DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT

OVERVIEW

BASIC ENERGY SCIENCES

The Basic Energy Sciences (BES) program supports research which provides the foundation for new technologies and improvements to existing technologies which are crucial to achieving the goals described in the National Energy Strategy. The nation has long recognized the importance of basic research and has considered the Federal investment in its scientific base a top national priority. The BES program is an essential component of both the Department and the Federal commitment to R&D in the U.S. today. The research funded by the BES program utilizes the expertise in existence at the national laboratories, universities, industry, and other government agencies.

Basic research is the first link in the chain of events from scientific discovery to technological innovation. Results from BES sponsored research become an integral part of the information base which underpins the nation's nuclear and non-nuclear technologies. In addition to supporting research for the nation's technology foundation, BES supported research helps to train our future scientists, and helps us attain our national goals. Better health and quality of life, economic competitiveness, energy self-sufficiency, and national security are each supported from a strong program in basic research. The research in the BES program is grouped into six major subprogram areas: Materials Sciences, Chemical Sciences, Applied Mathematical Sciences, Engineering and Geosciences, Energy Biosciences, and Advanced Energy Projects.

The principal focus of the BES program is basic research in support of the Department's energy goals; however, a number of other important national goals are also supported. The U.S. leadership in science and technology, the stimulation of economic growth, national defense, and the training of tomorrow's scientists are additional goals to which BES contributes through the support of basic research.

BES sponsored research contributes to the technological foundation of the DOE energy technology programs. This link is described in each of the introductions which describe the subprograms within BES. Whether the research is in the Materials Sciences, Chemical Sciences, or any of the other subprograms of BES, the research is primarily driven by the need for enhanced knowledge or understanding which is currently limiting existing energy technologies. The link between basic research and applications, however, is typically not confined to any single energy or technological problem, but has applications to a number of technologies. As an example, a new or improved heat transfer device may be applied to energy systems whether they be fossil, nuclear, solar or geothermal. Advances in the new high temperature superconducting materials also may be applied to a number of energy technologies such as more efficient motors, generators, power transmission lines and transportation systems which will have tremendous economic and energy savings. Each of the subprograms in BES support research projects which have similarly broad applications across a range of energy technologies. Whether attempting to burn coal cleaner or more cheaply, or to find ways to reduce the overall volume or hazards from wastes, nuclear or non-nuclear, each of these problems will ultimately depend on advances in basic research and the applications of those advances in the various energy technologies.

The BES program annually supports approximately 1,300 individual research projects at over 200 separate institutions with direct support for over 4,000 investigators in the physical, biological, and mathematical sciences. These projects are selected on the basis of scientific excellence, relevance to support of DOE long-term goals, and their contribution to a responsive National Energy Strategy. Also, Basic Energy Sciences has a heavy involvement in major scientific user facilities (the High Flux Beam Reactor and the National Synchrotron Light Source at Brookhaven National Laboratory, the Combustion Research Facility at Sandia National Laboratories Livermore, the High Flux Isotope Reactor and the Radiochemical Engineering Development Center (formerly the Transuranium Processing Plant) at Oak Ridge National Laboratory, the Stanford Synchrotron Radiation Laboratory at Stanford University, the Intense Pulsed Neutron Source at Argonne National Laboratory and the Manuel Lujan, Jr. Neutron Scattering Center at Los Alamos National Laboratory).

Many areas of modern science require large and costly facilities; without them, the necessary advanced research could not be done. These facilities not only provide BES with unique instruments to pursue forefront research, but also are made available to all qualified collaborations even those not supported by BES. Thus, the facilities actually leverage a great deal more research from the national effort. These major facilities account for a significant amount of the BES budget requirement. In general, facility costs have risen by an amount greater than the

cost of living. These higher costs can be attributed to higher than normal utility costs, safeguards, safety, and higher user demands, as well as the need for the most modern equipment. The large, expensive, unique facilities in the BES program are made available to qualified users of the U.S. scientific community to the extent that funds permit. At the seven major user facilities funded by BES, the number of users has grown to 2,600 in FY 1990 and 3,100 for FY 1991. BES also provides, through its Applied Mathematical Sciences subprogram, advanced state-of-the-art computational support for several Energy Research programs including High Energy Physics, Nuclear Physics, and Biological and Environmental Research, as well as its own program.

To fully appreciate the importance of the national user facilities to research in the U.S., one only has to look at the list of users at the facilities. For example, at the light sources, the largest U.S. companies (e.g., IBM, AT&T, Exxon, GM) have major research teams doing research in areas such as catalysis, electronics, polymers, and biomedicine. The research results are important not only to those companies, but also to the DOE. At the neutron sources, major oil companies are doing research in porosity of formations and neutron spectroscopy of hydrocarbons. The Basic Energy Sciences program also supports research in radiation effects on materials important to fission, fusion, and radioactive waste technology.

The strategic plan for BES has as its principal goals:

o Focus the research effort on energy related activities, especially those identified in the National Energy Strategy and emphasize a multidisciplinary approach with participation of several subprograms as appropriate.

o Completion of advanced scientific facilities for the nation and safe and productive operation of the BES facilities.

o Enhance the balanced approach to BES activities between research and facilities through growth in both areas where opportunities exist.

o Enhancement of math and science education - the BES program provides support for about 2300 graduate students and 2000 professors and post-doctoral researchers.

o Promote technology transfer.

The BES program takes advantage of the research capabilities available at national laboratories, government laboratories, universities, and private research laboratories. The program support can be divided into two distinct but related components: research and facility operations, design and construction. Research is supported at national laboratories, universities and other institutions. Approximately one-fourth of BES funding supports university-based research. The list of universities receiving support covers almost every state and includes participation by both large and small institutions. The facility component supports the operation of seven major user facilities for which access by qualified users is provided to the scientific community. In addition, the facility component includes the construction of two advanced light sources and the design of an advanced research reactor needed by the Department and the Nation.

In addition to universities and national laboratories, BES supports research in and maintains ties with industry. Representatives from different industries serve on the BES Advisory Committee; experts from industry participate in the review of research proposals and use the specialized facilities sponsored by BES; industrial scientists participate in program advisory committees at the national laboratories; and industry representatives are invited to attend BES conferences and workshops on special topics.

In order to make further progress in certain fields, new, more powerful facilities are required. In the past few years, the Department has given special attention to correcting deficiencies at its laboratories in areas such as environment, health, safety and security. However, less attention has been paid to improving the essential scientific facilities required to accomplish the main scientific mission of the laboratories. Three facilities have been identified by the scientific community as being the most critical to the future needs of the Department's Basic Energy Sciences program. The three facilities, all of which will be located at the Department's multiprogram laboratories are: 1-2 GeV Synchrotron Radiation Source - Lawrence Berkeley Laboratory; 6-7 GeV Synchrotron Radiation Source - Argonne National Laboratory; and Advanced Neutron Source - Oak Ridge National Laboratory.

The FY 1993 budget request attempts to maintain the necessary balance between all of the elements of the BES program. This budget is designed to balance: research and facility needs; university and laboratory supported research; core research and enhanced activities; and ensure that the BES program is responsive to the overall NES goals. The budget request for Basic Energy Sciences includes an enhancement for materials research as part of the Materials Research FCCSET initiative. Additionally, the budget request takes into consideration the need to strengthen the area of biotechnology in support of the FCCSET recommendations. The Applied Mathematical Sciences subprogram includes the DOE contribution for the second year of the President's High Performance Computing and Communications (HPCC) Program. Strengthened research focused on the goals of the National Energy Strategy is also requested. These research enhancements will strengthen small science at both the DOE laboratories and universities. The budget request also includes research in support of the Math and Science Education FCCSET initiative. The request contains funding to continue the 6-7 GeV Synchrotron Radiation Source, to initiate commissioning of the 1-2 GeV Synchrotron Radiation Source, and to continue advanced conceptual design for the Advanced Neutron Source.

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT

(Dollars in thousands)

LEAD TABLE

Basic Energy Sciences

| Activity | FY 1991 Enacted | | FY 1992 Enacted | FY 1993 Base | FY 1993 Request | Program Change Request vs Base Dollar | Program Change Request vs Base Percent |
|---|---|---|---|---|---|---|---|
| Operating Expenses | | | | | | | |
| Materials Sciences | $271,966 | | $257,116 | $257,116 | $290,227 | $33,111 | +13% |
| Chemical Sciences | 155,639 | | 158,300 | 158,300 | 175,400 | 17,100 | + 11% |
| Applied Mathematical Sciences | 52,134 | | 81,500 | 81,500 | 91,000 | 9,500 | +12% |
| Engineering and Geosciences | 33,907 | | 35,800 | 35,800 | 39,540 | 3,740 | +10% |
| Advanced Energy Projects | 24,674 | | 54,800 | 10,800 | 11,900 | 1,100 | +10% |
| Energy Biosciences | 21,808 | | 24,700 | 24,700 | 27,600 | 2,900 | +12% |
| Program Direction | 6,462 | | 7,500 | 8,400 | 8,400 | 0 | -- |
| Subtotal Operating Expenses | 566,590 | | 619,716 | 576,616 | 644,067 | 67,451 | +12% |
| Capital Equipment | 36,803 | | 37,000 | 37,000 | 46,300 | 9,300 | +25% |
| Construction | 102,433 | | 107,984 | 107,984 | 123,533 | 15,549 | +14% |
| Total | $705,826 | a/b/ | $764,700 | $721,600 | $813,900 | $92,300 | +13% |

a/ Total has been reduced as follows: $6,329,000 which has been transferred to the SBIR program; $4,111,000 for General Reduction; and $9,267 for the FY 1991 Sequester.

b/ Includes $9,575,000 for education programs funded in the Atomic Energy Defense Activities account.

| | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Base | FY 1993 Request | Program Change Request vs Base | |
|---|---|---|---|---|---|---|
| | | | | | Dollar | Percent |
| Summary | | | | | | |
| Operating Expenses | $566,590 | $619,716 | $576,616 | $644,067 | $67,451 | +12% |
| Capital Equipment | 36,803 | 37,000 | 37,000 | 46,300 | 9,300 | +25% |
| Construction | 102,433 | 107,984 | 107,984 | 123,533 | 15,549 | +14% |
| Total Program | $705,826 | $764,700 | $721,600 | $813,900 | $92,300 | +13% |
| Staffing (FTEs) | | | | | | |
| Headquarters | 69 | 68 | 68 | 68 | -- | -- |
| Field | 0 | 5 | 5 | 5 | -- | -- |
| Total | 69 | 73 c/ | 73 | 73 | -- | -- |

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

c/ Revised request.

DEPARTMENT OF ENERGY
FY 1993 OMB BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

SUMMARY OF CHANGES

Basic Energy Sciences

| | |
|---|---|
| FY 1992 Enacted Appropriation | $ 764,700 |
| FY 1993 Base Adjustments | |
| - Congressionally Directed Projects | - 44,000 |
| - Program Direction - Increased Personnel Costs | + 900 |
| FY 1993 Base | $ 721,600 |

The FY 1993 base provides funding for the core research and major facility operations, capital equipment, and construction at the FY 1992 level.

The following additions in research will support "small science" at both the DOE laboratories and universities. The major FCCSET activities are identified by subprogram. Likewise, the major enhancements are briefly explained in this table, but further details are provided under the appropriate section of operating, capital equipment, or construction.

Operating Expenses:

Materials Sciences ..... + 33,111
Increased funding is provided to support the Materials Research and the biotechnology FCCSET initiatives. Supports research related to the National Energy Strategy (NES) with particular emphasis on materials for heat engines. The Advanced Neutron Source R&D continues and funding is provided for an environmental impact statement, a preliminary safety analysis report, and further design. Increased funding for commissioning and operation of the 1-2 GeV (LBL) and R&D and commissioning components of the 6-7 GeV (ANL) radiation sources is provided.

Chemical Sciences..... + 17,100
Supports chemical sciences research important for the materials research and biotechnology initiatives in addition to the NES with particular emphasis on catalysis, combustion, non-automotive battery technology, and separations research.

Applied Mathematical Sciences..... + 9,500
Provides funding in support of the DOE contribution for the second year of the President's High Performance Computing and Communications (HPCC) Program.

Engineering and Geosciences..... + 3,740
Supports engineering research related to the materials research and biotechnology initiatives and geosciences research important for the NES with particular emphasis on underground imaging, and fluid flow in porous media.

Advanced Energy Projects..... + 1,100
Supports the materials research and biotechnology initiatives in addition to the NES with particular emphasis on the support of research to prove the scientific feasibility of materials processing, waste management and liquid fuels conversion ideas.

Energy Biosciences..... + 2,900
Supports the biotechnology and materials research initiative in addition to the NES with particular emphasis on plant sciences research for alternative fuels.

Capital Equipment..... + 9,300
Provides increases for both the 6-7 GeV Synchrotron Radiation Source to maintain project schedule and the 1-2 GeV Synchrotron Radiation Source to support initial operations. Also provides funding to support the High Performance Computing and Communications FCCSET program.

Construction..... + 15,549
Continues support for all ongoing construction projects: 6-7 GeV Synchrotron Radiation Source, Accelerator Improvements Projects and General Plant Projects.

FY 1993 Congressional Budget Request..... $813,900

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Materials Sciences

The Materials Sciences subprogram conducts research aimed at increasing the understanding of materials related phenomena and behavior which addresses the materials needs for safe, reliable, and environmentally acceptable energy technologies including fusion, fission, fossil, solar, geothermal, conservation, and waste containment. The subprogram supports research at DOE laboratories, universities, and to a lesser extent in industry. The laboratory component is the largest and accounts for approximately 45% of the research funding, excluding facility operations. The major laboratory participants are the Ames Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, Oak Ridge National Laboratory, Lawrence Berkeley Laboratory, and to a lesser extent Los Alamos, Lawrence Livermore, Pacific Northwest, and Sandia Laboratories. The laboratory programs as a whole tend to contain larger groups of scientists, are multidisciplinary, and involve longer-term research projects. Many of the DOE laboratory programs have unique, major facilities which are open to outside users from universities, industry, and other government laboratories. The university component of the program includes top researchers from universities throughout the country. A typical project includes several graduate students in addition to the principal investigator. The projects cover all areas of materials sciences and tend to be narrower in scope and of shorter duration than projects at the laboratories. The funding associated with the university portion of the program is approximately 15%. Most of the industry supported portion of materials research takes place at smaller businesses through the Small Business Innovation Research program. Other industry groups are funded by their home organization and work with members of the laboratory or university research groups. Due to the unique, expensive, and specialized nature of the user facilities, the largest participation of industry researchers occur at these facilities. So long as the research conducted by industry is available to the scientific community and is of interest to DOE, there is no charge imposed on the industry groups for the use of these facilities. Funding for the facilities portion of the Materials Sciences budget is about 40%.

