Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

28-Mar-2012

English - Or. English

NUCLEAR ENERGY AGENCY
RADIOACTIVE WASTE MANAGEMENT COMMITTEE

NEA/RWM/WPDD(2012)5
Unclassified

Working Party on Decommissioning and Dismantling (WPDD)

Summary of the Special Seminar Commemorating the 10th Anniversary of the OECD/NEA Working Party on Decommissioning and Dismantling

Held on 16th November 2011.
NEA Offices in Issy-les-Moulineaux, France

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JT03318772

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Introduction

The OECD Nuclear Energy Agency set up its Working Party on Decommissioning and Dismantling (WPDD) in 2001. The working party is sponsored by and reports to the Radioactive Waste Management Committee, one of the seven standing committees of the NEA. The WPDD has brought together project implementers, regulators and policy makers in a constructive forum to further their mutual interest in advancing the safe, cost effective and environmentally responsible decommissioning of nuclear facilities in OECD member countries. To celebrate the first and very successful ten years of the WPPD's work, this special celebration seminar was held.

The participants at this seminar were an invited audience of WPPD current members, previous members and other special guests. The speakers were also specific invitees and the agenda carefully arranged to cover the following topics:

- The history of the WPDD and its achievements over its first ten years.
- The global outlook for decommissioning and the possible future developments that may affect it.
- The experience from some major decommissioning projects, including the dismantling of core damaged reactors.
- Other significant issues impacting on the success of decommissioning programmes, namely costs and financial provisioning arrangements, organisational aspects and skilled human resources.

The seminar culminated with a panel and audience discussion, the panel comprising the speakers and other invited specialists. A key feature of this discussion session was the objective of informing the future programme of the WPDD during the near term and over its next ten years.

The agenda for the seminar is available in Appendix A; notes on the speakers can be found in Appendix B; presentations made at the seminar can be found on http://www.oecd-nea.org/download/wpdd/WPDD-10thAnniversary-Seminar.html and on http://www.oecd-nea.org/rwm/wpdd.html .

Opening Addresses

The seminar began with the current chair, Ivo Tripputi, welcoming the delegates and introducing Stan Gordelier. As the first ever chair of the WPDD, Stan had been invited to preside the celebration seminar.

Address from the NEA, Janice Dunn Lee, Deputy Director General

Janice welcomed the delegates to the seminar on behalf of the NEA. She observed that the origins of the WPDD date back 13 years to the NEA's first Strategic Plan, where it was recognised there was a need to establish decommissioning as a discipline in the NEA committee structure; the RWMC was seen as its natural home. She reflected on and complimented the achievements of the WPDD over the ten years since its inception. Twelve full meetings have been held, all of them including Topical Sessions addressing key issues to the decommissioning community; working groups have been established, providing detailed focus on the more complicated topics. Conferences have been organised and many publications produced: technical reports for experts, policy papers for decision makers and more general material to reach out to the general public. Janice also remarked on the

strong co-operative ties between the WPDD and the NEA's Co-operative Programme on Decommissioning and Dismantling1, the IAEA and the European Commission.

Looking to the future, she noted that despite the tragic earthquake and tsunami and its consequences for the Fukushima nuclear plant in Japan, nuclear power on a worldwide basis was still expected to grow considerably. Meanwhile, some 11% of existing nuclear capacity in the OECD would be retired by 2020 and over 35% by 2035. While decommissioning has a significant degree of maturity, it is still some way from being a normal industrial, competitive, market driven activity. The challenges are multiple, from costing and funding, through to issues of decommissioning specific regulation, technology and skills and human infrastructure. She commended the WPDD for its "can do" attitude and thanked all of those who have contributed to its work and its success.

Marie-Claude Dupuis, CEO ANDRA and Chair RWMC

Marie-Claude expressed her pleasure at being able to celebrate the WPDD's 10th anniversary with the delegates. She observed that the events of Fukushima may result in some countries shutting down nuclear plants or refusing life extensions. Even where his is not the case, there will be a tendency to accelerate decommissioning in order to free nuclear sites for new build. Decommissioning will thus become more important, more visible and more scrutinised than ever before, increasing the pressure for appropriate provisions to be made in terms of policy, financing and the management of the large volumes of materials that would arise.

Reflecting on the origins of the WPDD, she observed that the RWMC already had a very effective group in the CPD for the exchange of hands-on experience among decommissioning projects, but in the late 90s the committee recognised it also needed a means to address policy, regulatory issues and societal aspects in a visible manner. Following its creation in 2000/2001, the WPDD is now the longest standing international working group dedicated to decommissioning. She saw a continuing need for its work; the RWMC has identified "Effective Decommissioning" as one of the seven challenges in its Strategic Plan for 2011-2016.

Marie-Claude moved on to compliment the WPPD on its many publications, identifying specific documents in both policy and technically-oriented works that she regarded as particularly valuable, and noting the ground breaking work currently in progress on decommissioning R&D needs. In closing she thanked both the WPDD and the CPD on behalf of the RWMC and wished them continued success, for the benefit of both the international community of decommissioners and waste managers of the NEA member countries.

Patrick O'Sullivan, Decommissioning Specialist, IAEA

Patrick thanked the NEA for the invitation to join in the WPDD's celebration. In a former role he had been a member of the NEA and had worked directly in support of the WPPD's activities. In this respect, he was very familiar with the work of the group and its many successes over the years, and he complimented the WPDD on its achievements. He observed that in this, as in all other areas, the NEA and the IAEA work in close collaboration to the benefit of their respective international communities and he looked forward to a continuing close collaboration with the WPDD in the coming years. In the important area of decommissioning costs, he made reference to the "Yellow Book" as a specific example of such collaboration. This has now been further developed, also in collaboration with the European Commission, and is shortly to be jointly published in the report "International Structure for

1. The Co-operative Programme on Decommissioning and Dismantling (CPD) has been operating for more than 25 years under an NEA framework. Under a confidentiality agreement, member decommissioning projects of the programme exchange their information and experience.

Decommissioning Costs". This will provide an important tool for the community in estimating, tracking and comparing costs across projects.

