Minutes for the
Nuclear Energy Research Advisory Committee Meeting
November 17-18, 1998, Hyatt Regency Crystal City, Arlington, Virginia

NERAC members present:

John Ahearne (Tuesday only)
Thomas Boulette
Thomas Cochran
Joseph Comfort
Jose Luis Cortez
Maureen S. Crandall (Tuesday only)
Allen Croff
James Duderstadt (Chair)
Marvin Fertel
Beverly Hartline
William Kastenberg
Dale Klein
Linda Knight
Robert Long
Warren Miller
Sekazi Mtingwa
Richard Reba
Joy Rempe
Robert Socolow (Tuesday only)
Daniel C. Sullivan
Bruce Tarter (Tuesday only)
Charles E. Till
Neil Todreas

NERAC members absent:

J. Bennett Johnston
C. Paul Robinson
Miguel Rios
Glenn Seaborg
Allen Sessoms
John Taylor

Also present:

Norton Haberman, Senior Technical Advisor, Office of Nuclear Energy, Science, and Technology, NE, DOE
William Magwood, Director, Office of Nuclear Energy, Science, and Technology, NE, DOE
Ernest Moniz, Under Secretary, DOE (Tuesday only)

November 17, 1998

Chairman **James Duderstadt** opened the meeting at 10:35 a.m. He thanked the members for donating their time and effort to serve on this committee and went around the table for each member to introduce himself or herself. He pointed out that it is widely held that nuclear energy option should continue to be a part of the nation's energy portfolio. The responsibilities of this committee are quite broad and should have an impact on the research effort required for nuclear energy to make that contribution.

He introduced **William Magwood**, who welcomed and thanked anew the members present. He said they were selected because of their special expertises. After a hiatus, he said, DOE's nuclear budget is recovering. As nuclear programs disappeared from the DOE budget, no effort was made to think out what DOE's role should be in the development of nuclear energy. That loss must be corrected during this recovery period. He presented the charge letter to the members; it outlines how this

committee can contribute to the recovery. He reviewed the agenda for the meeting and thanked his staff for their help in holding this meeting.

He turned the microphone over to **Norton Haberman** who described the meal schedule and the briefing books, requested any needed corrections to the address information contained in the list of committee members, noted that the next meeting would be in March, and reviewed reimbursement procedures.

Duderstadt said that he would like to operate the meetings as informally and equitably as possible and that individuals' expressions of interest in serving on subcommittees would be solicited. The whole committee will meet about three times a year. He asked for questions; there being none, he introduced **Rachel Samuel** to review the mandating legislation and guidelines covering the conduct of the committee.

She noted that the committee is mandated by the Federal Advisory Committee Act, which was enacted to avoid government managers' getting self-serving advice from biased sources, and is governed by Title 41 of the *Code of Federal Regulations*, Part 101-6, and by DOE regulation M 510.1-1 (Advisory Committee Management Program). All DOE advisory committees are overseen by James Solit, and NERAC is guided by the Designated Federal Officer, Norton Haberman, whose responsibilities include setting agendas, attending meetings, and moderating discussions. The committee's role is strictly advisory (lobbying is prohibited); it must conduct its business openly; and it should provide advice on the development, implementation, and evaluation of policies and programs in a defined DOE subject area. The members were selected for their expertises and to reflect a balanced point of view; their membership reflects a geographic, ethnic, institutional, and public diversity. They must be sensitive to conflicts of interest and were provided with a conflict-of-interest charge letter. Requirements of members include commitment (prepare for meetings and ask questions), frankness (make candid and objective observations and recommendations), and the avoidance of even the perception of conflict of interest.

Duderstadt asked if there were any distinctions about how federal employees might be in conflict of interest. Samuel answered that federal employees must conform to a stricter policy on conflict of interest. The ethics officer is the arbiter of such issues. Ahearne asked if a committee member can participate in the submission of a proposal for agency funding, and Kastenberg said that he had been told that he could and that this was reflected in the handout on ethics restrictions. Samuel said that DOE is more concerned about contractors serving on its committees than about grantees. Fertel asked if committee members can talk to members of Congress about supporting nuclear energy. Samuels responded that one can talk but not lobby. Todreas commented that committee members have to be careful about the appearance of appropriateness and that membership on the committee should be closely monitored and directed.

Duderstadt introduced **Ernie Moniz** who thanked members for their participation and reviewed the concept of an advisory committee. He noted that DOE was in an ongoing process of developing roadmaps, identifying objectives, setting priorities, and selecting ways to attain those objectives.

He felt that cooperative activities between program managers and advisory committees was beneficial and effective. A number of forces are currently being felt in the energy area (e.g., climate change and environmental concerns), making the Department reexamine its options. The nuclear program has lost its focus during the past 20 years. Now we need to look ahead and set the goals and objectives for society and government not only in nuclear energy but also in medicine, ocean currents, and other R&D in which isotopes play a major role. Questions that must be answered include:

- What infrastructure is needed?
- What facility construction and human-resource planning will be needed?

The committee's advice will be sought on such questions, and he will insist that everyone in the organization consider very seriously the advice that comes out of this committee.

Ahearne noted that the NERI program is very fragile and asked if the Department is continuing to support the budget. Moniz replied that the Department will go back to Congress in support of the NERI and NEPO programs. It had another program that was not funded but feels strongly that elements of it should be funded. Long asked if health studies were the subject of another committee, and Moniz said that no specific committee has been set up to guide that work. A number of committees could contribute to the consideration and guidelines in this area. Tarter noted that this committee touches on many other activities of the Department and asked how closely it should stick to considering the programs of the Office of Nuclear Energy, Science and Technology (NE). Moniz said that it should be focused on the programs of NE but can also comment on programs that are contributed to by NE or are affected by or affect NE programs.

Duderstadt noted that NERAC advises DOE, not just NE. Todreas asked if there were some protocol that the committee should follow in communicating to those in DOE above Bill Magwood. Moniz said that communication is encouraged, and the committee is structured so that communication can easily occur through the structure and reports of the committee. Mtingwa asked what some of the major criticisms of earlier advisory efforts were, and Moniz responded that there was a feeling that business interests were too close to the program management.

Cochran commented that there was a perception that NE is designed to support the nuclear power industry and asked how DOE sees the role of NE in supporting an industry that has fallen on hard times. Moniz responded that fossil, hydro power, and energy efficiency research all affect industry. It is not up to us to advocate or influence market share of any specific technology. Climate change is a good example. It has been looked at for 20 years but has only recently been influential in setting policy. How it will shape the marketplace several years down the road is open to speculation. We want to make sure the marketplace has the broadest number of options to turn to when it seeks to deal with the needs of society. As another example, electricity restructuring plays an important role in how we do R&D and what our R&D portfolio should include. Cochran followed up by asking what NE's role should be an supporting the nuclear power industry. Moniz pointed out that the NERI program rather than NEPO was adopted. NERI does not support a specific license application but has research elements that will support nuclear energy broadly.

Crandall noted that the Energy Information Administration (EIA) has come up with some startling economic analyses about the response to climate change. The committee here, she said, seems split between nuclear research and nuclear power. How broad is the mandate and focus of this committee? Moniz said that EIA only considers when licenses expire. They do not build in anything more than extrapolating the present, the business-as-usual situation. That analysis has a number of faults. The committee has a broad set of issues to consider. It cannot accomplish everything at once, but through subcommittees it will develop roadmaps and other guidance on all these different issues.

Socolow asked how far away the military side of the issues is. Moniz said that this is not an area into which the committee wants to go. Fertel asked if this committee should be picking up issues on international safety, and Moniz said that core conversion is one example of that. But the issue of safety, no matter where, is one that is certainly important.

