Minutes for the
Basic Energy Sciences Advisory Committee Meeting
February 28 to March 1, 2000,
Gaithersburg Marriott Washingtonian Center, Gaithersburg, Maryland

BESAC members present:

Boris W. Batterman
Jack E. Crow
Jan F. Herbst
Anthony M. Johnson
Marsha I. Lester (Monday and Tuesday only)
Geraldine L. Richmond, Chair
Sunil Sinha
Joachim Stohr
David E. Tirrell (Monday and Tuesday only)
Collin L. Broholm (Monday and Tuesday only)
Patricia M. Dove (Tuesday only)
Linda Horton
Stephen R. Leone (Monday and Tuesday only)
Franklin M. Orr, Jr., Vice Chair (Monday only)
Zhi-Xun Shen (Tuesday only)
Richard E. Smalley
Patricia A. Thiel

BESAC members absent:

David D. Awschalom
D. Wayne Goodman
Walter Kohn
C. William McCurdy, Jr.
Edel Wasserman
James A. Dumesic
Robert B. Horsch
Anne M. Mayes
Samuel I. Stupp

Also participating:

Arthur Bienenstock, Associate Director for Science, Office of Science and Technology Policy, Executive Office of the President
Martin Blume, Editor in Chief, American Physical Society
Daniel S. Chemla, Director, Advanced Light Source, Lawrence Berkeley National Laboratory
James Decker, Acting Director, Office of Science, DOE
Patricia Dehmer, Director, OBES, DOE
Gregory Dilworth, Energy Biosciences Division, OBES, DOE
Judy Franz, Executive Officer, American Physical Society
Joseph Greene, Director, Materials Research Laboratory, University of Illinois
Keith Hodgson, Director, Stanford Synchrotron Radiation Laboratory, Stanford University
William Millman, Acting Director, Chemical Sciences, Geosciences, and Biosciences Division, OBES, DOE
David Moncton, Executive Director, Spallation Neutron Source Project
Frederick O'Hara, BESAC Recording Secretary
Yves Petroff, Director General, European Synchrotron Radiation Facility, Grenoble, France
James Roberto, Associate Director, Oak Ridge National Laboratory
Eric Rohlfing, AMO Physics Program, OBES, DOE
Michael Rowe, Director, NIST Center for Neutron Research, National Institute of Standards and Technology
Steve Shapiro, Associate Chairman, Neutron Scattering Group, Brookhaven National Laboratory

Gopal Shenoy, APS Program Administration, Argonne National Laboratory
John Stringer, Executive Technical Fellow, Electric Power Research Institute
Iran L. Thomas, Associate Director, OBES, and Director, OBES Division of Materials Science Nicholas Wood
In addition, about 70 others were in attendance as observers.

Monday, February 28, 2000

Chairwoman **Geraldine Richmond** called the meeting to order at 8:23 a.m. She had the members introduce themselves and reviewed the agenda. She introduced **James Decker** to give an update on the Office of Science (SC). He noted that the SC FY-2001 budget is a good one, providing significant growth, emphasizing new opportunities in the physical and life sciences, supporting new approaches in advanced computing, requesting new funds for scientific user facilities, and continuing construction of the Spallation Neutron Source (SNS) and Large Hadron Collider. All the offices of SC received increases, and of those, the Office of Basic Energy Sciences (BES) received the largest (30%), predominantly because of the funding of SNS construction. The Office of Biological and Environmental Research (OBER) received a 3% increase, but its budget is better than that percentage indicates because of congressional earmarks. After a healthy boost in FY 2000, Fusion Energy Science received no increase this year. Although Advanced Scientific Computing Research got a 42% increase, it is still operating under a tight budget. Other programs within SC received 2 to 7 % increases. The Nanoscale Science, Engineering, and Technology Initiative received a significant increase of $36 million (to $84 million). Most of the other major initiatives also received increases: High-Performance Computing (+$70 million), Understanding the Microbial Cell (+$12 million), Biomedical Engineering (+$5 million), Human Genome (+$1 million), Microbial Genome (+$8 million), Global Climate Research (+$3 million), Carbon Management Science (+$4 million), Robotics and Intelligent Machines (+$2 million), SNS (+$163 million), and User Facilities (+$65 million). Funding for the Large Hadron Collider remained constant.

Speaking to specific initiatives, he said that the Nanoscale Science, Engineering, and Technology Initiative is an exciting one that will make a huge impact on technology down the road.

Science is facing some very large complex problems in all areas; modeling will be very important in moving forward in combustion, materials, etc., requiring large-scale scientific computation. Some very-high-performance computers will become available but will be very difficult to program. In FY 2000, the lead computational problems are combustion and climate change. In FY 2001, $20 million is spread across all of SC, providing funding for large hardware, upgrading the National Energy Research Scientific Computing Center (NERSC), and developing new tools.

Understanding the Microbial Cell is a new effort funded both in BES and OBER to understand the complete workings of the microbial cell and to use this information to address DOE needs in energy use and production, bioremediation, and carbon sequestration. There is a need to understand the parts of these little living factories and how they work together. The challenges addressed include:

- Given the minimum set of genes necessary to sustain a simple free-living microbial cell, express the genes to produce the relevant proteins and determine their structure.

- Determine the physiological and biochemical functions of the genes and specific bioprocesses.
- Use gene-protein manipulation to enhance or suppress various cell functions.

Roadmapped in 1998 and now a program, Robotics and Intelligent Machines is a university-based research effort focusing on sensors and sensor integration, remote operation, data acquisition, and controls. Participants include nine offices of DOE, national laboratories, the National Science Foundation (NSF), and the Defense Advanced Research Projects Agency (DARPA).

Although experimental high-energy and nuclear physics did not get any initiative money, this should still be a good year. The Fermilab main injector was completed in FY 1999 on schedule and within budget. In FY 2001, experiments will take advantage of the new capabilities at the world's highest energy. The Stanford Linear Accelerator Center (SLAC) B-factory will be running at full operation in FY 2000 on schedule and within budget. The Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory will achieve full operation in FY 2001; four detectors and 950 researchers have already begun the search for a quark-gluon plasma.

The SNS is budgeted $183 million to keep it on schedule. It met all the requirements placed on it by Congress, the last of which was met when the Tennessee legislature voted to exempt it from the state sales tax, saving the project $28 million.

Each year, the SC scientific facilities are used by more than 15,000 scientists from universities, industry, and federal laboratories. They represent an investment of $1.21 billion in FY 2001. Included in this investment is a full upgrade of the Stanford Synchrotron Radiation Laboratory (SSRL), funded jointly by DOE and the National Institutes of Health (NIH) and operations, construction, and improvements for almost all of the DOE user facilities.

Leone asked him if he could break out how much of the budget was devoted to, say, neutron science and how much each of the other major components. Decker said that Iran Thomas would talk to that point. Orr asked about funding for computing, and Decker said that it will be an uphill battle again this year. Congress has asked DOE for a plan, and the Department is preparing such a plan. Computing has a large impact across all programs. Richmond stated that the scientific community needs to be vocal in supporting this budget.

Johnson asked what emphasis was being put on security issues, and Decker said that the topic is in flux. The Department is trying to keep control over as much of its turf as possible, especially the Tier III laboratories, those with no security work. The department wants them to have as academic an environment as possible. The real challenge is to get a reasonable security policy in place for the Tier II laboratories, those that have some security work.

Richmond introduced **Iran Thomas** to speak about the BES budget. He noted that this is a billion-dollar budget that represents $3 per person in the United States. The people are trusting us to spend it wisely, and that is why we have BESAC. He showed the changes in budget (in thousands of dollars) from FY 2000 to FY 2001 (requested) for each BES division/budget category:

	FY 2000	**FY 2001**
Materials Sciences	397,185	456,111
Chemical Sciences	206,554	223,229
Engineering and Geosciences	37,109	40,816

Energy Biosciences	30,713	33,714
Construction	100,000	261,900
Total	771,561	1,015,770

The major investments producing these increases were

- Materials Sciences: Nanoscale Science, Engineering, and Technology (NSET; +$15.2 million), Experimental Program to Stimulate Competitive Research (EPSCoR; +$3 million), upgrade to the Stanford Synchrotron Radiation Laboratory/Major Items of Equipment (SSRL/MIE; +$8 million), High-Flux Isotope Reactor (HFIR) and Los Alamos Neutron Science Center (LANSCE) upgrades (+$3 million), core research ($3.1 million, caused by the increase to MIE), facilities operations (+$22.1 million), and High-Flux Beam Reactor (HFBR; $2.1 million, which represents completing the shutdown process before transferring the facility to Environmental Management)
- Chemical Sciences: NSET (+$12.1 million), modeling and simulation (+$1.9 million), and core research (+$2.9 million, a result of the falloff of maintenance funding for the HFIR as the beryllium reflector replacement was completed)
- Engineering and Geosciences: NSET (+$1.4 million) and robotics research (+$1.9 million)
- Energy Biosciences: Microbial Cell Initiative (+$2.4 million) and National Plant Genome (+$0.6 million)
- Construction: SNS (+$161.9 million)

At the facility level, the changes in budget were

- HFBR: $2.061 million based on the requirements for a transition to safe storage
- National Synchrotron Light Source (NSLS): +$4.391 million for increased operating and infrastructure improvements and beamlines
- Combustion Research Facility: +$0.828 million, supporting research in the expanded facility
- Radiochemical Engineering Development Center: +$0.160 million for cost of living
- HFIR: $0.331, which is an artificial decrease because the beryllium-reflector replacement is complete and no longer in the budget
- Intense Pulsed Neutron Source (IPNS): +$1.943 to increase operational time
- Manual Lujan, Jr., Neutron Scattering Center (MLNSC): +$2,607 for new instruments and increased operating time
- SSRL: +$0.555 for cost of living
- Advanced Light Source (ALS): +$4.406 million for increased operating time
- Advanced Photon Source (APS): +$9.052 for additional operating time, front ends, and instruments
- SNS: +$1.2 million for construction

Thomas noted that, although the Department was expecting favorable results from the review, these numbers could change.

