The NEA in Brief – 2013

Governing body:
the Steering Committee for Nuclear Energy

31 member countries (24 in the Data Bank)
55 years of international service
7 standing technical committees
67 working parties and expert groups
22 international joint projects funded by participants
82 professional, project and support staff (NEA and the Data Bank combined)
€ 11.1 million budget for the NEA, supplemented by voluntary contributions
€ 3.1 million budget for the Data Bank, supplemented by voluntary contributions
24 publications produced

The NEA and its mission

The Nuclear Energy Agency (NEA) is a semi-autonomous body within the Organisation for Economic Co-operation and Development (OECD), located in the Paris area in France. The objective of the Agency is to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes.
The European Commission (EC) takes part in the work of the NEA. A co-operation agreement is in force with the International Atomic Energy Agency (IAEA). The NEA also maintains contacts with several non-member countries as well as the nuclear industry and a number of civil society organisations.
2013 was a year of continuing progress by the OECD Nuclear Energy Agency in a number of important areas, marked in particular by an increased scope and reach. Following the accession of the Russian Federation on 1 January 2013, the 31 members of the Agency now account for 90% of installed nuclear power generating capacity in the world, further expanding the significant international role that the NEA can play in the scientific, technological, legal and safety-related aspects of nuclear energy.

The NEA is a central part of concerted international efforts to enhance co-operation in the nuclear energy field. As part of these efforts, in 2013 the NEA and the China Atomic Energy Authority (CAEA) signed a Joint Declaration on Co-operation in the Field of Peaceful Uses of Nuclear Energy. The purpose of this co-operation is to enhance the exchange of experience and information at the international level so as to make nuclear power safer, and to ensure robust scientific, technological and legal bases for its development and use in an environmentally friendly and economical manner.

The NEA remains fully committed to these objectives, and in view of ongoing work following the 2011 accident at the Fukushima Daiichi nuclear power plant, the Agency published in September 2013 a summary of key actions and member country responses entitled *The Fukushima Daiichi Nuclear Power Plant Accident: OECD/NEA Nuclear Safety Response and Lessons Learnt*. NEA actions in response to the accident have primarily been led by the three committees concerned with nuclear and radiation safety issues: the Committee on Nuclear Regulatory Activities (CNRA), the Committee on the Safety of Nuclear Installations (CSNI) and the Committee on Radiation Protection and Public Health (CRPPH). However, the follow-up to Fukushima continues to involve all areas of the Agency’s work, as member countries look to implement practical measures and improvements based on lessons learnt. The NEA will continue to offer its direct assistance to the Japanese authorities in addressing remaining significant challenges, including environmental remediation and recovery, the management of radioactive waste and the decommissioning of the Fukushima Daiichi reactors.

This *Annual Report* provides an overview of NEA activities for 2013, ranging from specific follow-up to the Fukushima Daiichi accident to further work in the areas of nuclear safety and regulation, radioactive waste management, radiological protection, nuclear science, nuclear law and nuclear energy development and the fuel cycle.

While it is clear that Fukushima has had a profound effect on the nuclear energy sector, its development is set to continue in the coming years. Reflecting the need for secure supplies of low-carbon electricity, the use of nuclear power is projected to increase in a number of countries, notably in those that are seeking to diversify their energy mixes and to respond to global climate change objectives. The decision to introduce or to further develop the use of nuclear energy is an important one, which requires robust legal and regulatory frameworks and, first and foremost, an absolute commitment to safety.

Over the last 17 years as Director-General of the Agency, I have seen the vital importance of international co-operation for the safe, environmentally friendly and economical use of nuclear energy. The pursuit of these objectives has not been without a number of challenges, but also many accomplishments.

This is my last editorial for the NEA *Annual Report*, and I would like to take this opportunity to express my gratitude to all my NEA colleagues and those with whom I have had the pleasure to work as part of the NEA network. I wholeheartedly extend my best wishes to the next NEA Director-General and to the Agency as a whole in continuing the NEA’s important work in the future.
Since the Fukushima Daiichi nuclear accident in March 2011, the NEA has provided direct assistance to the Japanese authorities in the development and implementation of national safety reviews and stress tests, main elements to achieve effective regulatory reform, best practices in the remediation of land contaminated with radioactive materials, planning and effective management of decontamination activities, and long-term planning for the decommissioning of the plant. It has organised numerous international activities, including joint research projects and meetings among nuclear regulators, nuclear safety experts, public health specialists and civil society stakeholders. 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* was published in September 2013. The report, which can be downloaded from the NEA website, outlines international efforts to strengthen nuclear regulation, safety, research and radiological protection in the post-Fukushima context. It also describes work on new reactors and legal frameworks, and highlights key messages and lessons learnt, notably as related to assurance of safety, shared responsibilities, human and organisational factors, defence-in-depth, stakeholder engagement, crisis communication and emergency preparedness.

**Nuclear regulation**

The NEA began collecting information and sharing it among member countries immediately following the Fukushima Daiichi nuclear power plant accident. A web page was established to provide an overview of member countries' national follow-up actions. The NEA response to the Fukushima accident has been co-ordinated by the three NEA standing technical committees that address regulation and safety: the Committee on Nuclear Regulatory Activities (CNRA), the Committee on the Safety of Nuclear Installations (CSNI), and the Committee on Radiation Protection and Public Health (CRPPH). After the initial development of area-specific responses, a joint meeting of the three committees' bureaus was held to agree on a shared way forward. The CNRA, leading the integrated post-Fukushima co-ordination of NEA nuclear safety activities, then established the Senior-level Task Group on Impacts of the Fukushima Accident (STG-FUKU) on 23 March 2011, with both the CSNI and CRPPH represented. Each committee determined the specific direction of its work while building upon the shared mandate of protecting public health and safety, and the environment.

The STG-FUKU was tasked with identifying regulatory and safety concerns as well as activities that would benefit from international collaboration; carrying out timely exchanges of information; and maintaining awareness and co-ordination of activities in other organisations (see the 2012 NEA Annual Report for further details on the work of the group). At its June 2013 meeting, the CNRA approved the completion of the STG-FUKU mandate, although work on nuclear regulation and safety related to the Fukushima Daiichi accident will continue as part of the NEA's regular programme of work.

**Nuclear safety defence-in-depth**

On 5 June 2013, an international workshop on Challenges and Enhancements to Defence-in-Depth (DiD) in Light of the Fukushima Daiichi Accident was jointly organised by the CNRA and the CSNI, with input from the CRPPH. About 100 participants from NEA member countries, India, the International Atomic Energy Agency (IAEA), the World Association...
of Nuclear Operators (WANO) and Eurelectric held in-depth discussions in Paris on the DiD concept and its implementation in post-Fukushima. They also considered additional steps to be taken at the national and international levels to address the challenges identified and to make further enhancements to nuclear safety. Participants examined proposals for future NEA activities in support of these processes, with the workshop concluding that:

- The concept of DiD remains valid but strengthening may be needed.
- Implementation of DiD needs further work, in particular regarding external hazards.
- Additional guidance should be sought to harmonise implementation of DiD.
- The focus of improvements in DiD should not only be on the prevention of accidents but also on the mitigation of consequences.

At the December 2013 CNRA meeting, participants discussed the workshop outcomes and approved the formation of a small, senior-level task group to generate a mandate that would address the DiD implementation issues identified above. Workshop proceedings will be issued.

In October 2013, the NEA also took part in the IAEA International Conference on Topical Issues in Nuclear Safety: Defence-in-Depth – Advances and Challenges for Nuclear Installation Safety. The conference provided an opportunity to further explain the outcomes of the NEA report on the Fukushima accident, the DiD workshop and other ongoing work on DiD at the NEA.

### Radiological protection

Because the Japanese government recommended the rapid evacuation of the 78,000 people living within 20 km of the plant, the sheltering of those living between 20 and 30 km from the plant, and the evacuation of a further 10,000 people living to the north-east of the plant in what was determined to be the most contaminated area, health-significant population exposures were avoided.

From 2011 to 2013, Japanese authorities, TEPCO and several other organisations have estimated the amount of radioactive material released into the atmosphere by the Fukushima Daiichi accident (see Table 1). They have also estimated the amount of radioactive material released into the ocean in the vicinity of the port (see Table 2).

#### Table 1: Estimates of radioactive releases into the atmosphere

<table>
<thead>
<tr>
<th>Sources</th>
<th>Amount released (PBq(^{1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rare gas</td>
</tr>
<tr>
<td>TEPCO (24 May 2012)(^{2})</td>
<td>~500</td>
</tr>
<tr>
<td>Japan Atomic Energy Agency (6 March 2012)</td>
<td>-</td>
</tr>
<tr>
<td>Nuclear and Industrial Safety Agency (12 April 2011)</td>
<td>-</td>
</tr>
<tr>
<td>Nuclear and Industrial Safety Agency (6 June 2011)</td>
<td>-</td>
</tr>
<tr>
<td>Nuclear and Industrial Safety Agency (16 February 2012)</td>
<td>-</td>
</tr>
<tr>
<td>Releases from the Chernobyl nuclear power plant accident</td>
<td>6,500</td>
</tr>
</tbody>
</table>

1. ~1 PBq (peta Becquerel) = 1,000 trillion Bq = 10\(^{15}\) Bq.
2. The value estimated by TEPCO is rounded off to one decimal place and was originally reported in Bq.

#### Table 2: Estimates of radioactive releases into the ocean

<table>
<thead>
<tr>
<th>Sources</th>
<th>Released amount in PBq</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I-131</td>
</tr>
<tr>
<td>TEPCO (Central Research Institute of Electric Power Industry)</td>
<td>26 March 2011-30 September 2011(^{1})</td>
</tr>
<tr>
<td>Japan Atomic Energy Agency</td>
<td>21 March 2011-30 April 2011(^{2})</td>
</tr>
</tbody>
</table>

1. The amount released from 21 March 2011, when the measurement of the concentration of radioactive material in seawater near the water discharge canals began, to 25 March 2011, was tentatively calculated to be about 0.1 PBq for Cs-137. The ratio of I-131 and Cs-137 suggests a predominance of releases into the atmosphere.

2. Includes releases into the atmosphere.

Ground water continues to leak into and out of the damaged Fukushima reactor buildings. It is estimated that approximately 400 m$^3$ of ground water is entering the buildings per day, becoming contaminated by mixing with the water in the various installation basements and then part of that water leaking out of the buildings towards the sea. Contamination levels in the sea along the facility waterfront remain measurable, and fishing is forbidden within 20 kilometres of the plant. The prevailing current flows south along the coast from the Fukushima site, and seawater and sediments show measurable levels of Cs-137 and Cs-134 several kilometres south of the installation. However, locations beyond the 20 km no-fishing zone show non-detectable levels of Cs-134 (less than 0.001 Bq/L) and Cs-137 (0.002 Bq/L), where the level of detection is in the order of 0.001 Bq/L. These values are compatible with normal background levels in open sea water.

The Japanese government established dosimetric criteria to identify areas where evacuees could return. It decided that once the safety of the plant had been re-established, and following the government’s radiological characterisation and recovery plan of 26 December 2011, access to certain previously restricted areas could be reinstated in a phased manner using these criteria, while other more contaminated areas could not be directly re-inhabited. Areas where evacuation orders were issued have now been organised into three sections, corresponding to annual doses since April 2012 as follows:

<table>
<thead>
<tr>
<th>Area 1: 1 mSv~20 mSv</th>
<th>Area where evacuation orders are ready to be lifted.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area 2: 20 mSv~50 mSv</td>
<td>Area where citizens are not permitted to live.</td>
</tr>
<tr>
<td>Area 3: 50 mSv~.</td>
<td>Area where difficulties will limit the possibility of citizens returning over the long term.</td>
</tr>
</tbody>
</table>

In response to the accident, the Fukushima prefectural government developed and implemented the Fukushima Health Survey to facilitate suitable healthcare in the future. This health survey, which is being used to estimate individual external exposure between 11 March 2011 and 11 July 2011, was first issued to the residents of three towns (Namie, Iitate and Kawamata) near the Fukushima Daiichi nuclear power plant, and was then extended to all residents of Fukushima Prefecture. By 31 July 2013, a self-report questionnaire had been sent to 435 788 residents in the Fukushima Prefecture. For all residents except radiation workers, the survey suggested that most received less than a few mSv of exposure during the first three months of the accident. The highest effective dose was 25 mSv (see Table 3). Radiation workers showed higher doses during this time frame. These estimates are being used as basic data in health exams conducted for former residents of evacuated areas, as well as for future long-term health care.

In addition to these estimates of public doses, according to a report released by TEPCO on 3 December 2013, 29813 workers (TEPCO and contractor) participated in response activities at the Fukushima Daiichi nuclear power plant from March 2011 to September 2013. The report indicates that 173 workers (0.6%) have received over 100 mSv, 1 396 workers (4.7%) have received from 50-100 mSv and 28 244 workers (94.7%) have received under 50 mSv, with the highest dose being 678.8 mSv (see Table 4). As expected, there were no cases of immediate radiation sickness in workers or in members of the public as such effects appear only after exposures of greater than 1 000 or 2 000 mSv.

The Japanese government has initiated a long-term health programme to provide regular surveillance of those exposed, with levels of public exposure to be determined as time passes. It has also charged Fukushima Medical University (FMU) with managing the health surveillance of the Fukushima population, performing periodic whole body counts and internal dose estimates on prefecture residents, and providing technical information with regard to external dose readings from those wearing personal dosimeters. Together with the prefecture authorities, the FMU is creating a dosimetric database to assist in the management of health care for prefecture residents. The NEA continues to provide the experience of its other member governments to assist the Japanese authorities with recovery.