Patrick shared the view of the earlier speakers, that decommissioning would become of increasing importance in the near term. He emphasised the importance of conducting decommissioning in a manner that ensured that it was done safely, and of NEA and IAEA's work in enabling this. While safety was a clear need in its own right, it also has an impact on public confidence, without which the task of decommissioning becomes much more difficult. However effective we became at safe, efficient and cost effective decommissioning, we must continue to strive for improved performance; the status quo is never "good enough". He looked to continuing to work with the WPDD and to the NEA's and IAEA's joint interests in furthering these ambitions.

Thomas Kirchner, DG for Energy, European Commission

Thomas thanked the NEA and the WPDD for the invitation to join them at this celebration seminar. The decommissioning of nuclear facilities and the management of the arising wastes involves environmental, technical, social and financial responsibilities. The Commission recognises the increasing importance of decommissioning and has taken steps towards seeing that adequate funding will be available, that there will be a level playing field in the way that such financial provisions are made and that repositories will be available in member countries for the arising wastes. With respect to funding, the Commission's focus was on the adequacy of funding, its financial security and ensuring that the funds are only used for the intended purpose. These concerns relate not only to power reactors but to all nuclear facilities. It is clear that adequate financial resources can only be put aside in provisions if they are made on the basis of reliable cost estimation. He therefore welcomed the work of the NEA and the IAEA in this field and was pleased to see the co-operation with the EC on the publication "International Structure for Decommissioning Costs".

He then moved on to talk about the recent Council adoption (July 2011) of the "Radioactive Waste and Spent Fuel Directive". Member states will have to draw up national programmes and notify them to the Commission by 2015 at the latest. These programmes must contain a concrete timetable for the construction of radioactive waste disposal facilities, a description of the activities in the implementation plan, cost assessments and a description of the financing schemes. There must also be provision for public participation in the decision making process. The IAEA Safety Standards will be reference European standards. Member states are required to arrange international peer reviews at least every ten years. While two or more member states can agree to share a disposal facility, exports of radioactive wastes outside the EU would only be allowed under very strict conditions.

In conclusion Thomas expressed his appreciation of the collaboration between the international organisations in this subject area and expressed his good wishes for the future of the WPDD.

History of the WPDD – Significant Tasks and Consequences

The seminar moved on with two presentations on the history of the WPDD and its achievements.

Claudio Pescatore, Principal Administrator, NEA; "Setting up the WPDD in 2000 and the Early Years"

Claudio referred back to the early history, describing the year 2000 as a year of change for the RWMC, with the setting up of the IGSC (Integration Group for the Safety Case), the FSC (Forum for Stakeholder Confidence) and the WPDD; all three had stood the test of time. The aim identified then for the WPDD is still applicable today, "to provide a high-level, strategic perspective of the issues ... associating the views of regulators, implementers and policy makers ..." From the outset the

membership had included representatives of the CPD and of the RWMC and CRPPH[2] committees, to ensure excellent cooperation and cross fertilisation of ideas. He emphasised the cross cutting nature of decommissioning and the further links with the other standing committees of the NEA.

The *modus operandi* of the WPDD was established early:

- The WPDD would meet once a year.
- Its agenda would include a topical discussion.
- A task group would then prepare a publication on the topic following further detailed work.
- At least every other year the meeting would be held in a host country, to allow an exploration of the decommissioning issues and status in that country (a country overview).

In the period up to 2005 topical sessions were held on the safety case, materials management, building and site release and reuse, strategy selection, funding issues and stakeholder engagement. Country based meetings were held in Karlsruhe, Germany; Tarragona, Spain; Rome, Italy and Brussels, Belgium. Claudio illustrated the resulting publications and in particular the leaflet "Decommissioning: It can and has been done". This was published in several languages, reviewed successful projects for a wide range of nuclear facilities and was intended for a non-specialist audience. In this context of interactions with civil society, he also referred to the good partnership that had been established with the mayors of the European municipalities with interests in nuclear. Finally, he reviewed the lessons learned from the work during this period.

Ivo Tripputi, Sogin, WPDD Chairman; "WPDD – the Period till Now"

Ivo began his review of the WPDD "Storyboard" since 2005 by commenting on the huge amount of work that has been done, especially given the limited budget and resources. In good part this was due to the success of the topical sessions and the follow-up task groups. The more recent topical sessions were on emerging issues and trends in regulatory practices, human and organisational factors, applying decommissioning experience to the design and operation of new plants, the management of large components, R&D needs and radiological characterisation. Country overview sessions were held in Paris, France; Steventon, UK; Senec, Slovak Republic and Washington, USA. He commented on the unusual challenges that could be associated with decommissioning projects and the need to maintain an excellent safety culture, especially challenging with the transition from an operating to a dismantling site. He also emphasised the need for constructive engagement and listening to stakeholders and referred to WPDD's work in co-operation with the Forum on Stakeholder Confidence.

He moved on to refer to an impressive list of publications and yet more which were in the pipeline. He looked to the future of the WPDD and encouraged the seminar delegates to come forward with ideas and suggestions for the future programme. In reviewing the impact of the Fukushima events he recognised that they may also have an impact on the safety criteria for decommissioning, storage and disposal facilities, that public confidence in all matters nuclear (including decommissioning) will have been badly affected, that there was a need to be able to demonstrate the decommissioning of damaged reactors, and that remediation techniques would now be a major issue. He then reviewed his perception of the strengths and weaknesses of the way that it was necessary for the WPDD to operate before announcing that he would be standing down as chair and thanking all those who had made his time in that position so interesting and rewarding.

2. The Committee for Radiological Protection and Public Health.

Discussion

There followed a short discussion in which a number of points were made. Attendees expressed the view that we should be proud of what the decommissioning community is achieving and perhaps we are not good enough at advertising what we actually have done. Interaction with civil society is important, not just to promote our achievements but also to engage local communities in the decision making about decommissioning; the US DOE may provide useful examples in this respect. In the US there is also use of a risk informed approach to decommissioning. Recognising the increasing use of nuclear energy in India and China, there was interest in how the WPDD could bring them into future discussions. The seminar was informed that it would now be possible to invite India at NEA on an ad-hoc basis. A memorandum of understanding has been signed by the NEA and China and collaboration should be possible in perhaps two years. Finally, in view of recent events in Japan, members expressed an interest in how to approach clean up after accidents.