Crow asked how the waste-management issue is impacting core research activities in materials science. Thomas said that the funds for these activities are to be handled separately from research funds. At the present time, the cost of waste treatment is attached to the research funds in proportion to waste-treatment costs associated with the research. The previous year's costs are allocated as costs incurred in the current year. From now on, those who produce the

waste will pay for the treatment. The hope it is that this will cause researchers to pay more attention to the magnitude of waste produced.

Smalley said that he was interested in what was going to be done in the Nanoscale Science, Engineering, and Technology Initiative. Thomas said that there is always a strong desire to manage initiatives, but that presupposes you know what you are doing. We are going to say, here are the challenges, and ask the scientific community to propose how to address those challenges through research. We will put out a solicitation for proposals to universities and national laboratories.

Lester asked how the NSF portfolio will vary from the DOE portfolio. Thomas said that a number of meetings are being held to coordinate these efforts among agencies. DOE will focus on energy and infrastructure at the large facilities; NSF will focus on the centers and education. The two will collaborate; there may even be joint RFAs (requests for applications).

Leone asked what the effect and duration would be of the acting offices. Thomas said that the administration will propose a candidate for Director of the Office of Science, and Congress will confirm (or not). This process could last up to two years. It can go very fast or slow. Leone asked if there would be a wholesale replacement of personnel. Thomas said that only happens when there is a change of administration, so we can anticipate a round of changes next January.

Richmond introduced **Arthur Bienenstock** to talk about the President's goals and budget for science. He quoted President Clinton's speech at the California Institute of Technology to the effect that (1) the proposed budget supports increases in biomedical research and all scientific and engineering disciplines, (2) advances in one field often depend on breakthroughs in others, (3) science and technology have become the engine of our economic growth, (4) investments in science and technology are allowing us to lead longer and healthier lives, and (5) advances in science and technology are helping us to preserve our environment while producing economic growth. Bienenstock said that these views are very much reflected in the budget itself.

That budget was constructed according to several principles:

1. Favor long-term, high-payoff investments that would not occur without federal support.
2. Ensure a desirable balance in the government-wide R&D portfolio.
3. Encourage agencies to fund program proposals within budget guidance.
4. Maximize the efficiency and effectiveness of R&D investments through (1) the use of peer-review processes; (2) collaboration among agencies, industry, academia, and the states; (3) strategic international collaborations; and (4) improving, phasing down, or eliminating underperforming programs.

In a series of tables and charts, he showed that, in the FY 2001 budget, total R&D funding is up 3%, civilian research is up 6%, military research is flat, and peer-reviewed research is up 6%. Within these categories, basic research is up 7%, and applied research is up 5%. For the components of the 21st Century Research Fund, which was started in 1999, the proposed FY 2001 budget holds increases of 6% for Health and Human Services, 17% for NSF, 12% for the National Aeronautics and Space Administration (NASA), 13% for DOE, 4% for the Department of Defense (DoD), and 5% for the U.S. Department of Agriculture (USDA). Data from the American Association for the Advancement of Science (AAAS) showed that, over the past 30 years, funding for life sciences has more than tripled, while that for the physical sciences is up only 25%, engineering science up 4%, and social science not up at all. When these numbers are compared with the gross domestic product, the NIH budget parallels that indicator whereas all the others are essentially flat. Science programs have seen sizeable increases: The NSF core

research in biological sciences, engineering, mathematical and physical sciences, and social and behavioral science has received 15 to 20% increases. DOE's Office of Science has received a 13% increase in funding for its core research program. And the USDA's National Research Initiative has received a 26% increase for peer-review-competed research.

The Nanoscale Science, Engineering, and Technology Initiative has five components: fundamental research; grand challenges; centers and networks of excellence; research infrastructure; and research on the ethical, legal, and societal implications as well as workforce education and training. Funding (in millions of dollars) for the agencies involved in this initiative is: $217 for NSF, $110 for DoD, $94 for DOE, $20 for NASA, $18 for the Department of Commerce, and $36 for NIH.

The budget for the Information Technology Initiative increased 36% this year to $2.3 billion; the administration intends for this increase to be maintained. The Interagency Education Research Initiative is being funded reasonably well to conduct large-scale studies of education and training. An example is the Tennessee study of class-size impact, which showed that, through third grade, reducing class size increased performance significantly. Above third grade, the effect is not so noticeable, although the early effects followed through for many years.

The Bioenergy and Biobased Products R&D Initiative is budgeted for $289 million, split between DOE and the USDA. Its goal is to make biomass a viable alternative to fossil fuels as an energy source and chemical feedstock while protecting the environment. If Congress appropriates this budget, it will be a significant increase for science.

For many years, Congress has been supportive of NSF, often allocating more than requested in the President's budget. Just the opposite is true for NIH, although the differences between the requests and the appropriations are not great. If NIH and NSF get their funding, the quality of research at DOE will increase. The United States will fund scientific research well for many years to come. The nation is facing a very low unemployment rate: 1.8% among college graduates and 3.5% among high-school graduates with no college. This shortage of workers is limiting growth.

In 1962, science and technology was 11% of the workforce. In 1995, it was 15%; the fraction of the science and technology workforce has increased. Computer technicians and health technicians are where the growth is occurring. The ratio of workers to retirees will decrease, so productivity must increase, and that is done through scientific and technical advances. Therefore, society will want to keep the scientific and technical workforce strong.

Projections have been made of the scientific and technical workforce. They show that the total number of non-Hispanic, white males will drop significantly. Asians and Afro-Americans in that workforce will increase steadily; Hispanics will increase dramatically. As a result, greater efforts must be made to bring blacks and Hispanics into the scientific and technical workforce and to bring more women into areas in which they are underrepresented. The amount of the scientific and technical workforce coming from the United States will decrease. The nation has historically made up for such shortfalls in the labor market through immigration, and foreign nations are becoming concerned about this brain drain. The country would have been in tougher straits if blacks, Hispanics, Asians, and women had not earned increased numbers of bachelor's degrees in the past several decades. Because 40% of minority teachers begin their education in community colleges, more attention must be paid to community colleges. In particular, the flow from community colleges to universities needs to be increased. Academic institutions might determine if they have good matriculation arrangements with regional community colleges

serving minorities; industrial and federal laboratories might see if programs like the NSF's Advanced Technological Education and the Department of Education's TechPrep can help meet technician needs.

Richmond asked what role the Department of Energy could play in education given that education had been slashed from the budget. Dehmer said Congress did remove educational programs, but the Department does have a community college program.

Thiel questioned long-term plans being made on the basis of current conditions and are how long these conditions will last. Bienenstock said there will be fluctuations over time, but, on the aggregate, everything in society says we are moving toward a more technological society. It would be conservative and better to train too many scientists and technicians than too few.

Johnson commented that, given the data presented, there has been a retrenchment on fellowships and scholarships. Bienenstock said that the administration has been reviewing all programs for sustainability, and, for almost all agencies, there is an increase. However, he was afraid the issues will be testy because the question is being framed in terms of individual responsibility and rights.

Leone stated that industry should be putting more money on the table for education. Bienenstock said that, in many programs, the funding is shared with industrial partners, a trend that is reflected across the country at all levels of government. As for the balance between academia and industry, the government will not interfere there; there will always be a marketplace. However, the government will have an indirect role: if the number and lengths of research awards are increased, that will make academic life more attractive. Also, we are conducting a review of the government-university research partnerships and looking at the concerns there; that process should lead to resolutions of some of the existing problems.

Lester asked about his ideas on how this new budget might be pushed through Congress. Bienenstock said he was not recommending that anyone lobby. In 1995 and 1996, a critical decision was made to support all facilities and stop fighting among ourselves, giving us a large base of users across many congressional districts. Those users then made their interests known to their congressional representatives. Professional societies also had experts speak at congressional hearings to make a case for the science and technology. He suggested that the scientific community go for it all and not allow any badmouthing of one segment of science against another.

Thiel commented that the core research programs do not look all that healthy. Thomas said that is because of temporary shifts of funding among core programs, construction, upgrading, etc. The shifts occur all the time, and their appearance in the balance sheets is transitory. He said that he would not call these changes (as an example, the purchase of a large instrument) a decrease in the core program. Dehmer said that this is a stunningly good budget for Basic Energy Sciences. The core programs are up 40%. These increases are supported very broadly.

A break was declared at 10:32 a.m. Richmond reconvened the session at 11:01 a.m. and introduced **Patricia Dehmer** for a reprise on the budget and a review of the budget process. Dehmer said that the budgetary increases are a result of many individuals who worked very hard on the budget. She displayed the current organization chart and pointed out that the Office of Science has only one presidentially appointed person, the director. Dehmer has taken on a new role as principal deputy director until the end of March or until the new director is appointed.

The FY 2001 budget is the most spectacular for BES in a decade. The portions of the proposed SC budget that pertain specifically to BES are:

- Nanoscale science, engineering, and technology
- High-performance computing for science; SC received an increase of $70 million to $190, a small amount but one that will affect the whole of SC; of that, BES got $2 million
- Understanding the microbial cell; BES got $2.5 million
- Robotics and intelligent machines; BES got $3 million, more than four times last year's amount
- SNS; BES got $261 million, an increase of $163 million, which will allow completion of the project in 2006
- Upgrades and increased utilization of scientific user facilities operated by BES and OBER; the BES portion of the $1.2 billion proposed will be widely distributed throughout the BES user-facility system; OBER will put 70% of its portion into advanced light sources

This adds up to more than $230 million in increases for BES.

