

**Nuclear Energy Advisory Committee Meeting  
December 13, 2011  
L'Enfant Plaza Hotel  
Washington, D.C.**

Committee Members Participating

John Ahearne, Vice Chair  
Brew Barron  
Ashok Bhatnagar  
Matthew Bunn  
Dana Christensen  
Thomas Cochran  
Michael Corradini  
Margaret Chu  
Susan Eisenhower  
Marvin Fertel  
Susan Ion

Raymond Juzaitis  
Mujid Kazimi  
William Martin, Chair  
Regis Matzie  
Richard Meserve  
Carl Paperiello  
Burton Richter  
John Sackett  
Alfred Sattelberger  
Allen Sessoms  
Neil Todreas

Committee Members Absent

Donald Hintz

Other Participants:

Nancy Carder, NEAC Support Staff, Medical University of South Carolina  
Maureen Clapper, Science Advisor for Energy Affairs, U.S. Mission to the OECD at the Institut  
d'Etudes Supérieures des Arts  
Shane Johnson, Chief Operating Officer, Office of Nuclear Energy, USDOE  
Alexander Larzelere, Director, Office of Advanced Modeling and Simulation, Office of Nuclear  
Energy, USDOE  
Peter Lyons, Assistant Secretary, Office of Nuclear Energy, USDOE  
William Magwood, Commissioner, U.S. Nuclear Regulatory Commission  
Frederick O'Hara, NEAC Recording Secretary, Medical University of South Carolina  
Kenneth Chuck Wade, Designated Federal Officer, Office of Nuclear Energy, USDOE

About 40 others were in attendance in the course of the meeting.

**Morning Session**

The meeting was called to order by the Chair, **William Martin**, at 9:01 a.m., and he welcomed the members. He called for a motion to approve the agenda. Ahearne so moved, and Corradini seconded. The motion was approved unanimously.

**John Ahearne**, the Vice Chair, pointed out that, with the turnover of membership, new members should look at the subcommittee structure and decide what subcommittee(s) they might wish to serve on.

**Peter Lyons** thanked the retiring members of the Committee and welcomed the new members. It is a time when many challenges are facing the nuclear community: Fukushima and its related events; other events in the international sphere, such as the global nuclear renaissance; support for university programs; and budgetary delays.

**Chuck Wade**, the Designated Federal Officer (DFO), announced that the notes and presentations from the meeting will be available on the web. He made safety and convenience announcements.

Lyons asked each member to introduce himself or herself. After the introductions, Martin asked Lyons and Shane Johnson to review the budget and operations of the Office of Nuclear Energy (NE).

**Peter Lyons** introduced himself and the leadership team of NE. He then reviewed the NEAC membership-rotation policy, under which five members (John Ahearne, Marvin Fertel, Thomas Cochran, Allen Sessoms, and Neil Todreas, all of whom have served 13 years on the Committee) will rotate off on September 30, 2012. Seven new members (Matthew Bunn, Margaret Chu, Susan Eisenhower, Mujid Kazimi, Regis Matzie, Richard Meserve, and Alfred Sattelberger) have been selected on the basis of their knowledge of the back end of the fuel cycle and their international experience. This will bring the Committee to 18 members by October 1, 2012.

Lyons expressed pride in the U.S. response, its leadership, and its accomplishments during the Fukushima Dai-ichi disaster. The administration is committed to learning from Japan's experience as the Department continues to improve safety in current and future plants and to strengthen America's nuclear industry. In the aftermath of Fukushima Dai-ichi, NE is reviewing its research portfolio. It is looking at reducing the need for operator actions in accident responses to enhance overall safety. (Passive systems that require fewer operator actions enhance safety.) NE seeks to better understand dry-cask storage systems. Accident-resistant fuels will be pursued by re-engineering barriers that can reduce complications, such as silicon carbide cladding and enhanced fuel properties. The Office is re-evaluating potential natural phenomena, including U.S. seismic criteria. It is targeting the use of modeling and simulation, which permeate every activity of the Office. And it is enlisting the university community in this enterprise.

The draft Blue Ribbon Commission (BRC) report came out in July 2011. It has provided a coherent statement on the management of spent nuclear fuel in the United States. The final recommendations are due at the end of January 2012. The foci of those recommendations are

- A new consent-based approach to siting
- A new organization to implement the waste-management program
- Access to utility waste-disposal fees for their intended purpose
- Prompt efforts to develop one or more permanent geologic disposal facilities
- Prompt efforts to develop one or more consolidated interim storage facilities
- Support for advances in nuclear-energy technology and for workforce development
- Active U.S. leadership in international efforts to address safety, non-proliferation, and security concerns

In the past year, the NE University Programs awarded more than \$170 million in competitive grants and fellowships to 72 U.S. universities and their students.

Some changes have recently been made to the University Programs process. The first two Integrated Research Projects (IRPs), which are much larger than other awards, were made in September 2011. One went to the Massachusetts Institute of Technology (MIT) and the University of California at Berkeley for high-temperature reactor development; the other went to Texas A&M University along with a large number of partners to investigate dry-cask storage limits. Researcher/principal investigator project participation was limited to three proposals per year. Coordination has been improved between the Advanced Test Reactor (ATR) National Scientific User Facility and other facilities across the country. An increased emphasis has been placed on international collaborations. Performance metrics are to be implemented. The Department was unable to award scholarships and fellowships in FY11 and FY12; it is hoped that this component can be brought back into the University Programs in the future.

The lead AP1000 site is in Sanmen, China, where a gargantuan pressure vessel has been emplaced. The second site in Vogtle, Ga., is proceeding with site preparation but is still awaiting final combined operating licenses (COLs) from the Nuclear Regulatory Commission (NRC), which licenses are expected in a few weeks. China now has 26 reactors under construction among 65 such projects in the world. The quality of construction is impressive.