A break was declared at 12:00 noon for lunch. As lunch was progressing, Duderstadt called the committee back to order to hear Marvin Fertel of the Nuclear Energy Institute speak on the U.S. nuclear-energy program. He called attention to the fact that 18 states have acted to restructure their electric utility industries, splitting ownership of generating and distributing functions and opening the marketplace for electricity service to multiple rather than single suppliers. This deregulatory restructuring has led to a series of mergers and acquisitions as companies identify core-business strategies; define domestic and international markets; bundle electric, gas, and other energy services in product mixes; and divest generating or transmission functions (10% of the U.S. grid has been put up for sale at a value of $18 billion). In the past year, 24 mergers among energy companies were started, with the 104 operating U.S. nuclear plants a major part of these transactions.

Despite the fact that the most recent U.S. nuclear-plant order was in 1977, nuclear energy produces 20% of U.S. electricity, second only to coal as an energy source. Since 1990, America has experienced an excess of capacity, and electricity demand has changed. As a result, peaking (often gas-fired) rather than baseload (e.g., nuclear) plants have been needed by the utilities. The United States is not alone. The French, often cited for their aggressive nuclear-power program, have not started a new nuclear plant since 1986.

As restructuring progresses, about one-third of all stranded investment (costs that were accrued under regulatory control to underwrite plants, equipment, and programs but whose investors and owners will no longer be the same entities in the restructured industry) consists of nuclear facilities. This situation raises two major questions: How well are U.S. nuclear units positioned as competition develops, and how will U.S. nuclear units fare in a fully competitive market? These questions translate into two practical considerations: the recovery of sunk capital and the economics of operating nuclear plants. He presented charts (drawn to different scales, so they were not directly comparable) to show the differences in cost elements for nuclear power under the cost-of-service (regulated) and competitive systems, and he pointed out that nuclear energy is the only technology for which all costs have been internalized (including plant decommissioning, waste fees, and fuel-processing-plant decommissioning and demolition). A graph showed nuclear electricity production

costs to be comparable to those of coal and significantly less than those for gas and oil between 1986 and 1996. In addition, nuclear-power production costs were shown to have decreased from 1992 to 1996. High-cost nuclear plants outnumber low-cost nuclear plants both in absolute number and in operating and maintenance spending. This situation presents opportunities for improving economic performance. In light of the waning nuclear-industry infrastructure, the Nuclear Energy Institute published a visionary plan for the 21st century this past August. Most important of its eight "compass points" to guide the industry's direction is "excellence in safe and reliable nuclear power plant operations worldwide."

Fertel pointed out that nuclear energy receives no value for nonpollution as other fuels get or will get under the Clean Air Act (CAA) and the Kyoto Protocol; it gets no value for the capacity reserves it represents; and it is attributed no value for avoiding transmission requirements and constraints. These, he said, are hidden values of nuclear energy. In addition, in 1996, the use of nuclear energy avoided the production of 147.3 million metric tons of CO_2, about 90% of the carbon reduction achieved in the United States. Meeting the requirements of the Kyoto Protocol will be very difficult. For the United States, it will require the equivalent of renewing the licences of all currently operating plants and building 40 new plants. In addition to CO_2, nuclear power has avoided introducing SO_2, methane, nitrogen oxides, and other pollutants into the atmosphere. Replacing nuclear plants with fossil-fuel plants will place heavy pollution-control-attainment burdens on the electricity industry. Thus, he said, credit for nonemitting sources under the CAA and the Kyoto Protocol represents a significant benefit for nuclear plants.

He also reported the results of a poll of college graduates done this past year in which the respondents were asked "Which sources of electricity will be used most in the U.S. 15 years from now?" Nuclear energy was mentioned most frequently, with 45% of the respondents citing it; solar energy came in second, with 32% of the respondents citing that energy source. In another poll that encompassed Congress, opinion leaders, and the general public, 65% of the respondents favored the use of nuclear energy as one means of producing the United States' electricity, but only 21% of the respondents perceived the general public as favoring the use of nuclear energy.

He noted that the nuclear power industry faces a number of challenges. To play in the marketplace, it must provide safe and reliable operation, increase economic efficiency, develop a more effective regulatory process focused on safety, make progress on spent-fuel storage and disposal, and reduce the capital costs of new plants. He concluded by stating:

- A large number of existing nuclear plants will be competitive in the new electricity market.
- Many units will pursue license renewals.
- The economics of nuclear energy would be significantly enhanced by the recognition of their environmental benefits.
- U.S. leadership in nuclear technology should be bolstered by pursuing excellence in program implementation, resolving fuel-disposal issues, selling U.S. advanced light-water reactor (ALWR) technology overseas, and undertaking long-term R&D initiatives.

Comfort asked whether in the current environment a utility might build a nuclear plant. Fertel

answered, no. Our current ALWR technology is cheaper in a technical sense but not in a capital sense. There is no incentive to spend large amounts of money and five years to build a nuclear plant when I can build gas cogenerator plants faster and cheaper. From an electricity-supply perspective, there are a lot of risks that are not being addressed. Miller asked if Fertel could give any guidance on proliferation as a concern. Fertel said that if there is a large growth internationally, proliferation resistance takes on a larger role. Cortez noted that most utilities have a mixture of fuels, and asked whether, in restructuring, anyone had looked at buying the nuclear plants and making them efficient. Fertel responded, yes, some consortia are doing just that (e.g., Entergy); you are going to see it come together in consolidation.

William Magwood then took the floor to describe the activities and structure of his Office. He pointed out that NE previously focused on national security with emphases on improving international nuclear safety, conducting transparency activities for highly enriched uranium and reducing plutonium production and processing in the former Soviet Union. Most of these activities went to the Office of Nonproliferation and National Security. Now NE focuses on energy resources (including nuclear-power-plant optimization, the Nuclear Energy Research Initiative, and support for university nuclear science and reactors), science and technology (including space and defense power systems, the isotope program, and test and research reactors), and environmental quality (including managing nuclear facilities, deactivating unneeded facilities, developing nuclear-waste-treatment technologies, and managing DOE's uranium inventories).

He compared the funding for nuclear R&D in FY 1998 ($7 million) with that for FY 1999 ($30 million) within the total NE budget for FY 1998 ($241.2 million) and FY 1999 ($245.7 million).

In the future, the Office will focus on

- supporting NERI and NEPO at levels approaching those recommended by PCAST (up to $120 million/year for NERI and $10 million/year as seed money in NEPO-sponsored partnerships with industry);
- launching the Advanced Nuclear Medicine Initiative;
- determining and addressing the nation's nuclear research-facility requirements;
- increasing support for universities in nuclear engineering and related fields; and
- supporting NASA's potential manned mission to Mars.

Miller asked if the Office had any landlord responsibilities. Magwood said that NE is a landlord at two facilities: in Idaho and at Argonne National Laboratory (ANL) West. It also has some oversight responsibilities for some uranium-enrichment sites. Cochran noted that budgeting information for individual programs would be helpful. Magwood said that the office will see that information is provided in the future. Tarter asked how constraining the report language is on the budget, and Magwood replied, very.

