DRAFT
Minutes for the
Nuclear Energy Research Advisory Committee Meeting
May 18-19, 2004
Georgetown University Conference Center, Washington, D.C.

NERAC members present:

John Ahearne, Vice Chairman
Thomas B. Cochran
Joseph R. Comfort
Michael L. Corradini
Jose Luis M. Cortez
Allen G. Croff
Marvin S. Fertel
Beverly K. Hartline
Silvia S. Jurrison (Tuesday only)
Andrew C. Klein
Dale E. Klein (Tuesday only)
Robert L. Long
William F. Martin, Chairman
Warren F. Miller
Sekazi K. Mtingwa
Jerry Paul
Harold B. Ray
Richard Reba (Tuesday only)
Joy Lynn Rempe
Michael B. Sellman
Allen L. Sessoms
Neil Todreas (Tuesday only)

NERAC members absent:

Steve Fetter
Richard A. Meserve
Daniel C. Sullivan
Charles E. Till

Also participating:

Arnold B. Baker, Chief Economist, Sandia National Laboratories
Ralph Bennett, Director for Advanced Nuclear Energy, Idaho National Engineering and Environmental Laboratory
Nancy Carder, Medical University of South Carolina
Paul Dickman, Senior Technical Policy Advisor, RW, USDOE
John Gutteridge, University Programs, NE, USDOE
R. Shane Johnson, Associate Director, Office of Technology and International Cooperation, NE, USDOE
Helen Leiser, Policy Director, Generation-IV International Forum
Owen Lowe, Associate Director, Office of isotopes for medicine and Science, NE, USDOE
William D. Magwood, IV, Director, Office of Nuclear Energy, Science, and Technology, USDOE
Thomas Miller, Program Manager, Office of Technology and International Cooperation, NE, USDOE
Dennis Miotla, Deputy Director for Nuclear Operations, NE, USDOE
Frederick M. O'Hara, Jr., NERAC Recording Secretary
John Pantaleo, Office of Nuclear Facilities Management, NE, USDOE
Burton Richter, Professor of Physical Science, Stanford University
Mark Roth, NERAC Designated Federal Officer (DFO), NE, USDOE
John Sackett, Associate Laboratory Director, Argonne National Laboratory
Buzz Savage, Office of Advanced Nuclear Research, NE, USDOE
Michael G. Schmidt, Medical University of South Carolina

Over the course of the two-day meeting, about 35 others were present.

Tuesday, May 18, 2004
Morning Session

Chairman **William Martin** called the meeting to order at 9:03 a.m. He asked each member to introduce himself or herself and to comment on the agenda. Mark Roth (DFO) noted scheduling changes and the availability of meals. McNeill moved to approve the agenda, and Martin seconded. The motion carried unanimously. Martin introduced **William Magwood** to review recent developments in the nuclear-energy program.

Much effort has been expended on the new National Isotope Production Facility at Los Alamos National Laboratory (LANL), which was dedicated in January 2004. It will be used to produce copper-67, arsenic-73, germanium-68, and strontium-82. It will greatly enhance the security of the U.S. supply of short-lived medical isotopes. The facility will open soon, on time and on budget.

A draft request for proposals (RFP) for the award of a contract to manage and operate the Idaho National Laboratory (INL) was issued in February 2004. A parallel RFP for environmental management was also issued.

The FY05 budget request was submitted and is currently under consideration by Congress.

Four new NERAC subcommittees were established, and the establishment of a Japan-United States Senior Nuclear Energy Cooperation Advisory Panel is being proposed. This suggestion came from Japan, an important collaborator. A new cooperative agreement is being fashioned. Membership from NERAC members and other senior researchers and policy advisers is needed. Fertel asked if anything like this was in existence. Magwood said that it would be a subcommittee of NERAC but would allow Japan to transmit information to the United States. Corradini asked if any other countries would be selected. Magwood said that there would be none at first, but an assessment will be made of how this initial panel progresses.

Rempe asked how specific the information exchanged would be. Magwood said that it would be broad, high-level information to guide policy.

A lot of changes emerged in the structure of the budget as it was prepared for Congress. The Nuclear Energy Plant Optimization (NEPO) and Nuclear Energy Research Initiative (NERI) programs were zeroed out. NERI is to be funded in other ways and be aimed exclusively at universities. A solicitation is almost ready to be issued. There is increased funding for nuclear-energy technologies [the Nuclear Power 2010 (NP 2010) program] and the Generation-IV (Gen-IV) Nuclear Energy Systems Initiative, including $19.3 million for the Next-Generation Nuclear Plant and $11.2 million for other Gen-IV research. There is a reduction of $20 million in the Advanced Fuel Cycle Initiative (AFCI), and there is an increase of $3 million in the Nuclear Hydrogen Initiative. An overall decrease in AFCI funding reflects a shift to more research and long-term planning rather than near-term deployment of a large uranium extraction (UREX+) reprocessing facility.

Hartline asked what amount was being dedicated to the distributed NERI. Shane Johnson replied that it would be $3.5 million, doubling next year and growing to $15 million per year. Hartline asked if the $6.5 million listed in the proposed budget is for continuing contracts *and* the additional $3 to 5 million. Johnson said that that was right. A preproposal workshop has been held and was well attended and received.

Cochran asked what the reduction was in the educational program. Magwood explained that the apparent reduction is actually a net increase because spent-fuel funding was transferred to the Office of Civilian Radioactive Waste Management (RW).

Miller asked if the number of INL management personnel would stabilize in the future. Magwood replied affirmatively. The staff will be maintained for 2 years, and then an assessment will be made to see how the money gets redistributed.

Comfort noted that the budgets of the other programs among which NERI is being distributed add up to $100 million, and asked what the rest of the money is used for. Magwood said that the

Office was trying to grow the old NERI program but that the program will be associated with other, existing research programs. The solicitation will be open but will be focused on specific topics with a certain amount of flexibility.

Fertel said that the Office should be considering plans for what it is going to do in 3 to 5 years and noted that John Ahearne had held a meeting in Dallas years ago to construct a long-term R&D program. He suggested that that report be revisited. Magwood agreed that it would be helpful to review that report and see how the Office is doing.

Cochran noted that the Office did not get as much as requested for the NP 2010 Program and asked how the program will be impacted, especially the licensing demonstration. Magwood said that, if the Energy Bill had passed as originally submitted, the budget would be significantly different. Also, a solicitation went out last year; the responses to that solicitation only recently came in, and the Office can now conduct planning with that industry input. Budgeting should be easier.

Jurrison noted that there is no funding for isotope availability. Magwood replied that it is hidden in several line items. John Pantaleo said that about half of the isotope program's $35 million is for isotope availability, representing about a 4 to 5% increase. No R&D is included, though.

Mtingwa asked about the large reduction in the AFCI. Magwood replied that a UREX+ reprocessing facility had been planned. After a lot of input, the technology was found not to be developed highly enough and that more detailed R&D was required, delaying design and licensing work. The removal of this item from the budget resulted in the decrease. Mtingwa asked if that affects the COGENA [*Associazione Italiana per la promozione della Cogenerazione*] work. Magwood replied, no; investors are being sought for that work.

Comfort noted that the American Association for the Advancement of Science (AAAS) has made a projection about support for science in the future, and it is grim. He asked what the situation for NE is. Magwood replied that minor increases are expected for 5 years but that major decisions still must be made.

Corradini asked what collaboration was being carried out with the Office of Civilian Radioactive Waste Management (OCRWM or RW) and the Office of Science (SC). Magwood said that the staffs talk regularly and noted that a presentation was being made on that subject later in the meeting. A joint workshop had been held with SC on materials science recently, and another on hydrogen.

Todreas commented that the way the university NERI program has been put together is clever and could work. The critical link is the selection boards and how they are charged.

Martin said that three issues will drive NE programs and the budget: energy security, nonproliferation, and environment. He asked how this budget fitted into these issues, noting that the budget has to be responsive to these issues.

Magwood noted that the Next-Generation Nuclear Plant (NGNP) is envisioned as a high-temperature gas-cooled reactor operating at 1000 °C or higher. Japan and France would like to pursue this technology. This plant would get the INL off the ground. It will be developed through an early investment in key materials, fuels, and hydrogen-production technology in addition to an aggressive, well-planned collaboration and cost-sharing with international partners and the private sector. A strategy for dealing with this issue will be available soon. It is an exciting area of technology.

Comfort asked if this facility will be dedicated entirely to hydrogen production. Magwood replied, no; it will have combined hydrogen and power outputs (in series). That is to say, it will be a cogeneration plant, with hydrogen being competitive with $1.50/gallon gasoline and the electricity generated being competitive with today's costs for electricity. It would be good to have as much industry input on this topic as possible.

Corradini asked if the RFP was written for a specific reactor design. Magwood replied that it is focused primarily on a high-temperature gas-cooled reactor but is open to other possibilities.

The INL will be DOE's "command center" for nuclear-energy R&D. It will be composed of the technical areas of the current Idaho National Engineering and Environmental Laboratory (INEEL) and Argonne National Laboratory-West (ANL-W), and it will become INL in February on March 2005. Bob Long's subcommittee report at the previous NERAC meeting was instrumental in conceptualizing this structure, although the incorporation of some facilities [e.g., the Idaho Nuclear Technology and Engineering Center (INTEC)] were not economically feasible. An RFP has been issued for managing these facilities for 10 years. The programs are speculative, but could range up to $1 billion/year, depending on Gen-IV's and other programs' development. INL will be involved in all NE programs and will coordinate many of them.

Magwood introduced the staff members who were present, a number of whom were new. He turned the floor over to **Dennis Miotla** for a description of the INL transformation.

