The NEA in Brief – 2014

Governing body:
The Steering Committee for Nuclear Energy

31 member countries (25 in the Data Bank)
56 years of international service
7 standing technical committees
74 working parties and expert groups
22 international joint projects funded by participants
2 Secretariat-serviced bodies
93 staff (official and voluntary contribution posts, NEA and Data Bank combined)
€ 11.1 million budget for the NEA in 2014, supplemented by voluntary contributions
€ 3.1 million budget for the Data Bank in 2014, supplemented by voluntary contributions
24 publications produced in 2014

The NEA and its mission

The Nuclear Energy Agency (NEA) is a semi-autonomous body within the Organisation for Economic Co-operation and Development (OECD), located in the Paris area in France. The objective of the Agency is to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes.
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2014 was a year of change for the Nuclear Energy Agency. After 17 years at the head of the NEA, my good friend Luis Echávarri retired, leaving an impressive legacy of growth and progress. In particular, his initiatives and leadership in expanding the membership of the NEA and enhancing strategic partnerships with China and India have and will continue to lead to profound changes. More change is underway and yet to come.

Since my arrival at the NEA on 1 September 2014, I have engaged with the staff of the Agency, various committees and many representatives of member countries to assess the state of the NEA and begin developing approaches to respond to the very significant changes transpiring in today’s complex, interconnected world and, particularly, in the nuclear field. It seems that every few years or so, some respected figure notes that nuclear energy is – once again – at a crossroads; that vital decision points are approaching that will set the path for the future. Only the perspective of history can reveal the reality, but it seems quite likely that the middle of the current decade will indeed be a major crossroads for nuclear energy.

In recent years, almost everything has changed in the nuclear landscape. Despite their continued technological pre-eminence, traditional suppliers of nuclear plants have seen their shares of the global market slipping away as new players enter the field, offering services and financing that many buyers find more attractive than the most advanced technologies. The list of countries building, planning and preparing to build new nuclear plants is the largest it has ever been with discussions and debates about new build taking place on every continent. While plants applying advanced Generation III+ technologies, long planned, are finally nearing completion, even newer light water reactor designs are already approaching the market. In parallel, the allure of small modular reactors attracts the attention of prospective buyers and policymakers alike.

At the same time, sweeping changes in the energy markets – from shale gas in North America to renewables support in Europe – have altered the plans of electricity planners and forced officials around the world to consider the market value of reliability and system stability in order to maintain the financial viability of baseload plants such as nuclear power stations. In some cases, nuclear plants will be closed permanently and decommissioned, which will present new challenges for many countries. Potentially adding a new dimension to these changes, the United Nations will soon convene the COP 21 conference which, if it is successful, could mark another dramatic shift.

Perceptions of nuclear safety have changed in the wake of the nuclear accident brought on by the Great East Japan Earthquake and Tsunami. Nuclear plants around the world have made physical and operational enhancements to respond to new regulatory requirements. We are reviewing and refining our approaches to ensure radiological protection and supporting the difficult work in Japan to remediate the Fukushima Daiichi site. Important progress has been made, but much work is still before us to address the most challenging lessons of the Fukushima Daiichi accident – how to deal effectively with the human aspects of nuclear safety as reflected in safety culture, training, organisational factors and regulatory independence.

Against the backdrop of so much flux and uncertainty, the work of the future must proceed. Member countries will need solutions to deal with radioactive waste. They will need access to advanced technologies and scientific information to make the best plans and decisions regarding their future directions. They will need strong legal frameworks to ensure strong nuclear safety regulation and the world must come together to provide a comprehensive, international approach to nuclear liability.

Change is upon us and the NEA must continue to adapt to the new challenges of the day. The expert analyses, reviews and recommendations we – staff, committees and working groups, experts and partners – bring to the global discussion has never been more important. This report highlights the work we have accomplished during 2014 but also sets the path for the steps needed to support the priorities of our members in the years to come.

William D. Magwood, IV
NEA Director-General
Nuclear Power in 2014

Nuclear energy development

In 2014, nuclear development projects slowed as demand and prices for electricity slumped, particularly in liberalised electricity markets, and project costs increased. Low coal and natural gas prices (particularly in North America), along with the subsidised development of variable renewable energy sources in several countries,1 also impacted markets, making new investments in large power plants more difficult. Despite these headwinds, significant steps towards the realisation of new nuclear power construction projects were taken in Hungary, Poland, Turkey and the United Kingdom. There are currently projects underway to build more than 60 new reactors in 13 countries around the world.

At the end of 2014, there were 358 operational reactors connected to the grid in the 31 NEA member countries. One reactor was connected to the grid in the Russian Federation (Rostov 3) and the European Union approved the contract for difference (CFD) scheme proposed in the United Kingdom.2 Elsewhere, one reactor in the United States was permanently shut down (Vermont Yankee) and all operational reactors in Japan remained offline. At the end of 2014, nuclear electricity generating capacity in NEA countries constituted approximately 16% of the world total, and production accounted for some 19% of their total electricity supply.

Significant reactor-related developments in NEA member countries include:

- In Belgium, concerns about security of electricity supply were heightened in late 2014 as a transformer fire forced an unplanned shutdown of the Tihange 3 reactor, at a time when the Doel 3 and Tihange 2 reactors were offline for further investigation by the regulator due to pressure vessel fault indications, and Doel 4 remained shut down after a lubricant leak. The Tihange 3 reactor was returned to service within two weeks after repair. Late in 2014, the Belgian government agreed to a ten-year extension of the operation of Doel 1 and 2 amid concerns about the security of energy supply.

- Canada is moving ahead with plans to refurbish up to an additional 10 reactors in Ontario over the next 15 years starting in 2016. These refurbishments represent a total investment of about CAD 25 billion and will add about 25-30 years to the operational life of each unit.

- In the Czech Republic, the state power company ČEZ cancelled the tender process for two additional reactors at the Temelin site after the government refused to provide guaranteed prices for electricity generated from the new units.

- In Finland, construction of Olkiluoto 3 was once again delayed, with grid connection now expected in 2018, some eight years later than originally planned. A revised proposal by the Fennovoima consortium to build a reactor supplied by Rosatom for the Pyhäsalmi site was approved by the government. However, a request for a five-year extension of the 2010 decision in principle for the Olkiluoto 4 project was turned down, meaning that the utility Teollisuuden Voima Oyj (TVO) will either have to apply for a construction licence before 30 June 2015 or apply for another decision in principle from the government at a later date.

- In France, legislation for the transition to a low-carbon economy, which would, in particular, reduce national reliance on nuclear power from the current 75% to 50% of electricity production by 2025, was approved by the French National Assembly, and is currently being discussed at the Senate. Completion of construction of Flamanville 3 was delayed by one year until 2017.

- In Hungary, an agreement was signed with Rosatom to supply two new units (approximately 1 200 MWe each) for the Paks nuclear power plant (NPP) and the parliament ratified a EUR 10 billion credit agreement with the Russian Federation to finance the project. Unit 2 of the existing four reactors supplied by the Russian Federation received a 20-year lifetime extension, the second at the site to be granted such an extension.

- In Japan, utilities have applied for the regulatory review of the conformity of 21 reactors to meet tough new regulatory standards, which is a crucial step in the restart process. By the end of 2014, four applications had been approved (Sendai 1 and 2, and Takahama 3 and 4), but all 48 operational reactors remained offline. A new energy policy dating from April 2014 states that nuclear power is an important baseload electricity source, but that it will be limited to the extent possible. To make up for the loss of nuclear generating capacity, imports of fossil fuels for electricity generation have resulted in increased greenhouse gas emissions, increased electricity prices and a growing trade deficit.

1. Note, however, both Germany and Spain have moved to slow the pace of developing renewables and to reduce the costs to consumers by changing the existing subsidy arrangements.

2. The CFD scheme guarantees a minimum price for electricity generated at new nuclear power stations for 35 years, and thus improves prospects of nuclear new build in the United Kingdom. This approach could be applied elsewhere.
### 2014 nuclear data summary (as of 31 December 2014)

<table>
<thead>
<tr>
<th>Country</th>
<th>Operational reactors</th>
<th>Installed capacity (GWe net)</th>
<th>Uranium requirements (tonnes U)</th>
<th>Nuclear share of electricity production (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>7</td>
<td>5.9</td>
<td>870</td>
<td>50.0</td>
</tr>
<tr>
<td>Canada</td>
<td>19</td>
<td>13.4</td>
<td>1 800**</td>
<td>13.7**</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>6</td>
<td>3.9</td>
<td>675**</td>
<td>33.3</td>
</tr>
<tr>
<td>Finland</td>
<td>4</td>
<td>2.8</td>
<td>425</td>
<td>34.7*</td>
</tr>
<tr>
<td>France</td>
<td>58</td>
<td>63.1</td>
<td>8 000**</td>
<td>77.0*</td>
</tr>
<tr>
<td>Germany</td>
<td>9</td>
<td>12.1</td>
<td>2 000**</td>
<td>15.8*</td>
</tr>
<tr>
<td>Hungary</td>
<td>4</td>
<td>1.9</td>
<td>215</td>
<td>49.1</td>
</tr>
<tr>
<td>Japan</td>
<td>48</td>
<td>42.4</td>
<td>1 200**</td>
<td>1.7**</td>
</tr>
<tr>
<td>Mexico</td>
<td>2</td>
<td>1.4</td>
<td>190</td>
<td>4.4</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1</td>
<td>0.5</td>
<td>60</td>
<td>3.5</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>23</td>
<td>20.7</td>
<td>4 200</td>
<td>30.0</td>
</tr>
<tr>
<td>Russian Federation*</td>
<td>34</td>
<td>24.7</td>
<td>3 800**</td>
<td>18.6</td>
</tr>
<tr>
<td>Slovak Republic</td>
<td>4</td>
<td>1.8</td>
<td>360</td>
<td>55.0**</td>
</tr>
<tr>
<td>Slovenia</td>
<td>1</td>
<td>0.7</td>
<td>150</td>
<td>37.2</td>
</tr>
<tr>
<td>Spain</td>
<td>8</td>
<td>7.5</td>
<td>1 125</td>
<td>20.4</td>
</tr>
<tr>
<td>Sweden</td>
<td>10</td>
<td>9.5</td>
<td>1 415**</td>
<td>42.6**</td>
</tr>
<tr>
<td>Switzerland</td>
<td>5</td>
<td>3.3</td>
<td>370**</td>
<td>36.3**</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>16</td>
<td>9.4</td>
<td>1 515</td>
<td>16.6</td>
</tr>
<tr>
<td>United States</td>
<td>99</td>
<td>98.5</td>
<td>17 650**</td>
<td>19.4**</td>
</tr>
<tr>
<td><strong>Total (OECD)</strong></td>
<td>358</td>
<td>323.6</td>
<td>46 020</td>
<td>18.6**</td>
</tr>
</tbody>
</table>

* Secretariat estimates. ** 2013 data. Operational = connected to grid.

- In Poland, the government adopted the national nuclear programme, moving the country closer to the construction of its first nuclear power plant. Site selection is planned to be completed in 2016.
- In the Republic of Korea, a new national energy plan was approved that reduces dependence on nuclear power but still requires that an additional nine reactors begin operation by 2022.
- In the Russian Federation, a technological solution was developed to resolve graphite stack problems in RBMK reactors that could have led to the early closure of some units and to repairs for all of the 11 large reactors of this type in operation. Plans to start the construction of three BN-1200 sodium fast neutron reactors by 2030 were announced.
- In the Slovak Republic, the completion of the construction of two additional units at the Mochovce NPP is delayed due to design safety improvements and technology updates. The new units are now expected to be in operation in November 2016 (unit 3) and 2017 (unit 4) respectively.
- In Spain, the Santa Maria de Garoña reactor moved one step closer to resuming operation when the operator submitted details to the nuclear regulator on how the company plans to meet requirements for restart.
- In Turkey, an environmental impact assessment (EIA) of the project to build four VVER reactors at the Akkuyu site was approved; a framework agreement was signed to build four ATMEAn reactors at the Sinop site; and an agreement was signed with Westinghouse and the China State Nuclear Power Technology Corporation for exclusive negotiations to construct four AP1000 reactors at a third, unnamed site.
- In the United States, the single Vermont Yankee reactor was shut down in late 2014, as small, single reactors operating in states with liberalised energy markets continued to face strong competition from gas-fired and subsidised renewable generating sources. Construction of two AP1000 units each at the Vogtle and VC Summer sites continued, with completion expected between 2017 and 2020. Construction of the Watts Bar 2 reactor resumed in 2007 and is expected to be completed in 2015. In September 2014, the economic simplified boiling water reactor (ESBWR) design was certified for use in the United States by the Nuclear Regulatory Commission (NRC).

Additional developments worldwide include:
- In Argentina, one reactor was connected to the grid (Atucha 2) and construction of the prototype SMR Carem 25 was initiated.
- In Bangladesh, the government and the Bangladesh Atomic Energy Commission (BAEC) continued preparations for the construction of the first two-unit NPP (2 GWe) in the country by completing an agreement with Russia for site preparation work in view of the planned official beginning of construction of the first unit in 2015.
- In Belarus, construction of the Belarusian 2 unit was started.
- India continued with its ambitious nuclear development programme, with six reactors under construction. Concerns arising from the 2010 Civil Liability for Nuclear Damage Act in India continued to limit participation of foreign vendors.
• Iran signed agreements with Rosatom for the construction of an additional eight units (four at Bushehr and four at another, undetermined site).

• In the Peoples’ Republic of China, which has the most rapidly expanding nuclear power programme, 3 reactors were connected to the grid (Ningde 2, Fuqing 1 and Fangjiashan 1) and 26 reactors were under construction. Furthermore, Chinese companies signed contracts with Argentina and Romania to work towards the construction of three additional heavy water reactors at existing sites in these two countries.

• South Africa advanced with its plans to construct an additional 9 GWe of nuclear generating capacity.

• In the United Arab Emirates, construction of the Barakah 3 unit was initiated.

• Viet Nam chose Rosatom’s AES-2006 design for the first four reactors in its nuclear power programme expected to begin operation in 2023. The country continues to work with Japan to determine technology options for a second nuclear power plant.

Uranium production, conversion and enrichment

Preliminary data indicate that global uranium production declined by about 5% from 2013 to about 56 500 tonnes of uranium (tU) in 2014, with production slowed at a number of facilities owing to poor market conditions. Uranium was produced in eight NEA member countries in 2014, although France, Germany and Hungary contributed only very small amounts as part of mine remediation activities. Australia (9%), Canada (16%), the Czech Republic (<1%), the Russian Federation (5%) and the United States (3%) together accounted for a significant share of world production. Production in NEA member countries totalled just over 19 000 tU in 2014, a decline of about 8% from 2013 but covering approximately 40% of NEA member country uranium requirements. Remaining requirements were met by other producing countries and secondary sources (material derived from dismantling warheads, excess commercial inventories and reprocessed uranium).

Commercial uranium conversion facilities were in operation in Canada, France, the Russian Federation, the United Kingdom and the United States. Construction of additional conversion capacity continued in France at the Comurhex II facility to reach a total capacity of 15 000 tU, with development paced to meet market requirements. Cameco ended a contractual arrangement with the Springfields conversion facility in the United Kingdom on 31 August 2014, several months earlier than the terms of the agreement, citing weak market conditions.

Two recently built high-efficiency uranium centrifuge enrichment plants (AREVA’s Georges Besse II plant in France and URENCO’s facility in the United States) continued commercial operations through 2014, with capacity expansions underway or planned at both facilities. In the United States, Global Laser Enrichment announced plans to slow development of its laser enrichment technology owing to poor market conditions, but it continues discussions with the US Department of Energy (DOE) on a proposal to re-enrich about 115 000 tonnes of depleted uranium tails stored at the Paducah site with the new enrichment technology.

<table>
<thead>
<tr>
<th>Country</th>
<th>Resources (%)</th>
<th>Production (%)</th>
<th>Production (tU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>28.9</td>
<td>9</td>
<td>5 000</td>
</tr>
<tr>
<td>Canada</td>
<td>8.4</td>
<td>16</td>
<td>9 000</td>
</tr>
<tr>
<td>United States</td>
<td>3.5</td>
<td>3</td>
<td>1 900</td>
</tr>
<tr>
<td>Namibia</td>
<td>6.5</td>
<td>6</td>
<td>3 600</td>
</tr>
<tr>
<td>Niger</td>
<td>6.9</td>
<td>7</td>
<td>4 000</td>
</tr>
<tr>
<td>South Africa</td>
<td>5.7</td>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>11.5</td>
<td>40</td>
<td>22 800</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>8.6</td>
<td>5</td>
<td>3 000</td>
</tr>
<tr>
<td>China</td>
<td>3.4</td>
<td>3</td>
<td>1 500</td>
</tr>
<tr>
<td>Ukraine</td>
<td>2.0</td>
<td>2</td>
<td>1 000</td>
</tr>
<tr>
<td>Others</td>
<td>14.6</td>
<td>8</td>
<td>4 200</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100</strong></td>
<td><strong>56 500</strong></td>
</tr>
</tbody>
</table>

*Identified resources recoverable at less than USD 130/kgU (2013 data).  **2014 estimates.
Nuclear safety and regulation

In 2014, NEA member countries continued to address lessons learnt from the Fukushima Daiichi accident as a high priority for nuclear safety. Lessons learnt have led to plant improvements (for example, improved diversity and robustness of safety functions), enhanced accident management (instrumentation, guidelines for impaired systems, enhancements in offsite response capability), innovative post-accident recovery and clean-up solutions (such as management of contaminated water, recovery strategies and innovative solutions, and regulatory infrastructure enhancements to oversight and guidance). Moreover, NEA member countries recognised the vital importance of developing and sustaining strong safety cultures in operating organisations and regulatory bodies, together with a clear understanding of the importance of effective crisis communication.

Looking forward, NEA member countries are exploring opportunities to address safety knowledge gaps through information that can be gained during activities to recover the Fukushima Daiichi site and to decommission the reactors. Valuable information can be gained during decommissioning and subsequent research activities, for example in relation to the performance of safety systems or safety-support systems beyond their anticipated capabilities, the mechanisms for component and system failure, the effects of salt water on reactor internals, the general behaviour of the reactor fuel and of fission products, and the validation of models and computer codes for severe accident consequences. Such information could also contribute to the safe and timely completion of decommissioning activities.

Countries all over the world, including NEA member countries, have completed self-assessments in light of lessons learnt from the Fukushima Daiichi accident. These self-assessments have outlined improvements in general nuclear safety, emergency preparedness and response arrangements. The assessments also show that countries are placing increased importance on the following areas: independence of regulatory bodies, transparency, safety oversight within licensees, safety culture, knowledge management, quality and availability issues in the supply of materials and services, instrument and control systems, long-term operation and the reduction of radioactive releases, and severe accident management and emergency preparedness. National safety frameworks are being further improved with steps being taken to establish the effective independence of regulatory bodies and to update regulations. International co-operation is also increasing with greater participation in peer reviews and exchanges of information among countries.

International collaborative efforts are yielding improvements in regulatory practices as well as enhanced knowledge and understanding of existing and new technology. NEA member countries have sought to reinforce nuclear safety worldwide by promoting a convergence in safety practices and combining the expertise of participating regulatory authorities, while improving and expediting the safety review of new designs. Lessons learnt from the Fukushima Daiichi accident will continue to impact the design requirements of new reactors.