Duderstadt then introduced **Earl Wahlquist** to speak on space nuclear power systems. The mission of this program is to develop, demonstrate, and deliver compact, safe nuclear power systems and related technologies for use in remote, harsh environments, such as space. The current emphasis is

on radioisotope power systems, but additional work could be performed on space reactors and space nuclear propulsion. The current radioisotope power systems use decay heat from Pu-238 to generate electricity and heat. They have a long history of use in space. DOE provides these power systems to user agencies but retains ownership of them. These power sources are slated to be used on a series of space missions during the next decade. The key components are the Pu-238 fuel, the iridium or platinum/rhodium cladding, a graphite block, and electrical converters. These components are manufactured in Tennessee, New Mexico, and Ohio. Before satellite launching, the NE program provides environmental-impact-statement support to NASA, safety analysis reports, and launch support.

Cochran asked if the program made batteries for warheads, and Wahlquist answered, no. Cochran asked if they made generators out of any other isotope than Pu-238, and Wahlquist answered, no, but previously we did. Cochran asked, why Pu-238? Wahlquist answered because of its long half-life and because it produces alpha particles, which require little shielding.

The major issues confronting the program are the need to develop advanced systems (the current model is only 7% efficient), the closure of the Mound Site and potential relocation of the activities carried out there, and the finite supply of Pu-238. An advanced model under development will be up to 20% efficient, employ the same heat source, have a smaller size, and require less fuel. The challenges it holds include the development of a new technology on a fixed scheduled, a 14-year operational lifetime, and cost restrictions. It is being developed by Lockheed Martin at Valley Forge. Miller asked if there was a research program to look at even further-advanced options. Wahlquist replied that there was, but it is funded at only $700,000/year. Cochran asked who assesses the needs and safety. Wahlquist replied that NASA assesses the needs and DOE assesses the safety; NASA and DOE jointly assess the technologies.

Because the Mound Site is being decommissioned, DOE is evaluating six potential sites for carrying out the work currently performed there: Oak Ridge National Laboratory (ORNL), Hanford Reservation, Pantex Plant, Nevada Test Site (NTS), Idaho National Engineering and Environmental Laboratory (INEEL), and Mound itself. The decision will be made on the basis of an environmental-impact-statement process, with the decision to be made shortly after October 1999.

Socolow asked if this was a part of a larger (military) program, and Wahlquist answered that, in the past, space has been larger than the military portion, but now they are about the same. Comfort asked if commercial satellites used this technology. Wahlquist replied that they use solar power; if they wished to use isotopic sources, they would have to apply to the Nuclear Regulatory Commission (NRC) for a license, and no such applications have been made. Tarter asked what the Europeans and Russians use, and Wahlquist said that the Russians use Pu-238. Socolow asked if this is the only place they are made, and Wahlquist said that the Russians also make some.

The halting of Pu-238 production at Savannah River is impacting this program.. About 9 kg are available to support this program through 2002. We have a contract with Russia to purchase up to 40 kg. A new facility to recover and use scrap for new missions is being established at Los Alamos

National Laboratory (LANL), and three facilities [Advanced Test Reactor (ATR), ORNL (the High-Flux Isotope Reactor, HFIR), and the Fast-Flux Test Facility (FFTF)] are being evaluated for producing Pu-238. The Department is initiating an EIS to assist in the determination of where Pu-238 should be produced. You need to keep the concentration of Pu-236 very low, so you have to use a reactor that produces neutrons that will produce Pu-238 while minimizing the γ-n and n,2n reactions that produce Pu-236. Socolow asked about recovering plutonium from waste streams, and Wahlquist replied that there is no Pu-238 in the waste stream; you have to reprocess Np-237. The French said that they would do that for us, but at a very high price, about $6000/g; the estimated cost to produce it at the ATR, FFTF, or HFIR is $3000 to$4000/g. Cortez asked how much we were paying the Russians, and the answer was about $2000/g but that price will change over time. Duderstadt asked if any of the program for nuclear thermal propulsion was still around. Magwood said that the facilities are gone and that DOE just did a white paper for NASA, scoping that out. We would have to build that capability all over again. Cochran asked if the program has an ongoing safety R&D program, and Wahlquist replied that safety is a driver of this program.

Robert Lange then spoke on facilities management. He said that his office has management responsibility for the safety basis, including approval of the safety analysis report; operating in conformance with user requirements; approval of unusual-occurrence reports; guidance addressing resource allocation; and restart authority after major modifications or prolonged shutdown. The facilities managed are at Brookhaven National Laboratory (BNL), Portsmouth Gaseous Diffusion Plant, Paducah Gaseous Diffusion Plant, ORNL, Sandia National Laboratories (SNL), INEEL, ANL-West, and Hanford.

The HFIR/Radiochemical Engineering Development Center (REDC) in Oak Ridge has a budget of $30 million/year. The HFIR is an operational 85-MW light-water-cooled reactor used primarily for beam-scattering research and isotope production. The REDC processes transplutonium materials into user-specified products. The HFIR has always met a high standard in its compliance with safety specifications but underwent a decline in its reliability. As a result, NE's assessment of its performance in FY 1997 was "marginal." NE has taken actions, together with the field office, that have begun to result in the improved performance of HFIR.

The High-Flux Beam Reactor (HFBR) at BNL is a 60-MW heavy-water-cooled reactor that produces intense beams of thermal neutrons for neutron-scattering experiments. It is in standby mode because of a leak of tritiated water from its spent-fuel pool. Remediation is under way, and whether it will be restarted will be determined after a review of its environmental impact statement. A safety analysis report upgrade is also being written. The Brookhaven Medical Research Reactor is an operational 3-MW light-water-cooled reactor that produces neutron beams for treating brain cancer.

Ahearne asked if the language of congressional legislation prevented proceeding with the upgrade of the HFBR, and Lange said no, that the modifications are needed whether or not the reactor is restarted. Miller asked if the split of environmental responsibilities created problems, and Lange answered that they did; NE probably would have wanted wells out in front of the underground

plume of tritiated water sooner. He said that, after wells are put in to drain the plume, the plume will advance at about 1 ft/year, and there are also several plumes of volatile organic compounds that NE monitors but has no responsibility for.

The ATR near Idaho Falls is an operational 250-MW light-water-cooled reactor and associated hot cells for producing isotopes and testing naval fuels and materials; the isotope production there has been privatized. About $7 million is in the NE budget for construction-operations support, maintenance and repair, general plant projects, environmental compliance, and line-item construction. After a fatality there this year, EH (Environmental Health and Safety) put a Type-A evaluation team onsite the next day in which NE participated. A 400-page report on lessons learned and recommendations has been produced. The system then communicates these lessons and recommendations throughout the DOE community. Issues that must be dealt with at this site include attention to operations associated with nonprocess facilities, configuration management, and construction work for upgrading the site.

The Annular-Core Research Reactor (ACRR) in Albuquerque is an operational 4-MW light-water-cooled reactor for irradiating targets for the isotope program. Its hot cells are being reconfigured for the production of Mo-99. The upgrade was on schedule until a month ago, but check-out is taking longer than expected, pushing back the schedule.

The integrated site at ANL-West with the EBR-II reactor, spent-fuel facility, hot cells, and fuel-fabrication facility is being deactivated, and the spent fuel is being treated. Work is still proceeding with the Transient Reactor Test Facility (TREAT) and the Zero-Power Physics Reactor (ZPPR). Closure of the EBR-II is scheduled for January 2002. Both TREAT and ZPPR are currently being maintained in standby for potential future use.

The FFTF in Richland, Wash., is our newest and largest reactor. It is a 400-MW sodium-cooled reactor that could be used for burning plutonium and producing medical isotopes. It is currently defueled and has been maintained in standby since 1994 pending secretarial decision. It costs $40 million/year to maintain the facility..