### Decontamination and recovery

The most significantly contaminated areas are primarily within the Fukushima Prefecture, although contamination can be measured in many areas of Japan. The Japanese government has initiated a vast programme of decontamination and recovery, focusing on those areas where estimated doses to people living there would exceed 1 mSv a year. The Japanese central government is taking charge of areas where people have been evacuated (where estimated annual doses would be greater than 20 mSv). Municipalities, with support from the Japanese government, are responsible for developing
and implementing decontamination programmes where the populations still living in the areas are conservatively estimated to be exposed to doses between 1 and 20 mSv per year. Increasingly, individuals are now wearing personal dosimeters. The analysis of these dosimeters suggests that, in any given municipality, the distribution of annual doses can be shown as a log-normal curve, with an average value of a few millisieverts. The tail of the log-normal curve may extend to 10 or 20 mSv a year, depending on individuals’ habits; however, only a few individuals seem to have annual doses over a few millisieverts. This suggests that a key focus of the recovery should be to establish an accurate

<table>
<thead>
<tr>
<th>Effective dose</th>
<th>TEPCO workers</th>
<th>Contractors</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 mSv</td>
<td>1 035</td>
<td>7 310</td>
<td>8 345</td>
</tr>
<tr>
<td>1 to 5 mSv</td>
<td>655</td>
<td>6 523</td>
<td>7 178</td>
</tr>
<tr>
<td>5 to 20 mSv</td>
<td>960</td>
<td>7 180</td>
<td>8 140</td>
</tr>
<tr>
<td>20 to 50 mSv</td>
<td>604</td>
<td>3 977</td>
<td>4 581</td>
</tr>
<tr>
<td>50 to 100 mSv</td>
<td>565</td>
<td>831</td>
<td>1 396</td>
</tr>
<tr>
<td>100 to 150 mSv</td>
<td>118</td>
<td>20</td>
<td>138</td>
</tr>
<tr>
<td>150 to 200 mSv</td>
<td>24</td>
<td>2</td>
<td>26</td>
</tr>
<tr>
<td>200 to 250 mSv</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>More than 250 mSv</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3 968</strong></td>
<td><strong>25 845</strong></td>
<td><strong>29 813</strong></td>
</tr>
</tbody>
</table>

Maximum effective dose: 679

Average (mSv): 24


<table>
<thead>
<tr>
<th>Target Areas</th>
<th>Population in decontamination target area (approximation)</th>
<th>Decontamination target area (ha) (approximation)</th>
<th>Formulation of decontamination plan</th>
<th>Full-scale decontamination activities (as of August 2013)</th>
<th>Process securing temporary storage sites (as of August 2013)</th>
<th>Consent of landowners (as of July 2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tamura City</td>
<td>400</td>
<td>500</td>
<td>13 Apr. 2012</td>
<td>completed June 2013</td>
<td>secured</td>
<td>completed</td>
</tr>
<tr>
<td>Naraha Town</td>
<td>7 700</td>
<td>2 000</td>
<td>13 Apr. 2012</td>
<td>in progress</td>
<td>secured</td>
<td>almost completed</td>
</tr>
<tr>
<td>Kawauchi Village</td>
<td>400</td>
<td>500</td>
<td>13 Apr. 2012</td>
<td>in progress</td>
<td>secured</td>
<td>completed</td>
</tr>
<tr>
<td>Minami-Souma City</td>
<td>13 300</td>
<td>6 100</td>
<td>18 Apr. 2012</td>
<td>in progress</td>
<td>~ 20% secured</td>
<td>~ 30% complete</td>
</tr>
<tr>
<td>Litate Village</td>
<td>6 000</td>
<td>5 100</td>
<td>24 May 2012</td>
<td>in progress</td>
<td>~ 20% secured</td>
<td>~ 30% complete</td>
</tr>
<tr>
<td>Kawamata Town</td>
<td>1 200</td>
<td>1 300</td>
<td>10 Aug. 2012</td>
<td>in progress</td>
<td>~ 80% secured</td>
<td>~ 90% complete</td>
</tr>
<tr>
<td>Katsurao Village</td>
<td>1 400</td>
<td>1 700</td>
<td>28 Sept. 2012</td>
<td>in progress</td>
<td>~ 20% secured</td>
<td>almost completed</td>
</tr>
<tr>
<td>Namie Town</td>
<td>18 800</td>
<td>3 200</td>
<td>21 Nov. 2012</td>
<td>bidding process</td>
<td>~ 10% secured</td>
<td>~ 10% complete</td>
</tr>
<tr>
<td>Okuma Town</td>
<td>400</td>
<td>400</td>
<td>28 Dec. 2012</td>
<td>in progress</td>
<td>~ 70%</td>
<td>~ 60% complete</td>
</tr>
<tr>
<td>Tomioka Town</td>
<td>11 300</td>
<td>2 800</td>
<td>26 June 2013</td>
<td>in preparation (contractor decided)</td>
<td>~ 50% secured</td>
<td>in preparation (contractor decided)</td>
</tr>
<tr>
<td>Futaba Town</td>
<td>200</td>
<td>200</td>
<td>co-ordination process</td>
<td>co-ordination process</td>
<td>co-ordination process</td>
<td>co-ordination process</td>
</tr>
</tbody>
</table>

Note: Decontamination work has begun in areas where preparations have been completed. As of September 2013, decontamination plans had been established in 10 out of 11 target municipalities. Decontamination work is ongoing or in preparation in nine municipalities, and has been completed according to plan in one city. The work in municipalities is to be implemented on the premises of the decontamination plan, consent of land owners and securing of temporary storage sites.

personal dosimetry for the affected population and to focus on those citizens at the high end of the log-normal curve so as to help them alter their behaviour and lower their doses. Altering behaviour could mean, for example, spending less time in more contaminated areas such as forests. Although recovery management is technically challenging, the rehabilitation of living conditions in these affected areas is achievable, but only through the extensive involvement of exposed populations in identifying local priorities, customs and needs. The status of decontamination in various municipalities as of 30 August 2013 is shown in Table 5.

Many former residents of the Fukushima Prefecture are still living as evacuees. Some are living in specially-designed evacuation facilities, while others have moved in with family elsewhere or have simply established their households in a new area outside the Prefecture. The decision whether to stay or leave, for those who did not evacuate, or to return or not for those who did, is extremely complex. While potential exposure and concern about possible future health effects are important aspects of such decisions, other more practical issues, such as the existence of a social and physical infrastructure (stores, businesses, schools, hospitals and doctors), and of viable work are also important issues.

As of 13 September 2013, there were a total of 174 682 evacuees from the Fukushima Prefecture. From the areas where evacuation orders were issued, 33 079 were from Area 1 (1 mSv–20 mSv), 23 394 from Area 2 (20 mSv–50 mSv) and 24 818 from Area 3 (50 mSv–). For further information on the number of evacuees from individual municipalities, see www.meti.go.jp/english/earthquake/nuclear/roadmap/index.html.

The NEA has been supporting Japanese recovery efforts through workshops and seminars intended to provide examples of the extensive experience in stakeholder involvement of other NEA member country governments. It has also involved other countries that have been addressing the consequences of the Chernobyl accident for the past 25 years to discuss technical experiences. The NEA participated in the organisation of a symposium on the Experience and Technology of Russia, the Ukraine and Belarus on Remediation and Restoration of Environments, which took place in Tokyo on 4 February 2012; and organised a one-day session on stakeholder involvement in Fukushima City on 5 February 2012. It also participated in the organisation of the International Symposium on Remediation of Site Contamination Caused by the Fukushima Accident in Fukushima, which took place in May 2012.

In addition, the NEA has supported and participated in seven dialogues organised by the International Commission on Radiological Protection (ICRP), which have brought together affected stakeholders from the Fukushima Prefecture and the Tokyo area with international experts from France, Norway and Belarus who have extensive post-Chernobyl experience. The meetings – held in November 2011, February, July and November 2012, and in March, July and November 2013 – were hosted by municipalities in the Fukushima Prefecture. Participants discussed their concerns regarding general, agricultural and food distribution issues, as well as education and information issues. The experience from these meetings is being summarised by various Japanese NGOs involved in the process. The NEA will continue to participate in and support these meetings, the next of which is scheduled to take place in May 2014.

Finally, the NEA has been asked by the Japanese Ministry of the Environment to organise two workshops in 2014. The first, which will take place in Tokyo on 21 to 23 February, will be the International Workshop on Radiation and Thyroid Cancer. The venue of the second workshop is yet to be determined, but it will address Large-scale Decontamination Experience and will be held in October 2014.
Nuclear energy development

In 2013, the nuclear power industry began recovering as post-Fukushima reviews of the safety of nuclear facilities were completed and recommendations to further improve safety for beyond-design-basis events were implemented. The media continued to focus on the challenges in managing contaminated water at the Fukushima Daiichi site, although monitoring showed the extent of sea contamination to be very limited.

Nuclear energy development resumed in some NEA member countries, with construction of five units initiated during the year and plans for additional construction advancing. However, low natural gas prices, particularly in North America, along with subsidised development of renewable energy sources elsewhere, continued to limit nuclear energy development.

At the end of 2013, there were 359 operational reactors connected to the grid in the 31 member countries of the NEA, including 33 reactors in the Russian Federation, which officially joined the Agency on 1 January 2013. No new reactors were connected to the grid in 2013 and four reactors in the United States were permanently shut down. Operations were suspended at all 50 reactors in Japan by September 2013 (only 2 had been in service earlier in the year), but operators applied for permission to restart 16 reactors once regulations governing the resumption of operation were issued by the new Japan Nuclear Regulation Authority (NRA) in July. At the end of 2013, nuclear electricity generating capacity in NEA countries constituted about 87% of the world total; production accounted for some 19% of their total electricity supply.

Significant developments that occurred in NEA member countries include:

- In Belgium, the Doel 3 and Tihange 2 reactors were restarted in July after an investigation by the regulator determined that the pressure vessel fault indications discovered using new ultrasonic equipment in 2012 did not constitute a danger to pressure vessel integrity. In December 2013, the updated law on nuclear phase-out was approved by parliament, imposing a 40-year life cycle limit on all nuclear reactors except Tihange 1, where the limit is 50 years.

- In Canada, the Ontario government announced that the plan to build two additional reactors at the Darlington site would be cancelled owing to

### 2013 nuclear data summary (as of 31 December 2013)

<table>
<thead>
<tr>
<th></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>1 160</td>
<td>53.7</td>
</tr>
<tr>
<td>Canada</td>
<td>19</td>
<td>13.5</td>
<td>1 700**</td>
<td>16.0*</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>6</td>
<td>3.8</td>
<td>670**</td>
<td>35.8</td>
</tr>
<tr>
<td>Finland</td>
<td>4</td>
<td>2.8</td>
<td>565</td>
<td>33.1</td>
</tr>
<tr>
<td>France</td>
<td>58</td>
<td>63.1</td>
<td>8 000**</td>
<td>73.3*</td>
</tr>
<tr>
<td>Germany</td>
<td>9</td>
<td>12.1</td>
<td>2 000**</td>
<td>15.4*</td>
</tr>
<tr>
<td>Hungary</td>
<td>4</td>
<td>1.9</td>
<td>365</td>
<td>51.2</td>
</tr>
<tr>
<td>Japan</td>
<td>50</td>
<td>42.4*</td>
<td>1 960**</td>
<td>1.9**</td>
</tr>
<tr>
<td>Mexico</td>
<td>2</td>
<td>1.4</td>
<td>185</td>
<td>4.6</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1</td>
<td>0.5</td>
<td>60</td>
<td>2.3</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>23</td>
<td>20.7</td>
<td>4 500</td>
<td>27.0</td>
</tr>
<tr>
<td>Russian Federation*</td>
<td>33</td>
<td>23.6</td>
<td>3 800</td>
<td>17.8</td>
</tr>
<tr>
<td>Slovak Republic</td>
<td>4</td>
<td>1.8</td>
<td>375**</td>
<td>51.9*</td>
</tr>
<tr>
<td>Slovenia</td>
<td>1</td>
<td>0.7</td>
<td>150**</td>
<td>33.3*</td>
</tr>
<tr>
<td>Spain</td>
<td>8</td>
<td>7.5</td>
<td>1 660</td>
<td>19.7</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>290</td>
<td>35.5**</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>16</td>
<td>9.2</td>
<td>1 220**</td>
<td>17.0**</td>
</tr>
<tr>
<td>United States</td>
<td>104</td>
<td>98.6*</td>
<td>23 085**</td>
<td>19.7**</td>
</tr>
<tr>
<td><strong>Total (OECD)</strong></td>
<td><strong>364</strong></td>
<td><strong>322.3</strong></td>
<td><strong>53 160</strong></td>
<td><strong>18.8</strong></td>
</tr>
</tbody>
</table>

* Secretariat estimates. ** 2012 data. Operational = connected to grid.
Reduced electricity demand. Preparations for the refurbishment and life extension of ten Darlington and Bruce reactors were underway.

- In the Czech Republic, the state power company ČEZ delayed its decision by a year on the winning bid for two additional reactors at the Temelin site after the unexpected fall of the government in June.

- In Finland, construction of the Olkiluoto 3 EPR reactor continued, with grid connection expected in 2016, some six years later than originally planned. Bids for the construction of Olkiluoto 4 were under review, and the Fennovoima consortium was in discussions with Rosatom for the construction of a reactor at the greenfield Pyhäjoki site.

- After a national debate on energy policy came to a close in September, legislation in France is expected to be presented to the government in late 2014 on reducing the country’s reliance on nuclear power for electricity production from 75% to 50% by 2025. Construction of the Flamanville 3 EPR continued, with operation expected to begin in 2016.

- In Japan, regulatory standards brought into force in July by the new independent NRA established requirements for reactor restarts with the process expected to take between 6 to 12 months. Without nuclear power, Japan has been importing fossil fuels for electricity generation, resulting in increased greenhouse gas emissions, significant increases in energy costs and a trade deficit for the third consecutive year.

- In Spain, the operating licence for the Santa Maria de Garoña reactor expired in July 2013 after it had been shut down in December 2012 because new taxes made continued operation uneconomic. The operator is to be given one year from the shutdown date (July 2013) to request an operating life extension and restart the reactor under provisions proposed in an amendment to existing regulations.

- In Sweden, Vattenfall announced its plans to invest USD 2.4 billion between 2013 and 2017 to modernise and upgrade its five most recently built units (Ringhals 3-4 and Forsmark 1-3) in order to continue operations for up to 60 years.

- In Turkey, the government continued with its NPP construction plans as the rapidly growing economy faces escalating electricity demand. Preconstruction activities were underway for four units at the Akkuyu site, a framework agreement was signed for four units at the Sinop site and sites were under consideration for the construction of a third NPP.

- In the United Kingdom, negotiations between NNB GenCo (a joint venture led by EDF) and the government over a guaranteed price for electricity, referred to as a contract for difference based on a “strike price”, were finalised in October (pending approval by the EU Directorate-General for Competition). An investment decision is expected in 2014.

- In the United States, three reactors were shut down for technical reasons (Crystal River 3, and San Onofre 2 and 3) and one for economic reasons (the single Kewaunee unit). It was announced that the single Vermont Yankee unit would be closed for economic reasons in late 2014. Small single reactors operating in states with liberalised energy markets are facing strong competition from gas-fired and renewable generating sources. Construction of two AP1000 units each at the Vogtle and VC Summer sites officially began in 2013, and work continued to complete the construction of the Watts Bar 2 reactor.

<table>
<thead>
<tr>
<th>Shares of uranium resources and production</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resources (%)</strong></td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Australia</td>
</tr>
<tr>
<td>Canada</td>
</tr>
<tr>
<td>United States</td>
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<td>Namibia</td>
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<tr>
<td>Niger</td>
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<tr>
<td>South Africa</td>
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<tr>
<td>Kazakhstan</td>
</tr>
<tr>
<td>Russian Federation</td>
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<tr>
<td>Uzbekistan</td>
</tr>
<tr>
<td>Ukraine</td>
</tr>
<tr>
<td>Others</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

*Identified resources recoverable at less than USD 130/kgU (2011 data). **2013 estimates.
After reassessments of nuclear power safety were restarted in non-NEA member countries, notably in China which has the most rapidly expanding nuclear power programme worldwide (30 reactors under construction). Three reactors were connected to the grid outside the NEA area in 2013 (Hongyanhe 1 and 2 in China and Kudankulam 1 in India), and construction of four reactors was initiated (Belarusian 1 in Belarus, Tianwan 4 and Yangjiang 5 in China, and Barakah 2 in the United Arab Emirates). India continued with its ambitious nuclear development programme, with six reactors under construction. Concerns arising from the 2010 Civil Liability and Nuclear Damage Act have, however, limited participation by foreign vendors. Bangladesh signed agreements with Rosatom for the construction of two units, Jordan selected Rosatom as the preferred bidder for the construction of two units. Pakistan announced an agreement with China to construct two units. Vietnam signed an agreement with Rosatom for the construction of two units, and negotiations with Japan were being finalised for the construction of an additional two units. South Africa continued to advance plans for the construction of an additional 9 GWe of nuclear generating capacity.

Uranium production, conversion and enrichment

Preliminary, unofficial data indicate that global uranium production remained steady at about 58 200 tonnes of uranium (tU) in 2013, as increased production in Kazakhstan balanced reduced production in Niger and elsewhere. Uranium was produced in eight NEA member countries in 2013, although France, Germany and Hungary contributed only very small amounts as part of mine remediation activities. Australia (12%), Canada (15%), 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 approximately 26 850 tU in 2013, an increase of over 15% from 2012 (due to the inclusion of the Russian Federation), covering approximately 35% of NEA member country uranium requirements (38% including Russia). Remaining requirements were met by other producing countries and secondary sources (material derived from dismantling warheads, excess commercial inventories and reprocessed uranium).

