Minutes for the
Nuclear Energy Research Advisory Committee Meeting
March 30-31, 1999, Marriott Crystal City, Arlington, Virginia

NERAC members present:

John Ahearne
Thomas Boulette
Thomas Cochran
Joseph Comfort
Jose Luis Cortez
Maureen S. Crandall
Allen Croff
James Duderstadt (Chair)
Marvin Fertel (Wednesday only)
Dale Klein
Linda Knight
Robert Long
Sekazi Mtingwa
Richard Reba
Joy Rempe
Miguel Rios
C. Paul Robinson (Tuesday only)
Allen Sessoms (Wednesday only)
Daniel C. Sullivan
John Taylor
Charles E. Till
Neil Todreas

NERAC members absent:

Beverly Hartline
J. Bennett Johnston
William Kastenberg
Warren Miller
Robert Socolow
Bruce Tarter

Also present:

Norton Haberman, Senior Technical Advisor, Office of Nuclear Energy, Science, and Technology (NE), DOE
John Herczeg, Lead Nuclear Engineer, Office of Technology, DOE
William Magwood, Director, Office of Nuclear Energy, Science, and Technology (NE), DOE

March 30, 1999

Chairman **James Duderstadt** called the meeting to order at 10:30 a.m. and welcomed the members. He asked each member to introduce himself or herself for the benefit of the other members. He noted the tragic loss of Glenn T. Seaborg, whose activities had touched all of our lives and announced a memorial that will be prepared. He outlined the agenda of the meeting.

William Magwood then discussed the FY 2000 budget request. He noted that the request was level with the previous year's budget, although key decisions [e.g., funding for the Fast Flux Test Facility (FFTF)] still need to be made. The molybdenum-99 project is being completed, and other programs are pushing forward.

The Nuclear Energy Research Initiative (NERI) has gotten off to a good start. The peer-review process has been started and the point of prioritizing the work to be funded is approaching. $25 million was requested, and $19 million was appropriated. Duderstadt asked if that meant that the $25 million was what the Department asked for or what came down from higher up. Magwood said that he had probably asked for $50 million, knowing that that number would be reduced after all

the other pressures on the budget were taken into consideration. The President's Committee of Advisors on Science and Technology (PCAST) recommended about $70 million, but that was not going to happen. The Department received about 500 preproposals, and about two-thirds of those were selected for more detailed peer review.

The Nuclear Energy Plant Optimization (NEPO) program was turned down by Congress last year, and it has been resubmitted this year at the urging of several congressmen; $5 million has been requested to set the groundwork. The Office will supply the NEPO R&D plan to NERAC. Ahearne asked if the Department was staying away from relicensing because Congress would not support it, and Magwood said that the Department did not feel that it was necessary because Duke Power and others are already taking care of that issue. Taylor noted that devoting attention to licensing would also take away from the necessary topics of the program. Jim Lake of INEEL asked if there would be a call for proposals. Magwood replied that priorities would be set up to identify tasks and that requests would then be issued for open, competitive solicitations to perform those tasks. Comfort asked if the relicensing requests coming down the line would need R&D for relicensing. Magwood said no, that we got smarter as we built these systems and built these concerns into the plants; it is envisioned that relicensing will be granted years in advance of when the existing licenses expire. He showed a chart from the *Joint DOE-EPRI Strategic R&D Plan to Optimize U.S. Nuclear Power Plants* that plotted the anticipated funding needs for plant aging (28 tasks), license renewal (4 tasks), and generation optimization (9 tasks) for the seven years of NEPO. Klein asked if the plants themselves might provide funding, and Magwood said that the utilities and the Electric Power Research Institute (EPRI) are doing a lot of R&D on near-term issues; what NEPO is designed to do is to bring the long term back into the game. Cochran said that this is not a lot of money but did not see why the government needed to be in this business at all. Magwood responded that the utilities, with consolidation and restructuring of the electric power industry, are not looking farther down the road than one or two years. Because the ownership of any given plant two years from now is uncertain, the current owners are not interested in making, say, a seven-year investment. Ahearne asked if the values in this chart are what EPRI and others think the level of funding should be. Magwood said that the anticipated DOE funding level is still under the amounts shown in the chart. After the work is prioritized, there will be a lot of tasks that will not be done. DOE is not in this for the long haul; it is trying to get this work started with the expectation that industry will eventually take it over. Taylor noted that there is a role for the government in keeping the industry viable. Magwood pointed out that the whole plan covers about 300 tasks, of which about 40 are high priority.

Between 1996 and 1999, university nuclear science and reactor support has increased from $3 million/year to about $11 million/year. The number of undergraduate students enrolled in nuclear engineering has been in freefall, and about two university nuclear reactors a year are shut down. This situation needs to be turned around. There are now 28 university research reactors, and how many are really needed needs to be assessed. Duderstadt commented that the significant educational level appeared to be the master's degree and that restructuring the program to encourage graduate education in nuclear engineering might be considered. Todreas asked what the basis was of the $11.3 million FY-2000 budget request for university reactor fuel assistance and support. Magwood answered that the $0.3 million increase from the previous year was the best that he could get. Ahearne asked if any thought had been given to using simulators for training, and Magwood replied

that not a lot of thought had been given to that approach because the Department wanted to keep the university reactors up and running for training purposes. Duderstadt commented that the universities' senior vice presidents for research need to be involved because they are the ones that will ultimately make the decisions about continuing reactor operations. Magwood responded that the universities are often dealing with a lot of local issues and not recognizing the national interests.

In isotope production, a defense-program reactor is being converted to the production of Mo-99; the Department feels that a private operator should step in at this point and fund the operation of the reactor and the associated hot cells. The calutrons at Oak Ridge had to be shut down because the market for stable isotopes is depressed by foreign competition and because a large supply of stable isotopes is available for research purposes.

The Department is looking at the potential role for the FFTF. The Secretary will decide in April whether to shut it down or prepare an environmental impact statement (EIS) for the restart of full operations. He will base his decision partly on NERAC's recommendation. The money now in the budget only covers standby operations. Whatever the Secretary decides to do will require more funds. The conditions under which the prior study was conducted have changed significantly, so the possible roles and needs for the facility need to be seriously considered.

The funds that have been requested for the Advanced Radioisotope Power Systems (generators for NASA and national-security systems) are for the maintenance of the infrastructure for producing such generators. Our supplies of plutonium-238 will run out in 2003 or 2004. Possible new sources include the FFTF in Hanford, the Advanced Test Reactor (ATR) in Idaho, and the High-Flux Isotope Reactor (HFIR) in Oak Ridge. The EIS is expected to be completed next year, making it possible to go to the private sector for participation in production. Cochran asked what the problem was with Russian Pu-238, and Magwood replied that the Russian Pu-238 was contaminated with Pu-236, which produces more gamma rays during decay, which interfere with satellite operations.

The Termination Costs Program funds the EBR-II Shutdown and the EBR-II Spent Fuel Treatment Programs. The Department has been decommissioning this reactor to make it radiologically safe, but this is very difficult to do because the fuel has sodium in it. A demonstration program is under way for a technology for removing the sodium from the fuel so it can be disposed of at Yucca Mountain. A major issue is the characterization of the resultant waste. Cochran asked if the EIS is going ahead despite the fact that the R&D program is not complete. Magwood answered that the Department went ahead with the EIS after receiving two reports from the National Academy of Sciences (NAS) that the process warrants a high degree of confidence and that what has not been finished is the study of the blanket fuel, which does not have a lot of highly enriched uranium (HEU), so there is less concern about its treatment. Cochran asked if this same process will be used for other sodium reactors, and Magwood replied that this process would not be needed for other reactors because they do not have sodium *in the fuel*.

