Nuclear Energy Advisory Committee Meeting
April 21, 2008
Crystal City Marriott Hotel
Arlington, Virginia

Committee Members Participating
William Martin, Chair
Brew Barron
Thomas Cochran
Michael Corradini
Marvin Fertel
Susan Ion
Daniel Ponemaan
Burton Richter
Allen Sessoms
Kunihiko Uematsu

Committee Member Absent
Neil Todreas

Other Participants:
John Boger, Designated Federal Official, Office of Nuclear Energy, USDOE
Nancy Carder, Medical University of South Carolina, Support Staff
Trevor Cook, Office of Nuclear Energy, USDOE
Phillip Finck, Associate Director, Idaho National Laboratory
Shane Johnson, Director, Office of Nuclear Energy, USDOE
Paul Kearns, Battelle Memorial Institute
Paul Lisowski, Deputy Assistant Secretary for Fuel Cycle Development, USDOE
Harold McFarlane, Deputy Associate Laboratory Director for Nuclear Programs, Idaho National Laboratory
Edward McGinnis, Deputy Assistant Secretary for Corporate and Global Partnership Development, USDOE
Dennis Miotla, Deputy Assistant Secretary for Nuclear Power Deployment, USDOE
Thomas O'Connor, Director, Office of Gas Reactor Development, USDOE
Frederick O'Hara, Medical University of South Carolina, NERAC Recording Secretary
Daniel Stout, Director, Office of LWR Spent Fuel Separations, USDOE
Dennis Spurgeon, Assistant Secretary for Nuclear Energy, USDOE

About 35 others were in attendance.

Prior to the meeting, the Committee members were sworn in and given an ethics briefing by members of the DOE General Counsel's Office.

Chairman **William Martin** called the meeting to order at 8: 35 a.m. The agenda was accepted unanimously. Designated Federal Officer **John Boger** introduced himself and reviewed the procedures of the meeting.

Assistant Secretary **Dennis Spurgeon** thanked the members for their participation on this Committee. For the programs of the Office of Nuclear Energy (NE) to be successful, they have to be framed for continuity and sustainability and policy direction and funding. The Committee is balanced to get a full spectrum of perspective. The change in name from Nuclear Energy Research Advisory Committee (NERAC) to Nuclear Energy Advisory Committee (NEAC) implies that this Committee will look at more than just the Office's research. This technology must be gotten into the marketplace. To do that, concrete advances need to be made on several current issues and to make important programmatic changes recommended by the Committee.

Chairman Martin had each member of the Committee introduce himself or herself and to make any personal comments on the nature and function of the Committee. Themes raised were sustainability, informing decision-making about technological options, climate-change mitigation, the need for a national energy portfolio, a need for support of long-term applied research, the introduction of nuclear energy into the broader policy-formulation processes, new rules to address proliferation risks, the worldwide trend toward nuclear energy, energy security, new players coming onto the field in Gen-III and Gen-IV reactor designs and deployments, the downselection of reactor designs, the importance of the Global Nuclear Energy Partnership (GNEP) concept with its emphasis on safety and safeguards in a framework of international cooperation and collaboration, the need to reach out to colleagues in the Office of Science (SC), and being able to effectively communicate why the Office is doing what it is doing. Something has to be done before next fall with an eye to the transition to the next administration to address near-term challenges. Issues include the reliability of energy sources, interim storage, and disposal of nuclear waste. One needs to look over the horizon while removing the roadblocks to the near term. Licensing of new technology is a significant barrier to the introduction and use of advanced technology.

Dennis Miotla was introduced to speak on assessing alternatives for fueling radioisotope power systems. Plutonium-238 heat sources allow the National Aeronautics and Space Administration (NASA) to do deep-space missions. The United States stopped making Pu-238 in 1988 and has been using U.S. and Russian reserves since then. Plutonium-238 production needs to be started again. The method of production used in 1988 was very expensive and had a very small throughput. Several new ideas are available. A solicitation is expected for next year.

A lot of target material (neptunium) is available from Savannah River. NASA is the only user of Pu-238 at this time, and it will run out at mid-decade. It is assumed that NASA will obtain funding for planned missions; Russia will be out of material to sell to the United States; and DOE will maintain the balance of the radioisotope-power-source infrastructure in Oak Ridge, Idaho, and Los Alamos during the period of depleted supply.

Plutonium-238 has a long history of use in power sources because it has a long life, a high power density/specific power, and low radiation levels, inter alia. Three designs have been proposed for power generation: the General Purpose Heat Source (GPHS) radioisotope thermoelectric generator (RTG), a multi-mission RTG, and an advanced Sterling radioisotope generator. The multi-mission RTG is preferred because of costs, the material used, and reliability.

The United States has been using 5 kg per year, with up to six modules being used per mission. The next two budgeted missions will exhaust the remaining inventory, including expected Russian purchases. Significant amounts of Pu-238 would be needed in the following decade to support proposed missions.