The FY11–FY12 budget summary shows some of the challenges faced by NE. The Integrated University Program from which scholarships and fellowships are derived has \$5 million added to it in the FY-12 House version after being zeroed out in the previous year; the Senate version still has zero dollars for this program. \$67 million was requested for FY12 for small modular light-water reactor licensing technical support; the House adopted that number, but the Senate has zeroed it out. In Reactor Concepts R&D, \$125 million was requested, the House increased that by almost \$12 million, but the Senate reduced it to about \$32 million, a gigantic difference. In Fuel Cycle R&D, the President requested \$155 million, which was reduced to \$132 million by the House and increased to almost \$188 million by the Senate; this large difference in amounts reflects the language added by the Senate to pursue repository characterization, to develop models for potential partnerships to manage spent nuclear fuel and high-level waste, and to move ahead with the design of uniform casks. For the Oak Ridge Modeling and Simulation Hub, the President requested \$97.4 million, the House reduced that to \$95 million, and the Senate reduced it to a little less than \$69 million. For International Nuclear Energy Cooperation, \$3 million is uniformly allocated. Radiological Facilities Management is currently slated to receive about \$50–\$60 million; however, radioisotope thermal generators and plutonium-238 are in short supply and can support only one more National Aeronautics and Space Administration (NASA) deep-space mission. Idaho Facilities Management is slated to receive approximately \$150 million. And Idaho Sitewide Safeguards and Security are allocated \$93.35 million by both the House and Senate.

**Shane Johnson** reviewed the goals and priorities of NE for 2012. He pointed out that the NE budget 13 years ago, when NERAC started, was about one-third what it is now. Most of the programs to be reviewed are covered in the core program’s budget.

The Office’s goals and priorities for 2012 are to

- Pursue the deployment of small modular reactors by establishing a cost-share program with industry
- Use the Modeling and Simulation Hub with participation by national laboratories, universities, and industry
- Assess and, where appropriate, respond to the recommendations of the BRC report with proposals to implement the recommended changes
- Pursue the ATR upgrades at Idaho National Laboratory (INL) for studying material degradation and for monitoring and evaluating materials of components
- Continue the Remote Handled Low-Level-Waste Disposal Project at INL; it is to be closed in FY17; a replacement facility needs to be designed and constructed with the Office of Naval Reactors
- Investigate accident-tolerant light-water-reactor (LWR) fuel R&D, looking at what can be done better and improving fuel performance during upset conditions
- Study LWR sustainability R&D, working closely with industry to identify key technical issues involved in relicensing
- Reexamine the extraction of uranium from seawater, building off Japanese experience through the funding of laboratory-scale tests
- Make a decision on the INL contract option, which contract expires in 2014; such a large procurement requires long lead times; the Office is looking at extending the current contract for 5 years
- Advance international stakeholder support for the Comprehensive Fuel Services (CFS) concept by putting forward business models for international cooperation
- Address the current skills mix and critical-skill gaps in the federal staff in Idaho
- Evaluate and screen sustainable-fuel-cycle options through a comprehensive peer review to focus R&D resources on the most promising technologies

- Stand up the university-based IRPs on extended used-fuel storage and high-temperature-reactor development
- Complete development of the advanced Stirling radioisotope generator in support of NASA missions
- Study high-temperature reactor development for process-heat applications; this is where the R&D program is heading, looking to nontraditional applications for such energy
- Continue support for the International Framework for Nuclear Energy Cooperation (IFNEC) for safe and secure deployment of nuclear energy
- Continue international engagement to support U.S. policy and U.S. commercial nuclear-industry objectives
- Complete Phase I of the joint feasibility study with the Republic of Korea on pyroprocessing of spent fuel
- Complete the update of DOE's Uranium Management Plan with the National Nuclear Security Administration (NNSA) and the Office of Environmental Management to manage depleted-uranium holdings
- Implement independent peer reviews of the technical campaigns within the fuel-cycle R&D program, looking at relevancy and scheduling
- Develop an NE corporate-level strategic plan that integrates the activities of the program offices
- Fully establish NE's public affairs and outreach programs
- Rebuild the NE website and implement new change procedures

Martin stated that NE's responsibilities have expanded greatly in the past 4 years, but its resources have not kept pace. A lot of organizations rely on NE. There needs to be a balance between responsibilities and funding.

A break was declared at 10:36 a.m. The meeting was called back into session at 10:54 a.m. A review of NE's activities and budget ensued, and each member was asked to comment on the previous presentations.

Barron said that NE should be the focal point for developing a roadmap for the current fleet of nuclear power plants and should establish a policy on life extension and what activities are required for owners and licensees.

Christensen questioned how NE would respond to the BRC report. Strategic planning is needed. He noted that the 23 priorities presented are not doable with existing funding.

Sessoms asked what would happen if small modular reactors (SMRs) do not get funded. Fellowships are crucial and part of DOE's charter; pressure needs to be put on someone to get them funded.

Cochran commented that, of all the activities cited, the most important ones are not at the top of the list. There are 104 LWRs in the United States that need R&D for an alternative-fuel program.

Corradini said that the community needs to revisit what was done in Gen III and Gen IV. He asked whether vendors wanted a system. DOE should look at its portfolio for advanced systems and analyze it in terms of accident initiation, failure modes, and consequences. One needs to look beyond the maximum credible incident. Flooding, as has been seen, may be a critical event. DOE and NRC have tools that can test management guidelines. A connection must be made with the Gen II reactors, and a path forward needs to be put in place.

Ion said that a question that needs to be asked is, if the uranium resource is a problem downstream, what should be done? U.S. leadership should be reestablished in international endeavors. Europe is not a homogeneous body. The different European Union (EU) states have different views on nuclear power. The United Kingdom is looking at a roadmap for the future to underpin a justifiable R&D program. Advanced reactor technology is generally desired.