On July 15, 2002, the Secretary of Energy announced a new nuclear-energy mission for INEEL that defined the role of nuclear energy in the National Energy Plan, established INEEL and the ANL-W as centerpieces of the nuclear-energy effort, stated that INEEL will be the center for Gen-IV systems/AFCI research, and declared that NE will focus on the nuclear mission and the Office of Environmental Management (EM) will complete the site cleanup (under a separate procurement). On April 30, 2003, the Secretary announced that DOE will compete and award separate contracts to implement its nuclear-energy mission and the accelerated cleanup at the Idaho site. The new INL will include INEEL and ANL-W. Cleanup work will be managed on a project basis and accelerated.

In February, DOE released the draft RFPs to establish a world-class nuclear technology laboratory in Idaho and dramatically accelerate cleanup. The RFPs call for combining INEEL and ANL-W; define the missions (NGNP, GEN-IV, RW, etc.); combine safeguards and security (S&S), buses, cafeterias, and small business functions; and base the acceleration of risk reduction and cleanup on performance. These RFPs engendered a large amount of comments, many of which did not deal with the substance of the RFPs. The only changes to result were in peripheral areas. On April 26, 2004, DOE announced the decisions on key contract issues for the INL and Idaho Cleanup Project, including a number of site-service issues [buses, cafeterias, and laboratory-directed research and development (LDRD), which will be maintained at historic levels] and a 10-year base term for the contracts.

The main objective is to establish INL as the finest nuclear energy research center in the world within 10 years. The long-term goal is to revitalize nuclear science and education training by establishing Idaho as a premier center for nuclear education and establishing an INL nuclear-technology campus. These objectives will require a good 10-year site plan for the infrastructure and more-substantive relationships with universities. The end results of the contracts will be to consolidate ANL-W and INEEL programs, facilities, and human resources; to separate EM programs under the Idaho Cleanup Project contract with separate facilities with clear ownership by the different DOE offices; and to improve lab efficiency and increase contractor accountability.

Long noted that the 10-year site plan only looks at Idaho and stated that one has to recognize what is at the other laboratories. Miotla replied that the plan is designed for property management and that it is immature. It will get better. In the long run, the other sites will be integrated with INL.

Fertel asked if any benchmarking had been performed on any cooperation to see what works and what does not. Miotla said that no official study had been performed, but what has worked and what has not worked at that site in the past has been looked at. Fertel noted that there may be some experience on the industrial side in operating multiple sites as one.

Miotla listed the following issues as having been set:

- Ten-year base term with a five-year option
- Establishment of a Center for Advanced Energy Studies

- Linkage to the NGNP and the NGNP expression of interest (EOI)
- Equitable treatment of site services

The planned schedule for the transformation calls for the release of the final RFP in May 2004. Proposals will be due to DOE in July. The decision about the selected proposal will be made by Nov. 10, and the contract will be awarded by Nov. 15. The contract takeover date is set at February 1, 2005.

The major challenges that are faced are the competing of a new contract, the restructuring of site services, settling complex labor issues (dealing with 25 labor forces and 2 guard forces; 5000 people have to be interviewed), fixing the infrastructure, and getting people to let go of the past and to look to the future.

Hartline asked how the DOE field office is being changed. Miotla responded that that change is complicated. It will be separate program managers for EM and NE. There is only a small federal presence at ANL-W; they will be rolled into the INL management.

Warren Miller noted that NERAC has a Subcommittee on Nuclear Laboratory Requirements and asked how they can help. Miotla responded, by telling the DOE staff about new perspectives and experience. DOE needs to educate the people that are out there; they have been isolated for a long time. That Subcommittee's report has been read very carefully.

Mtingwa asked him to expand on the projected educational opportunities at INL. Miotla replied that a press release will be issued later in May that will detail how INL and university people and procedures will be integrated. There are world-class people at INL who will be focusing on nuclear energy.

Sessoms commented that the coupling with universities will require improvements to the intellectual, cultural, and transportation aspects of the area.

Cortez said that the NE budget does not reflect the necessary effort needed to create a world-class facility. Miotla said that the 10-year term is an indication of DOE's long-term commitment. Other work (e.g., homeland security) will be going to INL that does not show up in the NE budget.

Martin noted that the Secretary's Advisory Board has conducted two studies on national laboratories and noted that NE cannot be isolated from DOE as a whole. Dale Klein commented that one of those studies looked at how to manage the national laboratories better; the INL is the first opportunity to bring a new management method to bear on doing it right.

A break was declared at 10:51 a.m. The meeting resumed at 11:16 a.m. with **Tom Miller** speaking on the Nuclear Power 2010 Program.

The report of the National Energy Policy Development Group recommended that the president support the expansion of nuclear energy in the United States as a major component of the National Energy Policy. It specifically recommended supporting the licensing of new nuclear reactors.

NP 2010 assessed the business case for building new nuclear power plants and identified the following barriers to such construction:

- commissioning uncertainty
- high initial capital investment
- long construction duration
- nuclear-waste disposal, and
- accident indemnification (Price-Anderson renewal)

The program is working with industry in four areas:

1. exploring sites for new nuclear plants;
2. demonstrating key regulatory processes, including early site permitting (ESP) and development of a combined Construction and Operating License (COL) that is quite different from the old licensing process, which required separate construction and operating licenses;

3. developing new reactor technologies, including design certification for new technologies and first-of-a-kind engineering for new standardized nuclear-plant designs; and
4. developing concepts to mitigate financing risks.

The program started in February 2002, and site-scoping studies were completed during FY02. Those studies looked at commercial and federal sites and conducted cost-shared projects with Dominion and Exelon.

The ESP demonstrations were started. ESP resolves site safety and environmental issues and can be banked for 20 years. Three ESP applications were filed with the Nuclear Regulatory Commission (NRC) in fall 2003; NRC approval is expected in 2006.

Corradini asked if NRC's timescale is truly 3 years. Tom Miller replied that it runs from 30 to 36 months. Corradini asked why they needed so much time for previously licensed sites. Tom Miller said that he did not know why but pointed out that seismologic requirements have been tightened. Sellman pointed out that they go through a linear process, and staff workload may play a part in the delays. Fertel noted that they have to meet the National Environmental Policy Act (NEPA) requirements, also.

Cochran said that there seems to be a hidden agenda: waiting for the Domenici bill. He asked whether companies would have gone through early site planning had DOE not shared the cost. Tom Miller responded that they would not have and did not. McNeill noted that one has to ask what important investment risks are associated with new plants. The utilities have been burned before. Companies will not go forward with a new permitting process before it is proven to be cost-effective. Cochran noted that, in the COL stage, several consortia are stepping forward to get federal funds. He asked why two consortia should not go forward at taxpayers' cost and two at investors' and ratepayers' cost. He said that the incentive to utilities here is to get more government money. Tom Miller said that the amount totals about $18 million. Cochran said that, in addition to the $18 million, there is also going to be construction and licensing money and then the big money from the Domenici bill. Fertel stated that Cochran was right. The utilities could go on without federal money, but not as quickly. McNeill observed that the same argument could be made about wind energy.

Tom Miller returned to describing the program status. The Electric Power Research Institute and the Nuclear Energy Institute have been developing a generic COL, including application-preparation guidance and generic resolutions of COL issues.

Several other studies and analyses are under way. A schedule and constructability assessment of candidate reactor technologies is being conducted by Dominion Energy, the Tennessee Valley Authority (TVA), and Entergy; it includes decommissioning costs. TVA is also preparing a site-suitability study of a new location on the Bellefonte Site, which is a small project. The Texas Institute for Advancement of Chemical Technology is looking at new nuclear plants in Texas to replace natural gas as an energy source for refineries. And ANL and the University of Chicago are looking at employment rates for currently proposed nuclear technology and potential economic results.

The next major step will be new plant-licensing demonstration projects to bring advanced-technology designs to the completion point. A solicitation will be issued in November for a power-company plan leading to a license to build a new nuclear plant. The work scope to be proposed by industry is to include a COL, advanced-reactor design completion, a project cost and financial analysis, and the completion of siting analysis and permitting. It will have a long solicitation period that will extend through December 2004 to get maximum feedback. Proposals will be evaluated on a first-come, first-served basis. Three applications have already come in:

1. Dominion Energy with Atomic Energy of Canada, Ltd.; Bechtel; and Hitachi
2. TVA with General Electric, Toshiba, Bechtel, Global Nuclear Fuels–America, and the United States Enrichment Corporation (USEC) on the Bellefonte site

3. NuStart Energy–Exelon, Entergy, Constellation Energy, Southern Company, Duke Power, and Electricite de France International with General Electric (a simplified boiling-water reactor) and Westinghouse (an AP 1000 reactor)

Application review is currently going on, and award selections are expected to be completed by the end of June 2004. The consortia are currently making technical presentations.

Corradini asked how much the shares of industry are. Tom Miller replied, 50%. McNeill noted that some designs are already licensed, so some will have higher development and certification costs than others. Tom Miller agreed and pointed out that the AP 1000 is in the certification process now and will need another 12 months at least before it is certified.

Cochran asked if the foreign participants are getting their designs certified with U.S. taxpayer money so they can sell those plants overseas in competition with U.S. firms. Tom Miller responded that that is a concern and that the issue needs to be considered.

Martin introduced **Richard Reba** to present a report from the Subcommittee for Isotope Research and Production Planning. That Subcommittee was charged with the creation of a comprehensive, long-term isotope research and production plan to guide the Department's isotope-related activities during the next 10 years. Reba reviewed the history of isotope supply by the government, starting after World War II. That program was significantly subsidized by DOE and its predecessor agencies. More recently, nonenergy programs were curtailed in DOE, and isotope production was cut back.

