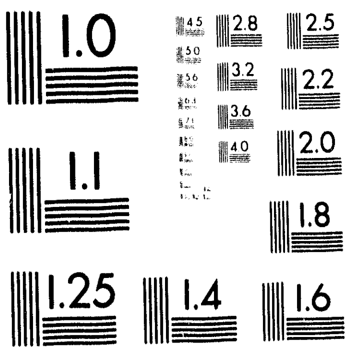
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CALIFORNIA INSTITUTE OF TECHNOLOGY

DIVISION OF GEOLOGICAL AND PLANETARY SCIENCES 170-25

September 28, 1993

Dr. James F. Decker, Acting Director
Office of Energy Research
Department of Energy
Washington, DC 20585

Dear Dr. Decker:

On behalf of the Basic Energy Sciences Advisory Committee (BESAC) we transmit to you the annual report of BESAC activities, findings and recommendations for 1992. As you know, the charges to BESAC for 1992 required major investments of time for the members of BESAC, as well as for representatives of the four major Energy Research national laboratories and the Office of Basic Energy Sciences. We wish to acknowledge particularly, the dedication to voluntary service, the objectivity and the informed insights of our BESAC colleagues. The cooperation, forthrightness and elasticity of DOE representatives at the laboratories was also noteworthy. In particular we appreciate the openness and assistance of the management of OBES.

At this writing, we have retired from BESAC. We congratulate you on the quality of the new membership. We believe that BESAC has many important additional tasks to complete, including monitoring the balance of the basic research programs and the operation of superior facilities by OBES on behalf of DOE and the national science community.

We wish you and them well.

Sincerely,

Leon T. Silver
Chairman, BESAC, 1992
California Institute of Technology

J. Michael Rowe
Vice Chairman, BESAC, 1992
National Institute of Standards and Technology

LTS:kle

Pasadena, California 91125 Telephone (818) 356-6490

DOE/ER-0604P

A REPORT OF THE BASIC ENERGY SCIENCES ADVISORY COMMITTEE

1992 REVIEW OF THE BASIC ENERGY SCIENCES PROGRAM OF THE DEPARTMENT OF ENERGY

SEPTEMBER 1993

U.S. DEPARTMENT OF ENERGY
OFFICE OF ENERGY RESEARCH
WASHINGTON, D.C. 20585

1992 REPORT OF THE BASIC ENERGY SCIENCES ADVISORY COMMITTEE

EXECUTIVE SUMMARY

Introduction

The Basic Energy Sciences Advisory Committee (BESAC) supports the activities of the Office of Basic Energy Sciences (OBES) with external advice, as requested, and reports to the Director of the Office of Energy Research (OER) in which OBES is an integral unit. Dr. Will Happer, Director, OER, charged this Committee with two major tasks in his letters of April 22 and June 1, 1992 (Appendices 1,2):

Task (1): The Department of Energy (DOE) has been designing a new high flux research reactor, the Advanced Neutron Source, to replace DOE's two aging research reactors. International progress has been made on the production of neutrons using accelerator-based systems. To assist DOE in reviewing the two methods for producing neutrons, their different fluxes, energies and time structures and how they complement or duplicate one another, BESAC was requested to establish a balanced expert panel to address the relative strengths and weaknesses of reactor-based steady state and spallation-based pulsed neutron sources.

BESAC promptly established a distinguished panel under the chair of Prof. Walter Kohn, University of California, Santa Barbara. In two months the panel visited the four DOE neutron sources, conducted a three-day review of Neutron Sources and their applications with more than 60 national and international experts and provided a preliminary but substantive report to Dr. Happer by letter of September 15. The final report of this panel, "Neutron Sources for America's Future," was published in January 1993 (DOE-ER-0576P). (See Appendix 3.)

The two principal recommendations of this report were:

(1) Complete the design and construction of the Advanced Neutron Source (reactor) according to the schedule proposed by the project, and

(2) Immediately authorize the development of competitive proposals for the cost effective design and construction of a 1 megawatt pulsed spallation source, leading promptly to a construction timetable that does not interfere with rapid completion of ANS.

BESAC considers that the neutron source panel produced a balanced and informative report which fully and fairly met the charge under which it was convened.

Task (2): BESAC, itself, concentrated on the second major task, a review of Basic Energy Sciences (BES) activities at the major ER laboratories: management and directions of the research, operation of user facilities, and relevance of the research to DOE and the National Energy Strategy. Total program quality, impact, and potential value to applied research efforts received special focus. A request to look into the benefits of the BES program to industry (Dr. Happer's letter of April 22, 1992) was assigned to BESAC recognizing that several committee members are from industry and others have significant experience with industrial technologies. BESAC was also asked to update its previous report on the Combustion Dynamic Initiative (CDI). This effort was incorporated in the Committee's visit to Lawrence Berkeley Laboratory (LBL).

The Committee held five extended meetings at the major multipurpose laboratories and the Office of Basic Energy Sciences. The schedules and agendas of these visits are included in Appendices 4,5,7. After visiting all four laboratories, a letter progress report was sent to Dr. Happer on August 17 (Appendix 6).

The Role of the Office of Basic Energy Sciences

The primary role of OBES is to support diverse basic research (i.e. generic, precompetitive, long-range research) of the highest possible quality to establish the foundations upon which the energy technologies of DOE and the future competitiveness of the nation rely. In support of this goal, OBES supports individual investigators and groups of investigators (at the laboratories and at universities) to conduct research in areas of relevance to the DOE mission. OBES supports the design, construction, and operation of major state-of-the-art user facilities, primarily at the laboratories, which enable the entire national research community to conduct cutting edge research which would be impossible without such facilities.

Consideration of Findings and Recommendations

Some narrower committee findings specific to each DOE laboratory visited and for the Office of Basic Energy Sciences are detailed in the full report. Each should be interpreted carefully and in the light of the extended discussion that accompanies it in the full report.

The complex issues of technology transfer have been analyzed in considerable detail and recommendations for increasing the effective utilization in the national interest of OBES principal products, scientific knowledge and unique facilities, are presented.

General findings and major recommendations follow.

GENERAL FINDINGS AND CONCLUSIONS

1. The general quality of Basic Energy Sciences research conducted at each of the four multipurpose laboratories is high. The program is a national achievement, making valuable contributions to American and international science. Its sustained performance requires budgetary attention.

2. Each laboratory has its own style of managing and performing BES programs. There are benefits in maintaining this diversity as long as the primary BES mission and goals are clearly identified and effectively pursued.

3. The principal products currently being transferred by the BES programs to other units of DOE and outside the department are scientific knowledge and the operation of unique facilities to pursue frontier science.

4. In order to maintain the high quality of their scientific personnel, in general, the laboratories need to draw more on external sources of personnel (including increased turnover) and on more external assessments and reviews of individuals and personnel review practices. DOE should encourage this.

5. The two new light sources, Advanced Light Source (ALS) and Advanced Photon Source (APS), will be world-class facilities. They will come on line well before large parts of their beamline instrumentation can be funded, developed and installed. Time lines for achieving satisfactory research output will be extended accordingly.

6. The facilities currently in operation are well managed and generally have large and satisfied user communities. Users are identified, provided with feedback loops, and find their operational needs and concerns well-tended.

7. Funding for user instrumentation at facilities is becoming more difficult to assemble.

8. Incremental underfunding of both facilities is beginning to adversely affect programs at all laboratories.

9. The burden of unfunded compliance with new EH&S and other regulations is a major contributor to research underfunding.

10. The Office of Basic Energy Science runs an effective program and maintains good communication and coordination with the four ER laboratories. Its managers are operating large programs with a minimum of personnel. Its major role in technology transfer is to ensure that much of the OBES supported research is in the general areas that underpin potentially useful technology relevant to the DOE mission.

11. The prolonged interval without permanent leadership has been detrimental to the effectiveness of OBES programs. Appointment of a permanent director and deputy for OBES would enhance OBES effectiveness in budget planning and intra-DOE program coordination and collaboration. With the recent resignation of the Acting Director of OBES, it is now critical that an effective, permanent management team be promptly installed.

12. Technology transfer has become a significant part of the laboratory culture at the management level. It has not penetrated as widely at the working scientist level and continuing efforts to make the general scientific laboratory community aware of the mission, goals and potential "customers" of BES research are required.

13. Some DOE laboratories (including some of the DP laboratories) have, by virtue of their traditional missions, developed substantial infrastructure and capabilities which match well into industry needs at the development-applications interface. These capabilities and their associated industry relationships could be utilized in partnership with the OBES programs in the ER labs to involve them in the technology transfer process more efficiently. The partnership between LBL and Sandia-Livermore in the area of combustion science and technology is an example. We encourage formation of inter-laboratory partnerships to both reduce duplication and to bring more elements of the DOE research-development-application spectrum to bear

upon interactions with the industrial sector. We perceive a clear opportunity for OBES and OER to take a leadership role.

BESAC RECOMMENDATIONS

1. The Office of Energy Research should continue to make every effort to maintain funding for basic science research programs at FY1993 levels augmented annually to take into account the real inflation factors that science research faces. These programs are essential to the energy and technology future of the nation.

2. Future BESAC activities should monitor closely the updating of strategic and long-range OBES plans to ensure that the balance between basic research and facilities construction and operation is maintained.

3. BESAC is pleased that extra funding has been proposed to initiate construction of the Advanced Neutron Source, and strongly supports construction of this facility. We reiterate, however, our recommendation that this should not be done at the expense of the research programs.

4. OBES should plan and operate current and new facilities on a more optimal schedule providing new and upgraded instrumentation in a timely way, where budget feasibility exists.

5. Large new facility starts should be undertaken only when commitments to adequate new funding have been obtained. There are extensive "mortgages" on future facilities budgets for current construction that will not be relieved for the next five years. BESAC endorses the scientific merits of APS Phase II and CDI Phase I, when adequate funding is available to initiate these projects. Construction and operation of large scientific facilities for DOE and the nation are a unique contribution of OBES.

6. The Department of Energy should make greater efforts at its highest internal levels to facilitate coordination and collaboration between OBES programs and the applied programs (Nuclear Energy, Energy Efficiency, Fossil Energy, Environmental Restoration and Waste Management) in order to achieve more effective transfer of OBES scientific knowledge and technology.

7. The Department, OER, and OBES and the national laboratories should develop more visible and attractive reward systems for effective contributions to technology transfer at the levels of individual investigators,

divisions and laboratories. University investigators supported by OBES should be included in these efforts. Technology transfer will be most effective if the levels of quality and productivity of scientific knowledge are maintained.

8. BESAC supports the SEAB Task Force on Energy Priorities report that calls for well-defined missions for each laboratory. This will require an extensive examination of the role and distribution of OBES support. In the meantime OBES and the national laboratories should work together to decrease the number, increase the size and more closely align FWP's with BES program mission and goals. This would optimize proposal writing and management decision efforts.

TABLE OF CONTENTS

1. INTRODUCTION 1
   1.1 The Role of the Office of Basic Energy Sciences 3
   1.2 The Role of the National Laboratories 5
   1.3 Quality and Management of Research at the Laboratories 5
   1.4 Science Knowledge and Technology Transfer 6
2. THE CLIMATE FOR BASIC SCIENCES RESEARCH IN DOE 7
3. BASIC ENERGY SCIENCES AT THE FOUR MULTIPURPOSE LABORATORIES . 9
   3.1 Argonne National Laboratory 10
   3.2 Brookhaven National Laboratory 12
   3.3 Lawrence Berkeley Laboratory 15
   3.4 Oak Ridge National Laboratory 18
4. THE IMPORTANCE OF PROGRAM BALANCE 21
5. TECHNOLOGY TRANSFER 22
   5.1 Support of U.S. Industrial Competitiveness by Science and Technology Originated in OBES-Supported National Laboratories 22
   5.2 Modes of Knowledge Transfer 22
   5.3 Recommendations for Greater Effectiveness in Contributing to the Competitiveness of U.S. Industry 24
6. INTERACTIONS BETWEEN THE OFFICE OF BASIC ENERGY SCIENCES AND THE NATIONAL LABORATORIES 26
7. BESAC AND THE OFFICE OF PROGRAM ANALYSIS REVIEW 28
8. DISCUSSION OF NEUTRON SOURCES PANEL REPORT 29
9. GENERAL FINDINGS AND CONCLUSIONS 30
10. BESAC RECOMMENDATIONS 32

APPENDICES
1. Dr. W. Happer letter to BESAC, April 22,1992
2. Dr. W. Happer letter to BESAC, June 1, 1992
3. Executive Summary, "Neutron Sources for America's Future"
4. BESAC list of preliminary questions sent to each laboratory
5. Schedule and agendas of BESAC meetings
6. BESAC letter report to Dr. W. Happer, August 17, 1992
7. BESAC list of preliminary questions sent to OBES

1. INTRODUCTION

The Basic Energy Sciences Advisory Committee (BESAC) supports the activities of the Office of Basic Energy Sciences (OBES) with external advice, as requested, and reports to the Director of the Office of Energy Research (OER) in which OBES is an integral unit. Dr. Will Happer, Director, OER, charged this Committee with two major tasks in his letters of April 22 and June 1, 1992 (Appendices 1,2):

Task (1): The Department of Energy (DOE) has been designing a new high flux research reactor, the Advanced Neutron Source, to eventually replace DOE's two aging research reactors. At the same time international progress has been made on the production of neutrons using accelerator-based systems. In order to assist DOE in reviewing the two methods for producing neutrons, their different fluxes, energies and time structures and how they complement or duplicate one another, BESAC was requested to establish a balanced expert panel to address the relative strengths and weaknesses of reactor-based steady state and spallation-based pulsed neutron sources; optimum design goals in light of their strengths, weaknesses, cost, readiness, and other appropriate factors; and the proper timing for construction of new neutron sources. A report was requested by the end of September, 1992.