Commercial scale 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 with a total capacity of 15 000 tU envisaged. In the United States, the Metropolis conversion facility was restarted in July after being shut down in May 2012 in order to implement upgrades required by the regulator to strengthen the facility’s resistance to earthquakes and tornadoes.

Two recently constructed, 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 2013, with capacity expansions underway or planned at both facilities. Development of centrifuge enrichment capacity led to the closure of the Eurodif Georges Besse gaseous diffusion enrichment plant in June 2012 and the Paducah gaseous diffusion plant in the United States at the end of May 2013. Global Laser Enrichment was selected by the United States Department of Energy (USDOE) to build and operate a laser enrichment facility that would re-enrich about 115 000 tonnes of depleted uranium tails stored at the Paducah site.

Nuclear safety and regulation

A number of activities were undertaken by the international community to identify and address lessons learnt from the Fukushima Daiichi nuclear power plant accident. Preliminary safety assessments were promptly conducted by every regulatory authority in countries with established nuclear power programmes to evaluate the safety of their operating nuclear power plants under similar, severe conditions. These preliminary safety assessments concluded that the existing nuclear power plants were safe for continued operation while longer-term programmes were implemented to assess safety enhancements that would improve the protection of public health and the environment. The lessons learnt have emphasised the importance of continuing to enhance the safety of nuclear power plants by, for example, ensuring the robustness of their designs to withstand severe natural phenomena and other hazards; applying defence-in-depth approaches to ensure that mitigation strategies are in place to address a loss of electrical power and ultimate heat sink; developing and sustaining strong safety cultures in operating organisations and regulatory bodies; and understanding the importance of effective communication during a crisis. Accordingly, NEA member countries have been actively engaged in assessing and implementing actions in response to these lessons and in developing comprehensive approaches for regulatory bodies to consider as they enhance their regulatory framework in light of the Fukushima Daiichi accident.

At the same time, several countries are also licensing and constructing new reactors. A number of these countries continue to share experiences on various international initiatives, including the Multinational Design Evaluation Programme (MDEP). International collaborative efforts are yielding improvements in regulatory practices as well as enhanced knowledge and understanding of new technology. These initiatives are seeking to reinforce nuclear safety worldwide by promoting convergence on safety practices and combining the expertise of participating regulatory authorities while improving and expediting the safety review of new designs. The lessons learnt from the Fukushima Daiichi accident will also impact the design requirements of new reactors.
New approaches, new concepts and new technology often present new issues for nuclear safety. The development and validation of new analytical tools and research is necessary to support the identification and resolution of new or unique safety issues based on the technology of advanced designs. Regulatory and safety practices for advanced designs have the greatest potential for international harmonisation and should be pursued to the extent practical. Likewise, international collaborative projects and cost-sharing have significant potential for mutual gains.

Radioactive waste management

Significant efforts are 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 has completed the first phase of preliminary assessments in collaboration with 8 of the 21 communities that expressed interest in learning about Canada’s plan for the safe, long-term management of used nuclear fuel. Preliminary assessments are the third of a nine-step, multi-year process for evaluating the potential suitability of sites to host a deep geological repository and an associated Centre of Expertise. The conceptual design and safety case for a repository were submitted to the regulator for review.

- 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.

- 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.

- In France, a national debate was carried out over a project proposal for a geological repository of high-level and long-lived, intermediate-level waste in the Meuse-Haute Marne area. This public debate ended in 2013 and will inform the promulgation of a law by the National Assembly.

- In Germany, legislative proposals have been made on a strategy and schedule for the siting of a geological repository for high-level waste.

- In Japan, the work of the geological disposal research programme is ongoing while a high-level waste management policy is being debated among several national organisms.

- In the Republic of Korea, stakeholders submitted their views on spent fuel management policy to government, and a larger engagement process is planned.

- In the Russian Federation, the design process has begun for development of a deep geological repository for high-level and long-lived waste in the region of Krasnoyarsk.

- In Sweden, the nuclear regulator, the Environmental Court and Osthammars municipality have begun a review of the general licence application for spent fuel disposal.

- In Switzerland, the sectoral planning process for deep disposal of radioactive waste has now reached phase 2. Areas for potential installation of deep geological waste repositories for either high- or low-level waste have been identified from a technical point of view. In the new phase, logistical and economic aspects will be examined with the relevant communities and Cantons in view of reducing the number of identified sites.

- In the United Kingdom, following the withdrawal of one of the three communities that participated in pre-siting for a deep geological repository for high-level radioactive waste, the Department of Energy and Climate Change launched a new consultation in September 2013.

- In response to the Blue Ribbon Commission report, the USDOE released the “Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste” in January 2013. This response is a “framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing and disposing of used nuclear fuel and high-level radioactive waste.” Later in the year, the United States Nuclear Regulatory Commission (NRC) announced that it would resume work on a safety evaluation report of the formerly proposed repository for spent fuel and high-level waste at Yucca Mountain. This decision, which has symbolic significance, was prompted by a court order.

Overall, there has been good progress in both the technical and societal development of geological repositories, but in many countries, the timing of the implied decision-making processes makes it necessary to consider storage for extended periods, notably in Germany, Japan and the United States. In Spain, the project to implement a centralised interim storage facility for all high-level radioactive waste and spent fuel is on schedule, with construction anticipated to begin in Villar de Cañas in 2018. In the United States, the NRC is working on its “Waste Confidence Rule”, a legal document that would provide generic criteria for the environmental impacts of the continued storage of spent nuclear fuel beyond the licensed life for operation of a reactor. A draft rule was circulated for public comment through to the end of 2013. In Hungary, an operating licence was granted for further modules of interim spent fuel
Progress has also been made in the area of low-level waste. In Belgium, a licence application for a surface disposal facility at Dessel was submitted in 2013. In Canada, the public hearing process for the proposed deep geological repository for low- and intermediate-level waste in Ontario ended on 30 October 2013. The Joint Review Panel will now prepare its Environmental Assessment Report to the Federal Minister of the Environment outlining its conclusions and recommendations. In Hungary, a first disposal chamber in the Bátaapáti repository was licensed for operation. In the Russian Federation, the development of documents on radioactive waste classification, unified management and funding is ongoing, based on a 2011 federal law (the main sub-law documents have been issued). Discussions are ongoing for a low- and intermediate-level radioactive waste (LILW) repository planned in the Leningrad region, and construction began on another LILW repository in the Ural region in 2013.

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, for example, the extension of existing disposal facilities. Decommissioning plans, as well as decommissioning cost estimation studies, continue to be updated regularly in NEA countries. In Sweden, for example, operators have presented updated decommissioning plans for nuclear power plants, and these are currently being reviewed by the Swedish Radiation Safety Authority. In October 2013, the operator announced a planned shutdown of the Mühleberg NPP, in Switzerland, by 2019. The International Research Institute for Nuclear Decommissioning (IRID) in Japan was established on 1 August 2013 to improve nuclear decommissioning technologies for the Fukushima Daiichi NPP decommissioning programme on the basis of international co-operation and information exchange. Experience shows 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 most significant radiological protection events of 2013 continued to be those resulting from the Fukushima Daiichi nuclear power plant accident. With the more detailed aspects of consequence management only beginning to emerge, the implications of the accident for international standards and national regulations are only now becoming clearer.

The focus of much emergency management work since the Chernobyl accident in 1986 has been on the emergency phase of an accident, and a great deal has been learnt in this regard. However, the specific circumstances of the Fukushima Daiichi accident in 2011 have suggested that further work is needed in certain areas. For instance, the accident has clearly underlined the importance of communication with the public, among national regulatory authorities and among governments. In addition, while strategies for monitoring incoming products existed in all countries, there was no common approach. Existing international criteria (Codex Alimentarius) were not perceived to be directly applicable to the Fukushima situation and were thus quickly abandoned in favour of criteria being used in Japan. Technical assessments of early, uncertain accident situations are important to decision making, but with the lack of information during the first weeks of the accident, such assessments could only be based on credible, conservative estimates. This would suggest that information collection and sharing (communication plans), as well as mechanisms for sharing the technical aspects that inform national decisions (monitoring of goods and technical assessment tools), could be better co-ordinated in the future. On a more detailed level, the accident also underlined a need to review the approaches taken to developing emergency planning zones and to assess how countries could more coherently align criteria for protective actions.

There has been much less focus at the national level on recovery planning than on emergency planning. As a starting point, it was deemed important to define pre-determined criteria so that citizens could return to evacuated areas. However, there is also a need to clarify the relationship and bridge the gap between self-help actions initiated by stakeholders and support from government authorities and radiation protection experts. Surveys have confirmed that stakeholder involvement in recovery decision-making processes have been helpful in national and regional efforts. Much of the provisional aid seems to have focused on providing information to affected populations, but communication and dialogue remain important issues for governments as well.

These emerging topics have made it clear that the early top-down approach to consequence management will evolve into a much more bottom-up approach during recovery. As such, stakeholder involvement will become increasingly important even during the emergency phase. It will also be crucial when making decisions on citizens returning to evacuated areas, on clean-up criteria, temporary storage and disposal of waste, communication strategies and support for self-help initiatives.

**Nuclear science**

Responses to the Fukushima Daiichi accident are becoming increasingly focused on longer-term R&D needs. Enhancing the capacity of light water reactors (LWRS) to withstand an accident is now the subject of detailed technical study. Programmes of work at national and international levels have been initiated to assess alternative fuel and cladding materials with enhanced capability to retain radioactive nuclides during extreme events. While there is broad consensus on the desired characteristics of these alternative materials (avoidance of hydrogen...
production and exothermic reactions with steam, increased thermal conductivity, higher melting point), the net benefits of moving away from the well-established zircaloy/uranium dioxide fuel design is open to debate. It is clear that such a move could only be sanctioned and supported after an extensive testing and simulation programme.

Regarding simulation, an important development has been the availability of plant information on the evolution of reactor conditions at Fukushima Daiichi Units 1 to 3 following the loss of emergency cooling at the site. This information can be used to provide benchmarks against which analysts may now test and improve their severe accident modelling codes. In science, it is also relevant to steering research towards the development of new fuel designs by providing a means to quantify 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 also continues to be interest in the possibility of switching from the current uranium/plutonium fuel cycle to a thorium/uranium-233 approach. Interest in advanced nuclear systems remains strong, as is the need for the testing and development of modelling tools for spent fuel and waste management analyses.

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. These trends serve to emphasise the importance of the rigorous treatment of uncertainties and the need for validation against appropriate experimental data.

Many of the technical areas discussed above have seen a decline in the number of experts actively involved in their research programmes. 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.

**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 of NEA member countries. In the wake of the Fukushima Daiichi accident, the IAEA Action Plan on Nuclear Safety 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 towards providing appropriate compensation for damages suffered. The NEA is a member of the International Expert Group on Nuclear Liability (INLEX), which issued a set of recommendations in 2012 to facilitate progress towards a global nuclear liability regime. It encouraged nuclear and non-nuclear states to consider joining one or more of the relevant international instruments and reflect the international principles in their national legislation in order to establish a more universal system.

The United States and France issued a Joint Statement on Liability for Nuclear Damage in August 2013 agreeing to “promote efforts to achieve a global nuclear liability regime based on treaty relations among France, the United States and other countries that might be affected by a nuclear accident”, to “coordinate their actions in encouraging adherence to the enhanced international nuclear liability instruments” and to “urge countries to adopt national laws that incorporate the nuclear liability principles and recent enhancements to those principles”, as well as certain best practices. The joint statement is significant because it reflects a common stance on the importance of further progress in achieving a global regime from two major nuclear power generating states.

In addition, the declaration issued by the G-20 in September 2013 after its meeting in St. Petersburg encouraged “multilateral cooperation towards achieving a global nuclear liability regime”. Although achievement of a global liability regime may take some time, there are signs of progress. Canada, which signed the Convention on Supplementary Compensation for Nuclear Damage (CSC) in December, and Japan have indicated their intention to ratify the CSC in the near future, which would allow the CSC to come into force.

The NEA member countries that signed the 2004 Protocols to amend the Paris Convention on Third Party Liability in the Field of Nuclear Energy (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 Belgium, Italy and the United Kingdom will adopt ratification and implementation legislation which should allow the 2004 protocols to enter into force by 2015. Belgium, like some other signatories, has already adopted transitory legislation which transposes into its national legislation the compensation levels provided in the 2004 protocols pending their entry into force.
Technical Programmes
Nuclear Development Committee (NDC)

The NDC continues to support member countries by providing authoritative, reliable information on nuclear technologies, economics, strategies and resources for use in policy analyses and decision making, including the role of nuclear energy in reducing greenhouse gas emissions and enhancing the security of supply of electricity.

Policy and strategic issues

While there is now more clarity in member countries’ approaches and policies on nuclear energy post-Fukushima, a major continuing challenge facing the 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 with first-of-a-kind projects and general economic constraints, making affordability of electricity a concern in many countries. Thus recent IEA projections, which were undertaken in conjunction with the NEA, show decreases in nuclear growth outside of developing economies. The NDC has initiated activities in its 2013-14 programme of work to emphasise the importance of understanding the full system costs of various energy sources.

Another key issue the Fukushima Daiichi accident called attention to was the costs associated with decommissioning, remediation and compensation following an accident. An expert group was established in 2013 to lead a project with the following main objectives: to conduct an appraisal of existing studies and data on the economic costs of severe nuclear accidents that have occurred in civil nuclear energy (Three Mile Island, Chernobyl, Fukushima), to develop methodological advice on cost assessments, to perform damage estimates for selected accident scenarios and to describe the existing liability regimes in OECD countries, as well as consider implications and potential improvements.

The NEA Secretariat continues to work with other parts of the OECD on energy and climate issues. It took part in IEA in-depth reviews of the Netherlands, the Russian Federation and the United States this year, and assisted the IEA with the nuclear parts of the Clean Energy Ministerial and Energy Technology Perspectives reports. With support from the OECD Environment Directorate and the IEA, the NEA also initiated a project entitled Climate Change: Assessment of the Vulnerability of Nuclear Power Plants and Cost of Adaptation.

Economics and financing

The feasibility and costs of spent nuclear fuel (SNF) management and disposal of ultimate waste continue to be the subject of public debate in many countries, with particular concerns often raised about the lack of experience in implementing final disposal of spent nuclear fuel and high-level waste (HLW) from reprocessing.

The report on The Economics of the Back End of the Nuclear Fuel Cycle presents an appraisal of economic issues and methodologies for the management of SNF and HLW from commercial power reactors. It reviews different back-end options, policies and practices, with a focus on cost estimates and funding mechanisms in place or under consideration in NEA member countries. A generic economic assessment of back-end cost impacts on fuel cycle costs was undertaken for selected “idealised” scenarios, and sensitivity calculations were conducted to evaluate uncertainties in major components and to identify cost drivers.
The results of the fuel cycle cost calculations show that costs for the open fuel cycle option are lower than for the partial and full recycling options assessed. Differences among the three options in the total fuel cycle component of the levelised costs of electricity remain, however, within uncertainty bands. For the recycling options, additional costs from reprocessing are partially offset by savings on fuel costs at the front end. Differences, however, are more noticeable if the back-end component of the fuel cycle cost is considered in isolation, since offsetting effects are not taken into account. It is important to note that, for all options assessed, the fuel cycle cost component associated with the management of SNF represents a relatively small fraction of the total levelised costs of electricity generation. A related project on the costs of decommissioning of nuclear power plants was initiated and two meetings were held to prepare a publication on this subject by the end of 2014.