The Uranium Program previously was responsible for the operation of the gaseous-diffusion plants in Tennessee, Kentucky, and Ohio. When these facilities were privatized, large amounts of legacy materials, especially UF_6, were left. Facilities will be built to convert those materials to disposable forms. What is envisioned is the development of the process and the hiring of a contractor to operate

it for 20 to 30 years. Ahearne asked if there were budget schedules for this activity in the handouts, and Magwood said that headquarters is now working with the field offices to build a budget request. The DOE Controller's office will then adjust the requests on the basis of markups from both houses of Congress. That budget will then go to the Office of Management and Budget (OMB), which typically revises the numbers down.

Duderstadt asked at what time and in what form would input from this committee be best so as to have an impact on the 2001 budget. Magwood replied that a letter to the Secretary or Undersecretary by August 9 would have an impact. Cortez commented that the figures presented make it look like there is no growth in the nuclear programs and that the Committee's input seems late. Duderstadt interjected that the figures are for 2001, and Cortez said that even so, it seems rather late. Magwood said that what is asked for in the 2000 budget request will not have much influence on the 2001 budget request; what will be important is Congress's reaction to the 2000 budget.

Todreas asked if there were any DOE-wide mechanism (such as an intern program) for broadening the experiential base of the staff. Magwood replied that DOE is not strongly committed to intern programs, but that an additional four to six young people in the program were being requested for next year; a reply from the Secretary concerning this request is expected in the next few weeks. Todreas said that the chairman of this Committee should send a letter to the Secretary supporting that request, and Duderstadt said that he would do that.

Cochran noted that the Natural Resources Defense Council (NRDC) has sued one of the DOE environmental-management contractors who proposed to dispose of the K-25 nickel by selling it to the private sector and asked if DOE should develop a decontamination capability for steel and nickel. Magwood said that he was not familiar with that situation, that there were programs in DOE that were looking at decontamination of scrap metals, but that NE was not involved in those programs.

Magwood then introduced **John Herczeg** to speak about the NERI program. Mtingwa asked him if he was satisfied that this process was bringing out new and exciting ideas. Herczeg answered that he was, and Duderstadt commented that it might be interesting to look at NSF processes and procedures because they have a lot of experience in this area.

Herczeg said that PCAST had recommended the establishment of (1) NERI with $50 million funding in 1999 and (2) a program to address current operating plants with funding of $10 million in 1999. A NERI workshop was held by DOE in Washington Apr. 23-24, 1998, and the FY-2000 budget request included $24 million for NERI and $10 million for NEPO. Congress appropriated $19 million for NERI and nothing for NEPO. The NERI application process has started with 523 preapplications and 308 full proposals. These proposals have been forwarded to 14 peer-review panels made up of 119 people. The peer-reviewed proposals have been forwarded for relevance review, which should be completed by April 9 and received by NE by April 27. The Office's award recommendations will be made before May 11, and the award announcements will be made on May 11. The agreements will then be worked out by DOE Procurement during the next several months. This is the first time that DOE-ER has gone through the peer-review process for the NERI Program, which is very costly but produces excellent results. The 14 panels of six to ten reviewers considered

five categories of proposals: reactor technology, instrumentation, advanced fuels, nuclear waste, and science. In this process, each proposal was assigned to a lead reviewer who then presented it to the relevant panel; the panel discussed each proposal, and each panel member independently reported on the proposal, ranking the proposals as "must fund," "should fund," or "do not fund" and assigning a numeric ranking. These data are then used to assign a final ranking. A stumbling block in this process is the fact that comparisons from field to field are not straightforward. As it turned out, the funding requested for the "must fund" proposals ($14.7 million) was just less than the available funding. At the 125% cut point, 14 of the remaining proposals were from national laboratories, 6 were from universities, 4 were from industries, and 47 were from collaborations. Todreas noted that this distribution would change as the funding decisions were made. Herczeg replied that he hoped that more proposals would be received from universities in future years but that a high level of collaboration had been achieved. Ahearne noted that that is not what PCAST wanted; it wanted to get more involvement by universities to renew their research capabilities.

Chairman Duderstadt declared a break at 12:31 p.m. He called the session back to order for a working lunch at 12:46 p.m. and introduced **Scott Sitzer** of the Energy Information Administration (EIA) to speak about the outlook for U.S. nuclear power through 2020. His talk was based on the EIA publication *Annual Energy Outlook 1999* (AEO), which was issued in December 1998 and is heavily dependent on key assumptions on world oil prices and economic growth because oil is the linchpin of economic growth. The AEO in 1998 had predicted a gradual, linear rise in world oil price from about $18.50/bbl in 1997 to about $22/bbl in 2020. Instead, because of warm weather, high world production, and a slowdown in demand brought on by the Asian economic crisis, oil prices plunged to about $12/bbl in 1998. This year, the EIA predicts a recovery in oil prices and a resumption of that gradual, linear increase to about $22/bbl. An analysis of gross domestic product (GDP) growth predicts an overall growth of 2% per year between now and 2020. The services sector, which is not energy intensive, is expected to grow at the greatest rate, 3% per year. More energy-intensive sectors, such as transportation and manufacturing, are expected to grow more slowly. Thus, a 1 to 1.5% annual growth is expected in electricity sales, with electricity growth slacking off from GDP growth rate because of saturation of the market for appliances and because of the higher efficiencies of appliances. Electricity demand in the United States is expected to continue its historic upward trend, increasing from 1392 billion kilowatt-hours in 1970 to 4345 in 2020. In 2020, coal is expected to be used to meet 50% of electricity demand, natural gas about 30%, nuclear and renewables about 10% each, and petroleum a negligible amount. Both new generating capacity and generating-plant retirements are expected to peak in the first five years of the new millennium (because of the retirement of many uneconomical steam plants), with much more new capacity being installed than old-plant capacity being retired.

A decade-by-decade chart of the ages of operating nuclear reactors indicated that by 2010 most will be 20 to 29 years old and that by 2020 the overwhelming majority will be 30 to 39 years old. The data assume that no new plants will be installed and that at 30 years of age the plants will require refurbishment at a cost of $150/kW. That refurbishment cost is weighed against the costs of available electricity. If the cost is higher, the unit is assumed to be retired; if it is lower, the plant's operation is assumed for another 10 years. Then the comparison is made again. Fewer than 10% of the existing nuclear power plants pass the economic test at 40 years of age.

Cochran asked how the model accounts for the effects of deregulation, and Sitzer said (1) it assumes the continuation of current laws and regulations, (2) it uses 13 regions and considers what each state in each region has done about deregulation, and (3) it has a sensitivity test in which full deregulation is assumed.

Nuclear generating capacity each decade was analyzed by region. In the Midwest, it is expected to decrease almost 60% between 1997 and 2020; in the Southwest, about 20%; in the Northeast, about 67%; in the Southeast, about 50%; and in the West, no change. Actual generation by nuclear power plants in each region during the same period, however, is expected to change according to a different pattern: in the Midwest, it is expected to decrease about 40%; in the Southwest, about 15%; in the Northeast about 60%; in the Southeast more than 50%; and in the West a slight increase.

An analysis of projected electricity-generation costs in 2005 and 2020 indicates that combined-cycle (natural gas) plants will have the lowest overall costs, coal plants will be slightly higher, and nuclear plants will be significantly higher. With capital costs two to eight times higher than plants using other fuels, nuclear plants are not competitive. Crandall commented that everything that she had seen indicated that natural gas is plentiful in the United States and Canada and will continue to be so for the next 15 to 20 years. Cochran asked if the EIA had looked at what the coal and gas costs would be if there were a carbon tax. Sitzer said that nuclear was not competitive even then. Figures indicate a 20 to 65% decrease in operable nuclear capacity between 1995 and 2020, depending on whether a high-nuclear or low-nuclear scenario plays out. A chart of projected energy-related U.S. carbon emissions from 1990 to 2020 indicated an increase of about 14% each decade with the rate of growth slacking off slightly in the years from 2010 to 2020. These increases were projected to occur fairly uniformly among the transportation, industrial, commercial, and residential sectors, and the greatest increase among fuels was contributed by natural gas.