Led by Dr. J. Michael Rowe, vice chairman, BESAC promptly established a distinguished panel under the chair of Prof. Walter Kohn, University of California, Santa Barbara. Two members of BESAC, Prof. Robert Birgeneau, MIT and Dr. Paul Fleury, Sandia National Laboratories agreed to serve on the Kohn Panel. The complete list of membership is included as Appendix 3. In an accelerated two-month schedule, members of the panel visited the four DOE neutron sources, conducted a three-day review of Neutron Sources and their applications with more than 60 national and international experts in different areas of neutron science and technology, and met to provide a preliminary but substantive report to Dr. Happer by letter of September 15. Professor Kohn made oral presentations to Dr. Happer and subsequently to the Secretary of Energy's Advisory Board Task Force on Energy Research Priorities, on September 24, 1992, in Fairfax, Virginia. The final report of this panel, "Neutron Sources for America's Future," was published in January 1993 (DOE-ER-0576P).

The two principal recommendations of this report were:

(1) Complete the design and construction of the Advanced Neutron Source (reactor) according to the schedule proposed by the project, and

(2) Immediately authorize the development of competitive proposals for the cost effective design and construction of a 1 megawatt pulsed spallation source (1MW-

PSS). Evaluation of these proposals should be done as soon as possible, leading to a construction timetable that does not interfere with rapid completion of ANS.

The executive summary of the Kohn Panel report containing some additional recommendations is presented in Appendix 3.

BESAC considers that the neutron source panel produced a balanced and informative report which fully and fairly met the charge under which it was convened. BESAC's consideration of the report in the light of overall OBES and OER goals is contained in a later section.

Task (2): BESAC, itself, concentrated on the second major task, a review of Basic Energy Sciences activities at the major laboratories: management and directions of the research, the operation of user facilities, and the relevance of the research to DOE and the National Energy Strategy. Total program quality, impact, and potential value to applied research efforts received special focus. An initial request to put together one or two all-industry panels to look into the benefits of the BES program to industry (Dr. Happer's letter of April 22, 1992) was subsequently modified in view of the magnitudes and timetables of the first two assignments. This task instead was assigned directly to BESAC recognizing that several committee members are from industry and others have significant experience with industrial technologies. The analysis was to be incorporated in the report on the laboratories. BESAC was also asked to update its previous report on the Combustion Dynamic Initiative. This effort was incorporated in the Committee's visit to Lawrence Berkeley Laboratory (LBL) and is discussed in the section on that laboratory and in Appendix 6.

BESAC's review was paralleled by an independent individual project-by-project review of BES research activities organized by the DOE Office of Program Analysis (OPA). We have concentrated on the context in which individual investigator programs aggregate into the larger programs of each laboratory. It is only in this context that the multi-disciplinary, mission-oriented approach which most distinguishes the laboratory programs from university-based research can be evaluated.

The Committee held five extended meetings. Four were held at the major multipurpose laboratories: Brookhaven National Laboratory (BNL), May 18, 19; Oak Ridge National Laboratory (ORNL), August 3, 4; Lawrence Berkeley Laboratory (LBL), August 6-8; and Argonne National Laboratory (ANL), August 10, 11. A set of questions (see Appendix 4) was sent to each laboratory in advance of the two day visit (except Brookhaven which was visited first – BNL responded to a later opportunity [October 1] to formally address them). The schedules and agendas of these visits are included in Appendix 5. A letter progress report was sent to Dr. Happer on August 17 (Appendix 6). After visiting all four laboratories, a review of program management within OBES itself was conducted at a one day meeting ne^r Germantown on October 1, followed by a BESAC report organization meeting on October 2.

Much of the Committee discussion revolved around four major issues:

- What is the proper mission of OBES within DOE and the nation, and how do the multipurpose ER National Laboratories, as distinct from Defense Production (DP) Laboratories, serve this mission?

- What is the overall quality of the BES research performed at the four laboratories reviewed, what are measures of quality, and by these measures how well is it sustained and managed?

- What distinguishes the DOE non-DP National Laboratories from universities and from other major laboratories (e.g. industrial or other government)?

- What are the most effective methods for the transfer of scientific knowledge and technology from the basic research programs supported by OBES to the technology programs of DOE and to U.S. industry and commerce?

While the examination of these questions is the main subject of this report, some preliminary discussion of the organizational structures, goals and strategies of the Basic Energy Sciences programs is appropriate to provide context.

1.1 The Role of the Office of Basic Energy Sciences

The primary role of OBES is to support diverse basic research (i.e. generic, precompetitive, long-range research) of the highest possible quality to establish the foundations upon which the energy technologies of DOE and the future competitiveness of the nation rely. In support of this goal, OBES supports individual investigators and groups of investigators (at the laboratories and at universities) to conduct research in areas of relevance to the DOE mission. OBES supports the design, construction, and operation of major state-of-the-art user facilities, primarily at the laboratories, which enable the entire national research community to conduct cutting edge research which would be impossible without such facilities. This latter role is a legacy from the Atomic Energy Commission, is unique to DOE, and is particularly well suited to the infrastructure established by the laboratories. In considering the OBES programs, it should always be remembered that OBES supports most of the DOE basic research in the physical sciences that is not in high energy physics or nuclear physics. For many fields of "low energy" science, it is the largest single national source of funding.

In the Office of Energy Research Strategic Plan (June, 1992) the multi-disciplinary Basic Energy Sciences Program is to be implemented with strategies to:

- Focus the program on long-term requirements and opportunities for meeting the nation's energy needs, minimizing waste and reducing the environmental impact of energy conversion, and providing fundamental knowledge to support DOE technology programs as well as industrial programs engaged in energy research and development.

- Identify, develop, and support jointly planned budget initiatives with Conservation and Renewable Energy (CE), Fossil Energy (FE), Nuclear Energy (NE), and Environmental Restoration and Waste Management (EM) in specific scientific and technical research areas of mutual interest to both the Office of Energy Research and the DOE technology programs.

- Foster participation of university and industrial scientists and engineers in pioneering energy research through widely accessible grant research programs and facility utilization.

- Extend the frontiers of energy-related disciplinary areas such as: chemistry; metallurgy; ceramics; geosciences; biotechnology; mathematical, computation and computer science and technologies; solid-state, atomic, molecular, optical, and plasma physics; and engineering to provide the information basis for new technological applications.

- Provide data and knowledge to improve the understanding of research topics such as: corrosion-resistant, tough, lightweight materials; high-temperature superconductors; radiation damage in metals, ceramics, and polymers; combustion processes; solar energy conversion; catalytic conversion; underground imaging techniques; advanced manufacturing methods; nonlinear phenomena in wave mechanics, fluid flow, and coupled chemical reactions; microbiological and plant processes; high performance computing; and novel, energy-related concepts.

- Complete, upgrade, maintain, and operate major scientific facilities needed to advance the frontiers of knowledge, including electron microanalysis, scattering, and microscopy centers; synchrotron radiation sources; neutron sources, together with planning for a new research reactor; and combustion research-related facilities. Coordinate the planning and use of U.S. facilities with international needs and foreign facilities to gain full scientific benefit from investments in these advanced research devices.

- Develop designs and options for a new high flux research reactor, the Advanced Neutron Source (ANS), to produce the world's most intense, continuous beams of neutrons for neutron scattering research, the study of radiation effects and the production of radioactive isotopes for industry and medicine and other uses. The purpose of the ANS would be to provide scientific capability exceeding that currently available from the High Flux Isotope Reactor and the High Flux Beam Reactor, which are more than 25 years old and will soon have to be retired. Establish the performance capability and use of this reactor in accordance with worldwide science program needs.

1.2 The Role of the National Laboratories

The DOE non-DP, multipurpose National Laboratories (as exemplified by the four visited) represent irreplaceable national assets. They were developed in large part to support major facilities – reactors and accelerators – and they have developed the large infrastructure necessary for the successful accomplishment of major, multidisciplinary projects. In contrast to universities, they can, in general, support team-based research rather than individual entrepreneurial investigators, giving them the resources to respond rapidly to changing roles and missions. Within this framework, their role in conducting OBES-supported research is to achieve scientific excellence in support of "The principal goal for basic energy sciences research [which] is to expand scientific and technical knowledge and skills needed to develop and use new and existing energy resources in an efficient and environmentally sound manner" (1992 Office of Energy Research Strategic Plan). The laboratories serve as training grounds for scientists and engineers at both the graduate and post-doctoral levels, providing the opportunity for first-rate research without the explicit teaching mission of the universities. Also, as a meeting ground for BES researchers with representatives of DOE technology programs and industrial users of facilities, they provide a unique basis for transfer of science knowledge and technology.

1.3 Quality and Management of Research at the Laboratories

The quality of research supported by OBES at the national laboratories reflects three elements: OBES program management; national laboratory facilities and program management; and the quality of the investigators and the adequacy and stability of their support. While creativity most often appears at the level of the individual investigator, laboratory and OBES managements have the responsibility for selecting and guiding research programs in directions compatible with the energy component of the DOE mission. Laboratory management has the responsibility for recruiting and organizing multi-disciplinary high quality talent; for providing and effectively operating world class facilities and instrumentation; and for providing the focus on the laboratory and departmental missions. The ability to establish teams to attack special problems, and to co-locate the basic research (the mission of OBES) with the technology programs of DOE is a very important distinguishing feature of the national laboratories. A special example of this role is, of course, the design, construction, and operation of major user facilities.

1.4 Science Knowledge and Technology Transfer

Science knowledge transfer has always been a mission of the OBES-supported programs at the laboratories. With increased national emphasis on technology transfer and international competitiveness, it is clear that the laboratories must devise more appropriate and effective processes in support of those objectives. While we understand and support the goals of technology transfer and competitiveness, it is important to remember that the primary mission of OBES is and must remain facilitation of mission-oriented creative basic research. The changes that are being implemented must be carefully managed to ensure that scientific excellence and productivity are maintained, particularly because they represent the front end of the entire wealth-generating process.

2. THE CLIMATE FOR BASIC ENERGY SCIENCES RESEARCH IN DOE

Although the goals and strategies for BES programs have been clearly stated, success in current and future implementation requires addressing a number of critical issues facing the national laboratories and OBES in light of the fiscal limitations on research budgets anticipated for the next five years. In the current subdued national economic climate, research budgets in all sectors are stagnant at best. All parts of the national research enterprise are showing increasing strain, including the DOE laboratories and OBES programs. It is therefore imperative that OBES and OER set and/or adjust priorities among the different types of programs, emphasizing those which best support the DOE mission.

It has been a continuous concern to BESAC that an appropriate balance of support between facilities and active research programs be maintained to implement the OBES mission (e.g., see recent BESAC annual reports for 1989-1991). Regulatory and compliance pressures, along with increasing technical sophistication, have caused the costs of building, equipping and operating forefront facilities to escalate much faster than general inflation. Each new facility commonly has capital costs an order of magnitude more than the preceding generation (compare costs for the Advanced Light Source [ALS] and the Advanced Photon Source [APS] with the National Synchrotron Light Source [NSLS] and the proposed ANS with the aged High Flux Beam Reactor [HFBR]). Although the capabilities of the new facilities are also increasing dramatically, all of the laboratories report a decreasing level of effort within the research programs as facilities and their operating costs increase. If the nation is to have access to the best research tools, the OBES budget must increase sufficiently to allow for both facilities and a healthy research program. The ALS and the APS are being brought in on time and on budget. They will provide unparalleled new scientific opportunities, but neither will be adequately, let alone fully, instrumented when they first operate, or for a considerable time thereafter, unless additional funds are provided. The HFBR, the nation's premier neutron source, is operating at less than 1/3 maximum capacity for want of an instrumentation upgrade which has been recommended continuously for high priority implementation over the past eight years. There are many similar examples, at all scales, at all of the laboratories.

As each new facility goes into operation, national economic constraints place limits on the contributions to instrumentation support that can be expected from such non-DOE federal user agencies as NSF, NIH, and DOD, and from private industry. Shortfalls must be anticipated and will certainly be debited to the OBES budget. Great pressure thus will continue to fall upon the research program budgets. Expensive facilities cannot operate with eager and able but underfunded research investigators.

Increased demands that government-supported basic research (replacing decreased private sector support) enhance national industrial competitiveness places increased emphasis on relevance and technology transfer efforts. This translates into further demands on limited research budgets.

Other concomitant pressures are being felt by the national laboratories. For example, DOE has addressed its long term environmental responsibilities more forthrightly in recent years. The growing and necessary DOE emphasis on Environment, Safety and Health (ES&H) and on environmental cleanup is in response to well documented problems, primarily within the weapons production facilities. While there also are problems in the non-DP laboratories, in many cases the broadly applied regulations for ES&H should be carefully reconsidered case by case in the context of a cost/benefit/risk analysis. The laboratories are subject to an ever-increasing number of DOE orders, each of which addresses a particular part of a problem; however, due consideration is not given to the rationale for application of these orders in a context of the risk, of the entire safety situation at a laboratory, and of the laboratory mission. Authority and responsibility are separated in this area. While this ES&H activity is in response to earlier defaults in areas of safety and the environment, the current situation is leading to unnecessary reduction in the productivity of the research effort in some cases. The laboratories are intended to serve a fundamental national purpose, so their scientific and technical goals should carry appropriate weight in establishing balanced new requirements.

Another negative impact on laboratory budgets derives from their aging physical plants. Many buildings date back to the Second World War, and their maintenance is becoming ever more expensive. The older buildings were not constructed for compliance with today's environmental standards, and economical retrofit is difficult or sometimes impossible. In order to preserve the major national assets represented by these laboratories, it is essential that funding be provided so that the infrastructure can be maintained at an adequate level.