Groups of multidisciplinary researchers work together guided by opportunities within the general goals set forth by the subprogram. Current goals include uncovering the information needed to: develop new or substitute materials that improve performance or efficiency in energy systems; tailor materials properties to satisfy defined requirements such as improved corrosion resistance in fossil plants or radiation resistance in fusion plants; predict materials problems and service life to improve safety and reliability of components in energy systems; and improve the theoretical and experimental capability to analyze the fundamental structure and behavior of materials. Related to these goals is the support provided for major user facilities which are available to the entire scientific community for research. This budget includes $257,116,000 in FY 1992 and $287,300,000 in FY 1993 in support of the Materials Research activities. It also includes $1,900,000 in FY 1992 and $2,200,000 in FY 1993 in support of the Biotechnology activities. Coordination among the various materials research efforts within DOE and with other agencies is considered essential. Within DOE this takes place primarily through the Energy Materials Coordinating Committee (EMaCC) and with other agencies through the Committee on Materials (COMAT). Within the Materials Sciences subprogram, research is undertaken in the major areas of metallurgy and ceramics, solid state physics and materials chemistry. Some examples of research accomplishments during the past year include: demonstration of superplastic behavior in the ceramic titanium oxide which allows shaping of complex ceramic parts; commercialization of the thermite reduction process for high-strength neodymium-iron-boron permanent magnet alloys used to reduce weight in electric motors; delineation of effects of neutron and ion radiation on high-temperature superconductors on magnetic flux pinning which increases the current carrying capacity; development of processes for formation of nanophase precursor powders and processes for sintering of nanophase ceramics which both lower sintering temperatures and improve mechanical properties; simulation of elastic-plastic deformation in metal-matrix composites which will improve shaping and forming processes for these strong, light-weight materials; development of control of oxygen vacancy order in high-temperature superconductors which will lead to better control of processes for making wires; demonstration that implantation of oxygen hardens the surface of aluminum and reduces wear; delineation of hydrogen passivation of defects at silicon-silicon dioxide interfaces in microcircuit elements; fabricated and demonstrated an all high-temperature superconducting quantum interference device (SQUID) magnetometer which can be used for geological exploration; provided the basis of understanding for self-segregation in ceramics made by mixing different powders which can have drastic effects on mechanical properties made in this way; discovered a new mechanism for surface diffusion in which adsorbed atoms move by

I. Materials Sciences (Cont'd)

burrowing beneath the surface; synthesis of an organic superconductor with the highest known superconducting transition temperature for organic superconductors; demonstration that catalytic antibodies can be modified and used for the synthesis of non-biological materials; and first direct measurements of both the static and dynamic properties of lubricating films between two sliding surfaces which show that the structure of the liquid film is very different from thick films and has a large effect on lubrication properties. This budget includes $956,000 in both FY 1992 and FY 1993 in support of the Math and Science Education activities.

II. A. Summary Table: Materials Sciences

| Program Activity | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Materials Sciences Research | $ 144,593 | $ 158,994 | $ 169,000 | + 6 |
| Facilities Operations | 80,554 | 98,122 | 121,227 | + 24 |
| Congressionally Directed Projects | 46,819 | 0 | 0 | 0 |
| Total, Materials Sciences | $ 271,966 | $ 257,116 | $ 290,227 | + 13 |

II. B. Major Laboratory and Facility Funding

| | | | | |
|---|---|---|---|---|
| Ames Laboratory | $ 13,011 | $ 9,228 | $ 10,058 | + 9 |
| Argonne National Laboratory (East) | $ 39,966 | $ 47,937 | $ 66,209 | + 38 |
| Brookhaven National Laboratory | $ 53,842 | $ 51,870 | $ 53,738 | + 4 |
| Idaho National Engineering Laboratory - EG&G | $ 437 | $ 437 | $ 470 | + 8 |
| Lawrence Berkeley National Laboratory | $ 26,757 | $ 35,050 | $ 41,041 | + 17 |
| Lawrence Livermore National Laboratory | $ 3,613 | $ 2,183 | $ 1,938 | - 11 |
| Los Alamos National Laboratory | $ 12,574 | $ 12,490 | $ 13,086 | + 5 |
| Oak Ridge National Laboratory | $ 34,712 | $ 45,565 | $ 45,135 | - 1 |
| Pacific Northwest Laboratory | $ 3,010 | $ 2,863 | $ 3,063 | + 7 |
| Sandia National Laboratories | $ 9,021 | $ 7,697 | $ 8,324 | + 8 |

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Materials Sciences | | | |
| Materials Sciences Research | Metallurgy and Ceramics Research - Continuation of effort on understanding processing-structure-property relationships in ceramic superconductors and intermetallic compounds. Continued efforts on theoretical approaches to high performance metals and ceramics, structure-behavior relationships and interfacial bonding and adhesion. Continued reduction of effort on artificially tailored materials compounds. Increase in research on radiation effects on materials. | Metallurgy and Ceramics Research - Continue effort on understanding processing-structure-property relationships in ceramic superconductors. Continue efforts on theoretical approaches to high performance metals and ceramics, structure-behavior relationships and interfacial bonding and adhesion. Continued reduction of effort on artificially tailored materials, high temperature reactions and intermetallic compounds. Increase in research on radiation effects. | Metallurgy and Ceramics Research - Continue effort on understanding processing-structure-property relationships in ceramic superconductors. Continue efforts on theoretical approaches to high performance metals and ceramics, structure-behavior relationships. Increased efforts in National Energy Strategy thrusts in safety and reliable performance of materials. The following activities are part of the Materials Research FCCSET crosscut: corrosion resistant materials, surface modification to improve friction and wear, modeling of near-net shape production processes for complex materials systems, welding and joining of materials, materials for radiation environments, synthesis of photovoltaic materials, and high temperature structural ceramics. |
| | Solid State Physics Research - Continued selected efforts and priority research largely unique to DOE, such as in neutron scattering and synchrotron radiation. Continued effort on physics of high temperature superconductivity. New effort on field responsive polymeric materials. Continued efforts on solid state physics of surfaces and interfaces. Research on solid state physics of novel materials with energy-related properties and behavior. Increased effort on physics of radiation effects. | Solid State Physics Research - Reduction of selected efforts and continuation of priority research largely unique to DOE, such as in neutron scattering and synchrotron radiation. Continue effort on physics of high temperature superconductivity. Continue effort on physics of radiation effects. Continue effort on field responsive polymeric materials, solid state theory, and novel characterization methods. Continue efforts on solid state physics of surfaces and interfaces and on solid state physics of novel materials with energy-related properties and behavior. | Solid State Physics Research - Continuation of priority research largely unique to DOE, such as in neutron scattering and synchrotron radiation. Continue effort on physics of high temperature superconductivity. Continue effort on physics of radiation effects. Continue effort on field responsive polymeric materials, solid state theory, and novel characterization methods. Continue efforts on solid state physics of surfaces and interfaces and on solid state physics of novel materials with energy-related properties and behavior. The following activities are part of the Materials Research FCCSET crosscut: theory of photovoltaic materials, nanophase materials, physical properties of organic superconductors, |

III. Materials Sciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Materials Sciences Research (Cont'd) | | | magnetic materials, processing methods involving plasmas, microwaves, and lasers and theory of complex materials. Increased efforts in neutron, x-ray optics, and beam lines for synchrotrons. |
| | Materials Chemistry Research - Strong emphasis on organic synthesis for synthetic metals, polymer electrolytes, high strength polymer systems, enzymatic synthesis, and the materials chemistry of high temperature superconductors. Synthesis and characterization of other novel materials of long range interest for energy systems, in cooperation with other Division programs. Increased emphasis on study of cooperative interactions of molecular species on surfaces. | Materials Chemistry Research - Continue emphasis on novel organic and inorganic materials synthesis and characterization with focus on ceramic superconductors, organic superconductors, synthetic metals, high strength polymers, polymer electrolytes, inorganic polymers, preceramic materials, and novel materials synthesized using biological processes. Increased emphasis on the materials chemistry of macromolecules at interfaces and of polymer interfaces. Continue research program in chemical structure, surface chemical properties, and polymer research. | Materials Chemistry Research - Continue emphasis on novel organic and inorganic materials synthesis and characterization with focus on ceramic superconductors, organic superconductors, synthetic metals, high strength polymers, polymer electrolytes, inorganic polymers, preceramic materials, and novel materials synthesized using biological processes. These biological processes are part of the Biotechnology FCCSET crosscut. Increased emphasis on the materials chemistry of macromolecules at interfaces and of polymer interfaces. The following activities are part of the Advanced Materials and Processing crosscut: biomolecular materials, catalysts, synthesis of organic ferromagnets and superconductors, materials derived from small clusters, polymers, and tribology. |
| | Preconstruction R&D - Continued R&D support for the Advanced Neutron Source (ANS) ($11,000). | Preconstruction R&D - R&D support for ANS continued with additional funds provided for the completion of a conceptual design for the facility ($23,095). | Preconstruction R&D - R&D support of ANS continues with additional funds for environmental impact statement, preliminary safety analysis report, and probabilistic risk assessment for the ANS ($21,000). |

III. Materials Sciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Materials Sciences Research (Cont'd) | Upgrades of ESNET to conform to the National Research and Education Network standards continued; funding was shared among ER programs that benefit from ESNET. This subprogram's share was $247,000. | ESNET will be fully supported in the Applied Mathematical Sciences subprogram. | ESNET will be fully supported in the Applied Mathematical Sciences subprogram. |
| | No activity. | No activity. | In an effort to manage administrative costs more closely, the PSO/Office Director's share of FTE-dependent costs for space, supplies, and telecommunications are included in this budget and will be transferred during the execution year. |
| | $ 144,593 | $ 158,994 | $ 169,000 |
| Facilities Operations | Increased support for major facilities in the Materials Sciences subprogram. Increased funding for increased operating personnel and safety requirements at HFBR. Increased support for R&D and commissioning of components at 1-2 GeV and 6-7 GeV light sources. R&D support for ANS. (For more detail on Facilities Operations see the Major User Facilities section following the Construction section.) | Continue support for major facilities in the Materials Sciences subprogram. Increased funding for safety requirements at HFBR. Increased support for R&D and commissioning of components at 1-2 GeV and 6-7 GeV light sources. (For more detail on Facilities Operations see the Major User Facilities section following the Construction section.) | Continue support for major facilities in the Materials Sciences subprogram. Increases support for commissioning and operation of 1-2 GeV (LBL) and R&D and commissioning of components of the 6-7 GeV (ANL) synchrotron radiation sources. |
| | $ 80,554 | $ 98,122 | $ 121,227 |
| Congressionally Directed Projects | Funding provided for Congressionally directed projects, including $2,982,600 for the Technical and Administrative Services Facility at Ames Laboratory. | Funding for the Technical and Administrative Services Facility at Ames Laboratory is budgeted for in the Multiprogram Energy Laboratories - Facilities Support program. | Funding for the Technical and Administrative Services Facility at Ames Laboratory is budgeted for in the Multiprogram Energy Laboratories - Facilities Support program. |
| | $ 46,819 | $ 0 | $ 0 |
| Materials Sciences | $ 271,966 | $ 257,116 | $ 290,227 |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Chemical Sciences

The Chemical Sciences subprogram supports a broad range of basic research in chemistry and atomic physics necessary for future, both mid- and long-term, development of energy technologies. Major program efforts are in photochemistry important for the efficient conversion of solar energy to fuels or electricity; chemical physics related to combustion processes and improved utilization of fossil fuels; atomic physics related to fusion energy; heavy element chemistry related to nuclear waste management; a broad program in homogeneous and heterogeneous catalysis related to coal conversion and improved processes for the commercial production of fuels and chemicals; separations and analytical sciences related to virtually all process chemistry and nuclear energy technology; and chemical thermodynamics to assist in predicting physical and chemical properties of hydrocarbon fuels. This budget includes $3,100,000 in FY 1993 in support of the Materials Research activities. It also includes $14,580,000 in FY 1992 and $16,800,00 in FY 1993 in support of the Biotechnology activities. Recent examples of research results that may have significant technological impact may be cited as follows: A five-part molecule has been designed and synthesized which uses an electron transfer strategy similar to that of natural organisms for capture and conversion of light energy. X-ray studies have shown the location of active catalyst sites that will lead to the development of improved catalysts. Research in dynamics of chemical reactions has led to the discovery of a previously unobserved species that will provide insight into hydrocarbon combustion. A new separations process permits the isolation of a radioisotope of sufficient purity to permit the preparation of reagents for testing certain promising cancer treatment protocols. Lasers have been used to initiate a chemical reaction at a specific, desired part of a molecule that may point to entirely new methods to produce desirable chemicals. Support is also provided to major user facilities which are made available to the entire scientific community for research. This funding includes not only the annual operating costs of major user facilities, but also upgrades where necessary to maintain safe operation. This budget includes $900,000 in both FY 1992 and FY 1993 in support of the Math and Science Education activities.

II. A. Summary Table: Chemical Sciences

| Program Activity | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Chemical Sciences Research | $ 95,339 | $ 101,419 | $ 115,100 | + 13 |
| Facilities Operations | 60,300 | 56,881 | 60,300 | + 6 |
| Total, Chemical Sciences | $ 155,639 | $ 158,300 | $ 175,400 | + 11 |

II. B. Major Laboratory and Facility Funding

| | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Ames Laboratory | $ 3,649 | $ 3,751 | $ 4,011 | + 7 |
| Argonne National Laboratory (East) | $ 16,095 | $ 16,352 | $ 16,883 | + 3 |
| Brookhaven National Laboratory | $ 17,379 | $ 17,791 | $ 17,753 | 0 |
| Idaho National Engineering Laboratory - EG&G | $ 290 | $ 315 | $ 315 | 0 |
| Lawrence Berkeley National Laboratory | $ 7,549 | $ 7,742 | $ 7,901 | + 2 |
| Lawrence Livermore National Laboratory | $ 2,269 | $ 40 | $ 40 | 0 |
| Los Alamos National Laboratory | $ 1,022 | $ 840 | $ 840 | 0 |
| Oak Ridge National Laboratory | $ 48,077 | $ 44,508 | $ 47,015 | + 6 |
| Pacific Northwest Laboratory | $ 5,300 | $ 6,990 | $ 7,283 | + 4 |
| Sandia National Laboratories | $ 7,199 | $ 7,616 | $ 8,051 | + 6 |

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Chemical Sciences | | | |
| Chemical Sciences Research | The characterization of solvent effects on photoinduced electron transfer which is critically important for solar photochemical energy conversion technologies received preferred emphasis, as did the related areas of photosynthesis and photoelectrochemistry. Studies on the characterization of solution properties using radiation chemistry techniques and the unique chemistry of highly energetic atoms were maintained. Laser-based optical techniques capable of time resolution of less than a trillionth of a second allow the study of complex chemical reactions at a level of detail required to characterize processes that impact a host of energy technologies including artificial photosynthesis. | In general, the available level covers some cost of living increases for the research program and facilities operations. Program enhancements in one area will have to be offset by reductions elsewhere. A better understanding of solvent dynamics as they affect electron transfer is necessary for improvements in solar photochemical energy conversion and will receive emphasis. The related areas of photosynthesis and photoelectrochemistry will be maintained. Radiation chemistry, except as related to broader chemical questions, will be reduced. | The requested level provides for increases in several specified research areas such as catalysis, combustion, and separations chemistry. Other high-priority programs will be continued. The research program is aimed at understanding chemistry and reactivity at a molecular level. Much work will focus upon fast or short-lived phenomena. Understanding of solvent dynamics and electron transfer are necessary to achieve long-term goals of the National Energy Strategy (NES), the Biotechnology FCCSET crosscut and for improved solar photochemical energy conversion. This area will be emphasized as will the related areas of natural photosynthesis and photoelectrochemistry. |