She described the process and schedule of the development of the DOE/SC budget, noting that three budgets are being worked on at any given time: the current year's budget as it is spent, the next years's as it is moved through Congress, and the following year's as it is developed for presentation to Congress. She called attention to the superb and very effective lobbying efforts of Research America, which informs Congress predominantly about the needs of the health-research community, and noted that physical scientists have, from time to time, made presentations to Congress.

Stohr asked how she represented the Information Technology Initiative. Dehmer said that last year, SC began a campaign to increase computing (the Strategic Simulation Initiative or SSI) in the civilian sector of DOE. It was not successful. This year, the Department has put forth a very different plan for computing in the Office of Science. This is, perhaps, the most difficult job SC has to do in its FY 2001 budget. It is a large interagency activity. The new Office of Advanced Scientific Computing is small but has an enormous impact. We have a great need to move forward in this area. There are also components of computing in other initiatives, such as the Nanoscale Science, Engineering, and Technology Initiative.

Sinha asked how long Dehmer thought the emphasis on nanotechnology would be sustained. Dehmer said that it is difficult to tell because there will be a change of administration next year. Crow asked what happened to the spending caps, and Dehmer responded that that portion of the budget cycle was just being entered.

Richmond asked **Judy Franz** and **Jim Roberto** to comment on what we as a scientific community can do to further the budget interests.

Roberto said that what we have in nanotechnology is a large number of small efforts in a large number of disciplines, including health care. The American Chemical Society held a congressional briefing on nanoscience. The Materials Research Society has passed an endorsement of the initiative and sent a letter to Neal Lane. The American Vacuum Society and the American Ceramic Society are also working on such an endorsement. The Engineering Deans Council is developing a position. Individuals are putting together a one-page ad to go into the *Washington Post*. Locally, you can meet with your representatives.

Franz said that the American Physical Society (APS), through its Office of Public Affairs, will lobby the DoD and other agencies in support of scientific research. A special symposium on the Nanoscale Science, Engineering, and Technology Initiative will be held at the March APS meeting. Congressional visits day in April will be used to lobby for this initiative. It is hard to lobby for nanoscience because it is being done by individuals rather than institutions, so the

APS's Department of Condensed Matter Physics will fund researchers to come from Washington to lobby for nanoscience. The APS would encourage other societies to do the same to overcome the small-science problem.

Crow asked what happened to the Complex Systems Initiative. Thomas said the nanoscience highway in the roadmap is largely an effort to understand complex systems. Dehmer said in thinking about how BES would participate in nanoscience, it is obvious that we have to have all the research on complex systems done. Had we not had that planning foundation, we would not have been a nanoscience player.

Richmond then reviewed the status and future activities of BESAC. Three subpanels of distinguished and expert members of the scientific community were to report at the current meeting on major, high-interest topics:

- The Neutron-Scattering Subpanel is addressing the concerns of the neutron-scattering committee, especially in view of the shutdown of the HFBR. Cochaired by Martin Blume and Michael Rowe, it began its deliberations in December 1999 and has held two meetings.
- The Electron-Beam Microcharacterization Center Subpanel, chaired by John Stringer, started its investigation in August 1999. In December, it visited the Shared Research Equipment Program at Oak Ridge National Laboratory (ORNL), the Center for Microanalysis of Materials at the University of Illinois, the Electron Microscopy Center for Materials Research at Argonne National Laboratory (ANL), and the National Center for Electron Microscopy at Lawrence Berkeley National Laboratory (LBNL). That month, it also held a closeout meeting to draft its findings, conclusions, and recommendations.
- The Advanced Light Source Review Subpanel is conducting a follow up of the Birgeneau Report. Chaired by Yves Petroff, it toured the ALS and interviewed the management and user community in February 2000.

Richmond stressed that these reports are from subpanels to the full BESAC and contain information that has not yet been accepted by BESAC; they are drafts subject to modification until BESAC accepts them.

Coming up is the annual membership rotation, which is due in June 2000. She noted that Jan Herbst, Linda Horton, Stephen Leone, and Franklin Orr would be completing their terms on the Committee and thanked them for dedication and service. Also coming up are:

- a subpanel review of the science and user programs at the IPNS and the MLNSC and
- a survey by the Management Review Team (a committee of visitors that is to provide an assessment on a regular basis of matters pertaining to program decisions).

The next scheduled meeting is tentatively scheduled for Oct. 24-25, 2000, in Gaithersburg, Md. She dismissed the meeting for lunch at 11:50 a.m.

The meeting was called back into session at 1:30 p.m. Richmond introduced **Martin Blume** to report on the Neutron Scattering Subpanel. He reviewed the charge to the panel, its membership, and its activities to date, which included an organizational conference call and three meetings that culminated in the compilation of its report. The Subpanel noted that neutron scattering has been crucial to advances in fundamental science, technology, and medicine and that the primary priority of the neutron-scattering community in America is the SNS. That said, it made the following recommendations (and estimated costs) predominantly to DOE but also to the Department of Commerce and the NSF:

- Increase funding for existing and future neutron sources through an Initiative for Neutron Science User Support and support staff at realistic levels ($10 million per year).

- Increase funding for university and laboratory user research programs ($2 to 4 million per year).
- The IPNS should submit a proposal for increased operating time to provide machine time to former HFBR and future SNS users ($2 million per year).
- Fund Brookhaven National Laboratory (BNL) to allow active participation in Participating Research teams at the MLNSC, HFIR, and the National Center for Neutron Research of the National Institute of Standards and Technology (NIST; $3+ million per year).
- Install a second cold-neutron triple-axis spectrometer in the HFIR cold-guide hall ($1 million).
- Fully fund the Phase-II extension of the HFIR guide hall and strongly consider funding a Phase III extension to provide more space for additional instrumentation ($1.4 million).

These recommendations were based on the status of the five U.S. neutron-scattering facilities:

The NIST reactor has a full complement of instruments and, with reliable service, has been the workhorse of the U.S. neutron scattering community. Its user program is of high quality, and the reactor has a cold source and guide hall. However, its instruments need upgrades, it has little possibility for expansion, and would need additional staff were instruments added. In about a year, it will be shut down for several months for upgrades to the cold source, exacerbating the shortage of neutron-scattering research opportunities.

The HFIR, which produces the highest neutron flux in the nation, has recently been operating with high reliability. Beginning in September 2000, it will be shut down for a year to replace its beryllium reflector, install a high-quality cold source with a guide hall and attendant instrumentation, and increase the number of neutron-scattering instruments by 50%. That shutdown will further exacerbate the neutron shortage.

The MLNSC at Los Alamos National Laboratory (LANL) is a spallation neutron source that has been shut down for the past year to correct safety and operational deficiencies and to upgrade the neutron-scattering instruments. It should resume operation soon. Four neutron-scattering instruments are available to the user community, three new spectrometers will come online this summer, and two more spectrometers will be installed soon thereafter. For the MLNSC to reach its potential, LANL will have to make a major effort.

The IPNS, a relatively small spallation source, has a good record for operational reliability, instrument development, and scientific achievement. For the past several years, it has supported more users than any other DOE neutron-scattering facility. Its forte is in structural studies, but it cannot replace the inelastic-scattering capabilities of the HFBR. Significant gains in performance could be made by upgrading 11 of its 12 instruments.

The SNS is currently under construction and will provide an initial suite of 10 instruments when it comes online, which is currently expected to be 2006.

What is missing is the HFBR, which is shut down because of environmental concerns and will not be restarted. Only one of its 15 neutron-scattering instruments, the U.S.-Japanese triple-axis spectrometer, can, at present, be placed at another U.S. facility, the HFIR. The most significant loss is the six thermal-neutron triple-axis spectrometers used for inelastic-scattering studies. Similar instruments elsewhere are oversubscribed. Construction of a thermal-neutron guide hall for these instruments at another facility could not be completed in time to alleviate the near-term neutron shortage (i.e., before the SNS comes online) but should be considered for the long term.

Because of these permanent and short-term shutdowns, experimenters have shifted their work to other U.S. facilities, overloading those facilities that are still operating, and to international facilities to the limited extent possible given that U.S. researchers do not contribute to the operating expenses of those international facilities.

The major findings of the Subpanel were

- extensive improvements and construction are under way at nearly all U.S. neutron-scattering facilities,
- a major new facility is under construction,
- nearly all facilities will experience shutdowns in the near future,
- inadequate funding is being provided for research programs and user support, and
- the lost HFBR capabilities cannot be replaced in the short term.

The Subpanel stressed the importance of

- completing construction and upgrades on schedule,
- establishing an initiative for research funding and user support (the Initiative for Neutron Science User Support),
- temporarily replacing lost HFBR capabilities through access to facilities abroad, and
- periodically reexamining long-term requirements with a similar subpanel.

Herbst asked why only one triple-axis spectrometer was to be moved. Blume said the facility will not accommodate more than that. Leone asked what quantitative data were gathered on users. Blume responded that it is known how many users were accommodated and how many went abroad but not how many were not served. The subpanel did not have time to pursue those figures. Orr asked what fraction of the total funding for neutron-based research did the $19 million per year and $3 million one-time funding increases represent. Blume said the amount was about equal to that for running the HFBR, about $19 million. Orr asked how realistic it is to look for this type of funding. Thomas responded that it depends on the importance of the science. Will an additional $19 million give that much more science? Also, what other uses might be made of those funds? Richmond asked if this was FY-2000 money, and Blume said it was.

Batterman asked if this money was for people that have found other sources of neutrons, and if so, what about those who had given up? Blume said Birgeneau had students coming in to do theses. They found that they could not do those these with neutron scattering, so they shifted to synchrotron radiation. The money in question would be used for travel for first-time users and such purposes.