Finally, the structural organization of DOE contains many parallel reporting chains (landlords, local operations offices, individual program managers, ES&H, Environmental Restoration and Waste Management,...) with divided responsibilities. These entities place competitive and redundant burdens on the laboratories, reducing program efficiency. Research program funding tends to come in from the bottom, to individual projects, while requirements come in from the top. Facilities budgets are determined from the top. While individual management contracts differ, a tendency to move towards a performance fee, with criteria based on factors other than the laboratory mission, seems to be prevalent. Reviews, audits, and assessments (including this one) proliferate, taking the energy of management away from their first priority – promoting the best science and technology. The result is increasing overhead and some loss of mission focus.

3. BASIC ENERGY SCIENCES AT THE FOUR MULTIPURPOSE LABORATORIES

Although each laboratory BES program has its individual characteristics, all share common features. At each of the four laboratories, OBES is either the largest or second largest single source of support, typically providing about 20-25% of total operating funds. Conversely, each laboratory derives the majority of its funding from elsewhere in DOE, or from outside sources. Each laboratory has at least one OBES-supported major user facility, and some smaller user facilities (ranging from the National Center for Electron Microscopy at Berkeley to the SHARE program at Oak Ridge). At each laboratory OBES programs are universally seen as the intellectual lifeblood of the laboratory, allowing for the development of special competencies and skills, which are then applied to other programs (a most effective form of technology transfer).

In laboratory organization, the division (or department) is the primary unit, although each division contains many groups, with even more individual Field Work Proposals (FWP's). The divisions have considerable autonomy, and provide the first level of laboratory screening for new ideas and programs in the "bottom-up" portion of the planning process. They report to the Laboratory Director either directly or through Associate Laboratory Directors (ALD's); in the latter case, one ALD has primary responsibility for all OBES programs (although large facility construction and operations are sometimes separate). The ALD's and/or the Division Directors, along with the Laboratory Director, form the senior management councils, providing the "top-down" planning and management. In this environment, one of the primary research management tools cited by the Directors is Laboratory Directed Research and Development (LDRD) funding, which is typically 1-2% of total funds received by the Laboratory. Although all of the laboratories have the authority to go to higher levels (up to 6%), all have chosen to remain at the lower levels to avoid increased pressure on overhead rates. These LDRD funds are used to start new programs, to coordinate laboratory responses to DOE and OBES initiatives, and to define new areas of emphasis for the laboratories. They are highly prized by management and individual investigators alike. Laboratory directors are encouraged to exercise more use of LDRD funds and to consider establishing higher percentage levels as circumstances permit.

With these general observations, each of the laboratories will be discussed in turn, emphasizing those aspects which shape the special character of the laboratory, and identifying some special issues.

3.1 Argonne National Laboratory

Argonne National Laboratory (ANL) is a direct descendant of the first fission chain reaction at the CP-1 pile at the University of Chicago during World War II. CP-1 was only the first of a series of nuclear reactors constructed by Argonne, including CP-5, Argonaut, Juggernaut and others, with EBR-II, which still operates at Argonne West, the only operating breeder reactor in the United States. Argonne is unique among the four laboratories in having two widely separated sites – Argonne East, just outside of Chicago, Illinois and Argonne West, located near Idaho Falls, Idaho. ANL is managed by the University of Chicago under a contract with the Department of Energy.

Over the past 30 years, ANL has evolved into a multipurpose laboratory, with less emphasis on reactors, and relatively more emphasis on materials science research in general. While the Argonne mission in reactor development with the Integral Fast Reactor program has been large, other programs have become relatively more important. The Intense Pulsed Neutron Source (IPNS) led the way in the operation of U.S. neutron sources as user facilities. IPNS also pioneered the use of spallation as an alternative to fission as a neutron source, and for many years was a world leader, although now surpassed by the ISIS source at the Rutherford laboratory in Great Britain.

The laboratory now has 4594 employees of whom approximately 40% are scientists and engineers, and a total operating budget (excluding construction) of $392 M (FY92). Of the staff, approximately 900 are located at Argonne West, with the remainder at Argonne East. While reactor development funded by Nuclear Energy has been the largest single program at the laboratory, providing 26% of the budget, total Office of Energy Research funding is larger, and OBES support alone was approximately 20% of the operating budget in Fiscal Year 1993 (the second largest single component).

The personnel policies for professional staff at ANL are based on three levels of progression – Assistant Scientist, Scientist, and Senior Scientist. All hiring and promotion actions are reviewed by a committee after recommendation by the appropriate Division Director. Entry is typically at the Assistant Scientist level, and for these staff there is a five year up or out policy – either promotion is approved to the Scientist level, or the person is terminated. The review on promotion is thorough, and involves solicitation of outside opinions, especially for promotion to the Senior Scientist level. On the average, only 20% of the staff ever reach the level of senior scientist. Within this top level, there is a further separation into two categories, with promotion to the higher level requiring approval by the Laboratory Director and a laboratory-wide committee. This level represents the top 1% of the laboratory professional staff.

The construction and operation of the Advanced Photon Source represents a further shift in laboratory priorities, since it will be a major national facility providing international leadership in capabilities. It will require substantial funding and staff for normal operation, which will greatly increase the magnitude of OBES funding which goes into facilities at ANL. It is therefore entirely appropriate that the OBES research programs at ANL be restructured so as to take advantage of this unique resource. This will help to ensure that the APS meets its scientific promise, and that its facilities are maintained at the highest possible level. In addition, there is one other major issue which must be addressed by both ANL and DOE. To exploit the potential of the APS, substantial additional funds will be required – both for Phase II, which will complete construction of the experimental space; and for the full instrumentation of all of the beamlines. The total cost of these two requirements is several hundred million dollars. Clearly, not all of this money need come from OBES, or even DOE, but a substantial fraction must. In the current economic climate, it is unlikely that a major portion of the funds required for APS beamlines will come from U.S. industry. The budget of the National Science Foundation is highly constrained. Since the operating costs of the APS are relatively inelastic with respect to the number of operating beamlines, operation of fewer beamlines results in a larger cost per line and per experiment. It is not cost-effective to build a world-class facility with a large construction and operating cost, and obtain only a small fraction of the possible research yield as a result of inadequate funding of instrumentation and operating costs.

The laboratory faces other strains on its OBES budget, as a result of both equipment and operating needs. The Laboratory argues that IPNS could operate for a longer fraction of the year (up to 16 more weeks, to effectively double DOE-funded operation), at an annual cost of $4 M/year, and also could greatly improve efficiency by installing a new booster, and upgrading instruments. ANL has also proposed a substantial upgrade to provide a new spallation source with one MW of beam power. The cost estimates for this proposal are not yet well established. This issue has been addressed in some detail by the special BESAC panel on neutron sources. The electron microscopy capabilities of the laboratory would need to be augmented to remain at the forefront. Perhaps the most important problem identified, common to all four laboratories, is the declining level of effort in the base research programs.

The special issues that face the laboratory in the near future are identified in the ANL Draft Institutional Plan for FY1993-FY1998 that was made available to BESAC. This document reflects the view of the strategic planning committee, which consists of the Director, the Associate Directors, the Chief Operations Office, and the Director of Strategic Planning. As stated in the plan, the Laboratory's mission is basic and applied research that supports the development of energy-related technologies. The major elements of this mission are national research facilities, basic research, technology-directed research, technical evaluation and technology transfer. Within this framework, full development and use of the APS is a top laboratory objective, and the necessary resources are being pursued to achieve it. However, as we have noted, resources are limited, especially in the light of the FY1993 budget appropriations passed by the Congress. This will be a continuing issue, and will put heavy pressure on other laboratory goals and programs. The laboratory should also address the impact of the APS on the directions of its existing OBES research, presenting both a challenge and an opportunity.

Committee Findings:

1. The construction of the APS, Phase I, is proceeding on schedule and within budget, reflecting well on the project management.

2. The forward costs of the APS budget for construction, instrumenting beamlines and Phase II construction would require a large and increasing fraction of the projected overall OBES budgets. The sources of these additional funds are not established, therefore the associated timelines are not clear.

3. Achievement of the research potential of the APS will require major restructuring of OBES programs at ANL.

4. The planning for the restructuring of the OBES programs should be put in place promptly. The role of pulsed neutron source research (IPNS) will be affected by decisions on the recommendations of the Kohn panel.

5. The laboratory would profit from adding more industry representatives to advisory panels to enhance possibilities for effective science and technology transfer. They should include people who know and understand engineering, manufacturing, and technical marketing operations.

3.2 Brookhaven National Laboratory

Brookhaven National Laboratory (BNL) is a multi-program laboratory that carries out basic and applied research in the physical, biomedical, and environmental sciences and in selected technologies. The laboratory is managed by Associated Universities, Inc. (AUI) under contract with the U.S. Department of Energy. AUI was formed in 1946 by a group of nine universities for the purpose of establishing and managing the new laboratory. AUI's nine sponsoring universities are Columbia, Cornell, Harvard, Johns Hopkins, MIT, Pennsylvania, Princeton, Rochester, and Yale.

BNL, in common with ANL and ORNL, was an early pioneer in nuclear reactors, with the Graphite reactor coming on line in the early 1950's. This reactor was followed by the HFBR – the first high flux reactor designed expressly for the production of beams of neutrons for research in nuclear physics, solid state physics, and chemistry. This reactor design pioneered the concepts that are at the heart of every major beam reactor built subsequently (including the one at the ILL in Grenoble and the proposed ANS at Oak Ridge).

The laboratory has three primary missions. The first is to design, build, and operate large, complex research facilities for the benefit of the national research community. The second is to carry out basic science research in long-term, high-risk programs which have potential for rich payoffs in knowledge gained. Many of these programs employ the unique facilities mentioned above; others take advantage of the special scientific and technical expertise and ancillary support services and facilities at the laboratory. The third is to contribute to the technology base of the nation. BNL is engaged in the development of new technology and the transfer of this new knowledge to the commercial sector. This mission has remained constant since the beginning of the laboratory.

Today, BNL has a staff of 3480 of whom approximately 25% are scientists or engineers, and a total operating budget $301.3 M, of which 72% comes from the Office of Energy Research. While High Energy Physics has been and remains a major component of the BNL program, in FY1992 OBES provided the largest single component of financial support (25%). As the Relativistic Heavy Ion Collider (RHIC) comes on line, High Energy Physics will decrease in relative importance, and be replaced by Nuclear Physics. The activities at BNL are dominated by large facility operation, and this is equally true for the programs funded by OBES, where 61% of the total OBES funding is for operation of the National Synchrotron Light Source (NSLS) and the High Flux Beam Reactor (HFBR). Much of the remaining OBES-sponsored research is centered in and enriched by these two facilities, with all divisions having strong components of facility-based research and facility development.

The personnel system at Brookhaven is unique among the four laboratories in having a formal tenured category, similar to that in universities, although with somewhat less job security. Approximately 26% of the scientific staff are tenured, with another 8% as research associates. The balance of the staff hold either continuing appointments (for staff who are not accepted for tenure, but have ongoing appointments) or term and project appointments (for limited time positions). Tenure decisions are made in a manner similar to that in a university, with final approval coming from the Associated Universities Board, and letters of reference being solicited from the outside. The tenure system provides senior investigators with considerable autonomy, although department heads have management responsibility to guide the direction of the overall effort. As a laboratory policy, the age profile of the staff is kept relatively flat between 35 and 65 years of age, with a small peak at the lower ages.

The particle physics component of the BNL program is in the midst of a transition from High Energy to Nuclear Physics as the Alternating Gradient Synchrotron-High Energy Physics programs phase out, and the RHIC project moves forward. Within the OBES-sponsored programs, other transitions are visible over the next decade. NSLS is at present the premier synchrotron radiation laboratory in the U.S., covering both the Vacuum Ultraviolet and hard X-ray regions of the spectrum, and serving a very broad user community. The operation of the NSLS is funded solely by DOE, but much of the research is funded from outside. However, with completion of the ALS at Berkeley, and the APS at Argonne well into construction, NSLS will not be the forefront facility for either region of the spectrum. OBES budget strains will increase as operating funds are required at the ALS and APS, and some users transfer to these new facilities. NSLS is and can remain for many years a superb, cost-effective facility, but the pressures of other facility needs will require that continuing operation of NSLS have the strongest justification. At the same time, some of the more aggressive researchers will migrate eventually to the new forefront facilities, making it more difficult to maintain scientific vitality.

The High Flux Beam Reactor (HFBR) is the nation's premier facility for neutron scattering research. An instrument upgrade for the HFBR, which would greatly increase its effectiveness, is a major Laboratory priority. This upgrade has been strongly recommended many times, by BESAC among others, and would be cost-effective in the near and long term. The HFBR is scheduled to shut down when the Advanced Neutron Source operates (if it can operate until then) and the research staff at BNL intend to travel to the ANS to perform their experiments. The instruments developed in the upgrade at HFBR could be moved to the ANS at that time.

Strategic planning at BNL is done by the senior management with input from the Department Heads, and the results are the basis for the Five-Year Institutional Plan which is updated every year. The mission of the laboratory remains centered in the provision and use of major national research facilities, with the Relativistic Heavy Ion Collider now under construction. Under the sponsorship of OBES, BNL operates the NSLS and the HFBR, two of the nation's premier facilities for research in condensed matter science, materials science, chemical science, and the life sciences. The NSLS and HFBR are also at the heart of much of the in-house OBES-sponsored research at BNL.

Committee Findings:

1. The operation of the National Synchrotron Light Source is an outstanding success among national user facilities, reflecting positively on BNL and OBES. Many years of productive life remain.

2. The future role and health of the two major facilities (NSLS and HFBR) present a vital challenge to laboratory management in both the near and long term future. It is essential that long range planning begin now, in consultation with DOE and OBES, to ensure a continuation with appropriate transitions for the current highly successful and productive programs that are centered in these two facilities.