III. Chemical Sciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Chemical Sciences Research (Cont'd) | Theoretical and experimental research on the detailed dynamics of chemical reactions related to combustion remained a high priority effort and continued unabated. Support for high priority fundamental studies of interactions of atoms and molecules with surfaces and clusters as a means for developing general theories of catalysis continued. High priority was given to experimental and theoretical research in molecular aspects of interfacial science to understand the reactivity and control or prevent transport of hazardous chemicals and species in the environment. The research program emphasized both theoretical and experimental efforts to characterize extremely fast or short-lived phenomena. The CRF contributed substantially to the combustion part of this effort. | The dynamics of chemical reactions critical to an improved understanding of combustion processes will be given priority. Studies of the electronic properties and chemical reactivity of metal clusters will be important to an improved knowledge of catalysis and will remain as a high priority area. Research in the areas of theory, dynamics and structure related to chemical aspects of environmental restoration and waste management will be maintained. Studies of dynamical processes at extremely short times coupled with more extensive theoretical computational efforts will be performed in areas related to energy technologies including artificial photosynthesis, combustion and catalysis. The CRF will contribute substantially to the combustion part of this effort. R&D in combustion dynamics will continue with emphasis on building on capability at the Lawrence Berkeley Laboratory and Sandia National Laboratory. | Critical to a successful National Energy Strategy is improved understanding of combustion processes through a thorough knowledge base in chemical reactivity. Increased funding will permit advances in the dynamics and kinetics of simple combustion related reactions which will be given highest priority. Modeling efforts will be continued. The CRF will continue as a major site devoted to combustion research. Research on chemistry at the liquid-solid interface which is important to understanding reactivity and to control or prevent the transport of hazardous chemicals and species in the environment will continue. The properties and reactivity of clusters, both metal and semiconductor, will be important in the long-term for improved catalysis to achieve NES goals and understanding behavior of materials that will contribute to the Materials Research FCCSET crosscut. |
| | Research on the characterization of the electronic structure and dynamics of multiply charged ions, particularly the exchange of energy and momentum during collisions of these ions with other ions, atoms, electrons, and photons, remained a high priority, benefiting both fusion energy and X-ray laser development. The program in theoretical atomic physics continued. Recent experimental progress in the area of high-energy, atomic physics under extreme conditions far outstrips the theoretical and computational tools needed for the application of newly acquired knowledge to the development of fusion energy and X-ray laser technologies. New and improved theories are required to guide new experiments | The atomic physics research program as described in the FY 1991 budget will be continued. Every effort will be made to increase the theory component of the program and to implement recommendations of recent workshops sponsored by the Division of Chemical Sciences on "Opportunities in Atomic Physics". | The atomic, molecular, optical, and plasma sciences effort consistent with the NES will be expanded using the recommendations in the report supported by the Chemical Sciences Division on "Future Research Opportunities in Atomic, Molecular, and Optical Physics" and other reports providing research opportunity recommendations. Specifically, there will be enhanced efforts in molecular and optical sciences and properties of low-temperature plasmas. The opportunities in this activity are rich in such areas as understanding laser light-matter interactions, the behavior of photonic systems such as optical fibers and plasmas for materials processing. |

III. Chemical Sciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Chemical Sciences Research (Cont'd) | and to interpret existing data. Special attention was given to university-based efforts in order to address a serious national shortage of high quality scientists trained in modern atomic physics theory. | | |
| | Research programs in materials precusor chemistry, catalysis and coal chemistry were protected. Research leading to novel organometallic polymers, layered and zeolitic structures, membranes, polyoxmetallates, and metal clusters were supported at current levels. Their use in the preparation of advanced semiconductors, polymers, catalysts, superconductors, coated electrodes and separation membranes was explored. | Research on materials precursors and catalysis will be maintained. Growth opportunities in this area will be realized at the expense of research in areas such as isotopes effect chemistry. Program directions established in FY 1991 will be continued. | Materials precursor chemistry based on new synthetic processes for the molecular design of advanced materials will be increased to aid the Materials Research FCCSET crosscut. High priority research in the heterogeneous and homogeneous catalysis programs and coal chemistry research will continue to be emphasized in accord with NES goals. General program directions established in FY 1992 will continue. Research on aspects of macromolecular structure and function important to the Biotechnology FCCSET crosscut will be carried out as will research on catalytic biochemical systems. Included is a collaborative basic research program for Advanced Battery Technology R&D involving universities, national laboratories, and industry. The objective is to provide basic research results to aid development of new generic battery technology for a wide range of applications, with particular emphasis on improvements in battery size, weight, life, and recharge cycles for non-automotive applications. |

III. Chemical Sciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Chemical Sciences Research (Cont'd) | In the chemical engineering sciences program, continued emphasis is on research on solid-liquid phase equilibria, which is supportive of efforts in materials sciences research. Research on physical predictive models based upon chemical thermodynamics was supported. | Research on thermodynamics, physical and chemical rate processes will be supported. There will be emphasis on development of the scientific base for engineering generalizations. | Chemical thermodynamics research to assist in predicting physical and chemical properties of hydrocarbon fuels will be supported. Research efforts in materials precursor chemistry will be supported through chemical engineering sciences by research on solid-liquid phase equilibria. |
| | The chemistry of interfacial phenomena important to membrane and other separations processes increased. Analytical methods to determine the spatial distribution and identity of molecular species at interfaces such as a membrane liquid interface was supported. The design and synthesis of specific molecular complexing agents and reverse micelle work at near critical conditions were modestly enhanced. | Separations chemistry and environmentally related analytical research will be protected at current levels. To the extent possible ultrasonic studies for surface analysis and wet chemical surface analysis studies will be initiated. Research to determine the detailed role of electronic factors in membrane transport will be carried out. Studies of crown ether modifications to enhance solubilities will be explored. | Consistent with NES goals in improvements and innovations in analytical methods will be continued as will efforts to improve the understanding of separation processes. This will include studies of the design of ion-specific complexing agents for the selective removal of metallic species in aqueous process and waste streams and research on the energy and process efficiencies of vapor-liquid separations. |
| | Research on highly sensitive methods for speciation of solution actinide species was increased. The chemistry of actinides in superconducting mixed oxides was extended. New experimental and theoretical investigations on the stabilities of high temperature molecular species were pursued at the expense of other ongoing research. | Heavy element chemistry in the area of solid state work related to new superconducting materials will be protected. The organometallic chemistry of the actinides and lanthanides, particularly as it relates to catalysis will receive emphasis. | Studies of the characteristics of electronic bonding at high pressure and the behavior of the actinide elements in superconducting phases will be emphasized in solid state heavy element chemistry. Research on the electronic structures of the actinide elements in aqueous solution as it pertains to analyses and species characterization at environmental concentrations will be maintained. |
| | Upgrades of ESNET to conform to the National Research and Education Network standards continued; funding was shared among ER programs that benefit from ESNET. This subprogram's share was $246,000. | ESNET will be fully supported in the Applied Mathematical Sciences subprogram. | ESNET will be fully supported in the Applied Mathematical Sciences subprogram. |

III. Chemical Sciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Chemical Sciences Research (Cont'd) | No activity. | No activity. | In an effort to manage administrative costs more closely, the PSO/Office Director's share of FTE-dependent costs for space, supplies, and telecommunications are included in this budget and will be transferred during the execution year. |
| | $ 95,339 | $ 101,419 | $ 115,100 |
| Facilities Operations | More optimal levels of support for major user facilities were established in FY 1991. The safety, quality assurance and physical facility improvements planned for the HFIR were carried out to the degree possible. Increases for the CRF for ultra fast dynamics and theoretical computing capability were provided. (For more detail on Facilities Operations see the Major User Facilities section following the Construction section.) | The more optimal levels of facilities operations established in FY 1991 will be maintained. Analysis of increasing requirements for safety, quality assurance and physical facility improvements at the HFIR will continue so safe operating conditions can be maintained. (For more detail on Facilities Operations see the Major User Facilities section following the Construction section.) | Support is provided to major user facilities which are available to the entire scientific community. The facilities will continue to operate at the improved level set in FY 1991. Improvements in safety, management, and operations at the High Flux Isotope Reactor will be continued. Increasing requirements in quality assurance and conduct of operations will be addressed. (For more detail on Facilities Operations see the Major User Facilities section following the Construction section.) |
| | $ 60,300 | $ 56,881 | $ 60,300 |
| Chemical Sciences | $ 155,639 | $ 158,300 | $ 175,400 |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Applied Mathematical Sciences

The Applied Mathematical Sciences (AMS) subprogram, through the Mathematical Sciences Research Activity, supports fundamental research in the Mathematical, Computational, and Computer Sciences in support of all DOE program components. The AMS subprogram, through the Energy Sciences Advanced Computation Activity, provides access to forefront supercomputer systems, at two major supercomputer centers supporting over 4,000 researchers nationwide who are funded by the Office of Energy Research (ER) and who are connected via an interagency and international high speed computer network, the Energy Sciences Network (ESNet). The ESNet, a 19-node packet switched high-speed data network, is also an integral component of the National Research and Education Network (NREN). The AMS subprogram also includes the DOE contribution for the second year of the President's High Performance Computing and Communications (HPCC) Program, which was initiated in FY 1992. These activities are included in the FCCSET HPCC crosscut. This budget includes $75,500,000 in FY 1992 and $91,000,000 in FY 1993 in support of the High Performance Computing and Communications activities. The AMS subprogram, as part of the HPCC program in FY 1992, initiated applications oriented collaborations projects in computational research to advance 'grand challenge' energy applications such as: lattice gas calculations for fluid flow in porous media in cooperation with several oil company partners; macromolecular design calculations with a pharmaceutical company; environmental ground water transport modeling with university partners; computational research to predict properties of materials from first principles; and computational research to understand and model catalysis. Also included in this budget is $4,800,000 in FY 1992 and $3,000,000 in FY 1993 in support of the Math and Science Education activities.

The objectives of the AMS subprogram activities are to advance the knowledge of mathematical, computational, and computer sciences needed to model the complex physical, chemical, and biological phenomena involved in energy production and storage systems, to advance the knowledge of high performance communications techniques needed to support geographically distributed science collaborations and high performance computer systems access, and to manage the ER high performance computing research centers (including supercomputer facilities) and the ESNet as part of the overall HPCC Program.

II. A. Summary Table: Applied Mathematical Sciences

| Program Activity | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Mathematical Sciences Research..... | $ 28,274 | $ 41,000 | $ 46,250 | + 13 |
| Energy Sciences Advanced Computation..... | 23,860 | 40,500 | 44,750 | + 10 |
| Total, Applied Mathematical Sciences | $ 52,134 | $ 81,500 | $ 91,000 | + 12 |

II. B. Major Laboratory and Facility Funding

| | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Ames Laboratory | $ 1,563 | $ 1,450 | $ 1,500 | + 3 |
| Argonne National Laboratory (East) | $ 4,310 | $ 4,250 | $ 4,250 | 0 |
| Lawrence Berkeley National Laboratory | $ 2,092 | $ 2,150 | $ 2,350 | + 9 |
| Lawrence Livermore National Laboratory | $ 11,898 | $ 13,250 | $ 21,900 | + 65 |
| Los Alamos National Laboratory | $ 3,138 | $ 2,508 | $ 2,500 | 0 |
| Oak Ridge National Laboratory | $ 3,330 | $ 2,070 | $ 2,600 | + 26 |
| Sandia National Laboratories | $ 2,660 | $ 2,210 | $ 2,500 | + 13 |

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Applied Mathematical Sciences | | | |
| Mathematical Sciences Research | Research in analytical and numerical mathematics continued at the same level. A postdoctoral fellowship in computational mathematics continued to provide two fellowships for each major laboratory with substantial participation in the Mathematical Sciences research activity. | Research in analytical and numerical mathematics will emphasize the computational techniques applicable to the "grand challenge" problems including energy conservation and turbulent combustion, global climate modeling, structural biology, materials properties and condensed matter physics, quantum chromodynamics, and environmental modeling and remediation. | Research in analytical and numerical methods will continue to pursue fundamental research in areas important for understanding the physical, chemical, and biological processes related to energy production, use, and conservation. Basic research in this area will also investigate parallel numerical algorithms, matching algorithms to computer architectures, and theory of parallel computing complexity as part of the HPCC program. |
| | Projects in data analysis, display and management received increased attention, in order to investigate new techniques for handling large scale scientific data on new parallel architecture computing systems. | Research in data analysis, display and management will be focused on the large scale scientific data problems related to the above projects. Several special projects will be initiated including lab, university and industry researchers to attack the problems of data compression, storage, and management which are already overwhelming projects in DOE. | Research in applications and computational sciences will emphasize the computational techniques needed to model complex physical, energy related processes and computations applicable to the 'grand challenge' problems, including catalysis, combustion, materials properties and condensed matter physics, global climate modeling, enhanced oil recovery, quantum chemistry and environmental modeling and remediation. HPCC funding support will provide for an additional 'grand challenge' collaboration and for |

III. Applied Mathematical Sciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Mathematical Sciences Research (Cont'd) | | | expanded computational science education programs. |
| | Research projects that support investigation of scientific problems on parallel architecture computing systems continued building up to critical mass in the major laboratories supported by the AMS program. Progress on adapting new algorithms to new architectures focused on those techniques suitable to the "grand challenge" problems in physics, chemistry, biology, ecology, materials, and environmental studies. | High performance computing experimental research prototypes, including modern parallel computer systems, algorithm research, and visualization techniques, as described in the U.S. High Performance Computing and Communications Program Report will be emphasized at DOE laboratories and universities. Additional university based projects will be initiated to collaborate with the laboratories and provide postdoctoral fellows and graduate students to ensure future human resources in these areas. | Research will continue in advanced computer concepts, data management, and high performance computing technology development and evaluation. Emphasis for the HPCC program will be on software components and tools for massively parallel systems, distributed computing environments, scalable architectures and libraries, future generation data storage systems and visualization techniques. |
| | $ 28,274 | $ 41,000 | $ 46,250 |
| Energy Sciences Advanced Computation | Continued funding for supercomputer access to NERSC for all researchers funded by OER. A one year extension to the original five year cooperative agreement with FSU/SCRI was completed in FY 1991. | Additional support of the Advanced Software Technology and Algorithms category in the High Performance Computing Initiative will be provided for HPCC research centers. This includes support for experimental high performance computational facilities (including continued funding for the interim Cray 2, for one or more centers whose selection will be based on a competitive peer review of unsolicited proposals) and advanced software development projects in software components and tools, and computational techniques. Proceeds with the acquisition of a Class VII supercomputer to replace one of the older Class VI systems in use last year at NERSC. Delivery of the new Class VII is scheduled as part of a joint laboratory and industry software technology development project. | Continue funding for Class VII supercomputer implementation at the National Energy Research Supercomputer Center (NERSC) and for the HPCC Research Centers initiated as part of the HPCC program. Initiate partial support for an additional HPCC research center based on competitive peer review of proposals. Continue funding for supercomputer software tools for improved access to HPCC systems. |

III. Applied Mathematical Sciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Energy Sciences Advanced Computation (Cont'd) | | Continues funding for the FSU/SCRI cooperative agreement. | |
| | Upgrades of ESNET to conform to the National Research and Education Network standards continued to be pursued and were shared among ER programs that benefit from ESNET. | Initiate ESNET plan, in conjunction with the other Federal agencies as part of the High Performance Computing and Communications Program, to incorporate the DOE ESNET into the National Research and Education Network. Initiate a DOE program component for gigabit network research concentrating on distributed supercomputer applications and user interfaces projects. | Continue upgrade and evolution of Energy Sciences Network (ESNet) as part of the HPCC NREN project, including T3 implementation (45 megabits per second), remote conferencing technology development and distributed applications network support. Maintain gigabit network research at current level concentrating on multiprotocol support, interprocess communication techniques, and gigabit testbed support. |
| | $ 23,860 | $ 40,500 | $ 44,750 |
| Applied Mathematical Sciences | $ 52,134 | $ 81,500 | $ 91,000 |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Engineering and Geosciences

The Engineering and Geosciences subprogram supports DOE's principal fundamental research activities in the engineering and geosciences disciplines. The research serves the DOE goal of fortifying foundations: in particular, foundations for progress in the areas of respecting the environment, securing future energy supplies, and increasing energy efficiency. Principal expected payoffs from use of the research results are added domestic sources of liquid and gaseous fuels, better foundations for improvements in environmental technologies, reduction of capital needs for energy production and distribution, and addition of highly skilled personnel to the U.S. work force in energy-related fields.

