DEPARTMENT OF ENERGY
1985 CONGRESSIONAL BUDGET REQUEST
PROGRAM OVERVIEW

Supporting Research and Technical Analysis

The need to develop new and improved energy sources and to use energy more efficiently continues to be extremely important to the general welfare of the Nation. The role of basic (or supporting) energy research and technical analysis is to expand the scientific and engineering knowledge base on which the Nation's future energy options depend and to provide independent, objective analyses and assessments of research and technical needs relating to energy. Funding of basic research is an investment in the future. Through this investment, the applied technology efforts of industry and government will have a broader foundation of knowledge from which to discover new concepts, materials, processes and techniques important for energy production, conservation and utilization. Failure to strengthen our fundamental knowledge base of energy-related phenomena could result in limitations on productivity growth, erosion of the country's competitive position with foreign nations, additional pressure on the United States balance of trade and continuation of inflationary trends.

The following seven programs comprise the Office of Energy Research's portion of the Supporting Research and Technical Analysis category of the agency's budget: (1) Basic Energy Sciences (BES); (2) Energy Research Analysis (ERA); (3) Advisory and Oversight Program Direction; (4) University Research Support (URS); (5) University Research Instrumentation (URI); (6) Multiprogram General Purpose Facilities (MGPF); and (7) Policy and Management. All seven of these programs are organizationally in the Office of Energy Research.

The Basic Energy Sciences program is responsible for the long range, basic research of the agency to provide the fundamental scientific and engineering base on which the Nation's future energy options depend. The major product of the BES program is increased knowledge. This knowledge is developed by sponsoring research in the traditional disciplines: the physical and biological sciences, engineering and mathematics. The product of research in these disciplines then becomes a part of the body of data on which applied technologies rest. In addition to this focus on disciplinary research, there is also an emphasis on innovative applications of new knowledge to energy problems, and on the early application and, if possible, direct commercialization of the results.

Some examples of BES research efforts impacting technology areas of major interest are: new research results on stress corrosion cracking that already are being used to evaluate intergranular corrosion of the nickel based alloys that are being used in nuclear steam generators; several projects related to nuclear waste isolation which have provided new insights into important aspects of plutonium migration: these include effects of chemically active leachants generated in the focal aqueous medium by the high radiation field itself, immobilization effects of soils rich in organic humic materials, and the radiation stability of a simulated mineral planned to be a component in a long term storage host material for nuclear waste.

A solar related research result has been the experimental observance of a phenomenon in light-excited semiconductors which could lead to a doubling in the efficiency of photoelectrochemical solar devices. Related to transportation, conservation or electric generation technologies, the scientific feasibility was the demonstration with BES support of producing batteries, both storage and primary, with electrodes made of lightweight polyacetylene sheets. The successful demonstration of this concept can pave the way for a whole new technology and considerably improve the outlook for electrically powered vehicles.

The Energy Research Analysis (ERA) program provides the capability for independent, rigorous assessment of the base of research that underlies a variety of energy technologies. Assessments are consolidated under one organization, the Office of Energy Research, in fulfillment of legislated responsibility for the Director to advise the Secretary on the agency's research and development programs.

The University Research Support (URS) program consists of two major subprograms and a set of program activities focused on the following three primary objectives: To strengthen university capability to do energy research; to strengthen the quality and increase the number of students interested in pursuing energy-related professional careers; and to enhance technology transfer activities through cooperative research efforts between universities, the agency's national laboratories and private industry. The first subprogram, University/National Laboratory Cooperative Research, is directed at strengthening the capabilities of both universities and national laboratories as major energy research performers in the conduct of long range energy research. Many of the activities supported within this subprogram involve joint efforts between university and laboratory-based researchers. The second subprogram, Energy Manpower Development, includes efforts to increase the number of students pursuing energy-related engineering and science careers. This subprogram also includes the Department's statutory responsibility for assessing the supply and demand of manpower for both current and projected energy R&D programs.

The University Research Instrumentation (URI) program supports the purchase by the major research universities of state-of-the-art, scientific instrumentation used in energy-related research areas such as combustion, biological energy conversion, catalysis, radioactive waste management and engineering research.

The goal of the Multiprogram General Purpose Facilities (MGPF) program is to provide for the rehabilitation and replacement of general support facilities which are essential to the continued operations of the agency's multiprogram laboratories. Multiprogram General Purpose Facilities are facilities which are suited to many different users and programs; these are roads, railroads, site utilities, and support buildings such as laboratories, office buildings, shops, warehouses, etc. They are restricted to facilities where no one program uses more than approximately 60 percent of the facility.

The replacement cost of the existing general purpose facilities at the multiprogram laboratories exceeds $6,500,000. The MGPF program is required to maintain this investment and to ensure its viability. The program will be required as long as the multiprogram laboratory facilities are utilized to perform research and development functions for the agency. The program is an appropriate Federal role reflecting the responsible management of the Government's real property. The program is based on the premise that through continuous usage and aging, facilities deteriorate over time to a point where they are no longer useful to perform their intended functions and must be rehabilitated or replaced.

Advisory and Oversight Program Direction provides funds for the personnel resources required by the Director of Energy Research to carry out his responsibilities specifically assigned by legislation (P.L. 95-91) as well as those mandated by the Secretary in areas beyond the scope of the Energy Research and development program in order to advise the Secretary with respect to the well-being and management of the multiprogram laboratories; supervising or supporting research activities carried out by any of the Assistant Secretaries; and providing for program management of the Energy Research Analysis, University Research Support, and Multiprogram General Purpose Facilities programs. The program provides funds only for the salaries and related personnel expenses for the personnel who carry out the studies, analyses, monitoring and coordination activities required to support the Director. It does not include any funds for outside contracts.

The Office of Energy Research Policy and Management program provides for the salaries and related expenses associated with staff in the immediate office of the Director, Office of Energy Research, and in the Office of Management.

DEPARTMENT OF ENERGY
1985 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
BASIC ENERGY SCIENCES
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

| | 1983 Appropriation | 1984 Appropriation | 1985 Base | 1985 Request |
|---|---|---|---|---|
| Basic Energy Sciences | | | | |
| Materials Sciences | | | | |
| Operating Expenses.......... | $108,163 | $125,110 | $125,110 | $141,480 |
| Capital Equipment........... | 8,510 | 12,780 | 12,780 | 15,450 |
| Construction................ | 3,000 | 16,440 | 16,440 | 31,720 |
| Subtotal.................... | 119,673 | 154,330 | 154,330 | 188,650 |
| Chemical Sciences | | | | |
| Operating Expenses.......... | 70,000 | 75,500 | 75,500 | 80,930 |
| Capital Equipment........... | 5,510 | 6,520 | 6,520 | 8,840 |
| Construction................ | 400 | 450 | 450 | 8,050 |
| Subtotal.................... | 75,910 | 82,470 | 82,470 | 97,820 |
| Nuclear Sciences | | | | |
| Operating Expenses.......... | 30,644 | 37,900 | 37,900 | 49,755 |
| Capital Equipment........... | 1,556 | 2,150 | 2,150 | 2,950 |
| Construction................ | 0 | 270 | 270 | 300 |
| Subtotal.................... | 32,200 | 40,320 | 40,320 | 53,005 |
| Applied Mathematical Sciences | | | | |
| Operating Expenses.......... | 13,850 | 14,670 | 14,670 | 28,250 |
| Capital Equipment........... | 800 | 970 | 970 | 1,500 |
| Subtotal.................... | 14,650 | 15,640 | 15,640 | 29,750 |
| Engineering and Geosciences | | | | |
| Operating Expenses.......... | 17,200 | 19,000 | 19,000 | 20,795 |
| Capital Equipment........... | 1,120 | 1,150 | 1,150 | 1,500 |
| Subtotal.................... | 18,320 | 20,150 | 20,150 | 22,295 |
| Advanced Energy Projects | | | | |
| Operating Expenses.......... | 8,300 | 9,100 | 9,100 | 10,810 |
| Capital Equipment........... | 290 | 310 | 310 | 320 |
| Subtotal.................... | 8,590 | 9,410 | 9,410 | 11,130 |
| Biological Energy Research | | | | |
| Operating Expenses.......... | 9,500 | 10,580 | 10,580 | 12,490 |
| Capital Equipment........... | 370 | 400 | 400 | 560 |
| Subtotal.................... | 9,870 | 10,980 | 10,980 | 13,050 |
| Program Direction | | | | |
| Operating Expenses.......... | 3,170 a/ | 3,970 | 3,970 | 3,830 |
| Subtotal.................... | 3,170 | 3,970 | 3,970 | 3,830 |
| Total | | | | |
| Operating Expenses............ | 260,827 a/ | 295,830 | 295,830 | 348,340 b/ |
| Capital Equipment............. | 18,156 | 24,280 | 24,280 | 31,120 |
| Construction.................. | 3,400 | 17,160 | 17,160 | 40,070 |
| Basic Energy Sciences........... | $282,383 a/ | $337,270 | $337,270 | $419,530 b/ |
| Staffing | | | | |
| Total FTE's.................... | 56 | 62 | 62 | 62 |

Authorization: Section 209, P.L. 95-91

a/ Funding level above reflects a comparability adjustment of $70,000 and 1 FTE in connection with the Applied Mathematical Sciences subprogram.

b/ This decision unit reflects $3,000,000 for savings resulting from management initiatives in the area of administrative processes/field structure.

DEPARTMENT OF ENERGY
1985 CONGRESSIONAL BUDGET REQUEST
SUMMARY OF CHANGES
BASIC ENERGY SCIENCES
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(thousands of dollars)

| | |
|---|---|
| 1984 Appropriation enacted | $337,270 |
| **Operating Changes** | |
| Programmatic increases (described in detail below) | |
| Materials Sciences | +16,370 |
| o Provides for increased funds for facility operations, reactor fuel element requirements and additional requirements associated with the advanced materials research initiative | |
| Chemical Sciences | + 5,430 |
| o Provides increases for meeting facility commitments and reflects internal adjustments required to meet ongoing research commitments. | |
| Nuclear Sciences | +11,855 |
| o Provides increases to meet commitments for the National Nuclear Data Program, an expansion to the Heavy Ion Fusion Program, and to meet facility commitments. | |
| Applied Mathematical Sciences | +13,580 |
| o Provides increases for a significant expansion in basic research in scientific computing at national laboratories, universities and private research institutions. In addition, experimental computing capabilities are being established to support the exploration of new concepts in large scale scientific computing. Also, increase is provided for expanding access to Energy Research scientists to state-of-the-art computing capability. | |
| Engineering and Geosciences | + 1,795 |
| o Increases are provided to expand the number of scientists and engineers in these areas of research. | |
| Advanced Energy Projects | + 1,710 |
| o Increases permit an expansion to the number of research projects supported by this subprogram. | |
| Biological Energy Research | + 1,910 |
| o Increase will begin to address plant and microbial sciences research for interdisciplinary research groupings to focus on specific problems. | |
| Program Direction | - 140 |
| o Reflects lower administrative support costs. | |
| Subtotal Operating Changes | 52,510 |

Capital Equipment Changes

| | |
|---|---|
| o Programmatic increase in each of the subprograms will be provided to meet facility requirements, to support the recently assigned responsibility for General Purpose Equipment at Argonne National Laboratory, and to support new requirements in areas of increasing research........................................................ | + 6,840 |
| Subtotal Capital Equipment Changes........................................ | 6,840 |

Construction Changes

| | |
|---|---|
| o Programmatic increases for General Plant Projects (Argonne National Laboratory, Ames Laboratory, Notre Dame University, and Stanford University); Accelerator Improvement Projects; Kansas State University Ion Collision Physics Facility; National Synchrotron Light Source; Center for Advanced Materials and Stanford Synchrotron Radiation Laboratory Enhancement................................................ | +22,910 |
| Subtotal Construction Changes............................................. | 22,910 |
| 1985 budget request....................................................... | $419,530 |

## Overview

The FY 1985 request for the BES program is $419,530,000. Reflected in this budget request is $3,000,000 in savings from management initiatives in the area of administrative processes/field structure. This budget which is composed of $348,340,000 in operating funds, $31,120,000 in equipment funds, and $40,070,000 in construction funds, maintains the needed continuity of the FY 1984 program. An increase needed for facility operations and research will be provided; the principal goals of the research program and the goals of the new initiative in materials sciences will be met, the first step in expanding Energy Research computing activities to meet immediate needs for supercomputer access by ER researchers will be taken, and enhancements will be permitted in the most promising, selected areas of research.

In determining the appropriate Federal roles in the support of RD&D, the Administration has identified the support of long range basic research as the particular responsibility of government and, further, that "mission agencies should support the foundation of basic science, as well as mission-oriented applied research, in appropriate disciplines." The Basic Energy Sciences (BES) program is responsible for generic long-range energy related research in the Department of Energy (DOE). The research supported by this program has as its principal focus energy, but also supports a number of other important national goals. Because of the ramifications of technical breakthroughs, it is fair to say that national security, U.S. leadership in science and technology and training are all equally served by an aggressive program in basic research.

Improvements in existing technologies and the development of new technologies invariably come from the application of new scientific knowledge. External blue ribbon advisory groups have repeatedly recommended that DOE increase its funding of basic research and have called for BES to be given a larger role in developing the needed research base for the different energy supply and conservation options. BES has endeavored to respond to these recommendations. In FY 1984 a major new materials initiative was proposed that not only attempts to deal with advanced materials research but also with aspects of training new researchers. This initiative which will continue in FY 1985, and will result in the redirection of a major DOE laboratory, the Lawrence Berkeley Laboratory, which was recommended in a recent report of DOE's Energy Research Advisory Board.

The major product of the BES program is knowledge relevant to energy exploration, production, conversion and use; that product becomes a part of the body of information on which the applied technologies rest. While the pursuit of research by BES to broaden the technology base needed for identified energy technology options is extremely important, perhaps even more important is the need for basic research unfettered by preconceived notions of what technologies will be important several decades from now, so that new, currently unidentified options may emerge.

In support of basic research activities, BES supports a number of national user facilities. Recently four such facilities have been brought on line and each promises to open whole new areas of research possibilities heretofore not possible. These new facilities are: the National Synchrotron Light Source at BNL, the Intense Pulsed Neutron Source at ANL, and the 1.5 Mev high voltage electron microscope at LBL, for all of which FY 1983 has been the first full year of operation, and the Atomic Resolution Microscope at LBL, where the first full year of operation will be FY 1984. BES also undertook the responsibility for the operation of the Stanford Synchrotron Radiation Laboratory (SSRL), our second major research facility for synchrotron radiation. The coming of age of these new major facilities together with existing ones is placing an added burden on BES to provide the additional funding needed for their operation at levels commensurate with the needs of the researchers. BES also is undertaking provision of access to supercomputers to ER researchers through the Applied Mathematical Sciences subprogram.

Examples of research progress by the BES subprograms and their relationship to long term energy problems offer an insight into the nature of the BES program.

*In the* Materials Sciences *subprogram the research is directed towards understanding* basic materials phenomena and classes of materials important to energy systems. This past year it was found that, in metals, helium itself forms lattice defects which nucleate gas bubbles. This discovery alters present thinking on the role radiation damage plays in helium bubble formation in metals, a new insight that needs to be explored more deeply for fission and fusion systems where helium is generated by nuclear reactions. A second accomplishment in this subprogram has been the preparation of simple, yet highly efficient solar cells by glow discharge implantation doping of single crystal silicon followed by pulsed laser annealing; this process is expected to be commercially feasible.

Under the Chemical Sciences subprogram, it was found that the phase behavior for fluids under shear is different from fluids "at rest" and depends on the strain rate; this helps explain observations of anomalous phase separations under flow conditions and enhances our capabilities for predicting thermophysical properties of complex fluids and for modeling reaction systems. There have been several advances involving photo-chemistry: one has been the photocatalytic splitting of water to produce hydrogen using visible light and inexpensive modified iron oxide photoelectrodes; a second has been the discovery, with use of a newly devised light saturation technique, of the existence of one or more previously unsuspected chemical sequences in the chloroplast-ferrodoxin-hydrogenase photosynthetic system, a discovery which adds importantly to the arsenal of knowledge available for attempting practical water splitting technologies.

Under the Nuclear Sciences subprogram, the nuclear data measurements activity has been concentrating efforts on the neutron and gamma ray emission induced by fast neutrons on materials of interest to the fusion program. A new high resolultion gamma ray detector system to further theoretical understanding of inelastic neutron scattering phenomena has become operational.

Within the Engineering and Geosciences subprogram, basic studies of the effects of fluids in pores on sound waves transmission in rocks has led to discovery of a new approach to monitoring recovery of heavy oils. A field test of the new method is being sponsored by the oil industry.

The Applied Mathematical Sciences subprogram has demonstrated significant progress in the design of new fast algorithms for parallel machine architectures for several classes of computational models used in combustion experiments, reactor safety, plasma physics and weapons design. Five new parallel processor systems reached the engineering prototype stage and are successfully running problems at universities and laboratories.

A recent accomplishment under Advanced Energy Projects has been the measurement, for the first time, of fusion reaction rates in a scheme utilizing mu mesons as reaction catalysts. The reaction yield of neutrons is high and potential application of the concept to provide high intensity neutron sources is possible. The examination of such novel concepts is a unique feature of this subprogram.

The Biological Energy Research subprogram has made progress on a subject of major importance in the burgeoning field of genetic engineering. The successful use of Agrobacterium Ti plasmid, a DNA vector found in a bacterium that is particularly useful to introduce "alien genes" into higher plants has been marred by an unwanted side effect, tumor formation in the recipient plant. The significant accomplishment under this subprogram has been the actual elimination of the one gene responsible for tumor formation.

BES considers the merits of research in relation to the diverse needs for energy and selects those topics that, when taken as a whole, comprise an optimum, balanced program of mission-oriented basic research. To carry out this program, BES plans, supports and administers energy related research in the physical, biological and engineering sciences. New scientific information in these areas addresses the Administration's goals by providing the fundamental scientific and engineering base on which the Nation's future energy options depend. The strategy continues to be to:

- o Provide critical knowledge and data and develop trained scientific talent through support of highly competent scientists in DOE mission areas;
- o Provide for, and support operation of unique, specialized research facilities;
- o Maintain liaison with other DOE programs, federal agencies and the scientific, academic and industrial communities;
- o Seek the scientific and industrial communities' assistance for the identification of needs and opportunities for research in areas likely to be relevant to future energy options; and
- o Promote early applications of the results of basic research.