The Office also has responsibilities at the three gaseous diffusion plants in Oak Ridge, Tenn.; Paducah, Ky.; and Portsmouth, Ohio. At all three, the equipment to make highly enriched uranium is shut down, the accumulated inventory is being disposed of, and facilities are being leased to private or quasiprivate firms. DOE still has responsibility for the unleased properties and for cylinders of depleted uranium in the form of UF_6. At Paducah and Portsmouth, the U.S. Enrichment Corporation leases facilities to produce reactor-grade uranium.

Cochran asked whether reactor sites had been given more independence. Lange responded that for 20 MW and above, the Department took back that authority; for <20 MW, the site has the responsibility. The funding stays with the Office of Energy Research (ER), but the safety oversight has been shifted to NE, where most of the personnel are nuclear engineers who have experience in testing, monitoring, and documenting safety considerations. Tarter noted that a flow diagram of who

is responsible for what would be helpful. Lange agreed and went on to observe that the Office of Science has limited dollars to spend for research.

A break was declared at 3:35 PM.

At 3:50, Chairman Duderstadt reconvened the session and introduced **Owen Lowe** to present an overview of Isotope Programs, the mission of which is to serve the national need for a reliable supply of isotope products and services for medicine, industry, and research. Those isotopes are produced in reactors, accelerators, and calutrons at BNL, ORNL, SNL, LANL, and PNNL (Pacific Northwest National Laboratory). These isotopes are used in research (e.g., Bi-213 in monoclonal-antibody cancer-therapy research), medicine (e.g., Tc-99m, 36,000 doses of which are administered daily for disease diagnosis and therapy evaluation), and industry (e.g., Ir-192 to verify the structural integrity of aircraft, ships, bridges, and other structures).

Of special concern to the medical community is the isotope Mo-99. It decays to form Tc-99m, a highly important diagnostic radiopharmaceutical with a 66-hour half-life. In 1989, the last commercial reactor in the United States to produce Mo-99 shut down in Tuxedo, N.Y., and now an aging Canadian reactor slated for shutdown produces 60% of the U.S. Mo-99 needs. Replacement reactors in Canada are planned, but DOE will need to be a backup in the interim and is preparing a facility for the production of Mo-99. Klein asked if this will be spun off to a commercial firm when completed? Lowe said that is the hope. Socolow asked if there is a way to tell what is in the private and public sectors today. Lowe responded that iridium and Mo-99 are potential money-makers. DOE is in a commercial and research business. It sells to commercial distributors and thereby recovers its costs. It gets into areas where the commercial sources get out of the business. Fertel asked how many countries are in the market, and Lowe responded that DOE is in the market only where no private source is available. Socolow asked about P-32. Lowe responded that the University of Missouri reactor is the only producer of that isotope. Socolow asked what the barrier to entry was. Lowe answered the will and resolution to operate a reactor. Todreas commented that, for the University of Missouri, producing isotopes is tangential to the main thrust of their operations, which is research. Fertel asked, isn't that a market decision? And Lowe answered, yes. Socolow said that someday the Missouri reactor will shut down and the only source will be Europe. Klein pointed out that by then the market may have changed. Duderstadt mentioned that the Missouri operation is heavily subsidized. Socolow said that is what allows them to compete. Lowe responded in agreement; the Canadian reactors are underwritten with government funds, and that makes the price of Mo-99 artificially low.

Research isotopes are expensive to produce and are used in very small quantities. That is why DOE subsidizes their production. As other research programs have shrunk, the sources of these isotopes have dwindled. Therefore, DOE is going to relocate the Isotope Beam Spur Project at LANL. With a total estimated cost of more than $12 million, this conversion will be completed in FY 2001. This relocation will enhance the availability of accelerator-produced isotopes to up to 40 weeks a year, it will lower operating costs, and it will eliminate unplanned disruptions in the supply of medical isotopes used for vital diagnostic procedures and research.

The Isotope Program's strategy is to ensure the continued supply of isotopes of interest to the research community, to continue the production of isotopes required for medical and industrial applications, and to seek opportunities for private-sector investment in production and distribution. DOE looked at the total privatization of isotope production, but some of the legal impediments made this approach impractical. It asked the private sector what they would be interested in. The first venture in this area was in Idaho where a private firm now occupies the facilities. DOE used to spend $1.5 million a year there and get back $0.5 million. Now it spends $0 and gets back $200,000 to $400,000.

The Isotopes Program has set up a revolving fund to support its operations, financed by revenues from commercial customers and appropriations. In FY 1998, it had $32 million in expenses and $11.4 million in revenues while serving 300 customers with 1250 deliveries. Making this operation self-sustaining would require abandoning the production of research isotopes and concentrating on commercial isotopes. Most researchers depend on grants. Isotopes are considered supplies, and most grants are tight on supplies. If a proposed piece of research requires large amounts of funding for isotopes, the grant does not get funded. So, where should funds be put to encourage research? Currently, DOE is subsidizing the cost of isotope research by providing the materials below market value. Prices are based on the replacement cost, market value, and the research community.

Because of time constraints, the Chairman limited discussion and moved on to **Bob Knipp** and **Trevor Cook** who spoke on the nuclear science and technology infrastructure roadmap that NERAC is to help develop. That roadmap has to address two questions: Does the United States have the needed infrastructure to support R&D through 2020; if not, what gaps need to be filled in? How do we balance the mission (i.e., what mix among the different types of facilities is needed to meet the identified needs)? Examples of the existing reactors that the committee should consider are the FFTF (on standby), TREAT (on standby), HFBR (on standby), Brookhaven Medical Research Reactor, HFIR, ATR, and the Annular Core Research Reactor. Examples of the existing accelerators that the committee should consider are those at MIT, Cornell, BNL, Jefferson Laboratory, LANL, Fermi National Accelerator Laboratory, and the Stanford Linear Accelerator Center; the committee may also want to consider non-DOE accelerators because they are major R&D contributors. The DOE hot-cell facilities that the committee should consider are those at BNL, Savannah River Site, ORNL, ANL, LANL, ANL-West, INEEL, PNNL, and Lawrence Livermore National Laboratory.

They outlined a process of workshops, assessments, and gap analyses to produce the roadmap as a method that the committee may want to adopt (or reject). A framing workshop was held Aug. 6, 1998, to develop a consensus on the scope of research, process, and organizational participation that will be needed to attain DOE's objectives in nuclear science and technology. It was attended by eight national laboratories and three divisions of DOE. One team each was established for reactors, accelerators, and hot cells. These teams categorized the capabilities of the current facilities, produced a list of all the needs of those facilities, identified research needs that will not be met by current facilities (in the United States and elsewhere), and characterized facilities that would need to be built. A preliminary report from this internal panel is expected by December. The Department, however, needs an independently developed roadmap, and NERAC will be receiving a charge letter

to produce such a roadmap, unconstrained by prior methodologies employed or conclusions reached.

Duderstadt asked how one addresses the problem that a roadmap may have a down side as well as an up side. Cook said that we start with rules and therefore have traceability for our recommendations back to policy. Duderstadt asked what happens in the case where we have too much capacity. Cook said our preliminary results are that we have fewer facilities than needed. Socolow commented that it seems we should start with what the government's needs are going to be and then work back to the facilities that will be needed to fulfill those needs. Cook responded that that is the intent of the gap analysis. Boulette said, what you are looking at is only a small part of the scope; you do not have the personnel, computing facilities, etc. Cook said, that is true; this is only a preliminary exercise. Todreas commented that this seems to take on all the scope of DOE, rolling in ER's needs. Magwood said, that is true. This is being done for the whole Department. This has been a broad activity for a number of months. We have discovered that this is very complex and will need a lot of effort. This preliminary analysis will provide feedback that will bring in a broader cut of the public, and we believe that NERAC will be better positioned to handle that scope of inquiry.