An analysis of the effects of the Kyoto Protocol was conducted for the House Science Committee under a specified set of assumptions: a tax would be imposed on fuels on the basis of carbon content, the National Energy Modeling System would be used, no changes in current laws would be assumed, all carbon emissions would be assumed to result from energy production and use, and no mitigative actions would be considered. Seven scenarios were considered. Under these assumptions, the model indicates that carbon prices would range from $67 to $348 per ton in 2010 (in 1996 dollars), coal prices would be most severely affected, electricity producers would show the largest carbon reductions, and GDP losses would range from 1 to 4%. Todreas asked how they got the carbon prices, and Sitzer said they iterated the model to see how demand, fuel mix, etc. shifted until they reached a price settling. In the extremes of the seven scenarios, U.S. carbon emissions increased 32% (unconstrained) and decreased 7% (with no trading, sinks, or other considerations). Under these assumptions, carbon prices were seen to increase with limitations placed on CO_2 emissions: If emissions were allowed to increase 24% over 1990 values, the cost of carbon would increase about $100/ton; but if emissions were decreased 7% below 1990 values, the cost of carbon would increase about $300/ton. In all of these cases the nation would turn more to nuclear energy for its electricity. For the two extreme scenarios, nuclear-energy consumption would fall off about 50% if CO_2 emissions were unconstrained but would not fall off at all or might even increase slightly if CO_2 emissions were decreased 7% from 1990 values. With extreme CO_2-emission

reductions, fewer nuclear plants would be retired because the units' costs would be more competitive with the costs incurred by natural gas plants. In that case, the analysis indicated that up to 93 GW of nuclear generating capacity would be maintained. Even then, though, high capital costs and other factors mitigate against new nuclear orders through 2020.

Klein asked how accurate the EIA's projections were in 1980, and Sitzer replied that the costs for petroleum were way off and the costs for nuclear were too high. Taylor asked if EIA had data on the effects of externalities on fossil-fuel costs, and Sitzer said that they had output and projections on that or could produce it. Taylor noted that some say that these externalities could turn the tide for nuclear. Crandall asked what the inputs were for the 2010 GDP, and Sitzer replied that the GDP would temporarily dip about one-third of unconstrained growth. She asked why, given that forces for deregulation run hot and cold, EIA did not assume that all 50 states would deregulate their electric utilities, and Sitzer pointed out that there was a scenario reflecting full deregulation.

Duderstadt then introduced **Jeff Freidberg** and **Gary Was** to speak about nuclear engineering in the 21st century. They had been requested to develop a consensus in the university community about the future of the nuclear-engineering profession, to determine how nuclear engineering contributes to the national well-being, and to recommend how universities and DOE can help. Was said that the demand for nuclear engineers has changed rapidly in recent decades and has broadened to include such areas as medical technology, material processing, and nuclear-waste management. Indeed, demand for nuclear engineers is growing because nonpower applications are growing at a rapid rate. But at the same time, the supply of nuclear engineers is dropping: since the early nineties, undergraduate degrees granted are down 62%, master's degrees down 44%, and doctorates down by 29%. Because of lower enrollments, nuclear-engineering departments are being merged into larger departments or eliminated entirely, and the number of university reactors is decreasing. The current statistics show that there are 32 degree-granting programs, 20 nuclear-engineering departments (down from more than 80 in the seventies), 250 nuclear-engineering faculty, 570 undergraduates (in the United States, more students are majoring in ancient Greek), 910 graduate students, and 30 university research reactors.

To assess the supply and demand of nuclear engineers for the period 1999–2004, DOE, the Nuclear Engineering Department Heads Organization (NEDHO), and the ASEE are collaborating on a joint study. An initial assessment of the situation was published by NEDHO in the Dec. 1, 1998, report *Nuclear Engineering in Transition: A Vision for the 21st Century*. The results of a workshop and a survey will be presented in a final report due in summer 1999. A follow-up workshop will be held at the winter American Nuclear Society meeting. NEDHO feels that increased R&D funding would lead to more students, more faculty, more courses, more graduates, and more equipment and has recommended funding goals to DOE, including a 33% increase in the NEER grant program. That program (which covers reactor physics, reactor engineering, reactor materials, radiological engineering, radioactive-waste management, applied radiation science, nuclear safety and risk analysis, and innovative technologies) had 99 submissions and 19 awards in 1998 and 121 submissions and 20 awards in 1999. Cochran noted that the first three items covered by NEER are reactor-related, but DOE's nuclear expenditures are largely for environmental management. Was said that, actually, applied radiation science is the biggest DOE program and that maybe universities should reorganize their programs to reflect this new reality. Duderstadt noted that university faculty

are very market driven, that they go where the money is, and that no one is now responsible for the core knowledge of reactor engineering. Was continued that the universities think that NERI and NEPO are excellent ideas.

Freidberg analyzed the problem of declining enrollments in the following terms: No new U.S. nuclear plants have been ordered for 25 years. No new nuclear engineering research facility focusing on power generation exists at any national laboratory. Students equate nuclear engineering with nuclear power and therefore do not view it as a long-term career path, even though jobs for nuclear engineers are plentiful now. Comfort asked what the jobs were that make up the demand for nuclear engineers, and Freidberg replied that none of the students have any problem getting a job because of all the other needs for personnel with these skills. However, students do not recognize the opportunities open to them in radiation science (e.g., radiopharmaceuticals) and applications not in nuclear-engineering-focused industries.

NEDHO's recommendations were based on the premises that (1) nuclear engineering is too important to the well-being of the nation to give up and (2) radiation science and technology is a growing field based on the principles of nuclear engineering. Its specific recommendations for universities are that they

- Redefine nuclear-engineering education into a broader discipline, shifting from a curriculum focused on nuclear power to one focused on a broader range of topics;
- Define a new nuclear engineering core based on applied nuclear science, including low-energy nuclear physics, the interaction of ionizing radiation with matter, and plasma science and technology.

NEDHO's recommendations for DOE are that they

- Invest about $300 million in a large-scale research experiment or facility focusing on power to focus intellectual interest;
- Locate such a facility at a national laboratory to develop advanced means of power generation and to serve as the flagship of a reinvigorated interest in nuclear power;
- Create a new program focusing on radiation science and technology applications to biomedical research;
- Enhance the science base for radiation applications by supporting university-led consortia and funding research at the university reactors and accelerators; and
- Stabilize funding in the national fusion program and define where the field is going.

Ahearne asked if the $300 million for a research facility was not a small amount of money. Freidberg pointed out that DOE was starting with $20 million for NERI. Ahearne said that a program can be killed by grossly underestimating its costs. Freidberg countered that nuclear power has the advantage of having experiments modularly structured. Comfort asked if he was thinking of some specific project., but Freidberg said that NEDHO did not have a device in mind or even what the correct mission would be. Cochran said that since utilities were selling off nuclear plants at $100 million apiece, maybe someone should consider buying an existing commercial plant and using it for fuel-cycle and other R&D programs. Freidberg said that he was not anxious to build a machine in the next five years because the demand was not there; he was concerned that the facilities be there when the demand arises. Duderstadt said that if you look at the tradition of

nuclear-engineering education, it is not facility-oriented; it might be better to consider the Solid-State Consortium model of R&D. That paradigm may be coming to an end, but one does need to look at the long range. Todreas suggested that some government facility that already exists may be able to be converted to a testbed for materials science, fuel-cycle, and other R&D for less than the previously mentioned $300 million.