Isotopes, both radioactive and stable, make important contributions to research, medicine, and industry in the United States and throughout the world. Radionuclides have a fundamental role in biomedical research, in drug development, and in the application of diagnostic and therapeutic processes in medicine (especially in oncology, cardiovascular diseases, and psychiatric disorders). Each year, U.S. physicians employ radiopharmaceuticals in an estimated 15 million diagnostic and therapeutic procedures. Nearly one in three patients admitted to a U.S. hospital undergoes treatment with radiopharmaceuticals.

Some scientific disciplines that require stable and radioactive isotopes include chemistry, physics, geosciences, and fission and fusion reactor technology.

Annual sales of therapeutic products have risen from about $100 million per year in 1996 to $1.6 billion per year in 2002 and are projected to go to $2.6 billion per year by 2007. Annual sales of diagnostic products have risen from about $500 million per year in 1996 to $1.1 billion per year in 2002 and are projected to go to $2.5 billion per year by 2007.

About 40% of requests for Nuclear-Energy Protocol for Research Isotopes (NEPRI) isotopes came from outside of medicine. The main need is for medical isotopes, and that need is projected to grow exponentially. This technology and its programs have fostered new industries and jobs worldwide. There are tens of radiolabeled products currently in clinical trials.

More than 15 reports have been issued since 1982 about the need for stable and radioactive isotopes. These reports come to many of the same conclusions. They express some differences of opinion about the specific nuclides that will be needed or the rate of growth of medical radionuclide usage. But there is agreement that whatever isotopes are used, the demand will be high. All of these reports identify the same trends:

- an increased growth in isotope use,
- expected shortages of some major nuclides,
- lack of a reliable supply of research isotopes produced at a reasonable cost,
- deteriorating DOE infrastructure,
- overdependence on non-U.S. radionuclide production,
- lack of support for the basic science that drives the application of radiotracers in biomedical research and clinical practice, and
- few programs in educating radiochemists.

Currently, isotope production continues at the national laboratories. Construction and equipment installation is now complete for the Isotope Production Facility at LANL, but the operating schedule is uncertain. The "menu" of available isotopes is supplemented significantly by non-U.S. suppliers. A conceptual design is being prepared for a dedicated 70-MeV cyclotron. In the future, DOE plans to

- use a calutron for research quantities of stable isotopes,
- expand the availability of alpha-emitting radionuclides,
- continue to attract private-sector partnerships in isotope production,
- seek congressional support to expand research funding, but
- approve no new reactor for isotope production.

Pantaleo pointed out that the United States had coordinated with South Africa and other countries to produce the needed isotopes. One problem is that they have short half-lives; they cannot be stored.

Martin asked why there is not a market if these isotopes are so valuable. Reba replied that (1) the demand is very erratic and (2) isotope production has to be piggybacked on other research and production at the facilities.

The recommendations that are emerging in the workshop reports are

- NE must continue to provide a reliable source of radioactive and stable isotopes for research, medicine, and industry that are not available from commercial vendors. This will almost certainly require a dedicated program because the current NE isotope and distribution supply operates only as a parasite on research operations.
- DOE and the National Institutes of Health (NIH) must together develop the capability to ensure a diverse supply of radioisotopes for medical use in quantities sufficient to support research and clinical activities.

This program has been stalled; it is low on both DOE's and NIH's to-do lists.

Owen Lowe was asked by the Chairman to review where NE is now in isotope production. DOE is producing isotopes at LANL, Brookhaven National Laboratory (BNL), and at the High-Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory (ORNL). The research community relies heavily on the Missouri Research Isotope Reactor (a main source for 40 years). The operations at LANL, BNL, and ORNL are parasitic and make treatment logistics nightmarish. The bread-and-butter isotopes are strontium-82 and germanium-68. A run has to be fully subscribed from outside DOE before it is conducted. As a result, the production of some isotopes is impossible.

Magwood said that it is clear that this research is very important, but it is not clear that DOE should support it. It requires large facilitates (accelerators, reactors, and hot cells). To get that story told is very difficult. The program was retrenched quite successfully to protect it. It is hoped that NIH cooperation will be obtained to help the program be viable. That has not happened. The effort needs to be stepped up.

A break for lunch was declared at 12:19 p.m.

Tuesday, May 18, 2004
Afternoon Session

Martin called the meeting back into session at 1:30 p.m. to hear a report from **Burton Richter** on activities of the Subcommittee on Advanced Nuclear Transformation Technology (ANTT).

The Subcommittee met in February 2004 and focused on transmutation's potential to increase the capacity of Yucca Mountain. The conclusion arrived at was that transmutation in light water reactors coupled with a relaxation of the legislative limit on Yucca Mountain would potentially allow all spent fuel produced up to 2050 under any nuclear scenario to be handled in just one repository. The addition of fast-spectrum reactors would handle all spent fuel produced through the end of the century in one repository. A lot of well-funded work would be required to realize that potential; however, the budget situation is not very good.

The current plans for using Yucca Mountain postulate that spent fuel would be made up of three components. Fission fragments would comprise 4% of the total, and their intense radioactivity would require 200 years of isolation. Uranium would make up 95% of the total, and its negligible radioactivity would not require any isolation; one could put it back into the mines from which came. The long-lived component would make up 1% of the total, and its medium-level radioactivity would require isolation for 300,000 years; it is this component that thermally limits the capacity of the repository.

The current plan for operating the Yucca Mountain repository calls for 75 years of forced ventilation; at that point, the tunnels would be sealed, the radioactive materials would decay, the temperature would rise, but the design of the tunnels would limit the temperature to less than the boiling point of water.

The transmutation model postulates partitioning the spent fuel and storing the fission fragments separately in Yucca Mountain or elsewhere. They are not the long-term thermal limit. Plutonium, americium, and neptunium would be separated and recycled some number of times in light water reactors; 30% of the core of a light water reactor can be actinides. Curium would go to the repository. After *n* cycles, all the remainder would go to the repository.

One can calculate the increase in Yucca Mountain capacity with the same thermal limits as "once through" as a function of the number of recycles. A comparison of various recycling schemes shows that inert-matrix or nonfertile fuel burns out actinides quickly; nothing in the fuel produces new actinides. With the actinides largely gone after two recycles (22 years), the amount of waste that can be loaded into a repository is significantly increased without changing the thermal load on the repository. With californium-neptunium-technetium metal oxide (MOX) fuel, a great deal of the actinides is burned out after seven recycles, and the waste can be loaded into the repository with almost the same loading density as with the inert-matrix fuel. With MOX, the plutonium, americium, and neptunium are burned, producing new uranium-238. Both types of fuel seem to saturate at two times the base capacity of the repository. There are indications that continuous recycles (where the new actinides produced are equal to the old actinides consumed) may be possible. It is too early to say; but, if so, the capacity increase would be much larger than a factor of 2.

Richter reported that the current Yucca Mountain is designed to handle the total discharged fuel from today's nuclear power plants until 2100 [63,000 metric tons of heavy metal (MTHM)]. If current reactors received extended licenses, the number of needed repositories would increase to two. If energy demand continued to increase at current rates, the number of needed repositories would increase to four. If nuclear power also maintained its current market share (20%), the number of needed repositories would increase to nine. If its market share increased, the number of required repositories would increase to 21. With thermal recycling and fast-spectrum reactors, one Yucca Mountain capacity will handle all of the spent fuel for all of these scenarios. It is obvious that the back end of the fuel cycle needs to be looked at.

The recommendations of the Subcommittee in terms of capacity issues are that the light water reactor recycling study be continued, retaining the inert-matrix fuel (IMF) and MOX options. The feasibility of continuous recycling under realistic conditions should be determined; the question is whether one can get to the point that what comes out is equal to what goes in. The potential repository benefits indicate that a fast-spectrum system in Gen-IV should be a high priority. Fast-spectrum reactors also have the potential for reducing isolation times in comparison to the original two-tier program. If one uses only thermal reactors, one cannot get the capacity down; fast-spectrum reactors are needed to do that.

The COGENA experiment (separating uranium, fission products, and actinides) now under discussion may answer some of the radioactive-waste questions in a timely fashion. However, U.S. technical personnel will not gain design experience, and the full AFCI process will not be demonstrated. The Europeans now produce MOX fuels by partitioning, but the AFCI proposed process is more sophisticated than what is currently practiced.

The AFCI program is underfunded. The decrease in funding proposed for FY05 only makes worse the "options overload" that was noted in the Subcommittee's previous report.

A National Nuclear Security Administration (NNSA) review of the effect of a change in the plutonium isotopic vector on proliferation risk is not yet complete. The Subcommittee asked NNSA to look at the weaponization potential of the various isotopic combinations a year ago. No answer has been received about whether a deliverable weapon could be made from the recycled material. If a weapon cannot be constructed from that material, one can build down (rather than build up) the world's inventory of radioactive spent fuel. A rational discussion of this question of weaponization is needed.

Warren Miller asked if anyone had calculated the value of five repositories in terms of dollars. Richter replied that the first one would cost $50 billion; a crude estimate for a second repository would be $40 billion plus or minus $5 billion; the cost to increase the capacity of the first repository could be $30 billion. Cochran suggested including a 1500-MT/year reprocessing plant for every repository, assuming only recycling once. To do more recycling, one would have to have more processing plants. A hundred or more fast reactors would be necessary, a huge capital investment. Richter considered the fast-reactor issue. One Yucca Mountain repository can hold 230,000 tons of thermal-spectrum-reactor waste. With Gen-IV, there are going to be fast-spectrum reactors, about 200 reactors operating for 50 years. No one has any idea what direction the industry will be pursuing in 2050. Capitalization costs for recycling plants could be obtained from the French.