Miller said that there was considerable ambiguity whether neutrons or hot cells come under the charter articulated. In response to a question on overlap with other offices' activities looking into the same facilities, Cook said that Defense Programs (DP) is overjoyed to have our hot-cell roadmap in hand because that will do 95% of their work for them. Magwood indicated that Martha Krebs and Vic Reis understood the "corporate" nature of the roadmap effort.

Lowe then reported on the isotope expert panel that was convened this past summer on behalf of the committee. It was created because several reports had assessed the growth of nuclear medicine (estimated to be between 10 and 15% per year) and the consequent growth in the need for isotopes. If such a growth materializes, a substantial investment in isotope-production infrastructure will be needed because existing facilities will be unable to meet that need. But many DOE officials are skeptical about the growth numbers, so the expert panel was convened to provide guidance for the Department. The preliminary findings of the panel include:

- Available reports differ in their predictions of growth in demand for different isotopes.
- They agree that isotope use will grow, some shortages of major isotopes will occur, no reliable supply of research isotopes exists at a reasonable cost, production facilities are aging, the United States is overly dependent on foreign production for some isotopes, and support is lacking for basic research on radiotracers for biomedical research and clinical practice.
- During the next 20 years, the annual growth rates for therapeutic and diagnostic applications will be 7–14% and 7–16%, respectively.
- The United States should develop a large but decentralized capability to produce radionuclides.
- This capability should be made up of multipurpose facilities that are also used for other scientific and technological tasks.
- DOE should cooperate with other federal agencies, specifically the National Institutes of Health (NIH).

Sullivan asked about the public-private partnership in Texas, and Lowe responded that International Isotopes, Inc., intends to be a major producer of isotopes and to branch out into pharmaceuticals. They are solving a lot of problems that others have been unable to resolve, and it looks as though they are going to make a go of it. Cochran asked why DOE should subsidize isotope production. If foreign governments are subsidizing it, why not buy from them? Reba replied that you cannot buy some radiopharmaceuticals needed to further medical research. Who should take such a chance on the future? That is a role for government.

Lowe continued that the United States has had a policy for years that, if there is a commercial source, we have to get out of the business. But a short-lived isotope like Cu-67 is not going to make it all the way from Russia; it will decay away. Long asked if the electron-beam exposures are in competition with isotopic procedures. Reba answered no, that one technology gives different results and information than does the other; these technologies are more likely to be complementary than competitive.

Tom Isaacs was introduced to talk about the expert group that was convened by the OECD's Nuclear Energy Agency (Paris) in spring 1998 to consider the adequacy of nuclear education. As part of this effort, representatives from 17 countries and the European Commission conducted (1) a survey (distributed to universities, industry, and national laboratories) and (2) an analysis of education in the nuclear field. More than 200 of the questionnaires have been completed and returned. The final report is due in the fall of 1999.

The preliminary data indicate some inconsistencies in the results because of the international (multilingual) nature of the study. The numbers of students enrolled in nuclear-engineering programs are declining worldwide, with the United States showing the greatest decreases. The number of full-time faculty members is also declining, but not as radically. Perhaps more important, the age structure of the faculties is tilting higher; in the United States, 50% of the faculty are older than 50. Many of the facilities at the universities are also old, many are being decommissioned, and few new facilities are being built. Most bachelor and masters graduates are going on to continue their studies or going to work for electric utilities; most doctoral graduates are going into academic careers or working at nuclear research institutes. Most training that is provided is targeted at specific tasks within an organization.

The international community is in relative consensus that:

- Undergraduate programs are in decline, although the Japanese and French have robust programs.
- Those programs that remain are providing less specialization in classical nuclear engineering and are renaming their programs (e.g., as radiological physics programs).
- The best students are no longer going into this field.
- Departments (particularly those designed for undergraduates) are being merged with other departments or being eliminated; graduate programs are somewhat more stable.
- Programs are getting less government and industry support.

- Graduates readily find employment in the field; the prevailing perception of a poor job market is contrary to the facts.
- Changes in curricula have been modestly successful in retaining student populations.

Some key insights that have emerged from this study are:
- Collaborations (part-time lecturers from industry, cooperative research between students and faculty, theses conducted at research institutes or in industry, industrial sponsorship of students, and internships at research institutes) help the situation.
- A well-advertised, stable job market is needed to attract and hold students.
- The public needs to be made aware of the positive aspects of nuclear engineering, the variety of good jobs available, and the support available.
- Support from government, industry, academia, and national laboratories have helped maintain many nuclear programs.

Isaacs introduced **M. S. Kazimi** of Massachusetts Institute of Technology, who with J. P. Friedberg had conducted a study on how nuclear engineering contributes to the well-being of the nation and its citizens, how DOE can help the profession, and how academia can help. The report on the study is currently in review. The study found that society's needs for nuclear engineers are multifaceted and persistent and that the supply of new nuclear engineers is decreasing. The study concluded that the applications of nuclear technology (energy, national security, arms control, medicine, materials development, manufacturing, and management of radioactive waste) are vital to society and require proper planning at universities and significant support from government. But the education of new professionals has sharply declined in the nineties because:
- The only applications of nuclear engineering are perceived to be in electric power production and the defense program.
- Both of these applications have limited private investment, have received diminishing support from DOE during the past decade, and are viewed by students as unattractive career tracks.

The study recommends that universities restructure their curricula to provide broad educational opportunities in both nuclear energy and nonenergy applications and that they adopt a common core of applied nuclear sciences from which many applications can follow. The study recommends that DOE reinvigorate R&D in nuclear energy, support construction of a research facility to develop the "perfect" nuclear reactor, support fusion research, establish a program supporting radiation technology for biomedical fields, establish centers of excellence in nuclear and radiation science at universities, and save university research reactors from extinction.

Duderstadt expressed gratitude for the committee's participation in this initial meeting and asked them to prepare for the next day's session by reading the charge letter in their information packet. He adjourned the meeting at 6:10 PM.

November 18, 1998

Chairman **James Duderstadt** called the session to order at 8:02 am and reviewed the day's agenda. He initiated a discussion of the R&D activities of the Office of Nuclear Energy, Science, and Technology. **John Herczeg** began that discussion with an overview of the historical funding of the Office's R&D programs, a review of the PCAST results, and a description of the Nuclear Energy Research Initiative (NERI).

Herczeg showed a graph that traced the DOE funding of nuclear energy R&D (which went from almost $500 million to nearly zero between 1980 and 1998) and the total Office of Nuclear Energy (which went from $1300 million to about $500 million during the same period). A breakdown of the funding of nuclear-energy R&D showed the small amount of funding for light-water reactors essentially disappearing in 1987, the bulk of the funding (for advanced reactors like the Clinch River Breeder Reactor) dropping off precipitously by 1985 and disappearing by 1996, the beginning of funding for advanced light-water reactors beginning in 1986 and peaking at moderate levels in 1995 and nearly zeroing out in 1998 [except for $2 million for the Nuclear Engineering Education Research (NEER) Program], and a small level of funding for NERI beginning in FY 1999.

Cochran asked if these were subsidies to develop a light-water reactor that will be sold in foreign countries. Herczeg answered that vendors, utilities, international partners, and the U.S. Government all put funds into the light-water-reactor program, and the U.S. Government will get back royalties on each reactor sold.