Decommissioning Overview and Challenges

The next session of the seminar was designed to take stock of the current global position in decommissioning and to try to see what developments might take place in the future.

Patrick O'Sullivan, Decommissioning Specialist, IAEA; "The Global Outlook for Decommissioning"

Patrick commenced by reviewing the current, global position with respect to the decommissioning of nuclear power plants: 440 are in operation, 139 are shut down or under decommissioning and 11 have been fully decommissioned. Of the operating reactors, a significant number are due to shut down by 2025. He provided data on a regional basis. From this it was clear that the largest number either already closed or to be closed by 2025 is in Western Europe (>160), with the North America some way lower (>60), followed by Russia (>40). Moving to research reactors, 241 are in operation, 165 shut down on under decommissioning and 431 have been fully decommissioned. In this case the number of those either already closed or scheduled to be closed by 2025 is greatest in North America (>100), followed by Western Europe and then Russia. With respect to fuel cycle facilities, on a global basis 198 are shut down or under decommissioning and 172 have been fully decommissioned. The forecast of future decommissioning by 2025 shows Western Europe again with the largest demand (120).

Having presented this global picture, Patrick moved on to examine the position in more detail for two significant example countries, Germany and Russia. For Germany, he provided data for prototype reactors, for completed or active dismantling of power and research reactors and for fuel cycle plants. For Russia he showed that while some 220 legacy facilities had been shut down, only some 70 have been decommissioned. He then explored the reasons for not progressing faster, amongst which were no accumulated funds for decommissioning and no facilities for the final disposal of long lived wastes.

Patrick concluded by drawing lessons for decommissioners:

- Public confidence cannot be taken for granted; there was a need to continuously improve structures and working arrangements.
- A key requirement is an appropriate legal and institutional framework, including a funding system.
- It is necessary to have arrangements for capturing and sharing experience.
- An environment should be created where expertise from advanced programmes can be made available more easily to others.

Stan Gordelier, Consultant; "The Future of Dealing with the Past"

Stan began by exploring how much decommissioning there is to do in the coming few decades. The countries with the more substantial liabilities are those that have commenced nuclear power generation earlier and those who have also had substantial military programmes. There is four such prominent countries: the USA, France, the United Kingdom and Russia. Starting with the largest of these, he illustrated the large number of facilities in the USA. The US DOE had nuclear liabilities of the order of 35B USD and was spending around 6B USD/a. The current operating reactor fleet represented a future liability of around 470B USD. Moving to France, he illustrated the status there. The combined future liabilities of EDF, AREVA and the CEA are estimated at around 80B USD. Moving to the UK, the Nuclear Decommissioning Authority (NDA) has 2.2% discounted liabilities of 80B USD and are spending around 5B USD/a. The future liabilities for the operating EDF UK fleet are estimated at around 17B USD. These three countries, together with Russia, also own almost all of the nuclear submarines in the world, more than 400 of which have been taken out of service. Only 100 in the USA have been fully decommissioned, where the reactor compartments had been disposed of in one piece to a repository. The UK has recently issued a consultation document on how to decommission its redundant reactors.

Stan then used this background to set out the factors influencing the future of decommissioning, which he saw as:

- A large and growing decommissioning market.
- Plenty of new build (and hence competition for skilled nuclear resources).
- Competitive electricity markets (especially in Europe).
- The financial crisis; governments short of cash.
- Repositories will finally arrive.
- Public attitudes to nuclear and their desire for consultation.

Taking these in turn, he explored what they might mean for the future of decommissioning.

Moving to more provocative issues, he tabled a number. Perhaps the most contentious of these was an examination of how much nuclear generation was needed to make a 50% energy contribution by 2050, and hence a major alleviation to climate change. Around 7 000GWe would be needed, compared to 370GWe today. From this he concluded that we needed Generation III reactors to live up to their probabilistic safety assessment predictions, but even then we should expect to have to decommission a core damaged reactor every few decades.[3]

Discussion (Chair Ivo Tripputi)

In the following discussion delegates raised a number of issues. It was generally agreed that public acceptability and consultation would be an increasingly important aspect. US DOE delegates explained some of the lessons from their experience: avoid an information-only policy, enter "consultation" but not with with a solution; agree the clean up criteria with the public; repeat consultation at all key stages. Similarly DOE experience has shown that the accelerated decommissioning programme post-2000 was in part due to more appropriate regulation; risk based, with established guidance and agreement on how to conduct appropriate clean-up surveys. The IAEA

3. Note that this is based on core damaged frequencies, not large release frequencies, which are considerably smaller.

commented on the crucial change needed in moving from operations to decommissioning. There was agreement from several directions that we needed to develop better ability to clean up after accidents. Also, that it was important to take account of decommissioning needs for new build. The WPDD chair expressed interest in the development of a leaflet to explain the decommissioning profession.

Decommissioning Stories

The next session explored four significant decommissioning projects: Greifswald, a multi-reactor site in Germany; Rocky Flats, an extremely successful accelerated decommissioning of a multi-facility site in the USA; Three Mile Island, the decommissioning of a severely core damaged reactor in the USA; and Fukushima, an update on the damaged reactors in Japan.

Bernd Rehs, Federal Office of Radiation Protection (BfS), Germany; "Decommissioning in Germany: Griefswald NPPs"

When the Greifswald complex was shut down in 1990, it had been operating since 1973. It had five reactors that had been in operation and three more under construction; decommissioning commenced in 1995. The company Energiewerke Nord GmbH, which is fully owned by the Federal Ministry of Finance, was set up to manage both the decommissioning and the spent fuel, and to convert the site into an important centre of energy and technology. The approach taken was to undertake everything with Greifswald's own personnel using commercially available equipment as far as possible, with the objective of maintaining employment for the local population.