Radioactive waste management

Considerable effort is being expended in NEA member countries in the field of radioactive waste management. In several European countries, for example, acts or amendments to legislation have been adopted in order to meet the first transposition deadline (August 2013) of the directive adopted by the Council of the European Union on 19 July 2011. Under this directive, member states of the European Union are required to establish, maintain and implement comprehensive national programmes covering the management of all spent fuel and radioactive waste from generation to disposal. The directive also calls for provisions to ensure and reinforce transparency and public participation in decision making.

Other highlights are as follows:

- In Canada, the Nuclear Waste Management Organization (NWMO) is making good progress towards implementing a long-term solution for nuclear fuel waste. As of December 2014, there were 13 communities (i.e. 12 in Ontario and 1 in Saskatchewan) participating in the NWMO siting process to determine whether they would like to become host to a future deep geological repository project for nuclear fuel waste. Results to date do not confirm the suitability of any site, and no community has expressed a willingness to host the project at this early stage.

- In the Czech Republic, the siting process for a spent fuel repository is still being defined, with the implementer, the Radioactive Waste Repository Authority (RAWRA), focusing on dialogue with pre-candidate municipalities. Despite a considerable effort to move forward with the geological survey preparations, no significant progress was achieved. RAWRA has not received agreement from the local municipality representatives to begin geological survey activities at the selected localities.

- In Finland, the hearing process has been launched after the nuclear waste management organisation, Posiva, submitted a construction licence for a spent fuel repository in the municipality of Eurajoki. Posiva had applied for a construction licence in 2012 for a final repository, which includes an above ground encapsulation plant and underground repository, for 9 000 tonnes of used fuel from Olkiluoto and Loviisa. STUK was expected to complete its review of plans in February 2015.

- In France, a national debate was held on a project proposal for a deep geological repository (DGR) of high-level and long-lived, intermediate-level waste in the Meuse-Haute Marne area (i.e. the Cigeo Project). This public debate ended in 2013 and will inform the promulgation of a law by the National Assembly. To take into account the views expressed during the debate, the French national radioactive waste management agency, Andra, has decided to make four changes in pursuing
the project, including the incorporation of a pilot industrial phase of the DGR and the further implication of stakeholders in the continuing decision-making process. Andra expects to submit its plans to the government with a view to operation and disposal beginning in 2015.

- In Germany, a law was passed on a strategy and schedule for the siting of a geological repository for high-level waste (HLW). The siting process should restart after a review of the entire process by a federal parliament committee, comprised of waste management experts and members of relevant groups of civil society.

- In Japan, the work of the geological disposal research programme is ongoing while an HLW management policy is being debated among several national organisations. In April 2014, HLW disposal was part of the new Basic Energy Plan, which included facilitating the construction and use of new facilities for the dry storage of intermediate-level waste. A working group on geological disposal, composed of technical and scientific experts, was established and is currently examining the characteristics of geological formations suitable for disposal in Japan.

- In the Republic of Korea, stakeholders submitted their views on spent fuel management policy to government, and a larger engagement process is planned. The safety case for the HLW disposal programme is being developed.

- In the Russian Federation, the design process has begun for the development of a deep geological repository for high-level and long-lived waste. A working group on geological disposal, composed of technical and scientific experts, was established and is currently examining the characteristics of geological formations suitable for disposal in Japan.

- In the United Kingdom, Radioactive Waste Management Limited (RWM) was formed as a wholly owned subsidiary of the Nuclear Decommissioning Authority (NDA) on 1 April 2014. A white paper, “Implementing Geological Disposal”, was published in July 2014 and a national geological screening exercise was launched on 30 September 2014. This screening exercise will have three parts: development of guidance, application of the guidance and scrutiny of activities.

- In the United States, the Nuclear Regulatory Commission (NRC) requested that the Department of Energy (DOE) prepare the supplemental environmental impact statement (EIS) needed to review the licence application for the Yucca Mountain project under the National Environmental Policy Act. On 28 February 2014, the DOE notified the NRC that it did not intend to complete the supplemental EIS, but rather would provide the NRC with an updated analysis that would provide the technical information necessary to inform the supplement. Following the issuance of the Safety Evaluation Report (SER), and submission of the necessary technical information to complete the supplemental EIS, a number of licensing steps will remain to reach a decision on construction authorisation for a repository at Yucca Mountain. This includes holding adjudicatory hearings on nearly 300 admitted contentions. Volume 3 of the SER, the technical evaluation, was published in October 2014 and confirmed that Yucca Mountain would meet all the regulatory requirements for a repository.

### Interim storage

Overall, there has been good progress in both the technical and societal development of geological repositories, but in many countries, the timing of the decision-making processes has made it necessary to consider storage for extended periods, notably in Germany, Japan and the United States. In Spain, a project to implement a centralised interim storage facility for all HLW and spent fuel is on schedule, with construction anticipated to begin in Villar de Cañas in 2018. In the United States, the NRC completed work on its “Waste Confidence Rule” (now known as...
the “Continued Storage of Used Fuel” rule, a legal document that would provide generic criteria for the environmental impacts of the continued storage of spent nuclear fuel beyond the licensed operational life of a reactor. The rule, with the supporting generic environmental impact statement (GEIS), was adopted by the NRC in August 2014 and came into effect in October 2014. In Hungary, an operating licence was granted for further modules of interim spent fuel storage. In Australia, the Muckaty site (Northern Territory) remained under consideration as one of the potential sites for a low-level waste repository and an intermediate-level waste store. However, some of the traditional owners dissented and launched legal action to attempt to derail the process. The Northern Land Council (NLC) then withdrew the application in June 2014 due to “divisions within the aboriginal community” exacerbated by “outside pressures”.

Low- and intermediate-level waste

Progress has been made in the area of low-level waste as well. In Belgium, a licence application for a surface disposal facility at Dessel was submitted in 2013. In Canada, the Joint Review Panel (JRP) for the Deep Geological Repository Project for the low- and intermediate-level waste (LILW) held two rounds of public hearings to collect input from all stakeholders in 2014. The JRP will provide notice of the decision to close the public registry once sufficient information has been collected. An Environmental Assessment Report will then be submitted by the JRP to the Federal Minister of Environment, which will assist the Environment Minister in rendering a decision. In Hungary, a new governmental decree was issued on 30 June 2014 concerning the safety requirements for interim storage facilities and final disposal facilities of radioactive waste. For the LILW repository in Bátapáti, the disposal concept was developed and the construction of two new disposal chambers started in 2014. In Korea, the LILW repository in Wolsong was licensed in late 2014 and will start operation in 2015 after a two-month test operation. In the Russian Federation, a LILW repository planned for the Leningrad region is in the design stage, and the construction of the first stage of another LILW repository in the Urals region has been completed. In the United States, the NRC amended its regulation 10 CFR Part 61 to establish a site-specific, risk-informed approach to low-level waste disposal that can address a wide range of potential wastes.

Decommissioning

In general, as decommissioning programmes are implemented, the rate of production of very-low-level and low-level waste will increase, and waste management organisations will need to accommodate this increased flow, through the extension of existing disposal facilities for example. Decommissioning plans, as well as decommissioning cost estimation studies, continue to be regularly updated in NEA countries. In Sweden, for instance, operators have presented updated decommissioning plans for nuclear power plants, and these are currently being reviewed by the Swedish Radiation Safety Authority. The Nuclear Damage Compensation and Decommissioning Facilitation Corporation (NDF) in Japan was restructured on 21 August 2014 to implement a strategy of debris retrieval and waste management for the decommissioning of NPPs where an accident had taken place. Overall, experience has shown that NEA countries with nuclear power programmes are committed to learning lessons not only about improving safety but also about the decommissioning of plants and the remediation of sites.

Radiological protection

The first few years following the Fukushima accident were essentially dedicated to identifying and understanding the lessons from the evolving situation. Many of these lessons were revealed to have been based on widely known information that had not been fully understood or implemented around the world. Today, the bulk of the Fukushima radiological protection lessons seem to point towards areas that could evolve to better support radiological protection regulation and application, in particular as regards the importance of communication and approaches to emergency and recovery management.

While the need to communicate effectively has long been a topic of study, this specific aspect of radiological protection has emerged as an area of central importance. Good decisions in this regard cannot be applied unless they are understood and accepted by those to whom they will apply. For example, decisions made concerning an end to the application of evacuation-related decisions have been extremely difficult to communicate and therefore have not resulted in a significant increase in the number of evacuated persons returning to the area.

The identification and implementation of the optimum radiological protection decision for a particular circumstance has been shown to be a complex issue. The scientific aspects of any radiation exposure situation – the source of irradiation, the potential for internal and external exposure, the ambient dose rates, the size and nature of the areas contaminated – need to be characterised as well as possible, and the magnitude of scientific uncertainties also needs to be clearly portrayed. However, in many if not most situations the driving force behind decisions will be more judgement than fact, while what is of value to those being exposed (e.g. living at home, protecting their children, maintaining their jobs, maintaining social infrastructures) should be of central importance to those making decisions about how to manage exposure in an optimum fashion. The primary decision-makers include central, intermediate and local government officials, as well as industrial managers responsible for radiological protection and members of the public who may be exposed. Since the different aspects of radiological protection will vary from situation to situation, the radiological protection framework through which they should be taken into account should evolve to more directly support the different levels of decision-makers described.
Radiological protection science has continued to advance in 2014. Although epidemiological studies are difficult to undertake due to the vast uncertainties involved (e.g. assessments of individual doses after lengthy periods, accounting for personal habits such as smoking or diet, identification of relevant control groups), new results from the southern Urals suggest that chronic exposures carry a similar risk to that of acute exposures. Those exposed to a particular dose level over months or years, for instance, appear to have a broadly linear and similar risk to those exposed acutely to the same dose level over hours or days. Several studies appear to suggest that statistically significant risks (e.g. cancer incidence and cancer-caused death) may be associated with exposures in the 50 to 100 mSv range, and that a linear, non-threshold model of the dose/risk relationship remains among the possible options to describe the data that now exists. On the other hand, radiation biology suggests that the “bystander effect” (whereby cells around a cell hit by radiation, but not themselves hit, express injury) and “genetic instability” (whereby cells affected by radiation do not express genetic errors for several cell-division cycles) do not seem to be as relevant to understanding radiation-induced cancers as was originally suspected. Biomarkers, which could identify radiation-induced cancers, continue to be a topic of research rather than an available tool.

Radiological protection science and application studies continue to be carried out, with the scientific study of low-dose effects being a topic of particular interest in Europe. Approaches to applying the aforementioned lessons are being developed and shared internationally.

Nuclear science

Enhancing the capacity of light water reactors (LWRs) to withstand severe accidents continues to be the subject of detailed technical study at the national and, increasingly, at the international level. Several research programmes are underway to assess alternative fuel and cladding materials with enhanced capabilities to retain radioactive nuclides during extreme events. There is now broad consensus on the desired characteristics of these alternative materials, namely a capacity to avoid hydrogen production and exothermic reactions with steam, an increased thermal conductivity and a higher melting point. Several materials with these types of behaviour have been identified and current efforts are focusing on completion of laboratory tests ahead of the selection of the most promising materials for further development. The latter will contribute to new accident-tolerant fuel (ATF) concepts, which may ultimately move forward for extensive in-core testing. Part of the process of down-selection of candidate designs will involve the application (and possible enhancement) of severe accident modelling codes used to quantify and compare the effectiveness of such designs in reducing the consequences of this type of accident.

Research activities in support of advanced reactor systems are set to continue with further refinement of established design concepts over the next few years. For future reactor systems, there has been a continued trend towards the study and development of systems and fuel designs that help minimise radioactive waste. Some proposed fuel designs include the presence of significant quantities of minor actinides as part of transmutation strategies. There is also evidence of continued interest in the possibility of substituting the current uranium/plutonium fuel cycle with a thorium/uranium-233 approach. A key technical challenge for the development of advanced and innovative reactor systems is the prediction of materials performance, particularly in the area of fuels.

The trend for more probabilistic-based approaches to safety assessment continues, along with an associated move towards best-estimate modelling methods. In addition, the availability of high performance computers is leading to the development of ever more complex modelling methods, including coupled multi-physics simulations used for accident analyses and computational fluid dynamic (CFD) methods used for thermal-hydraulics modelling. These trends serve to emphasise the importance of the rigorous treatment of uncertainties and the need for validation against appropriate experimental data.

In the context of validation experiments, the availability of dedicated nuclear research and test facilities continues to be of concern, highlighting the value of data from completed programmes as well as the potential benefits of future experiments. An interesting development has been a recent trend to use measurements from operational power reactors as a supplemental source of validation data. In part, this has become feasible through the availability of higher fidelity modelling methods capable of simulating the detailed evolution of the reactor system during operational cycles.

Many of the technical areas discussed above have seen a decline in the number of experts actively involved in their research programmes over the past decade. With continued high rates of retirement, the need to train, educate and develop a new generation of technical specialists is becoming acute in some areas. It now appears likely that resource limitations (financial and skills capabilities) are at the point where continuation of some high-cost, specialised R&D programmes are perceived as no longer practicable at a national level and that future programmes are more likely be carried out through international collaboration.

Nuclear law

Ensuring that adequate and equitable compensation is made available to victims who suffer injury or damage as a result of a nuclear accident occurring at a nuclear installation or during the transport of nuclear substances remains a primary concern. In the wake of the Fukushima Daiichi accident, the IAEA Action Plan on Nuclear Safety, which was endorsed in September 2011 by the General Conference of the IAEA, called on member states to work towards establishing a global liability regime
that addresses the concerns of all states that might be affected by an accident with a view to providing appropriate compensation for damages suffered. The International Expert Group on Nuclear Liability (INLEX) issued a set of recommendations in June 2012 to facilitate progress towards a global nuclear liability regime. Several initiatives were also undertaken to encourage multilateral co-operation in achieving a global nuclear liability regime, such as the Joint Statement on Liability for Nuclear Damage issued by France and the United States in August 2013, the G20 Leaders’ Declaration of September 2013 and the Franco-Russian Nuclear Power Declaration signed in November 2013. In April 2014, the NEA Steering Committee held a policy debate on progress towards a global nuclear liability regime, during which it:

- stressed the importance of achieving greater globalisation and harmonisation of nuclear liability regimes in order to ensure adequate and timely compensation for damage to persons and property resulting from a nuclear accident and to promote consistent treatment of potential victims and operators worldwide;
- noted the benefits of adhering to one of the nuclear liability regimes, and more particularly to the enhanced nuclear liability regimes, to achieve greater globalisation and harmonisation of nuclear liability coverage, whether through adherence to the Paris Convention on Third Party Liability in the Field of Nuclear Energy (“Paris Convention”), the Vienna Convention on Civil Liability for Nuclear Damage (“Vienna Convention”) or the Convention on Supplementary Compensation for Nuclear Damage (CSC);
- encouraged NEA member countries with nuclear power programmes and other consenting countries to adhere to one of the enhanced nuclear liability regimes and to adopt consistent legislation, if they have not already done so;
- encouraged NEA member countries party to the regimes established by the Paris Convention or the Vienna Convention to join the efforts to establish a more global nuclear liability regime by adhering to the Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention, and/or to the CSC, if they have not already done so;
- noted the importance of ensuring an adequate legal framework to make the necessary funds available to compensate victims in case of a nuclear accident, while ensuring that the operator assumes the primary financial responsibility for compensation;
- invited NEA member countries to continue drawing lessons from the Japanese experience in order to improve states’ respective nuclear liability legislation and to ensure that states are prepared to manage the practical aspects of claims processing and administration;
- and identified the NEA as a useful forum for discussing the benefits of establishing a global nuclear liability regime and facilitating the harmonisation of national legislation in nuclear power states which are not yet party to one of the nuclear liability regimes, such as China and India.

The NEA member countries that signed the 2004 Protocols to amend the Paris Convention and the Brussels Convention Supplementary to the Paris Convention (“Brussels Supplementary Convention”) continue to work towards implementing 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. It is expected that Italy and the United Kingdom will adopt ratification and implementation legislation, which should allow the 2004 Protocols to enter into force by 2016. Belgium, Finland, the Netherlands and Spain have already adopted transitory legislation which transposes into its national legislation the compensation levels provided in the 2004 Protocols pending their entry into force.
The Fukushima Daiichi Accident and NEA Follow-up

Nuclear regulation

Since the Fukushima Daiichi nuclear power plant accident in March 2011, the NEA has provided direct assistance to the Japanese authorities in order to help in the development and implementation of national safety reviews and stress tests, to define the main elements in achieving effective regulatory reform, and to encourage best practices in the remediation of land contaminated with radioactive materials, as well as the planning and effective management of decontamination and decommissioning activities. Among the numerous international activities organised figure joint research projects and meetings among nuclear regulators, nuclear safety experts, public health specialists and civil society stakeholders. Following the 2013 publication of a summary report of key NEA actions and member country responses to the Fukushima Daiichi accident, entitled The Fukushima Daiichi Nuclear Power Plant Accident: OECD/NEA Nuclear Safety Response and Lessons Learnt, a fi e-year milestone report is now under preparation.

The milestone report will provide a high-level summary of the outcomes of activities initiated through the NEA to address safety issues arising from lessons learnt since the accident. The objective is to demonstrate what has been done by the NEA and its member countries to improve safety since 2011. While the Committee on Nuclear Regulatory Activities (CNRA) will lead the production of the report, input will also be provided from the Committee on the Safety of Nuclear Installations (CSNI) and the Committee on Radiation Protection and Public Health (CRPPH).

NEA committees continue to work on high-priority activities to address issues arising from the accident, including filtered containment venting, hydrogen management and related computer codes, and probabilistic safety assessments (PSAs) of natural external hazards such as earthquakes. Reports were produced on these subjects as well as on spent fuel pools under loss-of-cooling and loss-of-coolant accidents (LOCAS), metallic component margins under high seismic loads and on the robustness of NPP electrical systems in light of the Fukushima Daiichi accident.

Two other important initiatives taken by the NEA in 2014 were the formation of a Task Group on Natural External Events (TGNEV) and of a Senior Expert Group on Safety Research Opportunities Post-Fukushima (SAREF). The task group has reviewed possible areas for international collaboration and recommended that a working group be formed on external events in 2015. The senior expert group is making good progress in determining potential safety research that would address safety knowledge gaps and support the safe and timely decommissioning of the Fukushima Daiichi reactors. Following the accident, a joint project was initiated in 2012 to carry out a Benchmark Study of the Accident at the Fukushima Daiichi Nuclear Power Plant (BSAF) with eight NEA member countries. The project is intended to improve severe accident (SA) codes and to analyse accident progression and the current core status in order to support remediation and decommissioning activities. In 2014, a draft report was prepared for phase 1 of the project, covering the first six days of the accident. This report should be completed in early 2015. A second phase will cover a longer time frame and analyse fission product behaviour.

Nuclear safety defence-in-depth

The NEA Senior-level Task Group on Defence-in-Depth (STG-DiD) met twice in 2014 and made considerable progress on the preparation of the regulatory guidance report on defence-in-depth in light of the Fukushima Daiichi accident. One of the main objectives of the report is to explain the background, concept and context of defence-in-depth, which is a well-established tool to assist in delivering high levels of nuclear safety. The report will also make recommendations to enhance the implementation and use of defence-in-depth, while taking into account the lessons learnt from the Fukushima Daiichi accident.

