Minutes for the
Nuclear Energy Research Advisory Committee Meeting
April 30-May 1, 2001, Crystal City Marriott, Arlington, Virginia

NERAC members present:

John Ahearne
Joseph Comfort
Michael L. Corradini
Jose Luis Cortez
Maureen S. Crandall
James Duderstadt (Chair)
Marvin Fertel
Steve Fetter
Beverly Hartline
Leslie Hartz
Andrew Klein
Dale Klein
Robert Long
Benjamin F. Montoya
Sekazi Mtingwa
Lura Powell
Richard Reba
Joy Rempe
Allen Sessoms (Monday only)
Daniel C. Sullivan (Monday only)
John Taylor
Ashok Thadani (ad hoc)
Charles E. Till
Neil Todreas
Joan Woodard

NERAC members absent:

Thomas Cochran
Allen Croff
J. Bennett Johnston
Linda C. Knight
Warren F. Miller, Jr.
C. Bruce Tarter

Also present:

Ralph Bennet, Director, Advanced Nuclear Energy, Idaho National Engineering and Environmental Laboratory
Nancy Carder, NERAC Staff
Yoon I. Chang, Associate Laboratory Director, Argonne National Laboratory
John Flack, Office of Research, Nuclear Negulatory Commission
Norton Haberman, Senior Technical Advisor, NE, USDOE
John Herczeg, Lead Nuclear Engineer, Office of Technology, USDOE
R. Shane Johnson, Associate Director, Office of Technology and International Cooperation, USDOE
Salomon Levy, Levy & Associates
William Magwood, Director, NE, DOE (Monday only)
Gail Marcus, Principal Deputy Director, NE, USDOE
Tom Miller, Physical Scientist, Office of Technology and International Cooperation, USDOE
Frederick O'Hara, Jr., NERAC Recording Secretary
Burton Richter, Professor of Physical Science, Stanford University
Edward F. Sproat, III, Vice President of International Programs, Exelon Corporation
Craig Williamson, NERAC Staff

About 35 others were in attendance during the course of the two-day meeting.

Monday, April 30, 2001

Chairman Duderstadt called the meeting to order at 10:00 a.m. and asked each of the Committee members to introduce himself or herself. He reviewed the agenda and introduced **Burton Richter** to present the report of the ATW (Accelerator Transmutation of Waste) Subcommittee.

An initial ATW roadmap was prepared in FY99(Roadmap I) and described the processes for treating 78,000 tons of spent fuel from the present generation of nuclear power plants. First, the spent fuel would be partitioned into three parts: U (95% by mass); Pu, Np, Am, Cm, and long-lived fission fragments; and short-lived fission products (300-year storage required). The actinides and long-lived fission products would be transmuted by the use of special-purpose, large [800-Mw(t)] subcritical reactors driven by high-power accelerators. The accelerator design was based on technology developed for the accelerator production of tritium. The job would take more than 100 years to treat the spent fuel.

The Subcommittee developed four criteria for judging a transmutation program:

1. Reduce the long-term radiotoxicity.
2. Reduce the long-term proliferation risk.
3. Benefit to the repository storage.
4. Increase the acceptability of nuclear power (including economics).

Criteria 1 to 3 can be evaluated relatively soon, but Criterion 4 (economics) will require much longer.

There are many approaches to designing a transmutation system; choosing the right approach is important. The Subcommittee believes that the assessment of this technology should proceed on a modified basic assumption, that nuclear power will be a long-term part of the U.S. energy program. Also, the assessment should examine multiple approaches and configurations, including combinations of critical and accelerator-driven systems, such as

1. a once-through reactor plus a large accelerator-driven system (ADS),
2. a light-water reactor (LWR) plus a smaller ADS,
3. an LWR plus mixed-oxide fuel (MOX) plus an ADS (a fuel system used by the Europeans),
4. a fast-spectrum reactor acting alone, and
5. variants on all of the above.

The Subcommittee has recommended that Option 1 be dropped; the Office of Nuclear Energy Research (NE) agrees.

He sketched out the classic approach (Option 1, above) and the dual-strata schema (which recycles some of the spent fuel to the reactor to diminish the amount of material that must be sent to the accelerator). This cycling can be done again and again to reduce the amount of material that must be treated in the accelerator and the amount that must ultimately go to a repository. The potential payoffs of such a design are:

- The long-term radiotoxicity is reduced to below that of uranium ore in about 3000 years with once through. (Note that a repository is still required.) No detailed design of such a system is available, but the operation of French and British reprocessing plants indicate that such plants have a negligible radiologic effect on the general public.
- Proliferation potential is reduced because, although a fixed level of nuclear power gives a linear Pu buildup over time, transmutation gives a constant level equal to the “in process” Pu. Several cycles of

Pu burning are required, but the isotopic mix after the first pass through makes weapons building very difficult. [This question was posed to the National Nuclear Security Administration (NNSA) for analysis.] You could make a weapon out of this in principle, but that is not likely in practice.

- The mass of the actinides and fission products in the repository is reduced by a factor of about 20 (to 5% of the original). The volume is reduced by a factor of 3 to 10. The shorter required storage time simplifies design of containers and the repository itself.
- The impact on nuclear-power economics is unknown now and cannot be determined until the R&D is further along. (Because about 25% of the core is occupied by recycled material in equilibrium, it is likely that power efficiency would be reduced by about 5%.)

DOE is starting on the second round of the Roadmap II; NE has begun work assuming a long-term future for nuclear power. This roadmap will set forth R&D goals, milestones, decision points, etc. Teams from the national laboratories will narrow the number of approaches from the current six or seven down to the two or three most promising within the next 12 months. This roadmap must be a living document that evolves as the program evolves and takes into account the evolution of the nuclear power industry. It must also take into account advances in fuel cycles, new separation technologies, etc.

Waste transformation is of broad international interest, making a cooperative program possible and perhaps necessary. Other nations (France, in particular) are more advanced than we in some areas. There are facilities, in Europe in particular, where access would greatly benefit the program. For example, an experiment using a 1-MW proton beam on a target with a cooling loop would cost about $10 million to do on our own, but we can participate as a partner for about one-tenth of that. There is a potential for contributions to major facilities in the United States, but that will not happen without a demonstrated, long-term commitment to the program on the part of our government.

The Advanced Accelerator Application (AAA) program is justified because the United States is losing its nuclear R&D infrastructure. The nuclear expertise in the U.S. is aging. Facilities are needed to advance the program and to attract students into the field. An Accelerator Demonstration Test Facility (ADTF) can do both. The first experimental area that should be developed is one for target and materials testing. The role of ADTF as a tritium production backup facility is being discussed with NNSA. The facility should be sited to build on existing strengths. [Richter's personal recommendation is to build it at Argonne National Laboratory (ANL).]

In the R&D program, much good work has been done since the Subcommittee's previous report. This work will be covered in the written report on the Subcommittee's recent meeting. The Subcommittee expects to receive a preliminary analysis of the approaches within 6 months. Most of the required data exists. The administration's energy policy will, of course, be the major determinant on this and other nuclear-energy programs.

The Subcommittee suggests that its name be changed to: Subcommittee on Advanced Nuclear Transformation Technology.

A big problem is looming in that the budget is not likely to be big enough to accommodate ATW and other proposed programs. Some priorities must be set.

Fertel commented that a big Nuclear Energy Agency (NEA) study that will be published in the fall might have a lot of meaningful information for this program and asked what the timetable was for integrating ATW into commercial reactors. Richter responded that it would depend on the type of reactor, fast or thermal. The Subcommittee is going to continue working on this.