Paperiello said that he would be happy to see programs to put nuclear power on the bus bar now or in the near term. The NRC needs to understand where DOE is coming from; they will need to replicate DOE's modeling and simulations.

Todreas contemplated where the nation and the world are going to be in 2025 and 2030. A new LWR concept (beyond the AP1000) will be needed. DOE's role is to emulate and start such an activity. A fuel program will have to be conceived in relation to the reactor that the fuel will be used in. It should not be fully passive; there will be blockages that will need to be dealt with by pushing coolant through the reactor under electric power.

Ahearne said that Lyons's talk was discouraging. The budget will restrict progress. The huge wish list of goals far exceeds the budgetary capabilities. A strong case needs to be built to get the funding.

Bunn was surprised that NE was doing so well budgetarily. The responsibilities that DOE is required to fulfill may edge out R&D funding. He asked NE to consider narrowing its activities to a few things that DOE can do well. In the response to Fukushima Dai-ichi, there are elements that the United States cannot be proud of. There was not an international framework in place to deal with the emergency. The appropriate policy role of NE should be determined. Policy-focused R&D should be thought about. Few countries want to change the regulatory regime. The drivers need to be identified. The safety and regulatory cultures need to be changed in the United States and internationally. The question is how organizations should deal with low-probability events.

Sackett said that NE has become much more diffuse than it was 13 years ago. A one-sentence focus on NE is needed to gain the attention of Congress: Secure the role of the United States to lead the world in nuclear power. That would involve consolidation or coordination or cooperation among the many agencies that set U.S. nuclear policy. International cooperation is needed at much higher levels than it currently is practiced at (e.g., in safety culture and technology choices). The United States should look closely at its interests and its influence on international leadership.

Juzaitis pointed out that 4 years ago NE was talking about four pillars and now it was talking about 23 goals. NE has lost its focus. The university fellowship and scholarship program's demise has sent a chilling message to nuclear engineering departments; the Office of Management and Budget (OMB) should not be allowed to get away with a lie. There was no national-security nexus in the list of priorities. For U.S. leadership, a balance between R&D and development is needed. The new generation of nuclear engineers needs something to be built now.

Chu said that she was pleased with the attention paid to the NRC; DOE will be the backbone of R&D support; and the R&D direction will influence the fuel cycle. Also, the international program can be done successfully with focus, leverage, and commitment; the most beneficial activities should be chosen to receive support; international win-win situations need to be defined.

Sattelberger commented that, to establish leadership, a new reactor has to be designed and built in this country. Also, the <sup>238</sup>Pu issue needs attention soon.

Fertel said that the Fukushima Dai-ichi lessons learned are being studied by the Electric Power Research Institute, DOE, the Department of Defense, and the Japanese Government. A better protocol for interagency cooperation, coordination, and collaboration needs to be facilitated. Many of the 23 goals cited by Johnson are continuing activities that are already being funded. Budgets are going to be real tight for a long time. Programs should be looked at over the long term. A technology takes 20 to 30 years to be adopted. One should look for early-on collaboration with appropriate stakeholders. No one is looking at initiating events; they are looking at consequences. They are looking at beyond-design events in terms of what needs to occur during an emergency.

Eisenhower said that, if the list of goals were binned, it would be more helpful. The BRC should not be on that list. What should be on there are safety factors, fleet support, support to the United States Government, and future scenarios. She pointed out that nuclear energy is at a disadvantage with the discovery of huge natural gas deposits.

Richter said that the program needs more focus. The United States has little influence in the nuclear world. The Global Nuclear Energy Partnership (GNEP) was a great idea, but went away. Coordination of federal agencies used to be done by Bromley's Coordination Council, but it is not used anymore. In terms of alternative reactor fuel cycles, this Committee at its previous meeting said to shut down the effort if no industrial participation emerged. The LWR program will be around for many decades, and NE should be looking at LWR issues.

Bhatnagar observed that people tend not to look at non-maximum events. What types of responses should be made to such events need to be decided.

Meserve said that one needs to be nimble in deploying resources in the face of great uncertainty. This nation will be storing spent nuclear fuel for a long time, but it has little data on how that fuel behaves. That mechanism needs to be understood. The response to the BRC report needs to be coordinated; many of its recommendations (like changes to the Nuclear Energy Act) will not happen quickly. From Fukushima dai-ichi, a lot was learned about emergency response. The shortcomings identified will require a long period of R&D. In the past, NERAC heard a lot of expectations of exponential growth of support of new programs. That growth did not happen and will not happen.

Matzie pointed out that most organizations promote their strengths. The United States supports LWRs through such activities as life extension and passive safety systems. The nuclear community needs to build on that leadership. SMRs will need to be the next big step. Supporting those technologies and getting advanced light water reactors (ALWRs) online will produce U.S. international leadership.

Kazimi pointed out that it would be helpful if the risks from external events were better understood. He also called for a focus on fuel R&D; the fuel is what drives all the other system choices.

Martin said that a lot of the responsibility for choosing foci for the future lies with NEAC. The U.S. can lead by its activities at Fukushima Dai-ichi. Congress should agree on the need for nuclear power.

Lyons responded to the comments. He said that NE should work closely with the private corporation that the BRC is recommending and it should focus on the longer-range issues of the fuel cycle. It should involve other agencies in its roadmap activities. Pursuing scholarship and fellowship programs is worthwhile. Industry hired 1 of 89 PhDs who graduated in nuclear engineering this past year. The pipeline is not just for the nuclear-power industry but for the *whole* nuclear community. The other graduates went into industry, just not the nuclear industry. At the BS, MS, and PhD levels, only 10% of the nuclear engineering graduates go into industry. There are better ways to show our priorities. We *do* need U.S. leadership, not just participation. In the near term, DOE will not have the budget to enter into another construction project. It is true that NE needs to work closer with regulators; it can provide data and validated codes. NE is very limited in budget partly because the Office of Civilian Radioactive Waste Management was zeroed out, but its responsibilities live on and influence the Office's budgetary priorities.