Unused fresh fuel was sold to the Czech Republic and the USA; partially spent fuel was sold to Hungary. Used fuel was loaded into Castor casks for storage in an on site multi-purpose facility, Interim Storage North (ISN). This facility also contains decay storage space for large decommissioning components and facilities for monitoring, segregating and packaging decommissioning wastes. The philosophy is to separate these activities from the dismantling areas themselves.

The approach taken for the decommissioning is to classify areas according to their history: contaminated, suspicion of contamination, not contaminated. Dismantling is conducted room by room, starting with those of lowest contamination. Big dismantled components are taken for decay storage at the ISN facility before cutting and further treatment. Highly activated components such as the reactor internals may need to stay in situ for further decay. The total mass of material that is expected to be dealt with is 1 800 000t of which 1 236 000t is classifiable as not contaminated. Of the 564 000t of suspect contaminated material, 67 000t are dismantled equipment and 497 000t are building structures. After monitoring and segregation it is expected that there will be only 16 500t of radioactive waste to be disposed of. A key requirement is a material tracking system that keeps records and can monitor material from beginning to disposal.

Bernd illustrated his presentation throughout examples of the decommissioning activities. In his closing status summary he informed the seminar that 75% of plant in controlled areas have been dismantled and 95% in supervised areas and that the project is expected to be complete in 2012. Where possible, clean buildings will be left standing for subsequent industrial use.

Jeff Kerridge, VP Decommissioning and EPC Operations, CH2M Hill; "Rocky Flats Closure Project, Making the Impossible Possible"

At the start of the project the site had some 800 facilities on a 385 acre industrial area, including a building described as "The Most Dangerous Building in America". These facilities contained more than 21t of weapons grade nuclear materials, much of it inappropriately stored. There were also 30 000 litres of plutonium and enriched uranium in ageing tanks and 550 000m^3 of radioactive waste.

The site clean up was estimated to take 70 years and cost more than 36B USD. Following an FBI raid in 1989, the staff lacked direction, were demoralised and had "forgotten how to succeed".

When the Kaiser-Hill organisation won the contract, it introduced radical changes, replacing most of the senior management, setting quarterly performance metrics, and introducing a significant employee incentive scheme (20% of contract earnings). A radical rethink of what could be achieved identified a programme of ten years at a cost of 7B USD. The radical change to programme length and cost was achieved by negotiating new collective bargaining agreements, streamlining work rules and establishing composite crews, retraining and engaging workers as problem solvers. Low tech, high delivery solutions were employed, such as one piece disposal of large glove boxes without decontamination and dismantling. In addition, an extensive workforce transition programme was put in place to enable workers to move on to their next job, so that they did not fear the end of the project.

As a result of these changes, all buildings were demolished, all contaminated sites remediated, all plutonium, uranium and hazardous wastes removed and the site contoured and established as a wildlife refuge, while saving the taxpayer 30B USD. Jeff's lessons were;

- Safety is the foundation
- Incentive based contracts work, structure bonuses accordingly
- Disciplined project management pays
- Invest in robust project controls

He illustrated his presentation throughout with images of the work conducted on the site.

Andy Szilagyi, Director of D&D, US DOE; "Three Mile Island Unit 2 Overview and Management Issues"

Andy emphasised a key difficulty was not knowing what to expect with a damaged core. At TMI one of the first steps was a "quick look" video inspection; a more complete inspection took another year. A key decision was to use mostly manual manipulation with powered tools; thoughts of an in core shredding device were not followed through because of concerns of development timescale and the possibility of in core failure. A shielded work platform was installed and the refuelling canal was left dry to reduce the depth of water and the reach necessary for the manually controlled tools. Several robotic inspection devices were used including a modified, remotely-controlled toy and a mini-submarine. A core boring machine adapted from the mining industry was used to take samples of the solidified fuel mass and subsequently to break it up for extraction. A year's delay was caused by biological growth in the water and loss of clarity; managing water quality is a key issue.

With such a seriously damaged core, standard nuclear materials accountability was not possible and the NRC accepted a compromise approach so that progress could be made. Another significant advantage was having repositories or sites that were capable of accepting the materials, albeit at very considerable distance from the reactor site (low level waste to Barnwell, 600 miles; fuel and debris to Idaho National Lab, 2 100 miles; filtration vessels to Hanford, 2 800 miles).

Andy finished by drawing lessons for the future and making comparisons with the position at Fukushima. At TMI major advantages were that the reactor had only operated for 3 months and that the accident sequence was terminated before damage to the vessel. At Fukushima access to the containments and eventually to the reactors will be much more difficult, but much more advanced robotics and visioning equipment are now available. It will be necessary to deal with significantly more contaminated water. With respect to more general lessons Andy observed that exact conditions following an accident cannot be predicted. Nevertheless, consideration should be given to establishing comprehensive emergency and response scenarios, regional response centres with capabilities and equipment and specifically designed remote/robotic equipment.

Hiroshi Rindo, Director General, Nuclear Cycle Back End Directorate, JAEA; "Overview of Accident of Fukushima Dai-Ichi NPPs and Future Planning Towards D&D"

The first part of Hiroshi's material contained a great deal of information on what happened to the reactors during the earthquake and the subsequent tsunami, which he provided for information to delegates, but did not present; his intentions was to focus on what had been learnt about the state of the plant and the preparations for clean up and dismantling.

He showed a number of slides illustrating the damage and the difficulties with high dose rates that had been measured in a wide variety of locations, followed by the current status of a road map for restoration. Among the steps to be taken before the removal of the fuel debris from the reactors themselves were removal of the fuel from the spent fuel pools, remote decontamination of the high dose rate locations to allow improved access, development of technology to repair leaks on the PCV (it is expected that debris removal will be carried out under water) and remote investigations of the PCV and RPV. Some 3,100 fuel assemblies outside of those in the reactors themselves need to be removed from the buildings and about 2 700 of these are spent nuclear fuel. Most of the fuel rods are expected to be undamaged but this will not be true of them all. A particular difficulty is the presence of salt from the seawater and concerns about the corrosion that this can cause. How the rods could be cleaned and inspected and possibly reprocessed in the future is clearly an issue.