Radiological protection

By the end of 2014, nearly four years after the accident, significant decontamination and infrastructure work had been accomplished. Many people have remained in the Fukushima Prefecture, working with mostly local experts to try to understand the radiological nature of their situation and to adjust their lives to their new reality. Yet contamination and structural issues remain to be resolved, and many of those who evacuated have not returned, in particular young people and families with young children. Some of the areas initially evacuated have been decontaminated and more fully characterised such that evacuees will be permitted to return and live in these areas if they so choose.

Decontamination

Contamination levels in the Fukushima Prefecture have steadily decreased, mostly through natural radiological decay. Figure 1 shows the progressive status of the contamination footprint resulting from
the accident. The affected areas in the Prefecture remain divided into two sections: those to be decontaminated and managed by Japan’s central government (broadly within the 20-km zone and the evacuation zone to the northwest of the installation), and those to be decontaminated and managed through the Prefecture by the affected municipalities themselves. This delineation was made based on modelled annual doses that are either above or below 20 mSv/y.

This designation was enacted by law with the passage of the Act in August 2011 on Special Measures Concerning the Handling of Radioactive Pollution. According to this Act, which came into force in January 2012, the government and municipalities are required to develop decontamination implementation plans and to implement decontamination projects (collection, transfer, temporary storage and final disposal). The two areas designated by the Act are the special decontamination areas and the intensive contamination survey areas (see Figure 2).

It is in the special decontamination areas – the 11 municipalities in the formerly restricted zone or planned evacuation zone (< 20 km from the NPP, in which the annual cumulative dose is > 20 mSv) – where decontamination is to be implemented by the national government. These municipalities include the entire areas of Naraha, Tomioka, Okuma, Futaba, Namie, Katsurao and Iitate, and some areas of Tamura, Minami Soma, Kawamata and Kawauchi. See Table 1 for the status of decontamination activities in the different municipalities.

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**Figure 1: Progression of radiation levels in affected areas**

Source: Nuclear Regulation Authority (NRA), Japan.

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**Figure 2: Status of the evacuation areas**

Evacuation orders are still in effect for these municipalities:

- **Area 1** Dose < 20 mSv/y
  - Evacuation directive is ready to be lifted
- **Area 2** 20 mSv/y < Dose < 50 mSv/y
  - People are not permitted to live there at this time
- **Area 3** 50 mSv/y < Dose*
  - People are not permitted to live there

*Annual accumulative dose is not expected to decrease to 20 mSv by 2016.

Source: Support Team for Residents Affected by Nuclear Incidents, Cabinet Office, Japan.
Table 1: Status of decontamination activities managed by the central government

<table>
<thead>
<tr>
<th>Prefecture</th>
<th>Population in decontamination target area (approx. no. of people)</th>
<th>Decontamination target area (ha, approx.)</th>
<th>Progress of the decontamination work (as of the end of March 2014)</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tamura</td>
<td>400</td>
<td>500</td>
<td>Decontamination plan secured completed completed in June 2013</td>
<td>Completed in FY 2013*</td>
</tr>
<tr>
<td>Naraha</td>
<td>7 700</td>
<td>2 100</td>
<td>Decontamination plan secured completed completed in March 2014</td>
<td>Completed in FY 2013*</td>
</tr>
<tr>
<td>Kawauchi</td>
<td>400</td>
<td>500</td>
<td>Decontamination plan secured completed completed in March 2014</td>
<td>Completed in FY 2013*</td>
</tr>
<tr>
<td>Okuma</td>
<td>400</td>
<td>400</td>
<td>Decontamination plan secured completed completed in March 2014</td>
<td>Completed in FY 2013*</td>
</tr>
<tr>
<td>Minami-Soma</td>
<td>13 300</td>
<td>6 100</td>
<td>Decontamination plan secured ~ 30% in progress</td>
<td>FY2015* FY2016*</td>
</tr>
<tr>
<td>Iitate</td>
<td>6 000</td>
<td>5 600</td>
<td>Decontamination plan secured ~ 80% in progress</td>
<td>2014 2016</td>
</tr>
<tr>
<td>Kawamata</td>
<td>1 200</td>
<td>1 600</td>
<td>Decontamination plan secured in progress</td>
<td>Summer 2014 2015</td>
</tr>
<tr>
<td>Katsurao</td>
<td>1 400</td>
<td>1 700</td>
<td>Decontamination plan secured in progress</td>
<td>Summer 2014 2015</td>
</tr>
<tr>
<td>Namie</td>
<td>18 800</td>
<td>3 300</td>
<td>Decontamination plan secured ~ 40% in progress</td>
<td>FY2015* FY2016*</td>
</tr>
<tr>
<td>Tomioka</td>
<td>11 300</td>
<td>2 800</td>
<td>Decontamination plan secured ~ 40% in progress</td>
<td>FY2015* FY2016*</td>
</tr>
<tr>
<td>Futuba</td>
<td>300</td>
<td>200</td>
<td>Decontamination plan under co-ordination under co-ordination under co-ordination (plans not formulated)</td>
<td>Still under co-ordination to formulate a plan</td>
</tr>
</tbody>
</table>

*FY = Fiscal year. In Japan, the government’s financial year runs from 1 April to 31 March.

Management of contaminated food

A key concern after the accident has been the management of food from affected areas. The current contamination limits for food in becquerels/kilogramme (Bq/kg) – assuming that 50% of consumption is contaminated at the limit value and that this results in less than 1 mSv/y for those most at risk – are as follows: general food (100 Bq/kg), milk (50 Bq/kg), infant food (50 Bq/kg) and drinking water (10 Bq/kg).

Through significant efforts to reduce uptake by plants, focusing on caesium-137 and using approaches such as potassium fertiliser, or removal of contaminated bark from fruit trees, the number of samples of various foods exceeding the limit has been significantly reduced from 2011 to 2013 (see Table 2). Real food contamination was rare, particularly of food that was in the trade channels. Extensive measurements of rice from the region demonstrated low contamination on the one hand and an excellent measurement network for agricultural products on the other hand.

Table 2: Food sampling results

<table>
<thead>
<tr>
<th>Category</th>
<th>No. of samples</th>
<th>Sample &gt; limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2013 (no.)</td>
</tr>
<tr>
<td>Rice</td>
<td>10 990 000</td>
<td>28</td>
</tr>
<tr>
<td>Wheat</td>
<td>592</td>
<td>0</td>
</tr>
<tr>
<td>Beans</td>
<td>5 163</td>
<td>21</td>
</tr>
<tr>
<td>Vegetables</td>
<td>19 657</td>
<td>0</td>
</tr>
<tr>
<td>Fruits</td>
<td>4 243</td>
<td>0</td>
</tr>
<tr>
<td>Tea</td>
<td>446</td>
<td>0</td>
</tr>
<tr>
<td>Other agricultural products</td>
<td>1 618</td>
<td>0</td>
</tr>
<tr>
<td>Milk</td>
<td>2 040</td>
<td>0</td>
</tr>
<tr>
<td>Meat and eggs</td>
<td>194 945</td>
<td>0</td>
</tr>
</tbody>
</table>

*FY = Fiscal year. In Japan, the government’s financial year runs from 1 April to 31 March.
Continuing efforts

Although much has been accomplished, a significant amount of physical and social work remains to be undertaken in the Fukushima Prefecture. The Japanese government is continuing with work in areas such as environmental monitoring, decontamination, distribution of safe food, health surveillance of residents, health surveillance of NPP workers, assistance to residents who decide to return home, reconstruction work, compensation for residents and the decommissioning of the Fukushima Daiichi nuclear power plant.

Remaining challenges

Much progress has also been made in terms of clean-up activities in the various affected areas, but again more remains to be accomplished. Social reconstruction is the primary aspect, which includes helping evacuees to decide whether or not to return, and helping those who stayed to decide whether to leave. Concerns go well beyond radiological aspects, and relate more specifically to ensuring the sufficient number of schools, hospitals, stores, infrastructure and employment. Along with concern over risks to children, these appear to be the most important factors for citizens in the Fukushima Prefecture. It is essential for them to be appropriately informed and supported in making decisions about where and how to continue their lives.

One of the more sizable challenges that has arisen during work in the region thus far is that of enhancing trust in the Japanese government, a trust that was seriously eroded by the accident. The International Commission on Radiological Protection (ICRP) work with Fukushima Prefecture stakeholders has suggested that the government's work is having little influence on people's actions because it is often distrusted. The re-establishment of trust in the government would therefore be an important tool in improving the efficiency of extensive government efforts being undertaken to address the consequences of the accident.

Radioactive waste management

Since the Fukushima Daiichi accident, approximately 400 000 m³ of all forms of radioactive waste have been stored at the Fukushima Daiichi site. This volume of waste is expected to increase once full-fledged work on decommissioning and dismantling of the reactors and buildings begins.

In March 2014, the Radioactive Waste Management Committee (RWMC) decided to establish the Expert Group on Fukushima Waste Management and Decommissioning R&D (EGFWMD) with the primary aims of offering advice on the management of large quantities of Fukushima Daiichi onsite waste with complex properties and of sharing experiences with the international community. The EGFWMD is composed of international experts with experience in past nuclear accidents, as well as Japanese experts and waste management specialists from the NEA Secretariat. These experts have extensive experience in waste management during radiological contamination or in decommissioning and waste management R&D, for example, after the Three Mile Island or Chernobyl accidents. They are expected to provide technical opinions and advice on waste management and R&D at the Fukushima Daiichi site.

The first meeting of the EGFWMD was held in July 2014 in Fukushima, Japan. Participants had a lively exchange of views about waste management, offering their individual experiences and reporting on the current status of waste management at Fukushima Daiichi. They also took the opportunity to visit the Fukushima Daiichi site and its waste storage area in particular, as well as the Japan Atomic Energy Agency (JAEA) Fuel Cycle Engineering Laboratories where the radiological and chemical analysis of the accident waste is being carried out.

The EGFWMD will produce an advisory report in mid-2016 with the results of its research on waste management at the Fukushima site. The group began to discuss the report in detail at its second meeting in November 2014. The gaps between past experiences and current activities at the site will be identified in different technical areas such as the strategy for final waste destination, stakeholder engagement and the relationship between the regulator and implementer. These experiences will be shared with NEA member countries and will be a reference for future activities in radioactive waste management.
NEA Activities by Sector
The goal of the NEA in this sector is to provide governments and other relevant users with authoritative, reliable information on a broad range of factors relevant to the current performance and future viability of nuclear power generation – including economic and resource analyses, public opinion and perceptions, advances in nuclear technology and the nuclear fuel cycle, electricity production data and nuclear knowledge management – for use in policy analysis and decision making, as well as to provide forecasts on the future role of nuclear energy in a sustainable development perspective and within the broad context of national and international energy policies. The staff works closely with the Committee for Technical and Economic Studies on Nuclear Energy Development and the Fuel Cycle (NDC) and its expert groups in this area.

**Highlights**

- The NEA published a first-of-its-kind report on Managing Environmental and Health Impacts of Uranium Mining.
- Eleven countries adhered to the Joint Declaration on the Security of Supply of Medical Radio-isotopes established under NEA auspices.
- The International Energy Agency (IEA) and the NEA collaborated on the 2015 update of the Technology Roadmap: Nuclear Energy, highlighting the role that nuclear power can play alongside other low-carbon technologies in mitigating climate change.
- A workshop on the management of construction and the supply chain was organised in March 2014 to support the report on nuclear new build. It attracted approximately 75 participants from national governments, industry, the World Nuclear Association (WNA), the European Commission and the International Atomic Energy Agency (IAEA).

**Policy and strategic issues**

While most member countries have validated their nuclear energy policies following initial reactions to the Fukushima Daiichi accident, debates continue in some countries, including in France and Japan, on the role that nuclear energy will play in overall energy policy. A major challenge facing the nuclear sector is financing the construction of new plants in markets that do not provide long-term price signals. This challenge is exacerbated by cost over-runs and delays in relation to some of the first-of-a-kind projects for the construction of generation III reactors.

Another key issue that the Fukushima Daiichi accident called attention to was the costs associated with decommissioning, remediation and compensation following an accident. An Ad Hoc Expert Group on Costs of Nuclear Accidents, Liability Issues and their Impact on Electricity Costs was established in 2013 to conduct an appraisal of existing studies and data on the economic costs of severe nuclear accidents (Three Mile Island, Chernobyl, Fukushima Daiichi). It will also provide methodological advice on cost assessments, perform damage estimates for selected accident scenarios and describe the existing liability regimes in NEA countries, as well as consider implications and potential improvements. Several meetings and workshops were held in 2014 and a final report is expected in 2015.

The NEA continues to work with other parts of the OECD on energy and climate issues. It took part in the IEA in-depth reviews of Canada, the European Union, Japan, Spain and Turkey in 2014, and assisted the IEA with the review of the nuclear chapters of the 2014 World Energy Outlook. Together with the IEA, the NEA made final preparations for a 2015 update of the Technology Roadmap: Nuclear Energy, highlighting the role that nuclear energy can play in decarbonisation scenarios (such as the 2-degree scenario or 2DS) and identifying technological evolutions and policy measures that can support reaching 930 GW of installed capacity by 2050 to meet the 2DS.

Together with the IEA, the NEA is pursuing a 2015 update of Projected Costs of Generating Electricity. Overseen by an international expert group, the project is progressing well with publication foreseen in May 2015.

The NEA is also collaborating on the OECD-IEA-ITF-NEA report on Aligning Policies for the Transition to a Low-carbon Economy. This project responds to a mandate given at the May 2014 OECD Ministerial Council Meeting. Nuclear energy has a major role to play in the transition to a low-carbon economy, and the NEA is therefore working closely with partners to ensure its coverage in the report.

**Decommissioning and new build**

Work continued in 2014 on the project related to costs and funding for the decommissioning of nuclear power plants. This issue continues to attract much attention, as there is a need for more clarity on the main cost drivers for decommissioning and a means to quantify them in a robust way that includes associated uncertainties. The study should help to provide...
confidence in funding mechanisms and their capacity to adequately cover legacy costs. Two meetings of the Ad Hoc Expert Group on Costs of Decommissioning were held in 2014. Due to a delay in the collection of the data, it was decided to examine a set of available data for the United States, using a recent report prepared for the US Nuclear Regulatory Commission (NRC). More work is needed to compare data and analyse assumptions in order to formulate estimations of overall cost ranges for decommissioning. A final draft report should be prepared for the last meeting of the group in March 2015.

The project concerning the review of nuclear new build continued in 2014 to examine the structure of project management, the supply chain during construction and financing. The strategic challenge for new nuclear power is to manage the ongoing transition of the global nuclear power industry in technological (from Generation II to III), geographic (from NEA countries to Asia) and structural terms (reconfiguration of the global supply chain). Without government intervention, nuclear power will increasingly be confined to regulated markets with either strong population and electricity demand growth or long-term commitments to low-carbon electricity production. The conceptual framework of the study was developed in 2014, with the integration of results from a major workshop, expert contributions and four case studies. The report will be published in 2015.

Data and resources

The report Managing Environmental and Health Impacts of Uranium Mining was published in June and outlines the significant evolution of uranium mining practices from the time when uranium was first mined for military purposes until today. Given the importance of producing uranium in a safe and environmentally responsible manner, the report highlights the different approaches and outcomes of early production practices compared to today’s leading practices. In September, the 25th edition of Uranium: Resources, Production and Demand (the “Red Book”) was also published in collaboration with the IAEA. It documents a further 7.6% increase in global uranium resources since the last report in 2011, despite generally declining uranium prices. The total resource base identified to date will be sufficient for over 100 years at current rates of consumption.

Nuclear Energy Data 2014, an annual publication that provides an update on nuclear power developments and associated policies in OECD countries, was published in December.

Security of supply of medical radioisotopes

In 2014, the NEA continued its efforts to ensure the global security of supply of molybdenum-99 (99Mo) and its decay product, technetium-99m (99mTc), which is the most widely used medical radioisotope. The High-level Group on the Security of Supply of Medical Radioisotopes (HLG-MR) completed an updated capacity and demand review in April, entitled “Medical Isotope Supply in the Future: Production Capacity and Demand Forecast for the 99Mo/99mTc Market, 2015-2020”. It also completed a second review of the supply chain, released in July, on “Results from the Second Self-assessment by the Global 99Mo/99mTc Supply Chain”.

Information provided by supply chain participants indicates that further progress is being made by most reactor operators and processors to implement full-cost recovery, although at different speeds and in some instances without clearly defined timelines. Despite some progress, outage reserve capacity (ORC) – an essential market component ensuring security of supply – is still not widely accepted or used by the market, and remaining government subsidies continue to be a barrier to the implementation of full-cost recovery. Continued undervaluation and frequent non-payment by the market for ORC can exert downward price pressure. In addition, the pressure on health care budgets has also continued, which has a negative effect on nuclear medicine. Few governments have expressed interest in reviewing or adjusting reimbursement rates for medical radioisotopes, and existing reimbursement structures vary considerably from country to country, which further hampers change.

The HLG-MR, working with the European Observatory on the supply of medical radioisotopes, is examining the obstacles to reaching sustainability in the supply chain and seeking to widen the interaction between producers of medical radioisotopes and the medical community. Early discussions had concluded that it is unlikely that the supply chain will take the necessary action itself, without some further direct action from governments. In that context, the NEA Secretariat proposed the Joint Declaration on the Security of Supply of Medical Radioisotopes (Joint Declaration) developed by the HLG-MR. The adherence of 11 countries to the Joint Declaration was formally noted by the OECD Council on 17 December 2014.

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Established in 2001, the Generation IV International Forum (GIF) brings together 12 countries – including Canada, China, France, Japan, the Republic of Korea, the Russian Federation, South Africa, Switzerland and the United States – as well as Euratom, to co-ordinate research and development (R&D) into advanced nuclear energy systems. While generation IV reactors are not expected to be deployed commercially before 2030-2040, strong interest remains in developing advanced reactors and fuel cycles to improve the sustainability, economics, safety and reliability of nuclear energy systems while ensuring proliferation resistance and the physical protection of such systems. Of the 70 reactors under construction at the end of 2014, although 62 are light water reactors (with a majority of generation III designs) and 5 are heavy water reactors, 3 are based on technologies that are being further developed within GIF, namely sodium-cooled fast reactors and gas-cooled high-temperature reactors.

Six conceptual nuclear energy systems were selected in 2002 for collaborative R&D: the sodium-cooled fast reactor (SFR), the very-high-temperature reactor (VHTR), the supercritical water-cooled reactor (SCWR), the gas-cooled fast reactor (GFR), the lead-cooled fast reactor (LFR) and the molten salt reactor (MSR). The Technology Roadmap for Generation IV Nuclear Energy Systems (2002) described how the development of these systems was envisioned a decade ago. In January 2014, the GIF released a ten-year update of this report entitled Technology Roadmap Update for Generation IV Nuclear Energy Systems. The 2014 update provides a clear outline of how GIF members will focus their R&D efforts in the coming decade, with several systems having already entered (VHTR, SFR and LFR) or entering (SCWR) their so-called “performance phase” (testing of processes and materials at engineering scale under prototypic conditions) in the period to 2023.