To continue its effectiveness, the Basic Energy Sciences program must: 1) maintain a strong core program -- this involves equipping, supporting and encouraging the scientists involved in our current program activities, and the training of new, younger scientists, to expand the forefront of knowledge in areas likely to be important to future energy technologies; and 2) continue to support existing, unique facilities important to research in the U.S. while at the same time providing for needed new facilities and for their operation; and 3) create opportunities for exploiting new, emerging areas that have been identified as having great potential importance to energy.

Prime examples of needed new facilities and opportunities for growth are contained in the Advanced Materials initiative which was proposed as part of the FY 1984 budget and continues in FY 1985. The Center for Advanced Materials portion of the initiative will serve as a logical redirection of one of the Department's major national laboratories and will accomplish these important objectives:

1. Establishment of a basic research program strongly oriented toward the solution of technologically important problems with major industrial input and research participation. Heavy emphasis will be placed on the synthesis, characterization, and study of the properties of advanced materials.

2. Provide advanced facilities for research training of additional graduate students in physical sciences and engineering fields vital to U.S. high-technology industry.

| | FY 1983 | FY 1984 | FY 1985 Request |
|---|---|---|---|
| Materials Sciences | | | |
| Operating Expenses.......................... | $108,163 | $125,110 | $141,480 |
| Capital Equipment........................... | 8,510 | 12,780 | 15,450 |
| Construction................................ | 3,000 | 16,440 | 31,720 |
| Subtotal.................................. | 119,673 | $154,330 | $188,650 |

The goal of the Materials Sciences subprogram is to increase our understanding of phenomena and properties important to materials behavior which will contribute to meeting the needs of present and future energy technologies. This program is important because it underpins the high technology industrial areas of the Nation, pushes forward the frontiers of knowledge in this fundamental technical area, and trains new scientists in this highly interactive field, in addition to working on the long range problems of energy systems. It is well known that materials problems and limitations often restrict the performance of current energy systems and the development of future systems. A few examples of such problems and limitations include: low conversion efficiency in photovoltaic materials, radiation damage in fusion systems, thermal and mechanical stability of materials for heat engines, and corrosion and erosion of critical components in coal conversion plants. The Energy Research Advisory Board had placed the highest relative program ranking on this area of research in a review of major energy science and technology base programs last year and is currently undertaking an in depth study of all materials research and development in the Department.

While each Federal agency conducts materials research to meet its own particular objectives, coordination across agencies is readily accomplished through established committees and interactions. In the area of basic materials research, the Materials Sciences subprogram is most interactive with the National Science Foundation's Materials Research Division and the more basic programs of the Department of Defense. The unique aspect of the Materials Sciences subprogram is the focus on energy related research and the use of advanced diagnostic techniques made possible by state-of-the-art research facilities supported by this subprogram. These activities complement the NSF and other agency programs. The research is needed to carry out the mission of the DOE. It is different in both character and its interactions with other programs. Although the NSF program has significant breadth, it does not have the concentration in energy systems materials research. For example, there is relatively little work in the NSF program on radiation effects, corrosion-erosion related to fossil energy systems, solar photovoltaic materials, or nuclear waste isolation materials, whereas the Materials Sciences subprogram has very significant efforts in these areas. This subprogram also has large efforts in facility-related research such as neutron scattering, synchrotron radiation research and electron microscopy, compared to the relatively small efforts in the NSF program. The Materials Sciences subprogram has traditionally provided the development, construction and operation of large facilities for the total national program. Use of these major facilities is now formally open to all qualified researchers. A recent survey of twelve of the collaborative research centers under the purview of the Materials Sciences subprogram has shown that they accommodated about 900 users during the past year. The users came from DOE laboratories (21 percent), universities (48 percent), industry (14 percent), and the remainder from other organizations. The replacement cost for these facilities is estimated at $450,000,000. The Materials Sciences research funding around these facilities in FY 1983 was about $16,000,000 with another $11,000,000 being attracted from outside the Materials Sciences subprogram.

As in FY 1984, and in response to Congressional interest in materials research and in consonance with the President's materials policy statement, an Advanced Materials Research initiative is being continued. This initiative is described separately and builds upon the base of knowledge established by the Materials Sciences program and other such programs in the Government. It will complement ongoing core program activities, and emphasize high risk, high pay-off research with potential for technology transfer.

The FY 1985 request includes the following amounts for the Core Program: $132,110,000 for operating, $13,300,000 for capital equipment and $1,800,000 for construction. For continuation of the initiative on Advanced Materials Research, $9,370,000 is included for operating, $2,150,000 for capital equipment, and $29,920,000 for construction.

The field of materials sciences is timely for exploitation as a result of many new advances. We are approaching the ultimate resolution in microscopy. The LBL Atomic Resolution microscope has been installed and will begin research operation in FY 1984. Significantly enhanced spectroscopies are now available or will become available soon with new synchrotron radiation sources and neutron sources. The theory related to materials science is greatly improved although still difficult. Availability of high speed computers will help this area. Coupling these experimental and theoretical advances with our improved ability to prepare new materials will open up opportunities to design materials from fundamental principles and overcome or circumvent known and anticipated energy related materials problems. A recent National Academy of Sciences report on Materials Science supports this same general conclusion.

Some of the needs to which the Materials Sciences research ultimately contributes include:

- Developing new or substitute materials
- Tailoring materials to satisfy defined requirements
- Predicting materials problems and service life

- Improving the ability to successfully attack unforeseen materials problems in advanced energy systems, and
- Improving the theoretical and experimental capability to analyze the fundamental structure of materials

To provide the new knowledge and information to meet these needs, Materials Sciences, comprised of the subfields of metallurgy, ceramics, solid state physics, and materials chemistry, places emphasis on selected generic areas of fundamental importance and on areas where problems are known to exist or are anticipated. Some research is directed at a single energy technology (e.g., photovoltaic materials for solar energy conversion), some research would have applicability to many technologies simultaneously (e.g., embrittlement of structural materials due to the presence of hydrogen), and still other research has more fundamental implications underpinning all materials research (e.g., mechanisms of atomic transport of solids). The research is conducted among a variety of institutions--national laboratories, universities, and to a lesser extent, industry utilizing the talents of metallurgists, ceramists, solid state physicists, and materials chemists.

In addition to maintaining an appropriate mix among long-term science, multi-technology and single energy technology oriented research, a balance must be retained between forefront large facility-related research and small individual projects. Certain types of research simply cannot be carried out without large facilities (e.g., neutron sources with significant fluxes of neutrons cannot be made in "small" sizes). Also newer instruments with significant improvement in capability (e.g., synchrotron radiation sources) are very expensive to build and operate. The Materials Sciences subprogram utilizes several major facilities in the pursuit of its research goals, including the National Synchrotron Light Source (NSLS) BNL, High Flux Beam Reactor (HFBR) BNL, High Flux Isotope Reactor (HFIR) ORNL, Intense Pulsed Neutron Source (IPNS) ANL, Ion Implantation Facility ORNL, and Electron Microscopes at ORNL, ANL, LBL and the University of Illinois. Operation of facilities in FY 1983 required about 20 percent (and is increasing) of the operating budget of the Materials Sciences subprogram, not including the unique research associated with them. These facilities also are available to qualified users outside the national laboratory complex.

Current emphases and trends in the core program indicate utilization of the major user facilities will increase. The university portion of the program will be maintained at about 20 percent. When including Ames Laboratory (Iowa State University) and Lawrence Berkeley Laboratory (University of California) the support going to universities is approximately 38 percent. Research will be strengthened in the areas of organic-polymer conducting materials, surface modification utilizing ion implantation and laser or electron beam treatment, structural ceramics, condensed matter theory, critical materials substitution, and materials preparation among others.

This subprogram supports both directly and indirectly the development of a national position on critical materials, welding and rapidly solidified materials. The ability to provide such support stems directly from the experience and continuity within the Materials Sciences subprogram. The fundamental understanding of materials obtained in this subprogram has led to new approaches to alloy design for critical materials substitution, advances in welding and the science of rapidly solidified materials.

The subprogram utilizes workshops and reports of its Council on Materials Science (a non-Governmental body with representatives from academia, industry, and agency laboratories) to help focus on critical issues. Panel meetings on materials research at high pressure and materials aspects of nuclear waste isolation were conducted in 1982. During 1983, two panel meetings were held, one on surface modification and one on organic materials. The reports resulting from these workshops and panels are distributed widely, including publication in the open literature. Interactions and information transfer with the agency's applied materials research takes place through a number of mechanisms including a formalized Research Assistance Task Force. Examples of these latter activities include meetings on fast ion conductors and corrosion related to batteries. Through these latter meetings the basic researchers learn of the problems in the applied programs and the technology oriented programs are exposed to scientists with a fundamental understanding of matter.

The Materials Sciences subprogram is the basic materials program in the agency underpinning all the energy technologies. Materials play a crucial role in the development of energy systems. Coordination among the agency's materials programs takes place primarily through the Energy Materials Coordinating Committee. Within the Federal Government, the subprogram is coordinated in part through the interagency Committee on Materials (COMAT) and the basic Interagency Materials Group. At the Federal program level, Materials Sciences continues to represent about one-third of the Federal Government support for basic materials research.

Materials Sciences is recognized throughout the research community for its excellence. Past technical accomplishments have moved into the technological or commercial sector (e.g., radiation resistant alloys, glassy metals, ion implantation techniques for surface modification, and superconducting wire), and it is expected that through the proven methods of technology/information transfer and effective management this year's accomplishments will likewise find use either for building our fundamental base of materials understanding or in some technological application in the future. It should be noted that industrial interactions with this subprogram are encouraged and indeed have been successful. Significant progress was made during the past year in many areas of the subprogram. Some examples of recent accomplishments include:

- A new superconducting magnetic shielding method capable of sweeping out ambient magnetic fields to the nanoguass level has been demonstrated. This technique has the potential to revolutionize the methods of obtaining low and stable magnetic field environments necessary for low-noise operation of sensitive superconducting devices such as the Josephson Junction computer.

- Simple yet very high efficient solar cells have been produced by glow discharge implantation doping of single crystal silicon followed by pulsed laser annealing. The method is easily automated and could radically change the manufacture of solar cells.

- A new method was developed for the homogeneous addition of sintering additives to silicon nitride, and a procedure was derived to prevent the agglomeration of colloidal-sized powder. Homogenity and retention of colloidal particle sizes are essential requirements in order to sinter silicon nitride to obtain reliable components for ceramic engines.

- A study of simulated radioactive waste glass forms using uranium to substitute for transuranic elements has shown that they do not provide a reliable simulation of the structure and bonding properties of transuranics in silicate glasses. Since the leaching properties are dependent on bonding, this result indicates real waste systems must be investigated for reliable prediction.

- Neutron "time-of-flight" techniques have been used to successfully measure residual stresses in tungsten carbide cermet materials and in a zirconium alloy. The information on cermet materials is important in the design and development of drilling inserts for oil and gas well drilling apparatus. The detailed information on residual stresses in the zirconium alloy provides valuable data for reactor fuel element and pressure tube design and performance analysis.

- It has been demonstrated that the structure and surface hardness of ceramic surfaces can be modified and controlled by means of ion implantation. The properties that were obtained could be further changed by means of post-implantation thermal annealing.

- An effective method was developed which accurately describes the strain field around a crack in a class of materials termed "incompressible-fully plastic," known to be the most relevant to heavy section piping and pressure vessels in energy plants.

- It was predicted and discovered non-energetic helium forms lattice defects in metals to nucleate gas bubbles. This understanding alters present thinking on the role displacement producing radiation damage plays in helium bubble formation in metals and this must be regarded as a potential problem area in fission and fusion systems.

The request for the Materials Sciences core program will provide for needed continuity and permit a reasonable level of utilization of major facilities, strengthening of important topical areas and initiation of some new thrust areas recommended by workshops and panels of the Council on Materials Science. Of the $14,700,000 increase in operating funds in the core program over FY 1984, the most significant amount is for facility operations ($6,500,000) including increased costs for reactor fuel elements, and research ($2,700,000) at newer major facilities. The operational funding for NSLS will increase, which together with the Chemical Sciences funding for NSLS will allow NSLS to run about 19 out of a maximum of 21 shifts per week. Additional funding will be allocated to the other major facilities for operational costs, for example to the LBL Center for Electron Microscopy in order to permit close-to-optimum outside use.

The increase in equipment funds will permit the completion of the surface modification laboratory at ORNL ($500,000) and the analytical electron microscope at ANL ($950,000). The increase will also allow purchase of equipment for the low temperature neutron irradiation facility ($200,000), neutron scattering equipment ($800,000), synchrotron radiation equipment ($300,000), and electron microscopy equipment ($200,000). Accelerator and Reactor Improvement funds are requested for NSLS ($1,100,000), HFBR ($500,000), and the Bulk Shielding Reactor ($200,000) in the core program. Supporting information is provided in the construction project data sheet.

In addition to the Materials Sciences core program, continuing funds for the FY 1984 Advanced Materials Research initiative are requested. This was designed to satisfy a national need in materials science research, to undertake necessary forefront research outlined in various recent studies, and in response to Congressional interest and Administration policy. Funding for the second year, FY 1985, includes operating expenses ($9,370,000), capital equipment ($2,150,000), and construction ($29,920,000). United States economic health and national security requires the maintenance of a commanding lead in high technology and the reduction of vulnerability to critical and strategic imported materials. In response to this challenge, an Advanced Materials Research initiative was proposed in FY 1984. The FY 1984 initiative consisted of an expansion of activities at the National Synchrotron Light Source and the establishment on the West Coast of a new Center for Advanced Materials (CAM), which included enhancement of the Stanford Synchrotron Radiation Laboratory (SSRL). An ad hoc panel was established in April 1983 to review the proposed CAM. This request is consistent with the recommendations of that panel - to continue the initiative, but to delineate the synchrotron radiation sources from the materials research facilities and treat them separately. The panel made a number of constructive recommendations which are being used to shape the program and have been incorporated in this year's request. The Center for Advanced Materials will be organized to provide maximum benefit to the Nation. Industry will participate in the design and use of the facilities to assure that the research addresses America's high-technology needs. For example an advisory board composed of scientific leaders from industry, universities, and Federal laboratories will advise the LBL director on scientific program directions in CAM. An Industrial Fellows program will be established to provide joint LBL-industrial support for participation of outstanding industrial scientists in basic research studies of mutual interest to LBL and the scientists' parent companies. An initial workshop on industrial participation was held in 1983 where issues and follow on activities were agreed upon. A CAM Research Advisory Board has been established and workshops held for the initial research programs. Research teams from laboratories and universities will participate in the design and development of advanced synchrotron radiation sources, and beam lines. In view of a new National Academy of Sciences study of major facilities for Materials Sciences, decisions to proceed with construction of major new facilities will await the results of that study.

This initiative includes funds for: A) three construction projects (Center for Advanced Materials-$10,790,000, Stanford Synchrotron Radiation Laboratory (SSRL) Enhancement-$9,130,000 and the expansion of capability at the National Synchrotron Light Source-$10,000,000); and B) research associated with construction and a forefront programmatic research program $12,550,000.

| | FY 1985 Request |
|---|---|
| A. <u>Construction</u>............................................ | $ 29,920 |

1. Center for Advanced Materials.................... $10,790

The Center for Advanced Materials project provides for the construction of two facilities at LBL: 1) a Surface Science and Catalysis Laboratory (SSCL); and 2) an Advanced Materials Laboratory (AML).

<u>Surface Science and Catalysis Laboratory</u> (SSCL)

The SSCL will further the fundamental understanding of surfaces of materials with a view toward applications and catalyzed processes on solid surfaces.

<u>Advanced Materials Laboratory</u> (AML)

The AML will create a forefront facility for the synthesis and characterization of materials of novel or optimized physical or chemical properties. In addition, it will provide a focus for development of innovative devices and use of advanced materials to assist in creating among other things possibly new types of heat engines. Innovative device concepts for more sophisticated characterization of materials properties or behavior will be developed.

Both SSCL and AML will build upon the very strong programs in materials science and in surface science and catalysis already in existence at LBL.

2. <u>Stanford Synchrotron Radiation Laboratory (SSRL) Enhancement</u>.................................... $ 9,130

An enhancement program at the Stanford Synchrotron Radiation Laboratory (SSRL) will provide increased capability through the use of the PEP ring as a source of high energy (10-30 keV) photons, an advanced wiggler-based beam line for an unparalleled level of x-ray flux at SPEAR, and improved injection for greater time of use of SPEAR for synchrotron radiation. Provision will also be made for experimental set-up space to cut time losses for the many user scientists as they prepare to move experiments into place on SSRL's beam lines, and the laboratory and office spaces required to serve SSRL's much intensified pace of research use.

3. National Synchrotron Light Source (NSLS)......... $ 10,000

The third construction project will expand the capabilities at NSLS by allowing new beam lines to be built and by enlarging the existing building for the purpose of permitting additional experiments to be conducted. Construction of additional beam lines, including insertion devices, will be undertaken to accommodate the heavy use and demand by outside users from industry, universities, and other laboratories. The proposed building expansion will extend the northern perimeter of the existing building and add an additional floor above the existing office section.

Further details on each of these projects are provided in the construction project data sheets for Project 85-ER-111, 85-ER-112, and 85-ER-113.

| | FY 1985 Request |
|---|---|
| B. Programmatic Research and Research and Development Associated with Construction.......................... | $ 12,550 |

Operating funds are needed for research and development to achieve the design goals of the construction projects proposed as part of this materials initiative. In particular, development is required in the advanced synchrotron radiation sources and the Stanford Synchrotron Radiation Laboratory (SSRL), and development funds are also needed for support of the National Synchrotron Light Source (NSLS).

At SSRL, development funds are needed for research on the PEP beam line undulator, the SPEAR beam line wiggler and for mirror and monochromator research. Operating funds are also included for SSRL, to begin the important Materials Sciences interaction with the research program there.

Related to the NSLS expansion, operating funds are requested to conduct research and development necessary for the construction of new beam lines. It is important to conduct research on advanced wiggler and undulators which will be inserted in x-ray and VUV rings. In addition, R&D will be performed on advanced mirrors and gratings for the x-ray microscopy and x-ray spectroscopy lines.

Research related to the Surface Science and Catalysis Laboratory (SSCL), will be undertaken to further the fundamental understanding of surfaces of materials with a view toward applications and catalyzed processes on solid surfaces. The FY 1985 effort will include programs on: atomic rearrangement of surface properties under extreme conditions and on new zeolites and novel catalyst characterization. A theoretical and experimental effort will be initiated in FY 1985 to use techniques already developed at LBL for characterizing atomic surface structures. Theoretical predictions will be based on the pseudopotential model and related approaches, which have been perfected at LBL recently, while experiments will be performed using advanced surface and photoelectron diffraction. The program will later become oriented toward materials of interest for new device concepts. Thus emphasis will shift from clean surfaces to overlayer systems (adsorbates, Schottky barriers) to atomic interfaces and three-dimensional structures. Surface structures will be altered with high-energy particles or intense photon fluxes which introduce line defects and point defects, and cause evaporation and phase transitions, including melting. Zeolites and other novel non-metallic catalysts will be synthesized and characterized using synchrotron radiation.