Broholm asked if Blume could elaborate on any ideas the panel had about encouraging collaboration with the international neutron-scattering facilities before the SNS starts up. Blume noted that such efforts had been made; for example, a spectrometer at ISIS had been paid for by DOE. These issues require negotiation, and we cannot say what is an acceptable negotiating stance, only that the concept is good. Thomas interjected that the Department's position is that there be reciprocity. In Europe, several institutions are in financial trouble. With instruments, we have no problem. When it comes to operating time, we end up with complex accounting systems that do not make any sense. The call for user fees raises broader issues. The situation gets very complicated very quickly. Blume noted that the panel was against user fees, a sentiment that is consistent with what Thomas said.

Sinha noted that the core research program has actually decreased. He asked if the initiative could be used to provide indirect funding for neutron science. Dehmer said that the budget provides funding for the facilities, so several of the recommendations of the panel have already

been acted upon. Thomas noted that the request for proposals also covers funds for instruments. Stohr asked about the decommissioning cost of the HFBR, how long that will go on, and who will pay for it. Thomas responded that BES is responsible to put it in a stable condition, and then it is turned over to Environmental Management (EM). After that, BES is responsible only for monitoring costs, which are the subject of constant negotiations. Store asked if this was only a one-year problem. Thomas responded that within the department are several organizations that have spent this money several times over.

Johnson asked what type of industrial input the panel had, and Blume responded that one industrial representative was on the panel.

Lester said that she was still looking for better answer about the funding needed before the SNS goes online. She wanted a justification of the numbers themselves. Blume said that those details were not available because the panel had needed more time. Smalley asked if the panel was concerned that, if the neutron-scattering community is weakened, there will not be any users for the SNS when it comes online. Blume said that that is a concern; the SNS will broaden the research possible, offering research opportunities to more scientists. It should not have to build up the user community again.

Richmond asked if this money would be distributed in the form of peer-reviewed research grants. Blume said that is what the panel envisioned. Thomas said there is a two-part process: peer review for funding and granting of available time at the facilities by advisory groups.

Tirrell asked if there was a contradiction inherent in asking for increased research funding when the availability of facilities is limited. Blume said that those numbers are not steady-state. The Subpanel expects availability to be limited for about a year; but after that, it will probably be necessary to build up the user-support staff at the user facilities. Crow noted that efforts are going on at BNL, the SNS, and other places to stimulate the user community and those efforts should be expanded. Horton said priming the pump like that with researchers is important, but so are access to the equipment to do the science and all of the programs. Blume said that is a central point to our priorities. What has to be remembered is that neutron scattering can be a tool that researchers can use to address some small but important portion of their research efforts.

Broholm noted that what is needed is a balanced approach. Richmond said that BESAC is concerned about the quality of research being done. If the request for proposals goes out and there are few respondents, would not it be better to have a phase-in of funding? Blume said that just because money is available does not mean it has to be given out. Thomas commented that he was amazed at the results of a recent solicitation from the MLNSC to which a lot of new researchers responded with lots of good ideas. Dehmer noted that the implication here is that relatively large amounts would go to requests for proposals (RFPs), but it is only $4 million. Blume interjected that the bulk of the amount (about $13 million) would go to travel support, encouragement of first-time users, etc. Michael Rowe of NIST observed that their experience is there is no shortage of good science. What is needed is to help the science that should be done but is not being done. To accomplish that end, the scientists must be given the tools they need.

Richmond noted that the Committee had heard a request for clarification of the need for funding and that the members needed some time to consider the recommendations. She suggested taking this issue up again the following day for the possible acceptance of the report. A break was declared at 2:55 p.m.

The session was reconvened at 4 p.m., and Richmond introduced **Eric Rohlfing** to review BES activities in novel X-ray light sources, starting with the recommendations and report of the

Leone panel. That panel had recognized that there will be a symbiotic relationship between future accelerator-based sources and high-powered, ultrafast lasers. The panel recommended that

- the scientific case for coherent X-rays be improved,
- the hard X-ray region (> 8 keV) be emphasized in light of limited resources,
- the R&D program at DOE laboratories focus on linac-driven X-ray free-electron laser (FEL),
- laboratory-scale laser sources be supported,
- third-generation synchrotron sources be better utilized, and
- improved X-ray detectors and optics be developed.

To develop the scientific case for coherent, fast, intense X-rays, several topical workshops were held in association with other meetings with modest support from BES. These workshops were closely coupled to the Linac Coherent Light Source (LCLS) Scientific Advisory Committee and efforts in Europe. The ultimate goal is to produce a document by the summer of 2000, outlining the case. That document should probably be reviewed by a subset of the Leone panel and/or BESAC.

The LCLS is a testbed for the next generation of light sources. As proposed, it is an X-ray FEL, designed to produce spatially coherent subpicosecond X-ray pulses with a peak brightness that is about 10 orders of magnitude greater than that of third-generation synchrotrons. Its key components include a laser-driven photocathode radio-frequency electron gun, the last kilometer of the Stanford Linear Accelerator, electron bunch compressors, a 100-m-long undulator, X-ray optics, and detectors. It is a collaborative effort of the SLAC, ANL, BNL, LANL, and the University of California at Los Angeles. The four-year R&D effort is funded with $1.5 million per year from BES, matched equally by the laboratories. The estimated construction cost is $100 million. Optics-research issues associated with this proposal include the drive laser for the photocathode gun, synchronization with ultrafast pump lasers, handling the extreme intensities of these X-rays, and characterizing ultrafast X-ray pulses.

An RFA went out in August to support the development and application of tabletop X-ray sources, the better utilization of existing third-generation sources, and the exploration of scientific applications that use ultrafast X-ray pulses. The solicitation was open to both DOE laboratories and external (university) respondents. Two grants were begun in FY 1999 and will receive funding of about $1 million in FY 2000. This solicitation resulted in 18 proposals, covering the fundamental physics of HHG (high-order harmonic generation), propagation in waveguides, nonlinear optics, development of tabletop X-ray sources, utilization of third-generation sources, characterization of ultrafast X-ray pulses, and applications to chemical and material sciences.

Keith Hodgson gave an update on activities related to fourth-generation light sources, specifically the LCLS. Funding for this project began last July. It defines the fourth-generation light source as having ultrahigh brightness, coherence, subpicosecond pulses, and wavelengths of less than 1 Å. The concept is based on the single-pass FEL, uses a high-energy linac (~15 GeV) to provide a compressed electron beam to a long undulator, and is based on self-amplified, spontaneous-emission (SASE) physics to produce 1.5- to 15-Å radiation. The predicted results are a peak brightness 10 orders of magnitude above third-generation sources, a time-averaged brightness 2 to 4 orders of magnitude above third-generation sources, subpicosecond pulses, and transversely coherent radiation.

The SASE concept was first published in 1984 and demonstrated at LANL in 1998 at 12 μm with a gain of 3×10^5. Results from FEL radiation start from noise in spontaneous radiation. A

transverse radiation electric field modulates the energy and bunches the electrons within an optical wavelength, producing a buildup of radiation along the undulator's length. Experimental observations are now coming at a rapid pace at shorter wavelengths.

The Low-Energy Undulator Test Line (LEUTL) facility at the Advanced Photon Source (APS) has a magnetic bunch compression system similar to that in the LCLS design. It can test emittance preservation during bunch compression and explore the effects of coherent synchrotron radiation on emittance. It has already demonstrated the exponential gain expected and is slated to be operational in the APS in July 2000.

An FEL has been integrated with a prototype of the TeV-Energy Superconducting Linear Accelerator (TESLA) project at the Deutsches Elektronen-Synchrotron (DESY) in Hamburg, Germany. Preliminary results show that the observed intensity for spontaneous radiation in all plots is at about 0.014 a.u., the intensity fluctuations are SASE related and follow theoretical predictions, and the opening angle for laser radiation is 300 microradians compared to 3 milliradians for spontaneous radiation.

A third experiment just starting up is the Visible Infrared Amplifier Experiment (VISA) at the National Synchrotron Light Source (NSLS). In it, an electron beam is passed through an undulator that incorporates internal focusing plus extensive diagnostics to study the beam's position and radius and the undulator's radiation intensity.

The success of the LCLS depends on advances in three technologies: accelerators, undulators, and instrumentation. The project is guided by a Science Advisory Committee and a Technical Advisory Committee and represents a broad international collaboration among SLAC, DESY, and the High-Energy Accelerator Research Organization (KEK). The R&D components include:

- VISA's reaching saturation in SASE, measuring and characterizing the radiation and its time structure, determining startup noise, and benchmarking SASE codes;
- a fully instrumented gun test facility's developing the photoinjector to achieve the photocathode-gun performance and reliability needed for the LCLS design;
- SLAC's completing R&D on bunch compression, phase stability, and start-to-end simulations;
- APS's completing the design of an undulator with beam tolerances of better than 10 μm, high-precision diagnostics, and beam-based alignment; and
- LLNL's development of the X-ray optics with a beam-attenuator gas cell, computer modeling, and novel optical elements, such as liquid mirrors and a beam splitter with a femtosecond X-ray delay line, to handle the heat load and produce the high-precision optics.

Johnson asked about the 50-femtosecond pulses, and Petroff said that researchers are approaching that regime because of huge progress in the mirrors and are very close to handling these very short pulses in diamonds.

The R&D program calls for the completion of the conceptual design by spring 2001 and the completion of critical R&D and the beginning of construction in FY 2003. Hodgson described some experiments that could potentially be conducted with the LCLS, such as X-ray diffraction from a single protein molecule, and summed up by saying that the LCLS will be a source of unprecedented brightness and coherence delivered in subpicosecond pulses, is the most cost- and time-effective route to a fourth-generation X-ray facility, is based on technology and know-how available at the collaborating institutions, takes advantage of the SLAC, builds on current knowledge and activities here and abroad, and will be an extraordinary new scientific tool.