GIF has continued to work on the goals of achieving the highest levels of safety for generation IV systems, with the development of safety design criteria and safety design guidelines that incorporate lessons learnt from the Fukushima Daiichi accident. It also continues in its efforts to engage with regulators in discussions on reactor safety criteria and safety objectives, whether at the national or international levels, and particularly through the NEA Committee on Nuclear Regulatory Activities (CNRA). A constructive interface meeting between GIF and the CNRA was held on 1 December 2014, during which participants exchanged views on the need to identify and share safety research needs.

In terms of formal agreements to organise R&D efforts, in 2014 China joined the System Arrangement for the SCWR. The Project Arrangement on System Integration and Assessment for the SFR system, signed by China, Euratom, France, Japan, the Republic of Korea, the Russian Federation and the United States, became effective in October. All systems except the GFR have maintained a sustained level of activity in 2014 with regular meetings throughout the year. No meetings were held for the GFR system, which has suffered a significant decrease in funding, and discussions are ongoing among the signatories of the System Arrangement to see how to resume R&D collaboration.

The NEA has continued to provide secretariat services to the bodies in charge of the development of the six systems and the three methodology working groups on economics, proliferation resistance and physical protection, and risk and safety. At the request of the Policy Group, the NEA hosted the meetings of the Expert Group, the Policy Group and the Senior Industrial Advisory Panel for the first time at the OECD Conference Centre on 15-18 December 2014. Moreover, in a separate meeting organised the same week, the ten parties to GIF’s Framework Agreement agreed its extension for a new period of ten years. The OECD Secretary-General is the depository for the Framework Agreement.

The NEA is fully compensated for its support to the GIF through voluntary, financial and in-kind contributions made by individual GIF members.
The goal of the NEA in this sector is to assist member countries in their efforts to ensure high standards of safety in the use of nuclear energy, by supporting the development of effective and efficient regulation and oversight of nuclear installations and activities, and by helping to maintain and advance the scientific and technological knowledge base. The staff works closely with the Committee on the Safety of Nuclear Installations (CSNI), the Committee on Nuclear Regulatory Activities (CNRA) and their expert groups in this area.

Regulatory impacts of the Fukushima Daiichi accident

At its June 2014 meeting, the CNRA approved the preparation of a five-year milestone report in follow-up to the Fukushima Daiichi nuclear power plant accident. The report will provide a high-level summary of the outcomes of activities initiated under NEA auspices to address the safety issues arising from lessons learnt from the accident. The primary objective is to demonstrate what has been done by the NEA and its member countries to improve safety since 2011.

Operating experience

The Working Group on Operating Experience (WGOE) focuses on follow-up actions related to national trends and lessons learnt from national events submitted to the joint NEA/IAEA International Incident Reporting System for Operational Experience (IRS). The IRS is the only international system providing regulators with information about lessons learnt from safety-significant events at NPPs. The group completed its in-depth study of spent fuel pool events and evaluated trends on configuration control events by member countries, and it continues to assess lessons learnt from the Fukushima Daiichi NPP accident. In September 2014, a workshop was held on Operating Experience Programme Effectiveness Measures. The group also developed a proposal on tools for safety bodies to identify and share information on non-conforming, fraudulent and suspect items (NCSFI).

Regulation of new reactors

The NEA Working Group on the Regulation of New Reactors (WGRNR) is reviewing regulatory activities in relation to the siting, licensing and oversight of new commercial NPPs. The WGRNR has established and regularly updates the construction experience (ConEx) database to identify deficiencies associated with NPP design and construction. The ConEx database was populated with 12 new entries in 2014.

A report was completed by the WGRNR on regulatory practices used in NPP siting and on regulatory approaches to new reactor siting, including changes or enhancements as a result of the Fukushima Daiichi accident.

After a study was undertaken of recent regulatory experiences describing licensing structures, the resources and skills needed to perform design reviews, assessments and construction oversight, the types of training needed for such activities and the various licensing processes, the first volume of the report covering instrumentation and control was issued in July.

The WGRNR launched a new task in 2014 on the generic aspects of regulatory oversight of the commissioning phase for new reactors.
Regulatory inspection practices

The NEA Working Group on Inspection Practices (WGIP) issued the proceedings of its 12th WGIP workshop, which was hosted by the United States Nuclear Regulatory Commission (NRC) in April. Commendable inspection practices were identified at the workshop relating to the inspection of licensees’ outage activities (fire protection programmes), event response inspections and the impact of the Fukushima Daiichi accident on inspection programmes. The working group exercised the first routine task on NPP benchmarking inspection practices, with the United Kingdom hosting the inspection at the Sizewell B NPP in September. Spain, Sweden and the United States provided participants for the inspection. By participating in and observing the planning, performance and inspection enforcement actions, member countries assist in overall improvements to inspection techniques.

Nuclear regulators and public communication

The NEA Working Group on Public Communication of Nuclear Regulatory Organisations (WGPC) focuses on exchanging information, methods and experiences in the field of public communication of regulatory matters.

In July, the WGPC completed a report on “Nuclear Regulatory Organisations, the Internet and Social Media: The What, How and Why of their Use as Communication Tools”. It also continued to prepare a report on how nuclear regulatory organisations (NROs) elaborate their communication strategy for all situations outside of emergencies.

In parallel, the WGPC continues to develop its co-operation with stakeholders. A first workshop was held in April in Paris, bringing together NRO communication specialists and a wide range of European stakeholders including the media, communication experts, representatives of local information committees and non-governmental organisations (NGOs). Due to the success of the first pilot workshop, a second workshop will be held in April 2015 in North America and a third may be organised in Asia in 2016.

Analysis and management of accidents

The Working Group on Analysis and Management of Accidents (WGAMA) has continued to focus on the in-vessel behaviour of degraded cores, the thermal-hydraulics of the reactor coolant system, containment behaviour and protection, computational fluid dynamics (CFD) and fission product release and transport.

The WGAMA initiated four activities related to Fukushima issues in 2012, with the following progress made in 2014:

• the “Status Report on Hydrogen Management and Related Computer Codes” was issued in June, providing a summary of the knowledge base on hydrogen behaviour during severe accidents;

• the “Status Report on Filtered Containment Venting” was completed in July, offering a survey of the current approaches used by NEA members countries for venting containment structures during and following an accident;

• the “Status Report on Spent Fuel Pools under Loss-of-cooling and Loss-of-coolant Accident
Conditions" (a joint WGAMA-WGFS activity) was finalised and approved by the CSNI in December and will be issued in 2015;

- the final round of simulations for comparison and assessment of the international code benchmark of fast-running software tools modelling fission-product dispersion during accidents at nuclear power plants was completed in December and the final report is scheduled to be submitted to the CSNI for approval in June 2015.

The CSNI also approved a report in December on the "Benchmark Exercise on TMI-2 Plant Ability of Current Advanced Codes to Predict In-vessel Core Melt Progression and Degraded Core Coolability".

**Ageing and structural integrity of reactor components**

The NEA Working Group on Integrity and Ageing of Components and Structures (WGIAGE) focuses on the integrity, ageing and seismic behaviour of metal components and concrete structures.

In 2014, proceedings were issued for a Workshop on Non-destructive Evaluation of Thick-walled Concrete Structures, providing a review of methodologies for assessing the robustness of concrete structures in nuclear facilities. Work on the assessment of methodologies for structures impacted by missiles (IRIS) continued and a report on improving robustness assessment methodologies for structures impacted by missiles was issued. A report was also completed on bonded and unbonded technologies for pre-stressing nuclear reactor concrete structures, providing a thorough comparison of the main technologies for strengthening containment buildings.

In the area of seismicity, a report was issued summarising the current practices for defining the seismic requirements of nuclear facilities. A report on a Fukushima-related activity to quantify the existing margins in seismic analysis of safety-classified metallic components for high seismic loads was finalised, providing information on current practices for seismic design in member countries. The report did not identify any major gaps in the current knowledge base for metallic component behaviour under high seismic loads.

Finally, a report on high energy arcing fault events (HEAF) was completed in co-operation with the HEAF Project. This report provides the technical basis for the tests being conducted on the resistance of electrical systems to high energy arcing faults.

**Risk assessment**

The main mission of the NEA 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 Fukushima Daiichi accident triggered discussions about the significance of external hazards and their treatment in safety analyses. In addition, stress test results have shown vulnerabilities and the existence of cliff-edge effects in nuclear power plant responses to such hazards. These tests have also identified potential improvements and priorities for the implementation of safety measures and designs at specific sites.

In order to address these issues and to provide relevant conclusions and recommendations to the CSNI and the CNRA, the WGRISK directed, in co-operation with the WGIAGE, the "International Workshop on PSA of Natural External Hazards including Earthquakes" in 2013. The report from this workshop was approved in June 2014 and its recommendations are being reviewed in order to develop a Fukushima-related plan of work for 2015 and beyond. The report on "Use of OECD/NEA Data Project Products in Probabilistic Safety Assessment", a reference work in this area, was also issued at the beginning of 2014.

The report on "Failure Modes Taxonomy for Reliability Assessment of Digital Instrumentation and Control Systems for Probabilistic Risk Analysis" was also approved. This report essentially sets down a common language for future discussions among member countries on the important subject of digital instrumentation and control (DI&C).

In the context of a new CSNI activity on PSA insights relating to the loss of electrical sources, a study reviewing accident mitigation focused on loss of AC power for older plants with existing PSAs. As part of the study, a survey was completed of NEA member countries’ expertise and knowledge in this area.

An International Workshop on Fire Probabilistic Risk Assessment (PRA) was held in April, with 59 participants from 17 countries in attendance. A report will be issued in 2015.

**Fuel safety**

The NEA Working Group on Fuel Safety (WGFS) focused on four activities in 2014. The first two concerned fuel behaviour during a loss-of-coolant accident (LOCA) and a benchmark for reactivity-injection accidents. The latter constitutes phase 2 of the project and is following up on improvements identified during an earlier activity in 2013.

The other two activities concerned the report issued in July summarising current practices used in member countries for reactors with leaking fuel rods (fuel rods with defects that are resulting in fission products leaking into the primary circuit) and a second report on the Fukushima-related activity concerning "Spent Fuel Pools under Loss-of-cooling and Loss-of-coolant Accident Conditions" (a joint WGAMA-WGFS activity).

Two new activities were also approved by the CSNI. First, in response to a recommendation from the review of practices for leaking fuel rods, a survey will be undertaken of the safety impact of leaking fuel rods in accidents without fuel-rod failure. A workshop is also planned on pellet-cladding interaction (PCI), in anticipation of more flexible operating conditions for reactor fuel.
Human and organisational factors

The NEA Working Group on Human and Organisational Factors (WGHOF) constitutes a unique international forum addressing safety management issues such as safety culture, human and organisational factors and human performance in nuclear facilities.

In 2014, plans were finalised for a new workshop on lessons learnt from the Fukushima Daiichi accident and concerns human performance and intervention under extreme conditions. A model for decision making under conditions applicable to severe accident situations was developed, and a workshop was held in February to draw lessons and best practices from both within and outside the nuclear industry.

Fuel cycle safety

The NEA 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, PSAs, safety management, decommissioning, site remediation and fire protection.

The working group follows and periodically reviews the joint NEA/IAEA Fuel Incident Notification and Analysis System (FINAS), which is the only international system providing regulators and government bodies with information about lessons learnt from safety-significant events at fuel cycle facilities. There are about 170 events reported in the FINAS system, with a good balance of reporting across the range of facility types.

In 2014, the working group continued preparations for an international workshop in 2015 to gather information on operational and regulatory aspects of criticality safety in fuel cycle facilities. In addition, a new activity was initiated to review plans and regulatory approaches by member countries in light of lessons learnt from the Fukushima Daiichi accident, particularly in the area of new safety requirements and operational issues of fuel cycle facilities. Another new activity concerns the preparation of a topical report on the safety of long-term interim storage facilities. The report will summarise all requirements that should be taken into account when preparing for the long-term interim storage of spent nuclear fuel (SNF) and high-level waste (HLW).

Natural external events

The NEA established a Task Group on Natural External Events (TGNEV) in 2013 to determine whether individual activities would benefit from international co-operative work. Through its deliberations in 2013 and early 2014, the group determined that the scope of potential work was broad enough to warrant the formation of a working group, which the CSNI agreed to form in 2015. The task group continues to pursue its focus on severe weather events as a precursor to broader activities.

Post-Fukushima safety research opportunities

The NEA established a Senior Expert Group on Safety Research Opportunities Post-Fukushima (SAREF) in 2013 in order to identify opportunities to address safety research gaps and advance safety knowledge related to the Fukushima Daiichi accident. This work will also support safe and prompt decommissioning in Japan. The group will identify research options that use information from the Fukushima Daiichi site, either available or to be obtained during decommissioning. Two meetings were held in 2014, where senior experts from 11 countries discussed research areas of common interest related to the Fukushima Daiichi accident. Japanese experts contributed input on decommissioning at the Fukushima Daiichi site and safety research related to the accident.

Robustness of electrical systems

The NEA Task Group on the Robustness of Electrical Systems of NPPs in Light of the Fukushima Daiichi Accident (ROBELSYS) was set up in 2013, and continues to examine the robustness of electrical systems due to very low probability and high consequence external phenomena such as earthquakes, tsunamis and severe floods.

A workshop on electrical systems was organised by the NEA in April, with 105 participants representing industry and government organisations from 25 countries as well as international organisations. A total of 34 technical presentations were given, and lessons learnt from the Fukushima Daiichi accident regarding the robustness of electrical systems were discussed. Several issues were highlighted, including simulation of electrical transients and new reliable battery designs regarding station blackouts, and a recommendation was made to launch a more permanent international group that deals with safety issues of NPP electrical systems.

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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 130 organisations in 19 countries. The project benefits from stable and experienced organisation and a technical infrastructure that has undergone substantial developments over the years. Its objectives have been continuously adapted to users’ needs.

Work in the fuel area has 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 that complement the work done at laboratory scale in other institutions, notably in Japan and the United States.

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 have been studied. The experimental programme on the effect of water chemistry variants on fuel and reactor internals materials continued. Tests to investigate the cracking behaviour of reactor internals materials in boiling and pressurised water reactors also continued, with the aim of characterising the effect of water chemistry and material ageing. The project also contributed to international generation IV research in the areas of instrument development and material testing.

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), which aims to provide data suitable for probabilistic safety assessments and to improve the validity of HRA methods.

The results of the programme were reported at two meetings, the Halden Management Board (MB) in June and the Enlarged Halden Programme Group in September. The United Arab Emirates became a member of the Halden Project in 2014. The project has completed a new three-year programme, and the NEA is involved in advising the operating agent and the MB on restructuring and harmonising the new Halden Agreement (2015-2017) with the standard NEA model. The Norwegian Radiation Protection Authority recommended approval of a renewed licence for the Halden boiling water reactor (HBWR) to continue operating. Final approval of the renewed licence for a period of six years was given by the King of Norway in December.

The ATLAS Project

The Advanced Thermal-hydraulic Test Loop for Accident Simulation (ATLAS) Project is a thermal-hydraulic integral effect test facility for advanced LWRs located in the Republic of Korea. It was commissioned in 2006 and has been carrying out beyond-design-basis accident tests since 2012.

Following the Fukushima accident, the ATLAS Project was proposed by KAERI to study design- and beyond-design-basis accidents (bDBAs) in the ATLAS facility.

The ATLAS project investigates safety issues such as:

- prolonged station blackout (SBO), including asymmetric, secondary active or passive cooling;
- small-break loss-of-coolant accidents (SBLOCAs) during SBO, including reactor coolant pump (RCP) seal failure and steam generator tube rupture (SGTR);
- total loss of feedwater (LOFW), including anticipated transient without scram (ATWS) and additional multiple failures;
- medium-break loss-of-coolant accidents (MBLOCAs), including risk-informed break size definitions;
- open tests to address scaling issues by performing counterpart tests to previous integral effects tests (IETs).

[View of the ATLAS experimental loop.]
The experimental programme is devised to allow for an open test, which is to be defined in consultation with project members and which could cover the above issues or other safety-relevant issues. The experimental programme is to provide an integral-effect experimental database, which will be used to validate code predictive capability and the accuracy of models. The focus will be on investigating design extension conditions (DECs). This programme, along with associated analytical activities, will allow members – both NEA and non-NEA member countries – to share knowledge that will help maintain or improve the technical competence of thermal-hydraulics for nuclear reactor safety evaluations.

The project’s mandate runs from April 2014 to March 2017. It has 15 members including China, India and the United Arab Emirates, and 20 signatories. The management board and programme review group have been defined and an experimental programme was agreed for 2014-2015, including the selection of a benchmark test. The first test of the programme was successfully completed in October. Partners are carrying out significant analytical work alongside the experimental tests.

The BIP-2

The Behaviour of Iodine Project (BIP), hosted by Atomic Energy of Canada Limited (AECL) and supported by 13 member countries, started in September 2007. Phase 1, which was completed in March 2011, consisted of three tasks:

- quantification of the relative contributions of homogeneous and heterogeneous processes, and the measurement of adsorption rate constants on containment surfaces as a function of temperature, relative humidity and carrier-gas composition;
- the provision of radioiodine test facility (RTF) data from five RTF experiments to participants, for use in collaborative model development and validation.

A three-year follow-up project, BIP-2, started in April 2011 and attempted to answer some of the outstanding questions raised during BIP-1. Although progress was made towards determining the rate of iodine adsorption on paint under various conditions, the mechanism of the phenomenon is not known in detail. Similarly, while good progress was achieved in quantifying the rates of formation for methyl iodide from irradiated paint, the mechanism is not understood. The specific technical objectives for BIP-2 were:

- to obtain a more detailed and mechanistic understanding of iodine adsorption and desorption on containment surfaces by means of new experiments with well-characterised containment paint and paint constituents and novel instrumentation;
- to develop a common understanding of how to extrapolate with confidence from small-scale studies to reactor-scale conditions.

The BIP-2 experimental phase was completed in 2014. The final report is to be issued in 2015 and will present details on the following general results:

- the graduation of the degree of iodine adsorption from the solution and gas phases onto a variety of polymers, zinc primers and calcium silicate insulation, and the effects of Cl₂ and NO₂ in the gas phase;
- how well or poorly organic iodides formed on polymers and paints with and without irradiation;
- how well advanced techniques detected iodine and could examine surfaces.

Project participants have identified further aspects that require investigation and clarification, and these will be discussed during 2015 with the aim of establishing a third BIP phase.

The BSAF

The Benchmark Study of the Accident at the Fukushima Daiichi Nuclear Power Station (BSAF) was established among eight NEA member countries in 2012. The BSAF is intended to improve severe accident (SA) codes, and to analyse accident progression and current core status in detail for preparation of fuel debris removal as a part of the R&D projects for the mid- to long-term response for decommissioning Fukushima Daiichi units 1 to 4.

The project is hosted by Japan and brings together international experts to advance the understanding of the phenomena of severe accident behaviour specific to the Fukushima Daiichi nuclear power plant accident while also improving the methods and codes for modelling such behaviour. A phased approach will be applied in the NEA benchmark exercise. The range of analysis for this first phase will include: conducting a full-scope analysis of Fukushima Daiichi units 1 to 3 using currently available SA integral codes, using a time span for analysis of accident events of about six days from the occurrence of the earthquake (or reactor scram), and analysing in full a number of key phenomena such as initial transient, core heat-up, core melt, release of fission products (FPs) from fuel, core status including debris behaviour, and molten debris-coolant interaction.