Hiroshi then proceeded to show a series of slides on the work flow for the preparations for and subsequent removal of the fuel debris from the reactor cores. The shape and location of the debris are presently unclear and it will be necessary to develop remote inspection methods which can operate in the very high radiation environment. Techniques for debris sampling will also need to be developed. An additional difficulty for units 1 to 3 was that part of the debris may have leaked into the PCV. It would probably be necessary to develop more advanced techniques than those employed at TMI. TMI fuel debris was still in stable storage and this was the intention for Fukushima debris, but salt contamination was a concern for integrity of the storage containers. Hiroshi closed by referring to the large number of organisations engaged in resolving the difficulties at the site, indicating that he expected D&D to start in about three years and emphasising the importance of international cooperation for a successful outcome.

Discussion

A lively discussion followed. For Greifswald delegates questioned the storage policy for large components. The storage time was not yet fixed, but was expected to be between 30 and 60 years, after which they would be segmented in the ISN for subsequent disposal. On Rocky Flats there was interest in the means by which such a dramatic programme reduction had been accomplished. Different assumptions were part of the answer, on the end state and the approach of one piece disposal of large units. Not all countries had the infrastructure advantages of the USA, particularly with respect to repositories. Delegates asked whether the wastes had merely been transferred but were assured they had been disposed. For post accident clean up, there was an obvious concern on how disposal facilities could be quickly established where none already existed. Quantities of contaminated soils could be very large, for example. It was also noted that IAEA guidance on exposure limits were different for emergencies, raising the question of definition and how the transition from one state to another should be achieved. Members also noted that a key lesson from the two finished projects was to use simple technology as much as possible.

Aspects of Decommissioning

The final set of three presentations covered key enablers for successful decommissioning, the issues of costs and funding, organisation and the provision of skilled human resources.

Lady Balfour of Burleigh, Chair of the UK Nuclear Liabilities Funding Assurance Board and Chair of EDF UK's Nuclear Liabilities Fund; "Decommissioning Costs"

Lady Balfour began by recognising the importance that most nations are now attaching to accurate estimates of decommissioning costs and the need to make appropriate arrangements for their future funding. She intended to illustrate this by way of the history of such arrangements in the UK and how the current requirements in this respect for new build had been developed. She spoke frankly and without any PowerPoint presentation.

Originally the power generating reactors in the UK had been owned by nationalised industries (i.e. by government owned entities) and did not have segregated funds for their future liabilities, although provisions were made in the companies' accounts. In 1995/6 the more modern nuclear assets of the two companies Scottish Nuclear and Nuclear Electric were merged and privatised as British Energy (BE). The older first generation of reactors (the Magnox series) were left in government ownership and subsequently all merged under BNFL. On the later demise of BNFL, the provisions for future decommissioning were absorbed by government and a new body, the Nuclear Decommissioning Authority (NDA) established to manage these and other government owned nuclear liabilities. NDA's work is now funded directly from the UK Government's Department of Energy and Climate rather than from any separate provision.

The privatised BE company set up a segregated fund in the form of a Scottish Public Trust, in which the funding for future liabilities were intended to be fully ring fenced. However, changes in the UK electricity market later resulted in BE becoming close to insolvency, forcing a government rescue and a rearrangement of the trust. New requirements resulted in the assets of the fund being absorbed by government and 65% of BE's free cash flow going straight to replenish the fund. In 2009 EDF bought BE. HM Government announced at the time of British Energy's restructuring that it would fund the qualifying liabilities to the extent that they exceed all the assets of the Fund.

This rather tangled history has brought about strict rules for fully segregated funds for any new nuclear build in the UK, as defined in the 2008 Energy Act. Those wishing to construct new reactors must produce a Decommissioning and Waste Management Programme (DWMP) laying out how the decommissioning will be conducted and how much it will cost. It must also have a Funding Arrangements Plan which sets out how contributions will be made to the fund, and how it will be invested and managed to ensure independence and insolvency remoteness. These two components comprise the Funded Decommissioning Plan, which the Secretary of State must agree on behalf of government and which cannot be subsequently changed without his agreement. The Nuclear Liabilities Assurance Board, which Lady Balfour chairs, is there to advise government on the appropriateness of these arrangements.

Gerard Laurent, EdF CIDEN; "Organisational Aspects of Decommissioning at EDF"

In the first part of his presentation Gerard gave an overview of the EDF nuclear fleet in France and then more detail of the nine reactors that are in the process of being decommissioned. These comprise one PWR, one heavy water reactor, eight gas graphite reactors (GGRs) and finally one fast breeder reactor. The intention is to complete the decommissioning of these in two waves, within 25 years. However, there is currently no facility in France that would allow disposal of graphite, and decommissioning of the Gas Graphite Reactors will not proceed without this.

Gerard explained the logic behind the programme and that, in particular, the Chooz A 300MWe PWR is in the first group and it will provide feed back for decommissioning the large, more modern PWR fleet. The intention is to decommission most gas graphite reactors under water, as in the dismantling of the Fort St. Vrain reactor in the USA. Chinon A1 and A2 would be dismantled in air because their structures do not lend themselves to the underwater decommissioning approach.

In the next part of his presentation he explained the structure of CIDEN within EDF, how responsibilities are organised and the programme management system via yearly, five yearly and long term objectives. He also explained the extensive system of data collection and tracking used to manage the projects and to provide cost estimation for future projects.

Ashutosh Sharma, International Projects Manager, National Skills Academy Nuclear UK; "Human Resources in Decommissioning"

Some years ago the nuclear industry in the UK recognised that it was facing a future skills problem, given its ageing workforce. In addition, recruitment problems were exacerbated by rudimentary record keeping, security issues and, for decommissioning, (a) that the projects are long term (60-100 years) with resulting knowledge transfer issues, and (b) that decommissioning is not a self sustaining sector in its own right. In order to make progress it was necessary to understand and quantify the skills needed, articulate employer requirements, design standard qualifications and attract young people into the sector. It was also recognised that there were some base transferable skills that could move across sectors, such as project management and core engineering disciplines.