Leone asked how big a report they were talking about. Gopal said this is a collection of information; the panel will then produce from it what BESAC would want to see. Hodgson said that the panel would want to provide enough detail to demonstrate that these processes are real. Sinha asked if the panel was going to perform another review six months from now. Dehmer said that she would like to see and digest the report first and asked if it could be delivered by September 1. Gopal said that they could produce something by then. Smalley commented that he would need only a one-page letter report that shows a compelling reason why this is needed. Richmond said that once the detailed report is produced, perhaps a subcommittee of BESAC could study it and produce a report to BESAC. Thomas said that the office could mail it out to an expert panel; the topic covers a broad range of disciplines. Hodgson suggested that BESAC might want to convene a panel of experts for a presentation on the report. Richmond said the document should not be a list of the things possible but a statement of the priority of the most compelling possibilities. Leone noted that the document is going to have a large diversity of topics; therefore, a large amount of care has to be put into how that document is written. He then went on to ask if the panel had gone through the calculations to see if the modeling is correct. Hodgson said no; he had just gone through them sufficiently to understand what they were predicting to happen. The paper has been submitted to *Nature*. Stohr noted that there is a high dependence on the number of photons. Broholm asked what went into the decision on third-generation sources. David Moncton (SNS Director) noted that the strength of synchrotron radiation is the breadth of application. It is important to get both the breadth and depth of the process. That is the weakness of the one-page discussion.

Johnson stated that another approach would be vibrational spectroscopy and asked if there were any efforts to produce sources in the far infrared, as well. Hodgson said that he was ignorant of that. He went on to note that the problem is that you have a linear string of amino acids that then folds up. The question, which is just starting to be addressed, is, how do you take those folded linear structures and figure out how they translate into a protein function?

Richmond called for public comment. There being none, she reviewed the agenda for the following day and asked for people to forward to her their comments on the neutron-scattering panel's report. The day's session was adjourned at 5:22 p.m.

Tuesday, February 29, 2000

Richmond called the meeting back into session at 8:30 a.m. and introduced **John Stringer** to report on the Electron-Beam Microcharacterization Center (EBMC) Panel's activities. Stringer served as the chair of this panel. He reviewed the charge to the panel and identified the four centers supported by BES: the Electron Microscopy Center for Materials Research at ANL, the Shared Research Equipment Program at ORNL, the National Center for Electron Microscopy at LBNL, and the Center for Microanalysis of Materials (CMM) at the University of Illinois. The panel was a mix of those familiar with materials science and those familiar with electron-beam microcharacterization techniques. The panel or Stringer

- reviewed the charge with BESAC,
- discussed the process with the center directors,
- held an initial overview meeting,
- visited the four centers, and
- prepared the report for BESAC.

The directors of the centers were asked what areas of materials science they believed they were contributing to most. The answers were interface science; phase transformations and alloy design; defects, deformation, and radiation effects; nanostructures, thin-film and surface science; and microelectronic materials.

The techniques of EBM principally address the relationships between the structure and properties of materials. Structure includes atomic arrangements, phase(s), boundaries between regions, grain sizes, and departures from regularity. Defects on a very fine scale are largely responsible for the properties of a material. Because of the utility of EBMC instrumentation in probing structure, there are about 400 high-performance transmission electron microscopes (TEM) and 2000 scanning electron microscopes (SEM) in the United States. Of those, some are leading-edge instruments that are typically one of a kind, quantitatively different from their predecessors, and capable of doing significantly new science. Their operators are dedicated researchers, not casual scientific users. Others are state-of-the-art instruments offered for sale and supported by the manufacturer. These instruments are used by skilled researchers and made available to users with appropriate guidance. Still others are core instruments that can be operated by a competent researcher whose area of expertise lies elsewhere in science. With the exception of high-resolution TEM, improved electronics, and computer-control systems, many of the important developments in the past two decades have been in ancillary equipment, such as imaging energy filters and field emission guns, not in new base instruments.

An EBMC user facility should have state-of-the art instruments and sample preparation along with a staff of highly skilled researchers capable of supporting and guiding users. It will also have some core instruments. State-of-the-art instruments must be replaced or upgraded every 10 years.

The four EBMCs typically have budgets of about $2 million per year, five to ten professional staff members, three to five technicians, and four or five state-of-the art instruments. They also have a number of leading-edge instruments. Their clientele includes collaborators who work with senior staff at the center, users that come to the center and are assisted by the technical staff, and students who are trained in advanced EBMC techniques. Users from the host institution make up the majority of users. The use of the facilities by industry is small, about 5% of the users, although some indirect use is represented by research contracts awarded to facility staff by industries.

The recommendations of the panel are

- Funding of EBMCs should continue to be a high priority.
- BES should have a plan for the operation and development of the centers.
- The centers should develop long-range plans for the maintenance and development of their capabilities.
- The perpetuation of the excellent staff should be ensured through planning for succession.
- Specimen preparation at the centers should be upgraded by offsetting the toll taken on skilled support staff by retirement.
- The somewhat low size and funding levels of these centers should be carefully reviewed.
- Additional facilities should be provided at ANL (a 200- to 300-kV field-emission gun–transmission electron microscope/scanning transmission electron microscope), LBNL (an ARM-III microscope), and ORNL (a low-voltage electron-probe microanalyzer and a scanning atom probe/local electrode atom probe). Lester asked if priorities had been

discussed, and Stringer said they had not been talked about much, but these were the most obvious of the needs presented.

- The centers should make the availability of their facilities more widely known to universities.
- The centers should determine the needs of industry in nanotechnologies and develop a strategy for expanding this part of the user base.
- BES should address the issue of travel and accommodation costs for research students using the centers.
- The ANL center has issues concerning the renewal of infrastructure that the laboratory's management needs to recognize.
- BES should study the role of the University of Illinois center to see if it satisfies their requirements for a user center.
- The Materials Microcharacterization Collaboratory (which allows the remote operation of the microscope) should be continued.
- BES should give favorable consideration to the development of an instrument similar to the proposed National Transmission Electron Achromatic Microscope, which is the direction of the next major development in electron microscopy.

The panel concluded by saying that electron-beam microcharacterization is of very great importance to modern materials science, its importance is increasing, the user center is a valuable component of the spectrum of support, and the center concept requires the existence of planning vehicles to ensure sustainability.

Richmond asked if these centers were fully utilized, and Stringer replied that time was available on most machines; BES could explore ways to increase utilization of the instruments with the centers. Broholm asked if mechanisms were in place to do proprietary research, and Stringer responded affirmatively. These mechanisms range from full-cost recovery to an endowed chair. Leone asked what the thinking was on industrial acquisition of these capabilities. Stringer replied that the machines themselves are not expensive, but the operation and maintenance require skilled staff. If the machine is operated 40 hours per week, the costs can be justified; but in industrial settings, these machines are often required only for a short portion of the development cycle.

Crow asked if any of the centers are at the point where recompetition of the management or shifting of the location might be in order. Stringer said that the panel believed that the current locations are appropriate, and he went on to note that the original siting was not chosen by competition but by appropriateness. Crow asked if any emerging areas of science were not covered by the centers, and Stringer replied that it was his view that the role these centers play in nanotechnology is worthy of study.

Batterman noted that three of the four labs get funding from national laboratories but the University of Illinois center does not. The latter is supported by the users, mostly from the university community. Thomas responded that BES's support of the Illinois center has varied over time but that funding has always formed but a small part of the center's budget. Batterman noted that, if that center wanted to expand, it would have to do it through the Materials Research Laboratory (MRL) portion of the center, not from BES. Thomas agreed that any DOE support for expansion would go through the MRL. Stringer observed that the University of Illinois facility charges user fees, the only one of the EBMCs to do so.

Crow asked about the distribution of disciplines among the centers' users, and Stringer said that the life sciences were excluded from the panel's charge but several centers mentioned

wanting to move into biological sciences, away from their primary research in materials science. Crow asked about the possibility of funding from the NSF, and Stringer replied that the NSF has moved away from funding microscope *centers* although they still fund instruments. Crow asked about coordination across the centers. Stringer replied that the relationship among the centers is informal (e.g., the center representatives meet at professional-society meetings). They have jointly put out a document on electron-beam microscopy, and the individual staffs are considerable users of the other centers. Historically, there has been little collaboration in planning instrument purchases, but there is evidence that their collaboration is increasing.

Dehmer noted that the panel had recommended a number of improvements in support and asked if the panel had considered costs and priorities. Stringer answered in the affirmative. If the centers are treated as a group, they are quite large. The panel did not think that the senior technical staff is below a critical level, but the support staff does need to be increased. DOE needs to determine what it wants to achieve. The basic needs are service contracts, operational staff, instruments, and upgrades. It was noted that the centers had benefitted tremendously from the Scientific Facilities Initiative about five years ago, and a member of BESAC asked if another such initiative is planned. Thomas responded, no. Each laboratory has about 10% of its operating budget in capital equipment, but the most important needs are the ones that must be addressed.

Richmond observed that the panel had had some difficulty getting cost and spending data and asked if the panel was confident that the funding was being channeled to the right needs. Stringer said that it was not that the centers were unhelpful; the problems were in the time constraints and the panel's own ability to understand the different accounting systems of the different centers. In his opinion, the centers are using their funds wisely. To some degree, there is a trust that high-level people will use the machine time appropriately. These centers are producing about 250 papers a year in high-quality publications.