McNeill asked if there were any other potential technologies. Richter responded, yes: accelerators, but the economics were not promising. Accelerators trip out about three times a week; they are not a reliable technology. With recycling, only one recycling plant is needed for every 10 operating reactors, and one does not need to worry about downtime because electricity is not being sold to the grid.

Comfort asked if he had some specific recommendations about activities and costs. Richter replied that the Subcommittee expects Buzz Savage to determine from computer models what the cost would be. What is needed to be known is whether equilibrium is theoretically possible. Also, some hard data on inert-matrix fuels are needed. These topics will be pursued at the fall meeting of the Subcommittee.

Todreas commented that the thermal-management schemes for Yucca Mountain are wide open. The ANL studies are very helpful, but the thermal limitations are still unknown. In addition, the dynamic analysis of the number of reactors, tons of spent fuel, etc. over time are open to interpretation. The debate should be focused because the Secretary will have to make a decision about a second repository. Dispersing the recycling will disperse and increase the risks associated with those facilities, also. Richter agreed. The legislative limit on repository capacity needs to be abandoned, and the problem needs to be revisited. A lot of other changes will have to be made to build 10 reactors a year for the next 30 years, as projected by the MIT study.

Corradini also said that changing the design operation parameters of the repository needs to be considered as is being done by RW. Also, one should consider the policy, licensing, and security uncertainties and issues. A court ruling could turn all of the projections upside-down. Richter added that the attitude of the nuclear power industry toward this "funny" fuel needs to be assessed. NERAC might need to set up a subcommittee on nuclear industry responses.

Martin pointed out that these issues involved nonproliferation and other topics and suggested a need to get together all the parties involved. Richter pointed out that RW does sit in on all of the ANTT Subcommittee meetings.

Ahearne moved to accept the report and endorse the three recommendations. Comfort seconded. Cochran asked which recommendations were being endorsed. Richter reiterated the three recommendations from the report. Cochran noted that the third recommendation was not a true recommendation. Richter reworded the recommendation as: "The potential benefits of fast-spectrum Gen-IV reactors should be folded in." Cochran said the restatement would be satisfactory. The motion passed. The three motions, including the revision of the third are given in the appendix.

Martin introduced **Arnold Baker** to present a report from the Subcommittee on Economic Modeling.

The initial charter called for this Subcommittee to continue the preliminary work initiated by the ad hoc working group that was developing economic models to explore alternative energy futures based on Energy Information Administration data. A previous presentation of model results led to the notion that the Subcommittee should (1) serve as the primary modeling arm of NERAC, available to perform requested sensitivity analyses, and (2) be organized as a permanent subcommittee that will respond to specific requirements and requests set by the Department or NERAC.

In carrying out these roles, the Subcommittee will seek to help to improve the understanding of

- long-term energy, economic, and environmental trends and trade-offs (e.g., in deciding between coal and nuclear power);
- the potential role of research and development in reducing energy-market externalities (nonmarket considerations, such as emissions and security);
- the economics of nuclear power relative to other alternatives; and
- the budgetary requirements and potential impacts of nuclear-energy research and development (help make the need for funding more apparent)

and to foster communication among the DOE program offices and the energy-economics and nuclear-research communities.

This Subcommittee will be kept small and will reach out to other energy, economic, technical, and modeling experts in industry, government, national laboratories, universities, nongovernmental organizations (NGOs), and consultancies as needed to meet its responsibilities. Expert panels and workshops may be convened as appropriate, bringing in people from other disciplines.

McNeill said that one area that needs investigation is investment-risk decisions. One needs to know what incentives might be needed to get nuclear plants built. The industry was not very inspired in coming up with the answers. The spot price of natural gas was currently $6.3/MM Btu. Any nuclear plant in existence is better than that, but people are still not buying nuclear power plants. This issue has to be understood. That understanding should be part of the economic review.

Martin said that one needs to look at the impediments in the decision process. Also, there is a macro policy level. The real price of oil is more than the market price; environmental costs, military costs, and other externalities need to be factored in. If government were a partner here,

technological investment could be substituted for these externality costs. Showing the benefits of the R&D program should be an output of the Subcommittee.

Ray said that there should be a consideration of a renewables value for nuclear energy.

McNeill said that one has to have a market to ascribe to. One cannot live off the spot market.

Fertel offered that a workshop would be a good idea. Everyone has different assumptions, which confuses policymakers. He agreed with McNeill: the companies had lots of items they wanted; they simply did not know how to talk about them. The three consortia that have expressed an interest in building plants should be consulted, and they should be asked what steps need to be taken by the government.

Hartline cautioned that the independence of this advisory committee needs to be taken seriously, and the permanence and budget of this Subcommittee need to be weighed carefully. Baker offered to take the development of new economic models out of the recommendations.

Cortez observed that, somewhere along the line, an environmental term has to be introduced into the economics. Sessoms commented that economic modeling is already dismal and becomes more political as one introduces externalities. If one wants credibility, one should stay away from these issues.

Martin noted that one of the motivations is to get more money for NE. Concerns about climate change will be important in making the case for nuclear power. Society is going to pay for these externalities one way or another. Even back-of-the-envelope calculations help in government.

Warren Miller called into question a charter that calls for developing economic models. Other issues do not have economic models developed to explain them. He suggested changing the charter to "reviewing" rather than "developing." Baker suggested changing the title of this Subcommittee to the Subcommittee on Economic Analysis and changing the charter.

McNeill stated that the Energy Information Administration (EIA) uses construction costs that are not appropriate in its modeling. This Subcommittee would look more realistically at such costs.

Cochran seconded Hartline's concerns about independence. He pointed out that DOE was supposed to develop a large-systems-analysis modeling team, but such a team has not been assembled. He said that NERAC should not establish a small group to create new modeling assumptions. It would be better to have such a capability housed in an independent institution and to have the Committee critique those studies.

Comfort asked if it would be possible to incorporate economic studies into NERI. Magwood said that NERI would not be the best place; it is for hard technology R&D. The value of such a subcommittee is to sort through the issues. There are wide variations in, say, projected energy prices. None of the numbers is reliable.

Dale Klein said that this subcommittee would be invaluable in understanding the problem and could identify some specific topics to be addressed.

Martin observed that any time one moves away from the market, one gets into trouble. However, economics needs to be integrated into nuclear decisions. The Subcommittee will proceed and will take these recommendations into consideration.

Cochran suggested that some people like Paul Joskow from the MIT study need to be included on the Subcommittee as well as some that know about the economics of the externalities involved.

Baker added that the Subcommittee truly needs to be unbiased.

Martin introduced **John Ahearne** to speak about the Evaluation Subcommittee, which is intended to evaluate NE programs and measure those programs against their objectives. The review process of the Office of Management and Budget (OMB) is the driving force behind the Subcommittee's charge, which is

- to monitor, on a continuing basis, designated Nuclear Energy programs and

- to evaluate the progress of these programs against (1) direction and guidance provided by the full NERAC or any of its appropriate suborganizations and (2) any program plans or performance measures developed by the program under evaluation.

The Subcommittee held a meeting on April 21 to understand the task and to devise a framework that might be used to accomplish the task at hand. Briefings were also held on various NE programs.

OMB has a Program Assessment Rating Tool (PART) that has to be addressed. The PART asks questions about the results obtained from programs. Traditionally, NE programs are baselined and adjusted annually. On the face of it, that process sounds good. But when the PART was applied to those NE programs, the following scores resulted:

Program	Overall Score	Assessment
NP 2010	69	Adequate
AFCI	76	Moderately effective
Gen-IV	79	Moderately effective

All three programs got perfect scores for clarity of program purpose and soundness of program design. In the planning area, stronger links were found to be needed between budget and performance data for all three programs. In the program-results area, NP 2010 needs to establish an annual, independent assessment of the overall program; Gen-IV lacks periodic external review; and AFCI needs to better demonstrate its effectiveness.

This Subcommittee should evaluate programs against program plans etc. A lot of documents were provided to the Subcommittee along with the PART results. The Subcommittee had a 1-day snapshot of the main NE programs. This review found that NE was conducting many of the expected assessments. But the review also elicited preliminary general comments from the Subcommittee members, such as:

- "NP 2010 is not a true NE R&D program but rather a channel for subsidizing nuclear-energy generating companies and reactor-vendor companies."
- "In Gen-IV, maximizing fuel utilization should not be a goal because it meets clean-air objectives."
- "DOE and Congress are not providing sufficient funding to accomplish what DOE believes are the program objectives."
- "Little elucidation of progress or its measurement."

The major problem is that NE programs have goals and objectives that cannot be achieved with the budgets provided. A huge, unrealistic ramp-up is needed to support the programs proposed. The Subcommittee needs to dig deeper into these three programs. The Subcommittee will spend one day on each of the three programs. It needs to get reviews to NE by August 1 to meet budget schedules, so NERAC's acceptance of the Subcommittee's report will need to be accomplished by e-mail.

Corradini noted that the Gen-IV Subcommittee was looking at many of the same things that the Evaluation Subcommittee was looking at and asked whether the Gen-IV Subcommittee was looking forward and the Evaluation Subcommittee was looking backward. Ahearne responded affirmatively. The Gen-IV Subcommittee was looking to the future. The Evaluation Subcommittee is being asked to evaluate the effectiveness and accomplishments of the programs.

Corradini suggested that, if any one area is being looked at by the two subcommittees, the stress on the staff should be limited by combining forces. Ahearne noted that the evaluation needs to be independent.

Sessoms asked if the OMB was trying to make the programs look overoptimistic in view of limited funding.

Todreas said that something needs to be worked out so different subcommittees do not redo the same work.