Dale Klein asked how many systems would be needed to handle the current output of spent fuel.

Richter said one ATW for four or five reactors.

Comfort asked if Gen IV will put restraints on this technology. Richter said, no; there are many approaches to Gen IV, and noone knows how it is going to turn out.

Ahearne asked how one could overcome the resistance to the location of a repository. Richter replied that the public's concern about long-term storage is not in the Subcommittee's department.

Duderstadt said that he worried that the argument that "the nation's infrastructure needs to be rebuilt" is not compelling. He believed that the Subcommittee's approach is more logical. Richter said that the Fast Flux Test Facility (FFTF) might be a good facility to do R&D with. NERAC must look at science questions in terms of administration policy. Magwood noted that a 90-day review of the FFTF shutdown was currently under way. The reviewers will look at how the decision was made and what new information has come out. A lot more things are on the table than there were a year ago. He asked what needs there would be for a new repository as a result of this program. Richter responded that the Subcommittee felt that the original goal was too limited. If it is desired to progress with ATW, the long-term aspects of nuclear power should be examined. The ATW program reduces the actinides by a factor of 500, and the resulting radioactive material needs to be stored for a much shorter time. But a repository will still be needed. Fertel noted that, at this point, Yucca Mountain would be closed in about 50 years and that the fission products that would need to be stored would drive the design of any new repository. Richter said that you might go to a different design for a repository, but you cannot live without a repository.

Todreas asked if one can avoid testing of fuel and material at a fast spectrum with any of these approaches. Richter replied, no.

Sessoms asked what would be a timeline for collaboration with the French under a sensible budget scenario. Herczeg responded that the United States has a committee that is engaged in ongoing discussions with the French to test fuels in the Phénix reactor. That committee is about to sign an agreement. Richter noted that the French plan to shut down the Phénix in 2006. Magwood commented that the French are interested in using the FFTF to do testing related to an ATW process and to demonstrate the technology on a reasonable scale. If the FFTF were not around, the United States would turn to Phénix. Todreas pointed out that the Phénix plant is aging. Herczeg said that the Phénix facility would be more limited and also has an aging problem.

Fertel asked if the Committee had to act on Richter's request to change the name of the Subcommittee? Duderstadt said that, hearing no objection from the Committee, the name will be changed. He asked **William Magwood** to review the budget situation.

Magwood said that no new additions to the budget were being made until it was clear what direction the administration was going to follow. The Department is waiting until all the issues are sorted out. Much of the program is intact, with activities funded in all areas except AAA.

The Nuclear Energy Research Initiative (NERI) will announce the successful proposed projects in the next couple of weeks (about 13 new projects). In the International NERI program, all negotiations are complete with France and Korea, and agreements will be signed soon. Negotiations are progressing with other countries.

Nuclear Energy Plant Optimization (NEPO) Program is progressing with a lot of industry support.

The Advanced Nuclear Medicine Initiative (ANMI) program has awarded nine research grants and five grants to universities to develop curricula. The universities are very enthusiastic.

University Programs may see new, additional funding, depending on NERAC's response to the report of the Subcommittee on University Research Reactors.

Magwood stated the opinion that NASA will make a major investment in the Space Reactor Power program.

He said that the most exciting and gratifying program is the Gen IV initiative. About 100 people from 10 countries are working on the technology roadmap. The French have volunteered a senior person to work at Idaho Falls on this program.

He presented a budget summary (in millions of dollars) for the major NE R&D programs:

	FY 2000	**FY 2001**	**FY 2002**
Nuclear Energy Research Initiative (NERI)	22.4	28.2	11.3
International NERI	0	6.8	6.8
Nuclear Energy Plant Optimization	5.0	5.0	4.5
Advanced Accelerator Applications (ATW)	8.5	34.0	0
Advanced Nuclear Medicine Initiative	2.5	2.5	2.5
University Programs	12.0	12.0	12.0
Space Reactor Power	0	2.0	1.0
Gen IV	0	7.5	4.5
Total	50.4	98.0	42.6

The rest of the budget has remained at a steady state. Staff and administration goes from $23.0 million in FY01 to $25.1 million in the FY02 request; infrastructure goes from $156.5 million to $155.4 million. NE looks at 2002 as a transition year.

Duderstadt asked what effort was made by DOE to sustain the R&D budget. Magwood responded that the budget process was one of focusing on priorities set down by the Secretary. A major guidance was to avoid new initiatives until the administration has a chance to see where it wanted to go. Ahearne noted that the largest expenditure in the budget is FFTF. Magwood said that that is mortgage; you have to do that.

Ahearne commented that the "no new starts" in NERI is discouraging. Duderstadt observed that the entire portion of the Federal Budget devoted to developing new knowledge is off by 4% this year [after taking out funding related to the National Institutes of Health (NIH)]. NERAC should speak out against this, and DOE needs to be more aggressive in seeking R&D funds. NERAC would be derelict in its duty if it accepted this budget. Sessoms added that that budget is insulting and asked how much time was available to modify it. Magwood responded that the Vice President's report comes out in mid-May. The congressional subcommittee hearings start this next week and will continue until October. As a result, there will be a lot of opportunity to talk with Congress about these budget figures. The Department is hoping for better figures in FY03. Andrew Klein asked what was going on in the Senate. Magwood responded that Sen. Domenici and others have entered bills increasing the funding for nuclear energy. There is a lot of interest in the long-term investment (Gen IV) and in the short-term investment in current nuclear power

plants needed to increase power output. These bills also address concerns of universities. The program is expected to benefit from these bills over time.

Andrew Klein asked if there was any expectation that NE will seek funds for these activities in the FY03 budget. Magwood responded that the rubber hits the road in the appropriations process, where the DOE research programs are overshadowed by defense and water concerns.

Hartline noted that NERI is taking a hit this year, which is disturbing because this is the program's fourth year and the first-year grants are running out of funding. She asked how this funding target developed. Magwood said that there were some funding issues where the Office was told what to do. Hartline asked if higher-ups in DOE or the Office of Management and Budget (OMB) attacked NERI. Magwood responded, no. Hartline asked if Magwood could comment on the Vice President's panel on energy policy? Magwood noted that it is a closely held process. The Department is not writing the document. It is a small document and is on track for a timely release. Hartline asked if NERAC should be making contributions to this report. Magwood said that it is very late in the process for that to occur. It would be good for NERAC to comment to the task force on the items it is really interested in.

About the FFTF, Fertel asked if the Department would move forward on D&D if the Secretary lets the decision to shut down the facility stand. Magwood responded that the Department is making plans for D&D. Once the study is completed, decisions among many options will have to be made. Powell asked who was doing the study on the FFTF. Magwood responded that that was not known yet; the Office of Science (SC) might do it. Powell stated that NERAC should put forward compelling arguments for the budget issues it feels should be advanced. Ahearne commented that the national interest is clearly served by a strong R&D program across the board. Duderstadt said that the current administration does not have an R&D policy because it does not even have a policy infrastructure. NERAC should pressure the administration to put together such an infrastructure devoted to increasing R&D.

Comfort asked what the differences were between the guidance given by the previous administration and by the new one in putting together the FY02 budget. Magwood said that the old administration did not do a lot of work on forming an FY02 budget, and the new one had pretty much a blank page to start with. Duderstadt said that he believed that the new administration has more capability to advance R&D than they feel comfortable to use.