Stohr asked what the forefront problems are and how the centers stacked up against the rest of the world. Stringer pointed out that most cutting-edge microscopy facilities are not user centers, whose instruments and expertise must be available to a wide range of users. Rather, the are research centers, whose instruments are typically available to only a few expert users for their personal research. Some of the work at the four user centers is comparable to that at the best research centers; the majority may be regarded as being a cut below. Sinha asked how many users use these centers, and Stringer replied more than a thousand per year, predominantly at the University of Illinois center. Johnson asked if there had been any discussion about improving the temporal as well as spatial resolution and combining space and time resolutions. Stringer replied that we can look at 1 Å, and we can probe short-term events. Can we do both at the same time? Not in the way we are operating these machines at this time.

Herbst moved to accept the report as submitted, and Smalley seconded. The motion passed unanimously. A break was declared at 10:28 a.m.

Richmond called the meeting back to order at 10:52 a.m. and introduced **Yves Petroff** of the European Synchrotron Radiation Facility to present the report of the Advanced Light Source (ALS) review and follow-up on the Birgeneau report. He listed the members of the panel. The review occurred Feb. 3-4 at the ALS, and its goals were to

- check the quality of the science carried out,
- verify that the management has responded to the criticisms contained in the Birgeneau panel's report,
- see if user demand is fulfilled, and

- explore the scientific vision.

The panel toured the facility, reviewed 12 poster presentations highlighting recent research, and met with the ALS Scientific Advisory Committee and Users Executive Committee.

The panel found that LBNL has reacted very quickly and positively to the criticisms of the Birgeneau report by appointing a new director, upgrading and reorganizing its management, installing technical improvements (such as robotic crystal mounting, computational systems, and automated software), increasing links with the university, and markedly increasing interaction with the users. With one of the best beamlines in the world, the quality and quantity of science being done is clearly outstanding.

Today, the ALS has the lowest horizontal emittance in the world for machines having an energy lower than 2 GeV and is very reliable. The stability and lifetime have been continuously improved. Clearly, ALS has established areas of excellence in

- structural biology;
- femtosecond and picosecond dynamics in condensed matter and the gas phase;
- electronic processes and many-body effects in highly correlated systems, magnetic nanostructures, and correlation in small systems;
- surface science, thin films, and microscopy;
- ultrahigh-resolution spectroscopy of gas-phase atoms, ions, and molecules;
- chemistry and catalysis; and
- analytical sciences and metrology.

The number of users has been increased by a factor of three since the Birgeneau report. The users have been very pleased with the appointment of Chemla as the director, appreciating his openness and approachability. The ALS management and the user community have established productive, respectful, and direct two-way communication. Significant improvements have been made in both the User Services Group and the Scientific Support Group. Administrative procedures have been streamlined, and low-cost accommodations for users have been arranged near campus.

The main findings are that (1) the ALS is doing an outstanding job in many areas and (2) none of the criticisms of the Birgeneau report is still valid. Important projects for the near future include

- the ALS Molecular Environment Science (MES) Program, which is to investigate environmental surface science, heterogeneous surface and materials chemistry, metal-ion speciation in solution, actinide science, and microorganisms and biological systems;
- magnetic and polymer nanostructure research;
- femtosecond spectroscopy and diffraction (the only facility trying to do this);
- ultrahigh-resolution spectroscopy for the study of complex and correlated phenomena; and
- protein crystallography on superconducting bend magnets.

This order reflects logistical and managerial effects (e.g., the MES is 40% funded and needs to be completed), not just scientific importance.

One fascinating turn of events is the proposal to develop virtual beamlines with SSRL, which will ensure year-round access to beamtime at West Coast crystallographic facilities. It also represents a potential mechanism for streamlining application and proposal review for general-user beamtime at both institutions.

In one exercise, the panel compared the number of papers in different fields coming from the major light sources:

Facility	APS	ALS	CHESS	NSLS	SSRL	SRC
Structural biology	9	16	21	34	15	---
Solid-state physics and chemistry	10	17	6	32	6	9

When the number of beamlines in operation is taken into consideration, the results for the ALS are very good.

Petroff called attention to a "very surprising" sentence in the Birgeneau report: "Important scientific issues which require UV radiation have decreased in number compared to those which require hard X-rays." This is difficult to understand. Both the electronic properties (from UV and soft X-ray studies) and the structural properties (from hard X-ray and neutron studies) are needed to study a new material. Of the physics and chemistry papers cited above, almost half described work in the IR, UV, or soft X-ray regions and about an equal amount on work in the hard X-ray region. For beamlines on the superbends, a good balance must be maintained between structural biology and the other fields.

More importantly, the statement that the "ALS is a third-generation synchrotron radiation user facility of very high brightness, optimized for the UV and soft X-rays" is not true any more. In addition, where the Birgeneau report said that "Eleven rings are under discussion," these numbers are unrealistic and not comparable. A useful comparison should

- include all the costs,
- consider the construction period, and
- consider the number of beamlines.

The worst characterization in the Birgeneau report is the comparison on "Operational Cost/Gross National Product (GNP)," which is wrong to do; the numbers are not comparable because of what is included.

In summary, the main recommendations of the review panel are to

- lift the penalty that was imposed on the ALS after the Birgeneau report;
- increase the size of the Scientific Support Group;
- obtain funds for postdoctoral associates;
- support the ALS plan for a new building adjacent to the machine for additional office space and laboratories; and
- leave the ALS without a review for some months, at least.

Richmond asked the members of the Birgeneau panel who were present to comment on these findings. Shen said that the comment comparing the facilities in terms of costs and GNP is very important. The numbers were obtained from the facilities, and the Birgeneau panel was concerned about the variation in and comparability of these figures.

Horton said that what had evolved in the past two years has been very impressive, and the report reflects that. Chemla and the laboratory management should be commended for bringing the users into a greater role at the facility. Stohr said that the Birgeneau panel looked at all the other facilities and found an obvious shortfall in soft X-ray research. That deficiency has been corrected, and that correction has been noted in the report. He agreed with the recommendations of this report.

Petroff said that the Birgeneau report was very effective because of the responses in management that it elicited. Batterman noted that submicron X-ray beams (which can probe an

integrated circuit) are very exciting and promising, and the ALS will exert a strong influence in this emerging research. Sinha asked if this femtosecond X-ray research will be affected by the LCLS. Petroff responded that one should never put all the eggs in one basket. New technologies and new devices will come from different groups, and this field should be investigated.

Johnson asked if the panel discussed the prospects for a permanent director. Petroff responded that it is clear that Chemla and the new management have done an important job; it would be good for the facility if he stayed another two years.

Richmond asked for a motion on the report. Horton asked if the words on the transparencies or in the written report were the final versions. Petroff said that he had made changes from the report in his oral presentation, but the changes had not been reviewed and approved by the panel members, so the written version is the authoritative one. Leone moved to accept the report as submitted; Herbst seconded. The motion passed unanimously. A break for lunch was declared at 12:03 p.m.

The meeting was called back into session at 1:36 p.m., and Richmond reintroduced the topic of the report of the Neutron Scattering Subpanel. In informal talks with members of the Committee, she found that they were supportive of the general recommendations of the Subpanel but were uncomfortable with making recommendations regarding the finances requested by the group even though that task was in the charge to the Subpanel. Horton commented that the Committee needs to forcefully state that neutron scattering is an important tool that this country needs to support scientific and technological growth. Batterman stated that the concern was that the funding of this program should not come out of existing programs; it should be new money. Sinha said that his reading was that the money would come out of the savings from the HFBR, at least at first. It was unnecessarily pessimistic about the effects of the HFBR shutdown. The outlook for neutron scattering is bright if it is given the proper support. It is also important that the BNL group shift its work to other sites (e.g., the HFIR), and BESAC should endorse such a shift. Lester did not feel that the report gave an adequate justification for the dollar amounts cited; the funding level in this field should be examined. Sinha noted that the number was derived separately and just happened to equal the amount saved by the HFBR shutdown. Michael Rowe of NIST, a member of the subpanel, said that the basis for each of these estimates is given in the report and reflect actual costs experienced by other facilities.

Thiel said there is a consistent theme for increased support, but BESAC is operating in a vacuum, not knowing what else the money could be used for. Johnson said that in reading the report, he did not see an outcry from industry for this capability, just from the pure scientists. Rowe said there was one representative from industry on the panel; the panel realizes that the industrial users are there and do need this capability. The panel only had six weeks and did not have time to do a complete survey; it only noted that industrial researchers are among the users at the current facilities.

Tirrell noted that the report calls the cost estimates “crude” and that it calls for them to be reexamined. Therefore, he felt that endorsement of the figures is not appropriate. Rowe responded that the numbers are accurate within an order of magnitude, which is what the panel was asked to do. Dehmer commented that what he said was correct and that she was appreciative of their efforts and for their informing BESAC of the budgetary effects of these recommendations.

Lester said that she would not support these recommendations as long as they contain firm numbers and that BESAC should be able to see the $19 million in the context of neutron-

scattering funding and within the broader DOE portfolio. Thomas said that the current increase in neutron scattering funding in the budget is $13 million. Richmond noted that many other influences will affect these budget numbers.

Dehmer noted that a large number of studies of neutron scattering had been conducted, many of which had suggested increased funding with dollar amounts attached to give BESAC and the scientific community a sense of the magnitude of the funding needed. Often, BESAC sends such figures forward with caveats, such as "these amounts should not cut into the core program." BES takes these advisements very seriously. Thiel asked if this was what the Committee had done this morning with the EBMC and ALS reports, and Dehmer responded that it could be interpreted that way. Thomas commented that the EBMC is not in the same realm, and the ALS had a prior report that contained that funding data. Crow said that the subpanel had answered the charge. The report could be amended with a little justification for each expenditure. The detail may not be there, but could be provided and would not change the recommendations at all.