Rempe asked if OMB had said that this evaluation would be acceptable for the process. Ahearne responded, yes.

Hartline noted that the National Science Foundation gets fine marks from the OMB for its committees of visitors (COVs), which have guidelines for the conduct of their evaluations. SC uses COVs, also, and the Subcommittee might be able to learn from them.

Corradini noted that one needs to evaluate what the programs did with the resources given to them. There are two levels of goals: targets and want-goals.

Magwood agreed that the Office should look at other models as had been suggested. OMB said that NE's previous evaluations were not independent. That is why the new Subcommittee is being set up. The budget process is: the Office suggests what it would like to do, and OMB is supposed to find out why the Office should not get the funding to do what it wants to accomplish. NE has very ambitious goals. The decisions coming down the line will determine how (or if) NE advances.

Martin noted that NE is getting a lot of bang for the buck because it gets a large multiplier internationally. He declared a break at 3:41 p.m. and called the meeting back into session at 4:00 p.m., introducing **Paul Dickman** to present an update on the U.S. Spent Nuclear Fuel and High-Level Waste Program.

Congress has created a legal obligation to the government to dispose of nuclear waste. In 1982, the Nuclear Waste Policy Act established a national policy for the disposition of high-level radioactive waste and commercial spent nuclear fuel. Prior to this Act, the Waste Isolation Pilot Plant (WIPP) site in New Mexico had been selected for defense transuranic (TRU) radioactive waste. In 1987, Congress directed the DOE to characterize only the Yucca Mountain site. In 2002, Congress passed a joint resolution approving the Yucca Mountain site for development as a repository. The license application is due in December 2004; after that, the issue falls into the regulatory process.

The great majority of the material for Yucca Mountain comes from commercial spent nuclear fuel; smaller amounts come from DOE and Naval spent nuclear fuel and from DOE and commercial high-level waste. The nuclear-fuel waste is located at 126 sites in 39 states. Transporting this waste is not an easy problem; moving to rail transport makes the problem a little more tractable.

Money for this program is in a trust fund, but Congress does not always release it. About $0.75 billion has accumulated each year; it now totals about $14 billion. On the staff, there is someone who buys Treasury bills and zero-coupon bonds with these funds.

Postclosure safety is a very important chapter. No one has gone through the licensing procedure for such a facility. The key point is that, in December 2004, a license application will be sent to the NRC. They will review the application for 3 months for completeness prior to a 3-year technical review plus an optional year if unanswered questions remain. A construction authorization will be granted only if the NRC concludes that the repository would meet reasonable expectations for protecting the safety and health of the public and workers and for preserving the environment. That is to say, if they accept the postclosure safety plan.

The repository reference-design concept has changed over the years, but the 2010 opening date has not changed. All of the property is government owned. The waste will be brought in in containers. The original liability-assessment design called for wet handling of commercial spent nuclear fuel and one large building with five transfer lines. The site-recommendation design was a simpler system that still had wet handling in a single large building with three transfer lines and 5000-MTHM blending pools. The license application uses dry handling in multiple buildings with phased construction and dry-cask aging. It will handle 400 million tons of spent fuel in the first year and 600 million tons in the second year, going up to 3000 million tons per year. All the waste has to be at least 5 years old. Today's design has greater spacing between drifts; with a larger rock mass, more heat can be absorbed. The license application assumes a hot design, but it is flexible.

The waste package has evolved, also. The current design is a cask 12 to 14 feet long and 6 feet in diameter. The outer barrier is Alloy 22; the inner vessel is stainless steel. It is designed to survive in a repository environment for 10,000 years.

The most contentious Yucca Mountain lawsuits currently faced include the State of Nevada cases (many of which have been consolidated). These are based on process questions, not technical questions. A pronouncement is expected this year. A lawsuit over water rights is currently awaiting an appellate court ruling. There are 66 other lawsuits. The Indiana-Michigan trial ended on March 15, 2004.

Under the law, DOE must use private industry to the fullest extent possible for transporting the spent nuclear fuel. The transportation casks must be certified by the NRC. The DOE must notify each governor or designee prior to transportation through a jurisdiction. DOE must provide technical assistance and funds for training in emergency response and in safe routine transportation procedures. After many years of deferral because of budget shortfalls, transportation planning is being accelerated. Transportation was always the first thing cut; it cannot be cut any longer. DOE will build on the experience and proven safety record in the United States and Europe. Europe has already shipped more radioactive waste than the United States plans to ship. During the next 6 years, a transportation system will be developed that will be ready to ship spent nuclear fuel and high-level waste to the repository. Initially, transportation will be conducted with trucks, but NEPA requirements for rail alignment will be implemented. One truck cask can hold four assemblies; one train cask can hold 24 to 30 assemblies, and three casks can be transported per train. An Environmental Impact Statement has been begun for rail alignment. Cask and rolling stock procurement has been initiated.

Eleven nations have committed to incorporating repositories as part of their nuclear fuel cycle. Several others are looking at establishing repositories. Two have committed to a fuel cycle (United States and Finland); the Swedes are very close. A major problem is that the Russians do not have an authority to establish a repository. There are 12 repositories in the European Union.

In summary, DOE is proceeding toward the goal of waste acceptance in 2010. A request of $174 million for it is being requested directly from the fund. Otherwise, the program will only have $131 million and will be shut down.

Todreas said that, for Gen-IV, one needs to know about the need for a second repository. Dickman said that, in 2007, the government is to start looking at that need for a second repository and/or expanding Yucca Mountain. One thing that it will look at it is what fuel cycles are being used.

Martin asked **Andrew Klein** to report on the Subcommittee on Nuclear Laboratory Requirements.

A charge to the Subcommittee (and likely its charter) is to identify what characteristics, capabilities, and attributes the world-class nuclear laboratory in Idaho would possess. The Subcommittee is to become familiar with the practices, culture, and facilities of other world-class laboratories and to use this knowledge to recommend by the end of FY04 what needs to be implemented at INL. Many organizations have looked at this question before, and the Subcommittee will incorporate the findings of those others in its report. It has met once and will meet in Idaho in August to visit ANL-W and INEEL to discuss the draft report.

In the meantime, the Subcommittee will visit a number of world-class laboratories. The DOE laboratories that the Subcommittee will visit are

- Argonne National Laboratory
- Argonne National Laboratory-West
- Idaho National Engineering and Environment Laboratory
- Fermi National Accelerator Laboratory
- Los Alamos National Laboratory
- Oak Ridge National Laboratory

Other U.S. laboratories that the Subcommittee will visit are

- Naval Research Laboratory
- Army Research Laboratory, Adelphi
- Army Research Laboratory, Natick
- National Institute of Standards and Technology
- Jet Propulsion Laboratory
- National Center for Atmospheric Research
- MIT Lincoln Laboratory
- Charles Stark Draper Laboratory

International laboratories that the Subcommittee will visit are

- Japan Atomic Energy Research Institute/Japan Nuclear Cycle Development Institute
- Korea Atomic Energy Research Institute
- Chalk River Laboratory of Atomic Energy of Canada, Ltd.
- Commissariat a l'Energie Atomique
- Conseil Européen pour la Recherche Nucléaire [now Organisation Européenne pour la Recherche Nucléaire]

The Subcommittee will use a questionnaire during these visits and will also send that questionnaire to all NERAC members. The National Research Council has established a definition for a world-class R&D laboratory: one that is recognized by peers and competitors as among the best in the field on an international scale, at least in several key attributes. The questionnaire asks respondents if they agree with this definition. If not, how they would change or improve it? What do they considered to be the key characteristics, capabilities, and attributes of a world-class R&D organization? And what do they consider to be the key characteristics, capabilities, and attributes of a world-class *nuclear-energy* R&D organization?

NERAC members and other interested individuals can e-mail input to klein-wcl@oregonstate.edu for consideration by the Subcommittee.

Cochran asked if, based on what is known by the Subcommittee, INL can be made a world-class laboratory. Andrew Klein responded that the Subcommittee did not know yet.

Hartline noted that the report will come out after the RFP had been issued but before the responses are due back. She asked how this report would be used in judging the responses to the RFP. Magwood responded that there are many statements of goals for the laboratory to aim for but those statements do not say how to reach those goals. The bidders are expected to tell how they would accomplish those goals. This report will be used to evaluate the responses to the RFP. The contents of this report present a target that can be referred to. Hartline noted that some of the elements of the DOE boilerplate will be problematic for a world-class laboratory. Two things are key: people and leadership.

Martin asked Cochran to offer the proposal that he would like DOE to make to NNSA. Cochran said that the terrorist use of nuclear weapons is far more serious and important than their use of chemical or biological weapons. This holds true especially for crude nuclear weapons made with highly enriched uranium (HEU). Therefore, HEU inventories should be reduced. ANL has been responsible for converting research reactors from HEU to low-enrichment uranium (LEU) for two decades. This program should be accelerated. This Office and other agencies should review how to convert these reactors to another fuel and other ways to reduce the risks of HEU diversion. A draft letter expressing this request was circulated for consideration by the Committee.

Sessoms noted that the Committee had previously asked for a report on the Reduced Enrichment for Research and Test Reactors (RERTR) Program and asked that such a report be presented at the next day's session. Magwood said that he would see that such a report was made. Martin asked the Committee to study the draft letter and to be prepared to discuss it the next day when the RERTR Program report was made.

Martin introduced **Shane Johnson** to present an overview of the Generation-IV (Gen-IV) Program. The Gen-IV Program had its origin in NERI projects. The same can be said for the hydrogen-production program and for the program on proliferation-resistant fuels. The hardest difficulty is getting funding for programs that do not have a definitive endpoint.