In 2014, two meetings were held in June and November, reviewing progress and comparing modelling results, with discussions on the implications of the results. The first phase of the project was completed at the end of 2014 and the project report will be issued in 2015. During the two meetings, the second phase of the project was discussed, the scope of which will focus on fission product behaviours over a longer time frame. BSAF phase 2 will begin early in 2015 with a larger number of participant countries.

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.

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 project, will be carried out under both cold and hot coolant conditions, and with both BWR and PWR fuel.

In 2014, commissioning of the experimental facility started following the loading of new fuel. The regulators have now confirmed that they will accept the discoloured fuel and testing will likely begin in early 2016. The need for project extension beyond March 2015 has been raised with the Management Board’s Chair. At the Cabri Technical Advisory Group (TAG) meeting in September 2014, participants discussed the test matrix and made a number of decisions related to the test devices that require manufacturing prior to the restart of testing. The next Project Steering Committee meeting will be held in June 2015, and the next TAG meeting in October 2015.

The HEAF Project

Massive electrical discharges, referred to as high energy arcing faults, have occurred in nuclear power plant switching components throughout the world. These incidents have been increasing as a result of ageing infrastructures and increasing energy demands. The High Energy Arcing Fault Events (HEAF) Project was initiated in 2012 to perform experiments to obtain scientific fire data on HEAF phenomena through carefully designed experiments.

The HEAF Project is a three-year programme conducted at a facility in the United States. The project’s aim is to conduct experiments in order to explore the basic configurations, failure modes and effects of HEAF events. The equipment to be tested and considered primarily consists of switchgears and bussing components. Since the switchgears and other equipment necessary for testing is very expensive, the programme relies on signatories’ in-kind contributions.

The project was joined by a further two members during 2014 (Finland and Spain) and an additional member, Canada, is on target to complete the process at the beginning of 2015. Two objectives have been defined:

- to draft an international, peer-reviewed guidance document (in the US Nuclear Regulatory Commission NUREG series) that can be readily used to assist the regulators of participating countries;
- to draft a joint nuclear safety project report covering all testing and data captured.

A significant amount of equipment is now available to be tested. The initial testing took place in June in the presence of project members. Further tests took place in November and an additional test programme is planned for 2015. Data, including high speed high-definition video, is being shared among participants. The report is planned for June 2016.

The HYMERES Project

The main objective of the Hydrogen Mitigation Experiments for Reactor Safety (HYMERES) Project is to improve the understanding of the hydrogen risk phenomenology in containment so as to enhance its modelling in support of safety assessments that will be performed on current and new nuclear power plants. The HYMERES Project will introduce three new elements that were not included in previous projects related to hydrogen risk.

First, realistic flow conditions will be addressed. This will provide crucial information for the evaluation of the basic computational and modelling requirements (e.g. mesh size, turbulent models) needed to analyse a nuclear power plant. Second, tests addressing the interaction of safety components will be performed. Previous investigations have generally focused on the activation of one safety component (spray, cooler, passive autocalytic recombiner [PAR]) and have demonstrated the benefits and drawbacks of individual components. The project will study different combinations of “safety elements”, such as the thermal effects created by two PARs, spray
and cooler or spray and opening hatches operating simultaneously. The specifications for the design of the safety components (full cone versus hollow cone for sprays, PAR simulator power source time history, or cooler design) will be defined based on consensus among the project participants.

Third, the system behaviour for selected cases will be examined. In certain reactor types (various BWR, PWR or PHWR designs), the hydrogen concentration build-up in the containment depends on the responses of different components in the system. Consequently, the project proposes investigations for safety-relevant system behaviour related to BWRs, PWRs or PHWRs and the knowledge expected to be gained through the project will contribute to improving severe accident management (SAM) measures for mitigating hydrogen risks. The test series proposed in the HYMERES Agreement have been carefully defined, taking into account the operating agent’s experience in other NEA projects (SETH and SETH-2).

The HYMERES Project is specifically aimed at topics of high safety relevance for both existing and future nuclear power plants. The project will enable the full complement of measured parameters, configurations and scales to be explored, thus enhancing the value of the data in terms of code improvements.

The unique and complementary features of the PANDA and MISTRA facilities, with their difference in size and configuration, as well as the facilities’ comprehensive instrumentation in terms of both spatial and temporal resolution, will allow for high-quality experimental data. This data can be used to improve the modelling capabilities of computational fluid dynamics (CFD) and advanced lumped parameter (LP) computer codes designed to predict post-accident, thermal-hydraulic conditions in containments, and thus enhance confidence in their use in plant analyses. Operating agents may also consider new experiments in response to specific participant requests during the project.

The completed HYMERES agreement includes China, India and the Russian Federation. Testing is on schedule at the PANDA facility in Switzerland and at the MISTRA facility in France. Two project meetings were held in 2014 in conjunction with the first HYMERES Analytical Workshop in Switzerland in November.

The LOFC Project

Following a recommendation of the CSNI Task Group on Advanced Reactor Experimental Facilities (TAREF) for gas-cooled reactor safety studies, the Loss of Forced Cooling (LOFC) Project started in April 2011 with seven countries participating. The LOFC experiments studying the effects of reduction of reactor cavity cooling system (RCCS) performance are highly relevant for safety assessments of advanced reactors such as the high-temperature reactor. The experiments are to be run by the Japan Atomic Energy Agency (JAEA) in its high-temperature engineering test reactor (HTTR) in Oarai, Japan.

The objectives of the proposed project are to conduct integrated large-scale tests of LOFC in the HTTR reactor, to examine high-temperature gas-cooled reactor (HTGR) safety characteristics in support of regulatory activities, and to provide data useful for code validation and improvement of simulation accuracy. The objectives of the experimental programme are to provide experimental data to:

- clarify the anticipated transient without scram (ATWS) in case of LOFC with occurrence of reactor re-criticality;
- validate the most important safety aspects regarding reactor kinetics, core physics and thermal-hydraulics;
- verify the capabilities of the codes regarding the simulation of phenomena coupled between reactor core physics and thermal-hydraulics.

These goals will be achieved by using the HTTR to perform three test cases. The comparison of their results will provide the incremental performance availability within the vessel cooling system (VCS) range. The LOFC tests will be initiated by tripping all three helium gas circulators (HGCs) of the HTTR while deactivating reactivity control to disallow reactor scram due to abnormal reduction of primary coolant flow rate. They will address ATWS with occurrence of reactor re-criticality, and will be conducted with and without active function of the VCS.

The project remains on hold with reactor restart estimated for April 2015. An agreement for the project extension to March 2016 has been reached with the management board. No meetings were held in 2014 but the operating agent, JAEA, produced two progress reports in July and December. The latter confirmed that an application to the regulator had been submitted to move the reactor facility towards restart. No meetings will take place until a restart is confirmed.
The PKL-3 Project

The PKL-2 Project, which ran from July 2007 to December 2011, consisted of eight experiments carried out in the Primär Kreislauf (PKL) thermal-hydraulic facility, which is operated by Areva NP in Erlangen, Germany, together with side experiments conducted in the PMK facility in Budapest, Hungary and in the ROCOM facility in Rosendorf, Germany. The experiments investigated safety issues relevant to current PWRs as well as to new PWR design concepts, and focused on complex heat transfer mechanisms in the steam generators and boron precipitation processes under postulated accident situations.

The follow-up project, PKL-3, began in April 2012. PKL-3 tests investigate safety issues relevant to current PWR plants as well as to new PWR design concepts by means of transient tests under postulated accident scenarios and systematic parameter studies on thermal-hydraulic phenomena.

The first category of tests addresses current safety issues related to beyond-design-basis accident transients with significant core heat-up, for example station blackout (SBO) scenarios or LOCAs in connection with failure of safety systems. Without adequate accident management (AM) procedures, the postulated courses of events would lead to a severe accident scenario with core damage. The efficiency of AM measures initiated very late will be demonstrated and safety margins explored through these tests. Both scenarios will be connected to an assessment of core exit temperature (CET) performance, which is used as the criterion for the initiation of AM measures involving emergency operating procedures and/or severe accident management measures.

With respect to current safety issues, events in cold shutdown (i.e. failure of the residual heat removal system [RHRS]), will also be covered by the proposed PKL-3 test programme. Findings from the PKL and PKL-2 projects on thermal-hydraulic phenomena (e.g. pressure evolution following failure of the RHRS, or boron dilution) will now be compared to transient tests conducted with an open RCS.

The second category of tests addresses several test subjects that have already been investigated in the former PKL projects and that have not been completed. Parameter variations from tests conducted in the PKL-2 programme are implemented in the PKL-3 programme, either to provide an extension to already existing databases on cool-down procedures under asymmetric natural circulation or to determine the sensitivity of boron precipitation in the core following large-break LOCAs to specific parameters. Complementary tests in the ROCOM, PMK and PWR PACTEL facilities are also considered in the test programme.

Finally, three test subjects will be decided by programme partners following the results of preceding experiments. These will consist either of a confirmatory test or tests addressing specific participants’ requests.

Two meetings were held in 2014, with testing continuing to progress. Following a counterpart test carried out in the ROSA facility, a further counterpart test is being considered with ATLAS. Additional runs have been identified and will be financed with the supplementary funds resulting from China joining the project. A four-month delay in the programme has been requested by the operating agent to implement the essential instrument repairs necessary to complete the entire test programme.

The PRISME-2 Project

Fire is a significant contributor to overall core damage frequency for both new and old plant designs. Some of the technical studies related to fire probabilistic safety analysis (PSA) that remain open are: the propagation of heat and smoke through a horizontal opening between two superposed compartments; fire spreading on real fire sources such as cable trays and electrical cabinets; and fire extinction studies of the performance of various fire extinction systems.

Phase 2 of the Fire Propagation in Elementary, Multi-room Scenarios (PRISME-2) Project (from the French Propagation d’un incendie pour des scénarios multi-locaux élémentaires) is a follow-on project from the PRISME project that ran from 2006 to 2011. The PRISME-2 Project began in July 2011 and will run until June 2016. It currently has nine 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 mainly within the IRSN DIVA facility at Cadarache. 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 when simulating other fire propagation scenarios in various room configurations with a good degree of confidence.

The main experimental programme is made up of four large-scale test campaigns (20 tests) in the DIVA facility, in addition to other support tests. The first vertical smoke propagation (VSP) testing is complete, and the cable fire spreading (CFS) testing is nearing completion. The specifications for the fire extinguishing system (FES) test have been completed and work has begun on defining the open fire tests. A slight delay has occurred due to the Institut de radioprotection et de sûreté nucléaire (IRSN) request to carry out important glove box fire tests.

In 2014, the PRISME-2 management board and programme review group held meetings in May and November. The project’s analytical working group continues to carry out the benchmark exercises needed to conduct cross-comparisons and validations of code modelling approaches. The project is progressing although a six-month delay in testing was agreed with the management board due to a request from the IRSN to use the DIVA facility for urgent test requirements.
The SCIP-2 and SCIP-3

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 (HE): 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 was 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 was on cladding failures caused by pellet-cladding mechanical interaction (PCMI), 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 SCIP-2 programme was intended to complement other international projects in the fuel area. Extensive analyses and theoretical modelling of the fracture mechanisms accompanied the experimental programme.

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

- PCMI, the mechanical driving force for PCI and hydrogen-induced failures;
- PCI, notably when cladding fails due to stress corrosion cracking;
- hydrogen-induced failures, in particular as regards zirconium alloys, classic HE and DHC.

The SCIP-2 project completed its mandate in 2014 and a final project report was produced for members. Work is continuing on a summary report for wider distribution.

The process to formalise the SCIP-3 project began on 1 July 2014, with the agreement signature process underway. The SCIP-3 project will:

- determine parameters affecting fuel fragmentation and dispersal in LOCAs;
- analyse consequences of off-normal peak cladding temperatures and transients for handling and storage of fuel rods;
- study the impact of power ramp rates on PCI failure risk;
- support model development and verification.

The SERENA Project

The Steam Explosion Resolution for Nuclear Applications (SERENA) Project was launched in 2007 with nine member countries participating to evaluate the capabilities of the current generation of fuel-coolant interaction (FCI) computer codes to predict steam-explosion-induced loads in ex-vessel reactor situations. It included 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 objectives of the SERENA experimental programme, which concluded in March 2012, were to provide experimental data to:

- clarify the explosion behaviour of prototypic corium melts;
- validate 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;
- verify the geometrical extrapolation capabilities of the codes for the steam explosion in more reactor-like situations.

These goals were achieved by using the complementary features of the TROI Korea Atomic Energy Research Institute (KAERI) and KROTOS (French Alternative Energies and Atomic Energy Commission) 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.

The final version of the integrated report was finalised in 2014 and the DVD containing information on the project, including the final integration report, the summary report and all data reports, was distributed to project members. The non-disclosure date for this information has been extended to 2016 by agreement of the management board.

The SFP

The Sandia Fuel Project (SFP), supported by 13 member countries, began in 2009. The objective
of the project was 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 focused 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 was scheduled to last three years and to be conducted in two phases. Phase 1 was performed in 2011 and focused on axial heating and burn propagation. Phase 2, performed in 2012, addressed radial heating and burn propagation, and included effects of fuel rod ballooning. The final report of phase 2 has been issued to project members. A publicly available draft summary article was completed by the United States NRC for comment. This summary article will be released during 2015, as will a final DVD to members. The NRC confirmed that no further experimental work is planned following the completion of this project.

The STEM Project

The Source Term Evaluation and Mitigation (STEM) Project was initiated in 2011 to improve the general evaluation of the source term. The reduction of known uncertainties regarding specific phenomena is expected to help:

- provide better information and tools to emergency teams enabling a more robust diagnosis and prognosis of the progression of an accident and a better evaluation of potential release of radioactive materials;
- investigate phenomena involved in possible complementary mitigation measures, natural or engineered, so as to minimise releases to the environment.

The STEM Project is a four-year programme supported by seven countries and conducted at the IRSN facilities in Cadarache, France. It addresses three main issues:

- Radioactive iodine release in the mid- and long-term: to complement previous programmes, experiments have been proposed to study the stability of aerosol particles under radiation and the long-term gas/deposits equilibrium in a containment.
- Interactions between iodine and paints: no experiments are planned at this stage, but a literature survey specifically focused on the effect of paint ageing will be carried out. The survey is likely to lead to the definition of experiments in a possible follow-up project.
- Ruthenium chemistry: to complement previous programmes, experiments have been proposed to study ruthenium transport in pipes.

The first series of experiments (iodine behaviour under radiation) were dedicated to the analysis of radiation effects and were therefore realised in benches built on the EPICUR facility (Experimental Programme of Iodine Chemistry under Radiation). The second series of experiments (ruthenium transport) in the START facility aimed to analyse the chemistry of ruthenium in pipes including the reactor coolant system, and in filters. They were performed in dedicated benches allowing the injection of different chemical compounds followed by their transport through high-temperature gradient tubes up to aerosol filters and bubblers for gas-trapping.

Two meetings of the STEM steering bodies were held in 2014. Testing remains on schedule with good progress in the 19 tests planned within the EPICUR test matrix and the 20 tests planned within the START test matrix. Detailed reports will be drafted for each of the test series. The project will be complete in 2015, but further work has been identified which could form the basis for a further phase of this project.

The THAI-2 Project

Phase 2 of the Thermal-hydraulics, Hydrogen, Aerosols and Iodine (THAI-2) Project started in 2011. The new experiments will be conducted in the THAI facility operated by Becker Technologies GmbH in Germany.

The objective of this follow-up project is to address specific water-cooled reactor aerosol and iodine issues, and hydrogen mitigation under accidental conditions. The project will explore open questions concerning: a) the release of gaseous iodine from a flashing jet and iodine deposition on aerosol
particles, and b) hydrogen combustion during spray operation and passive autocatalytic recombination (PAR) operation in case of extremely low oxygen content. Understanding the respective processes is essential for evaluating the challenges posed by the amount of airborne radioactivity during accidents with core damage (iodine and aerosols) and containment integrity (hydrogen).

Regarding fission products, the programme will focus on iodine release from a flashing jet and gaseous iodine deposition on aerosols. In terms of hydrogen mitigation, the programme will focus on hydrogen combustion during spray operation and on its effective removal by means of PARs when approaching oxygen starvation. An analytical effort will accompany the experimental programme, mainly consisting of code calculations for pre-test assessments, result evaluations and extrapolation to reactor situations.

The overall test matrix of experiments was modified and agreed in 2012 in view of new priorities arising from the Fukushima accident. Testing was completed in 2014, and the final report and open summary report will be delivered in 2015. A post-project open seminar was held on 18-19 November in Frankfurt, Germany. A total of 27 papers on the application of the THAI and THAI-2 data to real reactor problems were presented.

Highlights from the project include the following:
- database delivered for code validation and development;
- effects of slow hydrogen deflagration in the presence of water spray examined;
- data gathered on PARs performance under SA conditions, including O₂ starvation conditions;
- fission product behaviour (iodine-aerosol interaction, iodine flashing) examined.

An expert meeting was held in Frankfurt, Germany on 17 November to discuss a possible third phase (THAI-3) of the project. Sixteen countries expressed interest in a third phase, and a research programme was identified for costing.

### Nuclear safety databases

#### The CODAP

The Component Operational Experience, Degradation and Ageing Programme (CODAP) builds on two recent NEA projects: the Piping Failure Data Exchange (OPDE) Project which ran from 2002 to 2011 and produced an international database on piping service experience applicable to commercial nuclear plants, and the Stress Corrosion Cracking and Cable Ageing Project (SCAP) which ran from 2006 to 2010 to assess, due to their implications for nuclear safety and their relevance for plant ageing management, stress corrosion cracking (SCC) and degradation of cable insulation. Twelve countries participated in the first phase of the CODAP, which started in 2011 and ran until the end of 2014.

The objectives of the CODAP include:
- collect information on passive metallic component degradation and failures of the primary system, reactor pressure vessel internals, main process and standby safety systems, support systems (i.e. ASME Code Classes 1, 2 and 3, or equivalent), and components not related to safety (non-code) but with significant operational impact;
- establish a knowledge base for general information on component and degradation mechanisms such as applicable regulations, codes and standards, bibliographies and references, R&D programmes and pro-active actions, information on key...
parameters, models, thresholds and kinetics, fitness for service criteria, and information on mitigation, monitoring, surveillance, diagnostics, repair and replacement;

• develop topical reports on degradation mechanisms in close co-ordination with the CSNI WGIAGE.

In 2014, two meetings of the CODAP Programme Review Group were held. The project issued three topical reports based on analyses of the data on:

• “Flow-accelerated Corrosion (FAC) of Carbon Steel and Low-alloy Piping in Commercial Nuclear Power Plants”;
• "CODAP Topical Report: Operating Experience Insights on Pipe Failures in Electro-hydraulic Control and Instrument Air Systems".

Work has begun on developing a new phase of the project with new membership opportunities to continue through 2015 and beyond.

The FIRE Project

The Fire Incidents Records Exchange (FIRE) Project started in 2002. A third phase of the project began in 2010 for a duration of four years with twelve countries participating. 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 has been 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 proven to be efficient on the first set of data provided. An updated version of the database, which now contains more than 400 records, is provided to participants every year. Two meetings of the project steering body were held during 2014. The new operating agent continued to develop the access database for event analysis. A summary report of the third phase was prepared for discussion. Progress has been made in preparing the fourth phase of the project.