It is hoped that the mission need to restart production will be approved in FY08 and that an alternative production-method selection will be made in FY09. The product must be suitable as feed to the current fuel-fabrication process. Candidate alternatives include various target-fabrication, irradiation, and post-irradiation-processing approaches. It is assumed that Pu-238 would be the selected isotope.

Sessoms suggested opening the solicitation to entities other than universities. Richter said that other isotopes might be better for the long term; the solicitation should not rule out other isotopes. Spurgeon noted that infrastructure needs to be maintained or re-created, and that can be very expensive and is complicated by overlaps with other agencies and activities.

A break was declared at 10:12 a.m., and the meeting was resumed at 10:24 a.m. **Thomas O'Connor** was asked to review the Next-Generation Nuclear Plant (NGNP), an initiative to develop an advanced reactor for electricity and/or hydrogen generation through the establishment of a cost-sharing collaboration with industry, with Idaho National Laboratory (INL) as the lead laboratory. High-temperature gas-cooled reactors (HTGRs) would be used by the hydrocarbon industry for processing oil sands, processing oil shale, converting coal to liquids and gases, and producing hydrogen for the enrichment of fuel oils and the production of fertilizers and plastics.

HTGRs are not a new technology. Several power reactors have operated in the United States and abroad, and there are currently two operating HTGR research reactors in the world. More-conservative designs are needed to make HTGRs commercially viable. Three teams are working on the ANTARES design. The Chinese also have a two-reactor system under development.

Necessary R&D includes work on analytical codes and methods; high-temperature metals; fuel qualification; graphite qualification; and American Society of Mechanical Engineers (ASME) collaborations, codes, and qualifications. A licensing strategy for the NGNP is due to Congress in August and will include ways in which current licensing requirements for light-water reactors (LWRs) need to be adapted, a description of analytical tools that will be needed, other needed R&D activities, and an estimate of resource requirements associated with licensing. The amount of effort required will depend on what licensing approach is used. One option is 10 CFR Part 50, in which a preliminary design is developed for the construction permit stage and a final design is developed for the operating license stage. Another option is 10 CFR Part 52, which can be carried out through a combined license (COL); an early site permit (ESP) and COL; a design certification application (DCA) and COL; or a combination ESP, DCA, and COL. A preferred approach has been selected, and that decision is being vetted through upper management at DOE. A customized approach will be needed no matter which path is followed.

The Energy Policy Act of 1992 (EPAct) laid out a project strategy and schedule for R&D, technology selection, final design, and construction. DOE is to fund not more than four designs in a final-design competition. The demonstration plant will be built in Idaho as part of a public/private partnership. The Act does not spell out the type of partnership but states that the cost sharing will be 50/50. The facility's ownership will be negotiated.

Cochran noted that NERAC had reviewed this program and provided recommendations. He asked what recommendations Congress had adopted. O'Connor replied that the NERAC review was of R&D activities; a future NEAC review would be much broader.

Richter commented that the NERAC review called for an analysis of coupling a nuclear plant with process heat and hydrogen production and asked if that had been done. O'Connor replied that that analysis is ongoing.

Fertel stated that this process gives NEAC another opportunity to look at the same machine to produce hydrogen and process heat and noted that the process temperature had been dropped. O'Connor affirmed that the process temperature had been reduced from 1000° to 950° in an effort to meet the needs of industry while ensuring reliability and materials' performance.

Corradini observed that the staff considered the recommendations and decided to pursue the dual mission and asked if the same schedule were still being maintained. O'Connor answered that the staff believes that a 2021 operability can be met.

Ion commented that it becomes very expensive when you pour concrete. It is the fuel that determines reliability, performance, and safety. Commercial-scale fuel must be pursued. O'Connor replied that laboratory-scale fuel is currently being produced; the next step will produce commercial-scale fuel.

Richter asked if the 950° operating temperature is still sensible. O'Connor replied that, if one just stops at 850°, one is deprived of future opportunities. There will be trade-offs in design and materials used. There have been comparative studies.

Sessoms asked if the infrastructure in DOE were robust enough to do this R&D. O'Connor said that all the work done at the national laboratories has to meet ASME quality standards. The expertise used is distributed throughout the DOE/NE infrastructure. If the NGNP is to advance, it has to have significant cost sharing, and reliability is the key to industry interest. A request for information and expressions of interest was published on April 16, 2008, seeking industry recommendations for structuring the project.

Barron said that he was not clear what the objective of this program was. O'Connor replied that DOE was trying to build a plant that provides demonstration of licensing basis. It also wants competition through certification of multiple designs. Barron said that he does not look to DOE for licensed designs but for materials, standards, validation methods, etc. Industry should figure out how to be competitive.