The engineering research objectives are (1) to improve and advance our knowledge of processes underlying current engineering practice, and (2) to expand the store of fundamental concepts for solving anticipated and unforeseen engineering problems in energy technologies. To meet those objectives, the program focuses on supporting individual investigators and small groups of researchers addressing the foundations of energy related engineering. Topics addressed include fundamentals important to increasing energy efficiency, to identifying potential new energy production and utilization processes, and to maintaining high environmental standards. Examples include multiphase flows (important to energy production and to waste management), instrumentation and control systems (important to intelligent systems for material processing and synthesis), and issues such as reliability and useful life prediction of aging energy production and distribution systems (important for safety and environmental considerations). An increasing fraction of the effort features joint research projects involving two or more participating institutions, among National Laboratories, universities and industry. In FY 1993, more than a third of the budget will be devoted to such collaborative activities. This budget includes $2,600,000 in FY 1992 and $3,500,000 in FY 1993 in support of the Biotechnology activities. Also included is $1,000,000 in FY 1993 in support of the Materials Research activities.

Geosciences research provides the base for efficient and effective use of our earth-based natural energy resources and the environmentally acceptable disposal of energy-related waste products in the earth and its environs. A sound predictive capability regarding the behavior of natural materials is essential for new and improved technologies bearing on fossil fuel and geothermal energy use and for improved environmental remediation and waste disposal technologies. Emphasis is on geologic fluids flowing in, and interacting with, porous and fractured rocks of the near-surface regime of the earth's crust. Fundamental understanding related to this emphasis is based on data collected by indirect geophysical methods (underground imaging program), by direct drilling and sampling (interagency Continental Scientific Drilling Program), by use of isotopic abundance as a tracer of processes, and in a broad program of studies of basic properties of these natural, and perturbed, materials of the earth's crust and atmosphere. Geoscience research bearing directly on a secure energy supply and environmentally acceptable uses of our energy resources must be a keystone in the National Energy Strategy.

II. A. Summary Table: Engineering and Geosciences

| Program Activity | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Engineering Research | $ 14,759 | $ 16,370 | $ 18,210 | + 11 |
| Geosciences Research | 17,159 | 19,430 | 21,330 | + 10 |
| Congressionally Directed Projects | 1,989 | 0 | 0 | 0 |
| Total, Engineering and Geosciences | $ 33,907 | $ 35,800 | $ 39,540 | + 10 |

II. B. Major Laboratory and Facility Funding

| | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Ames Laboratory | $ 130 | $ 0 | $ 0 | 0 |
| Argonne National Laboratory (East) | $ 661 | $ 699 | $ 870 | + 24 |
| Brookhaven National Laboratory | $ 0 | $ 175 | $ 200 | + 14 |
| Idaho National Engineering Laboratory - EG&G | $ 1,899 | $ 1,994 | $ 2,091 | + 5 |
| Lawrence Berkeley National Laboratory | $ 2,334 | $ 2,242 | $ 2,425 | + 8 |
| Lawrence Livermore National Laboratory | $ 2,103 | $ 2,308 | $ 2,450 | + 6 |
| Los Alamos National Laboratory | $ 2,621 | $ 2,833 | $ 3,012 | + 6 |
| Oak Ridge National Laboratory | $ 2,185 | $ 2,396 | $ 2,625 | + 10 |
| Pacific Northwest Laboratory | $ 810 | $ 844 | $ 907 | + 7 |
| Sandia National Laboratories | $ 2,612 | $ 2,306 | $ 2,527 | + 10 |

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Engineering and Geosciences | | | |
| Engineering Research | Support for critical long term basic engineering research in the area of Engineering Data and Analysis continued at about 3% below the FY90 level of effort. For example, funds were provided for research by experts in theory of chaos and non-linear dynamical systems drawn from such fields as engineering, mathematics, physics, chemistry, biology, and economics. Such theory is needed to model and study the evolution of engineering, physical, biological and economic systems. A notable achievement here was the completion of a monograph on non-linear models of hysteresis (systems with memory) aimed at the full range of energy engineering applications. Research continued in the areas of plasma processing and combustion. Researchers obtained accurate data for gas temperatures and flow velocities in thermal plasma jets essential for improved plasma processing of materials. | The available funds provide some enhancement of the level of effort, and this will enable a significant start toward engineering research aimed at exploiting biotechnology for use in processing of fuels and energy related wastes. This long term basic research effort will rely and build on the existing base of outstanding researchers in chemical engineering. Research by individual investigators will continue in carefully selected areas fundamental to creating new energy related technological opportunities, such as non-imaging optics contributing to improved efficiency in illumination; thermodynamics of engines operating in analogy with highly energy efficient oscillatory biological processes; and diagnostics and control of nonequilibrium plasma processing of materials for fast production of wear resistant coatings. | The request provides added long term basic engineering research in the area of Engineering Data and Analysis in support of the program-wide strengthening of materials synthesis and processing and of biotechnology. Selected topics in bioprocessing of fuels and energy related wastes will be emphasized, especially bioreactor systems, separations technology, and process monitoring and control. These bioprocessing activities are part of the Biotechnology FCCSET crosscut. Emphasis will be placed on studies of advanced processing technologies as part of the Materials Research FCCSET crosscut. Encouragement for collaborative national laboratory-university engineering research will continue in the areas of diagnostics and control of plasma processing of materials. |

III. Engineering and Geosciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Engineering Research (Cont'd) | Support for critical long term basic engineering research in the area of Control Systems and Instrumentation continued at about 4% below the FY90 level of effort. Existing strong collaborative work among universities, industries and national laboratories continued in such areas as welding automation and intelligent machines. In the latter area, experiments have started at Oak Ridge National Laboratory on communication and cooperation between autonomous robots with differing operational capabilities. Major advances have been made in handling uncertainties in signals from multiple sensors mounted on autonomous robots featuring both advances in mathematical methods and development of special purpose computer chips. | Research by individual investigators will continue in carefully selected areas fundamental to creating new energy related technological opportunities, such as robot-robot interactions and the development of process design and control strategies for energy efficiency, high product quality, and improved productivity in chemical and petroleum processing industries. Research on engineering design of energy intensive production processes, supported by BES, have led to software packages which have attracted widespread interest and use by U.S. industry. | The request also provides continued long term basic engineering research in the area of Control Systems and Instrumentation. Focus in this area will be on studies of intelligent machines, especially to the development of intelligent sensor systems, machine learning, and applications of high-performance computing, all aimed at providing a scientific infrastructure for multiple cooperating robotic systems. This focus will emphasize systems useful for energy production technologies and waste management. Studies of process design and control strategies and related instrumentation will also be maintained. |
| | Support for critical long term basic engineering research in the area of Mechanical Sciences continued at about 5% below the FY90 level of effort. Research in multiphase flow proceeded with emphasis on two-phase flow of liquids and gases and flow in porous media. Results from these studies are not only important in the design of many energy conversion devices but are also of importance to recovery of oil and gas deposits, management of nuclear waste repositories and the Department's long-term environmental restoration program. Results from recent engineering research continued to find their way into more applied R&D; e.g., work on multiphase flows funded by this program has been incorporated into development efforts funded currently by DOE's Office of Fossil Energy. Also, important for new energy efficient processing concepts, such as clean | Further research will be carried out towards improvement of reliability, safety and efficiency of systems based on the flow of mixtures of liquids and gases (two-phase flows); such systems range from nuclear reactors, through oil pipelines, to air-conditioning and refrigeration systems. In the area of multi-phase flows important to the fulfillment of the mission of the Department, existing effort will continue in the studies of flow through porous media, e.g., rock, sand, and packed-bed reactors. This area of research is important as underpinning for technologies ranging from oil and gas recovery to the long term stability of nuclear waste deposits. Where appropriate, efforts will be made to encourage the use of facilities at national laboratories by universities and related collaborative researchers. Also to be continued are the | This request will provide continued support for long term basic engineering research in the area of Mechanical Sciences with some strengthening for topics particularly important to goals of the National Energy Strategy. Mitigating effects of aging of energy production and distribution systems will be emphasized. Better understanding is needed of how structures behave under stress such as the high loads and thermal cycling encountered in energy systems. The studies will draw on recent advances in solid and structural mechanics. Special attention will also be paid to studies of flow through porous media and related flows encountered in bioreactors. Investigations of basic aspects of multiphase flows, and of heat transfer aimed at increasing the operational safety and efficiency of energy systems will continue. |

III. Engineering and Geosciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Engineering Research (Cont'd) | coal, was the gain in understanding how energy flows in crushing and pulverization of solids. Work continued on structural life prediction. | significant research investigations in the important area of fracture mechanics. | Encouragement for collaborative national laboratory-university engineering research will continue in the area of solid mechanics. |
| | No activity. | No activity. | In an effort to manage administrative costs more closely, the PSO/Office Director's share of FTE-dependent costs for space, supplies, and telecommunications are included in this budget and will be transferred during the execution year. |
| | $ 14,759 | $ 16,370 | $ 18,210 |
| Geosciences Research | Research was stressed on effects of fluid flow and reaction with porous and fractured rocks of the earth's crust. Researchers at Wisconsin, LANL, LBL, and SNL have used new techniques in assessing microfracture coalescence and propagation to provide a basis for incorporating multiple microfractures in rocks into constitutive models for rock failure and response to stress. Scientists at Stanford and Purdue Universities have advanced our knowledge of 3D fracture connectivity through integrated theoretical, modeling, and field studies. | Isotopic and physical methods of significantly increased sensitivity developed in this program will be used for tracing fluid flow in fractured reservoirs to yield new data and concepts important for enhanced oil recovery, geothermal energy use, and geologic isolation of hazardous, mixed, and nuclear wastes. Research on fluid transport in sedimentary basins will be enhanced to develop our technology base for finding and using energy resources, and to aid in the appraisal of pollutant movement. | This request provides added research contributing to goals of the National Energy Strategy. Emphasis will be given to fluid flow and chemical transport in fractured and porous rocks to provide key data on energy resource origin, distribution, availability and environmentally acceptable use. Research on mineral-fluid interactions at the atomistic and molecular scales will be strengthened as a foundation element for modeling geochemical interactions. The macroscopic studies of rock-water interactions in past years demonstrate the need for fundamental data at atomic scales in modeling geochemical transport. |

III. Engineering and Geosciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Geosciences Research (Cont'd) | Geophysical imaging of fluid bearing reservoirs is a key element of the program. Research has been oriented to development of new methods and approaches for high-resolution delineation of reservoirs. LANL researchers have shown that microearthquakes produced by hydrofractures can be used to obtain data on fracture filling and movement on fractures. | High-resolution geophysical imaging will begin to evolve toward an emphasis on near-surface structures and fluid-bearing systems. This will be critical in the environmentally conscious use of the Nation's energy resources as well as in restoration of contaminated sites. Geophysical studies of deep crust and mantle structure will decline. | The request also provides for strengthening research on underground imaging of geologic structures and fluid-bearing reservoirs. Fundamental studies are developing a science base for new approaches to be used in characterizing both subsurface oil and gas reservoirs and candidate waste repository sites, thus supporting the National Energy Strategy (NES) by improving the usable National resource base and waste management practices. |
| | Activities have been underway in measurement of fundamental geophysical and geochemical properties of minerals, rocks, fluids, and on the earth-sun system. ORNL researchers have shown that isotopic fractionation between rocks and fluids in the C-H-O-brine system depends on fluid composition. | Geophysical and geochemical processes taking place near the earth's surface will be given added emphasis in the continuing program on fundamental properties of earth materials. Studies related to magmatic and volcanic phenomena will receive less emphasis. | Effective and efficient use of energy resources is a key element of the NES. The program in fundamental properties of geologic materials will continue with increased emphasis on organic geochemistry in sedimentary basins as related to the origin, migration, and accumulation of hydrocarbon and geothermal resources. |
| | The emphasis in the DOE part of the interagency Continental Scientific Drilling Program (DOE, NSF, USGS) is on the Base program, including drilling at Long Valley, CA, and in preparatory studies at Katmai, AK. | In the Continental Scientific Drilling Program the emphasis will be on shallow drilling at sites chosen to improve knowledge of processes involved in sedimentary basins and petroleum reservoirs. | The Continental Scientific Drilling Program will emphasize participation in the Base Drilling Program ($1,000). The NEPA process for Katmai drilling will be completed, which will determine the appropriate next step. DOE is participating in the Katmai project together with NSF and USGS. |
| | $ 17,159 | $ 19,430 | $ 21,330 |
| Congressionally Directed Projects | Funding provided for Congressionally directed projects. | No activity. | No activity. |
| | $ 1,989 | $ 0 | $ 0 |
| Engineering and Geosciences | $ 33,907 | $ 35,800 | $ 39,540 |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Advanced Energy Projects

The Advanced Energy Projects (AEP) subprogram supports research on novel energy-related ideas. The ideas emerge either from advances in basic research or from heretofore untried approaches that warrant funding to establish feasibility. The projects involved have higher risk than those normally supported by the customary DOE technology offices related to those concepts. The high risk involved in an AEP project is balanced by a high reward for the nation's energy posture if the project is successful. The AEP program is broad-ranged and reflects present perceptions of national needs in terms of innovative technologies in energy.

To illustrate, a component of the AEP program consists of projects that can have a large impact on future energy conservation efforts, and projects to support the National Energy Strategy. An example is the railplug igniter for diesel engines. Other significant areas being explored are in support of the Advanced Materials and Processing FCCSET crosscut and the Biotechnology Research FCCSET crosscut. This budget includes $300,000 in both FY 1992 and FY 1993 in support of the Biotechnology activities. Also included is $500,000 in FY 1993 in support of the Materials Research activities. Examples include nanometer fabrication techniques and the development of the positron microscope. The Division also supports efforts in novel sources of electromagnetic radiation, such as portable x-ray lasers and new applications for microwave generators. Innovative concepts in nuclear technology and a possible approach to controlled thermonuclear fusion through the impact of accelerated clusters of heavy-water molecules with deuterated targets are also under investigation.