In response to this position there was a government-supported initiative by industry to create the National Skills Academy for Nuclear. The objective is to ensure safety and efficiency by developing a highly skilled nuclear workforce via a high quality provider network, together with the development and implementation of UK national standards. The academy now has over 90 members, it is employer-led and -funded and covers all skill levels.

Ashutosh moved on to present some of the data that had been collected and analysed; 14,000 new people were required in nuclear operations by 2025, and construction needs would peak at 13,000 between the years 2018-2020. He showed the data on the skills gap that would emerge due to the ageing workforce. He then talked about the development of the "Nuclear Skills Passport" which records nationally recognised skills and training at all levels. Finally, he looked to the future and identified potential areas for collaboration, amongst which were:

- It was in the interests of the established nuclear nations to support skills development in those countries new to nuclear technology.
- There was an opportunity to establish an internationally recognised network of training providers.
- We should be working collaboratively to develop international standards.
- The Nuclear Skills Passport could be established internationally.

Panel Discussion: Decommissioning in the Next Decade. Chair: Ivo Tripputi. Panel Members: Lady Balfour of Burleigh, Christine Wassilew (BMU, Germany), Stan Gordelier, Hiroshi Rindo, Jean-Luis Santiago (ENRESA, Spain), Andy Szilagyi

Ivo opened the discussion with a series of questions. Why does decommissioning take so long, why are we not replicating the Rocky Flats success story? How do we assure the correct qualified and motivated resources for the future? How can we demonstrate restoration after an accident? Are regulations sufficiently risk informed and appropriate for decommissioning? Should we be more content to accept brown field rather than green field end-states? Is the funding issue being properly addressed for research and fuel cycle facilities and finally, is decommissioning worth doing without repositories to take the wastes? He invited panel members to respond in turn, add their own thoughts and suggest what activities should be pursued in future by the WPDD.

Jean-Luis Santiago responded that, for Rocky Flats, the big advantage was fast and easy material flow from the project to the repositories, including the ability to dispose of large one piece components.

Many projects do not have this advantage. Also, the acceptance of an end state with some residual contamination is a key factor. Finally, we also need to recognise that the "can do" project culture added a lot.

Christine commented on the new position in Germany, which is now facing unplanned and unexpected decommissioning; the number of power reactors in decommissioning will increase from 8 to 17. Currently an ILW repository is expected to be available in 2019, but this is still open to question. Germany faces a situation where there are separate timescales for the repository and for decommissioning. There is also a new issue of partly irradiated, almost fresh fuel and there aren't enough transport casks to meet the need. The motivation of the personnel in the plants is also likely to be an issue. At the same time, the utilities intend to challenge the government imposed closures, so the situation is very uncertain. Moving to topics for the WPDD, she suggested the following topics: damaged reactor decommissioning; knowledge management, particularly important when there is a need for safe enclosure; how to reach agreement between the regulators and the operators and, finally, when should we regard the projects as finished, what should the end-state be?

Lady Balfour focussed on two main issues, those of funding and of public trust. She was of the view that more could be done to explore how various jurisdictions deal with the funding issue and what should be regarded as best practice. She was also concerned that we had been poor at explaining ourselves to the public, without whose support our work would be much more difficult. We needed to encourage openness and advertise our achievements more, perhaps even by encouraging television programmes on major projects. The industry does not always recognise that effective communication is "theatre", not reading material. Finally, she raised the issues of early shut down and pressures on skills and resources impacting on costing.

Stan expressed interest in systems for collecting real cost data and using these in a "learning system", such that we progressively improved our ability to estimate project costs; he was aware that CIDEN used such a system and would like to see if WPDD could develop some work in this area. He supported the issue raised by Ivo, that of helping to develop more appropriate risk informed regulation for decommissioning. He also believed that public consultation would become a more pressing issue and that WPDD could be looking to collect experience and develop best practice advice. At a practical level, ground contamination is a big issue on some sites and the "dig and dispose" approach is not very satisfactory; are there better ways?

Hiroshi expressed concern on the mismatch between decommissioning and disposal. Presentations at the seminar had shown the advantages of available disposal facilities and it was difficult to progress without them. He would like to see more done on knowledge management and lessons learned from practical experience. This should be fed back to new build in order to facilitate future decommissioning. He illustrated this with the example of a particular pressure tube material which becomes so activated that it may need deep geological disposal, where selection of an appropriate alternative avoids the problem.

Andy responded to Ivo's question on Rocky Flats. Such acceleration was being seen elsewhere; he cited the example of the Idaho National Laboratory. Part of the Rocky Flats success was due to all stakeholders having common objectives and also to the stability of funding. In pursuing rapid decommissioning, Andy raised the issue of entombment, rather than dismantling; should this be pursued as an acceptable option? He was keen to see more thought given to new technologies and planning for an emergency response. Finally he commented on the difficulties of making best use of lessons learned; what can we do to make this really effective? How do we translate this to planning for decommissioning during the construction of new plants? Can we do more, for example, with 3D cad modelling to improve designs to facilitate decommissioning?

Following these panel responses, Ivo invited comments and questions from the delegates. Forward thinking with respect to repositories was a concern; we should be addressing the question of what the

needs would be in 20 years, when there will be many more decommissioning projects. There was a proposal that a system of peer reviews for costings would be helpful to spread best practice. Short, two page summary documents from the WPDD were proposed on what had been done on each key topic and a similar document on "The Decommissioning Profession". Returning to the Rocky Flats acceleration, one effective practice had been performance incentives. What experience is there in employing such incentives in a heavily unionised environment? A number of delegates responded that, properly implemented, this had not been an issue. Finally and appropriately, delegates returned to the issue of safety culture and the need to maintain focus on this given the financial and time pressures during decommissioning project implementation.