Corradini asked what the point designs being addressed were. Cook said that 900° or 950° were the discreet design temperatures. O'Connor added that DOE is thinking of doing two designs, one for construction and another for certification. Corradini asked what the cost sharing was in the pre-application period. O'Connor replied that DOE would bear most of the cost in the pre-application period, with 50/50 sharing during the application process.

Fertel stated that the fuel fabrication facility will have to be licensed at the same time as the plant design. In addition, getting through a COL process with a new design that the Nuclear Regulatory Commission (NRC) does not understand will be a tortuous process.

Cochran said that someone should ask why the four licensing attempts that collapsed previously had failed.

On a broader note, Martin noted that SC had had a lot of programs that were not prioritized. Raymond Orbach had a committee consider the priorities and the facilities needed. A similar effort could produce a good roadmap of requirements, a plan for future resource uses, and an understanding for cooperation and coordination of national laboratories for NE.

Paul Kearns was asked to address the NE R&D facility requirements. The Assistant Secretary for Nuclear Energy has asked Battelle Memorial Institute to look at what R&D is needed by industry during the next 20 years, developing an industry- and university-supported list of facilities necessary to conduct a comprehensive nuclear R&D program, assessing the facilities that currently exist, and recommending priorities for support of facilities.

Some facilities that used to exist are gone. Foreign investment in nuclear R&D facilities has increased. Human infrastructure is needed, as well. And new ideas are coming on the table, including advanced computation and simulation. About a dozen recent studies have been conducted on this topic. Europe faced the same issues and has produced a similar review. Japan also has a database of research facilities.

Issues to be addressed include the evolution of U.S. nuclear policy, the use of international facilities, NE stewardship of facilities, reducing the mortgage associated with underused and excess facilities, investments in major R&D facilities, and university nuclear infrastructure. Sessoms noted that university programs are being defunded and programs are being canceled. Cochran pointed out that the NRC has just released its long-term R&D plan that includes some items on nuclear licensing.

The Battelle tasks include a complete and definitive index of the capabilities needed to support R&D within the domestic nuclear-power industry during the next 20 years. That index is to be used to establish long-range planning and budget. Richter asked who the umpire will be in setting priorities. Spurgeon replied that he would like to take a first cut and then leave the final say to a NEAC subcommittee. This assessment must include the international and weapons-program resources. NEAC will be tasked to develop such a roadmap by the end of this year. The Battelle study will be available in draft form by June 30.

The Battelle study seeks to learn from what others have done, to establish a working group, to reach out to industry and academia for input and support, and to deliver a report by June 30. The Office of Science (SC) produced a report entitled *Facilities for the Future of Science: A Twenty-Year Outlook* in 2003 that focused on new facilities and on upgrades to existing facilities. It has served as a roadmap and long-term vision to guide year-to-year DOE policy and funding decisions. It is widely recognized as successful by DOE, the Office of Management and Budget (OMB), and Congress. The process that was used led to stakeholder buy-in, strong leadership, support from the national laboratories, and acceptance by the broad scientific community. This report can be a model for NE. Another SC model is the Science Laboratory Infrastructure Modernization Initiative, a 10-year effort to improve infrastructure and to address a backlog of needs caused by aging infrastructure. Its recommendations have been proposed as part of the FY09 President's budget.

Martin asked what part of NE's infrastructure is shared with National Nuclear Security Administration (NNSA) and SC. Spurgeon replied that SC has done a great job revising its infrastructure. Oak Ridge national Laboratory (ORNL) is a terrific example. NE has not achieved that type of renewal for its facilities. Its facilities are dispersed.

Battelle is employing a multistep process to provide opportunity for input to a working group (balanced among industry, universities, and national laboratories), interviews of industry and academic centers, focus-group discussions, a focus-group review of the draft report, and a comment period. The draft report will garner comments.

Sessoms said that the final focus group should include people from high-energy physics, nuclear engineering, astronomy, etc., all from a variety of institutions.

Martin asked if they were going to extend the extant infrastructure or to come up with some bold, new ideas. Spurgeon replied that energy is needed for the world economy. A national plan is needed for meeting those energy needs, with nuclear contributing 30% by 2050 (reflecting 300,000 MW of new capacity by 2050). DOE needs to know where the country wants to go.

Harold McFarlane took over the discussion. The INL approach is to focus on the final facility plan, anticipate R&D requirements, and develop a consensus of valuation of facility utility for each major R&D element. To get this down to a manageable size, facilities have been divided into major high-value nuclear facilities and major non-radiation facilities. Facilities that are ubiquitous or would play only a modest, supporting role in any R&D program are not being considered.

The INL team has developed a rating scheme for viability that considers

- the physical condition, age, and maintenance status of the facility and its supporting infrastructure;
- the capacity, flexibility, location, and accessibility of the facility;
- the projected availability in the needed time frame;
- the safety basis, environmental impact statement, safety management program, environmental management program, and community support;
- the security requirements; and
- the requisite staffing.