**John Ahearne** was asked to oversee the presentation of the subcommittee reports. Subcommittees take on specific topics, report on their findings to NEAC, and pass them on to DOE if accepted by NEAC. He reviewed the Facilities Subcommittee, which was tasked in 2008.

The purpose of the Facilities Subcommittee is to review and provide expert guidance to the Nuclear Energy Advisory Committee (NEAC) and the Assistant Secretary for Nuclear Energy through NEAC on both the short-term and longer-term direction of research and development (R&D) facility requirements and capabilities. In its work it has referred to several reports:

- *Nuclear Energy for the Future: Required R&D Capabilities – An Industry Perspective*, Battelle, September 2008
- *Required Assets for a Nuclear Energy Applied R&D Program*, INL, September 2008
- *Executive Recommendations for Nuclear R&D Capabilities*, Battelle, July 2008

- *Evaluation of Existing DOE Facilities to Support the Advanced Fuel Cycle (AFC) Mission*, DOE, 2008

The Subcommittee has held three meetings and visited INL and Oak Ridge National Laboratory (ORNL), where it received briefings from upper laboratory management and toured the relevant facilities.

After visiting INL on May 19-20, 2010, the Subcommittee endorsed the overarching objective of building and operating a suite of world-class user facilities, primarily for fuel-cycle R&D, without engaging in advocacy for or against particular advanced reactor and fuel-cycle options. The INL facilities that were visited appear to be well maintained, and upgrades appear to be consistent with authorization-basis requirements. The Center for Advanced Energy Studies (CAES) represents a significant expansion of engagement for INL, and the Laboratory should capitalize on this facility as soon as possible. The ATR appeared to be in excellent working order and the life extension program appears to be addressing aging challenges within the facility. This facility is a national asset for materials research and will be essential to the development of next-generation-reactor fuels and materials. Hot-cell facilities all appeared to be in a well maintained condition and they all appeared to be well, perhaps fully, utilized. The development of new low-enrichment uranium (LEU) fuels for the Global Threat Reduction Initiative (GTRI), which is funded by NNSA rather than by NE, represents perhaps the best use of several of the INL facilities pending further development of NE-sponsored nuclear fuels research at INL.

After visiting ORNL on August 26, 2010, the Subcommittee concluded that, during the past decade, ORNL has done a good job in consolidating, integrating, and coordinating its hot-cell facilities, reducing the number of hot-cell facilities from 10 in 2001 to 4 today. These facilities, together with hot-cell facilities at INL are adequate to fulfill the basic R&D missions of DOE-NE that require hot cells. The High-Flux Isotope Reactor (HFIR) appears to be fully utilized and well run. Lack of facilities does not appear to be a roadblock to DOE-NE basic research and development plans. More critical are institutional inefficiencies (e.g., those caused by limits imposed by the State of Idaho on waste inventories at INL). The HFIR reactor is a national resource and highly utilized along with the Radiochemical Engineering Development Center (REDC) laboratories affiliated with it.

Managed collaboration/competition should be encouraged between INL and ORNL.

On December 10, 2010, the Subcommittee reviewed NE's infrastructure needs. Sol Golub concluded that the current infrastructure generally exists to support near-term R&D activities for most reactor concepts. Ken Keller provided a list of "Fundamental Fuel Cycle Needs" and concluded that NE lacks the suite of capabilities needed to develop and demonstrate advanced fuel cycles, which will require a test reactor. Todd Allen reviewed progress of the ATR as a user facility. Seventy-five proposals were submitted as part of the first five solicitations, but only eight were funded; eight more were approved but not funded.

Members of the Subcommittee have expressed the following comments:

- In this new era of shrinking budgets, the infrastructure of NE should be reviewed with an eye to consolidating similar facilities and making individual national laboratories lead laboratories for a certain aspect of the fuel cycle. Then the money can be concentrated, and the R&D can be properly funded. The Subcommittee could review the options and make recommendations. Budgets shrinking around the globe may offer a major opportunity for the United States to establish key jointly funded international facilities, so a review of international facilities by the Subcommittee may be very timely.
- The work of the Subcommittee is closely aligned with R&D requirements from the programs, which are in nearly constant flux. It would be good to identify facility capabilities that are broadly applicable to universal needs. When DOE invests in the maintenance or upgrading for these facilities, it offers the opportunity of maintaining what is essential as programs, policies, and politics change.

- Without a good discussion and agreement among the programs on what those universal needs are, they will continue to tear into each other and treat each other as the opposition.

Future activities of the Subcommittee might include meeting with industry representatives to get information on industry facilities and meeting with university representatives to get information on university facilities.

**Burton Richter** was asked to present the report from the Fuel Cycle Subcommittee. It meets twice a year and reports to NEAC once a year. The main issues include radioactive waste: What are we going to do with it? The BRC report is due soon. The Nuclear Waste Technology Review Board (NWTRB) is funded by Congress. Its relationship to NEAC is unknown. An informal discussion of relative roles was held with John Garrick [the NWTRB chair]. The issues of spent nuclear fuel will focus on LWR spent fuels. There are changes that are occurring in fuels (e.g., higher burnup and ceramic claddings), and DOE and the NWTRB will have to negotiate who does what. The BRC is recommending intermediate dry-cask storage. DOE should lead R&D on dry-cask storage for transport and storage.

The Subcommittee is looking at systems studies. NE has too many fuel cycles on its plate. Each fuel cycle is being evaluated. The relative weighting of the criteria affects the ranking arrived at. There is no mechanism for NE and NNSA to discuss proliferation issues.