Gen-IV reactors will offer improvements in reactors' safety and reliability, proliferation resistance and physical protection, economic competitiveness, and sustainability. In January 2000, the effort grew into an international collaboration now led by the Gen-IV International Forum, which has 10 members. Russia is still not a member, but the issues attendant to its membership are being ironed out.

The program's top priority is to develop and demonstrate the NGNP, a very-high-temperature electric generation plant. Several research programs are under way. Fast reactors have not been given up on; going to fast reactors will have a big impact on handling radioactive waste. Supercritical-water-cooled reactors are the top interest of the Canadian participants.

AFCI is integrated with Gen-IV nuclear-energy systems. There is good communication between the two programs, and they both report to Systems Analysis at INEEL/SNL [Sandia National Laboratories]. The technical directors of Gen-IV are located at INEEL/ANL, SNL, and ORNL; the technical directors of AFCI are located at LANL and INEEL/ANL. This integration will put together a national planning and modeling capability. More university participation is desired. U.S. personnel are working closely with their international partners according to the international R&D plan. These programs are working together to increase nuclear power production in the United States and to deal with radioactive-waste problems.

The NGNP is closely coupled with this program as is the hydrogen-production program.

This year, the Gen-IV program will establish bilateral agreements with Japan, South Africa, and the United Kingdom for performing cooperative research. It will also establish a multilateral agreement. The near-term expectations of the NGNP are to issue functional requirements, prepare materials requirements, define the R&D plan, initiate irradiation of the Advanced Gas-Cooled Reactor (AGR-1) fuel capsule, obtain the CD-0 [Critical Decision Zero] for the program, and select the U.S. company to be charged with leading the development of the NGNP.

Fertel stated that the materials for a very-high-temperature reactor are not going to be there in 5 years and asked if the program had looked at this issue. Johnson replied, no; that is why the main thrust is in materials.

Cochran asked if there was an agreement with France or Japan for fast-reactor research. Johnson replied, with France; other countries like Brazil are not interested. There are no bilateral agreements, and information on fast reactors is shared only within the party countries.

Sellman asked if there was any effort to get Naval reactor information declassified. Johnson replied, not yet; the program should look at that.

Croff asked how many Gen-IV concepts are being pursued. Johnson replied that five of the six identified designs are being pursued; the molten-salt reactor has not been pursued, but last week the French asked for a steering committee on molten-salt reactors.

Todreas noted that university researchers did unclassified work on high-temperature gas reactors that could be found in lieu of the Navy classified research.

The FY05 budget request for the NGNP is $19.3 million, up from the FY04 appropriation of $14.4 million. The FY05 request for other Gen-IV R&D is $8.4 million, down from $9.2 million. The FY05 request for the International NERI (I-NERI) is $2.8 million, down from $4.1 million.

Cortez asked what proportion the U.S. contribution was. Johnson replied that he did not know exactly, but the objective was to get a 50-50 split.

In summary, the Gen-IV initiative, in cooperation with the Generation-IV International Forum (GIF), is developing new advanced nuclear systems to realize gains in safety and reliability, economics, sustainability, and proliferation resistance and physical protection. DOE places first priority on the NGNP and Supercritical-Water-Cooled Reactor (SCWR) because that action supports President Bush's National Energy Policy, the Freedom Car Initiative, and the

Nuclear Hydrogen Initiative. DOE *does* recognize the need for a fast-reactor system for waste transmutation and long-term sustainability. The Gen-IV initiative will pursue its goals while working with the budget and time challenges.

Mtingwa applauded NE's coordination on Gen-IV and the AFCI, but noted that the AFCI work is not coordinated at the international level.

Corradini asked if the international NERI funds are for continuing awards. Johnson said that those are not new awards. The FY05 requirement is for near-term reactor systems and for engaging smaller countries in specific designs.

Martin commented that the report of the Idaho Infrastructure Task Force chaired by Robert Long has been delayed in getting to the Secretary. However, the interchanges that occurred in these meetings are very useful, and these reports are used in decision making even as they are developed and considered. He adjourned the meeting for the day at 5:33 p.m.

Wednesday, May 19, 2004

Chairman Martin called the session to order at 9:00 a.m. Magwood announced that John Sackett of ANL would arrive later to comment on the RERTR Program in response to requests for information made during the previous day. Martin introduced **Andrew Klein** to present a report on the Nuclear Power Engineering Curriculum Task Force. Andrew Klein listed the members of the task force.

The concerns that had been expressed to the Subcommittee about nuclear-engineering curricula were that those curricula had changed during recent times and that they were no longer producing engineers with training that was optimal to the needs of the power industry. The task force requested that universities provide copies of their nuclear-engineering curricula from 15 years ago as well as the current curricula. Methods of accreditation were found to have changed.

The task force members conducted the initial analysis of the curricula independently. They then met in November 2003 to discuss individual findings and to determine the direction for further analysis. They wrote a draft report and circulated it to universities (through NEDHO, the Nuclear Engineering Department Heads Organization) and industry for comment before they wrote the final report.

Large and small schools from all over the country responded to the call for curricula. All undergraduate curricula began with general and basic fundamentals, such as mathematics, physics, and general-education requirements. These were followed by general engineering sciences, such as thermodynamics. They finished with specific nuclear-engineering subjects. All of them were consistent with the Accreditation Board for Engineering and Technology (ABET) criteria.

Specifically, all included advanced mathematics through differential equations, chemistry, physics, English composition, public speaking, humanities, and social sciences. Some of them had additional content in areas like computer programming and numerical methods. All curricula included fundamental engineering sciences: statics, dynamics, mechanics, materials, economics, thermodynamics, fluid mechanics, and heat transfer. Many curricula included additional content like electrical fundamentals, control systems, and engineering graphics.

All curricula included content with specialization in nuclear engineering: atomic and nuclear physics, laboratory classes to measure radiation and radioactivity, interactions of radiation with matter, radiation protection, reactor physics and theory, reactor thermal hydraulics, and nuclear-engineering design. Most also included nuclear reactor laboratories. Because of the variety of faculty interests, curricula also included coverage in topics like reactor engineering, systems engineering, fuel management, reactor safety, fuel cycles, nuclear materials, nuclear-waste management, risk assessment, applied radiation protection, radiation transport, and fusion. (Generally, a student may take one or two of these courses.)

The subcommittee concluded that the nuclear-engineering curricula at U.S. universities have not changed considerably during the past 15 years and are adequate and appropriate to support the needs of the broad nuclear industry. The curricula are now stronger, even in the power area, because students are doing more in their first 2 years of study based on better mathematics skills and because faculty are connecting with students early in their programs to keep them involved in the nuclear-engineering degree programs. Furthermore, the ABET accreditation process supports continuous improvement with input from various constituencies, including the nuclear-power sector, and has had a positive effect on strengthening these programs. Each program has an advisory board, and those boards provide very good input.

It is impractical to attempt to establish an "optimal" educational curriculum for all "nuclear engineers" because there is a wide range of needs within the nuclear industry. The curricula are pretty much the same, already. There is no need for a direct role for DOE in formulating

undergraduate nuclear-engineering curricula. The one area that could be improved in the education of nuclear engineers is the development of practical engineering work experience and the individual practical skills appropriate for nuclear-power venues.

The task force recommends that the university nuclear engineering programs consider including at least one practical work-experience opportunity in all of their undergraduate programs. It also encourages the nuclear industry to make numerous opportunities available for all undergraduates studying nuclear engineering in the country. All components of the nuclear industry should become closely involved in the undergraduate-curriculum development at universities through their active participation on departmental advisory committees and boards. This recommendation also supports the ABET "continuous improvement" requirements.

All components of the nuclear industry are encouraged to directly support the research programs at universities to develop faculty who will work on industry-specific research problems and involve students with industrial interests. All components of the nuclear industry are also encouraged to support faculty members with research projects, including summer-internship work experiences and sabbatical opportunities for faculty.

Warren Miller asked what fraction of graduates of nuclear-engineering programs go to industry, graduate school, etc. Andrew Klein responded that roughly one-half go to graduate school and one-half go to work (especially the nuclear Navy).

Ahearne commented that the initial concerns seem not to have been true. Andrew Klein responded, that is correct. Ray noted that trying to interpret what was behind those stated concerns was the topic of the task force's first meeting.

McNeill commented that to define "optimal" for a specific job is difficult. Exelon was generally pleased with the graduates that came to its employ. Exelon provided them with a number of training opportunities. He asked if the Task Force had looked at such opportunities. Andrew Klein responded that they had not, other than graduate school.

Mtingwa stated that every student should study basic biology to understand the effects of radiation on living things.

Long noted that, in the most recent *Professional Reactor Operators* magazine, a two-year training program is pointed out as being effective. McNeill added that individual courses and training provided a mix of theory and practical experience. Fertel suggested that the Task Force get the help of Carol Berrigan of the Institute of Nuclear Power Operations (INPO). Also, a number of executives in industry say that it would be helpful if mechanical engineers and electronic engineers could get a minor in nuclear engineering. Andrew Klein responded that most programs have minors available. Interns should be advised to make use of them.

McNeill moved to accept the report; Ahearne seconded. The motion passed unanimously.

Hartline suggested thanking all the task force members for a very good job. Magwood added that this effort had debunked the idea that there is a problem and had made positive suggestions. He promised to distribute the report to all the nuclear-engineering programs. He also asked Fertel to distribute it to industry.

Martin introduced **John Gutteridge** to speak about nuclear-engineering education within NE.

In FY96, NE's University Programs were funded at a level of $3.5 million, which essentially covered only fuel for university reactors. Since then, the growth has been fantastic; today, the program is funded at $22.9 million per year and has participants in 27 states and Puerto Rico. As funding has rebounded, the number of undergraduate nuclear-engineering students has increased as well, and they now number almost as many as there were in 1990.