Programmatic research related to the Advanced Materials Laboratory (AML) will build on very strong ongoing programs in materials science at LBL. These programs, like others nationally, are handicapped by unavailability of novel and well-characterized materials for study. A particular objective of AML will be to create a forefront facility (for the synthesis and characterization of materials of novel or optimized physical or chemical properties); materials which may make possible devices, engines, or structures of superior performance in high technology and energy-related industries. Investigators in AML will collaborate with investigators in the Surface Science and Catalysis Laboratory (SSCL) by synthesizing and characterizing zeolites and novel new catalysts for investigation in SSCL. They also will collaborate with design engineers synthesizing new materials and materials improved properties. For example, initial research programs will focus on understanding the processing of polymers, the properties and behavior of new electronic materials including gallium-arsenide, and the processing of structural ceramics. In addition, research will utilize soft x-ray lithography to develop new experimental devices with dimensions of 100 Å or less. Success here would have an enormous effect on all electronic technology, perhaps most importantly on greatly advanced computers. The research will exploit exceptional properties of new materials in device concepts that have the potential for dramatic improvements--orders of magnitude increases in limits of sensitivities of sensors, for example, and will investigate device concepts with potential for yielding order of magnitude improvements in characterizing material properties and behavior.

For FY 1985, the equipment needed includes the following: Survey and alignment apparatus for tolerances of a fraction of millimeter, equipment for ultra-high vacuum (UHV) for materials testing, RF development instrumentation in the two ranges 500 MHz and 2880 MHz, pulsed magnet equipment capable of 50 nanosecond rise times and low duty factor, low level electronics for beam monitoring, and control system equipment for hardware and software aids. Equipment for programmatic research includes advanced instrumentation for new material synthesis and characterization, e.g., a molecular beam epitaxy (MBE) system, ion-implantation and laser process instruments, and liquid phase epitaxial growth equipment. All of this instrumentation is for the advanced material synthesis in both solid and thin film form as well as for surface modification and coatings.

| | FY 1983 | FY 1984 | FY 1985 Request |
|---|---|---|---|
| Chemical Sciences | | | |
| Operating Expenses | $ 70,000 | $ 75,500 | $ 80,930 |
| Capital Equipment | 5,510 | 6,520 | 8,840 |
| Construction | 400 | 450 | 8,050 |
| Subtotal | 75,910 | 82,470 | 97,820 |

The Chemical Sciences subprogram has two principal goals: to increase understanding of basic chemical and physical phenomena important to future energy production and conversion, and to promote the discovery of new concepts in chemical and physical aspects of energy processes. Within this framework the subprogram supports high quality research in a broad spectrum of chemical and physical scientific areas. Most of the research is conducted at national laboratories and universities, but research at not-for-profit institutions, other Federal laboratories and industrial laboratories is also supported.

Emphasis is placed on photochemistry, chemical physics, atomic physics, physical organic chemistry related to coal, catalysis, combustion thermodynamics of mixtures and separations. Continued research productivity in these areas is important, as is operation of two relatively new advanced major facilities and support of research efforts using them.

The Chemical Sciences subprogram provides the base support for operating the Sandia Laboratories' Combustion Research Facility, i.e., operating several state-of-the-art lasers, advancing their capabilities for users and providing services to visiting combustion researchers. Chemical Sciences is also the major source of support of basic research using this unique, world-class Facility. Its use by scientists from academia, industry and other laboratories is strong, both assisted by and in collaboration with in-house scientists. The facility has also been the center of limited exchange visits arranged through the International Energy Agency and through bilateral agreements with other countries entered into on a quid pro quo basis.

Chemical Sciences also provides about 40 percent of the support for operating the National Synchrotron Light Source (NSLS) at Brookhaven, and supports chemical sciences research using the NSLS. Following initial assembly and calibration, some initial experiments have been done on ionization of gaseous atoms by ultraviolet radiation. Other new areas of research have been initiated which are expected to help unravel questions in catalytic effects and combustion and to advance capabilities for analyzing the chemical elements in selected microscopic volumes at the surface of a solid.

The areas of chemistry and physics emphasized in the Chemical Sciences subprogram are those most likely to produce advances in knowledge and understanding which will be valuable for improving energy technologies. In photochemistry, for example, progress is being made toward the understanding of photosynthesis, the sequence of processes by which nature utilizes solar energy to convert $CO_2$ to biomass.

Researchers in chemical physics are developing understanding and techniques for such diverse areas as catalysis and combustion. An example is extended x-ray absorption fine structure (EXAFS) research using synchrotron radiation, which is yielding information about the geometry and chemistry of adsorption and chemisorption of small molecules on the surfaces of catalysts. This will help explain and predict their catalyzed dissociation and rearrangement into larger fuel molecules.

Atomic physics researchers are attacking basic questions underlying the behavior of atomic and molecular ions, because of their importance to such areas as magnetic fusion, combustion, electric arcs and lighting.

Study of the fundamental chemistry of coal is adding new insights into the characteristics of different types of coal. It is likely that knowledge of the (sometimes subtle) differences among coals will allow future coal conversion plants to be designed for better control of product mixes or more efficient operations or both. The very basic research necessary to acquire this knowledge will be validated by careful steps being taken to assure reproducibility of results in coal experiments between different laboratories and over a very long time span (20 years or more).

Combustion, still the most important means of converting energy for years to come, is only partly understood. Chemical Sciences supports an outstanding assemblage of chemists and physicists who are using and enhancing state-of-the-art techniques to unravel the complex phenomena that make up combustion. Not only at the Combustion Research Facility but also at other laboratories, especially at universities, forefront chemical research is underway to help us understand the extremely fast sequences of chemical reactions that occur in combustion. Technological benefits can be looked for in combating pollution, gaining efficiency and tailoring combustion systems to future alternate fuels when petroleum and gas supplies dwindle.

Separations of fuels from wastes, more valuable fuels from less valuable fuels and desired chemicals from other chemicals always consume energy. Research in basic techniques of separations is therefore supported to widen the spectrum of methods from which designers of separative processes can choose the most efficient method for a given need. Related to this is a group of research projects in analysis, since almost all energy processes, especially separations, require devising of tailored analytical methods. Chemical Sciences' effort in analysis seeks general advances from which the specialized users can draw.

From the numerous achievements and contributions produced by Chemical Sciences researchers, those below are typical.

- A method for catalytic conversion of methanol (wood alcohol) selectively to ethanol (ordinary alcohol) has been discovered, using a homogeneous cobalt-based catalyst. This is an important advance toward using coal syngas for selective production of ethanol without forming the higher alcohols.

- A dual-possibility discovery: visible light may be either converted to electricity or caused to split hydrogen from water, by use of inexpensive thin film photocathodes of amorphous hydrogenated silicon. (The research was collaborative between a DOE-supported university and RCA.)

- A method has been discovered for estimating hydrogen atoms' transferability from donor solvents, which is important to evaluation of direct coal liquefaction processes. The method is based on relative kinetics of a free radical reaction involving the donor solvent and a diphenylazo compound.

- The first-ever measurements have been made of dielectronic recombination of multiply charged ions. This is an energy loss process in fusion type plasmas, which needs to be measured and understood. Colinear ion-electron beams were invented for this very difficult experiment.

- A highly selective method has been discovered for determining ratios of isotopes in a sample, even for mixtures of isotopes of different elements but with the same mass number. It is based on laser-induced resonance ionization coupled with mass spectroscopy. The ability to make such measurements readily is important in advancing many areas of technology involving isotopes.

- It has been discovered by techniques of molecular dynamics that the equation of state (phase behavior) for fluids under shear is different from fluids at "rest" and is dependent on the strain rate. Anomalous observations of phase separation under flow conditions are now understood and predictive techniques to estimate thermophysical properties of complex fluids now appear possible. (Work primarily funded by BES; some early support provided by NBS competence funds).

The request of $80,930,000, an increase of $5,430,000 for operating expenses, provides for maintaining the ongoing research. In addition, the recently constructed major facilities, NSLS and CRF, will receive support for their basic operations as they attempt to get up to speed in beneficial use of their advanced capabilities, in order to realize the most important national research advantages for which they were built. Their use by researchers in the areas of basic chemistry and physics noted above will promote scientific advances important to a wide scope of energy processes.

In the other parts of the Chemical Sciences subprogram cost-of-living increases will be given to photochemistry, atomic physics related to fusion, heterogeneous catalysis and supercritical properties of mixtures. Supported at close to the FY 1984 dollar level will be projects in radiation chemistry, molecular beam research, coal chemistry, analytical research and chemical engineering sciences.

In the paragraphs below which address the Chemical Sciences funding requests for capital equipment and construction, a new requirement appears which has a significant impact on the levels requested. For the first time, General Purpose Equipment (GPE) for the Argonne National Laboratory (ANL) and General Plant Projects (GPP) for ANL, the Ames Laboratory, the Notre Dame Radiation Laboratory and the Stanford Synchrotron Radiation Laboratory are included in the Chemical Sciences budget request. These will be detailed below. Taken together, they add $7,750,000 to the requests. They have previously been budgeted in the Breeder program and in other parts of the BES program. The major share of this shift is specifically associated with the assuming by BES of landlord responsibility for ANL beginning in FY 1985. A significant backlog has developed at ANL for both GPE and GPP items. The capabilities of the Laboratory have been jeopardized as a result. The FY 1985 budget attempts a first step in a necessary replenishment in these two areas.

The FY 1985 budget request of $8,840,000 for capital equipment includes, for the first time, $2,000,000 for GPE at ANL, as mentioned earlier. It also includes $140,000 for GPE at the Ames Laboratory. The remaining $6,700,000 in the request is $320,000 above the level contained in the FY 1984 budget. It represents a continued attempt to replace equipment researchers are using. At the same time other requirements must be served: replacement of outworn equipment, the equipping of the Chemical Sciences part of the National Synchrotron Light Source and continued rounding out and advancement of the largely laser based equipment at the Combustion Research Facility.

The FY 1985 request for construction, again an explained above, includes for the first time, GPP funding at ANL ($5,000,000), the Ames Laboratory ($600,000), Notre Dame Radiation Laboratory ($50,000) and the Stanford Synchrotron Radiation Laboratory ($100,000).

For the Chemical Sciences subprogram itself, a significant construction project is requested for the Kansas State University Ion Collision Physics Facility and associated machines. In FY 1985, $2,000,000 is requested for this project which has a total cost to the Federal Government of $3,400,000. This facility will combine a remarkably high current source of highly charged, low velocity ions with existing accelerator-based research capabilities. The combination will be known as the Atomic Collision Physics

Institute; the State of Kansas will provide added funds for the building portion of this project. With the addition of this facility, US competitiveness in accelerator-based atomic physics, important for both basic scientific advances and fusion technologies, will be restored.

Finally construction funds for two Accelerator and Reactor Improvement and Modification projects are requested. At Argonne $200,000 will go to modification of the ANL ATLAS' accelerator to incorporate a beam line for atomic physics research. This will make available a high velocity beam of multiply charged heavy ions for study of interactions with atoms, ions, molecules, electrons and photons. The resulting knowledge will impact magnetic fusion and other energy technologies. At Brookhaven, $100,000 will allow improvements to be made to the x-ray facility at NSLS in order to permit atomic physics research. The improvement will enable research to be done on the interactions of intense, high energy x-rays with atoms and ions.

| | FY 1983 | FY 1984 | FY 1985 Request |
|---|---|---|---|
| Nuclear Sciences | | | |
| Operating Expenses | $ 30,644 | $ 37,900 | $ 49,755 |
| Capital Equipment | 1,556 | 2,150 | 2,950 |
| Construction | 0 | 270 | 300 |
| Subtotal | 32,200 | 40,320 | 53,005 |

Objectives of the Nuclear Sciences subprogram are: (1) measurement, compilation, and evaluation of nuclear data for fission and fusion energy technologies; (2) improvement of our knowledge of the chemical and physical properties of the actinide elements; (3) assurance of the availability for research of both isotopically enriched samples of the ordinary elements and samples of the man-made transplutonium elements; (4) operation of the Stanford Synchrotron Radiation Laboratory (SSRL), which shares use of the Stanford Positron Electron Asymmetric Ring (SPEAR) with the High Energy Physics program (Responsibility for operation of the SSRL was transferred from the National Science Foundation to BES in FY 1983); and (5) research on heavy ion accelerator technology and preparation for its evaluation as a driver for inertial confinement fusion applications.

The FY 1985 request includes $49,755,000 for operating expenses and $2,950,000 for capital equipment. Each of these activities which comprise this subprogram is discussed further below.

Nuclear Data

The goal of the Nuclear Data activity is to establish and maintain an accurate, complete, and accessible nuclear data base to meet long-term needs of the fission and fusion energy technologies and to support nuclear waste management and weapons development activities of the Department. The United States nuclear data effort is a well-integrated, time-tested activity involving data measurement, compilation, evaluation, processing, and dissemination. Measurement work is centered at the Oak Ridge Electron Linear Accelerator (ORELA); the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory is the focus of compilation and evaluation efforts.

Beginning in FY 1985, the Nuclear Science subprogram will assume greater responsibility for management and support of the national nuclear data system. In coordination with this subprogram, other nuclear-based programs (Nuclear Energy, Fusion Energy, Nuclear Regulatory Commission, and Defense Programs) are expected to participate by supporting data activities unique to the particular requirements of their respective technologies. This Nuclear Data activity will assume responsibility for the overall quality and breadth of the national nuclear data effort. The light water reactor industry participates in Cross Section Evaluation Working Group (CSEWG) activities and provides funds for special data projects through the Electric Power Research Institute (EPRI).

The request for FY 1985 ($11,380,000 operating and $700,000 capital equipment) maintains the overall DOE nuclear data activities at levels matched to national needs. This BES request includes funding for essential elements of the national nuclear data system that have previously been supported by Nuclear Energy. These elements include selected activities at Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Idaho National Engineering Laboratory (INEL), and Oak Ridge National Laboratory (ORNL).

Nuclear data needs are documented in great detail and are regularly updated: for the fission technology, as a part of the duties of the CSEWG; for the fusion technology, as a part of the duties of a special working group of the United States Nuclear Data Committee. The Office of Fusion Energy provides direct input to this special working group.

An important evaluation effort is currently under way involving scientists from the National Bureau of Standards (NBS), Los Alamos National Laboratory (LANL), ORNL and BNL who are attempting for the first time a simultaneous best fit to the major standard cross sections used in the Evaluated Nuclear Data File (ENDF), incorporating all the information on the covariances or correlations of the data measurements. Work is also proceeding on extensions of the ENDF formats that will permit the inclusion of more detailed data and make the file more useful for applications involving higher energy neutron reactions, e.g., fusion technology.

The second data base activity, the Evaluated Nuclear Structure Data File (ENSDF), is supported entirely by BES (with the exception of non-U.S. participants) and consists of a network of evaluators of "mass-chains" in the United States and abroad. Coordination, assembly, and production of the data file and the important continuing publication of revised "Nuclear Data Sheets" is performed by the NNDC. The United States ENSDF evaluation effort includes contributions from BNL, INEL, Lawrence Berkeley Laboratory (LBL), ORNL, and the University of Pennsylvania. A Radioactivity Handbook based on ENSDF is being prepared at LBL.

The BES Nuclear Data activity also includes a Nuclear Data Measurement effort in which the talents of experienced nuclear physicists are used at appropriate facilities to perform the difficult, painstaking measurements required to improve the data base. The major effort is carried out at the Oak Ridge Electron Linear Accelerator (ORELA). There, neutron cross sections can be measured efficiently with great resolution and over a wide range of energies. Three small university groups collaborate with ORNL staff in experimental work at the ORELA.

Measurements under way at the ORELA include studies of fast neutrons on materials of interest to the Office of Fusion Energy. A new high-resolution gamma-ray detector system has been developed for use in experiments designed to improve the understanding of neutron inelastic scattering at the higher energies of interest to the Fusion Energy program. Detector systems are being designed and tested to determine the capability of the ORELA to measure neutron-induced charged-particle spectra over a wide range of neutron energies and angles. For the fission technology, precise total cross section measurements from 0.01 eV to about 10 eV neutron energy will be carried out at the ORELA to determine resonance parameters of important fuel nuclides. The results should enable more reliable calculations of burn-up and a rational interpretation of applicable integral experiments.

Measurement efforts exploiting special facilities are carried out at several other national laboratories and at the NBS. Work devoted to the improvement of neutron standard cross sections is supported at the NBS, University of Michigan, University of New Mexico, and Idaho National Engineering Laboratory. Neutron cross-section measurements are also being supported at the University of Lowell, Ohio University, and the Triangle Universities Nuclear Laboratory (at Duke University).

Within the $500,000 in Capital Equipment funding requested for ORNL in FY 1985, $380,000 is planned for replacement of the 15-year-old computer used for data acquisition and on-line analysis at the ORELA with an efficient, modern computer system matched to ORELA's needs. To meet ongoing instrumentation requirements, a total of $200,000 is requested for BNL, INEL, LANL, NBS, and Pacific Northwest Laboratory (PNL).

Heavy Element Chemistry

This activity supports basic research in the chemical, physical, and nuclear properties of the actinide elements not only to increase our useful knowledge of these technologically important elements but also to contribute to a better understanding of the fundamental principles of physical science in general. Heavy Element Chemistry research supports a broadly-based effort in this area. The resulting knowledge meets some of the needs of DOE nuclear energy programs for specific information and data on the behavior of actinides in fuel reprocessing streams, in nuclear waste hosts, and in the environment. These high priority studies provide valuable information for the development and closure of the nuclear fuel cycle.

Research groups at national laboratories and universities are supported to pursue heavy element and radiochemical investigations. While some tracer work is done at universities, the study of actinide chemistry is largely limited to the national laboratories since high levels of radioactivity are involved. These laboratory facilities provide opportunities for visiting scientists from university and foreign labs to pursue collaborative research with the U.S. investigators.

A significant accomplishment of the past year was the first measurement of the metallic vapor pressure of the man-made element einsteinium. This is the heaviest and highest atomic number element for which this fundamental thermodynamic measurement has been made. The results confirm recent theories of the physical properties of the actinide metals and contribute significantly to our understanding of the actinide elements in particular and the relationship of these elements to the rest of the Periodic Table.