Todreas said that NERI and I-NERI should be linked and asked what the goals of I-NERI were and what projects it might pick up; specifically, whether I-NERI could pick up some of the slack in NERI. Magwood said that, from the U.S. perspective, I-NERI will feed the same universe of people that NERI does. The areas that our international partners will find of interest will be the types of projects NERI has been addressing. Private industry can also participate.

Reba asked what fraction is education and postdoc fellowships in the budget category research and technology. Magwood said that, of the $12 million, about half goes to grants and fellowships; also, ANMI has some education funds, and about $0.5 million come from AAA. Reba commented that the new administration has said that it supports education and that this is an area NERAC should emphasize.

Dale Klein asked what the total NE budget is. Magwood responded, $223 million. Dale Klein asked what happened to the NNSA in the budget process. Magwood responded that he did not know. Ahearne said that NNSA funding went up about $200 million but that they are asking for a lot more.

Taylor asked why, after no funding for NE for years, the Division is not expecting a favorable report from the Cheney Task Force and preparing to strongly advocate what is really needed by this country. Duderstadt stated that this budget is clearly inadequate and that DOE should say that it needs additional

funding this year. Magwood noted that NERAC can do whatever it wants, but he has to fight the battle within the Forrestal Building; if there is an opportunity to increase NE's budget, he will pursue that opportunity.

Corradini asked who should be the main audience of such a request for more funds, Congressional staffers, Congressmen, White House staffers, OMB, or who and whether there was something NERAC should do. Magwood responded that the budget has been presented to Congress, so it is a Congressional process now. That is where any discussions must take place. The administration could submit a supplemental budget for Congress to act on. Corradini asked if DOE has a supplemental-budget request in hand in case it is requested. Magwood responded negatively and said that he suspected that the budget the President sent up is what the Department will stand behind.

Mtingwa asked how the money would be used to save the universities' research reactors. Magwood said that, if NERAC wants to go forward (as stated by the Subcommittee report on that subject), the Department will reallocate funds to do that in concert with OMB. The Vice President's review could shed some light on this topic.

Cortez questioned whether the pullback in NERI will be interpreted by the nation's international partners that it might pull out of I-NERI, too. The United States will need to do something significant this year. In addition, the Gen IV program will need to be increased in funding and scope, looking at additional technologies, including the ATW concept. Magwood commented that it was always the Gen IV philosophy to look at the whole system for generating nuclear power. But, Todreas noted, there is no money in the current budget for Gen IV R&D. Magwood agreed.

Duderstadt said that NERAC has a bridging function here. There are supporters for nuclear power in the administration and on Capitol Hill. This budget, however, is so inadequate that it will set the nation back 10 years. He asked what industry is doing to advance nuclear technology to benefit the nation. Fertel replied that the Vice President's task force will come out with a positive document for nuclear power. NERAC needs to go to the Secretary of Energy and to Congress to lay out the needs implied by the recommendations of that task force's report. Moreover, NERAC should draft something here and now to state what those needs are.

Duderstadt asked if the task force members have the same enthusiasm for nuclear energy as NERAC has. Fertel responded that, until a month ago, the administration was talking about clean coal, more gas, and more petroleum. Now, after the nuclear industry has talked to them, nuclear power is also mentioned in the energy mix. Hartz commented that the industry is very interested in promoting the technology, but there is not a high level of detail or planning in evidence.

Sullivan observed that the amount that Magwood can do is limited. Instead, Congress (and DOE's administrative staff) have to be educated. NERAC and other groups should do that educating. Magwood said that silence is negative in this process. Duderstadt noted that that goes both ways. Congress is looking for a sign from the administration that they would be supportive. Powell stated that there is still an uphill climb with the general public. There needs to be more positive communications from DOE and the administration. Long stated that NERAC cannot sit back and let DOE chop NERI; it needs to register an objection. Fertel said that, as Richter said, the United States is losing credibility overseas. In addition, there is a perception gap. About 60% of the public favors nuclear energy, but people (including Congress) think that that percentage is much lower. In fact, 66% of the polled public said they favored building additional nuclear capacity at sites that already have nuclear plants. Magwood said that he believed that having the Vice President come out and voice an approval of nuclear power, as he has done recently, is very

important.

A break was declared at 12:12 p.m. to get food for a working lunch. Duderstadt called the meeting back into session at 12:40 p.m. to hear **Yoon I. Chang** speak on ANL's nuclear energy research capabilities. Argonne's reactor development began with the Chicago Pile-1 (CP-1) in 1942. It was designated as a Center for Reactor Development by the Atomic Energy Commission in 1947. Its Experimental Breeder Rector-1 (EBR-1) produced its first electricity in 1951 in Idaho. ANL has produced several prototype demonstrations, such as the Experimental Boiling Water Reactor (EBWR) and Materials Testing Reactor (MTR). Argonne's reactor development has emphasized fast reactors and operated the Integral Fast Reactor (IFR) from 1984 to 1994.

ANL's present program is focused on DOE's near-term priority missions: electrometallurgical technology for spent-fuel treatment, nonproliferation technologies, and environmental technologies. Its longer-term mission is the development of a next-generation advanced reactor/fuel cycle concept to maintain nuclear power as a long-term energy option, a mission for which ANL has the requisite infrastructure, people, technologies, and facilities.

The facilities available are the Transient Reactor Test Facility (TREAT), Experimental Breeder Reactor (EBR-II), Analytical Chemistry Laboratory (AL), Fuel Conditioning Facility (FCF), Zero-Power Physics Reactor (ZPPR), Sodium Process Facility (SPF), Hot Fuels Examination Facility (HFEF), Fuel Manufacturing Facility, Radioactive Scrap and Waste Facility (RSWF), and ancillary facilities, such as the Electron Microscopy Laboratory (EML).

The EBR-II spent fuel requires treatment for disposal because it contains reactive materials and highly enriched uranium. The FCF has been refurbished with electrometallurgical equipment to treat the fuel. A National Environmental Policy Act (NEPA) challenge resulted in a two-step approach to developing the treatment: a demonstration phase and the preparation of an environmental impact statement (EIS). DOE asked the National Research Council to set up a committee on electrometallurgical techniques for treating spent fuel. The EBR-II demonstration project has a high priority. The 1995 report of the committee stated, "If the EBR-II demonstration is successful, the DOE should revisit the ANL program at that time in the context of a larger, 'global' waste management plan ... ."

In the electrometallurgical technique, spent fuel is loaded into the anode basket and a current is applied between the anode and the cathode, which accumulates the uranium product. That product is melted with zeolite and a glass binder in a hot press to produce a ceramic waste. The fission products are partitioned according to the free energy of formation of their chlorides. The heavy metals will stay on the anode and form the metal waste. Uranium and plutonium are lumped together and deposited on the cathode; the uranium and plutonium free energies are too close to allow separating the two completely.

The FCF was constructed next to the EBR-II. The turnaround time (from reactor to reprocessing and back to the reactor) is 2 months, and this cycling has been done five times. In this process, the fuel elements are chopped up and fed to the electrorefiner. Uranium salt is melted in a cathode processor, mixed with depleted uranium, and cast in a furnace into ingots that are used to produce new fuel. (The casting furnace also has been used to cast cladding hulls into stainless steel zirconium waste form.) The uranium salt with transuranics, fission products, and NaCl is mixed with zeolite and glass and hot pressed into cylinders of ceramic waste. The salt-loaded zeolite converts to a sodalite when processed at 800 to 925EC. The cladding with noble metals and fission products is melted and clad with zirconium, ending up as metal waste.

The Mark-IV Electrorefiner could only handle 5 kg per batch, so the Mark-V Electrorefiner was developed to treat the cathode and anode simultaneously. In a subsequent step, the cathode processor

separates uranium salt from the combined electrorefiner products. They are now in the process of installing a new metal waste furnace that is much larger and produces ingots ready for the repository.