NE's programs still include fuel for reactors, matching grants, fellows and scholars, and reactor sharing. But they also support a large number of other projects:

- six Innovations in Nuclear Infrastructure and Education (INIE) consortia
- 26 new and 21 continuing nuclear-engineering-education research grants

- 95 fellowships, scholarships, or internships
- 20 grants for university-reactor instrumentation
- reactor-sharing support to 21 universities
- 35 teacher (7th to 12th grade) workshops offered through the American Nuclear Society
- three to four programs in radiochemistry at $300,000 per year
- five university partnership programs at minority institutions
- three new nuclear-engineering schools
- fresh fuel and spent-fuel support for all requesting university reactors; the spent fuel is to be handled by RW in FY05
- six U.S. and six foreign students supported in the international student-exchange program
- outreach to high school students about the Nuclear Hydrogen Initiative

The university partnerships in nuclear-engineering education are designed to attract minority college students into the field of nuclear engineering. It partners a majority school that has a nuclear-engineering program with a minority institution. Students at the minority school can complete their degree in a selected scientific field while obtaining a second or advanced degree in nuclear engineering. The program addresses the decline in the number of independent nuclear-engineering programs and the increasing workforce requirements in nuclear science. It is administered by South Carolina State University with the assistance of the South Carolina Universities Research and Education Foundation (SCUREF). Since the program was established, the following partnerships have been established:

- South Carolina State University/University of Wisconsin
- Tuskegee Institute/University of Cincinnati
- University of New Mexico/New Mexico State University
- Prairie View A&M University and Texas A&M at Kingsville/Texas A&M University

Support has been provided for more than 40 students and 2 junior faculty members. In 2004, the Polytechnic University of Puerto Rico will partner with the University of Missouri at Columbia. Missouri is funding a good deal of this partnership. It takes a lot of time to get these programs up and running.

The INIE Program was established on the basis of recommendations of NERAC, which had concerns about the nation's ability to respond to the growing demand for trained experts in nuclear science and technology and about the closing of valuable university research reactors. INIE is now the largest NE education program. The solicitation for the program was issued in December 2001; proposals were submitted in March 2002; in April, the six best proposals were selected from the 13 submitted; in September, funding was provided to four consortia; and in summer 2003 the fifth and sixth INIE projects were awarded. Thirty-two institutions are now involved in the six consortia that have been funded.

To interest students in the nuclear-hydrogen future, NE personnel are visiting high schools and demonstrating the benefits of using hydrogen for transportation in a fuel-cell model car. A car kit is left at each school visited. In addition, students in Boise and Idaho Falls got to attend a GIF meeting in Sun Valley.

In the future, the Office hopes to

- support new research-reactor designs and/or increases in power at existing research reactors
- support junior faculty research
- provide full support for INIE and matching grants
- establish additional university partnerships to increase the number of minority nuclear engineers
- improve the fuel-manufacturing process through the modernization of fuel-fabrication facilities

- support more health-physics education
- provide even greater security at research reactors in accordance with NRC guidelines and regulations
- increase the focus on the eventual conversion of university reactors to low-enrichment uranium fuel [this will be expensive; Training, Research, Isotope Production, General Atomics (TRIGA) reactor conversions cost about $4 million apiece]

There is trouble just getting fuel for the TRIGA reactors from France. Until the money is there, they will not open a second fuel line with LEU. The prospective Purdue reactor would have LEU fuel. The upgrade for the Missouri reactor goes through another office of DOE.

In summary, NE's University Programs office has come a long way from a fuel supplier to a program that supports major initiatives in many aspects of nuclear-engineering education. Enrollments are soaring; funding is steadily rising; and the members of the university nuclear-engineering community are working cooperatively with one another. New initiatives will make more research funding available for young professors, help design a new research reactor, and increase student interest in nuclear engineering, thereby increasing enrollments. The student population needs to be grown carefully so that supply is consistent with demand; this will help preserve salary levels, job opportunities, and student interest in nuclear engineering.

Martin commented that nuclear engineering is an exciting career today. The curriculum could be easily marketed. He asked if there was a broader picture than just NE and whether the broader community could be coordinated. Gutteridge responded that NE is the leader. The Navy has started a postdoctoral research fellowship program. SC has dropped the ball in health physics and radiochemistry. NE has picked up that ball because of the Office's and NERAC's leadership.

Hartline asked if any demographics were available for the 1300 to 1500 students now enrolled vs. those enrolled 15 years ago. Gutteridge replied that the information available was simply anecdotal. A lot of women are entering the profession. The program is working on developing such statistics now.

Corradini countered that women seem to be decreasing at the University of Wisconsin. Rather, they are going into other engineering programs. They are about 20% of the university's nuclear-engineering students. Gutteridge stated that the NE fellowship and scholarship programs are much more heavily weighted toward women.

Warren Miller noted that the weapons laboratories had large numbers of graduate students go into NNSA, which has not supported nuclear-engineering education. He asked to what degree NE could approach NNSA to provide support to nuclear-engineering students. Gutteridge responded that NNSA does a lot in education, just not in nuclear-engineering education. The NE staff is so busy with the current program that it has not had time to approach NNSA, but it will in the future.

Mtingwa asked if it would be useful for NERAC to investigate the paucity of programs in radiochemistry. Magwood stated that there is a problem, and it is well known. The Office is putting money into that area, but it is not enough. More funding is needed in that area. Support for that funding might be garnered by a survey. Gutteridge noted that the current program has a number of universities with radiochemistry programs that receive funding from the NE program, and the program's $300,000 is leveraged heavily by the universities.

Sessoms noted that a lot of work went into getting more women into science; the same has to be done for nuclear engineering. Long commented that one-week workshops for elementary-school teachers would be an effective method to improve the interest in nuclear science and engineering.

Paul noted that there is a synergy between the NNSA complex and the nuclear power industry with respect to cultivating the next generation of nuclear engineers.

Cortez asked for a short summary on the availability of university reactors and students interested in nuclear engineering. He also pointed out that, if the United States goes to Mars, it will need to nuclear energy to do it.

Fertel said that the nuclear community needs to figure out how to communicate the good news about nuclear power and engineering. Also, the letter about HEU should mention how the money to do that should be provided.

Gutteridge suggested that NE could do elementary-school teacher workshops through the American Nuclear Society.

Martin introduced **Michael Corradini** to speak about Gen-IV nuclear-energy systems and to present the Subcommittee's first progress report.

The NERAC Gen-IV Roadmap Subcommittee completed its work in early FY03. The roadmap was approved by NERAC and is now being implemented. NE has now asked for a new subcommittee to examine and review

- the current FY04 and draft FY05 program plans,
- the level of funding that was requested versus that needed,
- the organizations involved in executing the plan, and
- the technical results to date and expected results from planned future work.

The subcommittee was formed in March and held teleconferences in April and May. It reviewed the DOE Strategic Plan and the program plan for light-water reactor (LWR) R&D. A two-day meeting is planned for June or July.

The subcommittee plans to discuss three topic areas.

The first topic is the timing of Gen-IV nuclear-reactor systems. The Subcommittee notes that the program plan indicates that fast-spectrum reactor systems are the ultimate objective in a 2050 timeframe. Prior to 2050, several reactor systems are emphasized. A number of questions arise: Is the timing reasonable with the apparent dual nature of the goals? How does this timing reflect upon reactors that are deployed? What are the criteria or considerations that would move this need for fast reactors to an earlier or later timeframe? Given that a link to the AFCI is vital, how does the timing of Gen-IV mesh with the needs of AFCI?

The second topic is the relationship of Gen-IV nuclear-reactor systems. The program plan speaks about the SCWR as a thermal concept. However, the plan seems to remain silent on the use of the SCWR for the NGNP and hydrogen production. Is the SCWR considered to be a more economic LWR? Is the SCWR being considered as an NGNP concept? Is the SCWR being considered in fast-reactor concepts? To link all this together, what is the overall plan for the SCWR in a down-selection process; what does it compete with, and what is the timeframe?

The third topic is resources for Gen-IV nuclear-energy systems. The program plan has performance targets that are a bit vague, given the wide range of reactors and activities. In the out years, the plan has two sets of numbers (target funding and the amount needed to do it right). The target funding is relatively modest given the Gen-IV goals. Is the timing/process of down-selection linked to funding? If the resources available are limited, is there a hierarchy in the Gen-IV goals that favors one path or another? Can the performance targets be made more specific or be more closely related to a ranking of the goals? There has to be a closer linkage.

Cochran said that the goals of the Gen-IV program were to design reactors that were economically competitive with natural gas, safe, and nonproliferation resistant. The reactors currently being considered in the program did not meet those criteria. The Subcommittee is setting a new goal that is based on meeting the repository capacity, returning to fast reactors.

Ray said that the country needs to prepare for a far-different future that exploits the Gen-IV technology. If things go on as they are going, the hurdles will remain high. But the future possibilities may be more adverse than the basic assumptions.

Rempe said that a link needs to be maintained between Gen-IV and AFCI; also, a large number of options should be left open. Fertel added that R&D should be separated from

deployment. A large number of options need to be ready with the right technology to meet the needs of the future. No one will deploy a Gen-IV reactor in the next 10 years, but an NP 2010 reactor could be deployed in that timeframe.

Sessoms stated that public policy should also be looked at, separate from R&D, to see what is possible.

Cochran said that there is a near-term possibility (NP 2010) that needs a government subsidy to kick it off. The next generation of reactors should make the technology more economical so it can penetrate the market. If another $40 billion is spent on R&D for fast reactors, nuclear energy will be in the same boat that it is in today.

