

Post-Mission Quick Look Report

Travel Dates: 7/1/10 to 8/14/10

Location: Oxford, United Kingdom

Organization/Committee: World Nuclear University (WNU) Summer Institute 2010 Programme

Desired Outcome: To gain further understanding of international perspectives on the challenges facing nuclear energy, share perspectives, and build rapport with international counterparts.

Results Achieved:

By participating as a Fellow of the Programme, through lectures, facility tours, forum issues/working groups, a positive image of the United States and the NRC was projected to strengthen good will and cooperation with our international counterparts. NRC practices that contribute to our goals of being a strong, consistent, reliable, and predictable regulator were shared. Knowledge was garnered to support the NRR Executive Team in future international bilaterals/exchanges/interactions.

Summary of Trip:

During week one, the following topics were discussed: Fellows introductions; world energy demand & supply; climate change (Kyoto agreement); non-power/medical applications of nuclear technology and science; global water supply and nuclear desalination; and a survey of nuclear energy politics and history in key countries, such as the United States, France, Japan, and China. Many of these topics have worldwide societal implications. For example, the lack of electricity is directly correlated with poverty, low standards of living, and increased death rates. As the world population grows, the amount of potable water supplies is diminishing and desalination of sea water via nuclear heat appears to be a viable technical solution. From a political perspective, the oil crisis of the 1970s led to a French governmental policy to significantly expand nuclear power-generating capabilities in France while it had an opposite effect in the United States.

Dr. Warren Miller of the US Department of Energy provided perspectives of the “state of the union” of nuclear efforts in the United States. Janice Dunn Lee, a former NRC manager in the Office of International Programs, and Ana Maria Cetto, Deputy Director General, gave overview presentations of their organizations, the Organization for Economic Cooperation and Development/Nuclear Energy Agency (OECD/NEA) and the International Atomic Energy Agency (IAEA), respectively.

From interactions with foreign regulatory counterparts and utilities, it is apparent that many stakeholders are adopting a “wait and see” approach and are looking for the United States and the NRC to assume a leadership position in the nuclear realm. This includes environmental concerns through carbon emissions reduction, regulatory actions/initiative for nuclear safety, and the strategy for developing the nuclear power industry in developing nations.

During week two, the following topics were discussed: fuel cycle operations and market; Generation III reactors (BWR, PWR, CANDU, VVER, RBMK); vendor perspectives (supply chain and common mode failure mitigation); radioactive waste storage and disposal, including deep geological sites; societal factors in waste management; nuclear transport; and decommissioning. Converse to fossil fuels, nuclear energy has high initial

capital costs (50-60% of total expenditures) and low fuel costs (15-20%) so nuclear energy is largely unaffected by the price of uranium. The “Megatons to Megawatts” program of downblending Russian weapons-grade material will end in 2013. One speaker stated that depleted uranium produced by a light water reactor over a 50-year lifetime is worth more than 5000 years of the same power output from fast neutron reactors. While potentially very advantageous, the attractiveness of using fast neutron reactors may be hampered by proliferation concerns and the abundance of low-cost uranium supplies. The speakers on the disposal of high level radioactive waste believe that political debate and public acceptance are more significant challenges than the technical questions in storage and disposal. They also stated that, with current technology, a deep geological repository is safe and there is no feasible alternative. In regard to transport, Jack Edlow of Edlow International described that nuclear materials are similar to paint, bananas, gold, and eggs as they are hazardous, delivery schedule-driven, precious, and fragile. He stressed that the key tenets of successful nuclear transport are safety and security.

Jerry Grandey, CEO of Cameco – a Canadian uranium company, offered remarks about safety culture and the fear of “complacency in success” via descriptions of the flooding events at McArthur River and Cigar Lake mining operations sites. He compared these events to the Deep Horizon Oil Spill and stressed the importance of questioning attitudes, continual improvement, systematic training, and corrective action processes. Similar to NRC, Cameco has earned high marks in garnering “Best Places to Work” and “Diverse Workplace” awards. Likewise, Cameco has to strike a delicate balance in celebrating successes and continuing to pursue excellence – negative morale is possible as employees may be pushed “too hard.” In the area of knowledge management and training future engineers, Canada is experiencing similar challenges as the US. Of note, canteach.candu.org appears to be a strong resource with online documents and teaching tools (via BB Flashback-enabled videos). This resource may be a good template for NRC-related training.

Martin O’Neill, Lord in the British Parliament, gave a presentation on the history and political environment concerning the United Kingdom’s past and current nuclear environment.