Closing Remarks

The panel session now concluded, Ivo passed the chair back to Stan, as the seminar chairman. Stan thanked the speakers on behalf of the seminar, thanked the delegates for their active participation in the discussions, congratulated the WPDD on its first very successful ten years and wished the group well for the next ten to come. With that he closed the seminar and wished all attendees a safe journey home.

Appendix A

Agenda of the Special Seminar Commemorating the 10th Anniversary of the OECD NEA Working Party on Decommissioning and Dismantling

16 November 2011		
12th Meeting of the WPDD – A Special Seminar Commemorating the 10th Anniversary of WPDD OECD Nuclear Energy Agency, Le Seine Saint-Germain, 12, boulevard des Îles, Issy-les-Moulineaux, France NEA Room A and B		
Chair: Stanley Gordelier		
09:00	**1.**	**Opening** *Ivo Tripputi, WPDD Chair; Stanley Gordelier, Anniversary Meeting Chair*
		ADDRESSES
09:05	**2.**	**ADDRESS FROM NEA** *Janice Dunn-Lee, NEA, Deputy Director*
09:15	**3.**	**ADDRESS FROM the NEA Radioactive waste management committee** *Marie-Claude Dupuis, CEO, ANDRA; Chair of RWMC*
09:25	**4.**	**Address from IAEA** *Patrick O'Sullivan, IAEA*
09:35	**5.**	**Address from the European commission** *Thomas Kirchner, EC*
		History of WPDD – significant Tasks & consequences
09:45	**6.**	**Setting up the WPDD in the year 2000 AND Early Years** *Claudio Pescatore, Principal Administrator, NEA*
10:05	**7.**	**WPDD – Period till now** *Ivo Tripputi*
10:25		***BREAK***
		Decommissioning OVERVIEW AND Challenges
10:55	**8.**	**GLOBAL OUTLOOK FOR DECOMMISSIONING** *Patrick O'Sullivan, IAEA*
11:15	**9.**	**THE FUTURE OF DEALING WITH THE PAST** *Stanley Gordelier*
11:35	**10.**	**DISCUSSION** *Chair: Ivo Tripputi*
12:00		***Lunch***

		Decommissioning Stories
14:00	**11.**	**Experience from the Greifswald decommissioning project** *Bernd Rehs (BfS)*
14:20	**12.**	**ROCKY FLATS** *Jeff Kerridge, VP Decommissioning & EPC Operations, CH2M HILL*
14:40	**13.**	**Three Mile Island AND FUKUSHIMA** *Andrew Szilagyi, DoE and Hiroshi Rindo , JAEA*
15:10	**14.**	**DISCUSSION ON DECOMMISSIONING STORIES**
15:40		***BREAK***
		Aspects of Decommissioning
16:00	**15.**	**Decommissioning Costing** *Lady Balfour of Burleigh, CBE, Nuclear Liabilities Financing Assurance Board , Chair; Nuclear Liabilities Fund, Chair*
16:20	**16.**	**ORGANISATIONAL ASPECts of Decommissioning AT EDF** *Gérard Laurent, EdF/CIDEN*
16:40	**17.**	**Human Resources in decommissioning** *Ashutosh Sharma, National Skills Academy Nuclear, UK*
17:00	**18.**	**PANEL: Decommissioning in THE NEXT DECADE** *Panel chair: Ivo Tripputi* *Members: Lady Balfour of Burleigh, Stanley Gordelier, Hiroshi Rindo, Juan-Luis Santiago(ENRESA) , Andrew Szilagyi, Christine Wassilew (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany)*
18:15		***ADJOURN***
18:30		***RECEPTION***

Appendix B

Notes on the Speakers of the Special Seminar Commemorating the 10th Anniversary of the OECD NEA Working Party on Decommissioning and Dismantling

Lady Balfour of Burleigh

Janet Balfour of Burleigh taught politics and modern history for ten years at Oxford University, before moving to the Central Policy Review Staff in the Cabinet Office, where she specialised in work on the application of new technologies.

She has worked for governments in many countries and for a variety of public companies. Her current directorships are with the Scottish Oriental Smaller Companies Trust plc; Murray International Investment Trust plc; and Albion Enterprise VCT plc. She is chairman of Espirito Ltd, a spectrum management company. She chairs both the Nuclear Liabilities Fund and the Nuclear Liabilities Financing Assurance Board.

She is a Fellow of the Royal Society of Edinburgh and has held a number of public appointments, currently, as a trustee of the Carnegie Trust for the Universities of Scotland, the Trusthouse Charitable Foundation, and the Royal Anniversary Trust. She is Patron of the Porthcurno Submarine Telegraph Museum.

Her books include the three-volume edition of Richard Crossman's Diaries of a Cabinet Minister and his Backbench Diaries; works on constitutional affairs and on broadcasting; the authorised biographies of Agatha Christie and Edwina Mountbatten and, published in the summer of 2004, The Secrets of Rue St Roch, the true story of an intelligence operation behind enemy lines during the First World War.

Stan Gordelier BSc, CEng, FNucI, FIMechE.

Currently a consultant, Stan chairs the UK Nuclear Decommissioning Authority Research Board, is a shadow director of the embryonic liabilities fund company for New Nuclear Build in the UK, and a non-executive director of the decommissioning company Research Sites Restoration Ltd. Previously he spent almost 5 years as Head of the Nuclear Development Division at the NEA, was Executive Director for Southern Division of the UKAEA and before that the Director of Liabilities Management Division for Magnox Electric. He has a long association with the work of the NEA as a member of the Cooperative Programme on Decommissioning and as the first ever chair of the WPDD.

Jeff Kerridge

Currently Vice President for Programme Management for CH2M HILL, supporting Rolls Royce in the development of a Core Production Capability manufacturing facility. Previously, Jeff spent 7 years as the Vice President for Business Development for CH2M HILL's Nuclear Business Group. Prior to 2004, Jeff worked as a decommissioning program manager at the Rocky Flats Environmental Technology Site.

Gérard Laurent

Graduated Engineer from ENSIEG Grenoble, 33 years of experience in Nuclear Life, main topics of interest: wastes, safety, environment, radioprotection.