NEDHO would like to see NERAC

- Initiate a study of the priorities of a flagship power research facility;
- Determine the mission of the new facility;
- Involve DOE, universities, national laboratories, and industry in the facility's planning and operation;
- Determine the appropriate funding level for such a facility;
- Evaluate the level of DOE funding for radiation science and technology;
- Conduct a national review of university research reactors, determining
  - the research and/or educational mission of each reactor and its potential for serving as a national resource,
  - the physical status and relicensing date of each,
  - the total university subsidy required to operate these reactors,
  - the cost of upgrading these facilities to modern standards, and
  - DOE's role in supporting these reactors.

Duderstadt noted that NERAC has two standing committees and suggested that they consider these questions as they perform their duties. Magwood said that the Department is still considering how to go about gathering data on these programs. Ahearne asked how much effort NEDHO had made to approach Environmental Management (EM) and Defense Programs (DP) to assess their future needs for nuclear-engineering graduates. Freidberg responded that the nonpower sector of radiological science is so spread out that we do not know whom to approach. Ahearne suggested that they approach the other organizations that have so much money. Freidberg said that it is not that NEDHO does not talk with them, it is that their structure is not as focused. Was said that NE is the only group that would have anything to do with radiological science; EM and other divisions do not. Magwood offered to invite EM and DP personnel to the regular meetings of nuclear engineering department heads to initiate some contacts there.

Crandall commented that the assertion that nuclear engineering is too important to lose seems at odds with the EIA projections that indicate that nuclear power is going to drop off. Freidberg responded that it is difficult to predict what will happen; the EIA projections from 1980 were not very accurate. In the face of such uncertainty, we should keep as many options open as possible.

Duderstadt introduced **Robert Gottschall**, **Robert Price, and Paul Smith** to speak about the programs of DOE's Office of Basic Energy Sciences, recently renamed the Office of Science (SC). Gottschall pointed out that the Office has parallel functions to those of NE and in some cases shared or complementary responsibilities for research facilities. The mission of SC is to foster and support fundamental research and to plan, construct, and operate major scientific user facilities. Ahearne asked how strong the link was to energy, and Gottschall answered, very. Although he would speak about only the ties with NE, more than half of SC's budget goes to large national user facilities, and

its basic research covers a number of topics related to energy. The office's fundamental tenets are excellence in fundamental research producing new knowledge and ideas that (1) change the way people think, (2) endure, and (3) are widely used]; relevance to the nation's energy future; and stewardship to ensure stable and essential scientific communities, facilities, and institutions.

Topics in the SC research portfolio that underpin nuclear energy include radiation damage (a $4.5 million per year R&D program), corrosion and stress corrosion, welding (including the online repair of operating reactors, which is important in relicensing programs), nondestructive evaluation (including radiation effects and the prediction of material behavior in radiation environments), and degradation mechanisms and modeling of radioactive wastes and their containment systems. Cochran asked if the SC people are so good in transuranics, why can they not convince Sen. Domenici that transmutation is a bad idea. Gottschall answered that SC does not work in transmutation.

SC interacts with NE on the Energy Materials Coordinating Committee and its numerous subcommittees, in the NERI proposal and peer-review process, and through research-assistance task forces on (1) radiation materials science for the structural integrity of reactor components and (2) radiation materials science applied to reactor pressure-vessel embrittlement. Todreas asked what SC's interest in NERI was, and Gottschall said that SC has been partnering with NE, working with them on peer review, participating in the peer-review process, suggesting experts for panels, and sharing 40 years of experience in managing university grant programs.

The mission of SC's Division of Chemical Sciences is to develop energy technologies that meet national goals of energy efficiency, public health and safety, environmental protection and restoration, and conservation of natural resources. Of specific interest to NE are its programs in photochemical and radiation sciences and in heavy-element chemistry; the division is also focusing on combustion phenomena, catalysis, and homogeneous-phase chemistries. Several examples of funded research projects were described. Klein asked how much of SC's funds went to universities and national laboratories, Smith answered that about 90% goes to national laboratories because of the need for facilities suitable for handling these materials. As an example, SC funds four synchrotrons (three of which have facilities for handling radioactive materials) that can perform surface speciation structure at very low concentrations. A major facility funded by both NE and SC, with operational oversight provided by NE, is the High-Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory. Its mission includes isotope production, neutron scattering, and irradiation testing, and the facility has an associated Radiochemical Engineering Development Center.

Price then described SC's Engineering Research Program, which has as goals: (1) creating new options for enhancing energy savings and production, prolonging useful equipment life, and reducing costs without degrading industrial production and performance and (2) broadening the technical and conceptual base for solving future engineering problems in the energy technologies. The program focuses on long-term issues; does not do short-term, applied research; covers multiprogram, multidiscipline issues; and focuses on nonlinear, stochastic, and basic science. It funds research in advanced industrial technology, fluid dynamics and thermal processes, dynamics and control of processes and systems, and solid mechanics. From FY 1997 to FY 2000, its budget has declined about 17%, from $18 million to $14.5 million. As a result, in 2000, the fellowship

program, 13 university grants, three laboratory efforts, combustion research, and turbulence research will be terminated. About 70% of the program's money goes to three-year university grants, and about 25% goes to the national laboratories. All research programs are peer reviewed, and projects are monitored for progress. The program is involved in reviewing about half the NERI proposals and is setting up panels for reviewing proposals for the Environmental Management Science Panel. It is also involved in the Scientific Simulation Initiative, the Climate-Change Technology Initiative, the Robotics and Intelligent Machines Program, the Nano Technology Program (with the national Science Foundation, dealing with devices between the classical and quantum mechanical ranges), the Partnership for Academic-Industrial Research Program, and the Complex and Collective Phenomena Initiative.

Mtingwa asked if DOE had any idea of how much research is done outside DOE, and Haberman said about $1 billion. Todreas asked about the implications of the cuts coming down from OMB, and Price said that OMB looks at research and sees NSF and DOE funding research on the same topic and does not recognize the needs and differences in progress that the two agencies have. Duderstadt observed that it is worse for the Department of Defense (DOD), which had one-third of its R&D request denied. Matthew Quint of the Australian Nuclear Development Agency asked which office is responsible for the operation of the nuclear facilities. Paul Smith of DOE SC answered that NE is responsible for operating the facility, and SC is responsible for the science done; a memorandum of understanding (MOU) spells that out.

Chairman Duderstadt declared a break at 3:40 pm and called the session back to order at 4:00 pm to hear **David Thomassen** of the Office of Biological and Environmental Research (OBER) speak on DOE's Low-Dose Radiation Research Program. That program seeks to understand how radiation affects genomes and living organisms and, based on this knowledge, to develop radiation-protection standards. One of the basic questions the program is asking is whether there are any "safe" levels of exposure to radiation. Cochran asked if he was implying that background radiation has no implication. Thomassen said that was an excellent point and was well taken. Cochran said that what was at question was whether there was any effect of microrems above background. Thomassen said that that was exactly the goal of the program. The intent is to try to understand what is occurring in endogenous damage and to compare that to incremental additional damage. DOE's Biological and Environmental Research Advisory Committee (BERAC) put together a ten-year research program plan on the biological effects of low-dose and low-dose-rate radiation, which is available at www.er.doe.gov/production/ober/berac/ldfinal498.pdf.

OBER takes the proposals that come in and puts together a research portfolio that addresses four key research questions:

- In low-dose radiation and endogenous radiation, are the damages and responses the same or different?
- Are there thresholds for biological effects for low-dose radiation?
- Are there genetic factors that affect individual risk?
- How should we communicate research results to the research community as well as to the public?