A timeline of the major events in nuclear R&D during this period was presented along with a timeline of events leading up to the funding of NERI. Central to that history was PCAST's assessment of energy research for the next 20 years. DOE performed a parallel assessment so it would be ready to request funding to respond to PCAST's recommendations. PCAST noted that nuclear energy faced issues in proliferation, economics, and waste disposal and recommended funding scientific research proposed by universities, national labs, and industry to develop new, innovative solutions to ensure nuclear power's long-term success. In response, DOE requested $35 million for NERI; the Office of Management and Budget cut that request to $24 million, and Congress appropriated $19 million; PCAST had recommended an initial appropriation of $50 million with that amount growing by about $15 million per year. Two solicitations have been issued in close cooperation with ER, one to the national laboratories and one to all other entities. Proposals are sought on proliferation-resistant reactors and fuel technology; new reactor designs for higher efficiency, lower cost, and improved safety; low-output reactors; new technologies for nuclear waste (not permanent disposal); advanced nuclear fuels; and fundamental nuclear science.

Miller asked if nuclear physics is excluded, and Herczeg said that it is not within NERI's purview. Cochran asked what testbeds were available to try out these advanced fuels because not having facilities to test and license new fuels is a barrier to their introduction. Herczeg responded that DOE has some standby facilities (e.g., TREAT) and it has some industrial and international partners. Magwood pointed out that DOE also has the ATR in Idaho. Hartline asked if the Office saw increased relevance in what ER is doing. Herczeg replied affirmatively and said that NE is putting together a memorandum of understanding (MOU) with ER to work closely with them, particularly

in materials research. Hartline followed up by observing that many other DOE programs have an interest in nuclear waste and nonproliferation, and she asked if joint funding and cooperatively focused programs might be possible. Herczeg said that NE hopes to leverage as much research as possible with other people's money, but it needs a management structure and staff to put that together. The philosophy is that the more bridges built, the better.

The NERI proposals are due Jan. 29, 1999, and each will be subjected to an independent technical review by a minimum of three reviewers for scientific and technical merit. They will then be reviewed by DOE and program-office staff for relevance to NERI goals and objectives. Awards will be announced from May to September in 1999. Annual reports will be required of grantees, and these reports will be published in hard copy and electronically.

Fertel asked how they are going to avoid this crunch next year if funding is continued. Herczeg replied that the next year should be easier because some of the grants will be renewals. A lot will depend on how much is received from Congress. At least next year, the Department will be able to presume that some funding will be forthcoming; this year all activity had to wait until the funding was actually available. Fertel suggested that they allow multiple-year tasks. Herczeg noted that the solicitation says that multiple-year tasks can be proposed, but funding can be guaranteed for only one year. Fertel asked if such grantees would have to reapply, and Herczeg said, yes, but that should not be a daunting task.

John Kotek then described the Office's university programs, which are designed to ensure the continued flow of personnel educated in nuclear technologies by maintaining the infrastructure necessary to train and educate future generations of scientists and engineers. University research reactors are a vital component of this infrastructure, but their numbers are declining. NE's educational activities include the following eight initiatives (with their FY 1999 funding levels):

- ♦ providing fresh fuel to university research reactors ($2.3 million)
- ♦ funding the NEER Program at universities ($4.5 million)
- ♦ providing institutional support to nuclear-engineering degree programs ($1.0 million)
- ♦ encouraging universities with research reactors to share the use of those facilities with other institutions ($0.7 million)
- ♦ awarding fellowships and scholarships ($1.0 million)
- ♦ upgrading university research reactors ($0.8 million)
- ♦ funding minority fellowships and scholarships ($0.4 million)
- ♦ initiating a series of radiochemistry fellowships and scholarships ($0.3 million)

He chose to highlight two programs, the NEER grants and Historically Black Colleges and Universities (HBCU). NEER was reestablished in 1998 with 19 awards to 14 universities for a total of $2.1 million; $4.5 million will be available in FY 1999. Proposals are accepted in eight research categories. Awards are limited to $300,000 over three years, and universities are limited to two awards (three in FY 1999). Grants are provided to participating HBCUs for fellowships and scholarships, with about 28 scholarships supported each year.

Todreas asked what the language was that limited the funds for scholarships, and Kotek said that Congress did not see the need for growth in that program. Miller asked how NEER and NERI will evolve. Kotek responded that a researcher can get funding under both programs but not with the same proposal and that projects could get started under NEER and then be expanded under NERI. Comfort asked if the university reactors' financial difficulties had gone away. Kotek said that the NRC had proposed to charge universities up to $1 million/year for licensing and regulation because it was being forced to achieve full-cost recovery, and DOE sent a strong letter to NRC to get it to relent. Cortez observed that the University of Maryland is having difficulty staffing, maintaining, and operating its reactor. Miller interjected that he thought the total DOE-NE funding for research in 1998 was zero. Kotek replied, almost; it is $2 million.

James Bresee described a new program in civilian waste management: the accelerator transmutation of waste. This system would separate spent commercial nuclear fuel into: (1) depleted uranium, (2) short-lived fission products, and (3) plutonium long-lived fission products and minor actinides. The uranium and short-lived fission products would be placed in a repository. The other separated components would be formed into fuel elements that would be inserted into a lead-bismuth-cooled subcritical reactor activated by a proton beam from a linear accelerator. The waste stream would have to go through six to ten recycles because of the low efficiency of the processing by the reactor. This technology could reduce the amount of actinides dramatically, allowing the repackaging of a number of wastes in a much less radioactive form.

Cochran asked what the net energy of the linear accelerator was, and Bresee replied one-third to one-quarter of the power generated would be used by the process. Cochran said that a lot of people feel that this is a really dumb idea. This committee should send a letter to Sen. Domenici to tell him that this does not make a bit of sense. You have greater costs than storage and all the drawbacks, too. Miller interjected that not everyone here agrees with Tom Cochran.

Bresee continued that worldwide activities on accelerator-driven transmutation include an effort by the French funded at approximately $25 M per year. It is based on aqueous reprocessing of spent fuel and on fast-breeder technology. It assumes continued use of plutonium as a fuel. The study of this process is mandated by French law. The recent shutdown of the Super Phoenix took away the facility that they planned to use to burn their waste. Italy, the Czech Republic, Sweden, and the European Economic Community also have small programs, each funded at about $1 M per year. The Russians are working on a lead-bismuth-based process. Cochran said you cannot sell this program on the basis of commitment; you have to make the case on the basis that the technology works; this process does not. Bresee said that if he listened a little longer, he might change his mind.

Bresee noted that this program is not being funded; rather, a study is being conducted. In 1996, the National Research Council evaluated this technology broadly. The Department has been asked by Congress to look at this topic, to determine the cost-benefit ratio, and to evaluate the risks. Our purpose is to advise Congress whether or not to fund this line of research. We want to produce an honest assessment.

Comfort asked if the process is an energy source in that it produces more energy than it uses. Bresee said, yes, but if you take away the accelerator and use a breeder reactor, you get even more energy. But that is a much more difficult process to control; the tradeoff might be seen as better control for less energy.

The floor was turned over to **Dave Nulton** to speak on the development of a modular helium reactor with a gas turbine fueled with plutonium oxide. He reported that, since the end of the Cold War, the United States has declared 52.5 metric tons of plutonium as excess to national-security needs, and Russia has declared that it has withdrawn up to 50 metric tons from its weapons. Several agreements have been signed by the two countries, and negotiations are under way on a bilateral agreement on disposing of this plutonium. The United States is proceeding on a two-track plan for disposing of its plutonium: converting it to a mixed-oxide fuel for nuclear reactors and immobilizing it. The bilateral agreement will require the two countries to dispose of their plutonium stocks at comparable rates. Under current plans, the United States will be able to dispose of about 5 metric tons per year, but the Russians only 2.