3. Long-range planning for OBES-supported divisional research programs at BNL are also required to sustain their present vitality and quality. New facilities at other laboratories will provide both access to and competition for these programs which have enjoyed significant success to this point.

3.3 Lawrence Berkeley Laboratory

The oldest of the DOE National Laboratories, Lawrence Berkeley Laboratory (LBL) is the only laboratory located adjacent to a major research university, the University of California at Berkeley. Founded by Ernest O. Lawrence in 1931, LBL's programs emphasized fundamental research in nuclear chemistry and physics, and in high energy physics through the 1970's. However, during the 1960's and 1970's, numerous non-nuclear programs were started – materials sciences, earth sciences, and health and environmental research. LBL is managed by the University of California under a DOE contract.

LBL's transition from a high energy and nuclear physics-oriented capability to a broad-based multi-program laboratory was completed by the 1980's. Whereas OBES-funded programs at LBL were only a little over 8% of the operating budget in 1970, they account for nearly 25% today, the largest single program area. Much of this growth came about through creation in the 1980's of the Center for Advanced Materials and the Center for X-Ray Optics, together with the construction of the Advanced Light Source (ALS), which produced the first beam in 1993 and will be the world's brightest source of UV radiation and soft X-rays.

Today, LBL has about 3500 employees, including 900 scientists and engineers, and 750 graduate students and postdoctoral fellows. The operating budget of approximately $215 M supports a wide range of research in the physical and biological sciences, engineering, mathematics, and computer sciences. The most distinctive single feature of LBL is the close continuing relationship with the University of California, characterized by the fact that over 220 faculty are also laboratory staff members. This special relationship is the source both of great strength and considerable tension. It has been a great asset in the recruitment and retention of a very distinguished staff with a high level of achievement, and provides a steady supply of talented graduate students who pursue advanced degrees while working on research projects at LBL. On the other hand, the existence of two classes of staff members – those with faculty appointments and those without – is a significant management challenge. In many instances the faculty staff operate in the traditional mold of academic science entrepreneurs, making it more difficult to initiate and maintain the multidisciplinary, team based approach which is the hallmark of the national laboratories as distinguished from the universities. Another consequence in the past has been the limited amount of collaboration and participation with outside scientists from other universities and industrial laboratories; this is now undergoing change.

Researchers supported by OBES at the Laboratory include both full-time faculty members at the University of California, Berkeley (UCB) who have associate or senior faculty joint appointments at LBL, and full-time LBL staff members. For the former, all of the university personnel policies, which are similar to other major research universities, hold. For the latter, Laboratory personnel policies apply. Staff are recruited nationally, and candidates are reviewed by a Division Staff Committee. In the case of senior scientists, appointments are reviewed by a Laboratory Staff Committee formed by the Laboratory director. Professional salaries must be approved by the Laboratory's Professional and Executive Salary Committee. Annual performance reviews are required for all laboratory staff. Major promotion reviews, including outside letters of evaluation, are conducted on a regular basis by the division staff committees. Approximately 15% of the scientific staff are appointed to Senior level by the Director after recommendation by the Laboratory Staff Committee – this level is considered the equivalent of tenure, and promotion involves all of the usual rigor associated with this level at a major university.

Construction of the ALS has proceeded well – the project is on time and on budget. The first photons became available in 1993, as planned. However, the ALS faces a serious problem in developing the instrumentation to realize the scientific promise of the very-high-brightness beams that it will provide. As the capabilities of synchrotron sources have increased with the third generation machines, the cost of the required instrumentation needed to properly exploit them has increased significantly. At the same time, in an era of economic restrictions, private sector funding for beamline development is not available in the necessary amounts, nor is funding from other federal agencies. The unfunded cost of beamline development at the ALS is in excess of $100 M, and without adequate instrumentation the operating costs will be difficult to justify. While this problem is shared with other facility-based laboratories, LBL must address it immediately. Successful operation of the ALS will put additional pressure on the BES research programs of the laboratory as resources are redirected to this effort. At the same time, a successful ALS will be a major national research resource, providing unique measurement capabilities and fulfilling one of the major roles of a national laboratory. It will provide unique capability to the private sector for research in biology, materials, and chemistry which is at the heart of the DOE mission (e.g. the Combustion Dynamics Initiative).

At Berkeley, BESAC was briefed on a modified proposal for the Combustion Dynamics Initiative. In earlier reviews, concern was expressed about the suitability of the Infrared Free Electron Laser (IRFEL) for this facility. It was recommended that close attention be paid to possible replacements as a result of technology development. At this briefing, a two phase construction plan was presented, in which Ti-sapphire lasers would be installed in Phase 1, and would allow most of the combustion research to go forward. A superconducting IRFEL could be added later, as Phase 2, if it were subsequently judged to be a useful and necessary component. The Phase 1 project has a much reduced cost compared to the full project presented earlier. BESAC endorsed this new concept in a letter report to Dr. Happer of August 17, 1992 (see Appendix 7). BESAC maintains its recommendation that the Combustion Research Facility should be completed.

LBL is currently in the middle of an extensive exercise in strategic planning. The laboratory has set up a formal structure to develop a vision for the future, with input from all levels of the organization. We commend the laboratory management for their commitment to this in-depth examination of their present strengths and future goals. In view of the cost of building and operating forefront research facilities such as the ALS, it is essential that LBL increase its outreach to the national academic and industrial research community. Technology transfer and economic competitiveness are themes that have been addressed by the OBES-funded Centers for Advanced Materials and for X-Ray Optics since the mid-1980's; the growing national and DOE emphasis on these areas implies additional changes in the laboratory mission. The Laboratory management is aware of these issues, and is working vigorously towards a strategy which maintains the traditional strengths of LBL while positioning the laboratory for the future. Successful implementation of the final strategy is essential if LBL is to effectively serve the Department's mission.

Committee Findings:

1. The large involvement of UCB faculty at LBL adds great scientific strength and some structural weakness. In particular, this has diminished the Laboratory's ability to assemble effective groups and teams to address mission-oriented problems. A significant increase in the proportion of non-faculty staff is indicated. This is recognized by Laboratory leadership which is working actively to convert the staff culture at LBL to that of a more multi-disciplinary national laboratory focused on the DOE missions.

2. The ALS is a significant technical success but realization of its potential contributions to the DOE mission requires: (1) an aggressive recruitment of a large user community, (2) greater cultivation of industry participation to enhance technology transfer.

3. The Combustion Dynamics Initiative offers great potential in line with the DOE mission, if outside user and industry participation is assured. To this end, completion of the Combustion Research Facility at Sandia Livermore is a requisite.

4. The large cadres of graduate students and research fellows from UCB doing research at LBL facilities comprise a distinctive and very effective mechanism for LBL science and technology transfer to outside organizations.

5. The outreach of LBL to the regional and national scientific and industrial community is being expanded, but lags behind the efforts of the other laboratories the committee has visited.

3.4 Oak Ridge National Laboratory

The Oak Ridge National Laboratory (ORNL) grew out of the Manhattan Project as a laboratory to support the peaceful uses of Atomic Energy. As part of this mission, ORNL was deeply involved in the development of reactors – in fact, the first reactor at the laboratory was the Oak Ridge Graphite Reactor, which became operational in 1943. This reactor was the site of the experimental development of the field of neutron diffraction in the period immediately following the end of the war. The reactor-based mission of ORNL remained the major component of the laboratory for many years, but other areas have grown, including radiation damage studies, which formed the basis for the present materials science effort.

Today, ORNL is a multi-purpose laboratory, with 5308 employees, of whom approximately 1/3 are scientists or engineers. It is managed by Martin Marietta Energy Systems under a contract with the Department of Energy. Of the total laboratory operating budget of $663 M, OBES provides approximately 20%, the largest single funding component and the largest dollar amount of OBES funding at any of the laboratories. The fraction of OBES funding dedicated to major facility operation at ORNL currently is the lowest of the four laboratories. In contrast to the other laboratories, this program is far less associated with the special capabilities of large user facilities, such as HFIR. This condition will change with the initiation of the Advanced Neutron Source.

The personnel system at ORNL involves postdoctoral appointees, permanent staff members, and ORNL/University of Tennessee Distinguished Scientists. Much of the hiring is done at the postdoctoral level, including the prestigious Wigner Fellowship program. Many of the postdoctoral fellows are then converted to permanent staff members (approximately 50% of new staff members are recruited in this way). While the postdoctoral program is excellent, the Committee has some concerns about the large number of in-house appointees that are converted to staff positions, and would encourage ORNL to increase recruitment of people who have performed postdoctoral work elsewhere. While the original screening process for postdoctoral and staff appointments is good, there is no *formal* review at a later stage which requires a detailed evaluation, including solicitation of outside references, to ensure retention of only the best possible staff. There are informal reviews, along with annual performance evaluations, and staff may be moved into other areas, or encouraged to look for other opportunities. This is an essentially internal process, and there is no well-defined "up or out" policy such as is in place at the other laboratories. There is, however, a formal and rigorous review when staff are being promoted to high level positions. We would encourage ORNL to consider a formal review with external evaluations at an earlier stage in the career of staff scientists and engineers. ORNL management is aware of this problem.

If the ORNL proposal to construct the Advanced Neutron Source (ANS) goes forward, Oak Ridge will have a major national user facility. The ANS project has now completed a full Conceptual Design Report (CDR), with a total estimated project cost of $ 2.7 B ($ as spent). This estimate is deliberately conservative, includes instrumentation costs, and has been fully reviewed by DOE. The subject of new neutron sources has been reviewed by the special panel chaired by Professor Kohn. It has assigned a high priority to the ANS to replace the aging current reactors to serve the national needs for isotope production, materials irradiation, and neutron scattering. Construction of the ANS will put severe strains on the ORNL infrastructure, and will necessarily lead to changes in the laboratory goals and programs in order to ensure the success and full utilization of this unique national facility. The magnitude of this proposed project will require that the laboratory rearrange its priorities, and its management structure, in order to assure completion on time and within budget. If the project goes forward, ORNL will face a transition more profound than those faced by the other laboratories discussed here.

ORNL makes a special and commendable management effort to co-locate OBES scientific research in the same division as technology program research, especially within the Metals and Ceramics Division. This leads to a better defined focus for the laboratory on DOE mission-related research, and a good team-based approach. It also leads to a correspondingly lesser emphasis on individual scientists, as compared to LBL or BNL. The most important impact of this policy is that transfer of science knowledge and technology to the DOE applied programs is greatly enhanced, since it often involves exactly the same people. The laboratory is beginning to increase its outreach effort to universities and industry through smaller facilities such as the High Temperature Laboratory and the Share program.

ORNL has made a decision to emphasize advanced computing and applied math programs, and has established a Center for Computational Sciences to lead ORNL participation in the High Performance Computing and Communication Initiative. To enhance existing competence in this area, they have designated a fraction of LDRD funds for programs which are focused in computing. They have chosen to pursue a grand challenge problem in groundwater transport in environmental modeling, a topic which has special relevance to the cleanup problems associated with the defense production activities in the ORNL area, and to many other DOE laboratory sites.

Strategic planning at ORNL is the responsibility of the senior management. In the current Institutional Plan, the Laboratory mission is defined as basic and applied research, technology development, and other technological support for the missions of DOE and the nation. In particular, the laboratory sees a special role in energy production and conservation technologies, physical and life sciences, scientific and technological user facilities, environmental protection and waste management, science and technology transfer, and education. This is a broadly defined mission, reflecting the fact that ORNL is the largest of DOE's energy multi-program laboratories. In view of the large burden that construction and operation of the Advanced Neutron Source will impose on the infrastructure of ORNL, BESAC urges the laboratory to develop a strategic planning process which fully allows for the impact that this major national resource will have on the Laboratory's science operations.

Committee Findings:

1. ORNL personnel review practices would benefit from augmented periodic reviews, especially for tenure decisions, and more extensive utilization of external letters of evaluation.

2. ORNL has developed effective multi-disciplinary science teams for BES mission oriented projects.

3. The ANS design and building team has produced a commendable product and appears very capable of following through to completion. The anticipated advent of ANS is not matched by visible planning for a build-up in ORNL capabilities in neutron physics and more extensive application of ANS capabilities in in-house science.

4. THE IMPORTANCE OF PROGRAM BALANCE

The most important non-defense national responsibility of the DOE national laboratories has been the design, construction and operation of the large facility-based scientific research program; its achievements are unmatched by any other U.S. agency. As other aspects of the DOE mission (such as education and technology transfer) grow, and as the facility costs increase, pressures on the base research program (especially within OBES) have increased ominously. One measurable effect – common to all four laboratories examined here – has been a decrease in the support for scientific staff. At present, the support for facility operation at ANL, BNL, LBL and ORNL represents approximately 44, 67, 38, and 27% respectively of the total OBES operating support. Each of these laboratories has either ongoing or proposed facilities which rely primarily on OBES for support. LBL and ANL have the ALS and APS under construction, but neither will reach its scientific potential unless substantial new funds are forthcoming to instrument their many unfunded beamlines. The Advanced Neutron Source program, once initiated and constructed, will represent an unprecedented strain on the OBES budget.

As a result of these foreseeable pressures BESAC believes the issue of program balance has become critical. Although we have endorsed the construction of world class physical facilities to maintain the U.S. leadership role in science, we believe that facilities in themselves are enabling but not sufficient to produce the scientific progress expected. Adequate funding must be maintained both in the high quality research programs which utilize the facilities and in the very diverse non-facility-based research essential to the mission of OBES and DOE. These research programs are a critical component of the national research enterprise.