Ahearne asked were they not years away from needing that, and Thomassen responded that they were but that they wanted to make sure that the researchers were working on the right things as they

develop models etc. In response to these four questions, OBER is studying effects at many levels: DNA, cells, tissues, and organisms. They are looking at the responses, mechanisms, and relevance of chromosome abberations, DNA repair, mutation, adaptive responses, altered gene expression, cell killing, and cancer. These topics have been looked at for many decades, but the dose exposures considered here are lower than those previously considered. Large-dose, whole-animal studies were phased out because those studies had reached the limits of the science.

A first-level goal of this program is to take the information gained from the research and to couple it with new understandings of mechanisms to develop new models. Another area of research is sorting out human susceptibility to radiation. Animal models can be identified that reflect human susceptibility. Communicating research results is a two-way street among several sectors: the public, scientists, regulators, and legislators. The question is, what information do they need and use?

These research objectives are being pursued now because a wealth of radiation-biology research has accumulated during the past 50 years; new data and technology (such as the modification of organisms to make transgenics, microarrays, sequencing, and the production of genomic information for cytogenetic studies) are available, especially from the human-genome program; new instrumentation is available (such as the microbeam irradiation of single cells, mass spectrometry to detect damage, and capillaries for DNA sequencing); and congressional interest has been aroused. The program used $5 million last year, and $3 million was added to the budget this year. Future funding of $20 million per year is expected.

Ahearne asked if they will use peer review, and Thomassen responded that they already do; during the current cycle, they had 200 preproposals, of which 100 were encouraged to submit full proposals. Rios asked if the program included informatics, and Thomassen said only indirectly. Long asked if they were going to employ epidemiological studies, and Thomassen said they were not going to initiate any new epidemiological studies but planned to look at data from past studies and to reanalyze those populations with newly available capabilities. Cochran asked how OBER was going to integrate its work with that of the research community that is studying the causes of cancer. Thomassen said that the community studying radiation as a cause of cancer is small and that OBER meets with them regularly. The bigger picture is cancer research in general; there, the responsibility will lie with the office's peer reviewers. But, given the level of radiation that is being studied here, there is little chance that anything will be found about the causation of cancer; rather, what will be elucidated will be some presteps. Sullivan noted that in April a workshop would be cofunded by NIH and OBER and that workshop should enhance the interaction between the two agencies and their research communities.

Duderstadt introduced **Lake Barrett** to describe the operations of the Office of Civilian Radioactive Waste Management (OCRWM). He prefaced his remarks by noting that the office's title is slightly misleading in that it deals not only with waste from commercial nuclear-power operations but also with Navy spent fuel, waste weapons material, etc. On the commercial side, about 38,000 MTUs (metric tons of uranium originally charged to reactors) have been discharged from commercial reactors, 10% of which is stored onsite at shut-down reactors. The total is expected to rise to 87,000 MTUs by 2040. That amount, along with 19,300 cannisters of vitrified DOE high-level waste, 65 MTHMs (metric tons of heavy metal) of Naval spent nuclear fuel, 16 MTHMs of foreign research-

reactor spent nuclear fuel, 2419 MTHMs of DOE spent nuclear fuel, and 300 cannisters of vitrified commercial high-level waste are destined for geologic disposal by 2035 under the OCRWM program. The steps included in that task include the Nuclear Waste Policy Act (passed in 1982), its amendments (passed in 1987), a viability assessment (1998), a draft EIS (1999), a final EIS (2000), a site recommendation (2001), a license application (2002), construction authorization (2005-2006), and actual emplacement of waste (2010). No interim storage of the waste is currently planned. The viability assessment and its associated documents were completed in December 1998, including the volumes that described the costs to construct and operate the repository, the analysis of the total-system life-cycle cost, and the nuclear-waste-fund-fee adequacy report.

To date, $2.5 billion have been spent at Yucca Mt., the proposed site for geologic disposal of this waste, and a number of large experiments are going on there. The design calls for a 5-mile-loop tunnel to be bored out underground with drifts bored off the main tunnel. All of these tunnels are about 300 m above the water table. In all, 100 miles of tunnels will be produced and fitted with rails. Railcars carrying 100 packages of waste will be remotely placed in each drift, with each package holding 10 tons of commercial fuel assemblies or other waste. On the basis of this design, the viability assessment found that the monitoring period without major maintenance could be up to 300 years. In the analysis, hydrology is the main concern. The regional groundwater flow is southerly into Death Valley; it does not connect to any rivers or to the ocean. Although the repository will be 1000 feet under the mountain crest, rainwater will infiltrate through the geologic formation down to the water table. Because water would start the degradation of the waste packaging, the design's safety strategy is based on limiting the water that comes in contact with the packages; designing waste packages with a long lifetime; open breaching, producing a slow release from the waste packages; and a low concentration of radionuclides in the groundwater once water has absorbed materials. The model used to assess performance of the tunnels considers the thermal-hydrology drift scale, near-field geochemical environment, unsaturated-zone flow seepage, waste-package degradation, waste emission from degradation, and radionuclide mobilization through the engineered barrier system. The goals are to limit temperatures to 350°C at the fuel pins, 200°C at the rock walls, and 100°C in the Calico Hills. Rios asked what the estimated lifetime of the packages was. Barrett responded that they all will have failed at 1,000,000 years and 18 out of 10,000 will have failed after 10,000 years. Cochran asked about the status of the EPA standard, and Barrett said EPA was still working on it; the EPA focuses on the contamination of groundwater, and how that is measured forms an important detail in the system's assessment.

In addition to modeling the thermal hydrology of the tunnels, the assessment also models precipitation, infiltration, unsaturated-zone flow and transport, and saturated-zone flow and transport. These models allow the calculation of 10,000-, 100,000-, and 1,000,000-year dose rates at 20 km from the site from all pathways; those estimates are, respectively, 0.1 mrem/year, 10 to 20 mrem/year, and 30 mrem/year, although transitory spikes up to 200 mrem/year are produced by the decay of specific isotopes. Alternative design options, such as drip shields, backfilling, and ceramic coating of the packages, alter the model results significantly. For example, the ceramic coatings defer the onset of package failure to 400,000 years.

A breakdown of the costs associated with the preparation and submittal of the site recommendation and license application was presented. The total cost through FY 2002 is $1138 million. The

milestones for that process were listed and described as being in a state of controlled dynamic change. Because of management improvements, the estimated cost to complete the license application and construction has decreased from $6.3 billion to $4.1 billion between 1991 and 1998. The cost to construct and operate the repository through 2116 was placed at $19.8 billion. The total-system life-cycle cost to complete the program through closure and decommissioning in 2116 is $36.6 billion. Added to the historical program cost from 1983 to 1998 of $7.1 billion, this brings the total estimated cost of the repository program to $43.7 billion, the great majority of which would be expended before 2043. On the basis of these estimates, the 1 mil per kW-hr charged to commercial nuclear-power producers under the Nuclear Waste Policy Act has been determined to be adequate, but there are big uncertainties.

Because the Jan. 1, 1998, deadline specified in the law was not met, about 100 lawsuits are now ongoing. The Department has been found in breach of contract, and now the questions are how much is to be paid in damages, who is to pay it, and how is it to be paid.