The recent National Academy of Sciences Workshop on the Future of Transplutonium Element Research recommended the maintaining and expanding of basic research in this field. Study of this region of matter of highest atomic mass is expected to provide new insights into the chemical, physical, electronic, magnetic, and solid state properties of matter in general.

Operating funds for Heavy Element Chemistry in FY 1985 are requested at the level of $5,125,000, an increase of $434,000 above FY 1984. These funds will maintain the ongoing program of the study of the actinide elements both for the increase of our fundamental knowledge as well as a better understanding for the solution of technological problems. Consideration will be given to specific recommendations of the Workshop and new experiments will be implemented.

The request for capital equipment is $350,000. This will provide for necessary replacements of some items of equipment and instrumentation used for the studies in the base program and for mounting certain of the experiments recommended by the Workshop.

Isotope Preparations

The electromagnetic isotope separation facility (Calutrons) at the Oak Ridge National Laboratory provides isotopically enriched materials for sale and loan [from a Research Materials Collection (RMC) or "loan pool"] to an international community for a wide variety of medical, industrial, and research applications. By far the majority of Calutron samples are stable (nonradioactive) isotopes. The DOE fission and fusion energy development technologies are critically dependent on a continuing supply of these materials for measurement of neutron reaction cross section data needed in reactor design and for an understanding of fission fuel behavior.

The isotopes of the heavy actinide elements are produced by sequential operations at ORNL's High Flux Isotope Reactor and the Transuranium Processing Plant (HFIR and TRU). The principal purpose of HFIR and TRU is to produce research quantities of the very high atomic number actinide elements for the use of the Heavy Element Chemistry and other DOE programs. These facilities are the sole source of californium-252 for the fabrication of neutron sources for loan and sale and for DOE research programs. It must be noted, too, that an important additional function of HFIR is providing one of the world's highest fluxes of neutrons. These are used by researchers in neutron scattering studies of solid state properties of matter and as a neutron irradiation source for the study of neutron damage of materials. Neutrons from HFIR are also used for the production of radioisotopes for research and sale. The costs for these research activities, other than providing the neutron flux itself, are not borne by the Nuclear Sciences budget.

The operating funds request for Isotope Preparations for the FY 1985 request is $16,970,000, an increase of $4,731,000 over FY 1984. Of this increase, $2,024,000 is needed for the higher cost of maintaining the operation of HFIR and TRU; another $1,020,000 is needed to expand Calutron operations to two segments for a full 12 months. This substantial increase is vitally needed to increase the production of stable and long-halflife actinide isotopes for DOE programs in research and technology development and for the buildup of depleted RMC inventories needed for research loans and for sales. Also in this increase, $1,450,000 more is needed to meet the projected HFIR fuel inventory increase and $237,000 is required to meet other programmatic requirements such as decontamination and decommissioning costs at the Mound Laboratory. Just as with the Materials Sciences support of the BNL High Flux Beam Reactor, this change in inventory costs stems from the higher cost of the newer fuel elements, the need to maintain an efficient level of effort in launching the new fabricator, and replenishing of the fuel inventory, which was drawn down during the change of fabricators.

The capital equipment request for Isotope Preparations is $650,000. Funds are requested to continue the Calutron modernization and upgrade program started in FY 1983. This facility was originally built during the Manhattan Project and most of the supporting equipment is seriously worn and unrepairable. New equipment is needed to minimize the possibility of component failure and facility shutdown.

In addition, $300,000 is requested for accelerator improvements at the High Flux Isotope Reactor. This project will provide for modifications to permit remote sampling of the containment atmosphere and the primary coolant. Emergency sampling components will consist of items such as the necessary piping, pumps, valves, instrumentation, penetrations, and collection stations. In the unlikely event of a fission product release to the primary coolant and/or the reactor containment system, the remote sampling capability would aid in evaluating the extent of the release and enhance the recovery process.

Stanford Synchrotron Radiation Laboratory

SSRL, a key facility in maintaining U.S. leadership in synchrotron radiation, provides high quality and steadily improving capabilities for much of the user community in the U.S. and the Free World. The radiation arises from either magnetically steering fast-moving electrons around the evacuated ring of the Stanford Positron-Electron Asymmetric Ring (SPEAR) or from sequences of magnets ("wigglers" or "undulators") inserted to affect the electrons' path. SSRL shares equally with the High Energy Physics program the operating time and costs of SPEAR. In the enhancing of SSRL's capabilities so as to help maintain the strong U.S. lead in synchrotron radiation research, SSRL works closely with LBL, other DOE laboratories and some leading industrial scientific organization such as Bell Laboratories, Exxon Research and Engineering and IBM. Coordination is also strong with other facilities such as the National Synchrotron Light Source. Research using this unique type of radiation is advancing rapidly especially because of these two major DOE facilities, opening new possibilities in understanding catalysts, physics of ions, crystal dynamics, biological functions on a molecular level, nonintrusive medical diagnostics to replace more hazardous procedures, and many more areas. The costs of supporting SSRL include a half share of operating SPEAR, for time periods dedicated to producing the desired energies and intensities of synchrotron radiation. SSRL costs also include the staff and facilities to assist the visiting users with safety and operating procedures, since most of the users are scientists from other institutions (whose proposals have been carefully screened and reviewed by their peers). The FY 1985 request for operating funds for SSRL is $7,980,000, or $1,255,000 above the FY 1984 level. This increase is needed for several reasons: overdue correction of long standing understaffing; added people to assist with the growing number of experimental stations; increased efforts in development of SSRL's enhanced capabilities, some of these for DOE purposes; and strengthened research by SSRL's in-house scientists, at DOE's suggestion, in order to have sounder assistance to, and collaboration with, visiting scientists; and, finally, stepped up activities in preparing for use of the enhanced capabilities.

The requested FY 1985 capital equipment funds for SSRL are $600,000, a $110,000 increase above FY 1984. This is a tightly constrained equipment request in the above-noted framework of added activities.

Heavy Ion Fusion Accelerator Research

The goal of the Heavy Ion Fusion Accelerator Research (HIFAR) program is to develop heavy ion accelerator technology and perform appropriate ion-beam experiments to the point where an adequate data base exists for evaluation of heavy ion inertial fusion drivers and their possible use in civilian power applications of inertial confinement fusion.

The Heavy Ion Fusion Program was conducted by the Office of Inertial Fusion within Defense Programs from FY 1977 through FY 1983. In accordance with Congressional guidance and an agreement between the Assistant Secretary of Defense Programs and the Director of Energy Research, the accelerator research program was transferred to the Office of Energy Research. Beginning with FY 1984 funding has been sought directly for energy applications. Prior program accomplishments include numerous theoretical studies, conceptual designs, and minimal hardware studies. The promise of the heavy ion accelerator approach for fusion power has been the subject of a number of technical workshops and extensive reviews which have been uniformly favorable in their conclusions. A revised multi-year plan was formulated in connection with the transferred program. A recent JASON Panel considered the proposed National Plan for Heavy Ion Fusion to be a sensible next step in the program.

The revised program is based on the need for experimental verification of the previous theoretical studies at an appropriate scale. A two-stage plan has been formulated. The first stage (FY 1984-1986) primarily entails the research and development of critical elements of promising accelerator technologies with particular attention to the use of multiple beams for cost reduction. The second stage calls for a high-temperature experiment (HTE) in which a high temperature (50-100 eV) solid-density plasma would be created. Planned for FY 1987-1989, the HTE would entail the construction of an accelerator suitable for verification of the design principles of a reactor-driver accelerator and for verification that target heating predictions are correct. Production of high temperature in a solid-density plasma would represent a truly significant entry of accelerator technology into the parameter range needed for inertially confined fusion. It would settle questions relating to energy deposition and beam propagation, besides providing a crucial benchmark in the development of accelerators for fusion power. Given the long-established accelerator technology history that can guarantee repetition-rate, efficiency, and reliability, HIF could then be reliably evaluated as a serious candidate for a fusion power system for the next century.

In preparation for the high-temperature experiment it is crucial to have certain data from experimental tests on transport, acceleration, and the selected method for current amplification. Issues to be addressed in Stage I include: predicted transport space-charge limits on beam current; stability, reproducibility, and reliability of intra-pulse and pulse-to-pulse operation; accelerator cost reduction; preservation of beam quality including stability and containment of the high charge-density pulse; and final compression, transport, and focusing of the beam to the target.

The request for FY 1985 is $8,950,000 including $8,300,000 operating expenses and $650,000 capital equipment. This level of funds will provide 10 of an estimated 30 accelerating/focusing cells required for a "multiple beam experiment" which will serve to define and verify the HTE accelerator design. The remaining cells would be assembled in FY 1986. Principal FY 1985 milestones include completion of a multiple beam injector in addition to the 10 acceleration/focusing cells noted. The principal experimental work will be conducted at the Lawrence Berkeley Laboratory, with Los Alamos National Laboratory providing injector development and serving as lead laboratory.

| | FY 1983 | FY 1984 | FY 1985 Request |
|---|---|---|---|
| Applied Mathematical Sciences | | | |
| Operating Expenses............................ | $ 13,850 | $ 14,670 | $ 28,250 |
| Capital Equipment............................. | 800 | 970 | 1,500 |
| Subtotal..................................... | $ 14,650 | $ 15,640 | $ 29,750 |

The Applied Mathematical Sciences subprogram consists of two activities: Supercomputing Research and Energy Science Advanced Computation. The Supercomputing Research activity funds research in mathematical and computational sciences that is critical to the use and development of future supercomputer systems. The Energy Sciences Advanced Computation activity will provide network access to large-scale scientific computing required by several Departmental programs in the basic research activities funded by the Office of Energy Research in universities and national laboratories.

The first objective of the Applied Mathematical Sciences subprogram is to advance the understanding of the fundamental concepts of mathematics, statistics, and computer science underlying the complex mathematical models of the key physical processes in energy systems. Much of the scientific research and development effort throughout DOE programs is focused directly on analytical and numerical modeling of physical processes. An understanding of the fundamental principles upon which these models are based is important for developing energy systems for the future. Thus, research in mathematical analysis, algorithms, and computational techniques is crucial in conducting most scientific investigations.

The second objective is to meet the immediate needs for supercomputer access of the Department of Energy's High Energy and Nuclear Physics, Biological and Environmental Research, and Basic Energy Sciences programs and the long-range needs of the Department in computational research. This subprogram will make a substantial contribution to solving the national problems of providing access to supercomputers for energy researchers and ensuring that the U.S. maintains its lead in computational sciences related to supercomputer technology.

Supercomputers are playing an increasingly important role in many of the Department of Energy's programs. Every generation of large scientific computers has had a significant impact on the ability of the DOE laboratories to meet their mission goals. Each new machine has improved the laboratories' abilities to more accurately model complex physical phenomena thus improving their productive capability and reducing dependence on empirical scaling. This is particularly true in the design and testing of nuclear weapons and more recently in controlled nuclear fusion research. DOE programs in fundamental physical sciences are just beginning to use supercomputers as "experimental" devices for theoretical calculations. The need for large scale scientific computers is emerging in high energy, condensed matter, chemical and biological theory. Ab initio calculations for quark confinement, critical phenomena in alloy solidification and superconductors, ground state properties of chemical mixtures, and properties of long-chain polymers are providing insight into the basic properties of matter. The Energy Science Advanced Computation subprogram will provide increased access to researchers for these areas of research, many of whom had to travel to Europe to obtain access to advanced computers.

The Supercomputing Research activity retains the traditional roles of the vendors, DOE laboratories, universities, and Government. The activity planned will expand the long range research program in advanced computer architectures, algorithms, and software. The development of advanced supercomputer mainframes will continue to be carried out by the vendors without direct Government support. The Government will continue to be a friendly buyer.

The DOE scientific research community comprises a large fraction of this country's expertise in large scale computational modeling. With sufficient support and coordination, major advances in this area can be made in this decade by combining the skills of mathematicians and computer scientists to maintain our leadership in understanding the basic principles required for future development of energy systems. Coordination with the scientific community and other Federal agencies is carried out by participation in the Interagency Committee on Extramural Mathematics Programs and Federal Coordinating Council on Science, Engineering, and Technology panels.

Recent accomplishments in this subprogram include the following:

o Five Future Supercomputer Research Machines Tested:

  Initial tests have been completed on five research parallel processor systems that are being used to investigate a variety of approaches to the ultimate goal of simultaneous use of thousands of processors on a single problem. NYU/Courant Institute has a two processor ultracomputer prototype working. An eight processor dataflow prototype is running at MIT. A four processor-by nine memory device version of the Texas Reconfigurable Array Computer is running at the University of Texas. Los Alamos concluded an arrangement for leasing a Denelcor HEP-1 machine for the experimental computer program. They have already presented results of several physics problems on that machine and its availability in an open research environment should provide dramatic insight in concurrent processing on large scale DOE modeling problems. The new Cal Tech project started in FY 1983 is building on results already obtained on their four processor homogeneous machine. They have reported the calculation of theoretical masses of elementary particles on that system.

o Mathematical Analysis of Combustion Processes

  The Applied Mathematics group at LBL reports significant improvements in the mathematical modeling of combustion processes and gas dynamics. Two recent PhD students have demonstrated numerical techniques for modeling turbulent combustion that predict phenomena not yet seen in experiments, including the effect of exothermic reactions and viscosity on the combustion of fuel in a closed chamber.

<u>Supercomputing Research</u>

This activity funds basic research at the national laboratories, universities, and private research institutions in three major categories: Analytical and Numerical Methods, Information Analysis Techniques, and Advanced Computing Concepts. In addition, experimental computing capabilities are being established as research facilities to support the exploration of new concepts in large scale scientific computing.

In FY 1985 an enhancement in the large scale scientific computing activity is planned, with emphasis on algorithms for large scale parallel architectures based on several experimental computer systems under study. This program will greatly accelerate the pace of projects in parallel supercomputing so that some of the research machines can be brought to a usable state as soon as possible. Also included in the plan is an expanded participation by interdisciplinary teams working on problem decomposition, algorithm development, numerical analysis, performance evaluation, and languages for highly parallel analysis.

In FY 1985 a total of $21,250,000 in operating funds, an increment of $6,580,000 over the FY 1984 level, is requested to expand the long range research program in large scale scientific computing.

An increment of $1,500,000 will be used to enhance the subactivity in Analytical and Numerical Methods. This subactivity supports the investigations of the fundamental properties of mathematical models used to simulate complex physical phenomena observed in energy systems. This category includes applied analysis, numerical methods for solving large systems of differential equations, and numerical analysis of algorithms.

The subactivity in Information Analysis Techniques will be expanded with an increment of $1,850,000. This subactivity supports the investigation of data management and statistical analysis of large scientific data sets common in DOE mission programs, such as High Energy Physics, Magnetic and Inertial Fusion, and others.

The subactivity in Advanced Computing Concepts will be expanded with an increment of $3,230,000 in order to provide additional research staff, graduate students, and engineering support for research machines being invesigated at universities and laboratories that have demonstrated viable designs for novel architectures. This activity meets a wide range of problems associated with the effective use of large scale scientific computers for modeling energy systems. The areas of research include software engineering techniques for design of quality mathematical software, display techniques for scientific data sets, and parallel architectures for high performance scientific computers. A variety of new techniques for decomposing large problems to execute on a large number of concurrent processors is being investigated in DOE laboratories and universities. These techniques will provide the insight needed to build the supercomputers of the 1990's.

These new architectures, employing several to perhaps hundreds or thousands of fast processors working concurrently to solve a single problem, require a thorough reexamination of all aspects of the solution method. Problems have to be decomposed into parallel parts for optimum execution. Algorithm characteristics such as accuracy, stability, robustness, and correctness of implementation must be investigated anew.

The R&D projects envisioned have two important facets requiring substantial cooperation and coordination among traditionally separate groups. One facet is the interdisciplinary teams of computational scientists, computer scientists, and mathematicians working on all aspects of large-scale scientific computing problems. Another facet is the cooperation of industry, government and universities on the design and engineering of several potentially strong candidate architectures.

The university researchers will play the major role in generating ideas and prototype software and in training graduate students in generating new applications. Government laboratory staff are in the forefront of tackling real world, large scale scientific problems and have unique resources for participating in these research projects. Industry likewise has a unique role in providing state-of-the-art production and testing facilities and would stand to reap great benefits in understanding future architecture and software issues that tend to limit industry use of supercomputers currently. The transfer of technology from the academic and laboratory research environment to industry would be as rapid as possible through these cooperative projects. The DOE program will be coordinated with the other agencies to share common facilities where possible, such as very large scale integration (VLSI) design facilities and component fabrication.

Energy Science Advanced Computation

The Office of Energy Research (ER) funds frontier research and development in many fields of science and engineering. ER has provided its research and development programs with state-of-the-art experimental facilities; however, most scientists in the ER programs (with the exception of magnetic fusion) have not had access to modern, large scientific supercomputers.

Because the ER scientists and engineers are located in DOE laboratories, universities, and industrial laboratories that are geographically dispersed throughout the country, the only practical solutions to the ER large-scale computing access problem are to establish a new network or to use an existing computer network. The network concept allows matching of computer resources to requirements across all ER programs rather than on an institution by institution basis.

As an interim solution to the ER computing problem, five percent of the Class VI computer time on the Magnetic Fusion Energy network was made available to other ER programs starting in May 1983. This does not represent a permanent solution because the MFE program currently has need for more computing capacity itself and the five percent of each of the two Class VI MFE machines satisfies only about ten percent of the ER program requirements. However, in the near-term, expansion of the MFE network to serve the additional ER users does represent a cost-effective solution.

For FY 1985, a total of $7,000,000 in operating funds is requested as a first step in expanding ER computing activities on the existing Magnetic Fusion Energy Computer Network to supply the large-scale computing needs of the High Energy and Nuclear Physics, Basic Energy Sciences and Biological and Environmental Research Programs.

Substantial data on the computing requirements of the Energy Research programs (with the exception of MFE) to be served by the network indicates that one additional state-of-the-art supercomputer system will satisfy those requirements in FY 1985. The costs associated with providing supercomputing resources for Energy Research scientists can be divided into the following three categories:

1. $3,500,000 for the lease and maintenance of the machine;
2. $1,500,000 for support staff to provide services for the broad spectrum of new users and applications;
3. $2,000,000 to expand the network communications and access facilities for these new users and to maintain the existing research computing facilities at the national laboratories.