Two ceramic process options have been developed: hot isostatic pressing (HIP) and pressureless consolidation (PC, which uses sintering and requires no crushing). These waste processes operate in the HFEF.

The Electrometallurgical Technology Demonstration Project has been completed. It took place between June 1996 and August 1999. Argonne reports have been issued, and work has continued on process improvement and waste-form qualification.

The National Research Council Review Committee's final report was issued in April 2000. It concluded:

< ANL has met all of the criteria developed for judging the success of its electrometallurgical demonstration project.
< The Committee finds no technical barriers to the use of electrometallurgical technology to process the remainder of the EBR-II fuel.
< If the DOE wants an additional option besides PUREX for treating uranium oxide spent nuclear fuel, it should seriously consider continued development and implementation of the lithium reduction step as a head-end process to electrometallurgical technology.

ANL has since issued an EIS, and DOE has issued a record of decision (ROD) to process the rest of the EBR-II fuel by this method.

Dale Klein asked how the cost of this process compares to that of PUREX. Chang said that the analyses are not in agreement. This process is a simple batch process; the output can be put back into a reactor, and it has other benefits. This facility was first started in the 1950s. The upgrade cost only $29 million.

Todreas asked how long it will take to process the EBR-II fuel. Chang said that it will take 10 years with current funding; it could be done it in 5 years.

Long asked how old the staff is. Chang replied that the average age is 47, but young staff members are being introducing. Sessoms asked what types of people they were hiring. Chang said mostly PhDs in nuclear and chemical engineering. Sessoms asked if they had any trouble recruiting them, and Chang said, no. But Todreas noted that that effort hired 50 to 60 people over several years when other labs were not hiring. Magwood asked what issues came up. Chang said that this technique was found to be in concert with U.S. policy because it cannot separate plutonium to a pure form, only to a non-weapons-grade material. Plus, the material is easy to safeguard because it is produced in a batch process that requires advanced technology that cannot be replicated in a garage.

Sessoms asked if there was any interest in pursuing International Atomic Energy Agency (IAEA) certification. Chang responded that ANL would be open to that possibility.

Duderstadt then introduced **Edward F. Sproat, III**, of Exelon Generation to present a review of pebble-bed-reactor technology. Direct-cycle high-temperature gas-cooled reactors (HTGRs) have been studied since the late 1950s. A German pebble-bed reactor was demonstrated in the 1970s, operating at 15-MW(th) for 23 years. Its Triso-coated fuel was subjected to lots of tests. A later version, the the Hamm-Uentrop Thorium High-Temperature Reactor (THTR), had problems with control rods and the beryllium reflector; it used helium to generate steam rather than drive turbines. Modular HTGR studies (and a steam-cycle study) were commissioned by DOE in the mid-1980s, and a lot of work has been done on regulatory requirements (fuel testing etc.). Eskom, the South African utility, initiated alternative-generation

studies in the mid-1990s and selected the pebble-bed modular reactor (PBMR) concept in 1996. Almost all of Eskom's generation stations are mine-mouth coal-fired plants (they have only two nuclear plants); it is the second largest utility in the world and produces the cheapest electricity in the world.

Eskom recognized that it needed small, deployable nuclear units and believed that the pebble-bed design was workable. When it started looking for international partners, BNFL (British Nuclear Fuels, Ltd.) and Exelon bought in. Currently, the investment picture is Eskom, 40%; IDC (Independent Development Companies), 25%; BNFL, 22.5%; and Exelon, 12.5%.

The concept uses an HTGR with spherical fuel elements and is considered an inherently safe reactor. The turbine is powered by the reactor-outlet helium. The reactor is built in modules of 120 MW(e), and the estimated production costs are 2 to 4 cents per kWh. 100% of the spent fuel is stored onsite. The working fluid goes from the reactor to the high-power turbine to the low-power turbine to the power turbine to the recuperators and finally to the compressors and back to the reactor.

The fuel is in the form of spheres of UO_2 in middle with several layers of carbon and SiC and pyrolytic carbon. Some 300,000 spheres are in the reactor, of which some are carbon reflector spheres. The spheres are continuously cycled through the reactor and sampled (and possibly replaced) as they exit the reactor volume. A fuel sphere would make five or more cycles through the reactor before replacement for burnup.

The key technical licensing issues are:

< fuel qualification and fabrication-process licensing
< whether the source term should be mechanistic or deterministic
< whether the containment should be leak-tight or vented
< reduced exclusion and emergency planning zones
< materials qualification (at 900EC outlet temperature)
< computer code validation and verification
< probabilistic risk assessment uncertainties, initiators, and end states
< regulatory treatment of nonsafety systems
< classification of system components (safety vs nonsafety)

The key legal licensing issues (for deployment in the United States) are:

< antitrust review
< Price-Anderson indemnity
< Nuclear Regulatory Commission (NRC) fees
< decommissioning trust funding
< Untested Part 52 process
< gas reactor regulatory framework [a lot of current regulations are aimed at pressurized water reactor (PWRs)]

The timeline for development calls for the completion of the preliminary design by May 2001, the detailed feasibility study by June 2001, the decision to proceed in March 2002, demonstration construction from 2003 to 2005, and startup testing in 2006. Exelon has to decide whether to go forward with the South African demonstration plant. One need is to assess the economic case that can be made for such a system in a U.S. deregulated wholesale electric economy. On that issue hangs the decision of whether to go forward with U.S. licensing.

Hartline asked about the fuel-fabrication timeline.

Sproat said that the design was just completed in South Africa; groundbreaking is expected next year. The fuel would not be produced for 18 to 24 months after that.

Dale Klein asked if they had any experience with helium turbines. Sproat replied that they had data from the Oberhausser plant in Germany. That component is the highest-risk portion of the design. Ahearne asked if the licensing window includes licensing the fuel, too. Sproat said, no. Ahearne asked if the fuel cycle review can be done simultaneously with the plant licensing. Sproat said, yes.

Corradini asked where they would site these plants if they went forward. Sproat replied that they were considering building them at existing nuclear sites.

Crandall asked about the expected cost of production. Sproat said that the target is less than 3 cents per kWh, including all costs. Crandall asked why they assumed that antitrust is negligible. Sproat responded that this is a merchant power plant operating in a market economy.

Hartz asked why Exelon preferred this design over LWRs. Sproat responded that Exelon evaluated the best designs and economics of all sorts of systems and found that LWRs have too high capital costs and too long lead times (more than 6 years). Also, LWRs have to be built big for economies of scale. That limits the number of markets they can serve economically. Incremental additions are possible with these smaller units. Sessoms asked if the South Africans are looking at scaling up the unit. Sproat replied, no. When you scale it up, the design of the core has to change radically and fundamentally.

Corradini asked what made him say that the turbogenerator is the highest risk point. Sproat responded that the Germans have shown that the fuel can be made reliably. But the risk associated with making the vertical helium-driven turbine with magnetic bearings for the first time ever seems very high.

A break was declared at 2:21 p.m. The meeting was called back into session at 2:42 p.m. and **John Ahearne** was introduced to review the development of two documents: a goals statement and elevator speeches (short statements from the various subcommittees: TOPS, Taylor; Long-term planning, John Ahearne; and Nuclear Science and Technology Infrastructure Roadmap, Dale Klein). These brief writeups were produced and sent to Haberman in March. The goals statement was produced by Ahearne and Woodard, circulated to the Committee for comment, and summarized by Ahearne:

The federal government through the DOE NE program must strengthen its commitment to position nuclear energy as a viable and acceptable element in the portfolio to meet the nation's energy needs in the 21st century through the establishment and maintenance of a strong research and development program. In addition, a healthy infrastructure, including research and teaching facilities at universities, must be sustained. Support should be provided for the broader application of nuclear science to medicine, biology, and space exploration.