A workshop was conducted by INL, ORNL, Los Alamos National Laboratory (LANL), and consultants to assess this rating scheme on an example of fast-reactor R&D.

Brief facility descriptions are being assembled. A 95%-complete draft of the report is expected to be produced by June. A website will be opened for stakeholder input. Evaluations will be changed for documented evidence. Most of the national laboratories have had an opportunity to look at the estimated costs assigned to the facility upgrades. This is not a done deal by a long shot. The cost of implementation will be addressed in the near future, and the document will then be available for review. A break for lunch was declared at 12:12 p.m.

The meeting was reconvened at 1:05 p.m. **Paul Lisowski** initiated a discussion of the GNEP Program. GNEP promotes safe and secure expansion of nuclear power worldwide by facilitating global deployment of nuclear power, establishing reliable international fuel services, supporting grid-appropriate exportable reactor development and deployment, developing enhanced nuclear safeguards, developing and implementing advanced nuclear-fuel-recycling technologies, developing and implementing advanced reactors to consume transuranic elements separated from spent fuel, and improving used-fuel and nuclear-waste management.

GNEP now has 21 member nations with an Executive Committee, a Steering Group, and working groups. The key nonproliferation benefit is providing reliable fuel services in which

- fuel suppliers operate reactors and fuel-cycle facilities;
- fuel users operate reactors, leasing and returning fuel; and
- the International Atomic Energy Agency (IAEA) provides safeguards and fuel assurances.

Currently, the United States has a once-through fuel cycle with the output going to a geologic repository. If nuclear power increases as predicted, the United States will need multiple repositories (maybe three) by the end of the century. One option that GNEP is looking at is a closed fuel cycle in which used nuclear fuel would be separated into usable and waste materials; transuranics would be recycled in advance burner reactors; and residual waste would go to a geologic repository. About one-third of all reactors would have to be burners.

Ion noted that the once-through strategy is likely not sustainable. Barron added that a bigger and bigger plutonium stockpile is being built up, posing a diversion threat. Richter observed that the cost of MOX-fuel [metal-oxide-fuel] electricity in France is 2 to 3% more than that for uranium-fuel electricity, and the French have reduced their repository requirements.

A closed fuel cycle can reduce both high-level waste and the long-term radiotoxicity of material going to a geologic repository. The radiotoxicity of closed fuel-cycle wastes dies away in about 300 years as opposed to the millions of years it takes for the radiotoxicity from once-through wastes to decay away. The Advanced Fuel Cycle Facility (AFCF) is the best technology for making use of advanced reactor technologies.

The GNEP program structure is arranged to address R&D activities, required facilities, and international activities; it has a program manager and a deputy manager, a Science and Engineering Council, corporate and global partnerships, advanced-fuel-cycle R&D, modeling and simulation, an advanced burner reactor program, a consolidated fuel-treatment center program, and an advanced-fuel-cycle facility program. To support this effort, the national laboratories are organized into seven campaigns on fuels, separations, systems analysis, safeguards, waste, reactors, and grid-appropriate reactors.

The GNEP Technical Integration Office (TIO) serves as the point of contact between DOE and the national laboratories. It provides technical functions, project controls, and administration. The TIO is operational and is preparing a draft preliminary environmental impact statement (PEIS) that incorporates 14,200 public comments. It has established a planning process, an independent review committee, and a technology-development plan. GNEP funding-opportunity-announcement (FOA) awards have been made to industry. All program milestones for FY07 were met.

The major program activities have been the establishment of the Science and Engineering Council; participation in a National Academy of Sciences (NAS) review; support for a Government Accountability Office (GAO) review; completion of action plans; signing a memorandum of understanding (MOU) for sodium-cooled fast-reactor cooperation; signing an MOU with the Tennessee Valley Authority (TVA) to provide utility perspective and licensing insight; increasing university involvement; and preparing to award $15 million in FY08 funds in open competition for supporting R&D at universities, industries, and national laboratories. This last item fulfills a congressional mandate; teaming will be encouraged.

Preliminary studies have found that the initial fast reactor will have to be government-funded. Technologies exist that do not separate pure plutonium, and they can be used in commercial recycling facilities in the near term as an interim step toward fast-reactor recycling. A business case exists that uses the Nuclear Waste Fund to pay for recycling and repositories in an integrated manner that minimizes government funding.

Martin observed that the Secretary was to make a go/no-go decision by this summer. Lisowski replied that that decision has to await a record of decision on the U.S. policy on fuel cycles. A huge amount of public comment has delayed the issuance of that record of decision. Martin asked what the staff needed from NEAC. Lisowski replied that there will be a task charged to the Committee outlining those needs.

Daniel Stout picked up the discussion of industry engagement in GNEP. Richter and Fertel recused themselves from this discussion.