In support of the operating program described above, $1,500,000 for capital equipment is needed for this subprogram in FY 1985. This request will permit the expansion of ER computing activities using the MFE Network to serve all Energy Research programs and will provide additional capital equipment for communications, peripherals and remote network access computing facilities. Specifically, $500,000 will be used for a hyper-channel and $400,000 for expanded disk storage. The remaining $600,000 will be allocated for communications equipment at selected energy research sites.

| | FY 1983 | FY 1984 | FY 1985 Request |
|---|---|---|---|
| Engineering and Geosciences | | | |
| Operating Expenses................................ | $ 17,200 | $ 19,000 | $ 20,795 |
| Capital Equipment................................ | 1,120 | 1,150 | 1,500 |
| Subtotal................................ | 18,320 | 20,150 | 22,295 |

This subprogram provides for the Department of Energy's principal long-term, fundamental research efforts in the disciplines of mechanical engineering and electrical engineering, as well as geology, geophysics and geochemistry. Topics are chosen for funding for their long-term importance to meeting the Nation's energy needs.

The FY 1985 request provides for continuing the principal lines of research now underway and for increasing by about ten the number of scientists and engineers anticipating in these important aspects of energy research.

In addition to the requests for operating funds discussed more fully in the next several paragraphs, $1,500,000 is requested for capital equipment including, for example, prototype remote handling equipment for research on intelligent control systems at Oak Ridge National Laboratory, and telemetry and computer interfacing equipment to link existing seismic networks and the new Center for Computational Seismology at Lawrence Berkeley Laboratory. The request for capital equipment is 7.2 percent of the request for operating funds which experience has shown is the minimum level for effective research in continuing projects and for meeting the critical needs for the work to be initiated in FY 1985.

Engineering Research

To meet the long term basic research needs of energy technologies and of industry Engineering Research pursues two goals: 1) to broaden the technical and conceptual base for solving future engineering problems in the energy technologies, and 2) to extend the body of knowledge underlying current engineering practice in order to open new ways for enhancing energy savings and production, prolonging useful equipment life, and reducing costs while maintaining output and performance quality.

All the energy technologies benefit from fundamental advances in the areas emphasized in Engineering Research. For instance, improved basic understanding of heat transfer is pertinent to all known energy technologies. Such advances are essential to ensure flexibility in meeting the Nation's future energy needs.

With the advent of inexpensive, compact computer hardware and powerful new analytical methods for nonlinear problems, generic energy related engineering research is generated increasing opportunities for significant advances. Those advances have the potential not only for valuable, even revolutionary changes in future energy systems, but also for major improvements in energy utilization and production in the next few years. This is signaled by both the pressure of proposals with important new ideas and the achievements to date of this relatively new activity.

This activity seeks the knowledge and data bases needed for reliable and economical implementation of computer aided energy engineering. Specific fundamental areas addressed are 1) Mechanical Sciences - including tribology, heat transfer, fluidized beds, and solid mechanics; 2) System Sciences - including process control, and instrumentation; and 3) Engineering Data and Analysis - including nonlinear dynamics, and data bases for energy engineering systems.

Recent accomplishments in Engineering Research include:

- The discovery of fatigue induced surface oxidation as an important mechanism for wear of unlubricated metal surfaces sliding in close contact, a potentially catastrophic condition inside machinery.

- Initial research on integrated thermionic circuits with an unexpectedly early application to fast computer terminal displays.

In FY 1985 at the request level for Engineering Research, $7,115,000, an increase of $765,000, support of carefully selected, generic, high quality engineering research in the existing program areas enumerated above will be maintained.

Most of the requested increment will be applied to studies of energy related nonlinear systems which continue to pose challenges to both research oriented engineers and their practicing colleagues. Current design practice, based on research conducted as long as 20 years ago, and the design tools then available, continues to be limited by the assumption that many systems do operate at nearly linear conditions. Indeed, they do not, but the tools and understanding to handle the more complex nonlinear conditions have not been available. There is little if any understanding of the dynamic response of these large-scale, nonlinear, distributed parameter systems. Recent relevant developments in applied mathematics and great advances in experimental techniques offer important new research opportunities in this field. Exploitation of these opportunities is essential for improving the performance of many of the nation's energy systems.

## Geosciences

To meet the Department's long-range needs for earth science information, the Geosciences activity supports research in geology, geophysics, geochemistry, rock mechanics, tectonophysics and solar-terrestrial physics.

This research is carried out principally at the DOE national laboratories and at universities. All of the projects are chosen for their special significance to present and future energy technologies. For example, coordinated projects in nuclear waste isolation and Continental Scientific Drilling address long-range national energy concerns. Studies of the temperature and tectonic history of subsiding basins are leading to a better understanding of the development of energy resources in nature and thus to their more effective exploitation. Development of new geophysical methods and of computer codes for improved modeling of geophysical data and their use in resource exploration are leading to improved methods of locating resources, modeling the earth's crust and identifying sites for nuclear waste isolation.

Geochemical studies of element migration and energy and mass transfer are providing the knowledge base needed to understand the mechanisms of energy and mass transfer in hydrothermal systems, the potential migration of radio-nuclides from a repository, and the concentration and location of mineral resources. Research in organic geochemistry is yielding an improved understanding of the origin, development and emplacement of gas, oil, and coal deposits, is identifying the sources of pollutants in these resources and may suggest ways of dealing with them. As the traditional sources of energy diminish, alternatives must be found. Further, the extraction and use of energy resources result in wastes, the safe disposal of which requires a thorough knowledge and understanding of the earth's structure and processes which, in turn, requires continued fundamental research. The development of an adequate base of knowledge in the geosciences is therefore critically needed for energy resource recognition, evaluation and utilization.

Recent Geosciences accomplishments include the following:

- Basic data on sound waves have led to discovery of a new approach to monitoring recovery of heavy oils. Results from studies at Stanford University show that very large reductions in acoustic wave velocities (50 percent) and wave amplitude (6 fold) occur upon heating heavy oil sands under in situ pressure conditions, and that the low frequency dielectric constant of rock is a very strong indicator of the water content. These results form the basis for remotely monitoring enhanced oil recovery. A field test of this approach to geophysical monitoring is being sponsored by the oil industry.

- A newly designed device to measure convective heat flow within a wellbore has been tested by Sandia National Laboratory scientists. This instrument represents a significant achievement in thermal measurements in boreholes, as previous measuring techniques could not distinguish between conductive and convective heat flow components. This new device functions by thermally perturbing the convecting medium and measuring the response of the medium to the perturbation. The rate of decay of the thermal pulse is related to the ground water velocity vector.

The request for FY 1985 operating expenses for the Geosciences of $13,680,000 provides for support of the geosciences activities in DOE along lines for which the scientific priority is high and which bear directly on the long range research needs of the Department. The $1,030,000 increase over FY 1984 will be used for limited strengthening of ongoing efforts.

The thermal regimes portion of the cooperative interagency Continental Scientific Drilling Program will be maintained with geophysical studies, but without the option for intermediate depth drilling in the geographic areas under study in the thermal regimes part of the national program (Valles Caldera and Long Valley).

This program has attracted substantial interest and support from industry and academia and the portions dealing with thermal regimes is especially appropriate for support by the Department of Energy. The other cooperating agencies are NSF and USGS. The increase requested for the Geosciences in FY 1985 will provide for strengthening of research on downhole techniques for operation in a very hostile environment (corrosive, and at high temperatures and pressures).

| | FY 1983 | FY 1984 | FY 1985 Request |
|---|---|---|---|
| Advanced Energy Projects | | | |
| Operating Expenses.................................. | $ 8,300 | $ 9,100 | $ 10,810 |
| Capital Equipment.................................. | 290 | 310 | 320 |
| Subtotal........................................ | 8,590 | $ 9,410 | $ 11,130 |

The objective of the Advanced Energy Projects subprogram is to explore the feasibility of novel, energy-related concepts, as they evolve from basic research. Such concepts are at an early stage of scientific definition and therefore would not qualify for support by technology programs. Because they are new and untried, those concepts invariably represent a high risk; to qualify for support they must also have the potential for an eventual high pay-off. Also supported is exploratory research on concepts that do not fit easily into the existing Department of Energy program structure. An area of major programmatic attention is the transfer of successful projects to proper technology programs; such transfers now are effected every year.

Support of exploratory research on novel concepts of the type described above is needed to provide the seed for technical innovation. However, such research does not generally qualify as basic research, where the objective is to gain knowledge and understanding of processes and phenomena in nature. Neither does it qualify as technology-related: the link with any specific technology needs yet to be established. Hence, the Advanced Energy Projects subprogram fills a very real void between basic and technology-related research.

Thus, for example, two novel approaches to controlled fusion--very different from those currently pursued--have been proposed as a result of basic research in elementary particle physics. Both muon-catalyzed fusion and quark-catalyzed fusion are being actively explored under Advanced Energy Projects sponsorship.

The mode of operation for this interdisciplinary, and still relatively new, subprogram is to support individual projects for a limited time only; it differs from other subprograms in that it does not fund ongoing evolutionary research. The spectrum of projects supported is very broad, encompassing, for example, the development of new sources of electromagnetic radiation, new methods of better fossil fuels utilization, totally new approaches to controlled fusion and new approaches to solar energy collection and utilization, just to name a few. Close contact is maintained with DOE technology programs to ensure proper coordination. Projects are selected on the basis of unsolicited proposals received from researchers at universities, industrial laboratories (especially small R&D companies) and national laboratories. At present, about forty projects are being supported, which allows a turnover rate of about fourteen projects a year. A recent accomplishment of Advanced Energy Projects is the measurement, for the first time, of fusion reaction rates in a scheme utilizing mu mesons as reaction catalysts. Even though the practicality of the scheme for power generation remains questionable, mainly because of the high cost of producing mu mesons, the demonstrated high reaction yield may lead to other applications, such as high-intensity neutron sources.

Last year continued to bring evidence of a wide recognition of Advanced Energy Projects as an important vehicle in promoting science-based technical innovation:

- o In March 1983 the American Physical Society held its first Symposium on Advanced Energy Projects. All five invited speakers were Principal Investigators on projects supported by this subprogram.
- o The annual Energy Technology Conference and Exposition held in Washington, D.C. in February 1983, devoted a special session to Advanced Energy Projects. Speakers at the session were Principal Investigators on projects supported by this subprogram.
- o Articles describing Advanced Energy Projects appeared in journals such as Chemical & Engineering News, and Physics Today.
- o On the initiative of Advanced Energy Projects a Symposium on Novel Sources of Electromagnetic Radiation was held in Germantown, Maryland in April of 1983. The symposium reviewed recent progress in areas such as x-ray lasers, free electron lasers, etc. Advanced Energy Projects is the Department of Energy's focal point for support of non-defense related work in this field.

The FY 1985 request for the Advanced Energy Projects subprogram is $10,810,000 in operating expenses and $320,000 in capital equipment funds. The funding level translates directly into the number of projects which this subprogram will be able to start each year; that is, the number of new concepts which will be given a chance of being explored in some depth. The increase requested will maintain the total number of projects supported at any given time at last year's level of about forty; with a typical turnover period of three years, this translates into about fourteen new starts in FY 1985. In addition, the subprogram will develop, on a modest scale, a new initiative in exploring novel sources of electromagnetic radiation such as optical klystrons, x-ray and gamma-ray lasers and free electron lasers. A need for such an initiative has been pointed out in a report of the Symposium on Novel Sources of Electromagnetic Radiation (April 21-22, 1983).

| | 1983 | 1984 | 1985 Request |
|---|---|---|---|
| Biological Energy Research | | | |
| Operating Expenses................................. | $ 9,500 | $ 10,580 | $ 12,490 |
| Capital Equipment.................................. | 370 | 400 | 560 |
| Subtotal........................................... | 9,870 | 10,980 | 13,050 |

The objectives of the Biological Energy Research subprogram are a) to develop an understanding of fundamental biological phenomena in plants and microorganisms that will underpin the development of improved strategies for enhanced productivity of renewable resources; b) to generate a base of fundamental information on which to construct new and improved microbiological conversions of materials into useful fuels and chemicals; and c) to explore and understand basic biological phenomena which may be employed in developing biosystems as substitutes for energy intensive chemical processes.

The general area of biotechnology has been identified worldwide, along with computer technology and robotics, as one of the most promising areas for future technology development. The basis of that projection derives in large part from the almost explosive recent development in capabilities for manipulating genetic materials. These capabilities have their foundation almost exclusively on advances made in basic biological understanding primarily in molecular genetics. It is equally apparent that the application of biotechnology will remain greatly dependent on continuing advances in fundamental areas of biology including physiology, biochemistry and genetics. Recognition of the promise of payoff from enhanced plant science research was provided in a recent OSTP-COSEPUP (Committee on Science, Engineering and Public Policy) report, "Research Briefings for OSTP, NSF and Selected Federal Departments and Agencies."

Biotechnology may be expected to impact the energy sector in a number of ways. Clearly the use of biological renewable resources is growing and the future improvement of green plant productivity employing genetic engineering and other cellular techniques is almost assured. Likewise in the fermentation of renewable resources to useful fuels and chemicals there is high promise that new biotechnology will be developed. A number of potential biotechnological systems have been proposed for amelioration of pollutants emitted in combustion. In addition a number of potential biotechnological systems have been proposed for preprocessing of fuels for cleaner combustion. There is growing activity aimed at utilizing microbial systems either directly or indirectly as part of enhanced oil recovery techniques. Further, the use of biosystems for displacing energy intensive chemical systems as an energy conservation measure are options that are receiving more attention. The speed with which each of these developments will occur is dependent on a number of factors including continuing advances in the information base, the price of energy supplies and the attractiveness of other features of biotechnology.

The Biological Energy Research subprogram is the only program in the Federal Government specifically aimed at generating the basic biological information in support of energy biotechnology development. The subprogram covers work in the plant and microbiological sciences almost exclusively. The research covers fundamental studies on the light energy conversion process of photosynthesis, basic processes of plant growth and development, the effects of stress on plants, studies to understand the adaptive mechanisms plants have developed to survive under suboptimal conditions, the basic processes of genetic transmission and expression of characters in plants, how plants manage the energy that is trapped photosynthetically with respect to metabolic pathways and localization of products, the basic patterns of regulation of biochemical pathways in plants and how plants interact with other organisms with respect to pathogenicity, symbiosis and other molecular and cellular interplays.

Microbiological studies encompass work on basic studies of a variety of fermentation pathways leading to fuel and chemical production, microbial degradation of lignin, hemicelluloses and cellulose, the biological basis of methanogenesis; and how microorganisms deal physiologically and biochemically with harsh conditions, e.g., extremely high temperatures and total absence of oxygen (anaerobicity). The program emphasizes the genetics of little studied, but important, microorganisms in bioconversions, how microbes interact and form consortia to carry out complex metabolic conversions, and regulatory mechanisms that determine how the organisms grow and produce particular chemical products.

A major share (75%) of the work is conducted at university laboratories, the remainder is located at national laboratories.

Some representative recent accomplishments include:

- For the first time it has been possible to quantitate genetic transposition (movement of genes within the genome) in a higher organism. This was done in maize by following the frequency of movements among male fertility restorer genes in male sterile lines.

- The gene coding for susceptibility to the herbicide atrazine in plants has been identified, cloned and sequenced. A mutant gene which is responsible for resistance to the herbicide activity has likewise been studied. The difference between the two is simply one nucleotide in the DNA sequence.

- *Agrobacterium* Ti plasmid, a DNA segment found in a bacterium has now been used to introduce alien genes into higher plants. The unwanted side effect of this plasmid, namely tumor formation in the recipient plant, has been abolished by eliminating one gene of the plasmid responsible for the effect.

- o Stomata are tiny pores in the surfaces of leaves which control the entry and exit of gases (carbon dioxide, water, oxygen) to the interior cells of the leaves where photosynthesis occurs. Guard cells are cells that are part of the stomatal structure regulate the opening and closing of the pores and thus regulate photosynthesis. It has now been shown for the first time that individual guard cells may be studied using innovative microtechniques to gain a better understanding of regulatory behavior in guard cells.

There has been a significant increase in interest on the development of biotechnology in the industrial, university and federal components in the U.S. While industry has taken the lead in bringing on the commercialization of processes, there is a major role of the federal supported research network at universities and other laboratories to sponsor and conduct the vast amount of fundamental research requisite for any substantial industrial development of biotechnology.

The FY 1985 request for Biological Energy Research is $12,490,000 in operating and $560,000 in equipment. This represents a level which provides for a continuation of current activities. Specific areas of continued emphasis in FY 1985 will include:

- o Investigations on the molecular and cellular aspects of stress in plants, and studies in plant regulatory mechanisms,

- o Investigations on microbial interactions in bioconversions. In addition, interdisciplinary research in plant science and microbiology will receive some attention.

This level would allow a response to some of the numerous new proposals for very high quality research in these areas aimed at providing much needed fundamental information on which to base the nation's growing biotechnology industry.

This level of funding could also begin to address a need in the plant and microbial sciences, namely:

Establishment of interdisciplinary collaboration - the extremely impressive advances in genetic manipulation techniques will not be exploitable optimally unless there is parallel progress in the basic understanding of the characters which might be modified in plants and microorganisms. The complexity of biological systems is increasingly demanding the use of new and often more sophisticated techniques of physics and chemistry. Most investigators do not possess expertise in multiple areas. BER plans to initiate a very small number of interdisciplinary research groupings which focus on key plant and microbial science problems. These include studies on interactions of roots and soil, and metabolic regulation and the biosynthesis of important molecules. Only with an increasing injection of the more physical-chemical analytical approaches will it be possible to capitalize on the techniques of recombinant DNA and cell and tissue cultures to gain the depth of understanding needed in the plant and microbial sciences.

DOE is especially well equipped to pursue such interdisciplinary ventures because of its existing extraordinary strength in these areas as well as the flexibility available for organizing such groupings. The interdisciplinary initiatives would complement, not duplicate, research activities supported by the NSF and USDA.

| | FY 1983[a/] | FY 1984 | FY 1985 Request |
|---|---|---|---|
| Program Direction | | | |
| Operating Expenses................................ | $ 3,170 | $ 3,970 | $ 3,830 |
| Total FTE's........................................ | 56 | 62 | 62 |

[a/] Reflects comparability adjustment of 1 FTE and $70,000 from Magnetic Fusion Energy in connection with Applied Mathematical Sciences Research.

The FY 1985 request for Basic Energy Sciences Program Direction is $3,830,000, a decrease of $140,000 from the FY 1984 level. These funds are required to provide for the salaries, benefits, travel and related expenses associated with 62 full-time equivalents. This funding level represents a number of management savings while at the same time absorbing the increased personnel costs related to continuation of the FY 1984 staffing level. The increased workload resulting from growth in selected areas of the basic research program, management of the expanding Small Business Innovation Research Program (SBIR), and absorption of the expanded effort to meet the Department's future large-scale scientific computing requirements will require a considerable increase in staff productivity and more efficient management and coordination activities among the Headquarters, field, and contractor staffs.