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 phase 6 agreement covering 2011 to 2014.

The ICDE Project comprises complete, partial and incipient common-cause failure events. It 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 and batteries. Data exchange for switchgear and breakers and reactor-level measurement was completed. In 2012, two reports were issued on the “Collection and Analysis of Common-cause Failures of Centrifugal Pumps” and on the “Collection and Analysis of Common-cause Failures of Control Rod Drive Assemblies (CRDA)”.

In 2014, the ICDE Steering Group met twice in May and October. The following reports were issued using information from the database:

• “Collection and Analysis of Common-cause Failures of Heat Exchangers”;
• “ICDE Workshop on Collection and Analysis of Common-cause Failure”.

Phase 6 of the ICDE Project was completed in December 2014. Further work has been identified based on the interest of member countries and will result in a phase 7 of the ICDE Project.
**Secretariat-serviced bodies**

**Multinational Design Evaluation Programme (MDEP)**

The Multinational Design Evaluation Programme (MDEP) is an important regulatory forum for discussing new reactor safety issues and exploring harmonisation and convergence opportunities for new reactor regulatory practices. The five design-specific working groups (EPR, AP1000, APR1400, ABWR and VVER) of the MDEP are now fully active and addressing safety issues of concern to regulators. In 2014, the MDEP was therefore in a better position to examine and address the broad spectrum of existing challenges involved in the regulation of new reactor designs. Constructive engagement among member regulators led to a productive year in terms of sharing information on reactor design reviews, as well as on construction and commissioning activities. The design-specific working groups continue to discuss lessons learnt from the Fukushima Daiichi accident and their impact on new designs. MDEP stakeholders provided valuable feedback during the MDEP conference in May 2014, which will further strengthen co-operation between the MDEP and the nuclear industry to advance the safety of new reactors. Full members of the MDEP are regulatory authorities from Canada, China, Finland, France, India, Japan, the Republic of Korea, the Russian Federation, South Africa, Sweden, the United Kingdom and the United States. MDEP associate members are regulatory authorities from Turkey and the United Arab Emirates. The International Atomic Energy Agency (IAEA) is closely involved in generic MDEP activities to ensure consistency with international requirements and practices.

**2014 highlights**

On 14-15 May 2014, the Third MDEP Conference on New Reactor Design Activities was held in Bethesda, Maryland (United States). The purpose of this conference was to provide a forum to share the results of MDEP work with stakeholders, as well as to allow them to present ongoing activities related to new reactor licensing and to give feedback on MDEP activities and future work. Some 150 people attended the conference, with representatives from a broad range of national regulators, international organisations and the nuclear industry, including vendors, designers, licensees and applicants, and standard development organisations. Seven expert panel sessions were conducted, covering major topics of interest among regulators. In each of these sessions, the accomplishments and status of the MDEP and related international initiatives were discussed, with MDEP stakeholders underlying the need to continue work on the harmonisation of regulation and international practices. Stakeholders also emphasised the importance of anticipating new reactor reviews and taking advantage of knowledge already acquired through the MDEP. These stakeholder messages will inform the future work of the MDEP.

Commissioning activities are being addressed by all design-specific working groups as part of their programme of work, and most actively within the EPR and AP1000 working groups (WGs) that are overseeing 12 new constructions worldwide. The EPRWG is drafting a common position on the acceptance of first plant only tests (FPOT), by developing a set of conditions that would make successful tests performed on the first reactor acceptable for subsequent reactors being commissioned in other countries. Such topics are of great interest both for the regulators and the industry. As commissioning is the next step for several reactors under consideration in the MDEP, discussions will continue into 2015 and beyond.

The two most recent design-specific working groups (ABWR and VVER) have agreed to form technical expert subgroups. Such groups are now operating within all design-specific working groups as follows:

- EPR: accidents and transients, digital instrumentation and controls, probabilistic safety assessments and severe accidents;
- AP1000: digital instrumentation and controls;
- APR1400: severe accidents;
- ABWR: instrumentation and controls and severe accidents;
- VVER: severe accidents, the reactor pressure vessel and primary circuit, and Fukushima lessons learnt.

MDEP design-specific working groups have pursued in-depth discussions on the impact of the Fukushima Daiichi accident on new reactor designs. The EPRWG is finalising the three remaining technical appendices of its common position addressing Fukushima-related issues. The AP1000WG, APR1400WG and ABWRWG are also working on a similar common position. The VVERWG has chosen to form a technical expert subgroup to discuss design enhancements related to Fukushima lessons learnt.

In 2014, issue-specific working groups made significant progress. The Vendor Inspection Co-operation Working Group (VICWG) continues to benefit from carrying out vendor inspections with the participation of numerous regulators. In 2014, the first multinational inspection – an inspection carried out by two or more regulators based on the MDEP common quality assurance requirements – was performed on a steam generator tube manufacturer at Valinox Nucléaire in France. The inspection team was led by the United States Nuclear Regulatory Commission (NRC), the United Kingdom Office of Nuclear Regulation (ONR) and the French Autorité de sûreté nucléaire (ASN). Lessons learnt from this inspection will inform all VICWG processes and act as the basis of a report on good practices for vendor inspections. The Codes and Standards Working Group (CSWG) issued two technical reports and a common position related to the harmonisation of codes and standards. It also maintains active communication with the standards development organisations’ code convergence board and with the WNA Cooperation in Reactor Design Evaluation and Licensing (CORDEL) Working Group. The Digital I&C Working Group (DICWG) has issued two common positions.
Radioactive Waste Management

The goal of the NEA in this sector is to assist member countries in the development of safe, sustainable and broadly acceptable strategies for the long-term management of all types of radioactive waste, particularly long-lived waste, and spent fuel considered as waste. The staff works closely with the Radioactive Waste Management Committee (RWMC) and its expert groups in this area.

**Highlights**

- The RWMC has established new lines of work in areas such as regulator-implementer dialogue, radioactive waste predisposal management issues, a radioactive waste inventorying and reporting methodology and the identification in co-ordination with the Japanese government of waste management lessons to be learnt from the Fukushima Daiichi accident.
- The RWMC issued a collective statement on the guiding principles for the preservation of records, knowledge and memory across generations.
- The Forum on Stakeholder Confidence (FSC) produced two flyers on transparency and stakeholder confidence in radioactive waste management, and on national workshops and community visits.
- The Working Party on Decommissioning and Dismantling (WPDD) held its 2014 annual meeting in Moscow, enhancing co-operation with the Russian Federation in the field of decommissioning. The WPDD also produced two studies of strategic significance: R&I Needs for Decommissioning Facilities and a Guide for International Peer Reviews of Decommissioning Cost Studies for Nuclear Facilities.
- The NEA Co-operative Programme on Decommissioning (CPD) produced a study on Nuclear Site Remediation and Restoration during Decommissioning of Nuclear Installations.

**Strategic activities**

The Preservation of Records, Knowledge and Memory (RK&M) across Generations initiative attempts to bridge both societal and technical issues in radioactive waste management. It is now in its fifth year, with phase 1 conclusions finding that i) the context has changed greatly since the 1980s, when RK&M was thought to serve the sole function of deterring intrusion into a repository – today, the goal is to preserve information that will be used by future generations while maintaining technical and societal oversight of the repository for as long as practicable; ii) RK&M preservation can also be fostered through mechanisms outside radioactive waste management and the nuclear field; iii) the period that will follow repository closure – a few important centuries for RK&M preservation and for preparing the future – is rarely addressed specifically in the literature; iv) the regulatory aspects of long-term RK&M preservation are much in need of formulation and systematisation and v) the terminology is an important aspect when discussing long-term issues.

**Safety case for geological disposal**

In 2014, the Integration Group for the Safety Case (IGSC) carried out a review of current international activities relating to the development of safety cases for geological disposal of radioactive waste. It is particularly interested in activities undertaken internationally that could inform future work areas, identify potential collaboration opportunities and avoid duplication. A preliminary sourcebook has been compiled by the IGSC in collaboration with the European Commission’s Directorate General for Energy (EC DG-ENER) and the IAEA.

In 2014, two technical workshops were held by the IGSC Expert Group on Operational Safety (EGOS) of geological repositories to discuss and exchange experience in managing fire risks in underground facilities. Various fire risk mitigation and preventative measures have been identified and specific ventilation system designs were also evaluated in the workshops. The group also distributed a questionnaire to assess the potential hazards associated with construction and emplacement activities.

The NEA Salt Club held its annual meeting in March 2014 to discuss the status of various project activities. Its ongoing activities include i) work on microbial ecology in a salt repository; ii) an initiative to analyse available Pitzer thermodynamic data for radioactive and brine components; iii) a Features, Events and Processes (FEPs) catalogue for a high-level radioactive waste geological repository in rock salt and iv) an information management system for archiving salt literature. Two reports were issued by the Salt Club in 2014, the workshop proceedings of the “Natural Analogues for Safety Cases of Repositories in Rock Salt” and “Salt Reconsolidation Principles and Applications”.

The Clay Club, another scientific body of the IGSC, held its annual meeting in Bure, France in...
September 2014. Five countries presented their diffusion research programmes and findings during a topical session on the diffusion characterisation of radionuclides in clay.

**Radioactive Waste Repository Metadata Management (RepMet)**

The Radioactive Waste Repository Metadata Management (RepMet) initiative held its first meeting in January 2014, followed by a second meeting in September. RepMet aims to promote a better understanding of the identification and administration of metadata – a key aspect of data management – to support national programmes in managing their radioactive waste repository data, information and records in a way that is both harmonised internationally and suitable for long-term management and use.

**Forum on Stakeholder Confidence**

The Forum on Stakeholder Confidence (FSC) held its 15th regular meeting in November 2014, with continuing high interest among NEA member countries. A topical session investigated sustainable reporting and accountability standards, with examples given by Italy and the Russian Federation.

The themes of transparency, social media, added value and community benefits, as well as waste transport and stakeholder confidence, are high on the agenda of the FSC for the coming years. Lessons learnt and best practices will be integrated throughout the activities.

Two flyers were published in 2014 on transparency and stakeholder confidence in radioactive waste management and on national workshops and community visits. A detailed checklist was also developed to support potential hosts of future national workshops and community visits.

**Decommissioning**

The annual meeting of the Working Party on Decommissioning and Dismantling (WPDD) was held in Moscow after an invitation from the State Atomic Energy Corporation Rosatom was accepted to foster the integration of Russian specialists and their decommissioning knowledge into international discussions and exchanges on such topics. In a special session on decommissioning in the Russian Federation, experts presented initiatives, activities and practices in the field of decommissioning, all of which are conducted within the national regulatory framework and the Russian federal target programme Provision of Nuclear and Radiation Safety: 2008-2015.

The WPDD Decommissioning Cost Estimation Group (DCEG) produced a report entitled *Guide for International Peer Reviews of Decommissioning Cost Studies for Nuclear Facilities* that will help national programmes or relevant organisations to assess and improve decommissioning cost estimate practices in the future. It also approved a report on the same topic offering guidance on the creation of a “living” document, modified and updated when new and more detailed information becomes available. The DCEG continued to work on a joint undertaking with the IAEA on a description of different approaches to address uncertainties, contingency and risk analysis in decommissioning cost estimations.

The WPDD Task Group on Nuclear Site Restoration (TGNSR) continued work on recommendations for the development of strategies for nuclear site remediation, building on the findings of the NEA International Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects (CPD), as summarised in the report entitled *Nuclear Site Remediation and Restoration during Decommissioning of Nuclear Installations*. CPD work currently covers 63 decommissioning projects (38 reactors and 25 fuel facilities) in 12 member countries, 1 non-OECD/NEA economy and the European Commission. See page 39 for further details.

**Radioactive waste inventorying and reporting**

The RWMC Expert Group on Radioactive Waste Inventorying and Reporting (EGIRM) was established at the 48th RWMC meeting in March 2014. The group will develop a universal radioactive waste (RW) inventory-presenting scheme as an instrument to provide consistency in inventory data and comparability in national inventories. In 2014, the group completed a review of existing international approaches, types of disposal routes (including currently stopped or banned) and national RW classifications in NEA countries.

**Fukushima waste management and decommissioning**

The Expert Group on Fukushima Waste Management and Decommissioning R&D (EGFWMD) aims to offer advice on the management of large quantities of onsite waste at the Fukushima Daiichi nuclear power plant (NPP) and to share experiences with the international community. The expert group will provide advice to the Japanese government on the R&D programme being carried out, and specifically on waste management and decommissioning at the Fukushima Daiichi NPP. The first meeting of the EGFWMD was held in July 2014 in Fukushima, Japan, and a second meeting was held in November 2014. The group’s report is due in 2016.

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Joint Projects

The CPD
The NEA Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects (CPD) is a joint undertaking functioning under an agreement among 26 organisations in 13 NEA member countries, one non-member economy and the European Commission, actively executing or planning the decommissioning of nuclear facilities. 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. It has operated under Article 5 of the NEA Statute since its inception in 1985. A revised agreement among participants came into force on 1 January 2014 and will run until 31 December 2018.

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, 63 projects under decommissioning (38 reactors and 25 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 Task Group on Site Restoration continues to review the experience, approaches and techniques for nuclear site restoration.

In 2014, the Task Group completed a publication on Nuclear Site Remediation and Restoration during Decommissioning of Nuclear Installations.

The TDB Project
The Thermochemical Database (TDB) Project was initiated in 1984 by the NEA Radioactive Waste Management Committee to fulfil the need for a high-quality database for modelling purposes in the safety assessments of radioactive waste repositories. The project’s current mandate runs to March 2018. Fifteen organisations from 12 countries participate.

The project has so far produced 13 volumes of internationally recognised and quality-assured thermodynamic data, including a chemical thermodynamics of iron publication in 2013. Three volumes are in preparation on the chemical thermodynamics of molybdenum, iron (Part II) and the ancillary data used in the TDB Project. Related activities will be conducted over the next two years. The preparation of a state-of-the-art report concerning the cement phases started in 2012.

Phase 5 of the TDB project started in April 2014. The core of the TDB-5 programme of work comprises:

- the continuation of uncompleted tasks from phase 4;
- the update of the phase 2 actinide volumes, including technetium;
- the preparation of a state-of-the-art report on thermodynamic considerations for cement minerals;
- the preparation of a state-of-the-art report on thermochemical extrapolation of data to non-standard state temperatures pending the outcome of an initiation report;
- the preparation of a state-of-the-art report on thermodynamic considerations for actinide elements in high ionic strength aqueous solutions.

Example of dismantling work at a nuclear power plant.
The goal of the NEA in this sector is to assist member countries in the regulation, implementation and further development of the system of radiological protection by identifying and effectively addressing conceptual, scientific, policy, regulatory, operational and societal issues. The staff works closely with the Committee on Radiation Protection and Public Health (CRPPH) and its expert groups in this area.

Radiological protection consequences of the Fukushima Daiichi accident

While discussions on lessons emerging from the Fukushima Daiichi nuclear power plant (NPP) accident continue to include both emergency and recovery aspects, the management of recovery efforts has proven to be the most difficult to address. Recovery decisions increasingly require consultation with stakeholders about practical topics such as decontamination and its results, individual dose management, waste generation, and decontamination time frames and costs. All of these practical questions will affect a stakeholder’s decision to stay or to go, to return or not.

In ICRP Dialogue discussions with stakeholders, it would appear that those people who wish to stay in the affected territories, or to return to these territories, have developed a positive attitude towards the future, accepting that post-accident normality has become the normality. Considerations such as family history, local cultural ties, infrastructure and work, as well as age and family structure also appear to be important input into decisions to stay or return. These elements are only beginning to emerge and will be considered in the context of the ICRP radiological protection system update. The CRPPH will team with the ICRP to develop a summary of structural and procedural lessons learnt from these dialogue sessions. The 12th and final dialogue is scheduled for September 2015.

Evolution of the international system of radiological protection

The ICRP is in the process of updating its two publications on emergency and recovery management (Publications 109 and 111), which are expected to be released in 2016. The NEA Secretariat has been participating in this work so as to ensure that the document reflects NEA member experience and CRPPH views. The International Atomic Energy Agency (IAEA) updated its Preparedness and Response for a Nuclear or Radiological Emergency in October 2014, approved as General Safety Requirements (GSR) Part 7 (replacing GS-R-2 from 2002). The draft Safety Requirements document was reviewed by the CRPPH Expert Group on the Implications of Recommendations (EGIR). Extensive discussions were held between the NEA and IAEA Secretariats, with the NEA providing comments on drafts. The IAEA-approved draft will be reviewed at the 73rd CRPPH meeting in April 2015 and a recommendation will likely be made to the NEA Steering Committee for the NEA to co-sponsor the document.

Highlights

- During its 72nd meeting, the CRPPH held topical sessions on Fukushima recovery experience and on the evolution of radiological protection science.
- Two CRPPH workshops were held on radiation and thyroid cancer (Tokyo) and on occupational radiation protection in severe accident management (Washington, DC).
- The CRPPH Working Party on Nuclear Emergency Matters (WPNEM) initiated the INEX-5 table-top exercise, which addresses emergency management aspects of notification and communication.
- CRPPH subgroups finalised and submitted for review three reports on the state of the art in radiological protection science, on a framework for the post-accident management of contaminated food and on thyroid cancer science. Workshops planned for 2015 will include the 7th Asian Regional Conference, the 4th Science and Values Workshop and a Webinar on Stakeholder Dialogue Experience and Lessons.
- The CRPPH supported and participated in three International Commission on Radiological Protection (ICRP) Dialogue Initiative meetings in 2014.
- The Information System on Occupational Exposure (ISOE) programme completed reports on occupational radiological protection in severe accident management and on radiological protection aspects of primary water chemistry and source-term management.
As a result of earlier post-Fukushima work in the CRPPH, the NEA developed a report providing a detailed description of a framework for the post-accident management of contaminated food. It has since expanded this work with a study on the effects of the framework’s application to trade following the Fukushima accident. This new study examines trends in international trade through a series of food items moving from Japan to several Asian trading partner countries. The study superimposes on chronological graphs of import volumes the dates of changes in Japanese food criteria and the dates of the imposition of the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) on importing countries. While the data used is not detailed enough to show whether changes in Japanese allowable food contamination concentration levels affected trade statistics, the graphs do suggest areas for further study. The NEA will pursue these issues with a second report, which will be submitted for review and approval to the CRPPH in April 2015.

Radiological protection science and policy judgement

Radiological protection decisions are a combination of science and judgement, and making these two elements more transparent in decision making would help improve the acceptability and sustainability of decisions. The CRPPH is addressing such issues through a series of science and values workshops in radiological protection, the first three of which were held in 2008, 2009 and 2012. A fourth workshop will be held in Moscow on 9-11 June 2015. The workshop will continue the CRPPH tradition of addressing the science and value aspects of three topics, examining the medical surveillance of workers and post-accident victims, the use of dose measurements for the assessment of risks and the communication of low-dose risks.

Radiological protection science

The CRPPH Expert Group on Radiological Protection Science (EGRPS) completed its update of the Committee’s 1998 and 2007 reports on the implications of radiological protection science. The most recent report suggests that radiological, epidemiological and biological research continue to broadly support the assumption that radiological risks exist even at doses less than 100 mSv, and that one of the models that can be used to estimate the dose/risk curve is linear, with no threshold. The group’s report will be submitted for approval during the April 2015 CRPPH meeting.