Expressions of interest were solicited in 2006, siting studies were conducted in 2007, and an FOA was issued in 2007−2008. The FOA covered the conceptual design studies, business plan, technology development roadmap, and communications plan. Integrated applications were sought and received. The FOA design requirements and selection were set and resulted in four large, experienced teams being formed: Energy Solutions, GE-Hitachi Nuclear Americas, General Atomics, and International Nuclear Recycling Alliance. The first set of deliverables was received in January 2008. Expectations were exceeded. Fast-reactor technology development is needed to demonstrate safety, reliability, and economics. Any government-funded demonstration reactor could be deployed by 2025. Separation technologies exist that do not separate pure plutonium and that could be deployed by 2025, producing fuel for existing light water reactors. Business plans talked about integrated recycling and waste management, using funding from the utility waste fund, and substantial legislative and regulatory changes. The technologies and development plans require additional work but they did describe a range of risk in proposed cost, schedule, and performance.

For the initial advanced recycling reactor, the four teams recommended (1) sodium-cooled fast reactors with one team including gas-cooled reactors; (2) 300- to 500-MWe fast reactors; (3) deployment between 2020 and 2025; and (4) an expected cost of $2 billion to $4.5 billion. For the initial nuclear-fuel-recycling center, the four teams recommended various separation technologies, with two teams proposing that the initial separation facility co-extract uranium and plutonium and the other two proposing the extraction of transuranics; facility capacities ranging from 50 to 2000 MT/year; deployment between 2020 and 2028; and an expected cost between $400 million and $20 billion.

A variety of approaches were described. Some described small-scale, distributed systems with integrated fuel reprocessing and separations. Some described large-scale centralized separations facilities. All teams support two-tier approaches with thermal reactors and fast reactors. The submissions suggested that the government take a fresh look at nuclear-waste management, integrating recycling and repositories. All teams suggested the establishment of a government corporation with access to the Nuclear Waste Fund, which could result in effective management of the construction and operation of recycle facilities and repositories. This path would substantially reduce the investment required by the U.S. Government. However, these actions would require significant changes to legislation and regulations. Legislation would need to offer Nuclear Waste Policy Act amendments for new disposal strategies, waste forms, and nuclear-waste-facility modifications and the enablement of a government entity similar to TVA. Regulatory revisions would need to update 10 CFR 70 to support one-step licensing of reprocessing facilities, 10 CFR 50/52 for fast reactors, and 40 CFR 190 for radioactive emissions from the fuel cycle. Programmatic changes need to include the recycle of uranium/plutonium or uranium/plutonium/neptunium in commercial LWRs; reconsideration of transuranic (TRU) limits for GTCC wastes [greater than Class-C low-level wastes] following a risk-based approach; reevaluation of NRC categories and safeguards classification of actinide mixtures; and export licensing for uranium and possibly americium/curium targets in CANDU [Canada Deuterium Uranium] reactors.

Four awards are currently under Continuation-1 funding through September 2008. Updated summaries were received on April 11, 2008, that will be posted on the website. A Continuation-2 funding decision will be made in September with an FY09 funding target of $26 million that will focus on maturing conceptual designs and technology development roadmaps. During 2008 and 2009, DOE will develop acquisition plans.

Corradini asked if there will be a policy-analysis piece by the staff to accompany the industry findings. Stout agreed that that might be a good thing to do.

Uematsu asked if public funds would be used for the recycling facility. Stout replied that the utilities' waste fee would be used. Business plans did not reveal the industry's willingness to participate in the funding of the fast reactors.

Sessoms did not see a government business case to build the fast reactors. Stout replied that the benefit would be to use MOX fuel.

Cochran said that this initiative is doomed to failure. Fast-reactor programs have been carried out in a number of countries, and all have failed. Monju has a utilization factor rate of 0.4%. Fast reactors cost a lot more than LWRs and are much less reliable.

Barron noted that recycling through MOX fuel produces waste that is more radioactive and less proliferative. The business case calls for an entity that is isolated from the viscitudes of Congress. There is a potential that it would work. The inventory needs to be managed better than it has been.

Ion stated that fast reactors may cost more than LWRs, but that does not mean that one does not want them in the mix. Super Phenix was closed for political not technical reasons. LWRs did not work perfectly from day one, either. One needs to gain experience with a technology to learn from it and to make it work. One also wants to judge what leadership position the United States should maintain. The rest of the world is moving ahead. Stout replied that this new government entity makes possible a constant revenue stream, allowing long-term contracts and a sustainable management team. In perspective, 1 mil/kWh adds $0.18 per month to the average American electricity bill.

Phillip Finck was asked to comment on the R&D program of GNEP; Fertel and Richter rejoined the discussion. Richter pointed out that there has been no uranium exploration in a long time and that the extant LWRs are going to run out of fuel sometime between 2050 and 2100. Fast reactors may be needed for more than just burning the waste of LWRs.