Uranium from sea water could bring the cost of uranium down to \$250 per kilogram, which would obviate the need for fast reactors and mixed oxide fuels (MOX).

**Allen Sessoms** was asked to report on the International Subcommittee, which has four issues to deal with: the impact of the disaster at Fukushima Dai-ichi; comprehensive fuel services; U.S. non-proliferation policy; and the Department of Commerce's committee on improving exports, CINTAC.

The U.K. nuclear industry did a study of the Japanese earthquake and tsunami. The main finding was that the approach used to identify the nuclear-facility design basis is sound; we understand siting and thermal loads.

The disaster had consequences worldwide. The United States conducted safety reviews of plants and standards and reaffirmed support for new builds. Brazil thinks things look okay. Japan conducted safety reviews of plant standards and halted construction of new plants. China and South Korea conducted safety reviews of plants and inspected all units under construction. Germany immediately closed seven reactors for three months and placed a moratorium on lifetime extension. Italy canceled its new-build program. Switzerland conducted a safety review of existing plants and decided to phase out nuclear by 2034. France conducted a safety review of existing plants that had no impact on new-build projects; French elections may affect national policies, but a major shift would be very difficult, given the infrastructure in place. Poland and the Czech Republic see nuclear as a big opportunity.

The Royal Society issued a report, *Fuel Cycle Stewardship in a Nuclear Renaissance*. It made recommendations in three areas: non-proliferation, nuclear governance, and integrated fuel-cycle management. However, a lot of such reports have been issued and not a lot has been done.

The National Resources Defense Council issued a report in which Christopher Paine and Thomas Cochran developed the concept of nuclear islands with the international leasing of nuclear-fuel-cycle sites. The basic elements of the proposal are to establish a new freestanding International Nuclear Fuel Cycle Association (INFCA) that would be layered over existing International Atomic Energy Agency (IAEA) programs; to conduct enrichment (and later reprocessing) activities within long-term internationally secured leased areas controlled by INFCA; to require that lease contracts endure for the entire lifecycle of a civilian nuclear fuel cycle facility, through the end of decommissioning, even in the event that a state withdraws from the Non-Proliferation Treaty (NPT); and for INFCA to certify legitimate producers and track certified end-uses of critical components for enrichment and reprocessing. In response to this proposal, Tom Shea said that the international community may wish to find suitable locations for spent-fuel reception and storage,



spent-fuel recycling, nuclear-waste conditioning, and final waste repositories. All of these capabilities are essential to the long-term viability of nuclear power generation, and creation of global solutions will ensure that the needs are met responsibly. In response to concerns raised by some states, several proposals have been put forward under which nuclear suppliers would seek to ensure the supply of fresh fuel against political interruption not related to proliferation concerns as a means to dissuade states from pursuing enrichment technology. The German proposal for a multilateral enrichment sanctuary project is a particularly noteworthy example.

Some 20 countries have worked on nuclear weapons. The following steps could be taken to enhance the non-proliferation system:

- Reliance on constraining the use of sensitive nuclear technologies should be reduced, and this action should be coupled with a much more robust international and national inspection regime.
- The playing field should be leveled for 123 agreements; everyone should be treated sensibly.
- An international regime should be established for managing plutonium separated during commercial reprocessing by blending down to MOX.
- The IAEA should be funded as an entitlement under U.S. law, and funding should not oscillate.

A break for lunch was declared at 12:43 p.m.

### **Afternoon Session**

The meeting was called back into session at 1:30 p.m. Sessoms continued his report from the International Subcommittee.

The absence of NE from the table during international discussions of nuclear power put U.S. companies at a significantly competitive disadvantage when compared with other potential suppliers. NE is not funded to engage in these entities. The extent of international engagement by NE without adequate funding is substantial but not nearly as effective as should be the case if they are to support President Obama's goals with respect to national security and domestic job creation. The Subcommittee suggests that

- The Office staff should prepare estimates of reasonable costs per type of engagement as a function of time in order to be credible and effective in the international arena.
- The Subcommittee, working with Office staff, should analyze which current engagements are important to promote and what type of additional commitments are likely to emerge in the near to medium term.
- NEAC should send a letter to Secretary Chu by the end of January requesting that he work with the other relevant cabinet officers to press OMB to fund this activity at the appropriate level.
- The Subcommittee should work with the full Committee to informally convene a meeting with industry of senior-level U.S. Government officials (from the Nuclear Regulatory Commission, National Security Council, Department Commerce, Department of State, Export-Import Bank, Department of the Treasury, and Office of Science and Technology Policy) to consider how collectively they might aggressively support the President's goals of enhancing domestic job creation while improving the non-proliferation regime.

**Maureen Clapper** was introduced to discuss how DOE-NE and NNSA operate in the international arena. She worked at the Organisation for Economic Cooperation and Development (OECD), representing DOE's interests. The U.S. ambassador to France wanted a DOE attaché at the embassy in Paris. She filled that position under DOE Order 313.1, Management and Funding of the

Department's Overseas Presence. There is an Overseas Presence Advisory Board. There are 23 direct hires and 27 local hires in 13 countries, representing DOE's interests in those countries. Resources are provided by NNSA and several offices in DOE. The work involves directing work of interest to DOE, NRC, and the Department of State. This work draws a continuous cycle of visitors to chair and/or participate in ad hoc expert groups, governing boards, standing technical committees, and standing groups carrying out the work of the international agencies. The work results in flagship publications on energy, special reports, and papers that they reference.

The DOE Paris Office is located in a country that has 58 operating nuclear power plants and that draws on these plants to provide 78% of its electricity needs. France also reprocesses its spent fuel. There is a long history of cooperation between U.S. and French technical, research, and safety agencies working on nuclear. In addition, Office of Energy Efficiency and Renewable Energy plus the Office of Electricity and Energy Reliability (EERE/OE) cooperation is on the increase.

