WM2012 Conference Panel Report

PANEL SESSION 17: Exploring the Options for SNF/UNF in Light of US and International Decisions

Co-Chairs: Mary Peterson, *Pacific Northwest National Laboratory*
Chris Phillips, Energy*Solutions*
Panel Reporters: Chris Phillips, Energy*Solutions* and Mary Peterson, *Pacific Northwest National Laboratory*

Panelists:

1. Michaele Brady Raap, *Pacific Northwest National Laboratory*
2. John Kessler, *Electric Power Research Institute*
3. Ken Nash, *Washington State University*
4. Chris Phillips, *EnergySolutions (USA)*
5. Terry Todd, *Idaho National Laboratory*
6. Dorothy Davidson, *AREVA Federal Services*
7. Huw Morgan, *National Nuclear Laboratory (UK)*
8. Andy Griffith, *DOE Office of Nuclear Energy*

More than 50 people attended this session that explored and debated the disposal versus recycling options for SNF/UNF. The session opened with each of the panelists providing 10 – 15 minutes of prepared remarks that provided an overview of the options/issues in dealing with UNF, the case for long term storage of UNF, the importance of recycling to rebuild the workforce for nuclear processing, the status of aqueous and non-aqueous based recycling, the economic considerations, international lessons learned and the DOE Office of Nuclear Energy Perspective. The panel was then opened up to the audience for questions. There was a good discussion among the panel and with the audience on the options for addressing the SNF/UNF. There was, however, no consensus on the best way forward, with opinion evenly split between disposal, reprocessing & recycle and interim storage pending a future decision.

The following summary includes excerpts from the Conference's daily newsletter, *Insight:*

The diverse panel of technical experts from national laboratories, industry, government, and academia discussed the urgent need to find and develop into large scale realistic storage and disposal solutions for Used Nuclear Fuel (UNF). This issue is considered urgent because, with the demise of the Yucca Mountain repository scheme, the US has joined the ranks of countries with no long term storage solutions for their UNF, which in the US continues to build up at some 2100 tons per year on a base currently approaching 70,000 tons.

Michaele Brady Raap started the session with a presentation that emphasized the need for the US to develop a national energy roadmap with an integrated waste management strategy for the nuclear energy component. Nuclear energy currently contributes 20% of the nation's electricity needs and is likely to at least remain at this level and will probably need to exceed it in the future, as coal is retired from electricity generation. She noted the enhanced security risks associated with storage of UNF at power utility sites, even after the fuel has been moved from water filled pools to dry cask storage and she reviewed how countries around the world are planning to deal with their UNF. France, Japan, Russia and the UK reprocess their UNF rather than store it, and India, China and South Korea have announced their intention to do the same. Although the Yucca Mountain project has now stopped, she noted the large amount of technical data that it had generated, and she also noted that the great success of the Waste Isolation Pilot Plant (WIPP) in New Mexico showed that the US could successfully implement a permanent repository for radioactive waste.

John Kessler's presentation made the case for long term storage as the best solution for UNF, noting that such storage can be extended to perhaps 100 years or even longer. Combined with higher burn-up of nuclear fuel, re-racking of UNF in storage pools, more use of dry cask storage, and the construction of one or two centralized interim stores for UNF, he considered the UNF issue to be fully manageable for the foreseeable future with a deep repository ultimately being used to permanently store the UNF. He noted that EPRI, NRC, DOE, NEI, power utilities and vendors are currently engaged in a three-phase program to provide the technical basis for extended storage of UNF and emphasized that UNF storage arrangements should be integrated and managed at the national level.

Ken Nash noted that reprocessing of UNF allows the recycle of uranium and plutonium which extends the fuel supply, and the partitioning and transmutation of the minor actinides which reduces long-term radiotoxicity. He questioned whether UNF in long term storage is as proliferation-resistant as sometimes claimed, given that its intense fission product radioactivity declines markedly over 100 years. From his university base he sees great interest amongst today's students in nuclear energy and UNF recycling. This is important but needs to be encouraged and capitalized on now, if the US is to regain its leadership role in nuclear technology, which it has lost because of the US's lack of work in the nuclear field over the last 20-30 years.

Chris Phillips showed how UNF separation technologies have been developed and industrially proven over the 60 years of industrial reprocessing in France, the UK and Japan. This has progressively reduced the environmental impacts to near zero and enabled waste forms for ultimate disposal to be developed that are more robust than unprocessed UNF. Current world reprocessing facilities can thus be considered as using third generation technologies, while further developments aimed at reprocessing in the US are fourth generation, improving further the environmental performance and avoiding the separation of pure plutonium at any point, thus improving proliferation resistance. If the value of the recycled uranium and plutonium is taken into account, and the US Waste Fund is made available, a sound economic case can be made for reprocessing in the USA, as was demonstrated by several industry groups during the GNEP project from 2006-2009.