Nuclear emergency management

The INEX series of international nuclear emergency exercises, organised under the CRPPH Working Party on Nuclear Emergency Matters (WPNEM), have proven successful in testing, analysing and improving the arrangements for responding to nuclear accidents and radiological emergencies at both national and international levels. The INEX-5 planning and development stages were completed in mid-2014 and approved by the WPNEM in October. INEX-5 will be a table-top exercise addressing emergency management aspects of notification, communication and interfaces among countries and international organisations (IOs). While the INEX-5 scenario involves a release of radioactivity from an NPP, the exercise material is developed to enable NPP and non-NPP countries to conduct regional, multi-participant, table-top exercises, with independent exercises remaining an option.

The INEX-5 exercise will be an opportunity for participating countries to test and demonstrate the value of relevant changes put in place as a result of the Fukushima Daiichi accident. An important outcome of the exercise will be the identification of good practices, as well as key needs for future work that would benefit from international co-operation. The exercise will be conducted from September 2015 to June 2016, with an initial plan to hold the post-exercise evaluation workshop in spring 2017. INEX-5 is open to all countries (both NEA member and non-member countries) as well as to interested IOs.

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 ISOE programme, an NEA joint undertaking in the field of radiological protection co-sponsored by the IAEA. In 2014, the ISOE programme produced two important reports, one on radiation protection aspects of primary water chemistry and source-term management (approved by the ISOE Management Board in 2013 and published in April 2014) and another on occupational radiological protection in severe accident management (completed through an international workshop in June 2014). The workshop was hosted by the Nuclear Energy Institute (NEI) in Washington, DC, and identified best practices in occupational radiological protection approaches to severe accident management, limitations for developing effective management and selected national experiences to contribute to the interim report published in 2013. The final report was approved by the ISOE Management Board during its November 2014 meeting.

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The ISOE

Since its creation in 1992, the Information System on Occupational Exposure (ISOE), sponsored jointly by the NEA and the IAEA, has been facilitating the exchange of data, analysis, lessons and experience in occupational radiological protection (RP) at nuclear power plants worldwide. It maintains the world's largest occupational exposure database and a network of utility and regulatory authority RP experts. The new ISOE terms and conditions, covering the period 2012-2015, came into force on 1 January 2012. The ISOE programme includes the participation of 76 utilities from 29 countries, and 20 regulatory authorities from 18 countries.

Four supporting ISOE Technical Centres (Asia, Europe, North America and the IAEA) manage the system'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 482 reactor units (401 operating units and 81 units in cold shutdown or at some stage of decommissioning), thus covering about 91% 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 2014, the ISOE programme continued to concentrate on the exchange of data, analysis, good practices and experience in the area of occupational exposure reduction at nuclear power plants, and on improving the quality of its occupational exposure database. The ISOE regional Technical Centres continued to support their regional members through specialised data analyses and benchmarking visits. Key outcomes of work during 2014 included a decision to grant regulatory authority participants full access to the ISOE network data and website; the development of several new, standard, push-button database analyses; and the signing of a Technical Co-operation Agreement with the Nuclear Energy Institute (NEI) to facilitate the exchange of occupational radiation protection information.

In addition, two ISOE expert groups finalised reports addressing “Radiation Protection Aspects of Primary Water Chemistry and Source-term Management” and “Occupational Radiation Protection in Severe Accident Management”, completed through an international workshop in June. In addition, the ISOE programme held a joint topical session in November with another NEA joint undertaking, the Co-operative Programme on Decommissioning (CPD). As a result, a new working group was established by the ISOE, with participation of CPD experts, to develop the decommissioning aspects of the ISOE database. The ISOE programme organised regional symposia in Switzerland, the Republic of Korea and the United States in 2014.

Joint Projects
Nuclear Science

The goal of the NEA in this sector is to help member countries identify, collate, develop and disseminate the basic scientific and technical knowledge required to ensure the safe, reliable and economic operation of current and next-generation nuclear systems. The staff works closely with the Nuclear Science Committee (NSC) and its expert groups in this area.

Highlights

- Two new expert groups with programmes related to accident studies were launched in 2014; namely the Expert Group on Accident-tolerant Fuels for LWRs (EGATFL) and the Expert Group on Multi-physics Experimental Data, Benchmarks and Validation (EGMPEBV).
- Two state-of-the-art reports on multi-scale modelling of fuels and primary radiation damage were completed and will help guide the direction of future nuclear science activities in the field of materials modelling.
- The 13th Information Exchange Meeting on Actinides and Fission Products Partitioning and Transmutation (IEMPT) was held in September in the Republic of Korea.
- A study on the potential benefits and challenges that might result from a switch to a thorium-based fuel cycle has been completed. A summary of the main findings was presented during the policy debate of the NEA Steering Committee meeting in October.
- A development version of the new SFCOMPO-2.0 database of experimental assay data of spent nuclear fuel compositions is now available online.

Reactor physics

A significant part of NEA work related to reactor physics over the last five years has been 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 for both pressurised water reactors (PWRs) and boiling water reactors (BWRs) have been used to validate the models.

The outcomes from the uncertainty propagation studies will be used as part of a broader study on the validation of coupled multi-physics simulations initiated in 2014. Key issues will include the particular challenges associated with the need for experimental data at high spatial and temporal resolution to reflect the level of detail passed between the separate physics components of the codes during a simulation.

Work has also continued on fuel performance as well as radiation transport and shielding. The NEA has established corresponding databases containing experimental data used extensively in member countries to validate modelling codes and associated data. As part of the process of identifying, evaluating, reviewing and preserving such data, groups of experts are brought together to verify in detail the completeness of the information and its suitability for use as a benchmark.

Fuel cycle physics and chemistry

Activities in this area cover all aspects of the nuclear fuel cycle from the front end to the back end, and address issues arising from various existing and advanced systems including fuel cycle scenarios, innovative fuels and materials, separation chemistry and waste disposal.

Benchmarks devoted to advanced nuclear systems are near completion and the report on the benchmark concerning the effects of the uncertainty of input parameters on nuclear fuel cycle scenario studies is being drafted. Phase 2 of the benchmark on thermal-hydraulic loop models for lead-alloy-cooled advanced energy systems has been launched.

A key part of the 2014 programme of work focused on fuels and materials. A State-of-the-art Report on Innovative Fuels for Advanced Nuclear Systems was published in December and a benchmark on fuel performance codes and experiments has also been initiated, focusing on minor actinide bearing fuels. In the area of materials, the updated version of the lead bismuth eutectic handbook was completed. The 13th Information Exchange Meeting on Actinide and Fission Product Partitioning and Transmutation (IEMPT) was hosted by Seoul National University in September 2014 in Seoul, Republic of Korea. The meeting was attended by 110 participants from 19 countries and 2 international organisations. A plenary session was followed by five technical and poster sessions covering the whole area of P&T, including fuel cycle strategies and transitions scenarios, transmutation systems, transmutation fuels and target designs, advanced recycling and waste disposal.
Nuclear criticality safety

The expert groups of the Working Party on Nuclear Criticality Safety (WPNCs) carry out international benchmark exercises on used-fuel depletion and burn-up credit criticality, criticality excursion analyses and uncertainty analyses for criticality safety assessments. They also study the uses of Monte Carlo techniques for these assessments and work on the evaluation of assay data of spent nuclear fuel.

The WPNCs is responsible for co-ordinating the activities of the International Criticality Safety Benchmark Evaluation Project (ICSBEF) and the Spent Fuel Isotopic Composition Database (SFCOMPO). In 2014, the new SFCOMPO-2.0 database developed by the Data Bank was presented at the PHYSOR international conference.

Materials science

The NEA Working Party on Multi-scale Modelling of Fuels and Structural Materials for Nuclear Systems (WPMM) deals with the long-term objective of establishing multi-scale modelling and simulation, from atomistic to macroscopic scale.

Two state-of-the-art reports were completed in 2014 and will be published in early 2015. The first addresses multi-scale modelling methods applied to nuclear fuels, and the second examines primary radiation damage in materials, reviews the current understanding in the field and proposes a new standard for the displacement damage model to incorporate in-cascade defect production efficiency and mixing effects.

A new activity was initiated in 2014 with the objective of advancing the understanding of unit mechanisms of fission gas release, building on historical experience and exploiting recent advances in experimental capabilities and modelling simulations.

Discussions initiated in 2012 on enhancing the tolerance of current fuels for generation II and generation III LWRs have now led to the establishment of a new Expert Group on Accident-tolerant Fuels for LWRs. This group will focus on innovative candidate materials for fuels and cladding that have enhanced tolerance in accidental conditions with prolonged loss of cooling, examining inter alia conditions experienced at Fukushima Daiichi.

Thermodynamics of advanced fuels

The Thermodynamics of Advanced Fuels – International Database (TAF-ID), launched in January 2013 among nine organisations in six NEA member countries and co-ordinated by the NEA, is devoted to establishing a comprehensive, internationally recognised and quality-assured database. The database comprises phase diagrams and the thermodynamic properties of advanced nuclear fuels to meet specialised requirements for the development of advanced fuels for a future generation of nuclear reactors. Further details are provided on page 45.

Integral experiments for minor actinide management

Since the initiation of this activity in 2009, a review has been undertaken of existing integral experiments for minor actinide (MA) management. Inaccuracies and a lack of experiments have been identified in several areas. Following these reviews and benchmark studies, integral measurements have been recommended that are complementary to parallel efforts for differential measurements of MAs from the viewpoint of the design of transmutation systems and of fuel cycles.

It has been recognised that a limited number of facilities, expertise and resources exist which are suitable to carry out certain types of experiments, and thus there is a strong incentive to establish co-ordinated international programmes. The next phase of the activity, which began in 2014, addresses the pooling of resources and identifies qualified facilities, personnel, measurement techniques and available materials needed to meet specific MA data needs.

Knowledge preservation

To maintain the scientific and technical knowledge required to develop new nuclear facilities, work in this area is aimed at transferring knowledge and skills between generations. More specifically, the knowledge gained during previous experimental campaigns is being used to anchor modern day simulations to reality. Highlights in the area of knowledge management during 2014 include:

- publication of an article in a special double edition of Nuclear Science and Engineering highlighting the achievements of the International Reactor Physics Experiment Evaluation (IRPhE) Project over the past 15 years;
- establishment of the EGMPEBV which seeks to preserve multi-physics experiments in a standardised format, facilitating code validation;
- identification and organisation of key documents related to the Dounreay fast reactor programme in the United Kingdom for the purpose of knowledge transfer;
- continued improvement of the NEA databases, which organise and facilitate the management of knowledge from the NSC programme of work.

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The TAF-ID Project

The Thermodynamics of Advanced Fuels – International Database (TAF-ID) Project was established in 2013 and is supported by nine organisations in six NEA member countries. The project was designed to make available a comprehensive, internationally recognised and quality-assured database of phase diagrams and thermodynamic properties of advanced nuclear fuels with a view to meeting specialised requirements for the development of advanced fuels for a future generation of nuclear reactors. The specific technical objectives of the programme are to:

- predict the solid, liquid and/or gas phases formed during fuel cladding chemical interactions under normal and accident conditions;
- improve the control of the experimental conditions during the fabrication of the fuel materials at high temperature, for example by predicting the vapour pressures of the elements (particularly of plutonium and the minor actinides);
- predict the evolution of the chemical composition of fuel under irradiation versus temperature and burn-up.

The six countries taking part in this project are: Canada (AECL, RMCC, UOIT), France (CEA), Japan (JAEA, CRIEPI), the Netherlands (NRG), the Republic of Korea (KAERI) and the United States (three national laboratories – ORNL, LLNL and INL – representing the Department of Energy).

Two new releases of the TAF-ID database were issued to the project signatories in 2014, for a total of 25 new binary or ternary systems related to fission products, corium and metal fuels. A second version of the database, containing only data which have already been published in the open literature on oxide-carbide and metal fuels, was also made publicly available, free of charge. This second version will be accessible to all NEA member countries, upon request to the NEA and after signature of a non-disclosure agreement.
The goal of the NEA in this sector is to be the 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; and to provide a direct service to its users by developing, improving and validating these tools and making them available as requested.

Highlights

- Poland became the 25th member country to join the NEA Data Bank effective as of 24 October 2014.
- The Task Force on the Future Programme of the Data Bank was established at the end of 2013 and three meetings were held in 2014. The task force is reviewing current activities, such as computer program services, nuclear data services and database services, as well as other knowledge preservation and management functions, in order to assess Data Bank activities for future needs.
- The latest version of the Joint Evaluated Fission and Fusion File (JEFF) general purpose neutron library, JEFF-3.2, was released in March 2014.
- Seven workshops and training courses on the most popular computer codes were organised by the computer program services as part of the NEA Data Bank knowledge management activities.

Computer program services

In line with its general mission, the Data Bank acts as a focal point for the collection, validation and dissemination of computer codes and integral experiments. In order to provide a rapid and reliable service to its members, the Data Bank strives to employ the most modern computer technology and electronic communication techniques. The large amount of information managed by the Data Bank is kept in modern database systems to provide reliable storage of data and allow for rapid responses to users’ requests.

The Data Bank distributed more than 2,200 programs and integral experiments in 2014. Approximately 50 of these programs and integral experiments were sent to authorised non-OECD countries in accordance with a special co-operative agreement with the International Atomic Energy Agency (IAEA).

The Data Bank also added 25 new (or new versions) of programs and integral experiments to the collection, bringing the total of all nuclear energy applications to over 2,300. Areas of application that attracted the most interest in 2014 were radiation shielding, reactor safety analysis and fuel management. Detailed information about material available from the computer program services can be accessed at www.oecd-nea.org/dbprog/.

Knowledge transfer

As part of the Data Bank services, training courses on the use of the more popular computer programs are organised on a regular basis. Seven workshops or training courses were organised in 2014 on computational radiation physics, uncertainty analysis in dosimetry and on radiation transport using Monte Carlo codes and deterministic methods.

Preservation of information from integral experiments

In close co-operation with other parts of the NEA, the Data Bank has established a number of databases containing information from integral experiments. These data are especially important for the validation and benchmarking of computation methods and programs used in member countries to model nuclear systems. The databases maintained and updated by the Data Bank are SINBAD (integral shielding experiments), IFPE (International Fuel Performance Experiments), ICSBEP (International Criticality Safety Benchmark Evaluation Project), CCVM (CSNI Code Validation Matrix for LWR LOCAs and transients) and IRPhE (International Reactor Physics Benchmark Experiments). More than 1,400 copies of these databases were distributed in 2014. The most popular of the databases was IFPE, with more than 500 experiments distributed, followed by SINBAD and the CCVM.

Nuclear data services

The Data Bank maintains large databases containing bibliographic, experimental and evaluated nuclear data, which are made available online to scientists and engineers in member countries. An important nuclear data activity of the Data Bank is the development of the JANIS software, designed to facilitate the visualisation, comparison and manipulation of nuclear data. In 2014, JANIS 4.0 was continuously revised, updated and corrected according to user feedback.
The Data Bank contribution to the compilation of measured neutron and charged-particle-induced reaction data continues with the help of external consultants and in close co-operation with a number of Nuclear Reaction Data Centres worldwide, all under the auspices of the Nuclear Data Section of the IAEA. In 2014, the number of updates in the EXFOR database implemented by the Data Bank (or currently peer-reviewed by other data centres) amounted to 241 entries for neutron-induced reactions and 212 for charged-particle-induced reactions.

**International nuclear data evaluation co-operation**

The Data Bank co-operates closely with the NSC Working Party on International Nuclear Data Evaluation Co-operation (WPEC). The WPEC was established to promote an international framework for co-operative activities among the major evaluation projects and in close co-operation with the IAEA. The aim is to review worldwide progress in nuclear data evaluation and measurement activities, the status of joint actions and future challenges.

Ongoing subgroup (SG) activities focus on improved fission product yield evaluation methodologies (SG37), development of a modernised nuclear data format structure (SG38) and the implementation of methods and approaches to provide feedback from nuclear and covariance data adjustment for the improvement of nuclear data files (SG39). The Collaborative International Evaluated Library Organisation Pilot Project (CIELO) aims to foster nuclear data advances in six materials: $^1$H, $^{16}$O, $^{56}$Fe, $^{235}$U, $^{238}$U and $^{239}$Pu. A new subgroup was established in 2014 with the objective of improving nuclear data accuracy of $^{241}$Am and $^{237}$Np capture cross-sections (INDA), and a new proposal for 2015 was made on “Thermal Scattering Kernel S($\alpha,\beta$): Measurement, Evaluation and Application”.

Two final reports will be published in 2015: “Scattering Angular Distribution in the Fast Energy Range” and “Reporting and Usage of Experimental Data for Evaluation in the Resolved Resonance Region”. Further information on recent WPEC reports is available at www.oecd-nea.org/science/wpec.

**The JEFF Project**

The Joint Evaluated Fission and Fusion File (JEFF) project is a collaborative effort among Data Bank member countries to produce common sets of evaluated nuclear data, mainly for fission and fusion applications. The latest version of the JEFF general purpose neutron library, JEFF-3.2, was released in March 2014. JEFF-3.2 is a major update that includes a revision of all files in the library, which now includes neutron data for 472 nuclides or elements.

The 2014 Nuclear Data Week was organised at the NEA to review recent achievements, outline planned actions and identify possible new, joint initiatives and synergies to meet nuclear data challenges associated with the multi-year JEFF work plan. The workshop promoted co-operation among the different teams working on the measurement, modelling and evaluation of nuclear data. It also provided input into the NEEDS/Nuclear Systems and Scenarios (NS&S) partnership to prepare future projects dedicated to nuclear data. More information on the JEFF project is available at www.oecd-nea.org/jeff.

**The Thermochemical Database Project**

The Thermochemical Database (TDB) Project was initiated in 1984 by the NEA Radioactive Waste Management Committee to fulfil the need for a high-quality database for modelling purposes in the safety analyses of radioactive waste repositories. Now in its fifth phase, TDB-5 was initiated in April 2014 and runs to April 2018. Fifteen organisations from 12 countries participate and fund this project independently through budgetary and in-kind contributions.

The TDB project has produced 13 volumes of internationally recognised and quality assured thermodynamic data. Currently in progress is work to complete three reviews – on iron (second volume), on molybdenum and on ancillary data – as well as a state-of-the-art report on thermodynamic considerations for cement minerals. Additionally, a state-of-the-art report on thermodynamic considerations for actinide elements in high ionic strength aqueous solutions is in its preliminary stage, together with a second update of the phase 2 actinide volumes, including technetium. The programme of work for phase 5 includes plans for a state-of-the-art report on the thermochemical extrapolation of data to non-standard state temperatures.

**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. The computer services also develop software or software tools in relation to JANIS, DICE, IDAT, ISOE and SFCOMPO, and maintain collaborative platforms for the Multinational Design Evaluation Programme (MDEP), the Generation IV International Forum (GIF) and the Thermochemical Database (TDB) Project.

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The goal of the NEA in this sector is to help create sound national and international legal regimes required for the peaceful uses of nuclear energy, including international trade in nuclear materials and equipment, to address issues of liability and compensation for nuclear damage, and to serve as a centre for nuclear law information and education. The staff works closely with the Nuclear Law Committee (NLC) in this area.