There are three U.S. ambassadors in Paris, and they and their staffs make up the Tri-Mission: the Bilateral Embassy (U.S. Ambassador to France), U.S. UNESCO [the United Nations Educational, Scientific, and Cultural Organization], and U.S. OECD.

The flagship publications are World Energy Outlook (WEO), Energy Technology Perspectives (ETP), Nuclear Energy Outlook (NEO), and OECD Environmental Outlook.

Almost every office in DOE has a vested interest in the International Energy Agency (IEA), Nuclear Energy Agency (NEA), or bilateral work between the United States and France.

**Michael Corradini** was asked to report on the Reactor Technology Subcommittee, which, at the Secretary's request, conducted a comprehensive review of the Next-Generation Nuclear Plant (NGNP) project to see whether the project was ready to proceed to its second phase. That review was conducted, the Subcommittee report was approved by NEAC, and the report was forwarded up the chain to the White House.

The report resulted from a series of five meetings in which the Subcommittee reviewed the NGNP program plan, decision points, time schedule, cost estimates, and needed products. It also studied the NGNP licensing strategy with input from the NRC. In general, the Subcommittee recommended that the Government continue to support the development of the NGNP at an appropriate level for the next few years to sustain this investment. Specifically, the Subcommittee recommended that DOE

- Accelerate the formation of a public-private partnership as soon as practical to obtain end-user input into design activities and fund additional design activities to support this effort. The private sector of this partnership should, as a minimum, include (1) a vendor, (2) an owner/operator, and (3) a process-heat end user. A phased partnership should be pursued (with cost sharing requirements increased as uncertainties associated with NGNP deployment are reduced).
- Continue to engage the NRC for necessary licensing activities to ensure that the regulatory framework for this new reactor technology is ready to support commercialization. As noted above, it is expected that DOE would require increased cost sharing from partnership members as these licensing issues are addressed.
- Expedite NGNP deployment efforts by:
  - Revising the NGNP program plan to reflect the current situation and sustain progress through appropriate funding levels for a single design concept to move forward.
  - Completing additional design activities required to support a Preliminary Safety Analysis Report (PSAR) level of detail for the single design concept that is selected by the partnership. The partnership would select this concept based on site-specific information and end-user needs.
  - Focusing current research and design efforts on this single concept to accelerate initial deployment efforts. While high reactor outlet temperatures are desirable for

ultimate NGNP applications, issues associated with licensing and deployment must first be addressed.

- Removing the 2005 Energy Policy Act requirement that the NGNP first-of-a-kind be located at the INL site. Rather, the NGNP should be sited at an appropriate location defined by the industrial partnership that will be formed by the end of FY12.

- If the public-private partnership is not progressing, the effort should be repurposed.

This last recommendation was added at the June 2011 NEAC meeting.

Bunn said that, at one time, the private sector proposed the federal government's paying virtually all R&D costs, but DOE stepped back from that. Corradini responded that the Act said that there had to be a 50-50 split. OMB said that that split had to be overall, not on a year-by-year basis. The Subcommittee was split on this interpretation. Finding an owner and vendor that could work together with DOE on SMRs seemed possible. Lyons said that he found a strong need for a 50-50 split each year. Otherwise, three-quarters of NE's research budget would go to one program. Corradini pointed out that one should enter into an international agreement on some advanced reactor concepts to maintain a presence within the available budget.

**Raymond Juzaitis** reported on the newly charged Nuclear Energy Advanced Modeling and Simulation (NEAMS) Subcommittee. It covers all the other enterprise computing of NE outside the modeling and simulation hub. A 10-member subcommittee was pulled together; it reflects a wide range of perspectives. It will look into the suite of safety and performance codes as well as the program's management.

Richter and Todreas left the meeting.

**William Magwood** was introduced to reflect on the early years of NERAC/NEAC.

People never understood how important NERAC/NEAC was. Before NERAC, things were very challenging.

The Atomic Energy Commission (AEC) was an amazing animal. It accomplished a lot in about 15 years; its accomplishments were astonishing: the Experimental Breeder Reactor (EBR-1), the Plutonium/Uranium Extraction (PUREX) facility, and the Shippingport reactor. There was a lot of controversy about the regulator/promoter nature of the agency. After the split into the NRC and the Energy Research and Development Administration (ERDA), the politics were different. ERDA tried to move forward in light-water reactors, space reactors, gas reactors, breeder reactors, and high-level-waste disposal. A lot of those programs and people were eliminated under the Clinton administration. In reactors, the agency was down to the light-water reactor program.

The Office of Science had a program that they did not care about, the University Program, which supplied fuel for university reactors. It was shifted to NE. The Nuclear Energy Security Program (NESP) was set up to hold together the remaining programs when the light-water reactor program ended. A request for \$40 million was put out for the NESP. Even Pete Domenici hated it, but he wanted to grow it. The University Program had about \$6 million at that point, the *only* research funding in NE. The Office had to explain to the Japanese and others what it meant for the United States to have zero nuclear research dollars.

Ernie Moniz suggested that the President's Council of Advisors on Science and Technology (PCAST) be used to promote nuclear energy. A member of a PCAST committee, John Ahearne, forwarded information from NE to PCAST. At that time, the Energy Information Administration (EIA) said that the nuclear industry was shutting down. Some foundation to go forward had to be established. PCAST turned that situation around. It recommended that

- DOE should work with industry and fund nuclear R&D
- DOE should establish an R&D effort of up to \$100 million to fund investigator-initiated ideas

Peer-reviewed research was a big culture shock. A big meeting was held about long-term planning. That started the Nuclear Energy Research Initiative (NERI) program. The idea to have an advisory committee was adopted to gain credibility and influence. James Duderstadt chaired the Nuclear Energy Research Advisory Committee (NERAC) for 4 years and got it going. But NERI and

the Nuclear Energy Plant Optimization (NEPO) program still were not adequately funded, so DOE and NERAC worked on that.