Jim Ellis, President and CEO of INPO, spoke about energy, prosperity, and leadership. The US has the top 5 operating nuclear power plants in terms of capacity factor. He stressed the pursuit of excellence, safety, and emphasized that you “lead people and manage things.”

Given the discussion on advanced and new reactor designs, it is good to know that RES and NRO are applying resources in these areas, respectively. In regard to the storage of disposal of highly radioactive waste, while there are deep geological repositories in Sweden, Finland, and Japan, it is evident that the world is awaiting the progress of the Yucca Mountain site as it is the largest repository project in scale. The US and NRC are also viewed as leaders in decommissioning projects where success is tied to public outreach efforts.

During week three, the Fellows toured various nuclear facilities across the United Kingdom: Springfields, Heysham Nuclear Power Plant (NPP), Sellafield, and URENCO. As a Westinghouse site, Springfields produces fuel and fuel elements for advanced gas reactors and light water reactors. The actual machining and construction of the fuel

elements were observed. At Heysham NPP, observations of the advanced gas reactor (found in the United Kingdom) were limited to non-radiologically controlled areas. It was noted that there is no containment in the advanced gas reactor design. In addition to graphite for moderation, the core is surrounded by 6-meter thick concrete and the effluent from a release would be a mostly carbon dioxide emission which does not offer any significant negative health effects. The United Kingdom supported advanced gas reactors because of extensive experience in working with coal-powered plants – the primary difference in design is the nuclear energy source. At Sellafield, decommissioning, waste management, and reprocessing operations are executed. Before the 9-11 event, Sellafield hosted about a quarter million visitors and was home to the world's first commercial nuclear reactor, Calder Hall. Sellafield is comparable to the Hanford site in the US, but its area of operations is contained within approximately a 2-km square site. At URENCO in Capenhurst, UK, centrifuges enrich uranium. Understandably, this location was heavily fortified and observations were severely limited due to security concerns. URENCO controls about 25% of the worldwide enrichment business and faces strong competition from USEC.

During week four, the following topics were discussed: multinational approaches to fuel cycle (international low-enriched fuel bank); the legal framework for non-proliferation; safeguards implementation; Korean case study on nuclear power; comparative risk assessment; IAEA safety standards; operating experience; radiation protection (content, delivered by International Commission of Radiological Protection representative, similar to NRC Site Access Training); China and Kazakhstan (#1 in uranium mining in the world) as the keys to a nuclear renaissance; the role of the regulator in licensing and operation; and international standardization of nuclear reactor designs.

Regarding safeguards implementation, the frequency of weapons inspections is based on timeliness, the time required for detection and conversion of nuclear materials into an explosive device. These inspections provide assurance mainly regarding the correctness of the State's declared resources, not completeness as this includes undeclared resources. The presentation included inspection anecdotes about how discoveries were found and included opinions on activities by North Korea and Iraq. Through industriousness, South Korea has transformed its economy by embracing nuclear for peaceful uses (vs. warfare by North Korea) and has positioned itself as a major player in the world through the \$20 billion sale of four reactors to the UAE. In the IAEA safety standards hierarchy, the highest level are safety fundamentals (applied universally), followed by requirements, and lastly by guides.

The World Association of Nuclear Operators (WANO)'s mission is "to maximize the safety and reliability of nuclear power plants worldwide by working together to assess, benchmark and improve performance through mutual support, exchange of information and emulation of best practices." WANO has four key programs: operating experience, peer review, professional and technical development, and technical support and exchanges. The Chernobyl accident resulted from the lack of an experienced crew performing a first-of-kind test without oversight and a culture of "production first." The presenter stated that the transfer of operating experience is the greatest challenge as barriers to sharing knowledge are: human nature (embarrassment and trust); the perception of no value; legal; and poor reporting guidelines.

Clair Goddard of INPO shared a case study in safety culture with the description of the loss of the Columbia space shuttle caused by debris from the bipod ramp section that

damaged the leading edge on the shuttle wing. INPO's definition of safety culture is "An organization's values and behaviors – modeled by its leaders and internalized by its members – that serve to make nuclear safety the overriding priority." During a working group case study of this event, the resulting presentation identified key lessons learned and the corresponding corrective actions. In this tragedy, NASA engineers had to prove why the situation was unsafe instead of why it was safe – a change in normal processes. Complacency fostered the idea that previous repairs from debris issues were maintenance, not safety, issues. There were also breakdowns in normal communication and command channels. Cost-cutting emphasized money and schedule over safety. Maintaining a questioning attitude, learning from past mistakes, putting safety first in decision-making with clear communication, and getting "top-down" buy-in from leadership are vital to healthy safety culture.