Cochran said that, in 1979, the NRDC suggested that the harm from the repository should be no worse than that from a uranium-ore body and he asked if OCRWM could run such a comparison on its model. Barrett said that he had asked that of his scientists, that he had not been able to get a straight answer from them, and that he was still working on it. Cochran said that he did not understand how OCRWM can do an EIS with the EPA standard still undefined. Barrett said that it did not mean that an EIS could not be issued, but they would certainly like to have it. Cortez asked if it can be determined how radioactivity has migrated from underground nuclear tests. Barrett said that DOE has operated monitoring wells at the test sites (which are 40 miles from Yucca Mountain) and found plutonium colloid a mile away from the test site. Cortez asked if they could use that in their model, and Barrett said that they do. Rios asked to what purpose Yucca Mountain would be put if Domenici kills the project. Barrett answered that it would be used for interim storage and as a demonstration site for an accelerator waste-treatment plant. Klein asked if any countries were ahead of us in waste disposal. Barrett said that Germany was at one time, the French have performed a laboratory study, the Swedes and Swiss have program, but we are leading the pack. We have a small program with the Russians to use their data on thermal hydrology. Ahearne asked about the Australians. Barrett said that the British had proposed a depository in the Australian outback but there was an outcry from environmental groups; it is a technically good idea but fraught with political difficulties. Cochran asked what licensing issue this project was going to turn on. Barrett said that the main problems to be dealt with are that two government agencies are operating outside their normal operations: EPA and the Nuclear Regulatory Commission (NRC). The main point is that the NRC will set (1) an extremely low number as the upper allowable value and (2) uncertainty bands on each consideration. Madeline Feltus of Pennsylvania State University asked how much handling of the multipurpose cannisters was expected. Barrett said that the handling facilities are easy; the multipurpose cannisters will also be able to be handled as soon as they are licensed by the NRC.

The session was adjourned for the day by Chairman Duderstadt at 5:50 pm.

March 31, 1999

Chairman Duderstadt called the Committee to order at 8:30 am and opened the floor to public comment and questions.

Mary Lou Blazek of the Oregon Department of Consumer and Business Services came forward as an interested stakeholder in the Hanford site and presented that office's preliminary scoping comments on a potential EIS for the restart of the FFTF. Those comments called for evidence of a compelling need for any new mission for the facility, that the FFTF is the best choice for the mission, that there would be no adverse environmental impacts from operation of the facility, that the reactor can operate safely, and that operation will not have any negative impacts on the Hanford cleanup. It also called for the thorough analysis of FFTF vs. all other alternatives; all FFTF-related waste streams; the impacts of any mission on the process, nuclear, and radiologic safety of the FFTF; and all costs for restart. Ahearne asked how her department had analyzed the FFTF. She replied that they had several reactor operators on staff who had gone over prior analyses and technical specifications; they were concerned that it cannot be operated safely. She stressed that involving stakeholders is one way that DOE can establish its credibility.

Brad Morse of the Network for Nuclear Accountability said that the FFTF takes dollars away from cleanup of the Hanford site, that a new mission with new waste streams would be dangerous, and that no new mission would be the best option. Fertel asked if money was a problem in cleanup, and Morse replied that it was his understanding that there would be a shortfall this year.

Herb Feinroth of Gamma Engineering, Inc., asked what the long-term strategy of NE should be. He said that it is important that the DOE program put a high priority on the fuel cycle rather than on reactor development. Senator Domenici is concerned that Yucca Mountain may not be licensed, constraining the industry. Spent fuel should be considered a resource rather than a waste. Several brand new facilities are available in the country today that could be used for fuel-cycle development: the Fuels and Materials Examination Facility (FMEF) in Hanford, the Fuel Processing Facility in Idaho, and the Device Assembly facility in Nevada. He urged the committee to consider adapting these existing facilities rather than building new ones. Todreas asked about using reactors as testbeds, and Feinroth said that it is not the design of the fuel that is the problem but what you do with the spent fuel. Todreas asked whether you have to test the fuel after you reconstitute it, and Feinroth said that you do but that could be done in the Advanced Test Reactor or in commercial reactors. Cochran stated that, in his view, new fuel designs need to be licensed rather than mucking around with spent fuels because it takes ten years to demonstrate licensability of reconstituted fuels. Feinroth said that it is necessary to find a way short of chemical reprocessing to deal with these spent fuels and there are many ways to do this.

Duderstadt called upon **James Lake**, Director of the Advanced Nuclear Energy Program, for a briefing on nuclear R&D activities at his institution, the Idaho National Engineering and Environmental Laboratory (INEEL). He said that the first reactor to go critical at the site, the Material Test Reactor in 1952, is now shut down. In the intervening years, 52 reactors have operated at the site. During the seventies and eighties, a period of intense reactor-safety research, they conducted the Loss-of-Fluid Test, which examined fuels operating beyond their design conditions and the Three Mile Island Research Program, which included the Accident Evaluation Program and the Vessel Inspection Program.

In the current era, INEEL is continuing its safety program and its reactor development activities, although no new reactors are being built. Its mission may turn to fuel-cycle development because INEEL has the premier facility for testing fuels, the Advanced Test Reactor (ATR). Currently, INEEL is focusing on five major areas: safety analysis (developing safety codes, such as RELAP5, and simulator codes); risk analysis (where they are moving toward parametric-risk-analysis techniques to resolve generic safety questions, developing codes like SAPHIRE for risk analysis, and running training programs); support programs (provided to the Navy, DOE, etc., determining how they can operate their facilities safely), nuclear engineering (INEEL is a lead laboratory in fusion-reactor safety analysis, advanced reactor design, aging assessment and life extension, space reactors, and motor-operated-valve testing); and radiation physics. In the last category, they are working in (1) radiation therapy, developing software for patient treatment, experimental dosimetry, and reactor filters; (2) radiation detection and spectroscopy for the characterization of warheads, spent fuels, etc.; and (3) criticality safety, addressing how DOE preserves the extensive banks of information and experience now that the personnel are retiring and doing this by pulling together information from many nations and documenting it in a database compiled by a team of experts who look at the data, build benchmark models, and validate the understanding of the data (all done at INEEL, Los Alamos Scientific Laboratory, Oak Ridge National Laboratory, and other locations).

Ahearne asked if they provide training to commercial entities, and Lake said they do not because of conflict-of-interest considerations. Ahearne asked what happens when NRC regulates DOE, and Lake said that we then have a conflict of interest because we cannot support both agencies on the same activity; as a result, NRC is using INEEL less and less. Fertel asked how one would know one from the other. Lake said that, on the DOE side, INEEL supports their Occurrence Reporting and Processing System (ORPS) report; on the NRC side, it supports the staff's positions. Long asked if any work was being done on the impact of human performance, and Lake said that work was being done in human-factors research, much of it for the NRC and NASA on organizational structure and management styles. Fertel asked if he saw the needed personnel being available for the next ten years, and Lake responded that they have concerns about the quantity of trained graduates coming out of the schools.

The Laboratory's key competencies are systems simulation; risk analysis and human factors; large-scale test programs; reactor and radiological physics; nuclear safety and regulatory technical support; fuels development, testing, and modeling; and advanced reactor design. The ATR has facilities for radiation-effect research. It allows neutron spectrum, flux, etc. to be varied and can conduct nine tests at one time. It went critical in 1967 and began fuel testing in 1969. It is in good condition, has good funding, is well maintained, and can fulfill its mission through 2050. It has produced highly reliable fuels for Navy applications. Its isotope-production activities (Ir-192) were privatized in 1996. Its future programs will include safety, proliferation resistance, waste and cost controls, and long-life cores.

Ahearne asked if one would get higher burnup with higher enrichment, and Lake said that they are going to look at thorium-based fuels again. Cochran asked his assessment of the Radkowsky fuels, and Lake said that the seed-blanket concept may present a problem in separating the fission products. Cochran asked where they got their fuel, and Lake responded, Babcock and Wilcox. Ahearne asked if all nine test loops are used, and Lake said no, that they are not optimally used.