One exercise was the development of the Nuclear Infrastructure Roadmap [to restart the Fast-Flux Test Facility (FFTF)]. An attempt was made to build a case for added infrastructure. The Subcommittee on Technological Opportunities for Increasing Proliferation Resistance (TOPS) effort was even more interesting. Then came the Subcommittee on Advanced Nuclear Transformation Technology (ANTT), chaired by Burton Richter. The Gen IV roadmap was oversold to people all over the world. The Nuclear Power 2010 (NP2010) roadmap was initiated to ask, "What could be built by 2010?" NERAC also had a subcommittee and a report on the future of University Nuclear Engineering Programs and Reactors.

What became important was the greater acceptance of nuclear power. The paradigm shifted, and NE was prepared with plans. At the same time, the undergraduate nuclear engineering enrollment stopped declining and started to rise again. In the Innovations in Nuclear Infrastructure and Education (INIE) program, universities, industry, and the national laboratories were made to work together. The big 12 INIE participants still work together. NE put money in university programs and reactors and halted the decline in nuclear engineering university programs.

NEAC is rescuing the federal nuclear R&D program. The NRC was a good partner in this period. There are a lot of challenges today, but NEAC and its members will help meet those challenges.

Sessoms stated that, if it were not for Magwood, all of this would not have happened. Fertel said that he also wanted to thank Magwood for his efforts. [There was a round of applause.]

Magwood said that it had been a real pleasure serving as the Assistant Secretary for Nuclear Energy, and the staff was terrific. He left the Committee to ponder the frequently cited aphorism, "DOE is Darwinism [you have to fight for money and the fittest wins], and NRC is socialism."

**Dana Christensen** was asked to summarize the Workshop to Identify Potential Synergies Between Nuclear and Renewable Energy Opportunities.

The objective of the workshop was to assemble experts in nuclear energy and renewable energy to identify and prioritize potential synergies between nuclear energy and renewable energy/energy efficiency and to identify potential leveraging opportunities.

The advantages and challenges of each technology were noted. There were clean-air advantages in all of the nuclear and renewable technologies. The intermittent and variable production aspects of renewable energy sources wash out as one integrates different sources of power, such as solar and nuclear. The workshop started with specific-idea presentations, and then the participants brainstormed, prioritized the general categories of synergies, brainstormed some more, identified analysis and R&D needs, and prioritized those items to produce a list of leveraged needs.

The workshop presentations included ones on nuclear power policies and R&D programs (Peter Lyons), nuclear-wind-hydrogen systems for variable electricity and hydrogen-production synergies (Charles Forsberg), the potential role of thermal-energy storage (Paul Denholm), the Southeast Defense Energy Initiative (Benjamin Cross), small reactors (Philip Moor), grid-scale hybrid energy systems (Richard Boardman), nontechnical considerations for small modular reactors (Phillip Bond), and NRC readiness for licensing small modular reactors (David Matthews).

The opportunities seen were in hybrid energy systems, energy for transportation, and value-proposition/business-case development. One example considered was the use of nuclear power and wind or solar power feeding electricity to the grid, to industrial and fuel users, and to a reversible fuel cell that would produce hydrogen that could be used as a storage medium and for transportation.

Each topical area had a breakout session that identified potentials, challenges, priority analysis needs, and priority R&D opportunities.

The workshop concluded that there was an interesting potential for synergies among nuclear, coal, and renewable hybrid systems. A second workshop with INL was scheduled for March 2012. It

was decided to continue the dialogue and to provide further input for a roadmap. The workshop report was produced and is available at [www.nrel.gov/docs/fy12osti/52256.pdf](http://www.nrel.gov/docs/fy12osti/52256.pdf).

Bunn noted that both nuclear and renewable energies require huge initial investment costs. The equation is changed when one combines intermittent and load-following technologies. Solar photovoltaic costs will come down to a competitive level.

Paperiello pointed out that the operations and management (O&M) costs of SMRs need to be worked out.

**Alexander Larzelere** was asked to report on the NE Modeling and Simulation Energy Innovation Hub, a concept developed by Secretary Chu to institute a different business model for DOE: a light federal touch and a pathway to get in, get out, and go on to something else. The Hub is operated by the Consortium for Advanced Simulation of Light Water Reactors (CASL). That team consists of four DOE laboratories (Oak Ridge, Idaho, Los Alamos, and Sandia), three universities (MIT, North Carolina State, Michigan), and three industry partners [Westinghouse, Tennessee Valley Authority (TVA), and the Energy Power Research Institute (EPRI)].

The Hub explores whether an advanced “virtual reactor” can be developed and applied to proactively address critical performance goals for nuclear power, such as reducing capital and operating costs, reducing nuclear waste, and assuring nuclear safety. Each reactor performance improvement goal brings benefits *and* concerns. A requirements and validation plan has been developed to support and guide the development of the virtual reactor. That plan incorporates validation and uncertainty quantification, materials performance and optimization, radiation-transport methods, thermal-hydraulics methods, virtual reactor integration, and advanced modeling applications. A Virtual Environment for Reactor Analysis (VERA) baseline and advanced tools will be used to address challenge problems by coupling various codes, with the effects fed back into the analysis.

There is a broad source of validation data to ascertain whether the modeling and simulation results are real: plant and in-core diagnostics, post-irradiation examination of used fuels, in- and out-of-pile testing of prototypic fuels, separate-effect tests, and integral-effect tests. TVA’s Watts Bar Unit 2 reactor will be starting up and will be heavily instrumented to provide validation data.

The CASL “one-roof” facility is operational with its integrated virtual collaboration and data-analysis venues. It has a great spectrum of facilities.