The critical question is, should the DOE NE budget be expanded? It is essential that the United States assure a sustainable, reliable, and diverse U.S. electricity supply. A funding increase is needed to continue the focus on improved safety, reliability, cost, nonproliferation issues, and waste disposal. That funding must also be sufficient to ensure the research and development and the training of scientists and engineers essential to meet national needs and to regain U.S. leadership in nuclear science. Although electricity generation is commonly seen as the prime use of nuclear energy, other applications are becoming increasingly critical to society. These applications include the cleanup of nuclear legacies in the DOE complex, stockpile stewardship, nonproliferation initiatives, national security, advanced nuclear medicine R&D (including medical isotopes for diagnosis and therapy), industrial applications in manufacturing, food processing, and the use of nuclear energy for space exploration.

In this venture, research facilities and training are critical. It is hard to imagine a revitalization powered by the use of a 40- to 50-year-old infrastructure. The human (education/training), physical (research and test reactors, hot cells, and accelerators), and industrial (specialized nuclear design, testing, and

manufacturing capabilities) infrastructure must be reinvigorated and maintained. Strong support for educational programs at colleges and universities is essential and must include scholarships and fellowships, direct support of university reactors for training and research, and support for research programs and forefront facilities that bring vitality to the educational programs.

DOE must be a steward of the national nuclear-energy infrastructure. Six university reactors have been shut down and at least one more will shut down in the next year, with more to be closed in the near future. DOE should move swiftly to keep these investments alive. The reactors and processing facilities at the national laboratories have been entrusted to the care of NE and must be maintained in good, safe, and up-to-date operating condition.

The goals statement concluded with the observation that the United States once was the world leader in nuclear technology and applications. It no longer is. It can be once again, but that will require verbal and financial support. The Goals Subcommittee recommends that the United States proceed expeditiously with implementing *America's Nuclear Technology Future*, the Department of Energy's strategic plan for U.S. nuclear energy research and development.

Sessoms said that the statement is a very good job. What is needed is a baseline: the number of people needed. Ahearne said that analytic support is needed to take this mission statement further. Duderstadt said that a constant-dollar cost-of-nuclear-training graph would be a good way to show the trends in nuclear engineering education. Sessoms asked if there was any way to make the Secretary require Magwood to commission a study of what the manpower requirements are. Duderstadt said that he would like to see such a statement tomorrow afternoon.

Reba commented that the elevator speeches give figures on how much is needed for the next several years, but what is needed is a dollar amount for the next 5 years. Duderstadt suggested that a percentage of the economic activity in a sector be taken as the baseline of funding in the area. Hartline stated that the world has changed. The Cheney task force is going to say something nice about nuclear energy. Perhaps this document should be stronger in what it asks for. Ahearne suggested that that should be in the strategic plan.

Comfort said that he would like to see this statement presented to the Secretary and Vice President as soon as possible, adding that it could be sharpened up a bit. Long offered the example that the paragraph on "should the R&D budget be expanded" could be followed by a "Yes." He also emphasized the need to keep before the public the huge breadth of application that nuclear technology has (from dendrochronology to art history).

Corradini argued that the statements need to give readers just the bottom line and that the details should be put on a web site.

Dale Klein moved that NERAC approve Version 1 and let Ahearne and Woodard work on Version 2. The motion was seconded by Taylor.

Fertel said that he believed that NERAC should make a few changes in the document before releasing it to the public. For example, "are needed to improve" should be changed to "will help improve."

The vote was unanimously in favor of the motion.

Ahearne continued by noting that the Subcommittee was also charged with reviewing NERI. It is making site visits to assess the program.

Duderstadt asked if there are any people that are hostile to NERI. Magwood said that he had not heard of any. Duderstadt said that DOE has a broader responsibility than just to NE, as does the U.S. government in general [e.g., to the National Science Foundation (NSF)] and asked if NERAC would want

to call attention to these responsibilities. Ahearne responded that, in the past, people did not want to have anything to do with nuclear energy, but that attitude seems to be changing. For example, the nuclear navy has made many contributions to nuclear power, and SC has a great interest in materials science.

Mtingwa asked if the Committee could get brief summaries of the accomplishments of the NERI projects. Corradini responded that such summaries are available from Marty Martinez of Jupiter Corp., a contractor to DOE.

Comfort asked if this document could be sent on to higher echelons. Duderstadt said that that would be done by 3 p.m. tomorrow. Comfort went on to point out that NERAC and NE may need a new long-range plan. Duderstadt agreed and went on to say that the web site needs to be revamped. Magwood asked that Committee members' comments be gathered during the evening so a revised version could be put out the next day.

Powell pointed out that the elevator message is too long; it needs to be a one-page document with crisp bullets. Woodard said that she would like to see the Chair's name on the document. Hartline moved to commend Ahearne and his Subcommittee for a good job. The motion was passed by acclamation.

Duderstadt introduce **Robert Long** to present the report of the University Research Reactor Task Force, which was made up of Long, Cortez, and Sessoms. The Task Force found that near-term closures are of great concern to the Test, Research, and Training Reactor (TRTR) community and to the Nuclear Engineering Department Heads Organization (NEDHO). The three reactors that are threatened with imminent shutdown are at Cornell, Massachusetts Institute of Technology (MIT), and the University of Michigan. In all, there are 28 such reactors, of which 27 are operating; the reactor at the University of Illinois is in cold shutdown.

Cornell has a 500-kW TRIGA (Training, Research, Isotope Production, General Atomics) reactor and associated facilities in excellent condition. It also has a diverse set of faculty and student users for research and education and a number of long-time paying individual users and users from other universities and other agencies. They have shut down their nuclear engineering program, so there is not an on-campus need. They developed a plan for use of the reactor. Decommissioning plans are being prepared. It is uncertain whether the administration would support continued operation or would be interested in being a regional facility. It is used for neutron activation analysis, neutron radiography, and other applications.

MIT has a 5-MW reactor in good condition, but it is very much underused. Staff is needed to provide technical support to potential users. It has great potential if funds are made available to bring research capabilities up to the state of the art for a regional facility. The faculty and staff are very interested in medical research and materials studies. The administration believes that the focus of academic programs should be on fission and fusion power. A decommissioning plan is being planned. MIT would be interested in becoming a regional facility if support was made available.

The University of Michigan has a 2-Mw(t) reactor used by a diverse set of researchers from the university and across the nation. The facility has full-time staff support for neutron activation analysis and argon-argon geochronology. The facilities need substantial renovation and upgrading. About 75% of the users are external to the university but provide only 15 to 20% of the operating costs. The NRC is the major external user, doing pressure-vessel materials studies. A decommissioning plan is being prepared. The University of Michigan would be interested in becoming a regional user facility if funding is provided.

The near-term recommendation of the Task Force is that DOE should immediately allocate $250,000 to each of the university reactors for the current year (FY01) to ensure continued operation of the Cornell, MIT, and University of Michigan reactors. The universities would have to submit a letter of proposal

showing how the money would be used and committing to continued operation of the facilities.

Sessoms commented that, if there is no clear sign of financial support from DOE, all three of these reactors will be shut down. At MIT, they need $10 to 20 million in equipment. The University of Michigan also needs equipment. Cornell does not need anything, but they want to be cutting edge.