As more industrial laboratories cut back on long term research and development, it becomes more evident that only the government can support the longer term research which may have no short term application, research which yields the important new thrusts in science and technology. While the National Science Foundation has a lead role in the support of non-health-related basic research, the Department, and OBES in particular, historically has played a major role, and is in many vital areas now the major supporter. This research drives the need for facilities, and is supported by them in turn. However, it is essential that the level of *research* effort be increased, or, at least, protected from further erosion. There is international recognition of the role of OBES in building and operating major facilities in materials research and related disciplines, which are used not only by OBES-supported researchers, but by the entire community. Within this framework, the research programs built around the non-DP laboratories and in universities are also a unique national resource.

5. TECHNOLOGY TRANSFER

This section contains the response to the request that BESAC look specifically at the role of the OBES programs at the national laboratories in supporting U.S. industry. The material was initially generated by a subcommittee of industrial representatives and members with extensive industrial experience. It has received extensive committee consideration.

5.1 Support of U.S. Industrial Competitiveness by Science and Technology Originated in OBES-Supported National Laboratories

The principal goal for basic energy sciences research is to expand scientific and technical knowledge and skills needed to develop and use new and existing energy resources in an efficient and environmentally sound manner (OER Strategic Plan, 1992). In addition, "basic science programs within the DOE have actively pursued the transfer of scientific knowledge as part of their missions" (National Energy Strategy) in support of the competitiveness of U.S. industry.

The national laboratories are unique resources in terms of facilities, infrastructure, and skills for the origination of scientific concepts and knowledge that lay the foundations for technological innovation. As the amount of long-range and fundamental research in U.S. industrial laboratories declines, the OBES-supported programs can play a critical role in pursuing basic science in areas that will generate significant new industrial technology.

To be effective in transforming their excellent science into innovative technology, the OBES-supported research programs need to couple effectively to "customers" who will build on the new science. The immediate "customers" who develop the basic science findings into technology normally will be the mission-oriented programs in DOE. Ultimately, however, the science and technology will be applied and commercialized by private industry. The prompt and effective transfer of science and technology to these customers constitutes a major challenge to the effective management of the OBES programs.

5.2 Modes of Knowledge Transfer

The commonly discussed methods of technology transfer such as patent licensing and CRADA's have limited applicability as criteria for evaluation of basic energy science programs. Generally, the scientific knowledge is too far removed from industrially applicable technology for immediate commercialization. Knowledge transfer to industry or other DOE divisions is an important first step in technology transfer, but years of additional research and development are commonly needed to bring a product or process into industrial practicality.

There are many ways to transfer the results of BES research to both DOE and industrial "customers" as listed below. In general, the most effective are those based on having the basic energy scientists and the applications scientists working closely together.

- Publication of new results and concepts in the open literature and scientific meetings is an important means of knowledge transfer, but such disclosures are available to all, and do not contribute directly to U.S. competitiveness. Broad, well-crafted patents provide a valuable complement to publications because they offer an avenue for selective application of OBES-generated knowledge by U.S. industry. Increased diligence in assessment of BES research findings for technological significance can enhance the value of the patent program.

- The user facilities are an outstandingly effective mechanism for the OBES-supported laboratories to contribute to industrial research, as well as that of universities and other DOE divisions. These facilities provide thousands of scientists access to high quality, complex instrumental techniques which would otherwise be unavailable to them.

- The visitors' programs in which industrial scientists work in the national laboratories for periods of several months are similarly effective in making available the excellent facilities and unique skills of the laboratories. Furthermore, these visits build the basis for ongoing collaborations that can lead to the effective application of new science coming from the laboratories.

- A less commonly used complement to the visitors' programs is the situation in which OBES-supported scientists work for a period of time in an industrial laboratory or in a DOE application program. In another variant, OBES-supported scientists may serve as consultants to an applications program or industrial laboratory. The OBES-supported scientist garners useful insights on technology needs that might be satisfied by knowledge and skills residing in the OBES programs.

- Task-oriented teams including scientists from OBES-supported programs are often very effective in transforming scientific knowledge into useful technology. The applications scientists may be either technologists from another DOE program, or scientists from industry. In the latter situation, CRADA's are a useful means to facilitate the collaboration.

- The donation of BES-generated software, modeling tools and databases to U.S. universities and industries is an extremely valuable form of direct knowledge transfer that should continue to be encouraged and expanded.

5.3 Recommendations for Greater Effectiveness in Contributing to the Competitiveness of U.S. Industry

There appear to be two major approaches to increasing the contributions of BES research to the health of U.S. industry. One is to ensure that much OBES-supported research is in the general areas that underpin potentially useful technology relevant to the DOE mission. The other is to increase the effectiveness of knowledge transfer.

One of the greatest contributions that OBES-supported laboratories can make to the nation is to develop new science in areas that will lead to new generations of technology. (A prime example might be the work on semiconductors at Bell Laboratories that led to the transistor which in turn brought about a revolution in communications and information systems.) It is entirely appropriate that the evaluation of research proposals in OBES include asking the questions: "Suppose that the science all comes out exactly as you hope. Then what might be the eventual benefits to our missions? Not necessarily at the conclusion of this particular project, but after whatever further stages one might envision." In order to answer this question authoritatively, it is necessary that the proposer have a reasonable perspective on the technology related to his/her science. In order to help BES scientists gain such perspective, we recommend that:

- OBES-supported scientists be encouraged to work for periods of time in industrial laboratories or in relevant DOE technology programs.

- Collaborations with industrial visitors and with scientists in DOE mission-oriented programs be strongly encouraged.

- All BES advisory panels contain significant representation from industry. Technology-oriented scientists and engineers can be especially helpful in providing perspectives on industrial and energy-related needs.

- OBES evaluate funding mechanisms in which OBES funds are used to leverage funds provided by industry for support of long-range precompetitive basic research that will lay the foundations for new technological developments.

Perhaps the most effective way to facilitate effective transfer of new knowledge to industry and DOE applications divisions is to cultivate an atmosphere in which scientists are encouraged to consider and stimulate applications of their research findings. The success of MIT and Stanford faculties in finding applications for their science is attested by the growth of the Route 128 and Silicon Valley high tech industries. The research climate in these two universities has enabled them to bring about effective technology transfer without sacrifice of scientific excellence. Creation of a similar intellectual environment in the OBES-supported laboratory programs would be a major step toward effective utilization of their research.

To effect the desired change in research climate, we suggest the following actions:

- Coordination of OBES research programs with those of DOE mission-oriented programs should be encouraged in order to develop consistent research objectives and to start technology transition as soon as promising results are obtained. Co-location where feasible is highly desirable. Similarly, frequent consultation with potential industrial partners is needed at all stages of the research and development process.

- Incentives for BES scientists to participate in the technology transition should be provided. Success in technology transition to potential customers should be a positive factor in personnel evaluation. Patents should be given weight along with scientific publications in this regard. Special awards for successful technology transfer should be created and publicized. Leaves-without-pay should be available for those who wish to become more fully engaged in the transfer process or to join the startup enterprises for a limited time.

- Administrative barriers to patent licensing, collaboration with industry, and scientific consulting should be minimized.

In sum, OBES should work with the national laboratories' managements to define and disseminate a rational program of scientific knowledge and technology transfer that finds a natural resonance in the basic energy sciences environment.

6. INTERACTIONS BETWEEN THE OFFICE OF BASIC ENERGY SCIENCES AND THE NATIONAL LABORATORIES

In order to assess the roles of the program managers at OBES in the management of the Basic Energy Sciences portfolio, BESAC addressed a set of questions to them as well (Appendix 7). The responses to these questions were presented and discussed in depth at the meeting on October 1.

In questions and discussion, BESAC concentrated on the relationship between the OBES program managers and the management of the laboratories, and the manner in which priorities and directions are established. In particular, concern was expressed with the impact of the funding of individual projects by OBES on the ability of the laboratories to plan and implement long range strategies. BESAC was assured that there is constant communication between program managers and the laboratories, and that this allows proper planning and coordination. Major initiatives are reviewed at the laboratory level before being presented to the program managers. There is no formal barrier to the establishment of laboratory programs which span OBES divisional programs such as, for example, Materials Sciences and Chemical Sciences, nor is there any objection to aggregation of small, almost individual, programs into larger FWP's. The laboratory management is expected to coordinate programs within their own laboratories, and to ensure that all programs are consistent with overall laboratory priorities.

OBES chooses areas of interest through a wide variety of different mechanisms, including workshops, topical meetings, contractor meetings, and reviews. The staff members are expected to remain fully conversant with developments in their fields, through attendance at meetings and other means. In addition, the extensive use of temporary staff on rotating detail from the laboratories and universities provides a mechanism for technical renewal and fresh perspective. New program areas are chosen in response to perceived needs and opportunities, and workshops are held to determine the level of interest, the relevance to DOE missions, and the areas in which OBES can play a major role. Within OBES, there is presently a renewed commitment to removal of any artificial barriers to interaction across disciplines and divisions, so that interdisciplinary research efforts may be encouraged.

Another area of BESAC attention was the interaction between OBES and the other Offices within DOE, and the extent to which programs were coordinated with DOE mission needs. It is clear that the interactions with other offices within the Office of Energy Research, while not perfect, are stronger than those with Offices managing the applied programs. While there are formal coordinating committees within the Department, many channels of communication and collaboration at the working levels are not adequate at the present time. The staff of OBES is making a conscious effort at outreach, and is attempting to improve the communication process, with some limited success. Since cooperation with the applied programs offers the most natural route to technology and science knowledge transfer, improved communication and coordination of effort offers a potentially large payoff. Improved integration among DOE programs requires a concerted effort from all sides, and must have the committed support of management at the highest levels of the Department. Often, the interaction works better at the laboratories, through efforts to co-locate the research and the development efforts. Several examples of the benefits of this policy were observed at all four laboratories visited, with ORNL offering an impressive demonstration.

Committee Findings:

1. OBES has a clear commitment to support the highest quality of basic science research appropriate to providing science underpinning to the DOE mission.

2. Communications between OBES and the four laboratories are frequent and effective, both formally and informally. Individual investigators have free and easy access to program managers at OBES headquarters.

3. Micromanagement by OBES is generally not perceived as a problem except in one division where corrective actions have been discussed.

4. OBES recognizes the critical budgetary impact of facilities construction and operation on active research that its programs face.

5. OBES program directors are stretched by their present responsibilities. They agree that larger block grants (FWP's) to programs at the national laboratories will reduce the burdens on individual investigators. The larger FWP's will require more specific goals, objectives, performance targets and measures of performance. Individual investigators must still be judged on a competitive basis.

6. Coordination of OBES technology transfer efforts with applied technology development offices will require continuing encouragement and support at the highest levels (assistant secretary and above) in DOE.

7. BESAC AND THE OFFICE OF PROGRAM ANALYSIS REVIEW

The meeting on October 1 was the first and only formal opportunity for an exchange between the individual investigator program review undertaken by OPA and the broader review by BESAC of the laboratories. In a series of presentations, organized by Walter L. Warnick, OPA, and attended by Dr. Robert Simon, principal deputy director, OER, the methodology and intent of the reviews was outlined, followed by a summary of the results to date. The results of the approximately 10% of the reviews completed showed clearly that the OBES-managed program is of high, even outstanding, quality with no discernible difference in quality between the university and laboratory programs. The results are consistent with a previous statistical sample of 129 of 1200 OBES projects conducted in 1981. While we are confident that the final results will reinforce those obtained to date, we have some reservations about the comprehensive process. First, given the large cost of this review, the need to review all projects can be questioned – a statistical approach should be sufficient to establish general quality control. OBES management mechanisms should deal with individual cases. Second, BESAC is concerned that any review in which individual parts of larger projects are examined out of context (as in, for example, a large multi-disciplinary laboratory project) might not be fair to the investigator or useful as a management tool for assessing individual projects. When used to assess overall quality of a program, or to identify impacts, opportunities or gaps, the statistical aggregate data can be useful. We were assured by Dr. Simon that the results of the OPA reviews would not be used to terminate individual projects, or as a sole basis for evaluation of individual projects.

8. DISCUSSION OF NEUTRON SOURCES PANEL REPORT

The Basic Energy Sciences Advisory Committee, as stated earlier, believes that the report "Neutron Sources and America's Future" is a clear exposition of alternative sources for different types of neutron fluxes, their scientific potential and their applications. The report recommends (1) completion of the design and construction of the Advanced Neutron Source reactor according to the schedule proposed by the project, and (2) a call for proposals for cost-effective design and construction of a 1-MW spallation source. The ANS is the highest priority and funding for the spallation source should not interfere with the ANS project. Thus, the ANS would proceed to completion by the year 2002, earliest, at an estimated cost of $1.5 billion ($1992). The proposed pulsed spallation source is estimated to cost $0.7 billion.

BESAC strongly endorses the report of its Panel on Neutron Sources, and supports the construction of the ANS in order to preserve a U.S. capability in neutron research. We note with satisfaction that the President's Budget for Fiscal Year 1994 includes funding to allow ANS to proceed, and that future projections contained in the accompanying Economic Plan will allow for timely completion of this project. We commend OBES and the Department for their response to this highest priority recommendation in the Panel report, and urge them to pursue funding for the other recommendations in future budget submissions. At the same time, BESAC also wishes to reiterate its consistent recommendation that this project should not be funded at the expense of the research programs of OBES. These programs are a vital component in the national R&D portfolio, and should not be weakened in order to construct facilities. The ANS should be considered, as proposed by the administration, a separate national budget item.

9. GENERAL FINDINGS AND CONCLUSIONS

1. The general quality of basic energy sciences research conducted at each of the four multipurpose laboratories is high. The program is a national achievement, making valuable contributions to American and international science. Its sustained performance requires budgetary attention.

2. Each laboratory has its own style of managing and performing BES programs. There are benefits in maintaining this diversity as long as the primary BES mission and goals are clearly identified and effectively pursued.