Finck pointed out that precursors to the GNEP R&D program were initiated in the late 1990s, based on knowledge accumulated internationally since the 1960s. By the time GNEP was officially started in 2006, significant progress had been achieved on the connection between final disposal options and transmutation scenarios, the transmutation potential of the main reactor systems, the requirements-driven process, and the R&D program focused on Yucca Mountain. The seven national-laboratory campaigns mentioned earlier are being pursued.

Systems analyses have shown that partial burning of plutonium is feasible with existing technologies, extensive burning of plutonium is achievable with new technologies, and burning of minor actinides is not practical. The analyses also showed that the behavior of a repository is complex, with several different limits, and that differentiated thermal management can significantly increase the capacity of repositories. Specific separation flow sheets have been designed and demonstrated to achieve such thermal management.

The domestic used-nuclear-fuel-management options are

- a once-through cycle,
- limited recycle, and
- full recycle.

Reducing process losses is important to realize waste-management benefits, and higher burnups are important. These systems analyses led to the definition of an integrated waste-management strategy based on risk-based disposal of radioactive waste and consideration of waste management in the design of the fuel cycle.

Several critical technology issues need to be informed by scientific knowledge and industrial practice: process scale-up safeguards, integrated waste strategy, process scale up and process losses for transmutation fuel fabrication and separation, fuel performance for transuranic destruction, and the economics of a sodium-cooled fast reactor.

Fabrication development has been started for fuels. In the irradiation of TRU-bearing fuel, screening irradiations are currently performed in non-prototypic irradiation facilities, prototypic steady-state irradiation and examination are currently conducted in Phenix and are being pursued in Joyo, Monju, and BOR-60; and lead-test-assembly irradiation and qualification will be needed. Facilities are critical for the future, such as the; Advanced Fuel Cycle Facility (AFCF), Materials Test Station (MTS), and Advanced Burner Reactor (ABR). Cross-cutting modeling and simulation are being pursued to obtain a revolutionary capability allowing reduced experiments in the future. Conventional fast-reactor fuels are being qualified to about 10 at% burnup and demonstrated to about 19.8 at% burnup. TRU-bearing metal and oxide fuels have demonstrated performance and feasibility to about 6 at%, and current testing will extend this to about 20 at%. Nitrides have had difficulty with consistent fabrication but have performed as expected under irradiation. Metals have performed similarly to uranium, plutonium, and zirconium; and the onset of swelling has occurred at higher burnup than with conventional fuels. The performance and microstructure of oxides developed similarly to those of conventional MOX fuels. Recent transmutation metal-irradiation results show that the fuel swelling, fission-gas release, and microstructure behavior are similar to those of the uranium-plutonium-zirconium system.

The feasibility of aqueous and electrochemical separations has been demonstrated. LWR and transmutation fuels have been addressed, driven by repository requirements. Small-scale aqueous flowsheet tests with actual LWR fuel met separation criteria. Engineering-scale aqueous-separation-equipment testing capability has been developed for cold testing. Fast-reactor spent-fuel processing has been demonstrated for uranium recovery. Uranium and transuranic elements have been recovered at engineering scale with electrochemical methods. The initial oxide-reduction capability has been developed at the kilogram scale for surrogates and at the 50-g scale for actual fuel.

The key to the uranium-extraction (UREX) process is separating the transuranics and lanthanides. The strategic points are to understand balance-of-plant issues and the scale up of oxide reduction and electrorefiner capacity. Improved safety, reliability, and economics are needed to achieve long-term commercialization of sodium-cooled fast reactors. Cost-reductions and simplifications need to be pursued through advanced fast-reactor materials. Other issues that need to be looked at are alternative power-conversion systems, nuclear data, and modeling and simulation. DOE regulatory compliance and NRC engagement are being developed. There is a lot of international collaboration going on. Two major facilities are needed, one for hot engineering-scale demonstration for separations, fast reactor fuel fabrication, reactor components, and fuel radiation and another for conducting key tests in support of licensing. Such facilities would create attractive opportunities to train the next generation.

Workforce issues include strengthening universities essential to develop the needed expertise for industry, government, regulators, and laboratories. In FY09, 20% of the NE budget will be dedicated to universities. In addition, NE is exploring the establishment of centers of excellence in radiochemistry and actinide chemistry, safeguards, advanced materials, fast reactors, and advanced fuels.