Another new project, the Review of Nuclear New Build: Project Structure, Supply Chain and Financing, was launched in 2013. It involves an analysis of the experiences and lessons learnt from recent reactor constructions in order to identify characteristics of a successful nuclear new build project. Phase one, on financing and electricity price arrangements for nuclear new build in different market environments, concluded in September with an international workshop on The Role of Electricity Price Stability and Long-Term Financing for Nuclear New Build. Participants agreed that, for capital-intensive technologies like nuclear energy, political, regulatory and, above all, economic and financial stability are key elements. Such issues inevitably give rise to questions related to the appropriateness of market design and long-term electricity price arrangements. Phase two, on the structure of project management and the supply chain during construction, has begun with the development of the conceptual framework and the selection of case studies.

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 OECD/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.

**Data and resources**

Producing uranium in a safe and environmentally responsible manner is not only important to the producers and consumers of the product, but to society at large. For this reason, a report was completed in 2013 looking at the significant evolution of uranium mining practices from the time when uranium was first mined for military purposes until today. The report provides readers with an understanding of the circumstances under which historic practices led to the creation of environmental and health legacies and contrasts these past practices with modern, leading practices and their outcomes. Case studies of past and current practices are included to highlight these developments.

**Security of supply of medical radioisotopes**

In 2013, the NEA continued its efforts to improve the global security of supply of molybdenum-99 ($^{99}$Mo) and of its decay product, technetium-99m ($^{99m}$Tc) which is the most widely used medical radioisotope. The High-level Group on the Security of Supply of Medical Radioisotopes (HLG-MR) completed its first review of the $^{99}$Mo/$^{99m}$Tc supply chain and released a report in March entitled *The Supply of Medical Radioisotopes – Implementation of the HLG-MR Policy Approach: Results from a Self-assessment by the Global $^{99}$Mo/$^{99m}$Tc Supply Chain.*

Information provided by supply chain participants indicates that progress is being made to implement full-cost recovery by most (but not all) reactor operators and processors. This process is occurring at different speeds and, in some instances, without clearly defined timelines. In addition, government subsidies continue to be a barrier to full-cost recovery implementation.

Despite progress, outage reserve capacity (which significantly contributes to the security of supply and should therefore be appropriately valued) is still not widely accepted or used by the market. Pressure on budgets has led to reductions in public spending on health care, which has also affected nuclear medicine. As a result, very few governments have expressed interest in reviewing reimbursement rates for medical radioisotopes.

The NDC has approved a third two-year mandate for the HLG-MR (2013-2015) during which the NEA will undertake projects to update the global $^{99}$Mo/$^{99m}$Tc supply forecast for the potentially critical 2015-2020 period as well as a second self-assessment by the $^{99}$Mo/$^{99m}$Tc supply chain. The report on the updated $^{99}$Mo/$^{99m}$Tc supply forecast is scheduled to be released in 2014.
The CNRA contributes to developing a consistent and effective regulatory response to current and future challenges, addressing in particular operational experience feedback, inspection practices, the regulation of new reactors and public engagement concerning safety in the use of nuclear energy.

### Highlights
- The CNRA senior task group completed its mandate to co-ordinate NEA activities related to the implementation of lessons learnt from the Fukushima Daiichi accident. A final report entitled *The Fukushima Daiichi Nuclear Power Plant Accident: OECD/NEA Nuclear Safety Response and Lessons Learnt* was published in September.
- Work on crisis communication has been completed and has resulted in an extended Road Map for nuclear regulatory organisations.
- Emphasis continued to be placed on identifying and applying lessons learnt and commendable practices in the areas of operating experience and inspection practices.
- A workshop was held in October on Regulatory Approaches and the Characteristics of an Effective Regulator.

### Regulatory impacts of the Fukushima Daiichi accident
The Senior-level Task Group on Impacts of the Fukushima Accident (STG-FUKU), formed in March 2011, continued to provide a dedicated forum for the timely and efficient exchange of information on national activities and safety reviews in response to the Fukushima Daiichi accident until June 2013 when the group completed its mandate (see page 6 for further details).

### Operating experience
The Working Group on Operating Experience (WGOE) focuses its activities on follow-up actions regarding 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 nuclear power plants (NPPs). The group gained approval for the report on Fukushima Daiichi NPP Precursor Events at the December CNRA meeting. Preparations were made for the 14th WGOE workshop, to be held in Germany in September 2014, on the subject of Operating Experience (OPEX) Programme Effectiveness Measures.

### Regulation of new reactors
The Working Group on the Regulation of New Reactors (WGRNR) is reviewing regulatory activities concerning siting, licensing and oversight of new commercial NPPs. A construction experience programme (ConEx) has been developed to identify deficiencies associated with NPP design and construction, to assess the adequacy of, and to supplement if necessary, regulatory activities to detect and correct such events, and to disseminate information to ensure appropriate regulatory attention is given to lessons learnt from past events. In 2013, the process for approval of events reported in the ConEx database and for work to be performed was reorganised.

A report was completed on the regulation of site selection and preparation aimed at reviewing the various practices used by regulators. It is based on a survey covering different aspects of the regulation of nuclear sites. The group is finalising a supplemental report related to new plant siting, which includes changes or enhancements as a result of the Fukushima Daiichi accident.

A study was completed 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 these activities and the various licensing processes. The first two volumes of the report will cover “Instrumentation and Control” and “Civil Engineering Works and Structures”. The proceedings of a workshop held in October 2012 on licensing structures and site-related and construction activities were issued in 2013.

### Regulatory inspection practices
The Working Group on Inspection Practices (WGIP) completed two reports in 2013, one on the inspection of licensee maintenance programmes, and the other on the inspection of licensee emergency arrangements. Preparations were made for the 12th WGIP workshop, which will be hosted by the US NRC in April 2014. Topics will cover the inspection of licensees’ outage activities, including fire protection programmes, event response inspections and the impact of the Fukushima accident on inspection programmes. The CNRA also approved a new routine task on NPP benchmarking inspection practices. The purpose of this WGIP task is to implement a
process that would assist member countries in improving inspection techniques by participating in and observing the planning, performance and enforcement actions of inspections performed by other member countries.

Nuclear regulators and public communication
In 2013, the Working Group on Public Communication of Nuclear Regulatory Organisations (WGPC) completed its task on crisis communication. The proceedings of the “Crisis Communication: Facing the Challenges” workshop held in Madrid in May 2012 were published, as well as an extended Road Map for NRO crisis communication. The group redefined the “NRO Communication Strategy” (formerly “Communication Plans”) to address how NROs can elaborate an overall communication strategy for all non-emergency situations.

In 2013, the WGPC worked on interactions with stakeholders and is planning to invite European stakeholders, media and elected officials, as well as members of local information committees and non-governmental organisations for a one-day workshop during its 2014 meeting.

Accident management
The Task Group on Accident Management (TGAM) was formed in June 2012 to review the regulatory framework for accident management following the Fukushima Daiichi accident. The TGAM was requested to assess NEA member countries’ needs as well as regulatory challenges in light of the accident.

The report is being produced based on existing or proposed experiences and practices in NEA member countries, along with new findings from post-Fukushima studies to address accident management issues such as procedures and guidelines, equipment, infrastructure and instrumentation, and human and organisational resources. The report outlines commendable practices useful for regulatory authorities, operating organisations and others in the nuclear safety community to support regulatory framework enhancements and integrated on-site accident management responses. The final report on “Accident Management Insights after the Fukushima Daiichi NPP Accident” was approved by the CNRA in December 2013.

Senior-level Task Group on the Characteristics of an Effective Regulator
In December 2012, the CNRA decided to establish a STG to prepare a booklet on the characteristics of an effective regulator. It will focus on policy aspects of the higher-level attributes and behaviours that characterise an effective regulator, rather than on structural or prescriptive requirements. A workshop on Regulatory Approaches and the Characteristics of an Effective Regulator was held in October in Sweden. The first part of the workshop focused on the Swedish Radiation Safety Authority’s study on “Regulatory Approaches in Nuclear Power Supervision”. The second part focused on the characteristics of an effective regulator and the booklet that is being prepared. The workshop enabled synergies that will contribute to finalising the booklet, which the STG will present for approval at the June 2014 CNRA meeting.

Committee on the Safety of Nuclear Installations (CSNI)
The CSNI contributes to maintaining a high level of safety performance and safety competence by identifying emerging safety issues through the analysis of accidents and their management, ageing and structural integrity, fuel and fuel cycle safety, contributors to risk and human factors. The committee also facilitates the establishment of international joint research projects when useful.

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

During 2013, further progress was made on the PREMIUM benchmark, follow-up of the Three Mile Island-2 (TMI-2) benchmark and the State-of-the-Art Melt Coolability and Concrete Interaction (MCCI) report. The preliminary findings of the TMI-2 benchmark show that 1) for small-break loss-of-coolant accidents (LOCAs) and for surge line breaks combined with station blackout, there was general agreement up to core melt and significant deviations thereafter, even with the same computer code but very different core degeneration models; and 2) modelling reflood of a degraded core at high flow rate is very challenging.
The WGAMA initiated four activities related to Fukushima issues in 2012, with the following progress made in 2013:

- The first draft of a status report on filtered containment venting was produced following the collection of data for the group’s comment in August 2013. The target is a final report to be approved by June 2014.
- A number of simulations for comparison and assessment were completed by September 2013 on an international benchmarking project on fast running software tools to model fission product releases during accidents at nuclear power plants. The final report is scheduled to be submitted to the CSNI for approval in December 2014.
- A draft report was prepared on hydrogen generation, transport and risk assessment in December 2013, with submission to the CSNI expected in the first half of 2014.
- The first draft of a status report on spent fuel pools under loss-of-cooling accident conditions was produced and discussed in October 2013. The target is submission to the CSNI in December 2014.

The CSNI approved three WGAMA reports in 2013: the Proceedings of the Workshop on Computational Fluid Dynamics for Nuclear Reactor Safety Applications, the Containment Code Validation Matrix and the OECD/NEA PREMIUM Benchmark Phase II: Identification of Influential Parameters.

In addition, four new activities were approved on 1) CFD uncertainty methodologies, 2) a state-of-the-art report on scaling of thermal-hydraulic systems using water as working fluid during design basis accidents, 3) informing severe accident management guidance and actions through analytical simulation, and 4) a technical opinion paper on ex-vessel steam explosion phenomena in deep cavities.

**Ageing and structural integrity of reactor components**

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

In 2013, the WGIAGE finalised a report documenting the proceedings of a second workshop on seismic observations in deep boreholes. Deep boreholes are proving valuable in examining uncertainties in seismic behaviour of irregular geological structures. Two additional workshops were held in 2013, to share current practices for non-destructive testing of concrete structures and to finalise input for a report summarising technologies for pre-stressing concrete structures.

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

In 2012, a Fukushima-related activity on metallic component margins under high seismic loads was initiated to quantify the existing margins in seismic analysis of safety-class components for high seismic loads. The group has created a database of seismic tests of components and piping systems, and is in the process of surveying current practices for seismic design. Two benchmark exercises are planned for 2014.

**Risk assessment**

The main mission of the Working Group on Risk Assessment (WGRISK) is to advance the understanding and utilisation of probabilistic safety assessment (PSA) as a tool to support nuclear safety decision making in member countries.

The Fukushima 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 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”, hosted by ÚJV Řež on 17-19 June 2013 in the Czech Republic. A first draft report was completed in November 2013, and the final report should be submitted to the CSNI for approval in spring 2014.

Progress has been made on best practice guidelines for failure modes of digital I&C as well as preparations for a workshop on fire probabilistic risk assessment (PRA) scheduled for April 2014 in Germany.

The “Use of OECD/NEA Data Project Products in Probabilistic Safety Assessment” report was approved in December 2013. The CSNI also approved a new activity on probabilistic safety assessment insights relating to the loss of electrical sources. The task will review accident mitigation and is focused on loss of AC power for older plants with existing PSAs.

**Fuel safety**

The Working Group on Fuel Safety (WGFS) is addressing the systematic assessment of the technical basis for current safety criteria and their applicability to high burn-up, as well as to new fuel designs and materials being introduced.

The activities of the group in the area of reactivity initiated accidents (RIAs) continued to complement the task on the RIA fuel codes benchmark. The task included a blind calculation of eight RIA tests. Three seminars were held over three years where calculation results were presented and discussed. The final report summarises all calculation runs and recommends a second phase of the benchmark where a sensitivity study of the input parameter results and an assessment of the uncertainty of the results
would be performed for the different codes. The RIA codes benchmark follow-up will start in 2014.

In 2013, the activity related to leaking fuel impacts and practices continued, with the aim of discussing and reviewing current practices in member countries and drawing conclusions to help decision making on the specifications of reactor operation conditions with leaking fuel rods.

**Human and organisational factors**

The Working Group on Human and Organisational Factors (WGHOF) constitutes a unique international forum for addressing safety management including safety culture, human and organisational factors, and human performance in nuclear facilities. In 2013, a new task was undertaken with the objective of sharing best practices in conducting validation tests related to the performance of integrated systems, such as reactor control rooms. The purpose of such validation tests is to confirm the integrated performance of control systems, procedures and staff training. The joint WGHOF/WGRISK task continues to investigate key attributes of human reliability analysis (HRA) in nuclear risk assessments. Using the attributes scale developed, a number of well-known HRA techniques have been evaluated. A final report has been drafted and is under review with the goal of being issued in 2014. Another ongoing task is directly related to the Fukushima Daiichi accident and concerns human performance and intervention under extreme conditions. The task group has developed a model for decision making under conditions applicable to severe accident situations. A workshop is planned in February 2014 to draw lessons and best practices from both within and outside the nuclear industry, namely in other high hazard sectors.

**Fuel cycle safety**

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

The joint NEA/IAEA Fuel Incident Notification and Analysis System (FINAS) is the only international web-based system has been in operation since 2008. The group’s final report received CSNI approval in June 2013. The Task Group on Sump Clogging web page helps to facilitate information exchange.

**Sump clogging**

At the end of 2010, a Task Group on Sump Clogging was established to update the state-of-the-art report on the “Knowledge Base for Emergency Core Cooling System Recirculation Reliability”, taking into account progress in relevant R&D since its first edition in 1996. Special emphasis has been placed on chemical effects and downstream effects as well as long-term core cooling, which were identified as main concerns during a joint CNRA/CSNI workshop held at the end of 2008. The group’s final report on CSNI approval in 2013. The Task Group on Sump Clogging web page helps to facilitate information exchange.

**Robustness of electrical systems**

A task on the robustness of electrical systems of NPPs in light of the Fukushima Daiichi accident (ROBELSYS) was launched in 2013, complementing the completed DIDELSYS task, which had been undertaken following the incident at the Forsmark NPP in July 2006, where an offsite and onsite electrical system event played a major role. Although the conclusions drawn from the two phases of the DIDELSYS task mainly addressed internal plant and grid-related electrical system events, the Fukushima accident questioned 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 will be organised in April 2014, where lessons learnt from the Fukushima Daiichi accident regarding the robustness of electrical systems, provisions already taken or planned after the accident, sources, distribution systems and loads will be discussed. Other subjects to be explored include documenting the technical basis for improvements and possibilities to connect sources very close to the loads.

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NEA Annual Report 2013
Radioactive Waste Management Committee (RWMC)

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

Highlights

- The RWMC Integration Group for the Safety Case (IGSC) held an international symposium reviewing the state of the art in the safety case for deep geological disposal of radioactive waste.
- The RWMC issued a collective statement on the current status and prospects of estimating the decommissioning costs of a nuclear facility and their comparability.
- The IGSC formed an expert group to evaluate and address safety issues related to the operation of geological repositories for radioactive waste.
- A publication was completed on the evolving role of regulators and trends over the past decade, as well as a cost control guide for decommissioning projects.
- Several flyers on waste disposal were created for the wider public, notably on national commitment and regional and local confidence, on optimisation and on the newly released criteria of the International Commission on Radiological Protection (ICRP).