Herbst moved that the report be accepted as submitted with (1) a commendation to the subpanel for a superb job, (2) a recognition that the budget figures included are estimates, and (3) a caveat that the implementation not budgetarily impact the core program. Thiel seconded. The motion passed with two votes against.

Richmond introduced **Iran Thomas** to discuss the reorganization of BES. Thomas noted that reorganization costs a lot of money and is demoralizing. Fortunately, BES has had very few reorganizations during the past 20 years. With the downsizing and reengineering of the government, DOE has been trying to decrease the number of managers. The current organization has been in place for some time now. BES was very reluctant to change it, but it came to the point where something had to be done. An organization has been set up that makes sense to the disciplines the Office serves and embodies a structure that makes supervisory sense. In the new structure, two new organizations were created, the Materials Science and Engineering Division and the Chemical Science, Geoscience, and Bioscience Division. Each has an acting director and is subdivided into component groups. The Materials Science and Engineering Division has (1) Material, Ceramic, and Engineering Science and (2) Condensed Matter, Physics, and Material Chemistry. The Chemical Science, Geoscience, and Bioscience Division has (1) Fundamental Interactions, (2) Molecular Processes and Geoscience, and (3) Energy Bioscience. This organization is expected to provide better interaction among the disciplines.

Another wall was broken through in that support staff are no longer considered clerical positions anymore, but are considered analyst positions. This arrangement allows the Office to keep experienced personnel. He showed how the new organization of BES fits into the overall DOE organization. The BES organization chart has several vacant slots because the Office has not been able to hire for a long time. Recently, they have been able to establish four new positions and are fighting for more. A position has been posted for someone experienced in neutron scattering to oversee these programs.

Dove said that, given DOE's environmental problems, this organization does not address the needs for geosciences. Thomas responded that that is one of the arguments against it. In a disciplinary sense, putting engineering and materials science together makes sense, but it does not put a wall between engineering and other disciplines that it naturally interacts with. Dove further stated that she was concerned that geosciences appears to have been taken down several steps in the overall DOE organization. Thomas said that it will have more attention paid to it because it is located in a new, permanent organizational home; also, it used to be split up, and

now it is unified. Horton said that perhaps more significant is budget; will geosciences continue to be a separate line item in the budget? Thomas said that the budget should not change. William Millman pointed out that the reporting chain is stronger between geosciences and the director in the new organization.

Thomas then presented an overview of the Division of Materials Science and Engineering, starting with the organization chart of the new division. The direction of the Division's engineering research is guided by the Council on Energy Engineering Research. He noted that DOE is the Government's third largest funder of engineering after NASA and DoD. DOE's funding of engineering is more than twice that of NSF and supports work in science, energy efficiency, fossil energy, nuclear energy, weapons, stockpile management, and environmental programs. He compared the FY-1999 engineering funding of DOE and NSF for selected activities to support that assertion. He noted that for DOE, the problems addressed are relevant to DOE missions, research is the major driver, science and engineering are in the same organization, and engineering problems tend to be tackled from different disciplines. For NSF, the problems addressed are those of interest to the principal investigator (PI), education is a major driver, science and engineering are different organizations, most PIs are engineering faculty members, and few PIs are from the physical sciences (none from government laboratories).

DOE supports engineering research in the Materials Sciences and Engineering Division:

- $18.2 million for engineering behavior of materials;
- $17.8 million for engineering research (1) to create new options to save energy and improve industrial production and (2) to solve future engineering problems and make current scientific knowledge practicable; and
- in the Chemical Sciences, Geosciences, and Biosciences Division: about $7 million to study chemical energy and chemical engineering.

Examples of engineering research included making self-assembling nanocrystals, developing methods to encode self-assembly and replication of nanostructures, investigating the engineering principles to make a quantum-dot computer, researching ATP (adenosine triphosphate), and developing molecular motors.

With the FY-2000 and FY-2001 budgets, increased emphasis is being placed on microelectromechanical systems (MEMS) and nano engineering and on robotics and intelligent machines. Reduced emphasis is being placed on combustion, chemical processing, continuum and fracture mechanics, the manufacturing fellowship program (which is being terminated), and turbulence. Congress specifically requested a roadmap on robotics and intelligent machines because of the intellectual content, experience, and success of DOE's program. Defense Programs, Environmental Management, and Nuclear Energy research would all like to apply this capability to their problems, and Caterpillar has entered into a cooperative agreement with ORNL to apply it to remote operation of bulldozers.

Horton asked if the current engineering budget increase brings the funding back to its previous levels. Thomas said that it is hard to answer that question because of budgetary shifts, the completion of programs, inflation, etc., but these are substantial increases.

Batterman observed that the X-ray and neutron-scattering-facilities person is three levels down and is controlling about $300 million and that this person has to have the respect of the scientific community. Thomas stated that it was desired that this organization be driven by the science.

Herbst asked why three boxes under Energy Biosciences had the same three names. Thomas explained that this was a small staff in a large program, and they have to share handling the workload. Thiel asked if this reorganization meant that investigators will be reshuffled soon, and Thomas responded that the reorganization will be transparent to the investigators.

A break was declared at 3:13 p.m.

The Committee was reconvened at 3:36 p.m. with the introduction of **William Millman** to review the Division of Chemical Sciences, Geosciences, and Biosciences. He compared the old structure of BES with four divisions [(1)Materials Sciences, (2) Chemical Sciences (3) Engineering and Geosciences, and (4) Energy Biosciences] and four subprograms with the same titles (Materials Sciences, Chemical Sciences, Engineering and Geosciences, and Energy Biosciences) to the new structure of BES with two divisions [(1)Materials Sciences and Engineering and (2) Chemical Sciences, Geosciences, and Biosciences] and the identical four subprograms. The new Chemical Sciences, Geosciences, and Biosciences Division will be divided into three programs (Fundamental Interactions, Molecular Processes, and Energy Biosciences), and each program will be divided into three or more subprograms.

The division will investigate chemical interactions at metal-oxide–aqueous-solution interfaces; biogeochemistry; geophysics; new analytical approaches (including fourth-generation light sources), complex chemical, biological, materials, and geologic systems; and photosynthesis.

The majority of the division's funding (more than $150 million) goes to research, with most of the rest (about $70 million) going to facilities. Significant increases in research funds will occur in FY 2001 because of the Microbial Cell Program (+$2.44 million), nanoscience (+$13.48 million), computational chemistry (+$2 million), and a cost-of-living increase for facilities (+$1.35 million). Facilities funding will decrease somewhat that year because of the completion of the reflector replacement at the HFIR.

Nicholas Woodward then spoke about the Geosciences Research Program. Its purpose is to develop an understanding of fundamental earth processes as a foundation for the efficient, effective, and environmentally sound use of energy resources. The major parts of the program are the geochemistry of mineral–fluid interactions; geophysical investigation of the Earth's crust; basic properties of rocks, minerals, and fluids; and analytical instrumentation and computational methods. The program has faced three challenges in the past 18 months: an Office of Management and Budget (OMB) budget cut of 18%, the allocation of one-third of its budget to the Climate Change Technology Initiative, and the reorganization of BES.

The program's $22.5 million in operating funds in FY 1999 was cut to $20.1 million in FY 2000, taking the program back to its FY-1997 level of funding. The reduction/redirection was accommodated by cutting base program funding about 10% and paying off some operating mortgages during FY 1999 to allow some new starts. The Program currently funds 133 projects in fundamental research (including thermodynamics, seismic imaging, isotope geochemistry, and electromagnetic imaging) and 37 projects in CO_2 sequestration (e.g., mineral reactivity, rock fracture properties, reservoir integrity, coupled reactive flow and transport, fluid flow in porous and fractured media, and high-resolution geophysical imaging).

Calling attention to what is going on in the geosciences is difficult because, even though DOE spends about $100 million a year on geosciences, funding is dispersed throughout DOE (in the offices of Science, Nonproliferation and National Security, Fossil Energy, Energy Efficiency and Renewable Energy, Environmental Management, and Civilian Radioactive Waste

Management). Because of this fractionation, DOE has difficulty explaining to Congress and OMB what it is doing in geosciences, its relevance to the DOE mission, and the expertise accrued. This, despite the fact that DOE's funding for geosciences ranks in the top three of government agencies [USGS: $226.7 million; NSF: $103.1 million (largely constrained to highly focused initiatives); DOE: $104.4 million].

A list of national awards won by Program-funded investigators was presented along with principal-investigator symposia sponsored by the Program. The Program is guided by the Council on Earth Sciences, which selects and organizes workshops on science areas that highlight new research opportunities and support DOE's mission. Examples of research funded by the Program include determining rate laws with atomic-force microscopy, investigating the acoustic signatures of fractured rocks and investigating the implications of those signatures for fracture imaging, and studying fault-slip rates at depth from recurring intervals of repeating microearthquakes on the Parkfield segment.

Gregory Dilworth then spoke about the Energy Biosciences Program. Its purpose is to obtain the fundamental, mechanistic knowledge necessary to develop future energy-related biotechnologies. The rationale for this approach is that plants and microbes effectively and relatively efficiently capture solar energy; synthesize chemicals, materials, and potential fuels; and interconvert chemical and energy forms. The Program has been in existence since the late forties, focusing on photosynthetic organisms; biological synthesis and degradation; intermediary metabolic pathways; and novel biosystems, materials, and catalysis. Its significant accomplishments include

- biological methane production from CO_2 and molecular hydrogen;
- elucidation of the biochemistry and genetic regulation of plant lipid synthesis, leading to plants as a source of specific lipids and chemical feedstocks;
- determination of the chemistry and function of cell walls, approaching the problem through molecular-genetic and biochemical studies; and
- the development of a model plant experimental system.