Since an AEP project is typically supported for a period of three years, the Division is able to initiate new projects every year. At the end of its AEP funding period, each project is encouraged to attract continuation funding on its own, newly-established merit, whether in the Government or in the private sector. Projects are selected on the basis of unsolicited proposals received from researchers at universities, industrial laboratories and national laboratories.

II. A. Summary Table: Advanced Energy Projects

| Program Activity | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Advanced Energy Projects | $ 14,285 | $ 10,800 | $ 11,900 | + 10 |
| Congressionally Directed Projects | 10,389 | 44,000 | 0 | -100 |
| Total, Advanced Energy Projects | $ 24,674 | $ 54,800 | $ 11,900 | - 78 |

II. B. Major Laboratory and Facility Funding

| | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Argonne National Laboratory (East) | $ 1,380 | $ 1,525 | $ 1,525 | 0 |
| Brookhaven National Laboratory | $ 340 | $ 485 | $ 440 | - 9 |
| Lawrence Berkeley National Laboratory | $ 5,473 | $ 540 | $ 545 | + 1 |
| Lawrence Livermore National Laboratory | $ 280 | $ 0 | $ 0 | 0 |
| Los Alamos National Laboratory | $ 467 | $ 750 | $ 750 | 0 |
| Oak Ridge National Laboratory | $ 532 | $ 833 | $ 941 | + 13 |

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Advanced Energy Projects | | | |
| Advanced Energy Projects | Funds were available to continue with the mission to establish the technical feasibility of novel and highly unconventional concepts that span the Department's interests in energy technologies, as they emerge from basic studies. Projects currently underway at universities, national laboratories and industrial laboratories will be continued towards completion. These projects are in areas that include novel sources of short-wavelength radiation, unconventional approaches to chemical separations, innovative fossil fuel technology, and alternative approaches to fusion. As existing projects were completed, promising new concepts were considered for support. Program vitality was maintained by initiating approximately 10 new projects during the fiscal year. | Provides funds to continue to explore the technical feasibility of novel energy-related concepts that evolve from basic research. Existing projects, which include innovative techniques for cleaning oil spills, an unconventional approach to fossil fuel technology, and a novel processing technique for high-temperature superconducting materials will be continued toward completion. As projects are completed, funds would be available during the fiscal year to maintain program viability by initiating the exploration of promising new concepts. | Provides funds for converting basic research findings into applications that, if successful, would improve the nation's energy economy. Existing projects making satisfactory progress will be continued toward completion. These projects include the synthesis of new fluorinated high performance lubricants for use at extreme temperatures, and the exploration of cluster-impact fusion as a potential new approach to fusion energy-application. A major initiative will be to start promising new projects in areas stressed in the National Energy Strategy. Also, increased support will be provided as part of the Materials Research FCCSET crosscut and the Biotechnology FCCSET crosscut. |
| | The Heavy Ion Fusion Accelerator Research (HIFAR) effort continued towards its objective with existing apparatus. Emphasis was placed on using the ion injector system to examine beam physics issues. | TRANSFER: The Heavy Ion Fusion Accelerator Research (HIFAR) effort has been transferred to the Office of Fusion Energy. ($-6,850) | No activity. |

III. Advanced Energy Projects (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Advanced Energy Projects (Cont'd) | No activity. | No activity. | In an effort to manage administrative costs more closely, the PSO/Office Director's share of FTE-dependent costs for space, supplies, and telecommunications are included in this budget and will be transferred during the execution year. |
| | $ 14,285 | $ 10,800 | $ 11,900 |
| Congressionally Directed Projects | Funding provided for Congressionally directed projects. | Funding provided for Congressionally directed projects. | No activity. |
| | $ 10,389 | $ 44,000 | $ 0 |
| Advanced Energy Projects | $ 24,674 | $ 54,800 | $ 11,900 |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Energy Biosciences

Recent world events, the National Energy Strategy, concerns about global climate change and U.S. competitiveness all bring home the need to concentrate effort on the development of alternate fuel and chemical resources and related biotechnologies as one important facet of the nation's science policy. The research focus of the Energy Biosciences (EB) subprogram is to understand the fundamental mechanisms of how plants produce biomass and the mechanisms of biological transformation of abundant biomass into usable forms. The program provides the basic foundation for the exploitation of new sophisticated knowledge in molecular genetics. Currently, a major obstacle to the employment of molecular biological technology is the meager biological information base for defining new processes and applications. The EB subprogram is designed to fill this critical information gap by the support of research in the plant and microbiological sciences. The program supports developing understanding at the genetic, biochemical and physiological levels of the diverse capabilities of organisms to metabolically synthesize chemical compounds. Whereas the goal of this research is to achieve improved supplies of fuels, chemicals and materials, information useful in bioremediation may also result. The EB subprogram specifically focuses on the major classes of plant compounds, carbohydrates and lignins; how they are produced, how they function in the organism, how they are degraded, and what opportunities exist for their biological modification. Applications to energy problems would be expected in the mid- to long-term time scale. However, some EB program generated information is rapidly transferred. For example, in the past year the Patent Office's 5,000,000th patent was awarded to a university whose EB grantee work advanced the possibilities of using a broader range of starting materials for alcohol production. An industrial firm is now working on this patent.

The major focus of the program is on the potential biological solution of energy problems addressed at the fundamental level. These include photosynthesis, methanogenesis, fermentations, genetics of anaerobic organisms and others. The program interacts and coordinates with the Conservation and Renewable Energy program in DOE as well as USDA and NSF programs and participates with those agencies to support plant science centers. Where feasible, interactions with industry are promoted. The Energy Biosciences program is currently one of the active components in the development of a unified DOE biotechnology activity through the BioEnergy Coordinating Committee of DOE in response to the FCCSET effort on a biotechnology crosscut. This budget includes $24,580,000 in FY 1992 and $27,500,000 in FY 1993 in support of the Biotechnology activities.

The Energy Biosciences program is based on several precepts that fashion the content of the program:

1. There may be a growing replacement of fossil resources by renewables (biomass) for fuels, chemicals and new materials.
2. Increasing concerns about environmental issues will increase the emphasis on renewable resources.
3. Plants and microorganisms have extraordinary capabilities for synthesis and degradation, many of which have yet to be discovered and/or defined. Many of these capabilities will impact DOE's mission for energy production and conservation as well as for environmental remediations.
4. The exploitation of biochemical transformations and other capabilities applied to energy matters requires investment in fundamental research. The rapid growth of biomedically oriented biotechnology is the dividend from substantial previous basic research investments in the biomedical area. A similar investment should produce comparable applications.
5. The ability to genetically manipulate many organisms is growing more rapidly than our basic knowledge of the traits to be manipulated, i.e., there is a major gap in our understanding about the biochemical and physiological basis of important characteristics, e.g., yield in plants, biochemical pathways to valuable products, etc. This is a major obstacle to realizing more energy-related biotechnologies.
6. U.S. international competitiveness in energy related biotechnology depends both on our ability to generate a critical database about plant and microbial processes and on the ability of industry to receive and integrate this information into their operations. The U.S. biotechnology industry tracks basic research progress closely unlike some other segments of industry.
7. Most pay-offs in the development of energy related biotechnologies may be expected to be in the mid- to long-term (seven or more years), with some important exceptions.

I. Energy Biosciences (Cont'd)

The Energy Biosciences program, while diverse in scope, has many components that are strongly interrelated and integrated. The program may be arbitrarily partitioned into: 1) fundamental aspects of primary biological production, consisting of research on plant and microbial photosynthesis, growth and development in plants, host-pathogen relationships and plant physiological processes, all of which ultimately affect productivity. 2) conversions of primary biological energy products, a category that covers basic research in microbial fermentations, defining plant metabolism and its regulation, nitrogen fixation, structure and function of plant cell walls, and other topics, all of which determine the nature and amount of the end products available as fuels and chemicals. The research also contributes to understanding the origins of products that constitute parts of natural systems and cycles. 3) enabling biotechnology research, a grouping consisting of studies on the genetics of orphan microorganisms with possible roles in biotechnology, the mechanisms of genetic expression in plants, critical data base development, plus others that feed into building the framework on which to base new biosystems relating to energy matters. This budget includes $700,000 in both FY 1992 and FY 1993 in support of the Math and Science Education activities. Also included is $600,000 in FY 1993 in support of the Materials Research activities.

II. A. Summary Table: Energy Biosciences

| Program Activity | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Energy Biosciences | $ 21,808 | $ 24,700 | $ 27,600 | + 12 |
| Total, Energy Biosciences | $ 21,808 | $ 24,700 | $ 27,600 | + 12 |

II. B. Major Laboratory and Facility Funding

| | | | | |
|---|---|---|---|---|
| Brookhaven National Laboratory | $ 990 | $ 990 | $ 1,040 | + 5 |
| Lawrence Berkeley National Laboratory | $ 1,059 | $ 1,059 | $ 1,112 | + 5 |
| Los Alamos National Laboratory | $ 130 | $ 135 | $ 140 | + 4 |
| Michigan State University | $ 2,709 | $ 2,764 | $ 2,846 | + 3 |
| Solar Energy Research Institute | $ 125 | $ 164 | $ 150 | - 9 |

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Energy Biosciences | This was basically a modestly enhanced budget level for the Energy Biosciences subprogram in the plant and microbial sciences. It allowed maintenance of strong projects and initiation of a number of projects in areas of key importance for building of an information base for future energy related biotechnologies. | With the additional capacity provided by the FY 1992 budget responsiveness to high quality research proposals will make it possible to exploit more ideas on which to base future energy related biotechnologies. | The requested budget level would provide an opportunity to pursue much needed fundamental research that will serve as the basis for future energy related biotechnologies. The Energy Biosciences subprogram is expected to play multiple roles in relation to various specific DOE missions and national initiatives. Principally, the program generates and feeds basic information into activities identified with the National Energy Strategy, FCCSET crosscuts (Biotechnology and Materials Research), environmental and global change activities. These activities described below fall within the areas identified by the FCCSET Subcommittee on Biotechnology Research with one activity on biomolecular materials being covered under the Advanced Materials and Processing FCCSET Subcommittee. |
| | Some of the program areas that were affected in the Energy Biosciences area of primary biological production include the structure and function of plant and microbial photosynthetic mechanisms and the genetic and physiological control of carbon partitioning. Both of these subjects received more attention. | In the Energy Biosciences area of primary biological production, not only will it be possible to build modestly studies on photosynthetic mechanisms, the basis of renewable resource production, but also new studies are projected in the area of signal transduction, whereby the objective is to understand the mechanisms of how plants and microbes sense and translate outside stimuli such as light, temperature, chemicals and other ambient factors that influence growth, metabolic activity and other responses. How organisms sense and translate outside stimuli into trains of responses is poorly understood. This work will include discerning the receptor sites of outside signals, the molecular targets at those sites, and the nature of interactions between external stimuli and the organism. | To realize the tantalizing prospects of plant biotechnologies, as a significant resource for fuels, chemicals and other materials for the future, more understanding is necessary. Included is research on the partitioning of products synthesized in plants, the regulation and control of metabolic steps and the movement and storage of energy-rich compounds. The Energy Biosciences area of biological production will focus on these activities and the continued efforts to define the specific opportunities to enhance the photosynthetic solar conversion process. |

III. Energy Biosciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Energy Biosciences (Cont'd) | Projects falling into the Energy Biosciences area of conversion of primary biological energy products that were emphasized included studies on metabolic capabilities and their regulation in both plants and microbes with some additional increments in other of the components. | Activities in the Energy Biosciences area of conversion of primary biological energy products that will receive additional resources are investigations on diverse metabolic capabilities and their regulation in plants and microbes. (This area of knowledge is critical to future biosynthetic technologies, but is not heavily populated with researchers and hence the building of the base will be time extended.) Some modest increase of funding of nitrogen fixation research is also anticipated. | Projects in the Energy Biosciences area of conversion of primary biological energy products will be continued, with an emphasis on the important acquisition of additional knowledge of metabolic capabilities in plants and microorganisms. Such knowledge can lead to the use of organisms to produce fuels, industrial chemicals and entirely new biologically synthesized materials. The synthesis of the major components of plant cell walls (the principal component of biomass), cellulose, hemicellulose and lignin are examples of poorly understood metabolic pathways. Further, greater understanding of the metabolic capabilities of microorganisms affords potential development of new modes of product processing. The uptake of minerals by plant systems and the interactions of plants with organics in the rhizosphere (humus) will also be studied. |
| | In the Energy Biosciences area of enabling biotechnology research, some additional effort went into gaining a better understanding of the genetic control of transformations into new and novel materials (a joint effort with Materials Sciences), as well as increasing the comprehension of genetic expression in plants. Some enhancement of support of the thermophily (life at high temperatures) was anticipated. | In the Energy Biosciences area of enabling biotechnology research sector, new research projects in discovering how plants transfer and express genetic information are anticipated. Other new work in the area of surface biology will begin with the goal of understanding recognition events in plants that trigger whether pathogenicity, symbiosis or other key biological reactions that affect biomass productivity occur. Other very pertinent events in corrosion also occur on surfaces that involve microbes; these fundamental processes will also be studied. The basic biology of these interactions is poorly understood, thus limiting the possibilities for development of new biotechnological strategies. | The way plants perceive environmental signals, temperature changes, chemicals and others is a major problem in determining growth and development patterns as well as biosynthetic routes. This area will receive more attention. Another emphasis will be on enhancement of efforts to utilize biological systems in the synthesis of novel catalysts and polymeric molecules. |

III. Energy Biosciences (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Energy Biosciences (Cont'd) | The Energy Biosciences program continued a meaningful participation with USDA and NSF on plant science centers as well as aspects of plant genome studies that will lead to improved plant (biomass) productivity. | The Energy Biosciences program would continue a meaningful participation with USDA and NSF on plant science centers as well as aspects of plant genome studies that will lead to improved plant (biomass) productivity. | The EB subprogram, with this level of funding, will be able to continue its joint programs with other agencies, such as the plant science centers, with USDA and NSF. |
| | Expanded the fellowship program established in FY 1990. | There is the intent to continue a limited number of fellowships in certain key, important, but underrepresented topic areas, including microbial metabolism and physiology, plant biochemistry, and other topic areas whose lack of expertise delays biotechnology development. | There is the intent to continue a limited number of fellowships in certain key, important, but underrepresented topic areas, including microbial metabolism and physiology, plant biochemistry, and other topic areas whose lack of expertise delays biotechnology development. |
| | No activity. | No activity. | In an effort to manage administrative costs more closely, the PSO/Office Director's share of FTE-dependent costs for space, supplies, and telecommunications are included in this budget and will be transferred during the execution year. |
| | $ 21,808 | $ 24,700 | $ 27,600 |
| Energy Biosciences | $ 21,808 | $ 24,700 | $ 27,600 |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Program Direction

This subprogram provides the Federal staffing resources and associated funding required to develop, direct, and administer a complex and broadly diversified program for mission-oriented research to provide the fundamental scientific and engineering base on which the Nation's future energy, defense, and technology options depend. This staff administers a basic research program which helps us attain our national goals, i.e., better health and quality of life, economic competitiveness, energy self-sufficiency, and national security.