Edward McGinnis described the international GNEP activities. Thirty-one countries have nuclear power today, and that number is increasing rapidly. Leadership by the United States is desired around the globe. U.S. international engagement occurs in (1) technical areas, (2) policy and polity (partnership development), (3) infrastructure support, and (4) framework development (reliable fuel services). GNEP currently has 21 partners, 3 observers, and 17 candidate partner/observer countries. GNEP is structured with an Executive Committee made up of ministerial-level officials or designees, a Steering Group made up of partner and observer representatives, and working groups on infrastructure development and reliable fuel services. So far, it has established a structure, developed an action plan, established two working groups, and adopted terms of references. Its primary attraction is the full spectrum of issues it addresses. Its next steps will be to further expand the partnership; develop structures and mechanisms for partnership; and identify areas for partners to focus attention on, identify needed resources, and initiate activities.

Richter commented that one needs political and economic diversity to gain legitimacy and authority. McInnis noted that a meeting had just been held to discuss that very issue and to identify the barriers to diversity. That is why the Secretary General of the United Nation's IAEA expressed support for GNEP so readily. There has been a diversity of views. Each country is considered co-equal by GNEP. To date, the GNEP structure has been established, the GNEP Steering Group Action Plan has been put together, two working groups have been established, the Terms of Reference have been developed, and steering group meetings have been held.

Ion pointed out that GNEP is a regime driven by voluntary agreements. This situation is very different from what has been practiced to date. It will be difficult to get countries to give up the security of their fuel supplies. McGinnis agreed that the fuel bank is a critical component. The Reliable Fuel Services Working Group is working on the issues involved. The countries have to buy into this relationship. The Statement of Principles sets fuel services as a right that is not susceptible to political influences.

A break was declared at 3:35 p.m. The meeting was reconvened at 3:50 p.m. An open discussion of the day's proceedings was initiated among the Committee members.

Uematsu said that GNEP should consider who should be building and where facilities should be built. The International Thermonuclear Experimental Reactor (ITER) had a clear competition in site selection. GNEP should start a similar process for a fast reactor. Young people should be brought into the technology. Even the NRC does not have a good knowledge of fast reactors. The work force has to be trained and rebuilt. Young engineers need to be sent to France and Japan to see and use the equipment. The IAEA's introduction is just paperwork. The United States must take this training seriously. If one goes to Japan and ask about GNEP, one will get a very positive response, but the Japanese have no real interest in GNEP at all. They consider it a U.S. problem. The United States needs real contacts among the staff members and the young Japanese MBAs about building a fast reactor. A real interest in a fast-reactor system needs to be cultivated.

Corradini stated that there are a number of tasks for this Committee to address. He understands what the Idaho and Battelle groups are doing, but he does not see how they mesh and how the need for facilities will be identified and prioritized. He would like to hear more from the Richter subcommittee. The National Academy report (*Nuclear Wastes: Technologies for Separations and Transmutation*) should be reviewed, and the response to it monitored by the full Committee.

Ion commented that isotope manufacturing may be amenable to a creative approach to infrastructure. In terms of the infrastructure issues in general, this Committee needs to think about what is needed and why it is needed. The Committee should then pursue those needed facilities. Available international facilities should be used. The best people should be fielded overseas. GNEP raises questions about how to meet energy demands, what to do about recycling, and the reliable provision of fuel.

Ponemaan posed the question of how to expand nuclear energy without proliferating. GNEP needs more branding. It needs to be made more certain of its purpose and methods. There is no confidence in its assurances for fuel delivery. The fuel bank concept fits in. A technology kicker may be needed. It has to be voluntary. Time is of the essence; nuclear activities are expanding rapidly. There is a strong logic that develops over time that leads one to closing the fuel cycle. There is still a debate about subsidizing the nuclear industry; a rigorous analysis of this question is needed.

Sessoms stated that these same discussions have been held for 30 years but in the context of "nuclear" and not in the context of "energy." Energy is subsidized across the board in the United States. Basic technological development is a role of government. The funding profile of Idaho National Laboratory is 15% of what NERAC recommended; that shortfall needs to be corrected. The fast-reactor closed-cycle issue is a hot-button issue and is detrimental to nuclear progress in the near term. There may need to be a separation between nuclear energy deployment and fuel-cycle closure. All indications are that DOE does not want to develop the nuclear work force.

Richter said that DOE has done an abysmal job of explaining that nuclear energy is part of the nation's energy mix. In a carbon-constrained world, nuclear energy is the low-cost option. It is not urgent to get Yucca Mountain operating. Every nuclear power plant has enough dry-cask storage for *all* of its spent fuel. Places where there are no objections should be looked at. GNEP should be separated into now (nonproliferation issues) and later (reprocessing spent-fuel to remove plutonium). Carrots as well as sticks are needed to keep small countries from building their own enrichment plants. An internationalized fuel supply is needed. The countries that should be involved are those that want to develop nuclear capabilities for weapons capabilities. The United States should develop guarantees for non-Western commercial fuel services. The back end of the fuel cycle can wait. It should not be put on an equal level with the enrichment problem. Iran owns 10% of a French enrichment plant but cannot get 1 g of enriched uranium from that plant. The regulators who are new to nuclear power are a real problem.