To help boost the Russian disposal capacity, Congress appropriated $5 million for the joint U.S.-Russian development of a gas-cooled reactor capable of burning weapons-derived plutonium. The design of the reactor would be based on that of a reactor set up in Russia in 1985 by a U.S. firm, General Atomics. As currently envisioned, each of these reactors would burn 250 kg of fuel per year, and Russia would need 12 of them to use up 5 metric tons of plutonium per year. An alternative would be to use Ukrainian or Canadian reactors to burn the fuel. The design calls for a high-quality fuel and would produce a plant efficiency of 48%, but it is very complex and incorporates an undemonstrated feature, a 70-ton shaft supported by magnetic bearings. The fuel assemblies would be contained in graphite blocks, would operate at 1200°C, and could sustain 1800°C temperatures without failure.

A joint U.S.-Russian plutonium-disposition steering committee has been established that will have a working group on gas-reactor technology development to identify issues, technical needs, and funding requirements; prepare implementation plans; and conduct research, development, and design activities. Unverified reports from General Atomics and the Russians indicate that they have

- established design requirements
- completed the conceptual designs for the major systems
- developed detailed drawings of components
- established development plans for the plant and fuel technologies
- developed cost estimates and schedules
- initiated key development tasks
- documented the conceptual design

For the fuel, they have

- developed the technology for fabricating the fuel kernels
- established the TRISO coating technology
- developed the compact-fabrication technology

- designed a bench-scale fuel-fabrication facility
- developed a conceptual design for the fuel-fabrication plant
- initiated laboratory work to support development of the fuel-fabrication pilot line

The next steps will include establishing the working group on gas-reactor technology development within the joint steering committee, evaluating the design requirements, evaluating the design itself, and preparing a work plan for a demonstration plant in Russia.

Cochran commented that the advantage of this proposal is that you burn more plutonium and go beyond what is necessary. You could do this a lot more cheaply in current reactors if you went to a thorium cycle with a modified fuel particle. Nulton responded that this is a $5 million one-shot deal to determine if this is an option that would burn waste and produce electricity for Russia, not a long-term program in high-temperature gas-cooled reactors in this country. Cochran suggested that there are other proposals that are better and do not get funded and that those proposals need to be considered. Duderstadt asked about the possibility of looking at a broader array of technologies and picking some to investigate. Nulton observed that the program is very small and is therefore being focused on this effort in Russia. The Department is not in the reactor business; it wants a pilot line that will dispose of these plutonium pits. Klein asked if this was a once-through reactor, and Nulton said that it was, with a 90% burnup of Pu-239, so there is essentially nothing to reprocess.

A break was declared at 9:55 am. Duderstadt called the committee back to the table at 10:15 am and asked the next speakers to be brief so there would be ample time to discuss the charges to the committee. He introduced **Dennis Harrison** to speak on the proposed Nuclear Energy Plant Optimization (NEPO) Program.

Harrison noted that this program was not funded by Congress this year, but Congress asked that it be brought back in the FY 2000 budget. Its goal is to develop and demonstrate technologies that can make U.S. nuclear power plants safer, more reliable, and more economical. Drivers for its creation include deregulation of the electric power industry, premature plant closings, license expirations, the Clean Air Act, and the Kyoto Protocol. The program would be guided by a joint EPRI-DOE strategic plan, drafts of which have received broad review in the nuclear community, a report on which was approved by DOE and EPRI in March 1998, and which has been endorsed by EPRI, NEI, and NRC.

Under the proposed program, projects were selected by identifying the key issues, figuring out what can be done to resolve those issues, assessing what is already under way or planned, and identifying remaining critical R&D to:

- understand, characterize, and mitigate the effects of long-term material degradation on key reactor components;
- develop technologies to improve the power output or reliability of key components; and
- resolve generic technical issues that are barriers to a viable licensing-renewal option.

Costs would be shared between DOE and industry, and proposed tasks would be reviewed by a joint coordinating committee, which would report to DOE and industry its recommendations on priorities

and allocations. Charts of proposed funding levels (up to $60 million per year) and of the task selection process were shown.

Klein asked how NRC would be involved, and Harrison answered that NRC would be represented on the coordinating committee, during implementation, and during reassessment. Cochran asked what DOE's role is in licensing. Harrison replied that the ultimate success criterion of R&D is whether the technology can be licensed for use in a plant. For license-renewal demonstration, the program would support licensing efforts by providing the technical expertise to support DOE-generic reports. Also, DOE will try to enhance the reliability of the plant.

The chairman then reintroduced **Owen Lowe** to speak about the Advanced Nuclear Medicine Initiative. Lowe noted that this initiative was born out of feedback from the Department's research-isotope customers, but it has not made it through the internal-review stages of budget formation for the past three years. This initiative would:

- support nuclear medicine through direct research grants and the subsidization of the costs for research isotopes;
- provide training in nuclear medicine through scholarships, fellowships, and internships; and
- research the application of α-emitting isotopes to the treatment of diseases and disorders.

This initiative has been proposed because nuclear medicine has proven to be so important in medical imaging and diagnosis, in therapeutic applications, and in reducing health-care costs.

Nuclear medicine was born from DOE technology more than 50 years ago, and many of its important advances came from DOE laboratories. But, even though nuclear-medicine research enjoyed broad-based DOE support for many years, that support has narrowed recently, and industry is of the opinion that the support has eroded even more than it actually has. Currently, DOE produces isotopes at five national laboratories, maintains and upgrades isotope-production capabilities, develops new isotope-manufacturing methods and -delivery systems, and sponsors biotechnical research at the genomic level. In contrast, the National Institutes of Health sponsors medical research and practice, not isotope-based science and development. This new initiative would reinstate support for a broad range of nuclear-medicine research. Such an undertaking would be consistent with DOE's mission; would benefit from DOE's isotope-based knowledge, technology, and infrastructure; and would build upon DOE's past contributions to the field.

Kastenberg asked whether Congress had given $7 million to the Kirtland Center, and Lowe answered that it had, but that is not part of NE's program. Kastenberg asked if this program would be based on competitive grants, and Lowe assured him that it would. Miller asked what the boundary was between this proposed initiative and the Office of Biological and Environmental Research (OBER). Lowe answered that this program would complement OBER's program, which is diminishing and being focused on two or three areas. This program would look at some of the areas OBER is not looking at, such as monoclonal antibodies, peptides, and therapies appropriate for the early treatment of cancer. Fertel asked what the barrier was to funding this initiative, and Lowe responded that there is a target budget level and this initiative exceeds that target. Duderstadt commented that NIH's programs are rapidly growing beyond the technology available, and this may

be an opportunity for an MOU with them and to tie in with training grants from NIH. Todreas asked whether ER should be doing the broad research and this group the isotope production. Lowe responded that ER has focused on genomic-based research and imaging, so the logical situation has been reversed, somewhat. NE feels that some of the areas excluded from ER's narrowed focus are worthy of investigation.

The session was turned over to **William Magwood** to discuss the charges to the committee. He said that in the charge letter it points out that the Department would like the committee to address five areas:

1. a long-term nuclear energy strategic science and technology plan
2. a nuclear science and technology infrastructure roadmap
3. the medical isotope expert panel
4. a long-term isotope research and production plan
5. the drafting of a nuclear power plant technology coordinating and planning panel

In addition, the Department would like to propose that the NRC be asked to sit with this committee as an ex officio member.

