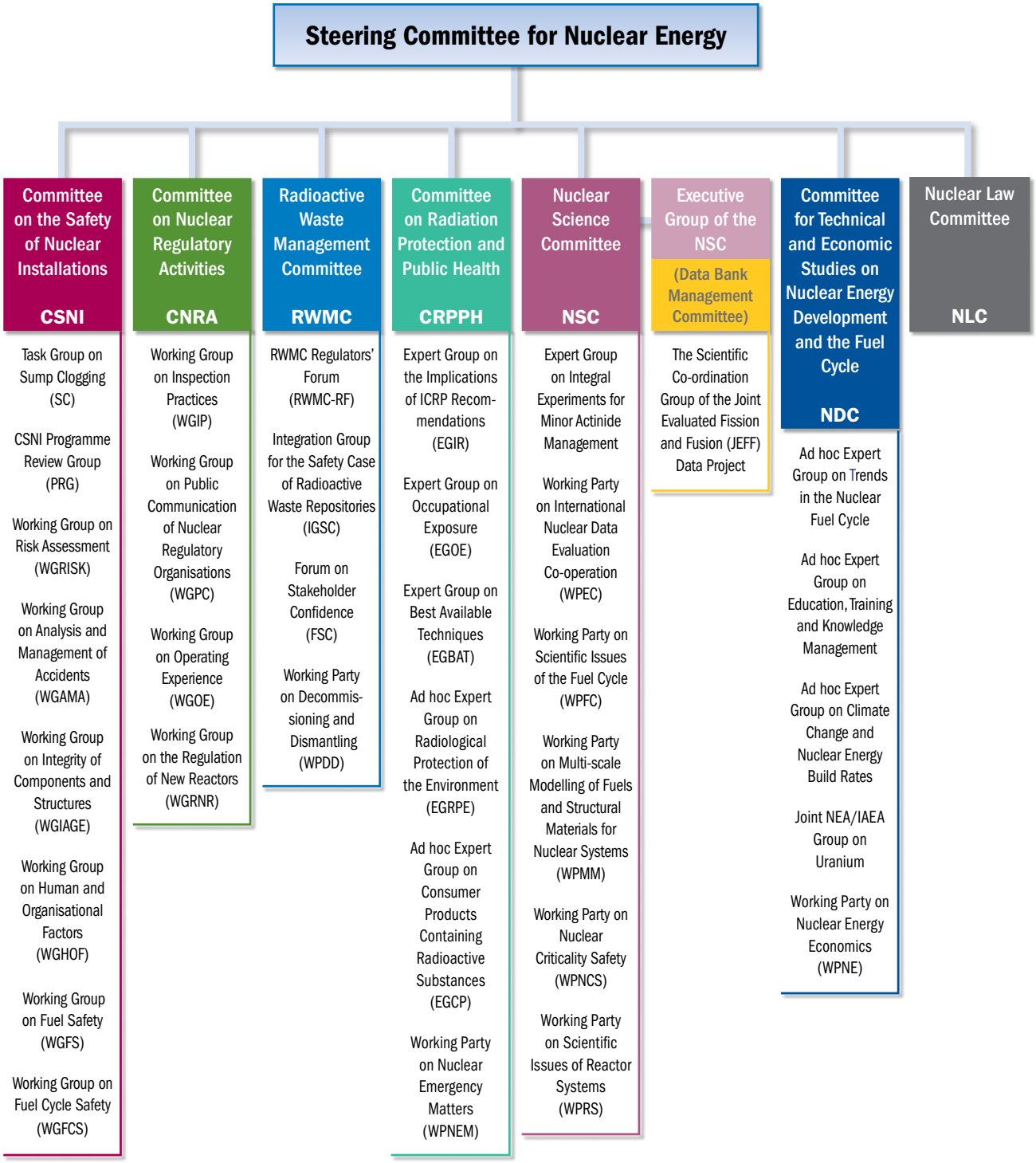
The Steering Committee for Nuclear Energy and the Agency's seven standing technical committees are serviced by **the NEA Secretariat**, composed in 2010 of 61 professional and support staff from 15 countries. Professional staff are often specialists from national administrations and research institutes, 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 all NEA standing technical committees and has recently applied for NEA membership. Experts from selected other countries, including China and India, take part in NEA activities on a more ad hoc basis.

The OECD Conference Centre, Paris.

One of the Conference Centre meeting rooms.

NEA Committee Structure



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Luis Echávarri
Director-General

Janice Dunn Lee
Deputy Director-General

Uichiro Yoshimura
Deputy Director
Safety and Regulation

Thierry Dujardin
Deputy Director
Science and Development

Serge Gas
Head
Central Secretariat, External Relations and Public Affairs

Ricardo Lopez
Head
Management Support Unit

Julia Schwartz
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Hans Riotte
Head of Division
Radiological Protection and Radioactive Waste Management

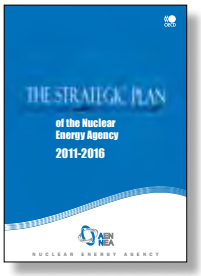
Javier Reig
Head of Division
Nuclear Safety

Ron Cameron
Head of Division
Nuclear Development

Thierry Dujardin
Acting Head
Data Bank
(Kiyoshi Matsumoto from May 2011)

Claes Nordborg
Head of Section
Nuclear Science
(Jim Gulliford from April 2011)

NEA Publications and Brochures Produced in 2010



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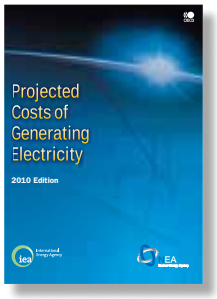

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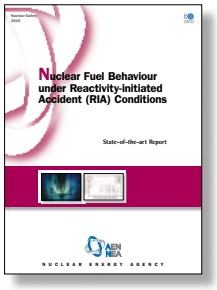

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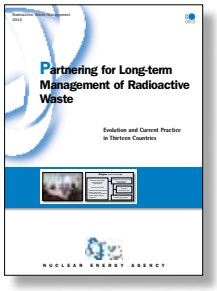

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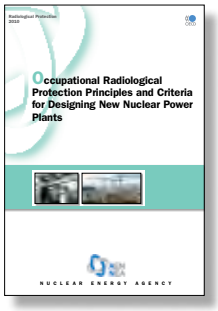

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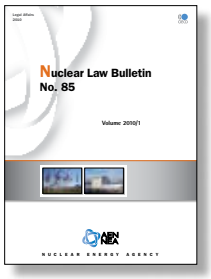

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