A lot of experiences at EDF:

Beginning at Fessenheim first big PWR power plant in France in 1978, then radioprotection studies, fuel handlings, waste treatment, main design changes on operating units, safety studies, environmental assessment etc...

Since 2001, working at EDF CIDEN unit at Lyon (in center east of France) and now in charge of the 'anticipation project for decommissioning issues' and the 'irradiated graphite treatment project' for EDF.

Patrick O'Sullivan

Patrick is a decommissioning specialist with the International Atomic Energy Agency. He has worked for more than 20 years in waste management and decommissioning, in UK, the Netherlands and France, as well as Vienna. This period included 10 years with the UK waste management organisation Nirex, now part of the Nuclear Decommissioning Authority and 6 years with the Nuclear Research Group in the Netherlands. Prior to this he worked for several years on reactor design and safety assessment issues on the UK reactor programme. Before joining the IAEA in 2010 he worked for the NEA as a decommissioning expert, and was Scientific Secretary of the WPDD during this period.

Claudio Pescatore

Claudio holds a PhD in Nuclear Engineering from the University of Illinois at Urbana-Champaign) and a Laurea cum laude in Applied Physics (University of Bologna, Italy).

He has over 30 years experience in the field of radioactive waste management. He has been a tenured staff scientist and group leader at Brookhaven National Laboratory and adjunct professor of Marine Environmental Sciences at the University of New York at Stony Brook. He is presently in charge of the programmes of the Nuclear Energy Agency (NEA) of the OECD in the fields of decommissioning and radioactive waste management and has played a central role, also in setting up the WPDD, in the past 20 years with the Agency.

Bernd Rehs

Working in the field of decommissioning and radiation protection since 1999 as an technical expert in a Technical Inspection Agency and later as staff member in the Federal Office for Radiation Protection (BfS) in Salzgitter, Germany. Since end of 2007 head of BfS-section "Decommissioning of Nuclear Facilities". Providing technical assistance regarding decommissioning for the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) and present in national and international committees.

Hiroshi RINDO

He has been working for the Power Reactor & Nuclear Fuel Development Cooperation (PNC), former Japan Nuclear Cycle Development Cooperation (JNC) and the Japan Atomic Energy Agency (JAEA) since 33 years.

He has 20 years experience in the field of Fast Breeder Reactor's R&D and management of Fast Breeder Reactor "MONJU". And also 13 years experience in radioactive waste management and decommissioning including the R&D activities. During 33 years nuclear energy field, he was also engaged in the Pu transportation and the public relations activities.

He is now Director General of Nuclear Cycle Backend Directorate, JAEA. He is in charge of radioactive waste management and decommissioning and the R&D of nuclear cycle backend activities in JAEA.

He is one of the Japanese members of CPD since 2005, WPDD and RWMC since 2006, and also IDN of IAEA since 2009.

Juan Luis Santiago

Juan Luis Santiago is Civil Engineer, Master of Science in Engineering (M.S.E.) by the University of Michigan, and Master of Business Administration (M.B.A.) by the Instituto de Empresa (Madrid). He has more than 25 years of experience in hazardous and radioactive waste management projects and for the last twenty years he has been working in ENRESA where he has coordinated the remedial action plans for uranium mill and mines and the decommissioning projects for nuclear power plants and research facilities. At present, is the head of the Decommissioning Projects Department, responsible for all decommissioning projects within ENRESA.

Ashutosh Sharma B.I.T., MSc, MIEEE, MBCS, MCSI, AMIETE

Ashutosh Sharma is International Project Manager at National Skills Academy for Nuclear in the United Kingdom. His role involves globalising the operations of the Skills Academy by analysing international markets and creating strategies for implementing products and services abroad. He is also participating in the Knowledge Transfer Partnership (KTP) between Liverpool Hope University and the National Skills Academy for Nuclear. Previously, Ashutosh has worked in the areas of High Performance Computing, Climate Change, Operations Management, Marketing and Branding at Liverpool Hope University, SONY and Government of India. He has lectured Masters Students and has been involved with enhancing student experience and pastoral care as a Resident Tutor.

Andrew Szilagyi

Andrew Szilagyi has a multi-disciplinary career spanning the last 34 years. He has a Bachelors of Science in Biology and a Masters degree in Environmental Sciences. He has worked worldwide, throughout the Caribbean Islands, South America, the Middle East - most specifically in Saudi Arabia, and Indonesia completing significant environmental assessments and impact statement for large industrial and military projects. Since 1991 he has worked for the United States Department of Energy in the Office of Environmental Management, overseeing DOE's portfolio of Deactivation and Decommissioning Projects. Since 2009, he has served as the Director for the Office of Deactivation and Decommissioning with responsibilities for the identification and development of innovative and distruptive technologies designed to accomplish D&D "smarter" i.e., safer, more efficiently and less costly.

Ivo Tripputi

Ivo is Nuclear Engineer graduated at University of Rome “La Sapienza”, currently manager responsible for international relations at Sogin. After other experiences in the Italian nuclear industry he worked for about 25 years in the ENEL Engineering and Construction Department working mainly on nuclear safety matters and participating at the development of the requirements for advanced LWR’s both in the US (at EPRI) and in Europe (EUR initiative). In Sogin he played several roles, including being the Director of the 4 nuclear research sites decommissioning for 3 years. He participated as expert in several IAEA missions worldwide and he is currently member of several international groups. He is the chairman of WPDD since November 2005.

Christine Wassilew

- Master in Physics of the Technical University Karlsruhe, Germany.
- Ph.D in Physics of the Technical University Darmstadt, Germany.
- Post-Doctoral Fellowship at the European Synchrotron, Grenoble, France.
- 5 years in a technical expert organization.
- Since 2011 in the Federal Ministry: Nuclear, Safety, Federal Supervision to German NPP.

- Since 2008: Head of Division Nuclear Regulatory Framework, Multilateral Regulatory Cooperation.
- Since spring 2011: Head of Division Fundamental Aspects of Nuclear Waste Management, Waste Management Planning, Decommissioning of Nuclear Installations.