Duderstadt interjected that MIT is generally regarded as the leading graduate school in nuclear engineering and the University of Michigan is generally regarded as the leading undergraduate nuclear engineering school.

Till asked what good $250,000 would do. Duderstadt said that it is earnest money. But Long pointed out that it does not mean anything unless there is a long-term commitment, also.

The long-term recommendations of the Task Force are that:

< DOE and OMB should adjust FY02 budget requests to include the funding authorized by Senate Bill 242.
< The DOE Nuclear Engineering University Support Program should be continued and enhanced.
< DOE should initiate funding in FY02 to establish five university research reactor user facilities.
< DOE should initiate funding in FY02 to establish up to four regional university training and education reactor user facilities (for training purposes).
< The user-facility concept should be peer reviewed.
< In FY01, DOE should organize and sponsor a "Workshop on Long-Term Strategies for Regional User Facilities."

The Task Force concluded that the need for federal government support for nuclear engineering education and university reactor operations has been well-documented during the past two decades and that it is vital that DOE act now on the recommedations from the Task Force.

The timeline proposed by the Task Force is

April 30	University Research Reactor Task Force Report received by NERAC
Early May	Report transmitted to DOE
June	Set up workshop
July 15	Deadline for participants' acceptance
mid August	Workshop held
mid Sept.	Workshop proceedings published
March 1	Deadline for proposals
August 1	Proposal reviews completed and selections announced
October 1	Funding of regional facilities begins

Ahearne asked if the Task Force meant to say that NE should fund all the user facilities' costs. Long said, no, the universities would have to make a financial commitment. Ahearne went on to ask if this report meant that only these 9 reactors are needed and that the other 18 can go away. Long said, no. Duderstadt said that this recommended action would provide the political device needed to focus on national needs. That does not mean that local needs can be met by local operation of a university research reactor. Corradini asked why NERAC should identify numbers rather than let people write competitive proposals. With no competition of ideas, you create two echelons of reactors (haves and have nots). A large number of other reactors can provide both training and research, and they will be left out under this plan. Duderstadt responded that if there is not a fixed number, the political pressure to expand and dilute the program is too great. The scientific community needs to come into the process with a political device to focus resources. Rempe asked why the money is just given to the three universities, and suggested that

there should be more justification. Long replied that the facilities at Cornell are the best available, and the users at the University of Michigan are more numerous than those anywhere else. Having that broad range of users is great outreach. Moreover, these three reactors have received death sentences. The Task Force members talked with the University of Illinois, and they feel local politics, not money, is the issue there. Andrew Klein said that next year other universities will issue death sentences to get the money, and the issue will snowball.

Sessoms said that the Task Force was asked to fix something that was broken. If the problem is seen to be broader, more money can be asked for.

Corradini commented that, if you call them user facilities, DOE should pick up all the costs; that is what will advance the level of science. Long stated that that is what should be discussed at the workshop.

Todreas said that, if you do not recognize the requirement for base support, you miss what is revolutionary here. If it becomes a true user facility program, there will not be enough money. Several respondents said that, if it does not deal with nuclear fission and fusion, they are not interested in it. This is not disingenuous. With the absorption of nuclear engineering into the more general engineering programs, the support has to be more broad based. Long offered that the Task Force did not put that in the report because there was not enough time. The universities spend about $1 to 2 million a year for operations and similar amounts for upgrades. This comes to approximately $24 million for the 9 facilities.

Dale Klein said that, clearly, there is no such funding available in the FY02 budget. A workshop that raises expectations that cannot be met may have a negative impact. Sessoms said that the Task Force believed that the worst thing would be not to try. Everyone understands education is important and that the infrastructure is deteriorating. Fertel stated that, if these three reactors shut down, that will send a worse message to all research reactors than anything else DOE could do.

Till said that this approach does not seem to meet the problem head on. Duderstadt said that what it will do is to give the university research reactors breathing space. There will need to be follow-up.

Hartline asked how long these 28 reactors will run. Long responded that the Task Force got widely varied responses. They can operate for long periods. In addition, they are getting grants to upgrade their facilities and equipment. Some are better than others in getting such funds. Duderstadt said that NSF established four or five supercomputer centers. In the first recompetition, two of them disappeared. That will happen with reactors, too. There will be a winnowing out of those that do not continuously improve. In most of these center concepts, there are sunsets. You must come up with something novel or irresistible.

Hartline asked how much of a difference it would make if these three facilities did not get a chance to sign letters of proposal this year if DOE said there would be a pot of money for university research reactors to compete for in the future. Sessoms said that, if there is not something to demonstrate good faith, the effort will fall on its face; it will not have credibility. Duderstadt said that the question is, “What do you have to do to get a stay of execution?”

Powell asked who sponsored the nonuniversity users. Long responded, the Endowment for the Arts, archeologists, anthropologists, etc. Powell asked if anyone had mentioned to these other agencies that these reactors may shut down. Long replied that one response is that “I can go elsewhere.” Another was that their grants do not have money in them for reactor time. Powell asked if there are other reactors that are in the same situation as these three. Long said, none that the Task Force talked to (about 20 out of the 27 operating university reactors). A few people said that, if MIT shuts down, theirs might, too. Powell said that additional earmarks will get written and peer review will suffer. Duderstadt noted that that is how the University of Michigan gets its funding: a huge earmark.

Dale Klein stated that a lot of universities will need to make decisions in the next 5 years because of the need to relicense these reactors. Corradini said that one should be careful how this was said because it can be perceived as pork barrel politics, particularly by the other university research reactors.

Long said that, if you are not going to do the long-term funding, you should not do the short-term funding. Corradini asked, because Senate Bill 242 is out there with a 5-year spending plan, why not use that as a reason for this infusion of money this year. Long commented that the Bingaman bill is not attracting any comment or support from universities. That fact is of concern. Furthermore, DOE has not requested that money.

Till commented that the fact that two of these reactors are at the top nuclear engineering universities says a lot. Andrew Klein commented that, when the possibility of peer review was brought up at NEDHO, MIT and the University of Michigan were the greatest supporters. I find it ironic that they are the ones being considered for noncompetitive funding. Duderstadt said that the best thing would be a continuing peer-reviewed program. What the Committee is trying to achieve here is a stay of execution so that such a program can be initiated.

Cortez suggested that this action is something that could be proposed to be done immediately in response to the Vice President's energy-policy statement.

Duderstadt recommended that the Committee accept this Task Force's report and forward it to the Director. The issues they have identified are serious and must be acted on. Fertel moved; Cortez seconded.

Hartline asked what NE will do in response. Magwood responded that it is clear that more funding is needed. NE will seek that funding in the future. DOE is worried about the university research reactors. Shutdown of these three reactors will have limited impact on the other 24 operating reactors. Some universities just do not want to continue. But the long-term funding that has been discussed must be pursued, and NE will release the short-term funding, including sponsoring the workshop, which, I assume, will be chaired by Robert Long. If Congress provides more money, we will be in a position to use it.

Reba said, the man at Cornell said they did not want it. Duderstadt replied that he believed it is still open to negotiation. The president of Cornell is dealing with a programmatic decision. We should have the flexibility to deal with them, whatever they decide. Going down the approval path in DOE will take some time, and many things can happen at Cornell during that period.

Fertel stated that NERAC has to say to the Secretary that both the long-term and short-term responses should be funded. Hartline observed that the long-time support will take a lot of mobilization. Magwood said that it was his intent to follow through with NERAC's recommendations. This issue needs to be NE's number-one concern. This community has a lot of friends on Capitol Hill that can be educated on this subject. Once DOE talks with the universities at the workshop, there will be a much better understanding of what to ask for in 2003.