3. The principal products currently being transferred by the BES programs to other units of DOE and outside the department are scientific knowledge and the operation of unique facilities to pursue frontier science.

4. In order to maintain the high quality of their scientific personnel, in general, the laboratories need to draw more on external sources of personnel (including increased turnover) and on more external assessments and reviews of individuals and personnel review practices. DOE should encourage this.

5. The two new light sources, ALS and APS, will be world-class facilities. They will come on line well before large parts of their beamline instrumentation can be funded, developed and installed. Time lines for achieving satisfactory research output will be extended accordingly.

6. The facilities currently in operation are well managed and generally have large and satisfied user communities. Users are identified, provided with feedback loops, and find their operational needs and concerns well-tended.

7. Funding for user instrumentation at facilities is becoming more difficult to assemble.

8. Incremental underfunding of both facilities operations and basic research programs is beginning to adversely affect programs at all laboratories.

9. The burden of unfunded compliance with new EH&S and other regulations is a major contributor to research underfunding.

10. The Office of Basic Energy Science runs an effective program and maintains good communication and coordination with the four ER laboratories. Its managers are operating large programs with a minimum of personnel. Its major role in

technology transfer is to ensure that much of the OBES supported research is in the general areas that underpin potentially useful technology relevant to the DOE mission.

11. The prolonged interval without permanent leadership has been detrimental to the effectiveness of OBES programs. Appointment of a permanent director and deputy for OBES would enhance OBES effectiveness in budget planning and intra-DOE program coordination and collaboration. With the recent resignation of the Acting Director of OBES, it is now critical that an effective, permanent management team be promptly installed.

12. Technology transfer has become a significant part of the laboratory culture at the management level. It has not penetrated as widely at the working scientist level and continuing efforts to make the general scientific laboratory community aware of the mission, goals and potential "customers" of BES research are required.

13. Some DOE laboratories (including some of the DP laboratories) have, by virtue of their traditional missions, developed substantial infrastructure and capabilities which match well into industry needs at the development-applications interface. These capabilities and their associated industry relationships could be utilized in partnership with the OBES programs in the ER labs to involve them in the technology transfer process more efficiently. The partnership between LBL and Sandia-Livermore in the area of combustion science and technology is an example. We encourage formation of inter-laboratory partnerships to both reduce duplication and to bring more elements of the DOE research-development-application spectrum to bear upon interactions with the industrial sector. We perceive a clear opportunity for OBES and OER to take a leadership role.

10. BESAC RECOMMENDATIONS

1. The Office of Energy Research should continue to make every effort to maintain funding for basic science research programs at FY1993 levels augmented annually to take into account the real inflation factors that science research faces. These programs are essential to the energy and technology future of the nation.

2. Future BESAC activities should monitor closely the updating of strategic and long-range OBES plans to ensure that the balance between basic research and facilities construction and operation is maintained.

3. BESAC is pleased that extra funding has been proposed to initiate construction of the Advanced Neutron Source, and strongly supports construction of this facility. We reiterate, however, our recommendation that this should not be done at the expense of the research programs.

4. OBES should plan and operate current and new facilities on a more optimal schedule providing new and upgraded instrumentation in a timely way, where budget feasibility exists.

5. Large new facility starts should be undertaken only when commitments to adequate new funding have been obtained. There are extensive "mortgages" on future facilities budgets for current construction that will not be relieved for the next five years. BESAC endorses the scientific merits of APS Phase II and CDI Phase I, when adequate funding is available to initiate these projects. Construction and operation of large scientific facilities for DOE and the nation are a unique contribution of OBES.

6. The Department of Energy should make greater efforts at its highest internal levels to facilitate coordination and collaboration between OBES programs and the applied programs (Nuclear Energy, Energy Efficiency, Fossil Energy, Environmental Restoration and Waste Management) in order to achieve more effective transfer of OBES scientific knowledge and technology.

7. The Department, OER, and OBES and the national laboratories should develop more visible and attractive reward systems for effective contributions to technology transfer at the levels of individual investigators, divisions and laboratories. University investigators supported by OBES should be included in these efforts. Technology transfer will be most effective if the levels of quality and productivity of scientific knowledge are maintained.

8. BESAC supports the SEAB Task Force on Energy Priorities report that calls for well-defined missions for each laboratory. This will require an extensive examination of the role and distribution of OBES support. In the meantime OBES and the national laboratories should work together to decrease the number, increase the size and more closely align FWP's with BES program mission and goals. This would optimize proposal writing and management decision efforts.

Department of Energy
Washington, DC 20585

APR 22 1992

Professor Leon Silver
California Institute of Technology
Mail Stop 170-25
1201 E. California Blvd.
Pasadena, California 91125

Dear Professor Silver:

I appreciate your continued willingness to assist the Department by participating in and chairing the Basic Energy Sciences Advisory Committee (BESAC) for the coming year. I want to outline for you and the Committee the charge for this year's activities. Please be assured that BESAC guidance on priorities and program balance for the Office of Basic Energy Sciences (BES) has been valuable in determining program directions.

The Office of Basic Energy Sciences supports about $800 million annually in fundamental science and engineering research and facilities operations, design, and construction. Projections for the budget of the Office through fiscal year 1996 are likely to be flat in current-year dollars. The flat growth projections and legislative budgetary caps make the difficult task of evaluating BES priorities particularly challenging. As BESAC reviews the programs of BES and advises on priorities, the development of an integrated approach to assessing the relevant merits of various BES research activities will help lay a foundation for determining relative importance to DOE missions in the future.

For the next year, I ask that BESAC develop specific recommendations on the following two issues:

1) The quality and impact of BES programs and projects at the national laboratories are of vital importance to the Department. The processes of choosing the avenues of science to support, selecting the proposals to fund, monitoring the progress of the research, and determining the merits of the achievements need to be performed as effectively as possible. The methods currently employed have produced high-quality results.

   In this time of budget austerity, however, it would be advantageous for BESAC to formally review BES program portfolios on-site at each of the major BES-supported national laboratories and point out strengths and weaknesses. These program assessments will necessarily require a multi-year effort, and I would like BESAC to begin with two or three on-site reviews of national laboratories in the coming year. The focus of the reviews should be on evaluating the total program quality, impact, and potential value to applied research efforts. The major result will be an independent assessment of how well BES programs at the national laboratories are underpinning the Department's long range technical goals.

The request for BESAC to conduct a programmatic review of BES-supported national laboratory programs is part of a two-part assessment which is being undertaken to externally review the BES program over the next three-year period. The other part is being conducted simultaneously and consists of a technical project-by-project assessment. The process of independently reviewing the majority of the over 1,300 ongoing projects within BES is being done by the Office of Program Analysis. The Committee will be briefed on this parallel endeavor at its first meeting so that your review can be conducted in a truly complementary manner.

In keeping with the recently launched National Technology Initiative, which is designed to introduce U.S. industry to the opportunities for technology transfer which exist in our national laboratories, I would also like you to put together one or two all-industry panels to specifically look into the benefits of the BES program to industry. The industrial perspective on programmatic thrusts and balance will provide me with a benchmark on how well BES is investing its resources. This all-industry assessment should complement the main emphasis of BESAC's review.

2) The Secretary of Energy Advisory Board (SEAB) Task Force on Energy Research Priorities identified the Advanced Neutron Source (ANS) as a much-needed facility for the Nation. The Task Force recommended examining the optimal timing for the construction of the facility under budgetary constraints. BESAC should follow up on this task by developing long-term priorities among ongoing base programs vis-a-vis the construction of the ANS. I would also appreciate an updated view of the proposed Chemical Dynamics Research Laboratory. I would appreciate your review of the importance and need for the ANS and CDRL relative to already approved projects and base research programs assuming budget scenarios where BES is restricted to: 1) flat current dollars, 2) flat constant dollars, or 3) a real growth rate of about 6.5 percent.

The Committee should develop one or more reports embodying its recommendations. A preliminary letter report by August 15 would be helpful in the development of the fiscal year 1994 budget.

I realize that this is a very challenging task, especially for the new members. Again, I want to express my appreciation for your efforts which are crucial to shaping the future program in BES.

Sincerely,

William Happer

William Happer
Director
Office of Energy Research

Department of Energy
Washington, DC 20585
JUN 01 1992

Professor Leon Silver
California Institute of
Technology, MS 170-25
1201 E. California Boulevard
Pasadena, California 91125

Dear Professor Silver:

Since my Basic Energy Sciences Advisory Committee (BESAC) charge letter to you of April 22, 1992, a Department of Energy (DOE) concern has arisen with regard to neutron sources that I wish BESAC to address. We are designing a new high flux research reactor, the Advanced Neutron Source, to eventually replace our two aging research reactors. In the meantime, progress is being made on the production of neutrons using accelerator-based systems and in the use of these higher energy neutrons and their time structure. It would be useful to the Department at this time to review the strengths and weaknesses of the two methods for producing neutrons and how and where they complement or duplicate one another. I ask that you please put together an expert, balanced panel to provide a report to me by the end of September 1992, addressing the following:

1. Review the strengths and weaknesses of reactor and spallation sources of neutrons for:

   - production of isotopes;
   - neutron scattering;
   - neutron irradiation effects; and
   - other neutron research.

   Where do they complement or duplicate each other?

2. Taking into consideration their strengths, weaknesses, cost, readiness, and other appropriate factors, discuss the design goals for:

   - a reactor only;
   - a spallation neutron source only; and
   - a combination of the two.

   Recognizing the design for a new reactor is underway and that similar data does not exist for a spallation neutron source, please extrapolate from existing facilities or studies.

3. From the available information, discuss the proper timing for:

   - a reactor only;
   - a spallation neutron source only; and
   - a combination of the two.

4. Discuss the major uncertainties in the analysis where additional information would permit more definitive conclusions.

In view of the very challenging task we have placed on BESAC this year and this additional study, let me try to give you our priorities to assist you in carrying out the charge. The main task you should concentrate on in addition to the above study is the review of Basic Energy Sciences (BES) activities at the major laboratories. We have started a project-by-project review of the BES program using the Office of Program Analysis (OPA). Your review should cover the laboratory BES programs in areas which OPA will not review. These areas which BESAC should especially review include: the management and directions of the research, the operation of the user facilities, and the relevance of the research to DOE and the National Energy Strategy. My original charge letter also asked that you provide me with your recommendations on the Advanced Neutron Source and Chemical Dynamics Research Laboratory, within certain budget constraints. The third task in my charge letter of April 22, 1992, asked for an all-industry panel to review the research thrusts in the laboratory programs. Realizing your limited time and also the fact that several members of BESAC are from industry and other members have significant experience and background with industrial technologies, emerging and mature, I suggest that you address this latter task within your committee as a whole during your reviews and not set up a special panel.

I appreciate your willingness to take on this important review of BES. Please let me know if I can provide further guidance.

Sincerely,

William Happer

William Happer
Director
Office of Energy Research

Appendix 3. Executive Summary, "Neutron Sources for America's Future"

1 Executive Summary

Neutrons are a unique and increasingly essential tool in broad areas of the physical, chemical, and biological sciences, as well as in materials technology and nuclear medicine. Over the past decade, neutron probes have made invaluable contributions to the understanding and development of many classes of new materials ranging from high-T_c superconductors to fullerenes. The most rapidly developing area is the use of cold neutrons in the science of polymers and complex fluids — materials with enormous industrial importance and applications. The many awards given in recent years for achievements in neutron scattering research attest to the growing importance of neutrons in U.S. science and technology. Isotopes produced by neutron capture are widely used by U.S. industry. Medical uses of such isotopes for diagnosis and therapy exceed 10 million applications per year. A recent notable example has been successful cancer therapy by using ^{252}Cf. Other essential uses of neutrons for technological purposes include radiation damage studies for fission and fusion reactors, depth profiling of near-surface impurities, and residual stress measurements in metals and ceramics, as well as composite materials.

Over the last 20 years, the United States has fallen alarmingly behind the European scientific community in the availability of up-to-date neutron sources and instrumentation. The major research reactors of the U.S. Department of Energy (DOE), HFBR and HFIR, were built more than 25 years ago and have an uncertain remaining lifetime of a decade or so, with an especially precarious status for HFIR. The earliest completion date of new sources is about 2000. A rapid decision and funding process is essential to assure that the nation retains a world-class position in the above-mentioned areas, which are of great importance to its economic strength and to its people's health. The new neutron sources recommended below will require about $2.2 billion in construction funds (1992 dollars) over a period of approximately 10 years. Construction will provide substantial new employment opportunities, with many in high-technology areas. These sources will serve the country for about 30 years after completion. Operating costs will be substantially offset by the closure of existing facilities. The new sources will be of great value to the missions of a number of DOE organizations in addition to Basic Energy Sciences — the Office of Nuclear Energy, the Office of Fusion Energy, the Office of Health and Environmental Research, and the Office of Defense Programs. Furthermore, advanced neutron sources are also increasingly important to the Department of Commerce and the Department of Defense, as well as to the National Institutes of Health.

The Panel that prepared this report had substantial representation from universities, industry, and government laboratories and included both neutron specialists and generalists. All four DOE laboratories with interests in constructing future sources were represented by nonvoting members. The Panel visited and heard presentations at each of these laboratories. It sponsored a Review of Neutron Sources and Applications, with the participation of 70 national and international experts. The Proceedings are a companion to this report. The Panel had three meetings in addition to the laboratory visits and also participated in the Review.

At its first meeting on July 31, 1992, the Panel discussed the written charge of June 1, 1992 (see below) with Dr. Will Happer, Director, Office of Energy Research. Dr. Happer made clear that he would also like an assessment of the importance of neutrons for the nation's science, technology, health, and economy, as well as recommendations for both short-term and long-term funding and construction strategies. These assessments and recommendations are presented in our report.