McNeill pointed out that progress in nuclear engineering is basically evolutionary and not planned. The next reactor is not going to be a Gen-IV reactor. No board of directors will support a large plant of untried design. Systems are needed that do not rely on probabalistic analyses. One needs to be thinking about what is deployable in the near- to mid-term. One does not need to face the radioactive-waste problem until 2020. Building a fast reactor to support radioactive-waste recycling is doable even today.

Ahearne noted that R&D is hidden in a lot of offices of the Department of Energy and that this committee needs to address issues that involve R&D.

Corradini stated that the Subcommittee assumes that NP 2010 will produce a reactor and that there will be a Yucca Mountain. The Subcommittee is not sure that there will be a second Yucca Mountain. The Subcommittee notes that there is a hierarchy of Gen-IV goals. The original goals are still there. The Subcommittee wants to know how the program needs to change as the landscape changes. Gen-IV has to be consistent with the requirements of AFCI. The Subcommittee is trying to get a clearer picture of the assumptions, goals, timing, etc.

McNeill said that, if one constrains Gen-IV to AFCI requirements, one has to throw out a lot of opportunities. Corradini said that his personal opinion was that making a fast-spectrum reactor that is economical, safe, and nonproliferation resistant is very difficult, and the task should be started. In the meantime, other designs should be exploited.

Magwood said that all of the speakers were telling the truth. The Gen-IV Program has two parts. The first part incorporates once-through thermal reactors [the very-high-temperature next-generation nuclear power (NGNP) reactor and the supercritical-water-cooled reactor (SCWR)]. The U.S. funding is going into the NGNP; the Canadians are interested in the SCWR. The second part of the Gen-IV Program is where fast reactors come in. It is not known if a fast reactor would be needed in 2040 and, if it is, which one. That is what the R&D program is for. The foreign participants in Gen-IV are looking at those possibilities. If one thinks that nuclear technology has a long-term role, one cannot ignore fast reactors. The uranium supply is limited. We are formulating a research program to address the uncertainties, not building reactors and deploying them.

Martin pointed out that these are huge national issues and that NERAC plays a major role in sorting out these possibilities. If the United States leaves the nuclear table, the rest of the world will go forward without us. The United States needs to be a leader, not a follower, of the international community. He declared a mid-morning break at 11:06 a.m. A revision to the third ANTT recommendation was displayed during the break for the committee members to view and consider:

"The Generation-IV Program should consider the benefits to the repository of a fast-spectrum system in its analyses."

In addition, a proposal was displayed for Committee consideration:

"A letter should be sent from the NERAC Chairman to the Secretary of Energy expressing NERAC's concern about the current situation regarding the availability of research isotopes and the issue of NIH engagement. The letter would be drafted by members of the Subcommittee on Isotope Availability and circulated to the full NERAC for comment."

Martin called the committee back into session at 11:32 a.m.

Ahearne moved and Mtingwa seconded that the revision of the third ANTT recommendation be approved. The motion was approved unanimously.

Magwood said that the NIH engagement would be appropriate. Ahearne moved and Sessoms seconded that the Subcommittee on Isotope Availability be asked to draft a letter for the Chairman to send to the Secretary calling for engagement with NIH on addressing the problems associated with making research isotopes available to the research community. The motion carried unanimously.

Martin introduced **John Sackett** to present a report on the RERTR. Sackett said that there are about 250 research reactors in the world; half are designed to use HEU. Of those, 38 have been successfully converted to LEU. The fuel developed can replace the fuel in 90% of the HEU-fueled research reactors, so the program has been successful in that regard. The program stopped in 1986 because of the difficulties in converting the remaining 10% of HEU-fueled reactors. In 1996, the program was restarted with technical progress in designing a very-high-density-uranium-235 (about 16 g/cm^3) LEU fuel that will replace HEU fuel for the remaining research reactors, including those in Russia. Five countries have qualified to use this fuel.

Hartline asked if there were any showstoppers. Sackett said, no.

Rempe asked if high-density targets for isotope production could be made. Sackett replied that, if one can produce a high-density fuel, one can make high-density targets. So that is part of the program.

Sessoms asked how much it would cost to convert, say, the MIT reactor. Sackett said that he did not have the exact number. It would be expensive, but less than $10 million. He promised to get more specific costs for the Committee.

Magwood asked Sackett to comment on the performance of the reactors converted to LEU fuel. Sackett said that there is a reactor analysis that goes along with matching fuel performance with a specific reactor design. So far, 38 reactors have been converted, and their subsequent performance matches their previous performance. It would not be unreasonable to expect equal or increased performance for future conversions.

Fertel asked if more money would speed up the conversion process. Sackett replied, no. The team can only do so much. Ahearne asked whether, once the design was worked out, the funding to fabricate the fuel was limited. Sackett replied affirmatively. Fertel said that this Committee should recommend funding for fuel design and fabrication. Martin cautioned that the Committee should also ascertain that the research performed with these fuels would be effective and should consider the economic efficiency. Sackett pointed out that there are synergisms within this program that help maintain capabilities.

Corradini asked if there was a white paper that substantiated these assertions. Sackett said that one could be provided by the afternoon. Corradini suggested that (1) the letter to the Secretary (proposed the day before by Cochran) include a statement that the effectiveness of the LEU fuel would not be decreased and (2) the white paper could be attached as background.

Cochran said that this program has to be accelerated. That is the purpose of the letter. The U.S. reactors have to be converted to encourage the foreign reactor operators to do likewise.

Fertel questioned whether others should make this statement rather than the Committee's writing a white paper. Ahearne said that NERAC needs to get something into the system to get things moving along. Cochran said that the NNSA has said that they are accelerating their program, but the U.S. program is stalled.

Comfort said that the letter did not have the punch that he was expecting and that some rearrangement might be helpful. Martin said that he and Ahearne would rework the letter and forward it to Magwood. He requested that the white paper be submitted from Sackett.

Magwood introduced **Helen Leiser**, Policy Director on the Generation-IV International Forum (GIF) Secretariat, to speak about the Gen-IV International Forum's progress.

The GIF was established in January 2000, and its membership has expanded to include the European Union. The GIF Technology Roadmap outlined R&D priorities, identified 16 near-term designs, and selected six Gen-IV systems:

- gas-cooled fast reactor
- lead-cooled fast reactor
- molten salt reactor
- sodium-cooled fast reactor
- supercritical-water-cooled reactor
- very-high-temperature reactor

The GIF policy group met in early May and approved a policy statement on GIF governance, agreed on arrangements for OECD's Nuclear Energy Agency (NEA) to provide a Technical Secretariat, discussed the proposed legal framework for R&D collaborations, updated R&D plans, approved the terms of reference for a Risk and Safety Working Group, reviewed areas for cooperation with IAEA and INPRO (the Innovative Reactors Project of the IAEA), and interacted with Idaho high school students.

The management framework of the GIF needed to be strengthened; the policy group was formed to determine consensus. The Policy Secretariat supports the chair of the Policy Group and helps build consensus. The Technical Secretariat supports collaborative R&D, including supporting the work of systems committees, project boards, and other groups with databanks etc.; NEA will assure continuity. The GIF members will contribute funds and cost-free experts.

Legal agreements are on the agenda now. They are needed for R&D costing $600 million to $1000 million per system. DOE is to lead the drafting of agreements that will be signed by participants in the system steering committees and project-management boards. Two task forces have been set up to help resolve the remaining issues on the agreements and to develop guidance on the valuation of contributions.

Provisional system steering committees are in place for the gas-cooled fast reactor, the lead-cooled fast reactor, the supercritical-water-cooled reactor, the sodium-cooled fast reactor, and the very-high-temperature reactor. In addition, the policy group agreed to establish a molten-salt-reactor system steering committee, which was proposed by France. The quality and consistency of system research plans are being reviewed by the Experts Group; most reviews will be complete by July. Good progress is being made in defining projects for each system. Much R&D is already under way under bilateral agreements.

The latest of the methodology groups, the Risk and Safety Working Group, was established. Its purposes are to define safety and quality-assurance goals and evaluation methods; to advise the Experts Group and Policy Group on interactions with nuclear-safety regulatory authorities; and to facilitate integrated consideration of safety, proliferation-resistance, and physical-protection goals.

The IAEA has a permanent-observer status in the GIF. Most GIF members are also in IAEA's INPRO. There has been much useful practical cooperation with the IAEA and INPRO:

- GIF experts assisted with the peer review of the INPRO methodology framework.
- IAEA experts participated in the GIF Proliferation Resistance and Physical Protection (PR&PP) working group.
- The IAEA code of accounts is used by the economic modeling group.
- GIF has a potential interest in the IAEA's project on the safety of innovative reactors and the development of sustainability indicators.

A GIF/ INPRO liaison meeting is expected to be held in September.

The key goals for the next six months are to get the GIF Technical Secretariat up and running, to put agreements in place for systems and key projects, to put quality-research plans in place, to perform methodology work on the schedule and integration, to dialogue with industry and regulators, and to bring up a GIF public website.

Ralph Bennett joined her on the floor to answer questions. Martin asked what the benefits to the United States were from this international cooperation, specifically whether there was a multiplier effect. Leiser said that this program puts the United States in the lead position to influence technological advances. The world has a global economy, and this program integrates the United States into that economy. The research results of this program will go a long way to allay public concerns about nuclear power.

Magwood said that the overall picture is that the development of the next generation of reactors will have to be an international effort.

A more detailed copy of the budget for the Office of Nuclear Energy, Science, and Technology was distributed.

Public comment was called for. There being none, Martin adjourned the meeting at 12:31 p.m.

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