**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 among member countries. Those countries that are party to the Paris Convention on Third Party Liability in the Field of Nuclear Energy and the Brussels Supplementary Convention worked towards implementing the 2004 Protocols amending those conventions. A few are still facing delays in implementation because, inter alia, private nuclear risk insurers are unable to provide full coverage for certain risks that nuclear operators are obliged to assume under the revised conventions.

The NLC held meetings in March and November 2014. During the March meeting, the European Commission (EC) reported on the latest progress achieved on the proposal for a Council Directive amending Directive 2009/71/Euratom of 25 June 2009 establishing a Community Framework for the nuclear safety of nuclear installations (Nuclear Safety Directive) and the Commission’s assessment to harmonise EU nuclear liability regimes. Presentations on national developments in nuclear law were given by five member countries (Canada, Finland, France, Slovak Republic and Turkey) and two invitees (India and South Africa). Several issues regarding the interpretation and implementation of the Paris Convention were addressed, including the proposal to exclude from the scope of the convention low-level radioactive waste disposal facilities and installations in the process of decommissioning. This latter proposal was approved by the NLC in September, and the Steering Committee subsequently adopted it on 30 October 2014. These exclusions are intended to avoid the imposition of disproportionate obligations on operators in relation to the actual risks posed by such installations. The EC representative, as well as the German and Swiss delegations, made presentations on the challenges of decommissioning.

During the November meeting of the NLC, the committee was provided with a report from the EC on the Euratom safeguards. Presentations on national developments in nuclear law were given by several

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**Highlights**

- Signatories to the 2004 Protocols to revise the Paris Convention and the Brussels Supplementary Convention continued to make progress towards the ratification and implementation of the provisions of those protocols into their national legislation.

- The NLC continued to address the legal implications of the Fukushima Daiichi accident and also organised sessions on decommissioning challenges, the implementation of the Aarhus and Espoo Conventions regarding consultations with the public and neighbouring countries, and on nuclear liability aspects of transport.

- A Steering Committee policy debate on progress towards a global nuclear liability regime was held on 16 April 2014.

- On 30 May 2014, the OECD Council adopted a Resolution on the Appointment of the Judges to the European Nuclear Energy Tribunal. The jurisdiction of the Tribunal is strictly limited to resolving disputes between the contracting parties to the Paris Convention or the Brussels Supplementary Convention concerning the interpretation or application of these conventions.

- On 30 October 2014, the Steering Committee adopted a Decision and Recommendation Concerning the Application of the Paris Convention to Nuclear Installations in the Process of Being Decommissioned, which updates the technical criteria that allows contracting parties to exclude certain installations from the application of the Paris Convention.

- The 14th session of the International School of Nuclear Law was held in co-operation with the University of Montpellier 1 from late August to early September.

- Two issues of the Nuclear Law Bulletin (NLB) were published and included articles on the Amendment to the Convention on the Physical Protection of Nuclear Material, progress towards a global nuclear liability regime, fusion energy and nuclear liability, a nuclear law conference in India and the legal status of nuclear power in Germany.
member countries – Canada, Germany, Italy and the Republic of Korea – as well as India. A topical session on nuclear liability and transportation was organised, which covered reviews of international nuclear transport under the international nuclear liability conventions, i.e. the Paris Convention, the Vienna Conventions and the Convention on Supplementary Compensation for Nuclear Damage. In addition to a presentation by the World Nuclear Transport Institute (WNTI), the session provided an overview of various issues related to international nuclear transport from the operator, transporter and insurer perspectives. The IAEA reported at both meetings on matters of special interest under its auspices. The NLC continues to address the implementation of the Aarhus and Espoo Conventions in relation to nuclear activities, as well as the legal aspects related to the Fukushima Daiichi nuclear power plant accident.

The NEA Secretariat participated in an EC expert group to analyse the potential for harmonisation across the European Union (EU) of national legislation regarding nuclear liability, and in the Stakeholder Conference on Nuclear Third Party Liability and Insurance organised by the EC on 20-21 January 2014. The aim of the conference was to present the group’s recommendations and the results of a public consultation that the Commission had organised from August to October 2013 in order to seek the views of all relevant stakeholders on the need for common rules at the EU level as regards insurance and compensation for nuclear accidents in the EU.

The NEA Secretariat also contributed to the work of the International Expert Group on Nuclear Liability (INLEX) established by the IAEA.

Nuclear law publication programme
The 93rd and 94th issues of the Nuclear Law Bulletin (NLB) were published in 2014. The NLB is a unique international publication for both professionals and academics in the field of nuclear law, providing comprehensive information on nuclear law developments. It features topical articles written by renowned legal experts, covers legislative developments worldwide and reports on relevant case law, international agreements and the activities of intergovernmental organisations. As from 2014, all issues of the NLB are available free online at www.oecd-nea.org/law/nlb.

Country profiles on the regulatory and institutional framework for nuclear activities in member countries are available at www.oecd-nea.org/law/legislation/. The NEA website also provides a list of latest legislative developments, which tracks recent changes in nuclear-related legislation. The list can be found at www.oecd-nea.org/law/legislation/updates.html. The NEA Secretariat has begun a concerted effort to bring the legislation information up-to-date and seeks the support of member countries in undertaking this effort.

Nuclear law education programmes
The 14th session of the International School of Nuclear Law (ISNL), a unique academic programme organised by the NEA and the University of Montpellier 1, was held from 25 August to 5 September 2014. Over the past 14 sessions, the ISNL has provided a high-quality educational experience to more than 700 participants from around the world. This session attracted 57 participants from 35 countries, including participants sponsored by the IAEA. The programme brings together leading experts in nuclear safety, security, liability, non-proliferation and safeguards to provide an in-depth exploration of the legal aspects of the use and oversight of nuclear energy. Participants enrolled in the ISNL are able to apply for a University Diploma in International Nuclear Law recognised by the University of Montpellier 1. Further information may be obtained at www.oecd-nea.org/law/isnl/.

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General Information
Information and Communications

The goal of the NEA in this sector is to provide member governments and other major stakeholders with information resulting from NEA activities and to enhance awareness and understanding of the scientific, technical, economic and legal aspects of nuclear activities as well as awareness of the NEA itself.

Public affairs and relations with the media

Relations with the media in 2014 covered a wide variety of topics and questions regarding the development and use of nuclear power. Fifteen press and news releases were issued in 2014, notifying the media, for example, of William D. Magwood, IV taking up his duties as the new NEA Director-General on 1 September 2014, Poland joining the NEA Data Bank, the Memorandum of Understanding in the Field of Regulation of Nuclear and Radiation Safety between the NEA and the National Nuclear Safety Administration (NNSA) of China, the International Conference on Global Nuclear Safety Enhancement and the Joint Declaration on the Security of Supply of Medical Radioisotopes. These press and news releases are available in the online NEA press room at www.oecd-nea.org/press.

The NEA participated in the 50th anniversary commemorations of Japan joining the OECD in April in Tokyo. The OECD Secretary-General spoke at the International Conference on Enhancing Global Nuclear Safety organised by the NEA in co-operation with the Nuclear Regulation Authority (NRA) of Japan.

Online networking platforms were used extensively throughout the year to communicate the Agency’s latest publications, news and events.

Publications

In 2014, the Agency produced 24 publications, with all material posted free of charge on the NEA website in line with the NEA publications policy. The list of publications is provided on page 57. Over 50 NEA technical reports were also issued under the unclassified “R” series, directly downloadable from the substantive areas’ web pages.

The NEA is an intergovernmental agency specialised in studying the scientific, technical, economic and legal 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.

Highlights

- The Agency produced 24 publications and over 50 technical reports in 2014. Overall dissemination and downloads remained very strong.
- Fifteen press and news releases were issued in 2014, including on the arrival of the new NEA Director-General William D. Magwood, IV, the signature of a Memorandum of Understanding between the NEA and the National Nuclear Safety Administration (NNSA) of China, Poland joining the Data Bank and the Joint Declaration on the Security of Supply of Medical Radioisotopes.
- The NEA participated in the 50th anniversary commemorations of Japan joining the OECD in April in Tokyo. The OECD Secretary-General spoke at the International Conference on Enhancing Global Nuclear Safety organised by the NEA in co-operation with the Nuclear Regulation Authority (NRA) of Japan.
- Online networking platforms were used extensively throughout the year to communicate the Agency’s latest publications, news and events.

Over the course of the year, numerous interviews with the Director-General and senior NEA staff were conducted with television, specialised publications and the international press such as El País (interview with former NEA Director-General Luis Echávarri), POWER Magazine (“William D. Magwood, IV on Nuclear Power’s Present and Future”) and the Korea Herald (“Officials from Northeast Asia discuss nuclear safety”). Significant efforts were also employed to ensure efficient internal and external co-ordination and communication, including with the OECD, the International Energy Agency (IEA) and the International Atomic Energy Agency (IAEA).
The most accessed online reports during the course of the year included The Fukushima Daiichi Nuclear Power Plant Accident: OECD/NEA Nuclear Safety Response and Lessons Learnt (154 968 downloads), Nuclear Energy Data 2013 (61 672 downloads) and Nuclear Energy Today (60 437 downloads).

The Agency’s specialised journal, NEA News, is published in English and French 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.

In 2014, NEA News covered such topics as the future of medical radioisotope supply, radiation and thyroid cancer, the Japanese nuclear liability regime, the safety case for deep geological disposal of radioactive waste and the fifth International Nuclear Emergency Exercise (INEX-5). The journal also featured an interview with Stephen G. Burns, newly appointed Chairman of the United States Nuclear Regulatory Commission (NRC) who was Head of NEA Legal Affairs until he became a Commissioner of the NRC in November 2014. NEA News is available free of charge on the Agency’s website at www.oecd-nea.org/nea-news/.

**Online communication**

The NEA’s online presence plays a key role in communicating the work and accomplishments of the Agency. There was a threefold increase in website traffic in 2014, with an average of nearly 5 000 visitors per day or 1.8 million visits and 5 million page views on an annual basis. The website sections that attracted the most views were, in order of magnitude: Publications, Press, Safety Joint Research Project Databases maintained by the NEA Data Bank, the NEA Data Bank’s Java-based Nuclear Data Information System (JANIS) and the NEA Monthly News Bulletin.

Online networking platforms are playing an increasingly important role in communicating NEA activities. The Agency maintains a regular presence on Facebook and LinkedIn, and can be followed on Twitter @OECD_NEA. In 2014, the NEA increased the frequency of its posts, its followership and engagement on all three platforms. As a result, these channels have helped increase the visibility of NEA results, publications and events.

Subscriptions to the NEA Monthly News Bulletin have remained constant with approximately 20 000 subscribers. Distributed free of charge, the bulletin includes monthly updates on NEA work, activities and newly released reports. Online subscriptions can be made at www.oecd-nea.org/bulletin/. Current and archive issues can also be consulted at www.oecd-nea.org/general/mnb/.

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. The Delegates’ Area of 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 NEA 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 NEA co-sponsored several international events during 2014, including:

- Public Information Materials Exchange (PIME 2014) Conference, Ljubljana, Slovenia, 16-19 February;
- Symposium on Recycling of Metals Arising from Operation and Decommissioning of Nuclear Facilities, Studsvik, Sweden, 8-10 April;
- European Nuclear Conference 2014, Marseille, France, 11-14 May;
- Fifteenth International Symposium on Reactor Dosimetry, Aix-en-Provence, France, 18-23 May;
- Eighth International Conference on Isotopes and Exposition, Chicago, Illinois, United States, 24-28 August;
- International Conference on the Role of Reactor Physics Towards a Sustainable Future (PHYSOR 2014), Kyoto, Japan, 28 September-3 October;
- On 14-16 October 2014, the NEA participated in the first edition of the World Nuclear Exhibition (WNE) in Le Bourget, France. NEA Director-General William D. Magwood, IV was a featured speaker in the panel discussion on preparing the future of nuclear energy. Mr Kevin Charlton of the NEA Nuclear Development Division participated in the panel discussion on radionuclides and health. NEA representatives were present throughout the exhibition at its publications and information stand.

The NEA also organised publications and information stands at the NRC Regulatory Information Conference (RIC) held in Bethesda, Maryland, United States in March and at the European Nuclear Conference in Marseille, France in May.

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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, 31 were members of the NEA in 2014:

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

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

The members of the Bureau of the Steering Committee for Nuclear Energy are (as elected at the October 2014 meeting):

- Mrs Marie-Elise HOEDEMAKERS (Netherlands), Chair
- Dr Kwang-Yong JEE (Republic of Korea), Vice-Chair
- Mr Frédéric JOURNÈS (France), Vice-Chair
- Dr Peter LYONS (United States), Vice-Chair
- Dr Hiroshi YAMAGATA (Japan), Vice-Chair
- Dr Marta ŽIAKOVA (Slovak Republic), 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 2014 of 93 professional and support staff from 16 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. Experts from selected partner countries, including China and India, take part in NEA activities on an invitee basis.
NEA Committee Structure in 2014

Steering Committee for Nuclear Energy

Committee on the Safety of Nuclear Installations (CSNI)
- CSNI Programme Review Group (CSNI PRG)
- Working Group on Risk Assessment (WGRISK)
- Working Group on Analysis and Management of Accidents (WGAMA)
- Working Group on Integrity and Ageing of Components and Structures (WGIAFE)
- Working Group on Human and Organisational Factors (WGHOOF)
- Working Group on Fuel Safety (WGFSS)
- Working Group on Fuel Cycle Safety (WGFCS)
- Senior Expert Group on Safety Research Opportunities Post-Fukushima (SAREP)
- Task Group on Natural External Events (TGNEV)
- Task Group on Robustness of Electrical Systems of NPPs in Light of the Fukushima Daiichi Accident (ROBELSIS)

Committee on Nuclear Regulatory Activities (CNRA)
- Task Group on Accident Management (TGAM)
- Working Group on Pre-disposal Management of Radioactive Waste (PMRW)
- Working Group on Waste Inventorying and Reporting Methodology (EGRIM)
- Working Group on Fukushima Waste Management and Decommissioning (EGFWM)
- Integration Group for the Safety Case (EGSC)
- Working Party on Decommissioning and Dismantling (WPDD)

Radioactive Waste Management Committee (RWMC)
- RWMC Regulator's Forum (RWMC-RF)
- Expert Group on Radiological Protection Aspects of the Fukushima Accident (EGRPPF)
- Expert Group on the Implications of Recommendations (EGRIR)
- Expert Group on Fukushima Waste Management and Decommissioning (EGFWMD)
- Expert Group on Lessons Learnt from Non-nuclear Events (EGNE)

Committee on Radiation Protection and Public Health (CRPPH)
- Expert Group on Improvement of Integral Experiments Data for Minor Actinide Management (EGIEMAM-II)
- Expert Group on Multi-physics Experimental Data, Benchmarks and Validation (EGMPEBV)
- Expert Group on Accident-tolerant Fuels for LWRs (EGATFL)
- Expert Group on Improvement of Integral Experiments Data for Minor Actinide Management (EGIEMAM-II)

Nuclear Science Committee (NSC)
- Expert Group on Radiological Protection Science (EGRPS)
- Working Party on Nuclear Emergency Matters (WPNEM)
- Expert Group on Lessons Learnt from Non-nuclear Events (EGNE)
- Integration Group for the Safety Case (EGSC)
- Working Party on Decommissioning and Dismantling (WPDD)

Executive Group of the NSC (NSC Data Bank Management Committee)
- The Joint Evaluated Fission and Fusion File (JEFF) Project
- Task Force on the Future Programme of the NEA Data Bank

Committee for Technical and Economic Studies on Nuclear Energy Development and the Fuel Cycle (NDC)
- High-level Group on the Security of Supply of Medical Radioisotopes (HLG-MR)
- Joint NEA/IAEA Group on Uranium (UG)
- Working Party on Nuclear Energy Economics (WPNE)
- Ad hoc Expert Group on Climate Change: Assessment of the Vulnerability of Nuclear Power Plants and Cost of Adaptation
- Ad hoc Expert Group on Costs of Decommissioning
- Ad hoc Expert Group on Cost of Nuclear Accidents, Liability Issues and Their Impact on Electricity Costs
NEA Publications and Brochures
Produced in 2014

All NEA publications are available free of charge on the NEA website.

▶ General interest

**Annual Report 2013**  
NEA No. 7174. 60 pages.  
*Rapport annuel 2013*  
AEN n° 7175. 60 pages.

**NEA News, No. 31.2**  
NEA No. 7169. 32 pages.  
*AEN Infos, N° 31.2*  
AEN n° 7170. 34 pages.

**NEA News, No. 32.1/32.2**  
NEA No. 7178. 40 pages.

▶ Nuclear development and the fuel cycle

**Managing Environmental and Health Impacts of Uranium Mining**  
NEA No. 7062. 140 pages.

**Nuclear Energy Data 2014/Données sur l’énergie nucléaire 2014**  
NEA No. 7197. 93 pages.

**Uranium 2014: Resources, Production and Demand**  
NEA No. 7209. 504 pages.

▶ Nuclear safety and regulation

**The Characteristics of an Effective Nuclear Regulator**  
NEA No. 7185. 32 pages.
Radioactive waste management

Guide for International Peer Reviews of Decommissioning Cost Studies for Nuclear Facilities
NEA No. 7190. 49 pages.

Nuclear Site Remediation and Restoration during Decommissioning of Nuclear Installations
NEA No. 7192. 244 pages.

R&D and Innovation Needs for Decommissioning Nuclear Facilities
NEA No. 7191. 314 pages.

Nuclear science and the Data Bank

International Handbook of Evaluated Criticality Safety Benchmark Experiments
NEA No. 7231. DVD.

International Handbook of Evaluated Reactor Physics Benchmark Experiments
NEA No. 7173. DVD.

State-of-the-art Report on Innovative Fuels for Advanced Nuclear Systems
NEA No. 6895. 193 pages.

Nuclear law

Nuclear Law Bulletin No. 93
NEA No. 7171. 133 pages.

Bulletin de droit nucléaire n° 93
AEN n° 7182. 140 pages.

Nuclear Law Bulletin No. 94
NEA No. 7184. 185 pages.

Also available

Perceptions and Realities in Modern Uranium Mining – Extended Summary of Managing Environmental and Health Impacts of Uranium Mining
NEA No. 7063. 19 pages.

L'extraction d'uranium aujourd'hui : perceptions et réalités – Résumé détaillé de Managing Environmental and Health Impacts of Uranium Mining
AEN n° 7064. 21 pages.

Technology Roadmap Update for Generation IV Nuclear Energy Systems
63 pages. Available at www.gen-4.org/gif/.

福島第一原子力発電所事故 OECD/NEA原子力安全の対応と教訓 - 要旨
NEA No. 7217. 8 pages.

Uranium 2014: Resources, Production and Demand – Executive Summary
NEA No. 7210. 12 pages.

Uranium 2014 : Ressources, production et demande - Synthèse
AEN n° 7211. 12 pages.
ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of 34 democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Commission takes part in the work of the OECD.

OECD Publishing disseminates widely the results of the Organisation's statistics gathering and research on economic, social and environmental issues, as well as the conventions, guidelines and standards agreed by its members.

NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1 February 1958. Current NEA membership consists of 31 countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, Norway, Poland, Portugal, Russia, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Commission also takes part in the work of the Agency.

The mission of the NEA is:

- to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes;

- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include the safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information.

The NEA Data Bank provides nuclear data and computer program services for participating countries. In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

Also available in French under the title:

AEN – RAPPORT ANNUEL – 2014