It also supports research on biomaterials and biocatalysis that emphasizes the unique properties of biological systems that act as novel biosensors and can consist of transmembrane proteins.

The Program is linked with other DOE research programs (e.g., the BioEnergy Coordinating Committee, Bioenergy Initiative Team, Microbial Genome Program, and Microbial Cell Initiative) and with interagency groups and programs (e.g., National Plant Genome Initiative, Interagency Plant Science Coordination Group, semiannual microbiology meetings, National Bioenergy Initiative, and National Science and Technology Council). The Program's relationships with other federal programs have worked very well historically, and the different programs complement each other well. The Energy Biosciences Program emphasizes energy capture; chemical, fuel, and material biosynthesis; and chemical and energy interconversion. The NIH emphasizes biomedical research and human health. The NSF emphasizes fundamental mechanisms of biological systems. And the USDA's National Research Initiative (NRI) emphasizes agriculture, food, fiber, and the environment. Funding (in millions of dollars) was analyzed in two areas in which Energy Biosciences overlaps with NSF:

	NSF	Energy Biosciences
Plant biology		
Mechanistic	33.5	21.2

Ecological and evolutionary	40.0	0.0
Infrastructure and genomics	68.0	1.1
Mechanistic microbiology		
Model systems	13.6	0.5
Nonmodel systems	9.3	6.8

The National Plant Genome Initiative is a major budget priority of the White House designed to develop plant genome information, new technologies and resources, and the enhancement of economically important plants. As part of this initiative, Energy Biosciences is funding genomic research related to photosynthesis, bioenergetics, intermediary metabolism, and biomass production.

Another major effort is the Microbial Cell Initiative, which seeks to establish a bacterial cell consisting of a minimal set of genes essential for life (the current guess is 630 genes and 600 to 700 thousand base pairs) and to determine the additional sets of genes and gene functions required for the addition of particular physiological processes. Energy Biosciences will look at reverse genetics, specific regulatory circuits, and metabolic profiling.

Energy Biosciences is also providing fundamental science support for joint DOE/USDA technology development for the Bioenergy Initiative, which seeks to address the growing demand for energy and chemical feedstocks, establish a renewable and secure fuel/chemical supply, develop more-energy-efficient industrial processes, create fuels that do not add net CO_2 to the atmosphere, develop green technologies, and triple America's use of bioenergy and biomass products by 2010.

The Energy Biosciences Program's budget totals $29.078, $30.713, and $33.714 million in fiscal years 1999, 2000, and 2001, respectively, with most of the increase going to the Microbial Cell Initiative. The great majority of those funds go to universities and other research institutions, with a small portion going to the national laboratories.

Sinha asked how you keep biomass from producing CO_2. Dilworth said it is a net-zero game; if you remove as much CO_2 from the atmosphere as you produce, you are not introducing new CO_2 into the atmosphere. Batterman asked what happened to the theory offered by Thomas Gold on the origin of methane in the Earth's crust being some intrinsic but as-yet unidentified source. Woodward responded that some deep holes were dug and not enough methane was found to validate the theory. Tirrell asked Dilworth how he saw the Microbial Cell Initiative functioning. Dilworth responded that the task is not trivial nor straightforward. As a result, the science is broad, and the structure that has evolved is dispersed.

Smalley asked how much of the Division's work was nanotechnology. Dehmer responded that plant and biochemistry work is not being included in the definition of nanotechnology. If something occurs naturally, it is not technology.

Richmond reopened the discussion about the ALS report. Sinha said that he had misgivings about the table on publications in major journals; it might inadvertently lead people to misjudge the performance of other institutions mentioned. He suggested leaving out those tables to avoid this potential problem. Crow stated that the Committee has to consider what metrics can be used to measure performance. Smalley suggested that the data are sensitive just because they are so eloquent.; if these tables are taken out, the statements that the panel makes are not as strongly supported. Sinha said that, if these numbers were put in the report, they should also include background information about each of the institutions to explain the comparability. Tirrell

suggested that the ALS numbers be listed against the average numbers for the other four institutions. Horton commented that, if this is the same type of information that was used in the Birgeneau report, it makes sense to put it in this report, also, for the sake of comparison. Stohr said that he thought the journals used to compile the table were the same ones used in the Birgeneau report, so he would have no objections to using those data.

Smalley moved that, if the numbers are correct, the tables be retained in the report; if they are not correct, they be corrected and included in the report. Crow seconded. The motion passed with two votes against. Horton asked if the other institutions should be given an opportunity to review the numbers. Smalley commented that, if another facility wanted to append an explanatory comment, such a comment should be included.

The chair called for public comment; there being none offered, the session was adjourned at 5:07 p.m.

Wednesday, March 1, 2000

Richmond called the meeting to order at 8:35 a.m. and opened the floor to discussion. Crow encouraged making the reports available to the Committee members ahead of the meeting so they can be read before the Committee votes on them. Sinha agreed and noted that the reports seemed to have been prepared in a hurry. Thomas commented that these are reports of panels of experts; BESAC can accept any or all of the recommendations made or add new ones. Usually, the Committee accepts the report. In some cases, the reports and recommendations are separate; in those cases, the reports are for information only, and only the recommendations are voted on for acceptance. It is the letter from the BESAC chair that BES responds to.

Crow noted that the Committee voted a number of recommendations this time that have budgetary impacts. As a committee member, he would like to be able to see how these come together and be able to see the effects in the budget in October. Thomas responded that, when the budget was drawn up and presented, it was based on anecdotal information with the understanding that the hard information was coming from this Committee. In October, we should be able to show how successful we were in getting these items into the budget.

Batterman asked what could be done to increase funding this year. Thomas said that the funding for FY 2001 is an increase over what was requested. What came back included all of the Nanoscale Science, Engineering, and Technology Initiative; additional facility funding; and an additional $10 million for structural biology. What else can we do this year? The answer is, not much. Moreover, the increased funding for facilities, like all of the proposed budget, may be modified during the budget hearings.

Crow asked what the Combustion Research Facility is and how it fits into the budget picture. Thomas said that it was a part of the Chemical Engineering Research Program, which had a 30% decrease. But combustion research is a very strong issue, so it got a slight increase, nonetheless.

Stohr asked how the membership and leadership of BESAC is selected and how BESAC can be more involved with that process. One way to get more involved, said Thomas, was to volunteer to be on the panels; it is vital that the Committee be represented on the panels. Stohr pointed out that it was important who is the chair because he or she has great influence on the recommendations and is largely responsible for the success (or lack thereof) of the panels. Richmond pointed out that she has gotten very few suggestions. Thomas noted that a chair for the

neutron scattering panel was currently being sought. Crow observed that the Committee's input on who should be on a panel is critical.

Richmond then reviewed what was coming up for BESAC. At the next meeting (Oct. 24-25, 2000):

- review of IPNS and MLNSC subpanel report,
- management review team, and
- additional topics.

Thomas suggested a teleconference on the IPNS and MLNCS this summer. Richmond noted that a follow up from the chair and/or Dehmer or Thomas after each BESAC meeting would be helpful in reminding people of their responsibilities and in focusing their attention on tasks to be accomplished. At any rate, the IPNS/MLNSC subpanel should conduct its study at least several weeks after the Lujan Center has started up. The panel should report back at the October meeting. The members need to be empaneled.

Crow recommended that a preliminary report with suggested recommendations be presented in October so the BESAC members can study it and have a final review in February. Horton commented that such a procedure would be critical if the panel produced a 90-page report; if it was a 2-page letter report plus recommendations, that elongation of the review period would not be needed. Crow noted that the study should not be delayed to the point that the panel is put in place in October and conducts its visits in November; the panel needs to be constituted now. Richmond noted that the Management Review Team is scheduled to visit the sites during the summer and report to BESAC in October. Thomas commented that the General Accounting Office (GAO) had just completed its audit of BES, going through the files and living in the Office for months. They reviewed the mechanisms of management procedures, and their report was stunningly positive. He pointed out that the Management Review Team will assess the quality of scientific work. Crow asked if the GAO report was available. Thomas said that it was not available yet because it had to go through the GAO vetting process first. Crow asked if a representative from that group could make a presentation to the Management Review Team, and Thomas replied that they could be asked.

There being no further discussion among the committee members, Richmond opened the floor to public comment. **Joseph Greene** of the University of Illinois commented that, in the electron-beam talk by John Stringer, the University of Illinois CMM facility was cited as being the only one to charge user fees. The reason is historical. The CMM came into existence under the initiative of the university. Its real strength is in surface science, but it has many other capabilities. The CMM is central to conducting the DOE-funded research. The operating costs are borne by the university ($600,000 per year) and by the user fees ($100 per hour). The hard question is, what should CMM do about it? The fees are antithetical to DOE's mission. CMM could be cut back to simply a research center, eliminating the user services. But these revenues allow CMM to supply a broad staff and wide range of instruments. The university is now willing to pick up half of the $700,000 per year that CMM gets from user fees. CMM hopes to eliminate the user fees next fiscal year, although it will still have to come up with about $400,000. Thomas termed this development exciting.

Linda Horton of ORNL said that she would like to augment John Stringer's response to the question from Jack Crow about the contributions of electron microcharacterization techniques to solid state physics. There have been numerous examples of important contributions to a wide range of research, including superconductivity and defects in electronic and optoelectronic

materials. Characterization of structures and chemistry at the atomic and near-atomic levels are critical in understanding solid-state phenomena. The research highlights compiled by the facilities and distributed to the meeting attendees included many examples.

There being no further public comment, Richmond adjourned the meeting at 9:28 a.m.

Respectfully submitted
Frederick M. O'Hara, Jr.
Recording Secretary
Revised by F. M. Orr, Jr., and L. L. Horton, 6/19/2000