II. A. Summary Table: Program Direction

| Program Activity | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Program Direction..... | $ 6,462 | $ 7,500 | $ 8,400 | + 12 |
| Total, Program Direction | $ 6,462 | $ 7,500 | $ 8,400 | + 12 |

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Program Direction | Provide funds for salaries, benefits, and travel related to 69 full-time equivalents (FTEs) in the Office of Basic Energy Sciences, the Scientific Computing Staff, the Office of Assessment and Support, and related program and management support staff. ($5,917) | Provide funds for salaries, benefits, and travel related to 71 FTEs included in the FY 1992 budget. A revised request for 2 additional FTEs is discussed below. ($6,925) | Provide funds for salaries, benefits, and travel for 73 FTEs. Provide for an increase of 2 FTEs over the FY 1992 budget level as discussed below. These FTEs are also required in FY 1992. Also provide for normal increased personnel costs resulting, for example, from a general pay raise and within-grade and merit increases. ($7,460) |
| | The Office of Basic Energy Sciences activities included assessing the scientific needs and priorities of the program; planning to meet those needs; technical review of proposals from laboratories and universities; and monitoring the progress of ongoing university contracts, laboratory programs, and construction projects. Provided staff support for basic research, R&D and facilities needed to continue U.S. leadership in key scientific areas and for numerous university construction projects. Managed preconstruction R&D and construction of advanced scientific facilities, and supported numerous current user facilities. Strengthened ES&H oversight of large research facilities and construction projects and maintained technical excellence in R&D in such areas as superconductivity, molecular sciences, oil and gas and coal chemistry. Interacted significantly with other agencies on National efforts such as superconductivity and supercomputing. Continued to support projects which are relevant to DOE's long-term goals and help maintain world leadership in science and technology. Supported the Basic Energy Sciences Advisory Committee, and managed the DOE-wide SBIR program. | Maintain program support as in FY 1991, while enhancing program management and contractor oversight and accountability of ongoing activities. Strengthen project management and oversight capabilities related to construction of large advanced scientific facilities and to support current user facilities. Provide program capability to meet National research goals supporting the country's energy-related technology foundation. Continue to strengthen ES&H oversight. Continue to interact with other agencies and help maintain world leadership in science and technology. Continue to support the Basic Energy Sciences Advisory Committee, and manage the DOE-wide SBIR program. | Continue program management as in FY 1992. Provide program capability to meet additional workload which will result from programmatic increases required to meet National research goals supporting the country's energy-related technology foundation. Enhance contractor oversight and accountability, strengthen project management, especially for the 6-7 GeV Synchrotron Radiation Source, continue research for the Advanced Neutron Source (ANS), and support current user facilities. Continue to strengthen and meet increased ES&H oversight requirements and provide contractor management oversight. Manage increased research program activities, which include, for example, manufacturing related engineering, materials processing, atomic physics, and energy biosciences. Continue to interact with other agencies and help maintain world leadership in science and technology. Continue to support the Basic Energy Advisory Committee, and manage the DOE-wide SBIR program. |

III. Program Direction (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Program Direction (Cont'd) | | | |
| | Supported the Scientific Computing Staff, whose activities included policy and program planning, representation on interagency coordinating councils (FCCSET), management of 90 research and development projects in mathematical and computational sciences, management of ER supercomputer centers, and management of Energy Sciences Network (ESNET) development and operations. These facilities supported approximately 6,300 users. | Develop and coordinate the OSTP/FCCSET high performance computing and communications (HPCC) initiative for planned program growth requiring increased interaction among five Federal agencies with a major goal of transfer of technology to U.S. industry and to support and coordinate multidisciplinary research collaborations with other ER program areas. Continue to manage R&D projects and support network users including development of an international network for the research community. | Continue to support the OSTP/FCCSET HPCC initiative as in FY 1992. The HPCC program will increase by over 20 percent above the FY 1992 budget, requiring increased workload involving interagency computer network research and infrastructure program management, coordination of the National Research and Education Network (NREN) and coordination of scientific information resources management functions resulting from the HQ/Field realignment. This staff will support new and important research areas in the HPCC program which will require focused expertise and specific program management experience to manage an estimated 400 additional proposals and 150 research projects as a result of the 20 percent growth. |
| | Provided a portion of the total staffing requirement for the Office of Assessment and Support to implement oversight and support activities to ensure compliance with applicable ES&H regulations and directives. | No activity. Transferred to the Advisory and Oversight Program Direction account within the Energy Supply, R&D appropriation. | No activity. |
| | Provided program and management support in the areas of budget and finance, personnel administration, acquisition and assistance, policy review and coordination, and construction management support. | Provide program and management support as in FY 1991 while strengthening line management control and accountability, primarily in acquisition activities and enhanced support of construction activities. | Continue to provide program and management as in FY 1992. |

III. Program Direction (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Program Direction (Cont'd) | No activity. | Provide two additional FTEs to Chicago Field Office above the FY 1992 budget level to support the increased workload related to the 6-7 GeV Synchrotron Radiation Source, a multimillion dollar project whose obligations total $300,000 per day. Provide the total support required for effective contract management oversight. | Continue to support the 6-7 GeV Synchrotron Radiation Source with two additional FTEs, also required in FY 1992. Additional support is required to support the 6-7 GeV Synchrotron Radiation Source project during the peak construction period from FY 1992 through FY 1994 to handle all the procurements, safety and environmental oversight, and project management activities. |
| | Provided a variety of program support such as electronic information and communications services, printing and binding, and contractual services, for example, for the SBIR program and to assist with the environment, safety and health workload required by current regulations and directives. ($545) | Continue the variety of program support required in FY 1991. ($575) | Continue the variety of program support required in FY 1992. Provide additional administrative and professional services, increased cost of support to the SBIR program, and increased support at Chicago for the 6-7 GeV Synchrotron Radiation Source. ($940) |
| | $ 6,462 | $ 7,500 | $ 8,400 |
| Program Direction | $ 6,462 | $ 7,500 | $ 8,400 |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Capital Equipment

Capital equipment is needed to support the research in each of the subprograms in the Basic Energy Sciences program. In addition, all the DOE programs at Argonne and Ames are funded for general purpose equipment through BES. Studies done both by the Department and by the laboratories continue to stress the importance of modernization in order to take advantage of technologically more efficient and safe instruments and equipment. Much of the research in the BES program involves experiments at extremes of temperature and pressure and requires unprecedented levels of resolution. Reliable, precise measurements under such conditions challenge the current state-of-the-art, and as improvements are made in instruments and equipment, it is important to benefit from them in a timely fashion. The quality of individual research projects and effective experiments at the major facilities depends on the availability of new state-of-the-art equipment and instrumentation, and on replacement of older, obsolete equipment. This budget includes $1,500,000 in FY 1993 in support of the High Performance Computing and Communication activities. Also included is $700,000 in FY 1993 in support of Biotechnology activities.

II. A. Summary Table: Capital Equipment

| Program Activity | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Capital Equipment | $ 36,803 | $ 37,000 | $ 46,300 | + 25 |
| Total, Capital Equipment | $ 36,803 | $ 37,000 | $ 46,300 | + 25 |

II. B. Major Laboratory and Facility Funding

| | | | | |
|---|---|---|---|---|
| Ames Laboratory | $ 2,005 | $ 1,510 | $ 1,510 | 0 |
| Argonne National Laboratory (East) | $ 8,266 | $ 7,810 | $ 14,416 | + 85 |
| Brookhaven National Laboratory | $ 4,258 | $ 4,085 | $ 4,585 | + 12 |
| Idaho National Engineering Laboratory - EG&G | $ 361 | $ 220 | $ 341 | + 55 |
| Lawrence Berkeley National Laboratory | $ 5,768 | $ 4,807 | $ 5,468 | + 14 |
| Lawrence Livermore National Laboratory | $ 705 | $ 260 | $ 420 | + 62 |
| Los Alamos National Laboratory | $ 1,356 | $ 835 | $ 706 | - 15 |
| Oak Ridge National Laboratory | $ 6,728 | $ 7,709 | $ 5,849 | - 24 |
| Pacific Northwest Laboratory | $ 3,452 | $ 1,225 | $ 1,275 | + 4 |
| Sandia National Laboratories | $ 2,015 | $ 1,610 | $ 1,325 | - 18 |

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Capital Equipment | Equipment needs were accommodated at the current level, including equipment necessary to expand research in molecular sciences. Replacement and acquisition of new equipment required continued to ensure that optimum research results can be obtained and properly analyzed. General purpose equipment requirements for Ames and ANL were met. In addition, equipment was provided to support the research and development associated with the advanced scientific facilities. Major items of equipment provided for were as follows: HFIR Spent Fuel Cask (TEC: $3.3); Corrosion and Thermal/Hydraulic Heat Transfer Test Facility (TEC: $1.2); and High Resolution Scanning Transmission Electron Microscope (TEC: $1.7). | Continues equipment funding at the current level, including equipment necessary to expand research in molecular sciences. Replacement and acquisition of new equipment required will continue to ensure that optimum research results can be obtained and properly analyzed. General purpose equipment requirements for Ames and ANL will continue to be met. Continue equipment support at the major user facilities. In addition, equipment will be provided to support the research and development associated with the advanced scientific facilities. Continues support for major items of equipment as detailed in FY 1991. | Continues core equipment funding at about the same dollar level as FY 1992. Emphasis in FY 1993 in equipment will continue in areas which require ES&H attention and in areas which have high priority in the research program. Increasing equipment requirements at the major user facilities will continue to receive attention and funding. General purpose equipment requirements for Ames and ANL will continue to be funded at the FY 1992 level. Provides increases for both the 6-7 GeV Synchrotron Radiation Source to maintain project schedule and the 1-2 GeV Synchrotron Radiation Source to support initial operations. The High Performance Computing and Communications program will be enhanced consistent with the FCCSET plan. Funds are included in support of the Biotechnology activities. Continues support for major items of equipment as detailed in FY 1991. |
| | | | No activity. |
| | | TRANSFER: Capital equipment relating to the Heavy Ion Fusion Accelerator Research (HIFAR) effort has been transferred to the Fusion Energy ($-850,000). | |
| | $ 36,803 | $ 37,000 | $ 46,300 |
| Capital Equipment | $ 36,803 | $ 37,000 | $ 46,300 |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Construction

Construction is needed to support the research in each of the subprograms in the Basic Energy Sciences program. Experiments necessary in support of basic research require that new state-of-the-art facilities be built and modified to meet unique research requirements. Reactors, radiation sources, and neutron sources are among the expensive, but necessary, facilities required. The budget for the BES program includes funding for the construction and modification of these facilities. This budget includes $96,858,000 in FY 1992 and $110,407,000 in FY 1993 in support of the Materials Research activities.

II. A. Summary Table: Construction

| Program Activity | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| Construction | $ 102,433 | $ 107,984 | $ 123,533 | + 14 |
| Total, Construction | $ 102,433 | $ 107,984 | $ 123,533 | + 14 |

II. B. Major Laboratory and Facility Funding

| | | | | |
|---|---|---|---|---|
| Ames Laboratory | $ 644 | $ 600 | $ 700 | + 17 |
| Argonne National Laboratory (East) | $ 71,253 | $ 93,910 | $ 114,607 | + 22 |
| Brookhaven National Laboratory | $ 3,012 | $ 2,065 | $ 4,265 | +107 |
| Lawrence Berkeley National Laboratory | $ 22,866 | $ 7,998 | $ 1,600 | - 80 |
| Oak Ridge National Laboratory | $ 2,783 | $ 1,861 | $ 1,061 | - 43 |
| Sandia National Laboratories | $ 348 | $ 100 | $ 200 | +100 |

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Construction | Continued all projects underway in FY 1990, except for the 3 GeV which was completed. | Continues all projects underway in FY 1991. | Provides necessary funds to continue all projects underway in FY 1992, except for the 1-2 GeV which was completed. |
| | $ 102,433 | $ 107,984 | $ 123,533 |
| Construction | $ 102,433 | $ 107,984 | $ 123,533 |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

MAJOR USER FACILITIES

I. Preface: Major User Facilities

The major facilities discussed below are used to conduct forefront research in materials, chemistry, biology, medicine, and in the applied sciences using lasers and high fluxes of neutrons or photons. These facilities are unique in their ability to probe the structure and properties of important energy related phenomena. In view of the expensive and unique character of these facilities, researchers from all parts of the Nation travel to these facilities to conduct their research, including researchers from government laboratories, industry and universities, in addition to DOE contractors. In addition to currently operating facilities, recommendations from national committees and DOE committees have identified needs for advanced facilities in order to continue to conduct leading edge research. The Department undertook to construct the major scientific facilities and is requesting continuing construction funding in FY 1993 for the 6-7 GeV Synchrotron Radiation Source and beginning of operations for the 1-2 GeV Synchrotron Radiation Source. Summarized below is a list of each of these facilities, as well as a description of the activities underway in FY 1991, FY 1992 and FY 1993 to provide for their operation and maintenance. Funding for these facilities is included as part of the budget request in the Materials Sciences and Chemical Sciences subprograms.

The National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory is a unique user oriented facility for advanced research with synchrotron radiation. At NSLS a wide range of research techniques are used by biologists, chemists, solid-state physicists, metallurgists, and engineers for basic and applied studies. This is a forefront dedicated facility which is used for vacuum ultra-violet and X-ray scattering and spectroscopy. The facility will be fully utilized in FY 1993, serving about 1000 users.

The High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory produces high flux neutron beams used for research in a variety of fields. Neutrons are used as probes by nuclear and solid-state physicists, chemists, and biologists. This 27 year old research reactor has been a pacesetting facility and continues to be an important research tool. The scientific activity has resumed in FY 1991. During FY 1990, the facility was shut down to allow for safety improvements.

The Intense Pulsed Neutron Source (IPNS) at Argonne National Laboratory is a dedicated user facility for advanced research with pulsed neutrons serving the physics, materials, chemical, and life sciences research communities. About 180 users are involved. With the improvements of the proton target source of neutrons and some of the spectrometers, the scientific activity at this facility will increase during the next 2 years.

The High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory is a multipurpose reactor which is used for the production of isotopes, and also used for materials sciences, nuclear chemistry, and radiation damage research. The isotopes are important to the research, medical, and industrial community. Many of these isotopes can only be produced at the HFIR reactor. When fully utilized, as proposed in FY 1993, about 150 users are involved with research at the facility. The reactor has recently been restarted following necessary safety improvements in plant and personnel. This includes the hiring of additional staff, modifications to the reactor, and additional training of the reactor staff. The Radiochemical Engineering Development Center, formerly the Transuranium Processing Plant, is a companion facility to the HFIR and was built to recover the transuranium elements from irradiated targets from the reactor.

The Stanford Synchrotron Radiation Laboratory (SSRL) at Stanford University is a national facility funded to permit the utilization of synchrotron radiation for basic and applied research in chemistry, physics, biology, and materials sciences. The operation of this facility has been dependent on the operation of the High Energy Physics electron injector. When fully utilized, as proposed in FY 1993, about 500 users are involved in research at the facility. With some new beamlines being commissioned, increased scientific activity is expected. The 3 GeV electron injector completed in FY 1990 will allow the SPEAR ring to operate as a dedicated synchrotron facility.