Cortez said that his gut feeling is that the Congressional support is there. This is a way to return something to the community.

Duderstadt called the question. The motion passed unanimously. No one having signed up for public comment, the meeting was adjourned at 5:15 p.m.

Tuesday, May 1, 2001

Chairman Duderstadt called the meeting to order at 8:58 a.m. He mentioned three editorials Hartline had distributed and that John Ahearne had revised the elevator speech for ths Committee's review, and

that Bill Magwood would not be present because he was testifying before Congress. He introduced **Neil Todreas** to speak on the status of the Gen IV Roadmap NERAC Subcommittee (GRNS).

Generation IV is a new generation of nuclear energy systems that can be made available to the market (but will not necessarily be commercialized) by 2030 or earlier and that offer significant advances toward challenging goals defined in the broad areas of sustainability, safety and reliability, and economics. The systems investigated include the entire fuel cycle. Design of the systems should be done by vendors.

GRNS reports to NERAC and operates in parallel with two DOE groups (the Roadmap Integration Team and the Near-Term Deployment Group) and an international group [the Generation IV International Forum (the GIF)]. These groups share a number of technical working groups that are set up by coolant and that also have groups that cut across coolant types to provide a different, broader perspective.

The roadmap groups focus on developing metrics, analyzing fuel cycles, collecting concepts, and soliciting designs. It is recognized that some degree of success in near-term deployment is a prerequisite for long-term participation. The near-term roadmap subcommittee will issue a report this fall. The long-term roadmap will be issued in 2002.

The Subcommittee considered three questions:

1. Should goals be prioritized? No! Not all goals must be met by each system, and goals must not be construed as regulatory requirements. The Subcommittee does not want to narrow down the possibilities too much. The goals have different importances to different constituencies, and concepts will meet specific goals to different degrees. The desired outcome is a portfolio of systems, each with likely different inherent characteristics that are best matched to the challenge of different goals.
2. What are the likely outputs of the Gen IV Program? They are designs for potential commercialization (this is possible but far down the road), international joint R&D on coolant family generic needs and possibly concept-specific needs (this is almost assured), and convergent positions on policy directions (in terms of fuel cycle, waste, and nonproliferation) and concept characteristic objectives (this is desirable).
3. Is the Gen IV Program sustainable in the United States? What the Subcommittee is aiming at is completion of the roadmap by September 2002, feasibility R&D for 5 years, and subsequent joint confirmatory demonstrations with industry. Gen IV will depend on what is on the ground as the result of the near-term effort. The limited number of industrial vendors will narrow down the number of designs that will be considered.

Todreas called upon **Shane Johnson** to speak about the Generation IV International Forum (GIF). The GIF is a group of nine countries (Argentina, Brazil, Canada, France, Japan, South Africa, South Korea, United Kingdom, and United States) interested in working together in planning the future of nuclear energy. Its objective is perform joint R&D for the next-generation of nuclear energy systems. The IAEA, NEA, and Euratom are involved as observer organizations. Powell asked if the IAEA has any efforts in this area. Johnson said they have a panel on innovative reactors and are adopting the GRNS technical goals. Marcus pointed out that NE hopes that the two efforts will assume complementary goals.

The GIF is organized into a Policy Group (made up of government officials) and a Technical Experts Group (with government and nongovernment members). At its second meeting in Seoul in August 2000, a charter was drafted, technology goals were set, and U.S. participation was recognized as critical. At its third meeting in Paris in March 2001, the technology goals were refined, the charter governing membership and objectives finalized, the Gen IV technology goals were endorsed with minor comments, and the Gen IV roadmap effort was internationalized, with different countries participating in different aspects of the

roadmap and international organizations adopting specific roles in the roadmap activities.

The OECD NEA will participate in the Evaluation Methodologies Technical Working Group, will act as Secretariat for two of the four working groups (the Liquid Metal and Gas Technical working groups), and will ultimately provide the management and coordination of the multinational R&D projects developed in the Gen IV Roadmap. Euratom will participate in the Gas, Liquid Metal, and Nonclassical working groups. The IAEA will participate in the Evaluation Methodologies Technical Working Group.

Andrew Klein asked what the budget held for this effort. Marcus replied that the funding from this year to next year is essentially unchanged. Comfort asked about the participation by industry. Todreas responded that there is an overlapping of responsibilities between the Nuclear Energy Institute (NEI) and DOE. Johnson said that the near-term is U.S.-oriented and the long-term is more international.

Comfort asked if there was any linkage with the ATW/AAA Subcommittee. Todreas said that that linkage is in the fuel-cycle crosscutting group. It is something that will need watching.

Till noted that the key players are Russia, Japan, France, and the United States, so it is too bad Russia that is not participating. He asked how strong France's participation was. Johnson replied, very strong, second only to that of the United States. In addition, the Subcommittee is optimistic that Russia will be joining in the near future.

Powell asked how innovative the concepts being considered are. Andrew Klein responded that some wild and crazy ideas are being considered, and one or two might be able to be deployed in 2030. Powell commented that, with the advance of technology, what is wild and crazy now might be a mature technology that meets all the goals well in 2030.

Corradini asked if the Subcommittee had looked at other roadmaps. Ralph Bennet responded affirmatively, but the Sucommittee had not found any shining models; it did find a number of lessons learned.

Todreas distributed the goals statement, which resolves the GIF comments that came up in March. These goals will be presented to GIF at its next meeting. He focused on the goals of sustainability, safety and reliability, and economics.

Sustainability is the ability to meet the needs of present generations while enhancing and not jeopardizing the ability of future generations to meet society's needs indefinitely into the future. Gen IV nuclear energy systems (including fuel cycles) will have the goals of

< providing sustainable energy generation that meets clean-air objectives and promotes long-term availability of systems and effective fuel utilization;
< minimizing and managing their nuclear waste and notably reducing the long-term stewardship burden in the future, thereby improving protection for the public health and the environment (although there is debate whether minimizations should be considered); and
< offering a very unattractive and undesirable route for the diversion or theft of weapons-usable materials.

Hartline commented that "minimizing" should not refer to just the volume. Long observed that, when the power generators minimized waste, the cost of repository space went up, and the utilities did not save any money. Fetter said that one should not focus on waste volume but rather on risk and cost, which are what people are interested in.

Safety and reliability are essential priorities in the development and operation of nuclear energy systems. Generation IV nuclear energy systems will have the goals of:

< excelling in safety and reliability,
< having a very low likelihood and degree of reactor core damage, and
< eliminating the need for offsite emergency response.

Todreas noted that the Subcommittee kept this last item as a goal; even though it may not be technically feasible, it is something to strive for. Long pointed out that it may not be politically feasible.

Economic competitiveness is a requirement of the marketplace and is essential for Gen IV nuclear-energy systems. Gen IV nuclear energy systems will have the goals of

< having a clear life-cycle cost advantage over other energy sources rather than a break-even basis and
< having a level of financial risk comparable to that of other energy projects (financial risk is the key factor that needs to be overcome).

Woodard asked whether he defined a life cycle as all the way, and Todreas replied, yes.

Fetter commented that, despite what Todreas says, there *is* a clear set of priorities:

1. Economic goals have to be met.
2. Safety is also important.
3. Sustainability does not have much to do with the market.

How these statements are translated into metrics is very important. The metrics must be transparent and understandable. We have to connect these principles to metrics; we have to relate them to the marketplace and to the end users. Levy commented that many of these concerns are reflected in the full document.