Rempe commented that during the site visit, the committee was told that they are funded but only 50% of the loops were used and that the staff is adequate but that, if someone is missing, they are stopped to fill out the workforce and carry out tests. Rios asked if advanced fuel concepts can advance fuel lifetimes to ten years. Lake said that fuel lifetimes can go beyond the current three years but not cover the full 30-year lifetime of the reactor.

Cochran asked what industry has to do to use a fuel after INEEL gets through testing it. Lake said that every fuel load would have to be licensed by the NRC. Industry wants a fuel that has long life, is proliferation resistant, and is economical. Todreas commented that industry is interested in long-life fuels but is wary of the effects of separative-work-unit costs. Comfort asked about opportunities for university research, and Lake that the ATR is a national user facility to test fuels, but it is an expensive reactor to operate. Magwood pointed out that, with ATR, outside users negotiate costs on a case-by-case basis; security issues are also involved because of the Navy work. He also said that industry is interested more in evolutionary changes to existing fuels than in advanced fuels that carry attendant costs and uncertainties. Cochran asked what cannot be done in the ATR that could be done in the FFTF, and Lake said the FFTF is better suited for higher neutron-fluence levels than is the ATR. Magwood said that fusion-reactor tests would get better results in the FFTF because of the higher fluxes.

Lake pointed out that INEEL maintains strategic collaborations with academic and basic research partners:

- With MIT, they are looking at performance-based regulation for DOE facilities, advanced reactor design, and the global fuel cycle.
- With Idaho State University, they are studying accelerators.
- With various universities they are conducting a half-dozen reactor-related topics chosen by peer review of university proposals.
- With Argonne National Laboratory, they are doing fuel development and testing, developing NERI proposals, studying spent fuel and the fuel cycle, and operating international nuclear- and environmental-safety centers.

Duderstadt asked how large an effort this was, and Lake replied 6000 employees with a $600 million/year budget dominated by EM. Ahearne said that he was having difficulty identifying what INEEL is, and Lake said that it is an EM laboratory, the only EM lab.

Cortez raised the question of university collaboration with DOE facilities, and Duderstadt and Ahearne joined in a discussion of the limited opportunities for such collaborations. The suggestion was made that, instead of the current regional associations between universities and national laboratories (which limit the topic of any collaboration to the specialty or specialties of the laboratory closest to the given university), DOE should be fostering collaborations between laboratories and universities at a national level so the scholarly needs of a university can be met regardless of where in the country it is located.

Cochran asked if they had collaborated with industry, and Lake replied that getting access to that technology is often difficult. Cochran suggested that industry make the fuel, INEEL test it in its reactors, and industry run it in their reactors. Ahearne said that industry has its own reactors to do those tests. Sessoms asked if INEEL had contacts with school districts and other lower-education

institutions to encourage interest and competency in math and science. Lake said that INEEL have had some high-school programs but they and DOE do not do enough in that arena.

Duderstadt declared a break at 10:00 am and called the meeting back into session at 10:16 am.

John Ahearne reported on the initial meeting of the Strategic Plan Subcommittee. They are setting meetings in April, May, and June to interview DOE personnel, after which they will draft their recommendations. Duderstadt said that the Committee should take these recommendations and put them in a letter to the Secretary.

Richard Reba reported on the Expert Panel on Long-Term Isotope Availability, which met for two days and used the collective wisdom of the group, relying on reports that had been produced since 1982. They found that

1. These reports all identify the same trend: the use of medical isotopes will expand.
2. The use of radioisotopes in therapy has not been great to date, but because of advances in molecular biology, the promise for future use is great.
3. The United States should develop a capability to produce large quantities of radionuclides.
4. The basic science and clinical aspects must be integrated and equally represented at the highest level of DOE and NIH and with industry collaboration.
5. DOE and NIH must develop the capability to provide a diverse supply.
6. Isotopes for chemical and research applications should be supplied reliably and with diversity in adequate quantity and quality. Scientific disciplines that require isotopes include chemistry and radiochemistry, nuclear physics, medicine, energy physics, geosciences, fission and fusion reactor technology, agriculture, and veterinary medicine. Many industrial users of radioisotopes rely solely on DOE for their supply.
7. The analysis done in the next six months will provide a rationale for DOE to evaluate its existing facilities and will identify new production capabilities within the United States.
8. Stable-isotope inventories are fine, but no data are available to back up that assertion. DOE should maintain its privatization policy on technical development. We do not know what isotopes will be used 20 years from now.

Duderstadt said there was a motion to accept the report from the Subcommittee and to route it back to the Subcommittee. Todreas objected that the report had no recommendations. Reba said that all the conclusions cited in the presentation are in the report and were extracted from the report. Cochran said that he did not see anything in the report that analyzed the available sources and facilities. Duderstadt commented that these are broad observations that they need to go back to the industry group with. Cochran said that he did not see any problem with using foreign sources. Reba said that the Subcommittee is going back to the various laboratories and private industries to answer Cochran's first question about analysis. At this time, 100% of clinical radioisotopes come from outside the United States, and at one time there was a truckers' strike in Canada that halted medical practice in the United States. Ahearne asked if the panel had looked at the possibility of NIH funding operations at DOE facilities. Reba said that DOE produces, and NIH purchases. This situation will continue. NIH Research Resources supports some isotope production, but their funding is very limited. They have not provided funding in the past but are becoming aware of the problem. Comfort asked if the panel, in reviewing the reports, thinks that they were reliable and

whether the panel had given any thought to other therapy techniques that might displace radioisotope therapy. Reba said that he did not understand the first question, but the short answer to the second was yes. In fact, the panel reflected this uncertainty by dropping its estimates.

The motion carried unanimously.

John Taylor reported on the Operating Plan Subcommittee, which met on March 12. At that meeting:

- The Subcommittee refined its charge, focusing its activities on reviewing and commenting on the DOE R&D plans, planning process, and key issues and urging the Subcommittee to coordinate its activities with the NEPO Coordinating Committee.
- It addressed specific concerns about the scope and charge, noting that
  - the focus should be on review, not formulation, of strategic plans;
  - that information should be made available on all relevant R&D programs in DOE;
  - that activities should encompass light-water reactor technology, and
  - that the appropriateness of DOE funding research in the broad area of "operations and optimization of the nation's existing nuclear power industry" should be questioned.
- It recommended setting up a screening process for prioritization that would consider
  - major national criteria,
  - major industrial criteria, and
  - specific criteria to assure the high value and timely application of the R&D results.
- It commented on the content of the *Joint DOE-EPRI Strategic R&D Plan to Optimize U.S. Nuclear Power Plants* (copies of which were distributed to the Committee members), saying that it had
  - insufficient emphasis on human behavior,
  - needed more emphasis on regulatory resolution,
  - identified promising technologies for plant optimization focused on nuclear fuel and on instrumentation and controls but not on other portions of the plant,
  - needed to specify R&D to extend the operating cycle to 48 months.
- It reviewed the status of NEPO Program, recommending that:
  - the Chair of the NEPO Committee be designated as a member of the Subcommittee, the Subcommittee obtain periodic reports on the NEPO Committee activities and recommendations, and the NEPO Committee be called upon to act as a task force for selective evaluations and
  - a NEPO Committee membership be allocated to an Institute of Nuclear Power Operations (INPO) staff member.

Taylor asked for approval of the report and of the Subcommittee's anticipated direction. Ahearne noted that this joint plan represents a lot of money. Taylor acceded that the money needed is enormously more than what Congress might appropriate for NEPO, so it is a wish list, only a small portion of which could be carried out. Ahearne asked if the Subcommittee would recommend which projects to fund. Taylor replied, yes, but with advice and assistance. Fertel asked if the Subcommittee's doing the peer review was kosher, and Magwood replied that it was as long as the committee members are not the proposers. Rempe asked if the Subcommittee could recommend that some of the research be funded by other divisions of DOE, and Magwood replied that NE is trying

to coordinate with other portions of DOE to do just that. Cortez asked if the Subcommittee saw the need to bring in others, and Taylor said that EPRI is very anxious to have participation from other agencies, particularly the NRC.