I. Major User Facilities (Cont'd)

The Manuel Lujan, Jr. Neutron Scattering Center (MLNSC) (formerly LANSCE) at Los Alamos National Laboratory is a dedicated user facility for advanced research with the nation's most intense pulsed neutrons serving the physics, materials, chemical, and life sciences research communities. The operation of this facility utilizes the Los Alamos proton storage ring facility which is budgeted by Defense Programs. Construction of a new experimental hall at the Center was completed in FY 1989. With the new experimental hall, the scientific program activity will involve more than 100 materials and materials-related scientists.

The Combustion Research Facility (CRF) at Sandia National Laboratory - Livermore provides a unique capability to outside users from industry, university, and laboratory scientists for combustion research. The focus of the laboratory is on laser diagnostics of combustion systems, but a variety of burner systems and special facilities are available, including those for research on coal combustion and internal combustion engines. About 30 experiments involving about 50 scientists were operational in FY 1991.

Funding in FY 1993 is requested to continue research and development activities associated with the two advanced light source facilities. These facilities are the 1-2 GeV Synchrotron Radiation Source (LBL) (construction completed in FY 1992) and the 6-7 GeV Synchrotron Radiation Source (ANL). In the case of the 1-2 GeV facility, construction is completed, and the R&D funds for this project are focused on improvements to the magnet lattice, start-up and commissioning, and related activities. For the 6-7 GeV facility, significant R&D activities are necessary due to the overall size and complexity of the project. Research activities at the 6-7 GeV facility will be focused on prototypes of the dipole magnets and insertion devices. Start-up and commissioning of the injector will begin in FY 1992, and continued in FY 1993 together with commissioning of the booster.

II. A. Summary Table: Major User Facilities

| Program Activity | FY 1991 Enacted | FY 1992 Enacted | FY 1993 Request | % Change |
|---|---|---|---|---|
| National Synchrotron Light Source | $ 23,358 | $ 23,445 | $ 24,400 | + 4 |
| High Flux Beam Reactor | 25,178 | 23,941 | 24,400 | + 2 |
| Intense Pulsed Neutron Source | 6,262 | 6,654 | 6,800 | + 2 |
| High Flux Isotope Reactor | 30,390 | 26,331 | 28,500 | + 8 |
| Radiochemical Engineering Development Center | 7,610 | 7,800 | 7,800 | 0 |
| Stanford Synchrotron Radiation Laboratory | 13,413 | 13,764 | 14,400 | + 5 |
| Manuel Lujan, Jr. Neutron Scattering Center | 5,501 | 5,774 | 5,900 | + 2 |
| Combustion Research Facility | 4,300 | 4,390 | 4,700 | + 7 |
| Advanced Scientific Facilities | 24,842 | 42,904 | 64,627 | + 51 |
| Total, Major User Facilities | $ 140,854 | $ 155,003 | $ 181,527 | + 17 |

III. Activity Descriptions: (Budget Obligations in thousands of dollars)

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Major User Facilities | | | |
| National Synchrotron Light Source | Continued full year of operations. | Continue full year of operations with increase needed to accommodate user support and fully utilize facility. | Continues operations at approximately the same dollar level as FY 1992. Reduction in operations and user support necessary to absorb the full effect of any cost of living increases. |
| | $ 23,358 | $ 23,445 | $ 24,400 |
| High Flux Beam Reactor | Restored operation and accommodated increased costs of safety requirements at the reactor. The full extent of the safety improvements identified by the NAS were implemented to the extent funds allowed. | Full operation, safety improvements implemented. | Continues operations at approximately the same dollar level as FY 1992. Reduction in operations and user support necessary to absorb the full effect of any cost of living increases. |
| | $ 25,178 | $ 23,941 | $ 24,400 |
| Intense Pulsed Neutron Source | Provided for increased user support and operations. | Continues operation and user support. | Continues operations at approximately the same dollar level as FY 1992. Reduction in operations and user support necessary to absorb the full effect of any cost of living increases. |
| | $ 6,262 | $ 6,654 | $ 6,800 |
| High Flux Isotope Reactor | HFIR facility improvements proceeded on a 12 month schedule. HFIR has continued to operate to provide full services to users while safety upgrades mentioned above continued as funds allowed. | HFIR will operate at a slightly reduced level and provide services to users with safety, quality assurance and physical facility improvements proceeding. | Continues operations. Reduction in operations and user support relative to the optimal level realized in FY 1991. |
| | $ 30,390 | $ 26,331 | $ 28,500 |
| Radiochemical Engineering Development Center | REDC facility operations and improvements proceeded on a 12 month schedule. | REDC operations and improvements will be carried out. | Continues operations at the same dollar level as FY 1992. Reduction in operations and user support necessary to absorb the effect of any cost of living increases. |

III. Major User Facilities (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Radiochemical Engineering Development Center (Cont'd) | $ 7,610 | $ 7,800 | $ 7,800 |
| Stanford Synchrotron Radiation Laboratory | Enhanced operation of SSRL. Operation with the 3 GeV injector began. | Full operations of SSRL as dedicated synchrotron facility with full use of the 3 GeV injector. | Continues operations at approximately the same dollar level as FY 1992. Reduction in operations and user support necessary to absorb the full effect of any cost of living increases. |
| | $ 13,413 | $ 13,764 | $ 14,400 |
| Manuel Lujan, Jr. Neutron Scattering Center | Increased operations and user support. | Continues operations and user support. | Continues operations at approximately the same dollar level amount as FY 1992. Reduction in operations and user support necessary to absorb the full effect of any cost of living increases. Users will be expected to transfer experiments to other facilities by FY 1994. |
| | $ 5,501 | $ 5,774 | $ 5,900 |
| Combustion Research Facility | Operations were enhanced to better serve the user community. | Continues operations and user support at the FY 1991 level. | Continues operations at approximately the same dollar level as FY 1992. Reduction in operations and user support necessary to absorb the full effect of any cost of living increases. |
| | $ 4,300 | $ 4,390 | $ 4,700 |
| Advanced Scientific Facilities | Provided support for needed R&D for the 1-2 GeV ($10,510) and 6-7 GeV ($14,332) radiation sources. The increase was required to begin to hire additional staff to ready the 1-2 GeV for operation and to meet the R&D schedule for the 6-7 GeV radiation sources. | Provides for necessary increase to fully support R&D of the 1-2 GeV ($19,124) and 6-7 GeV ($23,780) radiation sources. The increase provided helps ensure that the necessary R&D is completed to maintain the schedule and cost of these projects. | Increases support for commissioning and operation of 1-2 GeV ($24,000) and R&D and commissioning of components of the 6-7 GeV ($40,627) light sources. |
| | $ 24,842 | $ 42,904 | $ 64,627 |

III. Major User Facilities (Cont'd):

| Program Activity | FY 1991 | FY 1992 | FY 1993 |
|---|---|---|---|
| Major User Facilities | $ 140,854 | $ 155,003 | $ 181,527 |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

CONSTRUCTION PROJECTS

Basic Energy Sciences

IV. A. Construction Project Summary

| Project No. | Project Title | Total Prior Year Obligations | FY 1992 Appropriated | FY 1993 Request | Unappropriated Balance | TEC |
|---|---|---|---|---|---|---|
| 93-E-305 | Accelerator and Reactor Improvements and Modifications | XXX | $ 6,626 | $ 7,626 | $ 0 | $ 7,626 |
| GPE-400 | General Plant Projects | XXX | 4,500 | 5,500 | 0 | 5,500 |
| 89-R-402 | 6-7 GeV Synchrotron Radiation Source | 115,032 | 90,360 | 110,407 | 138,000 | 456,000 |
| 87-R-406 | 1-2 GeV Synchrotron Radiation Source | 93,003 | 6,498 | 0 | 0 | 99,500 |
| | Total, Basic Energy Sciences Construction | XXX | $107,984 | $123,533 | $138,000 | XXX |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET
OFFICE OF ENERGY RESEARCH
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

1. Project title and location: 93-E-305 Accelerator and reactor improvements and modifications, various locations

Project TEC: $ 7,626
Start Date: 1st Qtr. FY 1993
Completion Date: 3rd Qtr. FY 1995

2. Financial Schedule:

| Fiscal Year | Appropriated | Obligations | Costs |
|---|---|---|---|
| 1993 | $ 7,626 | $ 7,626 | $ 2,700 |
| 1994 | 0 | 0 | 2,700 |
| 1995 | 0 | 0 | 2,226 |

3. Narrative:

(a) 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. Two projects at the Brookhaven National Laboratory are requested to incorporate improvements at the High Flux Beam Reactor and the National Synchrotron Light Source, one project is requested for facility improvements at the Stanford Synchrotron Radiation Laboratory, one project is requested at the Oak Ridge National Laboratory for improvements to the High Flux Isotope Reactor, one project is requested for facility improvements at the University of Notre Dame Radiation Laboratory, and one project at Lawrence Berkeley Laboratory is requested for beam-line enhancements at the 1-2 GeV Synchrotron Radiation Source.

(b) 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.

National Synchrotron Light Source
Consistent with the increased user requirements at the NSLS, several additions and improvements are proposed at the facility including: improved controls and insertion devices, laboratory modifications and other modifications necessary to ensure reliable, safe, and efficient operation of this facility for the national research effort.

High Flux Beam Reactor
Several reactor additions and improvements are necessary to ensure the continued safe and reliable operation of this facility. Specifically in FY 1993, several projects are proposed including: to improve neutron beam delivery and instrumentation which will increase the utilization of the beam lines; improve components of the emergency calling system; and improve monitoring and controls of the facility.

Stanford Synchrotron Radiation Laboratory
Provide for improvements to the Stanford Synchrotron Radiation Laboratory necessary to meet changing research activities underway. Modifications to beam lines, enhanced monitoring, and evaluation equipment are among the types of improvements necessary at this laboratory.

High Flux Isotope Reactor
Provide for necessary safety improvements identified for the High Flux Isotope Reactor (HFIR) facilities and systems such as the confinement system, ventilation systems, confinement building, and auxiliary buildings.

Notre Dame Radiation Laboratory
Provide for the completion of funding for improvements at the Linear Accelerator Facility at Notre Dame. The present facility is being upgraded with a technically superior accelerator with substantially higher beam dosage, substantially better beam stability and reproducibility, and improved time resolution.

1-2 GeV Synchrotron Radiation Source
The 1-2 GeV Synchrotron Radiation Source, which begins operation in FY 1993, as originally configured, provided for straight sections and ports on bending magnets that were not initially instrumented and unfinished office and laboratory space in order to provide opportunities for further development to take advantage of new scientific opportunities or technical developments. This accelerator and reactor improvement and modification project will provide additional experimental equipment, office, and light laboratory space for users consistent with the project plan, to build on the experience gained in the recent development of synchrotron radiation beamlines elsewhere in addition to development of a complement of beamlines for the ALS facility. The additional equipment, office, and laboratories would supplement a complement of experimental facilities and would permit access to the facility by a broader community of users, thus enhancing the utilization of the facility and increasing its contribution to the nation's scientific, technical and education base.

4. Total Project Funding (BA):

| | FY 1993 Request |
|---|---|
| Construction | $ 7,626 |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

1. Project title and location: GPE-400 General plant projects

Project TEC: $ 5,500
Start Date: 1st Qtr. FY 1993
Completion Date: 4th Qtr. FY 1994

2. Financial schedule:

| | | Costs | | | |
|---|---|---|---|---|---|
| Fiscal Year | Obligations | FY 1991 | FY 1992 | FY 1993 | After FY 1993 |
| Prior Year Projects | 2,784 | 1,038 | 0 | 0 | 0 |
| FY 1991 Projects | 3,051 | 1,249 | 1,820 | 0 | 0 |
| FY 1992 Projects | 4,500 | 0 | 2,296 | 2,204 | 0 |
| FY 1993 Projects | 5,500 | 0 | 0 | 1,796 | 3,704 |

3. Narrative:

(a) 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 subprojects.

(b) The currently estimated distribution of FY 1992 funds by office is as follows:

| | |
|---|---|
| Ames Laboratory | $ 700 |
| Argonne National Laboratory | 4,200 |
| Notre Dame Radiation Laboratory | 100 |
| Sandia National Laboratories | 200 |
| Stanford Synchrotron Radiation Laboratory | 300 |
| Total project cost | $ 5,500 |

FY 1993 General Plant Projects (GPP) are miscellaneous minor new construction projects of a general nature. The total estimated costs of each will not exceed $1,200,000. These projects are necessary to provide for the continuing requirement to maintain the facilities in a good state of repair, to adapt the facilities to new or improved production or service techniques, to effect economics of operations and to reduce or eliminate health, fire, and security problems.

4. Total Project Funding (BA):

| | Prior Years | FY 1991 | FY 1992 | FY 1993 Request |
|---|---|---|---|---|
| Construction | $ 2,784 | $ 3,051 | $ 4,500 | $ 5,500 |

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
OFFICE OF ENERGY RESEARCH
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

1. Project title and location: 89-R-402 6-7 GeV Synchrotron Radiation Source
Argonne National Laboratory
Argonne, Illinois

Project TEC: $ 456,000
Start Date: 2nd Qtr. FY 1989
Completion Date: 3rd Qtr. FY 1996

2. Financial schedule:

| Fiscal Year | Appropriated | Obligations | Costs |
|---|---|---|---|
| 1989 | $ 6,000 | $ 6,000 | $ 5,633 |
| 1990 | 39,440 | 39,440 | 15,916 |
| 1991 | 69,592 a/ | 69,593 a/ | 37,347 |
| 1992 | 90,360 b/ | 90,360 b/ | 112,771 |
| 1993 | 110,407 | 110,407 | 117,153 |
| 1994 | 93,000 | 93,000 | 107,523 |
| 1995 | 45,000 | 45,000 | 56,290 |
| 1996 | 0 | 0 | 3,367 |

3. Narrative:

(a) Argonne National Laboratory has completed a conceptual design and is constructing a new-generation 6-7 GeV synchrotron radiation source. This facility is important for the Department's research program and will serve as a national resource for the conduct of research by industry, government, and university scientists. This facility will produce unprecedentedly brilliant x-ray beams to serve the research needs of virtually all scientific disciplines and many technological fields, e.g., physics, chemistry, materials and surface science, biology, and medicine. Users will include scientists, engineers, and graduate students from universities, industry, and research laboratories throughout the United States.

(b) The facility as currently envisaged will consist of a large storage ring containing as many as 35 insertion devices to give intense beams of hard x-rays. The injection and booster systems will be designed to inject positrons into the storage ring at the design energy of 6-7 GeV. Beam currents as high as 100 milliamperes and lifetimes of at least 10 hours are anticipated. Most importantly, the lowest possible beam emittance will be sought to give the highest brilliance x-ray source by a factor of 10,000 over any in existence. This facility will impact heavily on the fields of physics, materials, chemistry, biology and medicine, and many technologies. Determination of bulk and surface structure will be performed with greater resolution and accuracy. Microprobe characterization will allow impurity detection in the parts per billion range. The high brilliance will make possible inelastic x-ray scattering which is an essentially unexplored field. Investigating time-dependent phenomena in biological membranes and in photosynthetic processes will be possible, as will observing the motion of atoms in protein systems. Angiography and analysis of tumor diseases will be advanced through non-invasive and very fast x-ray diagnostics without, or with the minimal use of, dyes or drugs. Topography will be extended to time-resolved studies of plastic deformation and fracture. All of these investigations are made possible by the photon energy, time-structure, intensity, and unusual brilliance of the radiation source. Other experiments important to national security needs would also be undertaken.