A DOE annual review was conducted in August 2011, asking whether CASL was operating the Hub as it said it would. The findings are that the Hub is doing very well and is adhering to the management plans described in the proposal. The light federal touch was found to be doing well. The review team had no major recommendations for changes. The review team did suggest that CASL

- Continue vigilance for financial issues as it moves out of the startup phase to longer-term operations
- Work to fully integrate the outputs of all six functional areas into the CASL products
- Further defined the “test stands” proposed by CASL to deploy early versions of the virtual reactor to industry
- Spend time defining the path for CASL-developed products out of the Hub to allow a broader impact on U.S. energy security

CASL has already produced several effects. NEAMS started injecting modeling and simulation into the NE program, and the Hub has extended modeling and simulation to industry and nuclear engineering. The Hub found eight other modeling and simulation programs in DOE and is coordinating with all of them.

Martin asked for final comments from the Committee members.

Matzie said that he would like to see more focus in the use of R&D funds with the vital few objectives being supported: getting spent fuel out of reactor sites, getting accident-tolerant fuel, and having the U.S. Government help U.S. businesses be more successful and add more jobs.

Meserve said that the world is radically changed. The United States is no longer the controlling force. More nuclear activities will be centered in China, India, and South Korea. The United States might have less influence. His technical priorities would be the pursuit of the BRC recommendations, understanding spent-fuel behavior over time, developing new fuel claddings, and mitigating extreme events when they occur.

Bhatnagar said that NE should focus on its strengths, such as light-water reactors. It should pursue advanced fuels, SMRs, life extension beyond 60 years, and the back end of the fuel cycle.

Eisenhower suggested following up on dry-cask standardization. There should be a public dialogue about nuclear power. For example, she was astonished that the nuclear community did not point out that the dry casks stored at nuclear power plants were *designed* to move when the media stated otherwise.

Fertel said that NE should use NEAC to identify the problems it is going to face and use NEAC as a support group in dealing with Congress and others. SMRs are an export commodity. DOE has an opportunity to collaborate more. The Nuclear Energy Institute has filed a brief on DOE 8.10, which inhibits the marketing of U.S. nuclear technology.

Sattelberger worried about the sustainability issue of nuclear power. Will uranium reserves be used up in 80 years, 100 years, or what? Nuclear separation methods for recycling LWR spent fuel still use decades-old technology; a workshop is needed on that topic.

Chu asked what comes next. Are volunteers needed for subcommittees? Ahearne responded that the next chair will need to work with Lyons to determine what subcommittees there should be. The Secretary or Assistant Secretary would then issue charges to those subcommittees. The subcommittees would then talk those charges over with NEAC and seek members. Lyons said that he believed that the current subcommittee structure is well aligned with the needs of the Office. He said that, if NEAC members want any additional information, the Office will be glad to accommodate them.

Juzaitis called for a passively safe light-water reactor. He pointed to a need for a mission for students to be passionate about. There needs to be a sustainable solution to the nuclear waste problem. There should be a legacy of a technical foundation for proliferation resistance. Only DOE and NE can achieve these goals.

Sackett said that DOE should be the major U.S. voice in nuclear power development. It should provide support for light-water reactor operations. It should also support light-water SMRs.

Bunn said that he was glad to hear about a light federal touch. This different relationship with the national laboratories is refreshing. Security by design is important.

Kazimi noted that light-water reactors are going to be with us for a long time; their burn-up needs to be increased. DOE has done a lot of systems studies; NEAC should hear how they tie into R&D efforts. How much should be invested in short-term versus long-term R&D should also be considered.

Barron stated that there has to be a paradigm shift on the overhead infrastructure requirements on SMRs. It will take a long time to get the Waste Policy Act changed. DOE needs to change the use of the waste fees collected today; that money needs to be protected. The nuclear community needs to figure out what to do at the end of the current fleet lifetime.

Christensen said that a national research plan for energy is needed.

Sessoms urged DOE to coordinate with other agencies to increase nuclear energy production and the export of nuclear technology.

Cochran said that he would create Nuclear Fuel 2020, with the goal of developing a standard fuel element and bundle. New countries who want to get into the nuclear business could create a market for SMRs through long-term, fixed-price purchase packages. The United States should get out of the civilian use of highly enriched uranium, and it should have a program on international fuel-storage sites.

Corradini said that, if one wants a meeting of NEAC before June 2012, there should be a workshop to prioritize the NE goals. Risk communication should be emphasized. Industry, universities, and national laboratories need to be research partners from the get-go.

Ion was definitely interested in supporting light-water reactors for sustainability, staying with advanced fuel cycle international development, and looking at what in NE can be done without.

Paperiello said that the nation needs to deal with spent nuclear fuel. For the next 20 years, the reactors will be light-water reactors, and that type of reactor should be supported by NE. DOE's computer projects should be managed closely. DOE and NEAC need to see something about SMR costs.

Ahearne said that he was glad to see the success of this Committee.

Martin pointed out that there will be an election next November. The United States needs to be a leader in the nuclear era. By this summer, NEAC needs to bring to bear what it knows now.

Lyons responded that he liked the suggestion of bundling several programs around SMRs. Public outreach should be pursued, and it will be even more important when the BRC report comes out. A legacy needs to be left on proliferation resistance; the national Research Council report on improving the assessment of proliferation risk in nuclear fuel cycles is in process. The expertise of NEAC should be used to produce a policy/technology document; it would be very useful and engaging. He thanked the members of the Committee for their hard work. Nuclear energy must be a part of the national energy portfolio.

Wade noted that he was available to help all Committee members to receive any information they need and want.

No one had signed up to make a public comment, so the meeting was adjourned at 3:43 p.m.

Respectfully submitted,  
Frederick M. O'Hara, Jr.  
Recording Secretary  
January 6, 2012