Cochran noted that the Committee has four proposals for new subcommittees. That is too much. The Committee should not try to do all of these at once. GNEP should, indeed, be divided into two parts. A major question is whether GNEP countries have good rules of law and safety regulations. More emphasis *should* be put on enrichment. This Committee should not advise on how to close the fuel cycle as currently framed.

Barron said that SC should have a responsibility for research and NE should have a responsibility for applications, such as hydrogen generation, process-heat production, deep-space power sources, and maritime power sources. Discussions of Yucca Mountain or fuel cycles in isolation are inefficient and often counterproductive. Figuring out the R&D needs and the required facilities of nuclear power would be a better approach. He did not see that broad framework for the NGNP. A cradle-to-grave approach allows a better understanding of the issues. He recommended expanding that approach from GNEP to all of the NE programs.

Fertel agreed that four subcommittees are too many. The focus should be on those that provide the best sustainability of the program. NEAC should be looking at fuel issues, material issues, proliferation issues, and isotope production. Not having all the national laboratories fighting among themselves has been a great success. However, GNEP has marginal political support. A long-term R&D program on fast reactors is needed, allowing the United States to do more international collaboration. The dialogue on closing the fuel cycle should be continued. One cannot choose one nonproliferation path and ignore others that might be successful. Small reactors should be looked at for countries with small grids. A 40% increase in the budget is being proposed for NGNP, fast reactors, and infrastructure; it is not clear how NE can get all that money. A broad view has to be taken that can integrate all these issues.

Corradini asked if there were a priority in the charges. Spurgeon said that his top priority was infrastructure. Cochran asked if NEAC could focus on that and integrate the others into it. Spurgeon replied that this Committee cannot do an overall energy-mix analysis. If a guesstimate could be agreed on where nuclear energy should be in mid- and end-century, one could figure out what must be done to get there (e.g., a disposal path, a closed fuel cycle, or fast reactors). Then one could set priorities and determine when goals need to be met.

Fertel suggested that NEAC spend a day listening to people who have done such analyses.

Cochran stated that carbon-emission constraints are needed if nuclear power is to play a larger role. By 2050, 60 GW more energy than is produced today will be needed. Internalizing the cost of carbon is the only way to get there.

Richter noted that where the rest of the world is going is not necessarily where the United States is going. What drives the opposition to nuclear power in the United States are spent fuel storage, safety, and proliferation. Input is needed from the social sciences. In California, a nuclear power plant cannot be built until a permanent repository for spent fuel is opened. These issues must be addressed. The cost of coal has tripled in the past year. Nuclear electricity costs the same as coal electricity.

Sessoms stated that the spent fuel problem is a stalking horse for other issues. It is a sociological phenomenon.

Fertel observed that people in the United States do not think about energy security for the nation. In surveys of the general population, the biggest sources of electricity are said to be “switches” and “outlets.” If there are shortages, there will be more conservation and higher prices. Today, however, energy is taken for granted.

Ion said that NEAC needs to make some baseline assumptions about what will be needed and then choose the facilities that will get to that point.

Spurgeon stated that demonstration plants are part of infrastructure as is a recycle plant. Only pieces of the needed infrastructure exist now. There is a long way to go in building up the infrastructure to fill in the nation’s place in the international infrastructure.

Barron observed that the issue of safety and security is within the NRC’s scope. In regard to spent fuel, NE has a role to play and is not addressing that role today. The relative cost of differently fueled plants is based on outdated information. The prices of fuels and the construction costs of new plants are highly volatile. The utilities need to sort out those issues.

Sessoms noted that the concern about facilities is the budget. A strong nuclear infrastructure is needed, but getting it will be a big deal and very difficult.

Martin pointed out that Spurgeon has given the Committee four tasks. They can be integrated into two subcommittees. Facilities could be one area to be worked on, and GNEP another. International community interactions are important to both of these issues.

Spurgeon thanked the Committee members for their service. The challenge is that energy has not been at the top of the priority list. The energy supply fits in a $4 billion box in a $1 trillion budget. People concerned about energy must be more instructive about the importance of energy. The limits of energy efficiency and solar technology must be known. Everything that is wanted cannot be done with the NE budget. The case has to be made in a coherent way so people can understand the importance of nuclear energy. There are now nine COLs with 15 plants, one of which is under order. That is how the flywheel gets started in getting nuclear power advancing. Concerns about the safety of the current generation of nuclear power plants have been answered, but the waste problem has not been resolved. The fuel cycle must be closed, and interim storage must be developed. Nuclear power needs sustainability for the long term.

The floor was opened for public comment. No one had signed up to make comments, so the meeting was adjourned at 5:29 p.m.

Respectfully submitted,
Frederick M. O’Hara, Jr.
Recording Secretary
May 12, 2008