Corradini asked why a version of these goals cannot be applied to other energy sources. Why cannot other energy sources be held to these same high standards? Todreas responded that that is the work of a new task force. He turned the podium over to **Tom Miller**, who leads the Near-term Deployment Group of the Subcommittee. That group's mission is to identify the technical, institutional, and regulatory barriers to the deployment of new nuclear power plants and to recommend actions that should be taken by DOE. The expectation is that orders for new plants will be placed by 2005 and that multiple plants will be online by 2010.

The Group's participants include representatives from nuclear utilities, reactor manufacturers, national laboratories, academia, industry, and government agencies. The Group identified two deliverables: near-term actions for new plant deployment and a near-term deployment report.

The near-term actions that the Group is recommending for new plant deployment are

< an interim report to NE based on the Group's knowledge;
< an overview of recommended DOE activities and FY02/03 funding needs;
< providing backup documentation in the budget hearing process, congressional lobbying efforts by industry, and the Vice President's energy task force's discussions; and
< presenting this information to NEI and the New Plant Task Force.

Significant activities would include an early site permit demonstration, a combined construction/operating license demonstration, design certification of a 1000-MW(e) advanced light-water reactor, and design certification of an advanced reactor that employs new technology.

The near-term deployment report is to be issued by Sept. 30, 2001, and will be based on an evaluation of industry's response to a request for information. That request was issued to NEI New Plant Task Force members on Apr. 4, 2001. A public notice was also published in the *Commerce Business Daily*. It asks respondents to identify design-specific, site-related, and generic barriers to the deployment of new nuclear plants. Responses are due by May 4, 2001. The evaluation process is being developed.

The request for information covers two areas. The first is specific deployment candidate designs that meet six criteria:

< a credible plan for gaining regulatory acceptance,
< the existence of industrial infrastructure,

< a credible plan for commercialization,
< cost sharing between industry and government,
< a demonstration of economic competitiveness, and
< a reliance on an existing fuel-cycle structure.

The second area is generic information and barriers, including knowledge gaps requiring ranking and possible solutions and other gaps identified by the respondent.

The next meeting of the Group will be May 8-10, 2001.

Hartline asked about the involvement of the NRC. Miller said that the Subcommittee had asked them to respond to the request for information (RFI). Hartline asked what is being done to interest young people in nuclear engineering. Todreas replied that nothing has been done. Duderstadt said that the Subcommittee might want to interact with NEDHO.

Dale Klein asked if the Subcommittee was participating with the Vice President's committee. Miller responded, no. Marcus offered that DOE had provided input to that committee.

Mtingwa asked if any cost-sharing by industry was planned. Miller responded that a design will be done by industry and they will be asked to deal with certain long-term challenges.

A break was declared at 10:42 a.m. The session was resumed at 11:00 a.m. Duderstadt noted that he and the Executive Committee of NERAC will be meeting with the Secretary of Energy to communicate the recommendations of this Committee. He asked Fertel to circulate the results of opinion polls conducted by NEI, specifically the first question regarding NIMBY (not in my back yard). He reiterated that the general public does not think about nuclear power very much, but when asked, they are generally receptive to it, which is not the perception held by legislators and industry groups. Duderstadt introduced **John Taylor** to update the Committee on the activities of the Operating Plant Subcommittee. The Subcommittee had telephone conference on February 23 to review the Joint DOE/EPRI (Electric Power Research Institute) Strategic Plan for FY01, to review the plans for competitive bidding on FY01 NEPO projects, and to obtain an update on NEPO project implementation and related activities.

Volume 1 of the Joint DOE/EPRI Strategic Plan does not require an annual update. Volume II will be updated this year as an essential part of the project-management process. The Subcommittee recommends that a "Highlights" document be written based on Volume I. Those highlights would be 15 or fewer pages, would reduce the text devoted to the broad issues supporting nuclear power, would pay more attention to the immediate needs for R&D and the justification of its funding, would summarize the R&D content and the value of its accomplishments, would identify need for increased funding to sustain an ongoing effort and provide for new initiatives, would better recognize the problems of nuclear power in balance with statements of its benefits, and would have a primary target audience of upper DOE management and Congress.

In regard to the plans for competitive bidding, clarifications were provided on the limitations imposed on the national laboratories in competing with the private sector as well as the basis for sole-source procurements. Competitive bids have been solicited from the laboratories, and the responses continue to be evaluated. The Subcommittee concluded that the plans and criteria were appropriate and recommended that criteria for competitive bidding be generalized to cover later years rather than be restricted to fiscal years 1999, 2000, and 2001.

The Subcommittee made a number of recommendations last August. Since then, Project 5-108 on human performance was reinstated at $250,000 (which is lower than originally planned). The project will be reviewed in midrange; the initial phase will be sole sourced. Project 5-103 on dry casks for high fuel

burnup was dropped from the program. A new FY01 project implementation schedule was issued that identified minor slippage; the pace of the effort has improved over that in FY00. Three minority schools have been solicited for proposals to respond to the overall goals of the NEPO Program. A NEPO Workshop scheduled for May 16-17 in Charlotte, N.C., has been widely publicized. The revised Volume II of the Joint Plan will go to the Subcommittee in early July. The "Highlights" document has been prepared and will go to DOE and EPRI management later this week.

The Subcommittee has reviewed the modest level of ongoing R&D on advanced light water reactors (ALWRs), principally sponsored by EPRI and NERI. It has also reviewed DOE plans for the Gen IV Program and the Near-Term Deployment Working Group.

DOE has submitted a FY02 budget of $4.5 million for the NEPO Program. The Subcommittee was disappointed in the 10% reduction in a funding level that was already too low. The Subcommittee's concerns are the constraints on project selections that will result if funding remains constant, the conflicts that will arise between starting innovative projects versus completing existing projects to gain their expected value. It is encouraged by the news that Sen. Domenici has proposed $15 million for NEPO in FY02 and that Sen. Murkowski has proposed $10 million for NEPO in FY02.

The steps remaining for the Subcommittee include the selection process. Input will be provided at the Annual NEPO Workshop. The updated Volume II identifies the full list of potential projects. DOE /EPRI staff will recommend the highest-priority candidate projects during the week of July 23. (At that level of selection, the costs to fund all those projects would be two to three times as much money as is available.) The Subcommittee's comments on the recommendations are due the week of August 6. The Coordinating Committee meets on August 22 to recommend a subset of projects that is within the allowable funding. The Subcommittee will make comments on the Coordinating Committee's recommendations the week of September 10.

Mtingwa asked about the industrial part. Taylor responded that industry groups are required to put up at least half the money and are actually contributing more than that.

Long asked how one could plan with the discrepancies between the Domenici and Murkowski bills. Marcus said that two levels of possible funding might have to be planned for.

Duderstadt called for public comment. There being none, he opened the floor to questions. Mtingwa asked what the status was in NE of establishing a dedicated medical isotope production facility. Marcus replied that DOE has started the first steps of approval for a new cyclotron at BNL.

Mtingwa recommended the establishment of close ties between Richter's and Todreas's committees.

Duderstadt urged the Committee to look closely at the elevator-speech drafts that will be circulated during the next few weeks.

Haberman asked Committee members to e-mail him topics for the next (fall) NERAC meeting.

Duderstadt thanked the Committee for its hard work and promised to keep the members in the loop on ongoing activities. The meeting was adjourned at 11:27 a.m.

Prepared by
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Submitted by
James J. Duderstadt
Chaiman