The head regulator of the Czech Republic stated that the mission of the regulator is to provide "effective protection of the public health and safety, security, and the environment." She believed that there must be a balance between enabling the success of licensees and regulatory burden. A senior official from Britain's Health Safety Executive stated that the mission of the regulator is "protecting people and society from the hazards of nuclear activities." He stated that a "tolerability of risks" – society does not accept nuclear risk rather it tolerates it because of the benefits.

Since the NRC focuses on the domestic uses of nuclear power and sources, it was interesting to hear about weapon inspection activities. With South Korea's rapid nuclear expansion and its export of nuclear technology to UAE, there was no comment on the strength and experience of our South Korean regulatory counterparts. It was good to see a presentation and case study dedicated to safety culture efforts! Speaking with the British regulator revealed that while the US uses defined guidelines, the British employ a non-descriptive approach where a licensee must prove that their activities are safe against established principles. While this enables quick response to the evaluation of new technologies, such as digital instrumentation and control, it also requires very experienced staff. Under the US system, there appears to be the advantage in consistently training a higher number of regulatory staff in a faster manner than our British counterparts.

During week five, the following topics were discussed: public communications; emotional aspects of nuclear images with messages designed "to charm, to stir, and to convince;" economics of nuclear power and energy markets; and nuclear law.

Representatives from Bisconti Research and NEI conducted training similar to NRC's Media Workshop and stressed the "rule of 3" where three key messages are repeated three times over the course of a presentation to effectively deliver and reinforce a message. They presented case studies such as the Vattenfall (Germany) transformer fire event which led to the firing of senior corporate executives. They stressed the importance of building a rapport with the media and quick action in responding to unfortunate events. The Fellows were tasked to run mock press conferences in reaction to situations such as garnering local support in the community for a proposed new nuclear plant to dealing with the repercussions of a steam accident that resulted in the loss of plant workers. The economic presentations talked about basic microeconomics/macroeconomics concepts such as opportunity cost and mitigating risk through "hedging" of energy markets.

Nuclear law is a complete set of special rules created to regulate the conduct of people, companies or governments who are engaged in activities related to fissionable materials, ionizing radiation and exposure to natural source of radiation. Nuclear law enables the safe and secure development of nuclear energy for the benefit of society. It covers the entire fuel cycle and all types of nuclear activities. The regulator is essential to ensuring compliance with nuclear law. There needs to be a “balance” between victims of nuclear events and industry interests (concepts reinforced via case study) and these laws need to be accepted on the international stage.

Dr. Gregory Jaczko, Chairman of the NRC, presented a key message that “safety is not a technical issue.” He talked about the traditional (deterministic) approach to nuclear regulation that includes single failure criteria, redundancy, diversity, and defense-in-depth. He explained that risk is an attempt to quantify fear. He stated that the Safety Goal Policy Statement includes individual risk (death) and societal risk (cancer). He ended his talk by stressing that risk is one thing, but public perception is another.

Takoya Hattori, President of the Japan Atomic International Forum, Inc. (Japanese equivalent to NEI), talked about safety culture and assuring public confidence. He stressed the importance of safety culture, interface management, and international cooperation. Safety culture is about a moral attitude and engineering ethics with a questioning attitude. Interface management is transparency and communication with stakeholders. International cooperation is necessary as “nuclear technology is public property for human beings.” As such, he stated that an International Code of Conduct for responsible nuclear development might be necessary. Lastly, he offered that “young leaders have responsibilities for realizing the sustainable future of the planet.”

It was an honor to give the introductory biography of the NRC Chairman on behalf of the Fellows. It was good to see safety culture stressed by the Columbia shuttle loss case study and repeated by Mr. Hattori.

During week six (final), the following topics were discussed: international support for setting up nuclear programs (IAEA perspective); the new builds in the UAE (IAEA perspective); and nuclear programs in Latin America (CNEN: Brazilian regulator perspective – currently, Mexico, Argentina, and Brazil have domestic nuclear power generating capabilities). These presentations had a similar theme in that the nuclear landscape is a global one and therefore international cooperation and information exchange are fundamental to maintain the adequate level of competence. Also, during this week, the Fellows conducted presentations from their forum issues groups (FIGs). The FIGs worked on and discussed the following topics: health effects of low-level radiation; the pros and cons of fuel reprocessing; global warming; the initiation and expansion of nuclear power; nonproliferation efforts; international design authority; and safety culture.