Strategic activities

Meeting societal requirements and expectations is a prerequisite to the implementation of a geological repository, with local and regional governments playing an essential role in the decision-making processes. This message was confirmed in the 2013 Safety Case Symposium, hosted by the IGSC in October. Participants at the 2nd international symposium, The Safety Case for Deep Geological Disposal of Radioactive Waste: 2013 State of the Art, assessed latest advancements and concluded that the development of a safety case is not only a scientific and technical activity, but also serves as input for societal decisions.

An important initiative of the RWMC that bridges both societal and technical issues is the Preservation of Records, Knowledge and Memory (RK&M) across Generations. The initiative is now in its fourth 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, as 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; and ii) there are a number of mechanisms outside radioactive waste management and the nuclear field that can foster RK&M preservation. They constitute a potential resource for waste management organisations and governments. Monitoring of repositories over the long term is another aspect of interaction between society and technology, as shown in two recent studies carried out under the RK&M initiative.

As many waste management programmes continue to advance, the IGSC formed an expert group to evaluate and to address safety issues related to the operation of geological repositories. The main topics covered by the group include i) fire risks, ii) hazards associated with the operation and construction of a repository, and iii) the development of a hazard database.

Records, knowledge and memory

As radioactive waste disposal programmes approach the siting and operational stages, the preservation of RK&M across generations constitutes one of the pillars of confidence in safety and security, and a foundation for robust decisions by future generations once the repository is closed. Strategic articles and recommendations have been drafted on such topics as archives, regulations and markers. A new initiative has been launched amidst strong interest in order to help develop a better understanding of, and practices for dealing with, the large amount of data generated during the development of a repository. The focus is on metadata, as metadata allows content to be stored with data so that these can be located and re-used.

Safety case for geological disposal

The 2013 Safety Case Symposium demonstrated that while a clear understanding of the technical components of a safety case currently exists, there are divergences in national programmes in terms of the realisation and roles of a safety case, which depend on different legal, regulatory and social requirements. Dialogue among the implementer,
The regulator and other involved stakeholders must continue in order to achieve mutual understanding and improve confidence. The 2013 symposium attracted over 160 participants from 65 organisations, representing 17 countries and international bodies. Proceedings of the symposium will be issued in the first half of 2014.

The Salt Club held its 2nd annual meeting in September to discuss the status of various project activities, including developments in relation to the Features, Events and Processes (FEPs) catalogue for rock salts and a database to archive available salt reports/data. Proceedings of the Natural Analogues for Safety Cases of Repositories in Rock Salt Workshop, held in Germany in 2012, will be issued in early 2014.

Also in September 2013, the Clay Club held its 23rd meeting in Japan. At this meeting, the Clay Club assessed how geoscientific information can be used to boost confidence in predictions about the long-term performance of geological repositories. Experience gained within various national programmes were also discussed.

As noted above, the IGSC formed an expert group in 2013 to evaluate and to address safety issues related to the operation of geological repositories. The main topics of the IGSC programme of work include i) fire risk management, ii) operational hazards associated with the construction and operation of underground repositories, and iii) the development of an operational hazards database. The IGSC will continue the development and enhancement of safety cases and their core components. In particular, a workshop to evaluate how to develop, manage and present potential scenarios in a safety case is currently planned for late 2014.

Forum on Stakeholder Confidence
The Forum on Stakeholder Confidence (FSC) held its 14th regular meeting in September 2013, with continuing high interest among NEA member countries resulting in the renewal and expansion of membership. New countries include the Republic of Korea and the Russian Federation, while new individual participants attended from Belgium, France, Germany, Hungary, Poland, Spain, Switzerland, the United Kingdom, the United States and the European Commission. A topical session investigated the role of transparency as both a requirement and an aid in the changing dynamics of interactions among institutions, with radioactive waste management processes moving into new phases. During a topical session on early involvement of stakeholders in decision-making processes, including initiatives at the European level to foster the participation of citizens, the NEA Nuclear Law Committee contributed insight on the application of the Aarhus and Espoo Conventions. The FSC finalised its input to reports on monitoring and memory, focusing in particular on civil society viewpoints and demands in relation to geological facilities. A detailed planning questionnaire was developed to support potential hosts of future national workshops, community visits and social media initiatives, for example by hosting “frequently asked questions” to help waste management stakeholders.

Decommissioning
At the annual meeting of the Working Party on Decommissioning and Dismantling (WPDD), participants received information on preparing for decommissioning during operation and after final shutdown of a nuclear facility, as well as information on legal and regulatory frameworks and the current status of and plans for decommissioning in the Russian Federation.

The WPDD received a report from the Task Group on Future R&D and Innovation Needs for Decommissioning (DECOM-R&D), identifying areas and referring to techniques with the greatest potential for future improvements to reduce cost, dose and time. It also approved a report identifying and summarising a best practice on the selection and tailoring of strategies for radiological characterisation of decommissioning at various stages of a nuclear facility’s life cycle, and addressing other key issues of characterisation.

Concrete decontamination in progress.

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The WPDD Decommissioning Cost Estimation Group (DCEG) continued working on developing a methodology for peer reviews of decommissioning project costs so as to further improve transparency and auditability of decommissioning costing.

The International Co-operative Programme for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects (CPD) continued its work, which currently covers 63 decommissioning projects (38 reactors and 25 fuel facilities) in 13 member countries, 1 non-OECD/NEA economy and the European Commission (see Joint Projects and Other Co-operative Projects for more information).
Committee on Radiation Protection and Public Health (CRPPH)

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

Radiological protection consequences of the Fukushima Daiichi accident

Lessons continue to emerge from the Fukushima Daiichi accident and an understanding of the accident and its implications is evolving slowly. NEA member countries are only beginning to adjust their emergency and recovery management programmes to fully take into account these issues. A topical session at the May 2013 CRPPH/WPNEM meeting explored the key aspects of emergency management being investigated, including national and international communication plans, management of trade in foods and goods from affected areas, early technical assessment of extremely uncertain accident situations with little or no data, review of emergency planning zones and harmonisation of protective actions. Discussions suggested that international focus should include improving early information sharing, co-ordination of decisions and movement towards a more harmonised framework for the development of emergency protective measures criteria.

A second topical session on recovery management suggested that there has been much less focus on planning and preparations for recovery than on emergency management. The topical session broadly concluded that, although many countries had recovery management plans prior to the Fukushima accident, the general review of preparations for transition from an emergency to a recovery phase, and the necessary resources for transition and recovery, would need to be revisited. Member countries continue to observe the evolution of the situation in Japan and to review their own programmes in the context of post-accident circumstances.

Decontamination activities within the evacuated area of Fukushima Prefecture are being carried out by the Japanese government and are progressing. Decontamination efforts beyond the evacuation zones are being managed by individual municipalities. However, much decontamination work remains to be completed. The CRPPH is planning a topical session on large-scale decontamination experience during its May 2014 meeting so as to gather information on the extensive Japanese experience in Fukushima. In terms of stakeholder involvement activities, the CRPPH Working Party on Nuclear Emergency Matters (WPNEM) began planning for INEX-5, which will address a large-scale, intermediate-phase consequence management scenario.

Evolution of the international system of radiological protection

With the completion and approval of the new Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (BSS), in co-operation with the IAEA and the six other co-sponsoring organisations (EC, FAO, ILO, PAHO, UNEP and WHO), the focus of the evolution of the radiological protection system has turned to

Highlights

- During its 71st meeting, the CRPPH organised topical sessions addressing the results of the Fourth International Nuclear Emergency Exercise (INEX-4), as well as issues raised and lessons learnt in emergency management and recovery management as a result of the Fukushima Daiichi accident.
- Work began within the CRPPH to organise a series of workshops on thyroid cancer science and occupational exposure in severe accident management, and a CRPPH topical session on large-scale decontamination experience.
- Work also began on a state-of-the-art report to summarise what is known and not known in radiological protection science, and to suggest supporting research.
- The CRPPH supported and participated in three International Commission on Radiological Protection (ICRP) Dialogue Initiative meetings in 2013.
- The CRPPH Working Party on Nuclear Emergency Matters (WPNEM) began planning for INEX-5, which will address a large-scale, intermediate-phase consequence management scenario.
- The ISOE programme completed an interim report on occupational exposure in severe accident management and a report on the water chemistry aspects of source-term control.
emergency and recovery management. Following the 2009 recommendations of the ICRP in these areas, the IAEA agreed that its 2002 IAEA Safety Requirements for Preparedness and Response for a Nuclear or Radiological Emergency, GS-R-2 should be updated. The NEA, as a co-sponsor of GS-R-2, agreed to participate in the updating with a view to co-sponsoring the new version. A draft was sent to IAEA member states for comment and was assessed by the CRPPH Expert Group on International Recommendations (EGIR) in September 2013. Significant and constructive comments were sent to the IAEA, which is addressing all comments in view of presenting a new draft to the relevant IAEA safety standards committees in June 2014.

Near the end of 2013, the ICRP issued Publication 124, Protection of the Environment under Different Exposure Situations. This publication provides an ICRP framework for radiological protection of the environment, which will now be reviewed for its application in practice. The CRPPH will be studying the publication and following national assessments of its usefulness.

**Radiological protection science and policy judgment**

Radiological protection decisions are a combination of science and judgment, and making these two elements more transparent in decision making would help to improve the acceptability and sustainability of decisions. The CRPPH is addressing these issues through a series of science and values workshops, the first three of which were held in 2008, 2009 and 2012. A fourth workshop on Science and Values in Radiological Protection will be held in Moscow in early 2015. Further details on this workshop can be found on page 52 in the section on Nuclear Energy and Civil Society.

**Radiological protection science**

The CRPPH Expert Group on Radiological Protection Science (EGRPS) was created in May 2013 in order to develop a new version of the 1998 and 2007 reports by the Expert Group on the Implications of Radiological Protection Science. The CRPPH tasked the EGRPS with drafting a report summarising the current state of the art in radiological protection science. The group’s Terms of Reference were approved during the May 2013 CRPPH meeting, and the preliminary draft report will be discussed in May 2014.

**Nuclear emergency and recovery management**

Publication 109, the new ICRP emergency management recommendations, was issued in 2010, just before the Fukushima Daiichi accident. An expert group of the Working Party on Nuclear Emergency Matters (WPNEM) studied the national implementation of the new ICRP recommendations, and its report was approved during the December 2013 WPNEM meeting. The report noted that principles of Publication 103 and 109 were utilised by the Japanese government in addressing the consequences of the accident in 2011, and that the approach taken by the ICRP was broadly seen as a positive step in managing accident circumstances.

The WPNEM also completed its assessment of the INEX-4 results in a topical session held during the May 2013 CRPPH meeting. The Committee concluded that the consequence management needs of a dirty-bomb situation would be different than those of a nuclear installation accident situation. However, a flexible, all-hazard oriented response programme would be of great value in addressing general consequences. Recommendations for improvements were made during the meeting.

With the INEX-4 assessment completed, the WPNEM began work on INEX-5. The December 2013 WPNEM meeting approved a broad set of objectives for the workshop, and created a subgroup to develop the details and descriptive documents needed for the exercise. INEX-5 will be a large-scale nuclear power plant tabletop exercise, focusing on communications and consequence management during the intermediate phase of an accident, and could potentially be developed to include regional play.

**Occupational exposure at nuclear power plants**

The sharing of operational lessons and experience, as well as the collection, analysis and exchange of occupational exposure data, continue to be addressed by the Information System on Occupational Exposure (ISOE), an NEA joint project in the field of radiological protection co-sponsored by the IAEA. In 2013, the ISOE programme produced two significant reports, one on occupational exposure management during severe accidents and another on water chemistry and source-term management. These were both approved by the ISOE Management Board during its December 2013 meeting. The severe accident report in particular will be used as input for a workshop on Occupational Radiation Protection in Severe Accident Management: Sharing Practices and Experiences, which will be held on 17-18 June 2014 in the United States.
The aim of the NEA nuclear science programme is to help member countries identify, pool, develop and disseminate basic scientific and technical knowledge used to ensure safe and reliable operation of current nuclear systems, as well as to develop next-generation technologies. The main areas covered are reactor physics, fuel cycle physics and chemistry, criticality safety and material science.

### Reactor physics

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

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

In addition to the above-mentioned activities, work is also being carried out on fuel performance, as well as radiation transport and shielding, and involves the development of experimental databases. The NEA has established corresponding databases containing experimental data used extensively in member countries to validate modelling codes and associated data.

The database of International Reactor Physics Experiment Evaluation (IRPhE) Project has grown significantly in the last few years. In response, the NEA initiated a project to develop a database tool (IDAT) that would improve user access. This tool is based on the DICE tool already available for accessing data contained in the International Criticality Safety Benchmark Evaluation Project (ICSBEP) handbook.

### Fuel cycle physics and chemistry

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

A number of benchmark studies have been initiated including the benchmark on fuel performance codes and experiments focusing on minor actinide bearing fuels of different types. In addition, a benchmark on the effects of the uncertainty of input parameters on nuclear fuel cycle scenario studies is underway. Phase II of the benchmark of thermal-hydraulic loop models for lead-alloy-cooled advanced energy systems should be finalised in 2014, and results will comprise experimental data from an additional loop based in Italy (NACIE loop, ENEA).

Several state-of-the-art reports on innovative fuels and separation chemistry are currently being finalised. The updated version of the lead bismuth eutectic handbook is being peer reviewed.

### Nuclear criticality safety

The different expert groups within the Working Party on Nuclear Criticality Safety (WPNCS) carry out international benchmark exercises on 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 ICSBEP and the Spent Fuel Isotopic Composition Database (SFCOMPO). In 2013, considerable efforts were made to further develop the SFCOMPO database. This resulted in a new application and a database that aims at containing more than twice the number of datasets than the previous version. The database is now being reviewed by the Expert Group on Assay Data of Spent Nuclear Fuel.
and the updated version is expected to be available for public release in 2014.

Benchmark activities that concern the rigorous treatment of uncertainties in different criticality safety assessment methodologies are ongoing. In this context, a state-of-the-art report that reviews the methodologies used to determine calculational biases in criticality safety assessments was published in 2013.

Material 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, as a validated predictive methodology for performance optimisation and/or design purposes.

Two state-of-the-art reports were completed in draft form in 2013 and will be reviewed in 2014. The first addresses multi-scale modelling methods applied to nuclear fuels, and the second looks at 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.

Substantial progress was made on two other state-of-the-art reports scheduled for completion in 2014. The first assesses the possibilities and limits of both numerical methods applied to multi-scale modelling of materials for nuclear energy and the means to link them, and the second reviews multi-scale modelling applied to structural materials.

The 2nd OECD/NEA Organisation Meeting on Increased Accident Tolerance of Fuels for LWRs in October 2013 concluded with a request for the creation of an expert group focused on the fundamental properties and behaviour of advanced core materials (primarily fuels, cladding and control rods) under normal operations and accident conditions. The materials considered will be applicable to generation II and generation III LWRs, as well as generation III+ reactors under construction.

Thermodynamics of Advanced Fuels – International Database (TAF-ID)
This project, 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 in the section on Joint Projects and Other Co-operative Projects (see page 42).

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 MA from the viewpoint of the design of transmutation systems and of fuel cycles. The next phase of the activity will start in 2014 and will address pooling resources and identifying qualified facilities, personnel, measurement techniques and available material supplies to target experiments that will meet specific MA data needs.