After reviewing different alternatives for capability and cost-effectiveness, the Panel concluded that the nation has a critical need for a complementary pair of sources: a new reactor, the Advanced Neutron Source (ANS), which will be the world's leading neutron source; and a 1-MW pulsed spallation source (PSS), more powerful than any existing PSS and providing crucial additional capabilities, particularly at higher neutron energies. The ANS is the Panel's highest priority for rapid construction. In the Panel's view, any plan that does not include a new, full-performance, high-flux reactor is unsatisfactory because of a number of essential functions that can be best or only performed by such a reactor.

Recommendation 1: Complete the design and construction of the ANS according to the schedule proposed by the project.

Recommendation 2: Immediately authorize the development of competitive proposals for the cost effective design and construction of a 1-MW pulsed spallation source. Evaluation of these proposals should be done as soon as possible, leading to a construction timetable that does not interfere with rapid completion of the ANS.

These new sources must be firmly dedicated to neutron science and technology as their principal mission. Predictability and reliability are of the essence.

It is important to recognize that most of the modern applications of neutrons are intensity limited, and thus place a premium value on the neutron fluxes available. Consequently, most fundamental breakthroughs in both scientific and technological applications of neutron sources over the last 40 years have been directly associated with increases in the intensity and quality of the available neutron fluxes.

The ANS is at a highly advanced stage of design, with a fully developed Conceptual Design Report, so that its construction cost estimate of $1,500 million (FY1992) can be regarded as reliable if the proposed schedule is followed. Different concepts for a 1-MW pulsed spallation source are at a preliminary state of design by three DOE laboratories — Argonne National Laboratory , Brookhaven National Laboratory, and Los Alamos National Laboratory — and will require modest extrapolation of existing technologies. A preliminary cost estimate by two laboratories of approximately $500 million (FY1992) for construction (if some existing facilities are used) was considered reasonable by the Spallation Sources Group of the Neutron Review. However, on the basis of recent cost escalations beyond such preliminary estimates for other major facility construction, the Panel believes that this cost will increase considerably with more refined estimates. Each of the interested laboratories should be given the opportunity to develop a proposal of sufficient detail to allow for meaningful comparisons in choosing a design and site.

Input from the neutron community should be sought and given great weight by DOE. All cost estimates could be affected by unanticipated changes in regulation.

The recommended pair of sources would complement European facilities, which consist of a less powerful reactor in France, at the Institut Laue-Langevin (ILL), and a more powerful (5-MW) European Spallation Source in the planning stages.

The recommended construction program requires special appropriation and should not be carried out at the expense of individual investigators. While neutron sources for research are by their nature large facilities, they are used primarily to conduct thousands of small science experiments each year.

Recommendation 3: Enhance operation and instrumentation of existing sources.

These enhancements are highly cost-effective and clearly needed to prevent further erosion over the next decade and to prepare for the new sources. Detailed recommendations involving additional operating budgets of approximately $4 million and instrumentation of about $25 million are presented. The new instrumentation will be transferred to the ANS and PSS.

Recommendation 4: Devise a strategy for sustained R&D of neutron instrumentation.

The effectiveness of neutron sources is critically dependent on appropriately up-to-date instrumentation. As a model in this area, the United States should use the outstanding example of the ILL reactor in France, which is supported by smaller European "feeder" sources.

Recommendation 5: Effective management by DOE of the proposed facilities is essential.

In the opinion of the Panel, the present highly complex DOE management structure and regulatory process lead to substantial avoidable costs and delays, especially for reactors. In the Panel's view, appropriate steps to improve management and regulatory procedures will lead to major cost savings and increased effectiveness in both construction and operation without sacrifice of safety.

In summary, failure to move ahead quickly with construction of the ANS and development of a complementary 1-MW PSS would have serious, long-lasting consequences for the nation's competitiveness in cutting-edge science, technology, industry, and medicine. The construction of these facilities represents a cost-effective and productive investment in the nation's future.

Charges to the BESAC Neutron Panel

From the letter by W. Happer to L. Silver, 6/1/92 (Appendix 1):

1. Review the strengths and weaknesses of reactor and spallation sources of neutrons for:

   - Production of isotopes,
   - Neutron scattering,
   - Neutron irradiation effects, and
   - Other neutron research.

   Where do they complement or duplicate each other?

2. Taking into consideration their strengths, weaknesses, cost, readiness, and other appropriate factors, discuss the design goals for:

   - A reactor only,
   - A spallation neutron source only, and
   - A combination of the two.

   Recognizing that the design for a new reactor is underway and that similar data do not exist for a spallation neutron source, extrapolate from existing facilities or studies.

3. From the available information, discuss the proper timing for:

   - A reactor only,
   - A spallation neutron source only, and
   - A combination of the two.

4. Discuss the major uncertainties in the analysis where additional information would permit more definitive conclusions.

Expansion of charge to the Panel (meeting with Dr. W. Happer, 7/31/92):

1. Assess the importance of neutrons for the nation's science, technology, health, and economy.
2. Develop recommendations for both short-term and long-term strategies for DOE neutron sources.

Appendix 4. BESAC list of preliminary questions sent to each laboratory

PROPOSED QUESTIONS THAT BESAC WANTS TO HAVE ANSWERED FOR NATIONAL LABORATORY VISITS

Management

How does the Laboratory define, focus, implement and evaluate its integrated OBES programs?

How does the laboratory manage the OBES component of its effort to ensure responsiveness to changing DOE and national needs?

How does the Laboratory manage personnel to ensure quality, flexibility, responsiveness, and achievement of overall DOE goals?

How do the programs differ from those carried out at universities, and why are they best done at the laboratories?

How is effort reprogrammed to respond to changing DOE and national needs?

How important is the OBES component of the total Laboratory effort, and how is that reflected in laboratory planning and priorities?

How does the laboratory assure interaction between OBES supported research and the technology programs? university researchers? industrial researchers?

How does the laboratory interact with the OBES program managers? Is the interaction all one way? Does the laboratory define an area in which it wishes to be a center of excellence? Should it?

Does the laboratory have a long range plan? How does OBES activity appear in it?

User Facilities

How important to the laboratory and to the OBES supported research are user facilities?

How well are the facilities managed? Who do they serve? How productive are they? What is the availability? Are they unique and national in scope?

Do they support research that is relevant to the DOE mission?

Do they support proprietary research? If so, are the procedures in place adequate to the needs?

Are the facilities central to the research programs of the laboratory? Do the laboratory staff ensure that the facilities remain "state-of-the-art"?

Do the facilities support interaction between industrial, university and government researchers?

Do the facilities support other than DOE mission needs (e.g. NSF, NIH, DOD)? Are they enabling for whole classes of research?

Impact on DOE Technology Programs

To what extent are basic research programs chosen to support DOE technology needs?

To what extent are research directions dictated by OBES program managers? Is this good or bad?

Is there any planning process which involves direct interaction between OBES supported researchers or managers and the technology programs?

How tightly should the research programs be coupled to technlogy programs?

Impact on U.S. Industry

Do, or should, the national laboratories contribute potentially useful technology in a different fashion from that of universities?

How can the national laboratories focus either basic or applied research in areas that might contribute to the competitiveness of American industry?

How can scientists and managers in the national laboratories and in private companies communicate to define mutually productive research programs?

Are there procedural actions that DOE and industrial firms can take to facilitate the use of technology or information developed in the national labs?

Is there any formal outreach program to encourage greater interaction with industrial concerns?

Are industrial users welcomed i.e. is the laboratory "user friendly" for industrial researchers?

Is "technology transfer" activity on the part of the staff rewarded? If so, how?

Is there a culture that encourages entrepreneurs, such as exists at MIT? If not, what can be done to encourage such an attitude?

Are industrial representatives included on review panels?

Appendix 5. Schedule and agendas of BESAC meetings

Schedule of 1992 BESAC Meetings

May 18-19, 1992	Brookhaven National Laboratory
August 3, 1992	Oak Ridge National Laboratory
August 6-7, 1992	Lawrence Berkeley Laboratory
August 10-11, 1992	Argonne National Laboratory
October 1, 1992	DOE, Washington, D.C.

AGENDA
Basic Energy Sciences Advisory Committee Meeting
Brookhaven National Laboratory, Upton, New York 11973
Chemistry Building 555, Room 300
May 18-19, 1992

Monday, May 18

8:30 a.m.	Shuttle (Strathmore Hotel to BNL)	
9:00 a.m.	Discussion of Charge	L. Silver
9:30 a.m.	Status of BES Program	L. Ianniello
10:30 a.m.	Break	
11:00 a.m.	BNL Overview	M. Blume/J. Axe
12:00 Noon	Lunch (Meeting with NSLS Users Committee Chairman)	
1:00 p.m.	Chemical Sciences	J. Muckerman/Staff
3:00 p.m.	Facility Visit, NSLS	D. McWhan/Staff
5:00 p.m.	Conclude	
5:30 p.m.	Cocktails - Lobby, Berkner Hall	
6:30 p.m.	Dinner - Berkner Hall	
8:00 p.m.	Shuttle (BNL to Strathmore Hotel) in front of Berkner Hall	

Tuesday, May 19

7:30 a.m.	Shuttle (Strathmore Hotel to BNL)	
8:00 a.m.	Breakfast at Berkner Hall with NSLS User Group	
8:30 a.m.	Discussion of BESAC Activities	
9:00 a.m.	Materials Sciences Energy Biosciences Advanced Energy Projects Engineering & Geosciences Applied Mathematical Sciences Technology Transfer Program	M. Strongin W. Studier M. Blume M. Manowitz R. Peierls M. Bogosian
12:00 Noon	Lunch	
1:00 p.m.	Facility Visit, HFBR	J. Axe/M. Brooks Staff/Users
3:00 p.m.	BESAC Discussion	L. Silver
4:30 p.m.	Conclude	

Note: The Annual Users Meeting of the NSLS will be held on Monday, Tuesday, and Wednesday. Technical Workshops will take place Monday, with formal sessions in Berkner Hall Tuesday and Wednesday. A detailed agenda for this meeting will be sent separately from the information of BESAC.

AGENDA
Basic Energy Sciences Advisory Committee
ORNL Cafeteria Conference Room
August 3-4, 1992

Monday, August 3, 1992

Session I: Managing, Planning, and Evoluting Programs

8:00-8:30	Travel from Garden Plaza. Check-in	
8:30-9:30	BESAC Panel meeting. Breakfast provided	
9:30-9:50	Welcome and overview of ORNL	Al Trivelpiece ORNL Director
9:50-10:30	Overview of BES Programs at ORNL	Bill Appleton ORNL Assoc. Lab. Dir., PSAM
10:30-11:00	Break	
11:00-12:00	Management, Planning, and Evolution of BES Programs at ORNL	Bill Appleton
12:00-12:30	Questions from BESAC for BES Managers at ORNL	
12:30-1:30	Lunch	BES Panel, Guests, and ORNL Division/Program Directors

"Integration of Technology Transfer Within Energy Systems"
William Carpenter, Vice President, Technology Transfer

Session II: External Interactions, and Impact of DOE Programs

1:30-2:15	Managing External Interactions	Lou Dunlap, Dir. ORNL Off. of Guest User Interactions
2:15-2:45	Overview of BES User Facilities	Dave Zehner, Section Head, SSD
2:45-3:45	Tour of Surface Modification & Characterization (SMAC) User Facility	Dave Zehner, Dave Poker, Director, SMAC
3:45-4:30	BES Impact on DOE Technology Programs and Industry	Linda Horton BES Prog. Mgr., M&C Division
4:30-5:00	Toughened Ceramics - from Basic Science to Industry: A Case Study	Doug Craig, Dir., M&C Division
5:00	Leave for Garden Plaza	
6:30	Board buses at Garden Plaza for The Orangery	
7:00	Dinner - The Orangery	BESAC Panel ORNL Div./Prog. Mgrs.

Tuesday, August 4, 1992

Session III: New Program Initiation and Evolution

8:00-8:30	Travel from Garden Plaza Continental breakfast at ORNL	
8:30-9:15	ORNL Center for Computational Sciences	Bob Ward Dir., EP&M
9:15-9:45	BES/DMS 2% Initiatives: Atomistic Mechanisms in Interface Science	Steve Pennycook Group Leader, SSD
9:45-10:15	The Aqueous Chemistry - Geoscience Interface	Marv Poutsma Div., Chem. Div.
10:15-10:45	Break	
10:45-11:15	Evolution of Mass Spectrometry at ORNL	Scott McLuckey Section Head, ACD
11:15-11:45	Robotics and Manufacturing	Reinhold Mann Section Head, EP&M
11:45-1:00	Lunch	BES Panel, Guests, & ORNL Div./Prog. Mgrs.

Session IV: Managing Major Projects

1:00-1:30	Project Management: The Advanced Neutron Source (ANS)	Colin West Dir., ANS Project
1:30-2:00	Research Opportunities with Neutrons	John Hayter Scientific Director, ANS Project
2:00-2:30	Neutron Scattering User Program	Ralph Moon Section Head, SSD
2:30-3:00	Break	
3:00-4:00	Wrap-up Session	AWT, BRA, & BESAC Panel
4:00-4:30	Managing a Major Nuclear Facility: High Flux Isotope Reactor (HFIR)	Jack Richard Dir., Reactor Opers.
4:30-6:00	Tour of HFIR for BESAC	
6:30	Board buses for Calhoun's at the Marina	
7:00	Dinner - Calhoun's at the Marina	BESAC Panel, ORNL Div./Prog. Mgrs.