In their build, the UAE government wanted to serve as the model for other non-nuclear countries to obtain the peaceful benefits of nuclear power while ensuring the support of the international community and maintaining nuclear safety, security, and non-proliferation. In regard to non-proliferation, UAE made the decision to forgo enrichment and reprocessing capabilities within its borders. UAE is also dedicated to long-term sustainability of their nuclear program and has made provisions for building infrastructure, including the training of their nuclear workforce.

Regarding knowledge management, nuclear knowledge has several unique characteristics: complex and long-term accumulation; remarkable investment; non-proliferation; international obligations; and large critical mass of interdisciplinary and cross-cutting knowledge. The true danger of the loss of such knowledge is that nuclear accidents happen! It is vital to establish a foundation of knowledge and to ensure that a systematic process of maintaining it. Knowledge can be classified as explicit or tacit. Explicit knowledge can easily be documented while tacit knowledge dwells within the minds and experiences of people. The greatest challenge is transferring tacit knowledge effectively.

Dr. Steven Cowley of the UK Atomic Energy Authority lectured about the basic principles of fusion and the efforts at the Culham Centre for Fusion Energy with the Joint European Torus (JET) fusion research reactor. He talked about the eventual scale-up fusion reactor known as ITER. There was an opportunity to see the facilities at Culham.

Given a distinguished career, Zach Pate talked about his five keys to successful leadership: “never stop learning” and the importance of finding good role models; “expect the best from all”; “nurture accurate information flow” by being a good listener; “exercise healthy accountability”; and “foster team building.” In regard to nuclear safety, he spoke about the story of the boy who cried wolf and that the real moral was “when someone cries wolf, then always check.” With team building, he spoke of Albert Sloan and General Motors who made quick decisions except with matters dealing with people.

Laurent Stricker, WANO Chairman, stressed the importance of transparency and international communication with operating experience in ensuring nuclear safety. He talked about the safe operation of the existing fleet and the safe start-up in newbuilds. Further, he briefly discussed several key events: Davis-Besse (USA), Forsmark (Sweden), Kozloduy (Bulgaria), Brunsbuttel (Germany), and Narora (India).

In closing the formal presentations, John Ritch spoke about the major public concerns of nuclear power and challenged the Fellows to find solutions and to effectively communicate them to stakeholders. The major concerns were proliferation, safety, cost/affordability, waste, terrorism, and the shortages of fuel, people, and fuel fabrication capability.

Overall, my experiences at NRC prepared me to take a strong leadership role as well as being a heavy contributor in the various discussions among the Presenters and Fellows. Furthermore, from the content of the lectures and interactions with the other Fellows, it supported my belief that NRC training is top-tier among the world and that the NRC is a well-respected organization. Given the broad range of technical topics and the “safety-first” focus, I filled in knowledge gaps in my professional career such as health physics and fuel cycle. It was good to tour facilities in another country for comparison and to note what other Fellows knew and their topics of interest. This background knowledge will be helpful for potential bilateral/meetings in the future. Furthermore, since the NRC is geared towards the domestic uses of nuclear power and materials, it was eye-opening to learn about the global environment. Most importantly, it was very productive to learn about international perspectives on human resource management and different regulatory approaches to safety.

Many countries are taking a “wait and see” approach to see what the USA decides to do regarding nuclear challenges. In particular, the international community is interested in

the proposed deep radiological repository site at Yucca Mountain. It was good to hear about NRC key messages like safety culture and knowledge management and that these are issues that are also being tackled by the international community. Hearing about international struggles with these problems helps to strengthen the message and resolve in making improvements because you see these problems in a different angle and light.

Finally, there was significant leadership advice from nuclear leaders. My personal favorite message was that you manage things, but you lead people. Putting people first goes a long way in achieving organizational goals. Informally, I learned a lot from the other fellows, professionally, personally, and philosophically. Getting an opportunity to interact and work with other future leaders on the international stage was my most worthwhile experience. Given cultural/language barriers, it was a great opportunity to practice effective and clear methods of communication. Finally, safety is paramount everywhere as an event like Chernobyl has far-reaching and timeless impact on society, both domestically and abroad.

Next Steps:

It is recommended that the NRC continue to send Fellows for future WNU Summer Institutes to maintain continuity and ongoing efforts in strengthening international rapport. With world known invited speakers and varying perspectives of the Fellows, the Programme offers a bird's eye view of the current status and challenges of the nuclear environment. This information can be useful for preparing potential leaders with a more strategic knowledge base.

Were policy issues or other items of Commission interest raised? No
If yes, how will the Commission be informed? No

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