Knowledge preservation
In order to assist member countries in the development of new nuclear facilities, and in the context of a marked change in the composition of the skills base as a generation of highly experienced nuclear scientists and engineers retires, the NEA Nuclear Science Committee launched a programme establishing well-structured and highly accessible databases to preserve and evaluate information from reactor physics (IRPhE), criticality safety (ICSBEP), shielding (SINBAD), fuel performance (IFPE) and the isotopic composition of spent fuel (SFCOMPO). The maintenance and updating of these databases are performed in close collaboration with the NEA Data Bank; in 2013 this included a major update of the Research and Test Facility Database (RTFDB).

The contents of the above-mentioned databases were as follows in 2013:

- the IRPhE handbook included 130 series of reactor physics experiments performed at 47 reactor facilities;
- the ICSBEP handbook included 4 798 critical or subcritical configurations;
- the SINBAD database contained 46 radiation shielding, 31 fusion neutronic shielding and 23 accelerator shielding experiments;
- the IFPE database contained information on 1 452 rods/samples from various sources, comprising BWR, AGR, PHWR, PWR and VVER reactor systems;
- the SFCOMPO development version database contained assay data emanating from 29 reactors of 7 different types, totalling 335 samples and over 5 600 measured points;
- the RTFDB contained 888 entries of facilities from 37 countries in the field of nuclear science.

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

Computer program services
The collection of computer codes distributed by the NEA Data Bank covers most areas related to nuclear development, reactor design, dynamics, safety, radiation shielding, material behaviour and nuclear waste applications. After collecting and validating computer codes and associated libraries, the Data Bank distributes these, upon request, to scientists and engineers in member countries. The current co-operative arrangement between the United States Department of Energy and the NEA, signed in 2006, authorises the Data Bank to issue user licences and to distribute US computer codes to Data Bank member countries. Through a co-operative agreement between the NEA Data Bank and the International Atomic Energy Agency (IAEA), authorised non-OECD partners may also have access to these services.

During 2013, the Data Bank responded to more than 950 requests for computer programs, while 1850 sets of integral experiments and 23 new packages were contributed to the Data Bank. Detailed information about material available from the computer program services can be accessed via the NEA website: www.oecd-nea.org/dbprog.

Knowledge management
The preservation and transfer of data and information is a central role of the Data Bank. One of its key functions is to provide a comprehensive set of evaluated experiments against which computer codes and their associated nuclear data libraries can be validated. These data are then evaluated by teams of experts and stored in well-structured, readily accessible databases.

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

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

The Data Bank also works together with the NEA Radiological Protection and Radioactive Waste Management Division on a thermochemical database project, studying the key elements required for geochemical modelling. Teams of international experts are carrying out critical reviews of bibliographic references and have set up a quality-assured database.

As part of the Data Bank knowledge management activities, ten workshops or training courses were sponsored and organised in 2013. Subjects covered included computational radiation physics, criticality safety and radiation shielding, radiation transport using Monte Carlo codes and sensitivity/uncertainty analysis, as well as analytical benchmarks.

Nuclear data services
Using the Java-based nuclear data information software (JANIS) designed by the Data Bank to facilitate
the visualisation, comparison and manipulation of nuclear data, scientists and engineers can access a comprehensive choice of evaluated (ENDF/B, JEFF, JENDL), experimental (EXFOR) and bibliographical (CINDA) databases.

Online nuclear data services also include JANIS Books, comprehensive compilations of cross-section curves of experimental and evaluated data. These books are available for nuclear reactions induced by neutrons, photons and light-charged particles, and are based on JANIS Web. A new DVD and online version of JANIS was released in 2013. JANIS 4 introduces new features in addition to the Web interface to display fission yields on 2D colour maps, and to plot, tabulate and compare user's data in simple text format. Further information is available at www.oecd-nea.org/janis.

The Data Bank contributes to the compilation of experimental nuclear reaction data in the EXFOR database in close co-operation with other Nuclear Reaction Data Centres (NRDC). In 2013, a symbolic milestone was reached with more than 20 000 experimental works stored in EXFOR.

International nuclear data evaluation co-operation

The Working Party on International Nuclear Data Evaluation Co-operation (WPEC) reviews worldwide progress in the field of nuclear data evaluation, measurement and related topics with the objective of improving the quality and completeness of evaluated nuclear data files. It also provides a worldwide framework for co-operative activities among major nuclear data evaluation projects in the form of short-term subgroups. Ongoing subgroup activities focus on the reporting and usage of experimental data for evaluation in the resolved resonance region, on improved fission product yield evaluation methodologies and on the definition of a modern nuclear database structure beyond the current evaluated nuclear data format.

Two new subgroups were established in 2013. The first is studying how to develop methodologies to provide feedback from nuclear and covariance data adjustment so as to improve nuclear data files. The second, known as the CIELO pilot project, aims to foster nuclear data advances on six key nuclides (1H, 16O, 56Fe, 235U, 238U and 239Pu) by using the collective expertise of the international nuclear data community. 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 co-operative effort among NEA Data Bank member countries to produce a common set of evaluated nuclear data, mainly for fission and fusion applications.

Following a continued phase of testing and integral validation in 2012 and 2013, a major update of the JEFF library, JEFF 3.2, has been scheduled for release in 2014. The general purpose neutron file, which incorporates improvements in major isotope evaluations made in recent years, includes new evaluations for major actinides. The new release will also aim to include a revision of the special purpose files for light-charged-particle-induced reactions, activation, fission yields and radioactive decay data.

The 2013 session of Nuclear Data Week was organised in November to promote co-operation among experimentalists, evaluators and end-users of nuclear data involved in JEFF and the new French research framework NEEDS. More information on the JEFF project is available at www.oecd-nea.org/dbdata/jeff.

The Thermochemical Database (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 used for modelling purposes in the safety assessments of radioactive waste repositories. The project's current mandate runs to January 2014, following a one-year extension decided by the TDB Management Board. A total of 16 organisations from 13 countries participate in the project. Further details are provided in the section on Joint Projects and Other Co-operative Projects (see page 43).

In-house computer services

The Data Bank is responsible for NEA in-house computer services comprising internet and data servers connected to a fast network. In 2013, the NEA internet server registered 1.6 million visits, during which 4 million web pages were browsed and some 7.6 terabytes were downloaded. The computer services also develop software or software tools in relation to JANIS, DICE, IDAT, SFCOMPO and ISOE, and maintain collaborative platforms for the Multinational Design Evaluation Programme (MDEP), the Generation IV International Forum (GIF) and the Thermochemical Database (TDB) Project. Security enhancements of systems and applications were made in the course of 2013 following the recommendations of an external IT security audit.

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Nuclear Law Committee (NLC)

The NLC promotes the development, strengthening and harmonisation of nuclear legislation governing the peaceful uses of nuclear energy in member countries and selected partner countries. It supports the adoption, implementation and modernisation of national and international nuclear liability regimes. Under its supervision, the NEA analyses and disseminates information on nuclear law through a regular publications programme and two education programmes (the International School of Nuclear Law and International Nuclear Law Essentials).

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, including finding ways to financially secure those nuclear risks for which operators are unable to obtain private insurance.
- The NLC continued to review the implications of the TEPCO Fukushima Daiichi accident for nuclear third party liability regimes as well as other aspects of the framework for the safe use of nuclear energy. It also organised topical sessions on decommissioning challenges and the implementation of the Aarhus and Espoo Conventions regarding consultations with the public and neighbouring countries.
- An international workshop on nuclear damages, liability issues and compensation schemes, co-organised by the NLC and the NDC, was held on 10-11 December 2013.
- The 13th session of the International School of Nuclear Law was held in co-operation with the University of Montpellier 1 in late August to early September, and the 3rd session of International Nuclear Law Essentials (INLE) was held in October.
- Two issues of the Nuclear Law Bulletin (NLB) were prepared and included articles on improvements in nuclear safety after the Fukushima Daiichi accident, a nuclear law conference in India, the regulation of uranium mining, nuclear and environmental law, and the legal framework for nuclear energy developments in Turkey.

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 Convention Supplementary to the Paris Convention worked towards implementing the 2004 Protocols amending those conventions. A few are still facing delays in implementation because, among other reasons, private nuclear risk insurers are unable to provide full coverage for certain risks which nuclear operators are obliged to assume under the revised conventions. Such risks include claims instituted more than ten years after the occurrence of a nuclear incident.

Substantial progress has been made by the NLC, in co-ordination with the CRPPH, towards updating the technical criteria established under a 1990 Steering Committee decision that allows the contracting parties to exclude certain installations that are being decommissioned from the application of the Paris Convention. Work also continues on the possibility of excluding low-level waste disposal facilities from the scope of the convention. These exclusions are intended to avoid the imposition of disproportionate obligations on operators in relation to the actual risks posed by installations in these categories. Finally, a revision of the procedure is under consideration for the appointment of judges to the European Nuclear Energy Tribunal, which has sole competence in resolving disputes related to the interpretation or application of those conventions between the contracting parties to the Paris Convention or the Brussels Supplementary Convention.

During the NLC’s June 2013 meeting, the delegate from the Russian Federation gave a special address regarding the Russian Federation’s accession to the NEA and the Russian legislative, regulatory and institutional framework for nuclear energy activities. The NLC continued its work on legal developments arising out of the national and international response to the TEPCO Fukushima Daiichi accident. Japanese experts provided an update on nuclear liability issues. The Committee heard presentations from the IAEA, the European Commission and member countries on developments in nuclear law. Indian experts were invited to give a presentation on developments related to India’s national nuclear liability regime.
and on pending legislation to reorganise India’s nuclear regulatory body. The Committee held topical sessions on decommissioning challenges and on the implementation of the Aarhus and Espoo Conventions regarding consultations with the public and neighbouring countries.

The NEA Secretariat participated in the informal expert group set up by the European Commission to analyse the potential for harmonisation across the EU of national legislation regarding nuclear liability. The aim is to ensure legal coherence within the EU in line with international principles. The main objectives are to improve victims’ protection in the different member countries and to address the impact of diverging financial guarantee obligations. The group provided its recommendations to the Commission in 2013.

The NEA Secretariat has also contributed to the work of the International Expert Group on Nuclear Liability (INLEX) established by the IAEA, and assisted in the preparation of the recently issued Explanatory Text for the 1988 Joint Protocol Relating to the Vienna Convention and the Paris Convention.

In the context of the preparation of a study by the NEA Nuclear Development Committee (NDC) on the Costs of Nuclear Accidents, Liability Issues and their Impact on Electricity Costs, an international Workshop on Nuclear Liability Issues and Compensation Regimes was held on 10-11 December 2013. More than 70 participants shared their experiences regarding nuclear liability issues. The workshop presentations and documents cover subjects ranging from existing national and international nuclear liability regimes to insurance and other issues, and are available at www.oecd-nea.org/ndd/workshops/aecn/. The listing 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 13th 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 26 August to 6 September 2013. Over the past 13 sessions, the ISNL has provided a high-quality educational experience to more than 650 participants from around the world. This session attracted 57 participants from approximately 30 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/.

In October, the NEA held the third session of the International Nuclear Law Essentials (INLE) programme. Some 40 participants from 19 countries participated in this one-week comprehensive course covering various aspects of international nuclear law. Built on the success of the International School of Nuclear Law, INLE is designed to provide focused, practical training to mid- and senior-level professionals. Specialists from international organisations, governments and private industry led lectures, discussions and case studies across a range of topics, including environmental and nuclear law, nuclear regulatory and licensing regimes, international radiological protection standards, nuclear accident notification and assistance, liability and compensation issues, insurance, and transport of nuclear material and fuel. More information on the programme is available at www.oecd-nea.org/law/inle/.

Nuclear law publication programme

The 91st and 92nd issues of the Nuclear Law Bulletin (NLB) were prepared. 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. Beginning in 2014, all issues of the NLB will be 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 listing of “Latest legislative developments”, which tracks recent changes in nuclear-related legislation.

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NUCLEAR SAFETY RESEARCH

The Halden Reactor Project

The Halden Reactor Project, operated by the Norwegian Institute for Energy Technology (IFE), was established in 1958 and is the largest NEA project. It brings together an important international technical network in the areas of nuclear fuel reliability, integrity of reactor internals, plant control/monitoring and human factors. The programme is primarily based on experiments, product prototype developments and analyses carried out at the Halden establishment in Norway. It is supported by approximately 100 organisations in 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.

The project began its 19th three-year cycle in 2012. 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 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), aiming 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 regular meetings of the Halden Programme Group and two meetings of the Halden Board of Management in 2013. The Enlarged Halden Programme Group met in March 2013, as it does every 18 months; more than 130 papers were presented covering the project results and related work in other organisations.

The ATLAS Project

The Advanced Thermal-Hydraulic Test Loop for Accident Simulation (ATLAS) facility 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 (bDBA) in the ATLAS facility. A test matrix of up to 10 bDBA tests was proposed and the CSNI approved the creation of an experts group in December 2012.

An expert meeting was convened in Finland in June 2013 with participants from 13 member countries. All participants showed great interest in the proposed test matrix, in particular in high-pressure natural circulation, passive system performance and medium break LOCA. This programme will contribute to safety code validation and advancement of emergency operating procedures. KAERI considers the project to be an important contribution to nuclear safety worldwide. A draft agreement was issued for comment and review in September 2013. The CSNI approved the project in December 2013.
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 bulk aqueous phase processes, homogeneous aqueous phase processes in paint pores and heterogeneous processes on surfaces to organic iodine formation;
- the measurement of adsorption/desorption rate constants on containment surfaces as a function of temperature, relative humidity and carrier-gas composition;
- the provision of radioiodine test facility (RTF) data from five RTF experiments to participants, for use in collaborative model development and validation.

The final report was approved as a CSNI public report in December 2011.

A three-year follow-up project, BIP-2, started in April 2011 and attempts 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 quantifying the rates of formation for methyl iodide from irradiated paint, the mechanism is not understood.

Therefore, the objective of BIP-2 is to identify the mechanisms involved in these two processes. A mechanistic understanding applied to models for these phenomena would improve the ability to explain results to regulatory agencies, and justify application of these results to ranges outside the tested conditions (e.g. extrapolation to a wider selection of materials and to larger-scale experiments and containment conditions). In 2013, the Republic of Korea, represented by the Korea Atomic Energy Research Institute (KAERI) and the Korea Institute of Nuclear Safety (KINS), joined the BIP-2 project as a new participant.

The specific technical objectives for BIP-2 are:

- 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 constituents and novel instrumentation (spectroscopic methods);
- to obtain a more detailed and mechanistic understanding of organic iodide formation 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 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 including, but not limited to, initial transient from rated condition to core heat-up, core heat-up, core melt, release of fission products (FPs) from fuel, behaviour of core internals (core shroud), core status including debris behaviour, molten debris-coolant interaction in the lower plenum (if necessary) and FP transfer.

A meeting was held in October 2013 to review progress and to provide an opportunity to compare modelling results. Participants decided that the first phase of the project would run from November 2012 to September 2014 and that plans for future phases would be discussed towards the conclusion of the first phase.

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.

In 2013, water loop commissioning tests were ongoing. Taking into account the facility status, work remaining and the required nuclear regulatory approvals, the tests in the framework of the Cabri Water Loop Project (the CIP-Q tests) are expected to resume in the second half of 2015.

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. A meeting of the Cabri Technical Advisory Group was held in September 2013 and a meeting of the Project Steering Committee in December 2013.

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 currently supported by five countries and to be conducted at a facility in the United States. Two additional countries have shown interest in the project and arrangements should be concluded by early 2014 to include them. 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.

Two meetings were held in 2013. The experimental test matrix, experimental conditions and parameters to be investigated were discussed and will be finalised before the tests begin. Equipment for testing from the project member countries has begun to arrive in the United States, and project members plan to visit the facility to view the tests in June 2014.