Basic Energy Sciences is a broadly diversified program responsible for mission-oriented research, the chief purpose of which is to provide the fundamental scientific and engineering base on which the Nation's future energy options depend. Its staff must possess expertise covering many subfields in the areas of chemistry, physics, engineering, metallurgy, applied mathematics, geosciences and biology, as well as in administration, procurement and financial management. The staff is responsible for development, direction, and management of complex technical programs, each involving one or more of the scientific areas mentioned above. Their activities include assessing scientific needs and priorities of the program, developing long-range program plans, technical review of proposals from laboratories and universities, and monitoring the progress of ongoing university contracts, laboratory programs, and construction projects.

It is extremely important to appreciate the diversity and scope of the research effort involved in the Basic Energy Sciences program. In FY 1984, for example, approximately 1,300 research projects will be underway either at agency laboratories or at more than 150 colleges or universities in 45 states. Research projects are expected to increase in FY 1985. Evaluation, monitoring and management of this large number of diverse projects primarily from the Headquarters requires frequent contact with the contractors and laboratory staff and involves numerous workshops, planning meetings, and project reviews throughout the year.

During recent years research projects at universities have increased from 18 to 26 percent of the BES budget, and the workload per university project is significantly greater than that for a laboratory project. This is especially true with regard to evaluation of proposals, of which approximately 10 percent of those reviewed result in new contracts each year. A stable staff is required to maintain a strong core program; to evaluate research programs which have continued to grow in recent years in newer emerging priority areas having great potential importance to energy; to oversee management, operation, and ongoing construction of unique research facilities; and to promote early application of the results of this basic research.

In addition to the ongoing basic research program, the three-phase Congressionally mandated SBIR program (Public Law 97-219) will be entering its third year. Phase I was implemented in FY 1983 with 9,000 solicitations mailed, resulting in 1,734 proposals spread among 25 technical topics. There were 106 contracts awarded totaling over $5,000,000. The first year of operation resulted in heavier than anticipated workload with extensive overtime and assistance outside the SBIR staff. Workload in FY 1984 will increase even further as all 106 of the initial contractors are expected to submit proposals to enter Phase II of the program and new Phase I awards are also made. During FY 1985 the initial FY 1983 projects will enter the second year of Phase II, FY 1984 projects will enter their first year of Phase II, and new Phase I projects will begin. This results in substantial increases in the number of proposals to be processed and evaluated, increased procurements and projects to be monitored and evaluated, site visits for those projects entering Phase II, and increases in the number of debriefings requested by contractors not receiving awards.

Furthermore, this program now funds the scientific computing staff established to manage the newly assigned responsibilities related to large-scale scientific computing. This staff will manage two important activities related to large-scale scientific computing. Those activities are: (1) providing access to large computers for the researchers supported by the scientific programs of the Office of Energy Research; and (2) support of research in scientific computing necessary to meet the Department's long-range needs. Specific workload includes managing a number of research projects, including conducting peer reviews and evaluating proposals, performing economic and cost benefit studies and analyses of user needs, managing the Magnetic Fusion Energy computer network, and providing a single DOE focal point to maintain liaison with other Federal agencies, universities, and other concerned organizations.

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CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: General plant projects

2. Project No.: 85-ER-400

3. Date A-E work initiated: 1st Qtr. FY 1985

3a. Date physical construction starts: 2nd Qtr. FY 1985

4. Date construction ends: 4th Qtr. FY 1986

5. Previous cost estimate: None
Date:

6. Current cost estimate: $5,750
Date: 6/83

7. Financial Schedule:

| Fiscal Year | Obligations | Costs FY 1983 | FY 1984 | FY 1985 | After FY 1985 |
|---|---|---|---|---|---|
| Prior Year Projects | $ 300 | $ 100 | $ 0 | $ 0 | $ 0 |
| FY 1983 Projects | 300 | 200 | 100 | 0 | 0 |
| FY 1984 Projects | 400 | 0 | 300 | 100 | 0 |
| FY 1985 Projects | 5,750 | 0 | 0 | 2,300 | 3,450 |

8. Brief Physical Description of Project

This project is required to provide for minor new construction, other capital alterations and additions, and for buildings and utility systems. Where applicable, the request also includes the cost of installed capital equipment integral to a subproject. Funding of this type is essential for maintaining the productivity and usefulness of Department-owned facilities. Since it is difficult to detail this type of project in advance, a continuing evaluation of requirements and priorities may be expected to result in additions, deletions, and changes in the currently planned subproject. In general, the estimated funding for each location is preliminary in nature, and is intended primarily to indicate the relative magnitude of the requirements. No significant R&D program is anticipated as a prerequisite for design and construction of the subprojects under construction.

1. Title and location of project: General plant projects 2. Project No.: 85-ER-400

8. Brief Physical Description of Project (continued)

Included in our request for the first time in FY 1985 is full GPP funding for the Argonne National Laboratory. Previously, landlord responsibility at this laboratory has been with the Nuclear Energy - Breeder Program, but program shifts and restructuring necessitates the shift of this responsibility to the BES program.

Due to the recent budget constraints placed on the Breeder Program, the normal GPP requirements at the Argonne National Laboratory have deteriorated to the point that a major budget increase is required in FY 1985 to meet minimal laboratory requirements.

The currently estimated distribution of FY 1984 funds by office is as follows:

| | |
|---|---|
| Argonne National Laboratory | $ 5,000 |
| Ames Laboratory | 600 |
| Notre Dame Radiation Laboratory | 50 |
| Stanford Synchrotron Radiation Laboratory | 100 |
| Total project cost | $ 5,750 |

9. Purpose, Justification of Need for, and Scope of Project

The following are examples of the major items to be performed at the various locations. Since needs and priorities may change, other projects may be substituted for the examples listed below, and some of these may be located on non-Government owned property.

Argonne National Laboratory

Group I - Rehabilitation Projects - ANL-West

1. Replacement of Underground Steam and Condensate Piping
2. Rehabilitation of Industrial Waste and Drainage Ditches
3. Replacement of Power Poles

1. Title and location of project: General plant projects | 2. Project No.: 85-ER-400

9. Purpose, Justification of Need for, and Scope of Project (continued)

Group II - Rehabilitation Projects - ANL-East

1. Replacement of Water Chiller, Bldg. 202
2. Rehabilitation of Sewer System
3. Replacement of Water Chiller, Bldg. 205

Group III - Upgrade/Programmatic Projects

1. Thermochemical Properties Laboratory, Bldg. 205
2. Storage Building for EBR-II Water Treatment Chemicals, ANL-West
3. Upgrading of Variable Temperature Rooms, Bldg. 202

ANL allocates 50% of its GPP funds to plant rehabilitation and 50% for upgrading and programmatic projects. Given the relative size and condition of its two sites, ANL allocates 12.5% to ANL-West and 37.5% to ANL-East for rehabilitation projects. FY 1985 GPP funds of $7.0 million would thus allocate approximately $0.9 million to Group I, $2.6 million to Group II, $3.5 million to Group III.

At present, a total documented GPP backlog of $20.7 million exists, consisting of $1.2 million for ANL-West rehabilitation (Group I), $4.8 million for ANL-East rehabilitation (Group II) and $14.7 million for required upgrading and programmatic projects at both sites. Surveys made at both sites indicate that rehabilitation needs are fare more extensive; only those needs which are most critical are included in the above backlog. This backlog is not static and is constantly under review by ANL management so that the most critical requirements are taken care of as promptly as possible with available GPP funding. These requirements may come about as the result of the unscheduled failure of major plant components or the need to satisfy scientific program requirements. A recent example of unanticipated system plant component failures was the recent destruction of the roof over the Hot Fuel Examination Facility at ANL-West in a recent storm which required an immediate shifting of ANL priorities to provide the necessary construction funds for replacement of the roof.

The backlog of GPP projects has tended to increase steadily in recent years due to the shortfall in funding line item requests for plant rehabilitation at ANL-East and ANL-West, and because of programmatic shifts at ANL which have required modifications to the existing plant. When it is considered that total GPP funds available to ANL in FY 1983 and FY 1984 total only $2.1 million, it is readily apparent that ANL needs are far outpacing the availability of funds with which to satisfy them.

1. Title and location of project: General plant projects    2. Project No.: 85-ER-400

9. Purpose, Justification of Need for, and Scope of Project (continued)

Ames Laboratory........................................................................... $ 600

Requirements include for example: renovation of obsolete radioactive facilities; upgrading piping and pumps in the central steam plant; and energy conservation and safety components.

The probjects described will be constructed on the Ames Laboratory, non-Government owned property.

Notre Dame Radiation Laboratory........................................................... $ 50

Requirements include minor building modifications to properly house staff members and to make optimum use of laboratory research space.

The probjects described will be constructed on the Notre Dame Radiation Laboratory, non-Government owned property.

Stanford Synchrotron Radiation Laboratory............................................. $ 100

Requirements include a necessary safety upgrade of the hazardous gas exhaust system and an optics evolution laboratory for evaluation of the surface quality of mirrors before and after coating.

The probjects described will be constructed on the Stanford Synchrotron Radiation Laboratory, non-Government owned property.

10. Details of Cost Estimate

See description, item 8. The estimated costs are preliminary and, in general indicate the magnitude of each program. These costs included engineering, design, construction and inspection.

11. Method of Performance

Design will be on the basis of negotiated architect-engineer contracts. To the extent feasible, construction and procurement will be accomplished by firm fixed-price contracts and subcontracts awarded on the basis of competitive bidding.

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ENERGY SUPPLY RESEARCH AND DEVELOPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: Accelerator improvements and modifications, various locations

2. Project No.: 85-ER-401

3. Date A-E work initiated: 1st Qtr. FY 1985

3a. Date physical construction starts: 1st Qtr. FY 1985

4. Date construction ends: 4th Qtr. FY 1986

5. Previous cost estimate: None
Less amount for CP&D: None
Net cost estimate: None
Date:

6. Current cost estimate: $2,400
Less amount for CP&D: 0
Net cost estimate: $2,400

7. Financial Schedule:

| Fiscal Year | Authorizations | Appropriations | Obligations | Costs |
|---|---|---|---|---|
| 1985 | $ 2,400 | $ 2,400 | $ 2,400 | $ 1,000 |
| 1986 | 0 | 0 | 0 | 1,400 |

8. Brief Physical Description of Project

This project provides for additions and modifications to accelerator and reactor facilities, which are supported by the Basic Energy Sciences program. Since program priorities and needs change, the projects described below indicate the most likely projects to be funded. A continuing evaluation, however, is necessary to ensure that those projects with the greatest productivity are funded. Three projects at the Brookhaven National Laboratory are requested to incorporate improvements at the High Flux Beam Reactor and the National Synchrotron Light Source.

Three projects are requested at the Oak Ridge National Laboratory for improvements at the Bulk Shielding Reactor, Holifield Heavy Ion Facility, and at the High Flux Isotope Reactor. In addition, one project is requested at the Argonne National Laboratory for modifications at the Atlas accelerator.

1. Title and location of project: Accelerator improvements and modifications, various locations

2. Project No.: 85-ER-401

9. Purpose, Justification of Need for, and Scope of Project

The following are the projected items of work to be performed at the various locations. Since needs and priorities may change, other projects may be substituted for the examples listed below, and some of these may be located on non-Government owned property.

Brookhaven National Laboratory

High Flux Beam Reactor Facility (HFBR)........................................................ $ 500

Funds are requested to assure the safe and efficient operation of the HFBR. Funds requested will be used for monitoring devices within the reactor, electronic transducers, process recorders, and emergency generators.

National Synchrotron Light Source (NSLS).................................................. $ 1,200

Funds requested are for the total NSLS research facility which needs annual modifications, improvements and additions. Included are improvements for the: replacement components for X-ray and VUV lines, beam diagnostic devices, power supplies, vacuum, RF systems, and magnet systems. In addition, improvements will be made at the x-ray ring of the NSLS facility in order to establish a capability for atomic physics research. The main components to be added are a radiation enclosure and a photon analysis system consisting of a monochromator, a mirror for x-rays and a high vacuum pumping system, all of which will be coupled to the x-ray ring. The improvement will allow for study of the interaction of intense, high energy x-rays with atoms and ions. These will improve the performance of the NSLS and therefore will enhance the usefulness of the facility for basic research.

1. Title and location of project: Accelerator improvements and modifications, various locations

2. Project No.: 85-ER-401

9. Purpose, Justification of Need for, and Scope of Project (continued)

Oak Ridge National Laboratory

High Flux Isotope Reactor (HFIR)........................................................................ $ 300

This project will provide for improvements to those portions of the Critical Experiment Facility used to perform safety related reactivity measurements required by the High Flux Isotope Reactor (HFIR) Technical Specifications on all new HFIR fuel assemblies by replacing obsolescent facility safety and operating instrumentation with new instrumentation, and adding capability which will permit the required measurements to be made in the subcritical code. These measurements are safety related and are required to ensure compliance with the HFIR Technical Specifications. The presently installed safety and operating instrumentation is almost entirely early model vacuum tube equipment, some of it up to approximately 30 years old and difficulties are anticipated in maintaining and spare parts for this equipment as it ages further. Therefore, replacement of this obsolscent instrumentation with up-to-date equipment will help enhance future reliable operability of this facility.

Bulk Shielding Reactor........................................................................ $ 200

Funds requested are for slight modifications of the neutronics characterization through the reconfiguring of reflector and absorber components so that the research program will have access to the highest neutron flux available.

Argonne National Laboratory

Atlas Accelerator........................................................................ $ 200

The ANL ATLAS accelerator will be modified to incorporate a beam line for atomic physics research. A beam of selected heavy, multiply charged ions traveling with high velocities will be made available by the modifications and will allow study of interactions of these ions with atoms, other ions, molecules, electrons and photons. Knowledge important to energy technologies, especially magnetic fusion, as well as depended understanding of physics are expected. The principal components of the beam line are magnetic quadrupole focusing elements, control slits, beam profile monitor, steering plates and Faraday cups. An all metal high vacuum system pumped principally by two cryopumps and one ion pump will be installed. Electronic and power supplies associated with these elements will be added.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Accelerator improvements and modifications, various locations

2. Project No.: 85-ER-401

10. Details of Cost Estimate

| | | |
|---|---|---|
| a. | High Flux Beam Reactor Facility | $ 500 |
| b. | National Synchrotron Light Source | 1,200 |
| c. | High Flux Isotope Reactor | 300 |
| d. | Bulk Shielding Reactor | 200 |
| e. | Atlas Accelerator | 200 |
| | Total Project Cost | $ 2,400 |

11. Method of Performance

Design, engineering, and inspection will be performed by laboratory staff. To the extent feasible, construction and procurement will be accomplished by fixed-price subcontracts awarded on the basis of competitive bidding.

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BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: Stanford Synchrotron Radiation Laboratory Enhancement
Stanford Linear Accelerator Center
Stanford, California

2. Project No.: 85-ER-402

3. Date A-E work initiated: 1st Qtr. FY 1984

3a. Date physical construction starts: 2nd Qtr. FY 1984

4. Date construction ends: 4th Qtr. FY 1986

5. Previous cost estimate: $12,930

6. Current cost estimate: $13,030
Less FY 1983 PE&D: 100
$12,930
Date:

7. Financial Schedule:

| Fiscal Year | Authorizations | Appropriations | Obligations | Costs |
|---|---|---|---|---|
| 1984 | $ 1,240 | $ 1,240 | $ 1,240 | $ 1,240 |
| 1985 | 11,690 | 9,130 | 9,130 | 8,630 |
| 1986 | 0 | 2,560 | 2,560 | 3,060 |

8. Brief Physical Description of Project

The Stanford Synchrotron Radiation Laboratory (SSRL) Enhancement will be located at the Stanford Synchrotron Radiation Laboratory. SSRL is colocated with the Stanford Linear Accelerator Center (SLAC) on Stanford University property that has been leased to the Department of Energy.

The SSRL Enhancement project will include the construction of new conventional and research facilities and the alteration of and additions to existing facilities for the purpose of providing ultra-high brightness synchrotron radiation from insertion devices (wigglers and undulators).

The project is divided into three major portions: (a) construction of two beam lines, one on the SLAC Positron Electron Project (PEP) storage ring and one on the SLAC SPEAR storage ring; (b) alteration of the electron storage ring SPEAR for high flux synchrotron radiation research and (c) construction of three conventional facilities: a PEP Beam Line Facility (PBF) (3,500 GSF), a Light Assembly Shop (LAS) (8,600 GSF), and a Laboratory/Office Building (LOB) (19,800 GSF).

1. Title and location of project: Stanford Synchrotron Radiation Laboratory Enhancement
Stanford Linear Accelerator Center
Stanford, California

2. Project No.: 85-ER-402

8. Brief Physical Description of Project (continued)

SSRL Conventional Construction

The site at PEP chosen for the PEP Beam Line and the associated facility -- (PBF) is just within the existing SLAC lease boundary and it will not be necessary to acquire more land from the University for the facility. The site requires a retaining wall for the access road, service yard, and PBF building which will be half buried into the PEP ring earth shielding mount. The PBF will be an experimental hall with three adjoining rooms and partial mezzanine. The Light Assembly Shop (LAS) will consist of a Vacuum Clean Room, and Vacuum Shop Office, a Beam Line Component Assembly Shop, a small Machine and Welding Shop, a Machine Shop Office, a Beam Line Component Storage Deck, and support rooms. The Library/Office Building (LOB) will be a two story building. The upper floor will provide up to 43 offices, a library, a conference room, a drafting room, a lounge-kitchen area; seven work rooms and two HVAC equipment rooms. The ground floor will provide a receptionist area, two large work rooms, up to 24 offices, an x-ray lab, a meteorology lab, a VUV lab, an electronics lab and four lab storerooms.

The optimum location for the LOB is presently occupied by an existing SLAC liquid hydrogen facility which SSRL will relocate to a new site selected by SLAC.

Special Facilities

A 26-period, 2-meter rare-earth cobalt undulator magnet will be installed on the PEP storage ring to produce photon beams peaked at 13 KeV. A scattering beam line will originate with a 54-pole rare-earth cobalt wiggler magnet. Machine improvements will include reduction of SPEAR emittance and vertical aperture, beam stabilization, and a new LINAC electron injection system.