Terry Todd compared the non-aqueous UNF recycling processes with the industrially established aqueous ones, and described the non-aqueous options to remove fission products and unwanted actinides from the uranium and plutonium to be recycled – volatilization, halide volatility, partial oxidation and electrolysis in molten salt solutions (sometimes referred to as pyro-chemical). He noted the advantages of such processes including high resistance to radiation effects which allows the processing of short cooled and high burnup UNF, easing of criticality controls because of the lack of the water moderator, the compatibility with the metal fuels that could be used in new fast reactors, the compact process footprint and the small amount of low level waste produced. He contrasted these with the disadvantages which include the batch nature of the process which limits throughputs, the lack of compatibility with oxide UNF, the production of two instead of one high level waste streams, the need to develop completely new safeguards and accountancy methods, the inability to recycle products to LWRs, and the current very low technical and industrial maturity of the processes.

Dorothy Davidson focused on the economics of both interim storage and recycling of UNF. She noted that the cost of dealing with UNF is less than 3% of the overall cost of nuclear-produced electricity, so the cost differences between long term storage and reprocessing are should not perhaps be seen as the primary driver for decisions. Because of the long term experience with industrial scale reprocessing, there is currently more uncertainty over the cost of geologic disposal, but of course some waste for geologic disposal will arise even from reprocessing operations. The most important issue at present is the development of a comprehensive UNF management solution and, whatever is finally done with the UNF, the setting up of a centralized interim store (CIS) is likely to be the best first step. This would demonstrate the ability to license, involve local communities, create valuable infrastructure, is financially manageable and demonstrates a willingness to address the issue. Designing, licensing and construction of a CIS could be done for a relatively small sum in the region of $500-700M, with completion achievable in around 10 years. Subsequent operating costs would also be fairly modest at $100-150M per year. However, a CIS is likely to be more appealing to a host community if it is not seen as a de-facto permanent repository but rather as a first step to a geologic repository or to reprocessing at the same or adjacent site. For reprocessing a significant capital investment of perhaps $500m per year over 50 years would be highly attractive to the appropriate community, providing 18,000 high quality jobs during construction, 5,000 steady jobs for 50 years of operation and up to 30,000 additional indirect service and supply jobs in the community. The first step along this road would be the establishment of a public-private partnership along the lines of the 'FedCor' recommended by the Blue Ribbon Commission (BRC) to take charge of the wasted fund.

Huw Morgan gave a brief description of UNF management policies and plans in the United Kingdom, describing at the same time the UK National Nuclear Laboratory's role in this area. The UK government's policy is that UNF management is a matter for its owners to decide, subject to meeting all UK regulatory requirements. The resulting picture for UK domestic UNF includes (i) interim stored and reprocessed UNF, (ii) interim stored UNF pending geologic disposal, and (iii) interim stored UNF pending a decision to recycle or dispose. The current inventory of UNF in the UK includes large quantities of uranium metal 'Magnox' clad UNF (which must be reprocessed because of its corrosion properties), large quantities of uranium oxide UNF from both the domestic Advanced Gas-Cooled reactors and from overseas LWRs and a range of experimental and other ‘exotic’ fuels in small amounts. The current strategy being pursued by the UK Nuclear Decommissioning Authority is to complete the reprocessing contracts for the UK AGR and overseas LWR oxide fuel and cease reprocessing in the THORP facility and subsequently place into interim storage future arisings of UNF, pending a long term decision on how to deal with it. NDA considers that such placement of UNF in long term storage will not foreclose any future option for dealing with it, including reprocessing.

Andy Griffith described DOE’s Strategic Plan and R&D Roadmap for Nuclear Fuel Cycle Technology Development and the options that they describe – (i) the Open Cycle (once through and store), (ii) the Modified Open Cycle (partial separation of fission products from UNF) and (iii) Full Recycle. In all cases the aims include improvements in the utilization of uranium resources, maximizing energy generation, reducing waste generation, improving safety, protecting the environment, limiting proliferation risk and ensuring economic viability. He noted that since the issue of these documents, the BRC has reported and the event at Fukushima in Japan has taken place. Both could impact DOE’s policies going forward and are currently being studied. In the near term DOE’s priorities are to address the BRC’s recommendations, to increase the focus on accident tolerant LWR fuels and to down select fuel cycle options for further development. In the medium to long term, the intention is to develop a Test and Validation Complex for extended storage of UNF, to evaluate the benefits of various geologic media for disposal of UNF, to conduct R&D for selected fuel cycles and to demonstrate selected fuel cycle options at engineering scale.

###