Chairman Duderstadt proceeded to introduce **Dale Klein**, Chair of the NERAC Roadmap Subcommittee, which had been asked to review what DOE had done in developing a roadmap. That group had held a briefing on Jan. 26-27, 1999, and had toured the Transient Reactor Facility (the TREAT facility) in Idaho and the FFTF in Washington on Feb. 18-19. They looked at DOE's needs for facilities (specifically hot cells, reactors, and accelerators) and neutron science (specifically in regards to the space mission, medical isotopes, nuclear power, general science, and national security) and made recommendations on each of these topics. The group found that DOE had made a good start on the roadmap but needed to enhance integration, expand participation, get policy input, consider budgetary impacts, rank their priorities, address personnel needs, and enlist the active involvement of NERAC.

Ahearne said that he did not see much in the Subcommittee's report about international facilities, and Klein acceded that those portions of the report need to be more comprehensive. Sessoms said that the Subcommittee did make a specific recommendation about international facilities for neutron sources. Ahearne asked what would be done with the university reactors, and Klein said that the report did not cover that topic because it may not be the prerogative of DOE. Ahearne asked if the report addressed the decline in personnel and experience at DOE, and Klein said that it did not do that yet. Cortez observed that many of the facilities are operated by people near retirement age, so this is a critical issue. Cochran said that the report does not seem to address the program; the underlying documents need to be provided. Klein noted that this is still a draft report and the Subcommittee still has a lot of work to do. Cochran asked if NERAC will be asked to endorse the roadmap or the process used for deriving the roadmap, and Klein said that it was easy to endorse DOE's recommendations because they have not made any yet; the Subcommittee will review these recommendations as they emerge. Rios said that he had concerns about the extent of the Subcommittee's activities because not enough time was available to develop the roadmap and because the Subcommittee is operating on very limited data; he did not think the Subcommittee could go beyond critiquing DOE's roadmap.

Klein continued that the Subcommittee was asked to look at two facilities in standby and to make recommendations. They found that the TREAT is a facility with unique capabilities, it is relatively inexpensive to operate, and fuel availability is not an issue. The Subcommittee recommends that before a decision is made on whether or not to restart the TREAT, DOE must define a long-term mission for the facility and identify specific potential users. Duderstadt said that what the Subcommittee is saying is that this is *not* a specific recommendation to start up the facility but just a statement about the need to maintain the facility's unique capabilities.

With the FFTF, DOE is at a point where a decision must be made whether to restart or decommission the facility. The FFTF is not the type of reactor that would be built today; its original mission was to support the Clinch River Breeder Reactor, an effort that was abandoned. However, prior studies on the FFTF have not looked at DOE's long-term needs. DOE should go through an EIS on this to make the decision openly and to bring up all the issues, including specific missions

and users, support-level missions, collaboration with other countries, fuel supply, waste disposal, and costs to modify and restart.

Ahearne said that, as he understood it, the Secretary was going to make the decision to shut down or restart (with an EIS) in April, and he interpreted the Subcommittee's call for an EIS in effect a step toward restart. Klein said that the Subcommittee's position is that, before a decision is made, DOE should look at its current capabilities and future needs. Cochran asked if they were recommending an EIS even if the Secretary decides to shut it down, and Klein responded that, if he decides to shut it down, that is his decision. Cochran asked if the Subcommittee recommended an EIS in both cases. Klein said that it recommends an EIS to guide the decision and to determine whether the facility should be shut down. Such an EIS would not be tantamount to restart but would be a method for making the decision. The Subcommittee feels that DOE has a lot of little pieces of information and that an EIS would be an open, reasonable mechanism for pulling that information together. Magwood said that the Secretary will make the decision in April to (1) shut down the facility, (2) put the facility on indefinite standby, (3a) start the EIS process to allow restart, or (3b) start the EIS process to see if there is a defensible reason to restart.

Comfort asked if the Subcommittee felt that the FFTF has a significant mission. Klein said that there appears to be enough potential mission to justify restart and that the Subcommittee recommends that an EIS be started to get all these issues on the table. Sessoms said that the recommendation is that there is not enough information to make an up-down decision and that an EIS would bring out that information.

Cochran said that he did not see why anyone would want to use a sodium-cooled reactor to make isotopes and that he did not believe that enough little missions could be pieced together to justify restarting the facility. Sessoms reiterated that the Subcommittee did not feel that there was enough information to make such a decision. Ahearne commented that every study of the situation has concluded that there are possible missions but they have never been able to come up with a list of those missions that would justify restart. The fact that so much is spent on standby maintenance tells Congress there is no pressure for funds for nuclear energy. Recommending an EIS is telling the Secretary that he does not have enough information to make the decision. Duderstadt said that the Secretary may weigh the current cost against future uncertainty and make a decision based on those considerations. Fertel said that he did not think that anybody feels the answer is to maintain the status quo. Ahearne commented that, if the issue was the need to obtain specific information to inform a decision, that would be one thing; but the proposed reason to do an EIS implies that the Subcommittee thinks restart should be pursued. Cortez responded that what the Subcommittee is saying here is that an EIS may be the best way to get at the issues the public is most concerned with (the waste streams etc.).

Duderstadt said that the Committee had before it a report in three elements: the roadmap, TREAT, and FFTF. It could accept the report and express the concerns voiced around the table. Cochran said that he would not recommend acceptance because the report is flawed. Rios said that he would like to hear if there are any plausible missions from DP. Rempe said that there is not a clearly defined mission for the FFTF and that is what the report says. Cochran said that DP has millions of dollars; if they want it, have at it. Ahearne said that he had no problem accepting the roadmap and TREAT

portions of the report, but he did not believe there was any reason for DOE to continue spending so many dollars to maintain this reactor for no apparent reason. Fertel said that maybe the EIS process is not the best way to get information but, before a decision is made to shut down the facility, DOE should be sure to get good input from DP and industry sources.

Klein moved to accept the roadmap and TREAT sections of the Subcommittee's report and to pass the recommendation about an EIS on to the full NERAC. Cochran suggested separating the two statements in the motion. Sessoms seconded the motion (which now covered the first portion of the original motion), and it was unanimously adopted by the Committee.

Duderstadt said that the second motion is to pass the recommendation on the FFTF on to the Secretary. Reba said that he would not like to mention the EIS but to say that sufficient information is not available to us on the missions and importance of the facility; the Secretary has to make a decision. Duderstadt suggested putting the recommendation of the Subcommittee to do an EIS up for a vote; 20 voting members were present (including the chairman), and 10 voted for this position (with the Chairman not voting). Duderstadt put forward the motion that NERAC does not support the recommendations but does not have enough information to support a decision; 8 of 20 voted for this position. The Chair declared that he would cast an affirmative vote on the previous motion. Cochran noted that the missions proposed for the FFTF do not justify its continued support and that it should be shut down. Duderstadt said that it would be his intent to convey that concern and the other concerns of the Committee along with the report and the accompanying letter of acceptance. The summation of the vote is that 11 members voted to accept the recommendations of the Subcommittee, 8 voted that there was insufficient information to make a decision, and one voted to shut down the FFTF.

Magwood expressed thanks to the Subcommittee for its work.

The meeting was adjourned by the chairman at 12:30 pm. Written comments were submitted by the Government Accountability Project for inclusion in the minutes and are included here as an attachment.

Respectfully submitted
Frederick M. O'Hara, Jr.
Recording Secretary
June 21, 1999