The HYMERES Project

The main objective of the 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 in 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 autocatalytic 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-hydraulics 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 HYMERES Project has been elaborated on the basis of the conclusions of the expert meeting for the project held on 14 September 2011. Discussion among international experts continued during the first half of 2012. The draft agreement was circulated for comment on 10 April 2012, and then finalised and distributed for signature in the last quarter of 2012. Two meetings of the project steering bodies took place in 2013.

**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 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.

A third meeting of the project’s steering bodies was held in 2013 during which participants discussed benchmarking calculations based on the analyses of the first test and identified areas of interest to examine during the next tests in the reactor. Following the shutdown after the March 2011 earthquake, repair work was completed on the HTTR reactor and an application has been sent to the regulator requesting permission to restart. However, permission has not yet been granted due to the publication of new regulations governing research reactors. The regulatory permissions schedule indicates that the reactor is unlikely to restart before January 2015. The management board intends to extend the project until March 2016 so as to allow for completion of the remaining tests.

**The PKL-2 and PKL-3 Projects**

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.

In 2011, participants discussed the preparation and the results of the counterpart test with the ROSA-2 Project addressing small break LOCA with accident management procedures. In October 2012, a second and concluding analytical workshop was organised jointly with the ROSA-2 Project to discuss progress in reactor coolant system (RCS) thermal-hydraulic modelling with systems codes and initial results achieved in modelling with CFD codes.

In June 2013, the PKL-2 final report, “Updated Knowledge Base for Long-term Core Cooling Reliability” was approved by the CSNI, as was a report related to the October 2012 workshop, “Summary and Conclusions of the Joint PKL2-ROSA2 Workshop on Analytical Activities related to OECD PLK and ROSA Projects”.

The follow-up project, PKL-3, started on 1 April 2012. PKL-3 tests will 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 scenarios or LOCA 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 LOCA to specific parameters. Complementary tests in the ROCOM, PMK and PWR FACTEL 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 2013. Testing is ongoing with possible counterpart tests under consideration with the ROSA large-scale test facility and ATLAS facility.

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 following: 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. A final report of the PRISME Project was approved by the CSNI in 2012, and a concluding seminar was held in Aix-en-Provence, France at the end of May 2012. This seminar drew over 60 participants from 29 countries and international organisations.

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 for 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 IRSN request to carry out important glove box fire tests.

In 2013, 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 ROSA-2 Project

A first Rig-of-safety Assessment (ROSA) Project was carried out from 2005 to 2009 to address issues in thermal-hydraulics analyses relevant to LWR safety using the ROSA large-scale test facility of the Japan Atomic Energy Agency (JAEA). It focused in particular on the validation of simulation models and methods for complex phenomena that may occur during transients/accidents. The project was supported by safety organisations, research laboratories and industry in 14 countries, and provided an integral and separate-effect experimental database to validate the code predictive capability and accuracy of models. For example, temperature stratification and coolant mixing during emergency coolant injection, unstable and disruptive phenomena such as water hammer, natural circulation under high core power conditions, natural circulation with superheated steam, primary cooling through steam generator secondary depressurisation, and upper-head break and bottom break LOCA were addressed by the 12 tests carried out. The project was successfully completed and the final report was released on DVD.

ROSA-2, a second phase of the project that uses the same large-scale test facility, started in April 2009 with the support of 14 countries. The ROSA-2 Project was scheduled to last three years (extended by six months due to the Fukushima Daiichi accident) and to consist of six tests on:

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

In 2012, the participation of China, which joined as an associate member, enabled a seventh test based on an intermediate, cold leg break LOCA with full availability of the emergency core cooling system. All seven tests were successfully performed, including two counterpart tests with the PKL. The final report for ROSA-2, “Summary of the Final Integration Report of the OECD/NEA ROSA-2 Project” was approved at the December 2013 CSNI meeting, as was a joint PKL-2/ROSA-2 workshop report.

The SCIP-2

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

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

In December 2008, all members of the project steering bodies indicated their interest in continuing the project for another five-year period. SCIP-2 thus began in July 2009 with the participation of 13 countries (two more than in the first phase).

The main objective of SCIP-2 is to generate the high-quality experimental data needed for improving the understanding of dominant failure mechanisms for water reactor fuels and to devise means for reducing fuel failures. The major focus will be on cladding failures caused by pellet-cladding mechanical interaction (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 is intended to complement other international projects in the fuel area. Extensive analyses and theoretical modelling of the fracture mechanisms are to accompany the experimental programme.

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

- 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 hydride embrittlement and delayed hydrogen cracking.

Two meetings of the project steering bodies took place in 2013, as well as another workshop on fuel rod behaviour modelling. The programme of work for a potential SCIP-3 project was also discussed.

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 (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 multidimensional, 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.

A concluding seminar presenting the outcome of the tests was organised in November 2012, and the final report “OECD/SERENA Project Report – Summary and Conclusions” was approved at the December 2013 CSNI meeting.

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. A concluding seminar of the project took place in October 2013.

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 will address three main issues:
• Radioactive iodine release in the mid- and long-term: in complement to previous programmes, it is proposed to perform experiments 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: in complement to previous programmes, it is proposed to perform experiments to study ruthenium transport in pipes.

The first meeting of the steering bodies was held in 2011 during which the overall test matrix of experiments to be performed was discussed. The first series of experiments (iodine behaviour under radiation) were dedicated to the analysis of radiation effects and will thus be realised in benches built on the EPICUR facility (Experimental Programme of Iodine Chemistry under Radiation). The second series of experiments (ruthenium transport) 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 2013 during which the overall test matrix of the remaining experiments was modified.

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 the: a) release of gaseous iodine from a flashing jet and iodine deposition on aerosol par-
ticles, and b) hydrogen combustion during spray operation and passive autocatalytic recombiner (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. Two meetings of the steering bodies were held in 2013 during which further test results were presented and discussed.

**NUCLEAR SAFETY DATABASES**

**The CADAK Project**
The Cable Ageing Data and Knowledge (CADAK) Project provides a follow-up to the cable ageing part of the Stress Corrosion Cracking and Cable Ageing (SCAP) Project, funded by Japan and operated successfully from 2006 to 2010, due to its relevance for plant ageing assessments and implications for nuclear safety. The objectives of the CADAK Project are to:

- Establish the technical basis for assessing the qualified life of electrical cables in light of the uncertainties identified following the initial (early) qualification testing. This research will investigate the adequacy of the margins and their ability to address the uncertainties.
- Enter, for a number of member countries, cable data and information in the system, such as technical standards being applied in the qualification of cables and inspection methods being used regularly.
- Estimate the remaining qualified lifetime of cables used in nuclear power plants. The cable condition-monitoring techniques shared by the participants within CADAK will become an up-to-date encyclopaedic source to monitor and predict the performance of numerous unique applications of cables.
- Analyse the information collected to develop topical reports in co-ordination with the CSNI Working Group on Integrity of Components and Structures (WGIAGE).

During 2013, the CADAK Project launched the new CADAK web interface (based on the former SCAP database and knowledge base). NEA representatives presented the CADAK project at an international symposium on cable ageing in September 2013.

**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 are participating in the first phase of the CODAP which started in 2011 and will run until the end of 2014.

The objectives of the CODAP are to:

- 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 2013, two meetings of the CODAP Programme Review Group were held. The overall programme of work was further discussed, including support from the project Clearinghouse.

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. Twelve countries participate. The main purpose of the project is to collect and to analyse data related to fire events in nuclear environments, on an international scale. The specific objectives are to:

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

The structure of the database 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 2013. A new operating agent was selected for phase 4, which is to take place over two years. The goal of phase 4 is to define more detailed objectives for the future work of this database.

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, a report on “Collection and Analysis of Common-cause Failures of Centrifugal Pumps” was completed and approved to be issued as a CSNI report. A total of 353 ICDE events spanning a period from 1975 through 2009 were examined with respect to failure modes, degree of impairment, failure symptoms, failure causes and technical fault aspects. One of the report’s conclusions suggests that maintenance and test activities are significantly more effective for preventing complete failures in “failure to run” events than in “failure to start” events. Thus, maintenance and test activities should specifically focus on the prevention of “failure to start” events.

A report on “Collection and Analysis of Common-cause Failures of Control Rod Drive Assemblies (CRDA)” was also completed in 2012 and approved for distribution as a CSNI report. Some 169 ICDE events spanning a period from 1980 through 2003 were examined with respect to root cause, coupling factor, observed population size, corrective action, the degree of failure, affected subsystem and detection method. Most of these failures were caused by core or fuel assembly deformations due to irradiation, thermal, mechanical and hydraulic loading, and their mutual interaction. Communication of operating experience with CCF phenomena is important to ensure that plants can implement the appropriate defences and controls to prevent significant impacts on plant safety.

In 2013, the ICDE Steering Group reviewed the ICDE project report on external factors to be issued as a CSNI report.

NUCLEAR SCIENCE

The TAF-ID Project

The Thermodynamics of Advanced Fuels – International Database Project (TAF-ID) was established in January 2013 and is supported by nine organisations in six NEA member countries. It is devoted to establishing a comprehensive, internationally recognised and quality-assured database
of phase diagrams and thermodynamic properties of advanced nuclear fuels to meet the 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 interaction 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 DOE).

The flexible computational tool developed in this project, based on the CALPHAD method, will allow for the performance of thermodynamic calculations on different types of fuels (oxide, metallic, nitride, carbide) including minor actinides (Am, Np), fission products (Ba, Sr, Mo, Zr, lanthanides, metallic fission products) and structural materials (steel, Zr alloy, B4C, SiC, concrete) by merging existing databases developed within the organisations taking part in the project. Thermodynamic data are needed for various analyses involving nuclear fuel for generation II-III-IV reactors: design of the fuel element, modelling of the fuel-cladding system under normal conditions in performance codes, analysis of the fuel and cladding behaviour under severe accident conditions (pre- and post-fuel melting) and interaction of corium with the vessel and sacrificial materials (in-vessel) and the concrete (ex-vessel).

Two versions of the TAF-ID database are being developed:

- A working version, containing the description of all the systems addressed in the TAF-ID Project. This working version is currently accessible only to signatories of the project.
- A public release version, containing a more limited amount of data – i.e. only data which have already been published in the open literature at the time of release. This version, managed by the OECD/NEA, will be accessible to all OECD/NEA member countries upon request, following the signature of a non-disclosure agreement.

RADIOACTIVE WASTE MANAGEMENT

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, and a revised agreement among participants came into force on 1 January 2009 for a five-year period.

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.

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 January 2014, following a one-year extension decided by the TDB Management Board. Sixteen organisations from 13 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 will start in January 2014. The core of the TDB-5 programme of work comprises the:

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

In 2013, the ISOE programme continued to concentrate on the exchange of data, analysis, good practices and experiences in the area of occupational exposure reduction at nuclear power plants, on improving the quality of its occupational exposure database and on migrating ISOE resources to the ISOE Network website (www.isoe-network.net). The four regional ISOE Technical Centres continued to support their regional members through specialised data analyses and benchmarking visits. Key outcomes of work during 2013 included a decision to remove all database restrictions for regulatory authority users of the ISOE database, the development of several new, standard, push-button analyses of the database, and consolidation to a single report on the ISOE Technical Centres' performance indicators. In addition, two ISOE expert groups completed their reports, entitled “Radiation Protection Aspects of Primary Water Chemistry and Source-term Management”, and “Occupational Radiation Protection in Severe Accident Management and Post-accident Recovery”. The ISOE programme organised regional symposia in Switzerland, the Republic of Korea and the United States in 2013.

**RADIOLOGICAL PROTECTION**

**The ISOE**

Since its creation in 1992, the Information System on Occupational Exposure (ISOE), jointly sponsored by the IAEA, has been facilitating the exchange of data, analysis, lessons and experience in occupational radiological protection (RP) at nuclear power plants worldwide. 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 70 utilities from 29 countries, and 28 regulatory authorities from 25 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 in 29 countries (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.
Technical Secretariat
At the end of 2013, the number of nuclear power reactors under construction in the world reached 72, the highest number since 1987. The nuclear sector continues to face many challenges related to financing, ensuring projects are completed on time and within budget, and of course, addressing public concern in the wake of the Fukushima Daiichi accident. Nuclear energy nonetheless remains a technology that continues to be considered by many countries in planning their energy policy.

Nearly half of reactors now under construction are generation III reactors, with higher safety and performance levels compared to previous generations. Generation III reactors will be the primary means of nuclear power generation for several decades to come, but research at the international level to develop more innovative nuclear energy technologies and fuel cycles – known collectively as generation IV systems – is well underway.

The most important initiative to co-ordinate research and development (R&D) efforts on advanced reactors and fuel cycles is the Generation IV International Forum (GIF). Established in 2001, GIF brings together 12 countries including Canada, China, France, Japan, the Republic of Korea, the Russian Federation, Switzerland and the United States, as well as Euratom. The aim of the forum is to develop systems that offer improved sustainability, economics, safety and reliability, proliferation resistance and physical protection.

Six conceptual nuclear energy systems were selected in 2002 for collaborative R&D, comprising the gas-cooled fast reactor (GFR), the lead-cooled fast reactor (LFR), the molten salt reactor (MSR), the sodium-cooled fast reactor (SFR), the supercritical water-cooled reactor (SCWR) and the very high temperature reactor (VHTR). Detailed information on these systems can be found in the Technology Roadmap for Generation IV Nuclear Energy Systems (2002), which describes how the development of these systems was envisioned a decade ago.

Each system has reached a different stage of development, depending on the R&D efforts that have been made and the level of commitment each has received from participating countries. Assessing the progress made over the GIF’s first decade of existence and identifying the key development milestones for the next decade was one of the three initiatives taken by the forum in 2012, under the chairmanship of Mr. Yutaka Sagayama. This effort was continued under the new Chair of the GIF Policy Group, Dr. John Kelly, beginning in 2013. The three initiatives consisted in: 1) updating the technology roadmap, 2) identifying and implementing best practices in collaborative R&D within the GIF, and 3) reaching out effectively to international organisations, including the OECD/NEA, and academia.

The first initiative was successfully completed in 2013. The Technology Roadmap Update for Generation IV Nuclear Energy Systems provides an overview of how GIF members will focus their R&D efforts in the coming decade, with several systems having already entered (VHTR, SFR or LFR) or entering (SCWR) the performance phase (testing of processes and materials at engineering scale under prototypic conditions) in the period up to 2023. The other two initiatives are ongoing and will continue over the coming years.

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 that incorporate lessons learnt from the Fukushima Daiichi accident. In February 2013, the first draft of a report was discussed at a GIF/IAEA safety workshop on the SFR, and an improved version was approved by the Policy Group in May as a phase 1 report. Guidelines, which include quantification of the criteria, are now being developed as part of phase 2 work, while in parallel, GIF has engaged with national regulators and groups such as the MDEP or the NEA/CNRA, inviting them to review the phase 1 report and provide feedback.

In terms of formal agreements to organise R&D efforts, in 2013 the Russian Federation signed the Memorandum of Understanding overseeing the development of the molten salt reactor, previously signed by Euratom and France in October 2010. China has been invited to attend the System Arrangement on System Integration and Assessment has been finalised and the signature process started in December 2013.

Communication, dissemination and outreach are among the priorities of the new chair to ensure that the wider public, and in particular young researchers and engineers, are well aware of the work of the forum.

A new website was designed by the NEA Technical Secretariat team and presented in November to the Policy Group, which approved its launch. The site, now in operation at www.gen-4.org, provides education and training material and up-to-date information on the forum’s activities.