Wednesday, August 5, 1992

Session V: BESAC Executive Session

8:00-8:30	Travel from Garden Plaza Executive Conference Room, 4500-N, I-208C Continental Breakfast	
8:30-12:00	Wrap-up Session (ORNL management present upon BESAC request)	BESAC Panel
12:00-1:00	Lunch	BESAC Panel
1:00	Adjourn	

AGENDA
BASIC ENERGY SCIENCES ADVISORY COMMITTEE
LAWRENCE BERKELEY LABORATORY
BUILDING 2/100
AUGUST 6-8, 1992

Thursday, August 6

8:00 a.m.	Bus leaves Claremont Hotel for LBL	
8:30-9:00	Committee Business	L. Silver
9:00-9:30	BES Program Update	L. Ianniello
9:30-10:00	LBL Overview and BESAC Questions	C. V. Shank
10:30-10:45	Break	

Materials Sciences Program

10:45-11:30	Overview	D. Chemla
11:30-12:00	Center for Advanced Materials	R. Ritchie
12:00-12:30	Center for X-ray Optics	J. Underwood
12:30-1:30	Lunch	

BES Facilities

Advanced Light Source

1:30-2:00	Overview	B. Kincaid
2:00-2:45	Scientific and User Programs	P. Ross
2:45-3:30	Tour	
3:30-4:00	Shuttle to NCEM	

National Center for Electron Microscopy

4:00-4:45	Scientific/User Program/Upgrade	U. Dahmen
4:45-5:30	Meeting with ALS and NCEM User Representatives	Committee Members
5:30-6:30	Reception/Poster Session with Students (LBL Cafeteria)	
7:30	Dinner for BESAC members (C.V. Shank Residence)	

Friday, August 7

8:30	Shuttle Bus to LBL	

Chemical Sciences Program

9:00-9:45	Overview	C. Harris
9:45-10:15	Combustion Chemistry	N. Brown
10:15-10:30	Break	

Applied Mathematical Sciences

10:35-11:00	Mathematics	A. Chorin
11:00-11:30	Computing	W. Johnston

11:30-12:00	Technology Transfer	C. Fragiadakis
12:00-1:00	Lunch	
1:00-1:45	Energy Biosciences	S.H. Kim
1:45-2:30	Engineering & Geosciences	H. Wollenberg
2:30-3:00	Advanced Energy Projects	R. Gough
3:00-5:30	BESAC Discussion (including closeout session)	L. Silver
9:00-12:00	Informal Session at the Claremont Hotel	Review Committee

BESAC REVIEW OF ANL BES PROGRAMS
AUGUST 10-11, 1992
BUILDING 201, ROOM 275

AGENDA

Monday, August 10

8:00 a.m.	Bus departs Holiday Inn for Argonne	
8:30 a.m.	BESAC Committee Business	
9:00 a.m.	F.Y. Fradin Associate Laboratory Director for Physical Research	Overview of ANL Lab Organization ANL Strategic Plan LDRD Process BOG/STAC/UC Review Committees Professional Staff Organization of Physical Research Responsiveness to DOE (Pres. Initiatives, Cold Fusion, Waste Management, Tech Transfer) Response to BESAC questions
10:00 a.m.	Break	
10:15 a.m.	B.D. Dunlap Director, Materials Science Division	Materials Science (including BESSRC initiative, AMP initiative, EMC operation)
11:45 a.m.	R.L. Stevens Director, Mathematics and Computer Science Division	Applied Mathematics and Computer Sciences (including HPC-RC initiative)
12:45 p.m.	Lunch	
1:45 p.m.	L.M. Stock Director, Chemistry Division	Chemical Sciences/Adv. Energy Projects (including programs in CMT)
3:15 p.m.	W.F. Henning Director, Physics Division	Atomic Physics (including Synchrotron Science initiative)
3:45 p.m.	Break	

4:00 p.m.	N. Sturchio Program Manager, BES Geosciences	Geosciences (inlcuding Synchrotron Science initiative)
4:30 p.m.	S. Borys Director, Technology Transfer Office	Technology Transfer
5:00 p.m.	BESAC Executive Session	
5:30 p.m.	Cocktails, Freund Lodge	
6:30 p.m.	Dinner, Freund Lodge	

Note: Responses to BESAC questions will be made from a Laboratory perspective and from a program specific and facility specific perspective in the individual presentations.

Tuesday, August 11

8:30 a.m.	BESAC Committee Business	
9:00 a.m.	B.S. Brown Director, IPNS	Intense Pulsed Neutron Source (including IPNS upgrades)
10:30 a.m.	D.E. Moncton Associate Laboratory Director for APS	Advanced Photon Source
12:00	Lunch with Steve Durbin, Chair of APS User Committee	
1:00 p.m.	Executive Session with F.Y. Fradin and D.E. Moncton	
1:30 p.m.	Tours of APS and IPNS	
3:30 p.m.	BESAC Business Session	
5:00 p.m.	Conclude	

Wednesday, August 12

9:00-12:00	BESAC Informal Session

AGENDA
BASIC ENERGY SCIENCES ADVISORY COMMITTEE MEETING
OCTOBER 1, 1992
THE SHERATON POTOMAC INN
I-270 & SHADY GROVE ROAD
ROCKVILLE, MD

TIME	TOPIC
8:30 A.M.	DISCUSSION OF BESAC REPORT (SILVER AND ROWE)
9:00 A.M.	DISCUSSION OF BES PROGRAM MANGEMENT
11:00 A.M.	DISCUSSION OF BESAC QUESTIONS/ANSWERS FROM BROOKHAVEN (SAMIOS/BLUME/AXE)
12:00	LUNCH
1:00 P.M.	CONTINUATION OF BNL DISCUSSION
2:00 P.M.	DISCUSSION OF OFFICE OF PROGRAM ANALYSIS (OPA) REVIEW OF BES (IANNIELLO/OPA STAFF)
3:00 P.M.	CONTINUATION OF DISCUSSION OF BES PROGRAM MANAGEMENT
5:00 P.M.	ADJOURN

CALIFORNIA INSTITUTE OF TECHNOLOGY

DIVISION OF GEOLOGICAL AND PLANETARY SCIENCES 170-25

August 17, 1992

Dr. William Happer, Director
Office of Energy Research
Department of Energy
Washington, DC 20585

Dear Dr. Happer:

In accordance with your charge letters of April 22 and June 1, 1992, the Basic Energy Sciences Advisory Committee (BESAC) has been reviewing the Basic Energy Sciences (BES) activities at the four national laboratories which perform the largest portions of the BES research activities. We visited Brookhaven National Laboratory, May 18-19; Oak Ridge National Laboratory, August 4-5; Lawrence Berkeley Laboratory, August 7-8; and the Argonne National Laboratory, August 11-12.

The presentations by the laboratories generally were organized in response to an extensive set of questions submitted by the Committee to the laboratory managements. The questions dealt with the role of BES programs in the laboratory missions, the management of the programs in terms of relevance to DOE missions, quality of science, personnel matters, operation and upgrade of facilities, user programs, and transfer of knowledge and technology.

A BESAC subcommittee including members with industrial backgrounds under Dr. George Parshall, DuPont Corporation, considered the research thrusts from the perspective of transfer of knowledge to the Department and to industry. Their evaluation will be presented to the entire committee for incorporation in our final report.

Our visit to Brookhaven, which we believe was quite successful, was nevertheless an initial effort and it was conducted somewhat differently from the other visits. We will meet further with the BNL leadership to ensure comparable presentations, when we visit Germantown in early October.

The next phase of our discussions will be a one day meeting with OBES program managers organized by Dr. Lou Ianniello in response to another series of questions which the committee has submitted to him. This meeting stems from the committee's need to understand program managers' roles in program direction, definition of mission relevance, and approach to technology transfer.

At present, the committee is assessing the information gained in our laboratory visits, and will complete its report following the October visit.

Pasadena, California 91125 Telephone (818) 356-6490

Ti:sapphire lasers in the 3-10 μ spectral region. The CDRL would become a two phase program - Phase I being essentially the original CDRL proposal with the IRFEL replaced by Ti:sapphire lasers, and Phase II being the construction of a more advanced superconducting IRFEL. The design is such that the CDRL could effectively serve combustion needs at the completion of Phase I, while still allowing a Phase II addition of a superconducting IRFEL. The broader spectrum of capabilities associated with the superconducting IRFEL were presented to BESAC.

After extensive discussion, BESAC makes the following recommendations which are in priority order, and in accord with the 1991 BESAC report:

- Complete construction of the Combustion Research Facility, Phase II.
- Initiate construction of CDRL, Phase I and initiate ACME.

We also recommend a significant increase in user industrial relations for CDRL, and the establishment of an Industrial Advisory Board to ensure the most effective implementation and utilization of the CDRL. There should be a further review to establish the benefits of the IRFEL to DOE programs prior to commitment to the second phase of the CDRL.

Finally, as a result of our reviews of facilities operations at the four laboratories, we have concluded that several of the major user facilities face serious loss of operating efficiency as a result of inadequate operating budgets. It is a well known phenomenon that reduced operating time which arises from small shortfalls in operating budgets leads to a disproportionate loss in overall return in investment in these facilities. We have determined that the existing facilities are a major success of the BES programs, and urge you to ensure that they are properly exploited by supplying the small increments in funding required for proper operations. However, we recognize that the base research programs also suffer from inefficiencies resulting from inadequate operating budgets. This recommendation, therefore, should not be implemented by removing funding from these base programs. In effect, we ask that you consider an increase in funding in both of these areas.

Sincerely,

Leon T. Silver

Leon T. Silver
Chairman, Basic Energy
Sciences Advisory Committee

LTS:kle

Attachment

Division of Geological and Planetary Sciences
Pasadena, California 91125 Telephone (818) 356-6490

A major element of your charge to BESAC concerned the formation of an expert panel to evaluate the strengths and weaknesses of alternative reactor and spallation based neutron sources for future Departmental and national research. With special efforts by BESAC vice chairman Dr. J. Michael Rowe, a strong panel chaired by Professor Walter Kohn (UCSB) has been organized (see attached membership list). It has met to receive your charge on July 31, 1992, and has initiated a series of laboratory site visits starting with BNL (July 30, 1992). A major workshop on neutron sources and science will be held near Chicago, Illinois, the week of September 8, 1992, followed by a panel meeting.

As stated above, in response to your request we have appointed an expert committee to investigate alternative neutron sources. In addition, the design team for the Advanced Neutron Source (ANS) at Oak Ridge has completed the Conceptual Design Report and prepared an interim cost estimate. The team is presently refining this estimate, and fully expects to reduce the cost without major reduction in scope. In view of these ongoing activities, we are therefore not prepared to discuss priorities for ANS construction, within your three budget scenarios, at this time. We can, however, say with some certainty that this project will require substantial additions to the OBES budget. We would justify such an addition on the basis that this facility will serve a broader community than just OBES, or even DOE, and should be considered as a major national issue. We can also state that the scientific case for neutron scattering and other neutron based research is strong, while our premier reactors, the HFBR and HFIR, are continuing to age. Therefore, in order to maintain momentum, we recommend that the design team at Oak Ridge be funded for FY94 at a level which will retain the option of ANS operation early in the next century.

The Combustion Dynamics Initiative (CDI) is a major proposed OBES initiative supporting the DOE mission to enhance the efficiency of combustion processes while minimizing such undesirable effects as emission of pollutants. The CDI comprises two key experimental elements: completion of the existing Combustion Research Facility, Phase II at Sandia National Laboratory and construction of the Chemical Dynamics Research Laboratory (CDRL) at Lawrence Berkeley Laboratory. A third critical element of the CDI - Advanced Combustion Modeling Environment (ACME) - is aimed at using data from experimental and theoretical CDI studies, as well as advanced computer architectures to develop reliable, predictive models that U.S. industries can use in the design of next generation combustion systems.

This initiative has been the subject of numerous reviews, with the most recent being the BESAC oversight review in 1991. Consistent with prior reviews, BESAC strongly endorsed the initiative as a coordinated package (see the 1991 BESAC report), while cautioning that there should be a more detailed investigation of alternatives to the infrared free electron laser (IRFEL), proposed as a major facility in the CDRL.

BESAC was presented with an update on the CDI at its August 7, 1992, meeting at LBL. Partly in response to the issues raised concerning the IRFEL, the CDRL portion of the initiative has been modified. The revised proposal takes advantage of the rapidly evolving capabilities of

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Appendix 7. BES list of preliminary questions sent to OBES

Questions for BES from the BESAC Committee

Program Management

- How does BES define, focus, implement and evaluate its integrated program?
- How does BES manage its program to respond to changing DOE and national needs?
- How does BES integrate the overall effort of university and laboratory support? How does it differentiate the two parts of the program? How is balance set and maintained?
- What is the BES policy with respect to block vs. group vs. individual principal investigator grants within the National Laboratory program?
- How does BES coordinate its funding with other divisions and offices in DOE (inside and outside ER)?
- How do BES program managers interact with Laboratory managers? How are programs initiated? How are they terminated?
- How does BES formulate a strategic plan? Who is involved? How?
- How are research proposals to BES screened and selected? What external review systems exist? What fraction of proposals are funded annually?
- How is BES program management reviewed? What external mechanisms exist?
- How does BES support interaction between the research programs and industry? Universities?
- How does BES set priorities for the major program areas? (MS, CS EB, EG).
- Discuss recruitment/staff development at DOE Headquarters

Facilities

Major User Facilities

- How does BES establish facility priorities?
- How does BES formulate its long-range plan for facility support?
- Under the three scenarios established by ER budget guidance for BES, project fiscal constraints for current facility completion and operation, and further estimate available funds for new starts.
- Under the same scenarios as above, what are projections for non-facility programs?
- How does BES establish priorities between facility costs (construction and operation) and non-facility programs?
- How does BES set priorities between operation of existing facilities and new facility construction?
- How does BES weigh industrial interest in setting facility priorities?

Impact on DOE Technology Programs

Same as sent to Laboratories (attached)

Impact on U.S. Industry

- How are industrial interests represented in BES program planning?

DATE

FILMED

12/7/93

END