9. Purpose, Justification of Need for, and Scope of Project

Over the past decade, the development of synchrotron radiation has led to major advances in a number of different scientific and technological fields, but particularly materials science, condensed matter physics and chemistry, as well as the biological sciences. Each order of magnitude increase in photon flux or spectral brilliance achieved during this period has resulted in qualitatively new experiments which provide previously unobtained information and yield new understandings.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Stanford Synchrotron Radiation Laboratory Enhancement
Stanford Linear Accelerator Center
Stanford, California

2. Project No.: 85-ER-402

9. Purpose, Justification of Need for, and Scope of Project

The most significant recent advances in photon flux and brilliance have been, or will be, the result of: (a) the development of insertion devices (wigglers and undulators) at SSRL and (b) improvements in storage ring characteristics (reduction of emittance and increases in current).

As a result, new storage rings are presently being planned which are optimized for high spectral brilliance and photon flux through utilization of insertion devices, rather than bending magnets, for the production of radiation and through the achievement of extremely low emittances and high currents. These rings are also optimized for specific spectral regions through choice of stored electron energies. Generally, stored electron energies at 1.0 to 1.5 GeV are utilized for ultra-high brilliance soft x-ray and vacuum ultraviolet (VUV) generation whereas rings of greater than 3.0 GeV are used for ultra-high brilliance x-ray generation.

The SSRL improvements described here will rapidly and economically yield major increases in the photon flux and spectral brilliance available at SSRL in all spectral ranges. In addition, x-ray spectral brilliance far beyond those achieved or proposed elsewhere in the world will be obtained. The SSRL construction will also increase the time available for dedicated synchrotron radiation operation of the storage ring SPEAR and increase the effectiveness of utilization of the radiation. At the same time, it will provide for testing and development of individual insertion devices as well as the techniques for utilizing many insertion devices on one storage ring.

The existing Stanford Synchrotron Radiation Laboratory has outstanding user facilities that can be dramatically and quickly improved in the hard x-ray region, thereby providing researchers with unparalleled photon brightness over an extended portion of the electromagnetic spectrum. A past 100-fold improvement to SSRL intensity in the soft x-ray region involved the installation at SPEAR of a permanent magnet undulator conceived and built at LBL. A current LBL/SSRL collaboration will provide a 50-fold improvement over the entire energy range based on an LBL-developed wiggler. Therefore, it is logical to continue joint activities to further improve SSRL facilities as a cost-effective way of providing researchers with additional advanced tools to complement those available elsewhere.

This project will be constructed at the Stanford Linear Accelerator Center which is non-Government owned property.

## CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Stanford Synchrotron Radiation Laboratory Enhancement
Stanford Linear Accelerator Center
Stanford, California

2. Project No.: 85-ER-402

10. Details of Cost Estimate

| | | | |
|---|---|---|---|
| (a) | Engineering, design, inspection and administration... | 1,930 | |
| (b) | Construction costs................................. | 8,360 | |
| (c) | Standard equipment................................. | 230 | |
| (d) | Removals and relocations........................... | 0 | |
| (e) | Contingencies at approximately 19% of above.......... | 2,410 | |
| | TOTAL ESTIMATED COST.............................................................. | | $ 12,930 |

11. Method of Performance

The SSRL special facilities engineering design will be done by Laboratory (LBL, SSRL, and SLAC) personnel, as will major technical component construction and assembly. Technical component construction and fabrication will be done by a combination of SLAC shops and by subcontracts awarded on the basis of competitive bidding and managed by SSRL and SLAC personnel. Use of LBL shops will also be investigated for the fabrication of the SPEAR insertion device.

Conventional facilities engineering design will be performed under a negotiated Architect/Engineer subcontract. Inspection and some engineering will be done by Laboratory personnel. Construction and procurement will be accomplished by fixed-price subcontracts awarded on the basis of competitive bids.

12. Funding Schedule of Project Funding and Other Related Funding Requirements

| | FY 1984 | FY 1985 | FY 1986 | Total |
|---|---|---|---|---|
| a. Total facility construction costs:[a/] | | | | |
| SSRL Enhancement[b/]........................ | $ 1,240 | $ 8,630 | $ 3,060 | $ 12,930 |
| Total facility construction cost.......... | 1,240 | 8,630 | 3,060 | 12,930 |

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Stanford Synchrotron Radiation Laboratory Enhancement
Stanford Linear Accelerator Center
Stanford, California

2. Project No.: 85-ER-402

12. Funding Schedule of Project Funding and Other Related Funding Requirements (continued)

| | FY 1984 | FY 1985 | FY 1986 | Total |
|---|---|---|---|---|
| b. Other project funding: | | | | |
| SSRL R&D................................ | 700 | 700 | 0 | 1,400 |
| Total R&D/Startup........................ | 700 | 700 | 0 | 1,400 |
| Total Project Funding........................ | $ 1,940 | $ 9,330 | $ 3,060 | $ 14,330 |

a/ Includes escalation to midpoint of construction for all conventional facilities and compounded annually for special facilities; FY 1983 8%; FY 1984 8 1/2%; FY 1985 and beyond 9%.
b/ At the Stanford Linear Accelerator Center and includes the addition of an $18^{0}$ beamline.

13. Narrative Explanation of Total Project Funding and Other Related Funding Requirements

a. Total project funding

(1) The major elements of the SSRL Enhancement have been described in Item 8. The funding profiles were determined as follows:

(a) At SSRL the PEP Beam Line will be accomplished during the first two years. Improvements to SPEAR are schedules for the second year and the Laboratory Office Building is scheduled for the second and third years. Completion of the SPEAR scattering Beam Line and the Light Assembly Shop will occur during the third year.

(2) Other project funding

(a) Insertion Devices and Beam Line Optical Elements R&D activities include superconducting wigglers, in-vacuum undulators, and advance beam line components suitable for ultra high brilliance photon beams.

(b) SSRL R&D is related in support of the construction project includes prototype development and R&D on technical components.

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BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: Kansas State University, Ion Collision Physics Facility, Manhattan, Kansas

2. Project No.: 85-ER-403

3. Date A-E work initiated: 1st Qtr. FY 1985

3a. Date physical construction starts: 2nd Qtr. FY 1985

4. Date construction ends: 4th Qtr. FY 1987

5. Previous cost estimate: None

6. Current cost estimate: $3,400

7. Financial Schedule:

| Fiscal Year | Authorizations | Appropriations | Obligations | Costs |
|---|---|---|---|---|
| 1985 | $ 3,400 | $ 2,000 | $ 2,000 | $ 1,500 |
| 1986 | 0 | 1,400 | 1,400 | 1,000 |
| 1987 | 0 | 0 | 0 | 900 |

Financial schedule is based on the net Government funding associated with this project. The State of Kansas will provide an additional $600,000 for the conventional construction necessary to house the new capabilities.

8. Brief Physical Description of Project

The James R. MacDonald Laboratory will be expanded to house a new booster accelerator and a new low energy highly charged ion source. A 9,000 square foot basement addition will be required to house these facilities. The additional power requirement is 100 KVW. Very little additional water for cooling will be required.

## CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Kansas State University, Ion Collision Physics Facility, Manhattan, Kansas    2. Project No.: 85-ER-403

8. Brief Physical Description of Project (continued)

New equipment to be installed in new basement addition includes:

A. Cryogenic ion source including electron gun, superconducting solenoid magnet. Analyzing magnet, accelerating column and beam line apparatus.

B. Superconducting linear accelerator includes resonators, amplifiers, power supplies, RF control system, superconducting solenoids, liquid nitrogen system, liquid helium refrigerator and storage dewar, accelerator control computer system, data acquisition and data reduction computer system.

9. Purpose, Justification of Need for, and Scope of Project

The construction of the ion collision physics facility, together with the existing atomic physics capability at Kansas State University, will constitute the Institute for Atomic Collision Physics. The project will involve construction and installation of (1) an advanced source of low energy highly charged ions of the CRYEBIS type and (2) a LINAC booster comprising twelve superconducting split-ring resonators. Each of these two additions will function as an adjunct to the existing tandem Van de Graaff in ways that, along with a dedicated system for high speed computation and data analysis, will have the capability to study the atomic physics of a spectrum of ions, energies and intensities unmatched in the world. This will open new areas of atomic collision physics, allow long beam time experiments, and provide a forefront environment for training young scientists and encouraging interdisciplinary cross-fertilization.

This project will be constructed on the Kansas State University campus, non-Government owned property.

## CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Kansas State University, Ion Collision Physics Facility, Manhattan, Kansas

2. Project No.: 85-ER-403

10. Details of Cost Estimate

| | Item Cost | Total Cost |
|---|---|---|
| a. Engineering, design and inspection | | $ 100 |
| b. Land and level rights | | 0 |
| c. Construction costs | | 330 |
| 1) beam line construction | $ 315 | |
| 2) utilities | 15 | |
| 3) buildings | * | |
| d. Equipment | | 2,370 |
| e. Contingency | | 600 |
| Total Project Cost | | $ 3,400* |

*Kansas State University will provide additional funding to construct the building. a) Estimate is based on completed conceptual design; b) Escalation is based on annual 8% to the mid-point of construction

11. Method of Performance

This type of construction is unique and therefore the conceptual design, final design, assembly, and testing will be done by the staff of Kansas State University. Component parts equipment and building construction will to the extent possible be based on fixed priced competitively obtained procurement actions.

12. Funding Schedule of Project Funding and Other Related Funding Requirements

| | Prior Years | FY 1985 | FY 1986 | FY 1987 | Total |
|---|---|---|---|---|---|
| a. Total project funding | | | | | |
| (1) Total facility costs | | | | | |
| (a) Construction line item.................... | $ 0 | $ 1,500 | $ 1,000 | $ 900 | $ 3,400* |
| (b) CP&D.................................... | 0 | 0 | 0 | 0 | 0 |
| (c) Expense funded equipment.................. | 0 | 0 | 0 | 0 | 0 |
| (d) Inventories............................... | 0 | 0 | 0 | 0 | 0 |
| Total facility costs...................... | $ 0 | $ 1,500 | $ 1,000 | $ 900 | $ 3,400* |

1. Title and location of project: Kansas State University, Ion Collision Physics Facility, Manhattan, Kansas

2. Project No.: 85-ER-403

12. Funding Schedule of Project Funding and Other Related Funding Requirements (continued)

(2) Other project funding

| | | | | | |
|---|---|---|---|---|---|
| (a) R&D necessary to complete construction.... | $ 0 | $ 180 | $ 180 | $ 50 | $ 410 |
| (b) Other.................................... | 0 | 0 | 0 | 0 | 0 |
| Total other project funding.............. | 0 | 180 | 180 | 50 | 410 |
| Total project funding..................... | $ 0 | $ 1,680 | $ 1,180 | $ 950 | $ 3,810* |

As noted above, the State of Kansas will provide an additional $600,000 for conventional construction of housing.

b. Related annual funding requirements (estimated life of project: 20 years)

| | |
|---|---|
| (1) Operating costs.................................................... | $ 0 |
| (2) Programmatic operating expenses.................................... | 600 |
| (3) Capital equipment not related to construction but related to the programmatic effort in the facility.................................. | 50 |
| (4) GPP or other construction related to programmatic effort in the facility... | 0 |
| (5) Other costs........................................................ | 0 |
| Total.............................................................. | $ 650 |

13. Narrative Explanation of Total Project Funding and Other Related Requirements

No narrative required.

DEPARTMENT OF ENERGY
1985 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: Beam lines and support area construction
National Synchrotron Light Source (NSLS)
Brookhaven National Laboratory, Upton, NY

2. Project No.: 84-ER-111

3. Date A-E work initiated: 1st Qtr. FY 1984

3a. Date physical construction starts: 2nd Qtr., FY 1984

4. Date construction ends: 4th Qtr., FY 1986

5. Previous cost estimate:

6. Current cost estimate: $ 19,700
Less FY 1983 PE&D: 0
$ 19,700

Date: 9/83

7. Financial Schedule:

| Fiscal Year | Authorizations | Appropriations | Obligations | Costs |
|---|---|---|---|---|
| 1984 | $ 19,700 | $ 2,500 | $ 2,500 | $ 2,200 |
| 1985 | 0 | 10,000 | 10,000 | 8,330 |
| 1986 | 0 | 7,200 | 7,200 | 9,170 |

Work included for accomplishment with the first year's appropriation of $2,500,000 will include but not be limited to the design and engineering of beam line components and preliminary and detail design of the support area construction.

8. Brief Physical Description of Project

Current program planning anticipates the need for the insertion devices (wigglers and undulators) and beam lines (front and end beam transport and experimental stations) to the existing VUV and X-ray rings. Design, fabrication and construction of up to three insertion devices and six beam lines is presently anticipated with the final configuration to be dictated by programmatic demands and the state of the art at the time of construction.

The project also provides for design and construction of building space to house technical work areas, laboratories and offices and provide additional experimental staging and support areas.

1. Title and location of project: Beam lines and support area construction
National Synchrotron Light Source (NSLS)
Brookhaven National Laboratory, Upton, NY

2. Project No.: 84-ER-111

8. Brief Physical Description of Project (continued)

A. New Experimental Equipment

This project provides for an expansion of experimental capabilities which will be made available to general users from university, industrial, national and government laboratories. The greatest use is anticipated to be by materials scientists, but sizeable participation is expected by chemists, biologists and other disciplines.

The new equipment to be provided will take maximum advantage of the properties of the NSLS source. As noted above the exact design of this equipment will be determined as the project progresses to maintain the flexibility necessary to develop state of the art facilities which will ensure high quality research capabilities. Three beam lines and associated insertion devices have been designated. Up to three additional beam lines may be constructed as dictated by science and permitted by available resources.

1) High Q-Resolution X-Ray - This beam line and associated hybrid wiggler insertion device will provide high x-ray intensity levels for materials science research as well as biophysics and liquid crystal technology.

2) X-Ray Microscopy and Holography - This beam line and associated soft x-ray undulator insertion device will provide high brightness soft x-rays with photon energies from 0.28 KeV to 2.8 KeV to investigate three dimensional imaging. The technique will eliminate damage to specimens and allow simple sample preparation.

3) Superconducting Wiggler Line -his beam line will support high energy x-ray research in the field of digital subtraction imaging in medical systems without invasive chemical techniques. In addition the line will support a substantial materials research program.

B. New Building Addition

The proposed additions to the NSLS building will provide elementary support and staging areas, laboratories, technical work areas and offices to promote more effective utilization of the NSLS facility. The technical staff will move to new work areas, making more space available for the new beam lines. Extending the experimental space adjacent to portions of the VUV and X-ray storage rings will allow a number of long beam lines to be constructed, permit additional branching of existing ports, and give some extremely useful space to users for specialized support equipment.

1. Title and location of project: Beam lines and support area construction
National Synchrotron Light Source (NSLS)
Brookhaven National Laboratory, Upton, NY

2. Project No.: 84-ER-111

8. Brief Physical Description of Project (continued)

The proposed building expansion consists of several additions to the existing facility. The largest of these will be approximately 21,000 square feet continguous to the x-ray floor area. The addition will contain a machine shop, angiography laboratory with separate ambulance entrance, general laboratories, darkrooms, offices, an experimental staging and support area, technical work area, mechanical equipment room, and several public rooms. A partial second floor of approximately 8,000 square feet will house NSLS staff and visiting research teams. A small addition to the west portion of the x-ray floor will provide three laboratories a study area and a staging area.

The VUV area will also have several additions providing beam line extension areas, experimental staging and support space, offices and a receiving area.

In order to provide the space necessary for the Light Source Staff located in satellite buildings a 7800 square foot 3rd floor will be added above the existing 2nd floor office wing of the NSLS building.

Several other additions including a tunnel connecting the new facility to technical work space in an adjacent facility, a lobby addition and covered walkway will be provided.

The expanded building will be designed to current DOE energy conservation standards and contain fire protection systems. Access by handicapped persons will be provided by extending the present elevator to the new third floor and a new elevator to the 2nd floor x-ray expansion.

C. Existing Facility

The NSLS consists of two electron storage rings, an injection system common to both, experimental beam lines, experimental equipment, and office and support area all of which is housed in a 74,000 square foot building.

The high energy x-ray storage ring provides for the possibility of 28 primary beam ports, each of which is capable of accommodating several experimental beam lines. The VUV ring provides for 16 beam ports which are also capable of accommodating several experiments each. In sum, more than 90 experiments can be carried out at one time when the facility is fully instrumented. In addition to general users, research groups called Participating Research Teams (PRT's) from universities, industry and national and government laboratories, upon advice by a program committee, and approval by the NSLS Department Chairman provide instruments to carry out research programs at the NSLS facility. Their instruments are made available to general users for 25% of the available time. At present such groups provide an additional 20 experiments at the facility. General users are able to use any of the experimental lines, PRT or community lines, upon approval of their experimental proposal.

## CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Beam lines and support area construction
National Synchrotron Light Source (NSLS)
Brookhaven National Laboratory, Upton, NY

2. Project No.: 84-ER-111

9. Purpose, Justification of Need for, and Scope of Project

The NSLS is operated as a user facility. This means that researchers from BNL and other laboratories will be able, after review of a proposal by a committee of distinguished scientists, and acceptance by the NSLS Department Chairman to carry out an experiment using either the UV or X-ray radiation produced by the rings.

The response from users, both within BNL and outside, has placed a demand on the NSLS facility far surpassing its present resources. The limited beam lines combined with the limited space available makes expansion of experimental research within the present confines of this facility unpracticable. In order to support further development of this facility it will be necessary to provide additional floor, laboratory, and staging space. An experimenter should have a choice of a wide range of instruments which he can utilize for this research. To provide this choice, two types of instruments are proposed:

a) A group of instruments that will be available to general users that will complement in capability those already provided, and;

b) Several instruments (wiggler magnets and an undulator) which will provide a range of wavelength and intensity not available at the bending magnets. These instruments will be used both by general users and by members of the Participating Research Teams who will require such capabilities for their experiments.

A. New Experimental Equipment

In the original development plan, provision was made for a total of eight beam lines to be available to general users. Additional beam lines were to be provided at the rate of about two a year out of capital funds. Further instrumentation was to be made available by Participating Research Teams (PRT's), who would install beam lines at the rings at their expense and who would make 25% of the experimental time on those lines available to general users. However, the growth in user participation has far exceeded earlier expectations.

In order to provide experimental capabilities required both by PRT's and by general users, it is proposed to accelerate beam line construction. It is particularly important that the capabilities provided for in this project, such as wiggler magnets, be made available at the earliest possible date.

In addition to satisfying the requirements of the users, the accelerated design and construction of these beam lines will provide a cost saving because of efficiencies in planning, design, and construction.