Throughout 2013, the NEA Technical Secretariat continued to provide support to the technical bodies in charge of the development of the six systems and the three methodology working groups. The NEA is fully compensated for its support to the GIF through voluntary, financial and in-kind contributions made by individual GIF members.
With the formation of two new design-specific working groups and the addition of two new members in 2013, the Multinational Design Evaluation Programme (MDEP) has strengthened its role in providing a highly valuable forum for collaborating on new reactor design review and construction activities. These additions have also strengthened the MDEP’s other role in acting as a driving force in the harmonisation and convergence of practices and standards. The MDEP design-specific working groups are discussing lessons learnt from the Fukushima Daiichi accident and their impact on new designs. MDEP full members are regulators from Canada, China, Finland, France, India, Japan, the Republic of Korea, the Russian Federation, South Africa, Sweden, the United Kingdom and the United States. The United Arab Emirates became an associate member in 2013, and Turkey officially becomes an associate member on 7 January 2014. The International Atomic Energy Agency (IAEA) is closely involved in generic MDEP activities to ensure consistency with international requirements and practices.

2013 highlights

Several member countries have started preparations for the commissioning of nuclear power plants. To aid in this activity, the MDEP Policy Group (PG) agreed to initiate a pilot project involving the European Pressurised Reactor Working Group (EPRWG) and the AP1000 Working Group (AP1000WG). In June and July, these two groups met in China to discuss and lay the ground for regulatory activities regarding commissioning first-of-a-kind EPRs and AP1000s. Vendors and utilities were invited to meetings in order to present and share their views on the commissioning programmes and to openly discuss the expectations of both regulators and industry. The EPRWG, with the help of the AP1000WG and other MDEP working groups, has been tasked by the MDEP Steering Technical Committee (STC) to report back on how these activities can be integrated within the scope of the MDEP and to propose next steps.

On request of its members and in accordance with the Terms of Reference (TOR), the PG agreed to create two new design-specific working groups for the voda voda energo reactor (VVER) and the advanced boiling water reactor (ABWR). Both these groups will hold their first meeting in early 2014. Finland, India, the Russian Federation and Turkey will participate in the VVERWG; and Finland, Japan, Sweden, the United Kingdom and the United States will take part in the ABWRWG.

In May 2013, Sweden became a new member of the MDEP. Participants from the Swedish Radiation Safety Authority (SSM) have joined the EPRWG, AP1000WG, ABWRWG and issue-specific working groups. Turkey also intends to join the issue-specific working groups.

MDEP design-specific working groups have pursued in-depth discussions on the impact of the Fukushima Daiichi accident on new reactor designs. The EPRWG has published a common position specific to the EPR, which includes technical appendices that are still being finalised by technical expert subgroups. The AP1000WG is also close to releasing a common position addressing Fukushima-related issues for the AP1000 design.

The APR1400WG has formed two technical expert subgroups, which will address two issues of particular concern to members: long-term cooling and severe accidents.

In 2013, issue-specific working groups made significant progress towards the completion of their current programme of work. The Vendor Inspection Co-operation Working Group (VICWG) continues to benefit from carrying out vendor inspections with the participation of numerous regulators and is making progress towards harmonisation of quality assurance practices and standards. The Codes and Standards Working Group (CSWG) issued a technical report on the regulatory frameworks for the use of nuclear pressure boundary codes and standards in MDEP countries. 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 revised and/or issued five common positions and is moving forward with others.

The MDEP is currently working on the organisation of its third conference on new reactor designs, which will be held in May 2014 in the United States. The goal of the conference is to provide a forum where all MDEP stakeholders, industry and standards development organisations (SDOs) can actively contribute.

Further information about the MDEP and a number of its reports and documents are publicly available at www.oecd-nea.org/mdep.
Information and Communications

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

The NEA is an intergovernmental agency specialised in studying the scientific, technical and economic aspects of nuclear energy. It strives to provide high-quality, factual information in a timely manner to its member countries as well as to other interested parties wishing to learn about nuclear energy’s multiple aspects and the results of the Agency’s work.

Public affairs and relations with the media

Relations with the media in 2013 covered a wide variety of topics and questions regarding the development of nuclear power. In 2013, media interest in the NEA’s activities extended to the Agency’s publications, such as *The Fukushima Daiichi Nuclear Power Plant Accident: OECD/NEA Nuclear Safety Response and Lessons Learnt*, which was launched on 10 September 2013 during a press conference at the OECD Conference Centre.

Twelve press and news releases were issued in 2013, notifying the media, for example, of the accession of the Russian Federation to the NEA and its Data Bank, the signature of the Joint Declaration on Co-operation in the Field of Peaceful Uses of Nuclear Energy between the China Atomic Energy Authority (CAEA) and the NEA, the nomination of Dr. Alison M. MacFarlane as the new Chair of the Multinational Design Evaluation Programme (MDEP) and the accession of the Swedish Radiation Safety Authority to the latter. These press and news releases are available in the NEA press room at www.oecd-nea.org/press.

Over the course of the year, numerous interviews were organised with the Director-General and senior NEA staff, requested by television, specialised publications and the international press such as CNBC (Energy Matters live interview with Luis Echávarri), World Nuclear News (“NEA: No room for complacency on safety”) and the South China Morning Post (“Nuclear power popular despite Fukushima: OECD/NEA boss Luis Echávarri”). 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).

Publications

In 2013, the Agency produced 24 publications, with all monographs and reports released free of charge in line with the new NEA publications policy. The list of these publications is provided on page 56. As agreed by the Steering Committee and to accommodate the OECD 2013 subscription schedule, the *Nuclear Law Bulletin* will be provided free of charge as from 2014. NEA reports are also issued in the official unclassified “R” series, directly downloadable from the substantive areas’ web pages.

The most accessed online reports during the course of the year included *Nuclear Energy Today, Second Edition* (422 684 downloads), *JANIS Book of neutron-induced cross-sections* (317 391 downloads), *Japan’s Compensation System for Nuclear Damage: As Related to the TEPCO Fukushima Daiichi Nuclear Accident* (245 477 downloads) and *Nuclear Fuel Behaviour in Loss-of-coolant Accident (LOCA) Conditions* (146 397 downloads).
NEA News is the Agency's specialised journal, published in English and French, which endeavours to keep NEA correspondents and other interested professionals abreast of significant findings and advances in the Agency's programme of work. It provides feature articles on the latest developments in the nuclear energy field, as well as updates on NEA work, news briefs and information about NEA publications and forthcoming events.

In 2013, NEA News covered topics such as the system effects of nuclear energy and renewables in low-carbon electricity systems, stakeholder involvement in radiological protection, nuclear power in the United Arab Emirates, and estimation and comparability of nuclear facility decommissioning costs. The journal is available free of charge on the Agency's website at www.oecd-nea.org/nea-news/.

Internet-based communication

The NEA’s online presence plays a key role in communicating the work and accomplishments of the Agency. Website traffic remained steady in 2013 with an average of nearly 4 300 visitors per day or 1.56 million visits on an annual basis. The website sections that attracted the most views were, in order of magnitude: the NEA publications section, the NEA press room and the NEA Data Bank’s Java-based nuclear data display program JANIS.

Web 2.0 networking channels 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. 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 and newly released reports. A sign-up form is available at www.oecd-nea.org/bulletin.

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 on the NEA website also continues to provide an important service for many NEA committees and working groups. This section of the website provides authorised users with official 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 2013, including:

- Public Information Materials Exchange (PIME 2013) Conference, Zurich, Switzerland, 17-20 February;
- International Ministerial Conference on Nuclear Power in the 21st Century, St. Petersburg, Russian Federation, 27-29 June;
- International Nuclear Fuel Cycle Conference (GLOBAL 2013), Salt Lake City, Utah, United States, 29 September-3 October;
- Joint International Conference on Supercomputing in Nuclear Applications and Monte Carlo 2013 (SNA+MC 2013), Paris, France, 27-31 October;
- Ninth International Symposium on Radiation Safety Management (ISRSM), Daejeon, Republic of Korea, 6-8 November.

The NEA also organised publications and information stands at the Fast Reactors and Related Fuel Cycles Conference (FR13) held in Paris in March and at the International Ministerial Conference on Nuclear Power in the 21st Century in St. Petersburg in June. Several hundred copies of NEA reports and information material were provided at other events.
Nuclear regulators and the public

Information officers from regulatory bodies meet once a year under the auspices of the Working Group on Public Communication of Nuclear Regulatory Organisations (WGPC) to exchange information and experience related to communication with the public and to carry out related studies. In 2013, the WGPC dedicated efforts to developing guidance on the best use by NROs of Internet and social media. It also continued to work on NRO interactions with stakeholders and is planning to invite European stakeholders, media and elected officials, as well as members of local information committees and non-governmental organisations, for a one-day workshop during its 2014 meeting.

Forum on Stakeholder Confidence

The Forum on Stakeholder Confidence (FSC), established under the NEA Radioactive Waste Management Committee, held its 14th regular meeting in September 2013. Continuing high interest among NEA member countries in the opportunities provided by this forum has resulted in the renewal and expansion of its membership. The Republic of Korea and the Russian Federation were represented for the first time, while new individual participants attended from eight countries and the European Commission.

Participants in the topical sessions reviewed instruments (including the Aarhus and Espoo Conventions) and experience fostering early involvement of stakeholders in radioactive waste management decision-making processes. The FSC emphasised transparency as both a requirement and an aid in the changing dynamics of interactions among institutions and civil society. Local community requests for monitoring and memory keeping as related to geological disposal facilities were collected and elaborated. Looking forward, a detailed planning questionnaire was developed to support potential hosts of future national workshops, community visits and social media initiatives, which might include hosting “frequently asked questions” to support waste management stakeholders.

Radiological protection

The importance and implications of stakeholder participation in radiological protection decision making have been addressed by the NEA Committee on Radiation Protection and Public Health since the early 1990s, beginning with the Committee’s 1994 collective opinion, Radiation Protection Today and Tomorrow, continuing through three stakeholder involvement workshops in 1998, 2001 and 2003, addressing the balance of science and values in radiological protection through three workshops in 2008, 2009 and 2012, and specifically looking at stakeholder involvement in post-nuclear emergency management at a workshop in 2010.

The NEA has been actively involved in the International Commission on Radiological Protection (ICRP) Dialogue Initiative. Since November 2011, the ICRP has organised, with support from the NEA Secretariat, seven dialogue meetings (November 2011; February, July and November 2012; and March, July and November 2013). These two-day meetings provided a forum for affected stakeholders to share their concerns, their experience and their actions in order to better understand how to proceed. The NEA Secretariat will continue to support and participate in these activities.

The NEA has also been focusing on ensuring input from its Asian membership in the development of important radiological protection documents such as the new ICRP recommendations, IAEA Safety Requirements and other selected documents. The NEA has thus organised six Asian regional workshops on the Evolution of the System of Radiological Protection. The first two meetings concentrated on discussions of draft versions of ICRP Publication 103; the third to the fifth workshops focused on discussions of the Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (BSS); and the sixth workshop was held jointly with the 3rd Science and Values Workshop in Tokyo in late 2012 and focused on environmental contamination and recovery activities, as well as the protection of children. The CRPPH also agreed at its May 2013 meeting to organise, with the Japanese government, the 7th Asian Regional Workshop on the Evolution of the System of Radiological Protection. The NEA Secretariat is currently working with the Japanese government on the agenda and timing, tentatively scheduled for the second half of 2014.

Finally, the NEA continues to examine how science and social values can best be transparently articulated as components of the basis for radiological protection decisions in complex situations. The newest member country of the NEA, the Russian Federation, will host the 4th Science and Values workshop in Moscow in early 2015. The workshop agenda is still being determined, but it is likely that one of the breakout sessions will address the protection of children, a theme that was first addressed during the 3rd Science and Values workshop.
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 2013:

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

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 2013 meeting):

• Mr. Richard STRATFORD (United States), Chair
• Ms. Marie-Elise HOEDEMAKERS (Netherlands), Vice-Chair
• Dr. Kwang-Yong JEE (Republic of Korea), Vice-Chair
• Mr. Frédéric JOURNÉS (France), Vice-Chair
• Dr. Hiroshi YAMAGATA (Japan), Vice-Chair
• Ms. 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 2013 of 84 professional and support staff from 18 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 2013
NEA Publications and Brochures Produced in 2013

▶ General interest

Annual Report 2012
NEA No. 7144. 60 pages. Available online.
Rapport annuel 2012
AEN n° 7145. 64 pages. Disponible en ligne.

NEA News No. 30.2-31.1
NEA No. 7164. 32 pages. Available online.
AEN Infos vol. 30.2-31.1
AEN n° 7165. 32 pages. Disponible en ligne.

▶ Nuclear development and the fuel cycle

Nuclear Energy Data 2013/Données sur l’énergie nucléaire 2013
NEA No. 7162. 92 pages. Available online.

The Economics of the Back End of the Nuclear Fuel Cycle
NEA No. 7061. 188 pages. Available online.

▶ Nuclear safety and regulation

CSNI Technical Opinion Papers No. 16
Defence in Depth of Electrical Systems
NEA No. 7070. 48 pages. Available online.

Crisis Communication: Facing the Challenges
Workshop Proceedings, Madrid, Spain, 9-10 May 2012
NEA No. 7067. 240 pages. Available online.

The Fukushima Daiichi Nuclear Power Plant Accident: OECD/NEA Nuclear Safety Response and Lessons Learnt
NEA No. 7161. 68 pages. Available online.
Radioactive waste management

Stakeholder Confidence in Radioactive Waste Management
An Annotated Glossary of Key Terms
NEA No. 6988. 64 pages. Available online.

Radiological protection

Summary of the Fourth International Nuclear Emergency Exercise (INEX-4)
Exercise Conduct and Evaluation Questionnaires
NEA No. 7143. 48 pages. Available online.

Nuclear science and the Data Bank

Chemical Thermodynamics of Iron, Part I, Volume 13a
NEA No. 6355. 1124 pages. Available online.

International Evaluation Co-operation (Vol. 33)
Methods and Issues for the Combined Use of Integral Experiments and Covariance Data
NEA No. 7171. 178 pages. Available online.

International Handbook of Evaluated Criticality Safety Benchmark Experiments – ICSBEP (DVD)
Version 2013
NEA No. 7166. Available online.

International Handbook of Evaluated Reactor Physics Benchmark Experiments (DVD)
March 2013
NEA No. 7140. Available online.

Minor Actinide Burning in Thermal Reactors
A Report by the Working Party on Scientific Issues of Reactor Systems
NEA No. 6997. 82 pages. Available online.

Shielding Aspects of Accelerators, Targets and Irradiation Facilities – SATIF-11
Workshop Proceedings, Tsukuba, Japan, 11-13 September 2012

Status Report on Structural Materials for Advanced Nuclear Systems
NEA No. 6409. 107 pages. Available online.

Transition Towards a Sustainable Nuclear Fuel Cycle
NEA No. 7133. 68 pages. Available online.

Validation of the JEFF-3.1 Nuclear Data Library
JEFF Report 23
NEA No. 7079. 76 pages. Available online.
Nuclear Law Bulletin No. 91 and 92
Volume 2013/1, Volume 2013/2

Bulletin de droit nucléaire n° 91 et 92
Volume 2013/1, Volume 2013/2

Also available

The Economics of the Back End of the Nuclear Fuel Cycle
Executive Summary
15 pages. Free: paper or web.

The OECD Nuclear Energy Agency
8 pages. Free: paper or web.

L’Agence de l’OCDE pour l’énergie nucléaire

Also available in Chinese and in Russian.
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, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Republic of Korea, 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, Luxembourg, Mexico, the Netherlands, Norway, Poland, Portugal, the Republic of Korea, the Russian Federation, 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 cooperation, 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 – 2013

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