He elaborated on each of the five charges:

1. This plan is needed to establish a direction for DOE's nuclear energy program; through it, the committee can advise DOE on its role in nuclear energy technology vis à vis industry. An interim report is requested by July 31, 1999; a final report by Oct. 31, 1999.
2. This effort should focus on ensuring a viable infrastructure to meet U.S. R&D requirements through 2020. It should not be limited to NE missions, but incorporate Office of Science and Defense Program missions, also. Some preliminary work has already been done; it can be reviewed by NERAC and adopted, adapted, or rejected. However the Committee proceeds, an interim report is requested by May 30, 1999, and a final report by Aug. 31.
3. This panel was created in September in anticipation of the creation of NERAC. It is required for gathering advice to DOE on the long-term outlook and need for isotopes. Its findings may impact facility choices. Its preliminary results indicate significant increases in the need for isotopes during the next 20 years. Its report is expected in December or January, and NERAC's review of the subject matter should be completed in early 1999.
4. This plan is needed to establish long-term goals for the DOE Isotope Program. Currently, the Department is privatizing the production of commercial isotopes and focusing on the production of research isotopes. The growing medical-isotope market needs to be factored into this plan.
5. A coordinating panel was planned to guide the implementation of NEPO. Such a panel is needed to focus on long-term technology needs of current plants; the industry focus has a two-year horizon. The coordinating panel should act jointly with EPRI to coordinate future research; the NRC and universities should have strong roles, also.

He said that what are sought right now are reactions to the charge issues. We need to talk about mechanisms (e.g., subcommittees) to accomplish these tasks and to determine whether this committee should pursue additional activities.

Comfort asked whether he meant neutron or nuclear in the infrastructure roadmap. Magwood said he meant neutron for a broad array of applications; much of this has been taken on by the Office of Science. Comfort noted that the charges also mentioned fusion energy and asked whether this committee should take on this topic. Magwood responded that there is no way to do an assessment without considering fusion engineering and its needs. Fertel asked if there were any other entities looking at fusion that this committee should be working with. Magwood pointed out that the fusion program was not the topic here but rather its needs for materials and other support activities.

Cochran commented that there should be one subcommittee looking at the whole isotope program rather than separate subcommittees looking at pieces of it. Magwood responded that the expert panel on isotopes will go away in January when its work is done; perhaps we *could* just combine the other two panels. Kastenberg observed that there are a number of cross-cutting issues that could be overlooked and suggested that the committee look specifically at cross-cutting. Magwood replied that the Office is working closely with other programs in materials, high-temperature gas-cooled reactors, and other topics and suggested that the committee discuss this at the next meeting. Fertel observed that (1) these five items could "envelope" a lot of other items that should be discussed and (2) the plans have to be completed before the roadmap is developed. Therefore, he suggested, the timetable may need to be adjusted. Duderstadt pointed out that the committee has to be cognizant of the funding cycle and therefore these reports have to be completed early in the year. Klein said that it would be nice if the committee had a summary sheet of all DOE research activities, and Till observed that the committee needs to know the goals for fission energy. Duderstadt added that the committee also has to react to the PCAST report. Till asked what PCAST considers "the long term," and Duderstadt replied that fission belongs in the U.S. R&D portfolio in the next 20 years.

Todreas expressed a feeling of being overwhelmed by the scope, which seems to be the equivalent of several National Academy of Sciences reports. He said that he would like to have more pieces coming out of the Department that the committee could react to. Duderstadt said that it is important to bear in mind that advisory groups can set generaldirections, but the staff is responsible for detailed development and management work. Magwood pointed out that the Department has learned a lot about planning activities from others, like the Nuclear Safety Advisory Committee (NSAC). Comfort observed that an NSAC subcommittee is aware of the charge to it well in advance; and when they officially receive the charge, they work on it for a year or more, seeking and digesting information. To produce a roadmap and plan in such a short time would be very daunting. Magwood noted that, in one of these tasks, a draft has already been put together.

Cochran suggested that the committee address four topics:

1. Isotopes
2. The issue of FFTF standby for next year's budget.
3. The R&D role of DOE on anything related to reactor operations and specifically the GA (General Atomics) option in Russia.
4. What R&D DOE should be doing on next-generation reactor technology and on the fuel side.

Basically, he said, what we need to know is if there *is* a role for DOE here and *then* what that role might be and where it should take us.

Duderstadt said that we really need a mix of these approaches. There could be other issues. We need to know the answers to those issues before developing a plan, and we need to know where this technology is going. But we have to be prepared to enter the budget process for this coming year. Magwood stated that a decision about the FFTF may not be as critical as may have been perceived previously. It is a decision that has to be made in this budget cycle.

Till suggested that it might be helpful to solicit small proposals to look at next-generation reactors. He noted that the underlying assumption here is that there *should* be a next generation and asked if that is a generally held view. We have to face that question, he said. Although there are 68 hot cells, the number of functioning, manned cells can be numbered on one hand. Cortez commented that the road is quite broad and that more information is needed to do the roadmap. Reba observed that, at the Isotope Expert Panel, it was impossible to do a long-term (20 year) plan. Without discussing it, the preliminary draft is very general; then we set priorities for intermediate and short-term goals with the understanding that the long-term goals are going to change.

Todreas said that Tom Cochran left out the last item (the NEPO coordinating panel), a contentious issue but one that is important. Duderstadt said that companies are approaching R&D in a different way than in the past and that may change the environment in which R&D operates. Miller voiced the opinion that what Magwood proposed was not bad with the collapsing of the isotope entries into one. Duderstadt said that this group can certainly offer some reactions, but input from other communities than those represented on this committee is needed, also. Haberman interjected that some of these topics are not within Magwood's purview. Fertel said the he thought that he had heard Magwood say that, if activities had repercussions for NE, this committee should consider and comment on them. Magwood said that he was not sure there is any way to limit the committee if it wants to look at those issues. Duderstadt said that he thought that the committee needs to consider a mix of issues, some in the Office and some in other areas of the Department. Cochran said that he thought that the committee could help DOE as a whole if it addressed issues that are in other divisions. Duderstadt extended the comment by saying that that argument also applies to cross-agency concerns. Magwood voiced the opinion that the committee should be more inclusive than exclusive. Todreas felt that it should identify the promising directions in reactors. Cochran noted that some work on proliferation-resistant fuels is being funded by EM (DOE's Office of Environmental Management) and commented that perhaps it should be funded by NE and that maybe the committee should point that out.

Duderstadt suggested some next steps for the committee:

1. By the Monday after Thanksgiving, committee members should send additional thoughts to Duderstadt.
2. By early December, he will send a draft proposal concerning NERAC operations to the members.
3. By March, the key subcommittees will be launched. Those subcommittees will require additional efforts and will involve additional personnel than the committee members.

Haberman noted that the law requires that a period of public comment be part of this meeting and

invited the public to present their thoughts.

Suresh Srivastava of Brookhaven National Laboratory stated that the Department has traditionally supported nuclear medicine, which was developed at the national laboratories. But that type of support has dwindled badly. The Office of Biological and Environmental Research (OBER) has started getting away from the research. Essentially zero funding is available for new medical isotopes; we are currently benefitting from work that was done 20 years ago. We need to put new resources into the pipeline and train new researchers in this discipline. The major problem in this field of research is the reliability of sources of specialty isotopes, so a primary need is a dedicated isotope-production facility, such as a 70-MeV cyclotron.

There being no further public comment, the meeting was adjourned at 12:05 PM. Two written comments were submitted for inclusion in the minutes, one from the American Nuclear Society and the other from the Nuclear Medicine Research Council. They are included here as attachments.

Copies of the presentations given to the committee may be obtained by contacting Dr. Norton Haberman at 202.586.0136. His mailing address is Department of Energy, Office of Nuclear Energy, Science and Technology, Washington, DC 20585.