1. Title and location of project: Beam lines and support area construction
National Synchrotron Light Source (NSLS)
Brookhaven National Laboratory, Upton, NY

2. Project No.: 84-ER-111

9. Purpose, Justification of Need for, and Scope of Project (continued)

B. New Building

The design for the NSLS building emphasized long term space requirements for the accelerator/storage rings and the equipment associated with their control and operation. Adequate space for experimental beam lines around the VUV and X-ray storage rings was also provided, although future long beam lines that extended beyond the building walls were regarded as a possible future option.

The space for the machine and experiments was given highest priority in initial design, while support areas were provided to satisfy requirements for projected use during the initial years of operation. A possible expansion of experimental support areas, work areas, and offices was allowed as a future option. Therefore, only minimal space was given to several general laboratories, the second floor office-administration area, and other support areas.

It was projected that during the early years of operations, up to approximately 50% of the 28 X-ray and 16 UV ports would be utilized. The extremely enthusiastic response of the scientific community now forces us to advance the expected rate of beam line construction and building expansion. More than 20 experimental have been proposed by PRT's, which are expected to be constructed at an early date. This response, coupled with the beam lines to provide by the project, indicate that the experimental floor will be extremely crowded beyond October 1983 and additional support space will be essential.

The original design anticipated a possible need for future expansion. The building frame was designed to support a third floor over the office administration wing. Site utility lines were kept at least 30 feet from the building foundation. Adequate space was left between the NSLS buildings and the Safety and Environmental protection building.

In addition to the pressing need to return experimental floor space to its intended use, the expansion will provide adequate office space for the permanent staff and work areas to complement the research and development associated with the anticipated experimental and machine improvement programs. The short connecting tunnel between the NSLS building and the basement of the adjacent Instrumentation building will connect the NSLS staging areas to an area where now extensive NSLS vacuum, instrument, and diagnostic work is in progress and where UV and X-ray test sources are located.

1. Title and location of project: Beam lines and support area construction
National Synchrotron Light Source (NSLS)
Brookhaven National Laboratory, Upton, NY

2. Project No.: 84-ER-111

9. Purpose, Justification of Need for, and Scope of Project (continued)

Annual Costs

The estimated incremental operating costs of the proposed NSLS beam lines and support area construction are listed below. Costs are in the FY 1984 dollars.

| | (Dollars in Thousands) |
|---|---|
| Materials, Supplies, Support Services | $ 95 |
| Electric Power | 178 |
| General and Administrative | 42 |
| Total | $315 |

10. Detail of Cost Estimate[a/][b/]

| | Item Cost | Total Cost |
|---|---|---|
| a. Engineering, design and inspection, including A-E fee (approx. 21% of item c).. | $ | $ 2,970 |
| b. Land and land rights.................................................... | | 0 |
| c. Construction costs...................................................... | | 13,335 |
| (1) Beam line construction.............................................. | 6,030 | |
| (2) Improvements to land................................................ | 110 | |
| (3) Building............................................................ | 6,925 | |
| (4) Tunnel to S&EP building............................................. | 90 | |
| (5) Utilities........................................................... | 180 | |
| d. Standard equipment...................................................... | | 800 |
| Subtotal.................... | | 17,105 |
| e. Contingency, approximately 17% of above costs.......................... | | 2,595 |
| Total Project Cost.......... | | $ 19,700 |

a/ Estimate is based on a complete conceptual design.

b/ Escalation rates conform to the guidelines prescribed in the Department of Energy Field Budget Process Chapter, February 1983, which are based on the materials and labor data contained in the Energy Supply Planning Model and escalation rates forecasted by Data Resources, Incorporated (DRI). Current costs have been escalated by 7.6%, 8.6% and 8.7% per year for FY 1984 through FY 1986.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Beam lines and support area construction National Synchrotron Light Source (NSLS) Brookhaven National Laboratory, Upton, NY

2. Project No.: 84-ER-111

11. Method of Performance

Insertion device and beamline construction is unique and therefore the conceptual design, final design, assembly and testing will be done by the staff of the National Synchrotron Light Source of the Brookhaven National Laboratory. Component parts wherever possible will be fabricated by industry under fixed priced competitively obtained procurement actions. Some components may be fabricated in the existing shops at BNL. It is also anticipated that other laboratories, private consultants, and industrial firms will be used for advice on specific problems. Building design will be on the basis of a negotiated architect-engineer contract and its construction will be by a competitively obtained lump sum contract which may be phased.

12. Funding Schedule of Project Funding and Other Related Funding Requirements

| | Prior Years | FY 1984 | FY 1985 | FY 1986 | Total |
|---|---|---|---|---|---|
| a. Total project costs | | | | | |
| 1. Total facility costs | | | | | |
| (a) Construction line item......... | $ 0 | $ 2,200 | $ 8,330 | $ 9,170 | $ 19,700 |
| (b) CP&D.......................... | 0 | 0 | 0 | 0 | 0 |
| (c) Expense Funded Equipment....... | 0 | 0 | 0 | 0 | 0 |
| (d) Inventories.................... | 0 | 0 | 100 | 100 | 200 |
| Total facility costs........... | 0 | 2,200 | 8,430 | 9,270 | 19,900 |
| 2. Other project costs | | | | | |
| (a) R&D necessary to complete construction of beam lines.... | 900 | 500 | 500 | 0 | 1,900 |
| (b) Other......................... | 0 | 0 | 0 | 0 | 0 |
| Total other project funding.... | 900 | 500 | 500 | 0 | 1,900 |
| Total project funding.......... | $ 900 | $ 2,700 | $ 8,930 | $ 9,270 | $ 21,800 |

1. Title and location of project: Beam lines and support area construction National Synchrotron Light Source (NSLS) Brookhaven National Laboratory, Upton, NY

2. Project No.: 84-ER-111

12. Funding Schedule of Project Funding and Other Related Funding Requirements (continued)

b. Total related funding requirement (estimated life of project: 17 years)

| | | |
|---|---|---|
| 1. Operating costs | $ | 288 |
| 2. Programmatic operating expenses directly related to the facility | | 0 |
| 3. Capital equipment not related to construction but related to the programmatic effort | | 0 |
| 4. GPP or other construction related to the programmatic effort | | 0 |
| 5. Other costs | | 0 |
| Total other related annual funding requirements | $ | 288 |

13. Narrative Explanation of Total Project Funding and Other Related Funding Requirements

a. Total project funding
   1. Total Facility
      (a) Construction line item - no narrative required.
      (b) CP&D - no narrative required.
      (c) Expense funded equipment - no narrative required.
      (d) Inventories - it is anticipated that funds will be required for the procurement of special process spares.
   2. Other project funding
      (a) R&D necessary to complete construction - funds provided in the NSLS R&D budget. This item gives estimates of the R&D necessary to develop the monochromators, mirror systems, target chambers, detectors and superconducting structures for high field wigglers and undulators.
      (b) Other - no narrative required.

b. Total related funding requirements
   1. Operating Costs - There will be an annual requirement of additional materials, supplies, and support services associated with the new beam lines. Also, there will be a requirement for increased facility electrical power.
   2. Programmatic operating expenses directly related to the facility - no narrative required.
   3. Capital equipment not related to construction but related to the programmatic effort - no narrative required.
   4. GPP or other construction related to the programmatic effort - no narrative required.
   5. Other costs - no narrative required.

3,660
940 SSRL
1760 SSCL
300 AM

DEPARTMENT OF ENERGY
1985 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: Center for Advanced Materials, Lawrence Berkeley Laboratory, Berkeley, California

2. Project No.: 84-ER-112

3. Date A-E work initiated: 2nd Qtr. FY 1984

3a. Date physical construction starts: 2nd Qtr. FY 1984

4. Date construction ends: 4th Qtr. FY 1988

5. Previous cost estimate: $138,900

6. Current cost estimate: $ 40,250
Less FY 1983 PE&D: 0
$ 40,250
Date: 8/83

7. Financial Schedule:

| Fiscal Year | Authorizations | Appropriations | Obligations | Costs |
|---|---|---|---|---|
| 1984 | $ 1,760 | $ 1,760 | $ 1,760 | $ 1,760 |
| 1985 | 38,490 | 10,790 | 10,790 | 10,290 |
| 1986 | 0 | 14,440 | 14,440 | 12,940 |
| 1987 | 0 | 13,260 | 13,260 | 14,000 |
| 1988 | 0 | 0 | 0 | 1,260 |

8. Brief Physical Description of Project

The Center for Advanced Materials (CAM) is comprised of two research laboratories. This is a continuation of the FY 1984 request, Center for Advanced Materials (CAM), and which takes into consideration the recommendations of the ad hoc review Panel.

The Research Laboratories will involve two new laboratory complexes at LBL, the Surface Science and Catalysis Laboratory (SSCL) and the Advanced Materials Laboratory (AML).

1. Title and location of project: Center for Advanced Materials Lawrence Berkeley Laboratory, Berkeley, California

2. Project No.: 84-ER-112

8. Brief Physical Description of Project (continued)

The CAM facilities at LBL will be located on University of California property adjacent to the Berkeley campus, within the site of the Lawrence Berkeley Laboratory. The project will include the construction of new facilities, and the alteration of, and additions to, existing facilities. Plant and site facilities will consist of: a) improvements to land, including grading, drainage, paving, lighting, and walkways; b) a new Surface Science and Catalysis Laboratory (SSCL) building (47,500 GSF), located near the existing Materials and Molecular Sciences Laboratory (Building 62); c) the new 82,000 GSF building, the Advanced Materials Laboratory (AML); d) the extension of existing utilities, including electrical power, water, sewage, gas, and communications; and e) standard equipment and special facilities including office and laboratory furniture and equipment, fume hoods, ventilation and temperature control equipment, laboratory diagnostics and instrumentation equipment, fire protection equipment and computation equipment.

Conventional Construction

The Surface Science and Catalysis Laboratory will be located near the existing Materials and Molecular Sciences Laboratory (Building 62). The 3-story building will have a reinforced-concrete frame, shear walls, waffle roof-and-floor structure supported on spread footings. Auditorium and administrative area roofs will utilize metal deck on steel framing. The floor plan is approximately 95 x 150 feet.

The Advanced Materials Laboratory will consist of a single light-laboratory building. The proposed four-story building will occupy a hillside site providing a first floor with a main entrance at the grade level of the base of the hill. The full floor-plan will be L-shaped, about 192 feet long in one direction and 173 feet in the other; the longer element will be 63 feet wide and the other, 96 feet wide. The building structure will consist of a reinforced concrete frame with shear walls. Roof and floors above the base level will be of waffle-slab construction. Foundations will consist of poured-in-place reinforced concrete caissons.

Finishes on the new buildings will include: standard built-up roofing over insulation; exterior (non-bearing) walls of prefinished panels on metal studs (insulated cavity); and gypsum board interior wall surfaces throughout. Acoustical ceilings will be needed in certain areas; otherwise ceilings will be painted gypsum board. Laboratory furniture and fume hoods will be commercial products with acid/alkali-resistant tops and construction. Building elevators will be rated for 6000 lb. capacity, suitable for carrying freight and passengers. Heating ventilating and air conditioning (HVAC) needs will be met by central station air-handling units, draw-through cooling coils, return fan units and economizer controls. All supply and return air will be ducted. All buildings will be equipped with automatic fire springler and alarm systems. Utilities will be extended from nearby existing plant services.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Center for Advanced Materials
Lawrence Berkeley Laboratory, Berkeley, California

2. Project No.: 84-ER-112

9. Purpose, Justification of Need for, and Scope of Project

This research center is being proposed as a major scientific redirection of the Lawrence Berkeley Laboratory to address a vital national need, to accelerate basic research in an area that promises medium-term impact on high-technology industries, and to foster closer ties between national laboratory researchers and their counterparts in industrial and university laboratories. The CAM project will have two major objectives:

- To enhance understanding, through long-range basic research, of the synthesis, characterization, and properties of advanced materials in support of U.S. energy-related and high-technology industry.
- To provide advanced facilities for research training of additional graduate students in physical sciences and engineering fields vital to U.S. high-technology industry.

For three decades following the end of World War II, the United States led the world in materials research. In the last few years, we have been approached and sometimes passed in critical high-technology industries by Japanese and German companies, notably in such production areas as electronics, microcircuits, and specialty steels. One important reason for this deteriorating situation is that our foreign competition has produced reliable materials and parts for advanced technological applications. Their success, which reflects improved control of compositions and structures at every stage from powder or ingot to finished device, was made possible by coordinated research on the materials themselves and on sophisticated devices for materials characterization and automated processing control.

The West German and Japanese governments are supporting massive research programs to further their aggressive high-technology industrial development. For this country to mount a comparable interdisciplinary attack on the materials and materials-processing problems requires input from basic research efforts with longer time scales and higher risk than can reasonably undertaken by U.S. companies. The research needed also requires investments in improved apparatus and instrumentation that will strain the present resources of publicly-supported materials laboratories in this country.

The CAM project will provide the modern tools and facilities required for making possible major advances in energy-related and high-technology industries by improving the scientific understanding of the underlying chemical and physical phenomena that influence both materials and device behavior.

1. Title and location of project: Center for Advanced Materials Lawrence Berkeley Laboratory, Berkeley, California

2. Project No.: 84-ER-112

9. Purpose, Justification of Need for, and Scope of Project (continued)

Research Laboratories

Two research laboratories form the major components of the CAM:

- The Surface Science and Catalysis Laboratory (SSCL). A laboratory devoted to surface and catalysis studies using state-of-the-art instrumentation techniques.
- The Advanced Materials Laboratory (AML). A laboratory devoted to interdisciplinary study of the synthesis and characterization of energy-related, high-technology, and strategic materials. In addition, there will be research on the design of high-technology devices utilizing new materials and the design of innovative devices for the characterization of materials-property relationships.

Both the SSCL and the AML will be based on strong programs that already exist at LBL. Other elements are completely new, but they too build on experience and personnel already at LBL and at the adjacent University of California Berkeley campus. The first CAM research program associated with the above will be initiated in FY 1984.

Because of the pressing need to retain high-technology leadership, the proposed project schedule calls for the start of construction in FY 1984 and the completion of all facilities in FY 1988. Delays would extend the time at which research results can be generated and transferred to U.S. industry. A CAM Advisory Board composed of scientific leaders from industry, universities, and Federal laboratories will advise the LBL director on CAM scientific program directions to ensure that CAM basic research addresses America's long-range high-technology needs. The CAM affiliates, consisting of major research teams from industry and universities, will participate in CAM. The following cost estimates and mix among facilities may vary depending upon the research and development progress, but does represent the current plan.

This project will be constructed at the Lawrence Berkeley Laboratory which is non-Government owned property.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Center for Advanced Materials Lawrence Berkeley Laboratory, Berkeley, California

2. Project No.: 84-ER-112

10. Details of Cost Estimate

| | |
|---|---|
| a. Engineering, design, inspection and administration | 4,220 |
| b. Construction costs | 23,280 |
| c. Standard equipment | 6,350 |
| d. Removals and relocations | 360 |
| e. Contingencies at approximately 15% of above | 6,040 |

TOTAL ESTIMATED COST ........ $40,250

11. Method of Performance

Conventional facilities engineering design will be performed under a negotiated Architect/Engineer subcontract. Inspection and some engineering will be done by Laboratory personnel. Construction and procurement will be accomplished by fixed-price subcontracts awarded on the basis of competitive bids.

12. Funding Schedule of Project Funding and Other Related Funding Requirements

| | FY 1984 | FY 1985 | FY 1986 | FY 1987 | FY 1988 | Total |
|---|---|---|---|---|---|---|
| a. Total facility construction costs:[a/] | | | | | | |
| SSCL | $ 1,760 | $ 8,690 | $ 1,500 | $ 0 | $ 0 | $11,950 |
| AML | 0 | 1,600 | 11,440 | 14,000 | 1,260 | 28,300 |
| Total facility construction cost | 1,760 | 10,290 | 12,940 | 14,000 | 1,260 | 40,250 |
| Total Project Funding | $ 1,760 | $10,290 | $12,940 | $14,000 | $ 1,260 | $40,250 |

1. Title and location of project: Center for Advanced Materials
Lawrence Berkeley Laboratory, Berkeley, California

2. Project No.: 84-ER-112

12. Funding Schedule of Project Funding and Other Related Funding Requirements (continued)
Other related funding requirements (estimated life of project: 25 years)

| | FY 1984 | FY 1985 | FY 1986 | FY 1987 | FY 1988 | FY 1989 |
|---|---|---|---|---|---|---|
| Programmatic research | $ 2,300 | $ 3,300 | $ 7,800 | $11,300 | $11,300 | $11,300 |
| Capital equipment related to programmatic research | 1,300 | 1,650 | 1,900 | 2,700 | 2,700 | 2,700 |
| Total | $ 3,600 | $ 4,950 | $ 9,700 | $14,000 | $14,000 | $14,000 |

[a] Includes escalation to midpoint of construction for all conventional facilities and compounded annually for special facilities; FY 1983 8%; FY 1984 8 1/2%; FY 1985 and beyond 9%.

13. Narrative Explanation of Total Project Funding and Other Related Funding Requirements

a. Total project funding

(1) The major elements of the CAM facility have been described in Item 8. The funding profiles were determined as follows:

(a) The Surface Science and Catalysis Laboratory has a completed Title II design. Construction will be packaged with site preparation scheduled for FY 1984 so that building construction can be completed in the fourth quarter of FY 1986.

(b) The Advanced Materials Laboratory building is scheduled for Title I review in the first quarter of FY 1985. The project will be scheduled to sequence bid packages to minimize disruption to existing programs and construction congestion and to optimize favorable bidding conditions and work leveling. Site bid packages will be let in the third quarter of FY 1985 and in the first quarter of FY 1986. Building construction will begin in the second quarter of FY 1986 and end in the fourth quarter of FY 1988.

1. Title and location of project: Center for Advanced Materials Lawrence Berkeley Laboratory, Berkeley, California

2. Project No.: 84-ER-112

13. Narrative Explanation of Total Project Funding and Other Related Funding Requirements (continued)

b. Other related funding requirements

The annual costs of the scientific program are increased progressively to build up a high quality research staff for the CAM laboratories. Funding in the early years of the project is mainly to attract superior senior scientists to lead the new scientific programs described in Item 9. These researchers can be housed initially on the University campus and then in the SSCL Building until all conventional facilities are completed. The programs will expand in the latter years of the project to include the full complement of scientists and technicians. The capital equipment needs related to this research staff buildup reflect Laboratory experience that numerous laboratory equipment items will be needed at the level of approximately 20% of the operating program budget. These amounts were augmented in the first two years to take into account startup capital equipment needs.