4. Total Project Funding (BA):

| | Prior Years | FY 1991 | FY 1992 | FY 1993 Request | To Complete |
|---|---|---|---|---|---|
| Construction | $45,440 | $69,592 a/ | $90,360 b/ | $110,407 | $138,000 |
| Capital Equipment | 3,800 | 1,500 | 1,500 | 9,000 | 13,000 |
| Operating Expenses | 30,263 | 14,332 | 24,180 | 40,627 | 197,720 |

a/ Reflects reduction of $906 due to FY 1991 Sequester.
b/ Reflects savings of $2,200,000 of B/A due to proposed Davis Bacon Amendment.

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET SUBMISSION
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: Accelerator and Reactor Improvements and Modifications, various locations

2. Project No.: 93-E-305

3a Date A-E work initiated: 1st Qtr. FY 1993

3b. A-E Work (Title I & II) duration: Months vary per project

4a. Date physical construction starts: 3rd Qtr. FY 1993

4b. Date Construction ends: 3rd Qtr. FY 1995

5. Previous:--Construction cost estimate: none
--Total project cost: none

6. Current construction cost estimate: $7,626
TECC -- $7,626
TPC -- $7,626

7. Financial Schedule:

| Fiscal Year | Appropriations | Obligations | Costs |
|---|---|---|---|
| 1993 | $7,626 | $7,626 | $2,700 |
| 1994 | 0 | 0 | 2,700 |
| 1995 | 0 | 0 | 2,226 |

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. Two projects at the Brookhaven National Laboratory are requested to incorporate improvements at the High Flux Beam Reactor and the National Synchrotron Light Source, one project is requested for facility improvements at the Stanford Synchrotron Radiation Laboratory, one project is requested at the Oak Ridge National Laboratory for improvements to the High Flux Isotope Reactor, one project is requested for improvements at the University of Notre Dame Radiation Laboratory, and one project is requested at the Lawrence Berkeley Laboratory for beam-line enhancements at the 1-2 GeV Synchrotron Radiation Laboratory.

1. Title and location of project: Accelerator and Reactor Improvements and Modifications, various locations

2. Project No.: 93-E-305

9. Purpose, Justification of Need and Scope of the 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.

a. National Synchrotron Light Source (BNL)

Consistent with the increased user requirements at the NSLS, several additions and improvements are proposed at the facility including: improved controls and insertion devices, laboratory modifications and other modifications necessary to ensure reliable, safe, and efficient operation of this facility for the national research effort.

b. High Flux Beam Reactor (BNL)

Several reactor additions and improvements are necessary to ensure the continued safe and reliable operation of this facility. Specifically in FY 1993, several projects are proposed: to improve neutron beam delivery and instrumentation which will increase the utilization of the beam lines; improve components of the emergency calling system; and improve monitoring and controls at the facility.

d. Stanford Synchrotron Radiation Laboratory (SSRL)

This project will provide for improvements at the Stanford Synchrotron Radiation Laboratory necessary to meet changing research activities underway. The capabilities at this laboratory are an essential part of several BES research efforts, and to meet these unique requirements, modifications and improvements are necessary. Modifications to beam lines, enhanced monitoring, and evaluation equipment are among the types of improvements necessary at this laboratory.

1. Title and location of project: Accelerator and Reactor Improvements and Modifications, various locations

2. Project No.: 93-E-305

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

e. High Flux Isotope Reactor (ORNL)

The purpose of this project is to improve the safety of the HFIR and to assure compliance with DOE orders and with applicable standards, codes and regulations.

The HFIR is needed for isotope production, neutron scattering experiments, and irradiation services. Isotopes produced in the HFIR are used extensively in medical and industrial application. The HFIR is a major source of transuranic elements for researchers in the world. Neutron scattering facilities at the HFIR are used for fundamental research in materials science. The neutron scattering facilities are available to the DOE community and academic and industrial users. Experiments to be conducted at the HFIR will aid design of the proposed Advanced Neutron Source. Neutron irradiation services are of benefit to the High Temperature Gas-Cooled Reactor (HTGR) program through irradiation of fuels and graphite and to the Fusion Energy program through materials irradiations.

f. Notre Dame Radiation Laboratory

This budget request provides for the completion of funding for improvements at the Linear Accelerator Facility at Notre Dame. The present facility is being upgraded with a technically superior accelerator with substantially higher beam dosage, substantially better beam stability and reproducibility, and improved time resolution.

g. 1-2 GeV Synchrotron Radiation Source (LBL)

The 1-2 GeV Synchrotron Radiation Source, which begins operation in FY 1993, as originally configured, provided for straight sections and ports on bending magnets that were not initially instrumented and unfinished office and laboratory space in order to provide opportunities for further development to take advantage of new scientific opportunities or technical developments. This accelerator and reactor improvement and modification project will provide additional experimental equipment, office, and light laboratory space for users consistent with the project plan, to build on the experience gained in the recent development of synchrotron radiation beamlines elsewhere in addition to development of a complement of beamlines for the ALS facility. The additional equipment, office, and laboratories would supplement a complement of experimental facilities and would permit access to the facility by a broader community of users, thus enhancing the utilization of the facility and increasing its contribution to the nation's scientific, technical and educational base.

1. Title and location of project: Accelerator and Reactor Improvements and Modifications, various locations

2. Project No.: 93-E-305

10. Details of Cost Estimate

| | | |
|---|---|---|
| a. | National Synchrotron Light Source (BNL) | $1,600 |
| b. | High Flux Beam Reactor Facility (BNL) | 2,665 |
| d. | Stanford Synchrotron Radiation Laboratory (SSRL) | 200 |
| e. | High Flux Isotope Reactor (ORNL) | 1,061 |
| f. | Notre Dame Radiation Laboratory | 500 |
| g. | 1-2 GeV Synchrotron Radiation Source (LBL) | 1,600 |
| | Total Estimated Construction Costs (TECC) | $7,626 |

11. Method of Performance

Design, engineering and inspection will be performed by Brookhaven National Laboratory, Stanford Synchrotron Radiation Laboratory, Oak Ridge National Laboratory, and Lawrence Berkeley Laboratory. To the extent feasible, construction and procurement will be accomplished by fixed-price contracts and subcontracts awarded on the basis of competitive bidding.

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET SUBMISSION
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.: GPE-400

3a. Date A-E work initiated: 1st Qtr. FY 1993

3b. A-E Work (Title I & II) duration: Months vary per project

4a. Date physical construction starts: 2nd Qtr. FY 1993

4b. Date construction ends: 4th Qtr. FY 1994

5. Previous -- construction cost estimate: None
-- Total project cost: None

6. Current construction cost estimate: $5,500
TECC -- $5,500
TPC -- $5,500

7. Financial Schedule:

| Fiscal Year | Obligations | Costs FY 1991 | FY 1992 | FY 1993 | FY 1994 | FY 1995 |
|---|---|---|---|---|---|---|
| Prior Year Projects | $ 2,784 | $ 1,038 | $ 0 | $ 0 | $ 0 | $ 0 |
| FY 1991 Projects | 3,051 | 1,249 | 1,820 | 0 | 0 | 0 |
| FY 1992 Projects | 4,500 | 0 | 2,296 | 2,204 | 0 | 0 |
| FY 1993 Projects | 5,500 | 0 | 0 | 1,796 | 2,204 | 1,500 |

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.: GPE-400

8. Brief Physical Description of Project (continued)

The currently estimated distribution of FY 1993 funds by laboratory is as follows:

| | |
|---|---|
| Ames Laboratory | $ 700 |
| Argonne National Laboratory | 4,200 |
| Notre Dame Radiation Laboratory | 100 |
| Sandia National Laboratories | 200 |
| Stanford Synchrotron Radiation Laboratory | 300 |
| Total project cost | $ 5,500 |

9. Purpose, Justification of Need 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.

Ames Laboratory..... $ 700

Includes funds to maintain the research capability at the Ames Laboratory, to adapt the facilities to changes required to meet new and improved production techniques, to effect economies of operations, and to reduce or eliminate health, fire, safety or environmental problems. The highest priority will be selected based on the laboratory and DOE assessment of existing environmental, health, and safety needs at the laboratory. The projects described above will be constructed on the Ames Laboratory, non-Government owned property.

Argonne National Laboratory..... $ 4,200

The Argonne National Laboratory FY 1993 General Plant Projects (GPP) are miscellaneous minor new construction projects of a general nature. The total estimated costs of each will not exceed $1,200,000. These general plant projects are necessary to provide for the continuing requirement to maintain the facilities in a good state of repair, to adapt the facilities to new or improved production or service techniques, to effect economics of operations and to reduce or eliminate health, fire, and security problems. The highest priority projects will be selected as needs are identified in FY 1993.

1. Title and location of project: General Plant Projects 2. Project No.: GPE-400

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

Of the total requested for GPP at the Argonne National Laboratory, approximately 50 percent will be used for plant rehabilitation necessary to meet environment, health, and safety requirements and approximately 50 percent will be used for upgrading and programmatic projects.

Notre Dame Radiation Laboratory..... $ 100

Requirements include environmental and safety improvements as well as general maintenance requirements at the Radiation Laboratory Building, which is a Government-owned facility located on non-Government owned property.

Sandia National Laboratories..... $ 200

The Combustion Research Facility (CRF) at Sandia National Laboratories, Livermore (SNLL) has a continuing need for General Plant Project (GPP) funds for upgrading or the construction of facilities as required to meet expanding or changing programmatic goals and to meet identified environmental, health, and safety requirements. Some experiments, both active and proposed, have become increasingly complex and consequently require larger laboratory space than is currently available to them. The GPP funding in this request will provide for modifications and additions to laboratory space with appropriate modifications to suit individual experimental situations.

Stanford Synchrotron Radiation Laboratory..... $ 300

Requirements include minor modifications and additions necessary to support the optimum use of the laboratory research capabilities and to meet identified environmental, health, and safety requirements. These improvements are necessary to maintain the capital investment at the site and to accommodate the continuous changes to the physical site necessitated by the evolving SSRL research program. Examples include upgrading of laboratory space, modifications to roads and parking areas, and relocation of experimental equipment at the facility. The projects described will be constructed at the Stanford University, 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.

PROJECT DATA SHEETS

1. Title and location of project: General Plant Projects

2. Project No.: GPE-400

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.

DEPARTMENT OF ENERGY
FY 1993 CONGRESSIONAL BUDGET REQUEST
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: 6-7 GeV Synchrotron Radiation Source
Argonne National Laboratory
Argonne, Illinois

2. Project No.: 89-R-402

3a. Date A-E work initiated (Title I design): 2nd Qtr. FY 1989

3b. A-E Work (Titles I & II) duration: 34 months

4a. Date physical construction starts: 3rd Qtr. FY 1990

4b. Date construction ends: 3rd Qtr. FY 1996

5. Previous:--Construction cost estimate: $456,000
--Total project cost: $791,922

6. Current construction cost estimate: $456,000
TECC: $456,000
TPC: $791,922

7. Financial Schedule:

| Fiscal Year | Appropriations | Obligations | Costs |
|---|---|---|---|
| FY 1989 | $ 6,000 | $ 6,000 | $ 5,633 |
| FY 1990 | 39,440 | 39,440 | 15,916 |
| FY 1991 | 69,592 a/ | 69,592 a/ | 37,347 |
| FY 1992 | 90,360 b/ | 90,360 b/ | 112,771 |
| FY 1993 | 110,407 | 110,407 | 117,153 |
| FY 1994 | 93,000 | 93,000 | 107,523 |
| FY 1995 | 45,000 | 45,000 | 56,290 |
| FY 1996 | 0 | 0 | 3,367 |

8. Brief Physical Description of Project

The DOE has selected Argonne National Laboratory to design and build a new generation 6-7 GeV synchrotron radiation source. This facility is important for the Department's research program and will serve as a national resource for the conduct of research by industry, government, and university scientists. This facility will be located at the Argonne National Laboratory and will produce unprecedentedly brilliant x-ray beams to serve the research needs of virtually all scientific and disciplines and many technological fields,

a/ Reflects $906 reduction due to FY 1991 Sequester.
b/ Reflects savings of $2,200,000 of B/A due to proposed Davis Bacon Amendment.

1. Title and location of project: 6-7 GeV Synchrotron Radiation Source
Argonne National Laboratory
Argonne, Illinois

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

e.g., physics, chemistry, materials and surface science, biology, and medicine. Users will include scientists, engineers, and graduate students from universities, industry, and research laboratories throughout the United States.

The accelerator complex will consist of a 200 MeV electron accelerator, a positron production target, a positron linac, a positron accumulator ring, an injector synchrotron to accelerate positrons to 6-7 GeV, and a positron storage ring. The storage ring will be housed in an annular building and will provide space for more than 80 experimental beamlines and related equipment. Funding for an initial complement of beamlines is included in this construction project. The injector synchrotron will be housed in a separate, but related, structure. The complex will also include: offices; general and special purpose laboratories; clean room laboratories; and miscellaneous service operations areas. Provisions are included for site access roads, parking, service utilities, and miscellaneous site amenities.

The central lab/office building will contain laboratories, administrative offices, a control room, computer rooms, library and technical areas with an associated multiuse meeting facility.

The following is a brief physical description of the project facilities:

TECHNICAL COMPONENTS: The major system components for the production and injection of positrons are of conventional design. The storage ring, with approximately a 1100-meter circumference and 40 6-meter-long straight sections, is so designed that the positron beam size and position at each insertion device can be tuned independently for optimal performance. Storage ring magnets are of conventional design; however, a novel and highly effective vacuum system is proposed. The storage ring will operate at an energy (6-7 Gev) which will assure that 20 keV x-rays can be effectively obtained from an undulator in the fundamental mode.

Of the 40 straight sections, 6 will be occupied by accelerator equipment. Thus a total of 34 straight sections are available for insertion devices (undulators and wigglers). In addition, 35 photon beams from bending magnets (BM) can be provided. The initial complement of beamlines included directly in the project are based on three different types of radiation sources. Additional beamlines, as provided through Collaborative Access Teams (CAT's), are also expected to be ready at commissioning.

1. Title and location of project: 6-7 GeV Synchrotron Radiation Source
Argonne National Laboratory
Argonne, Illinois

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

CONVENTIONAL FACILITIES: The central laboratory and office building is a conventionally designed building with structural steel framing, concrete floor slabs, and an architectural metal exterior curtain wall with insulated glass windows. The office/laboratory section is four stories high, with mechanical penthouses, while the adjoining support wing areas 1/2 story high which forms a "Y" shaped building footprint. An adjacent building houses a multipurpose meeting facility designed for seminars and user meetings.

The heating, ventilation and air-conditioning systems are generally variable volume, constant temperature air supply systems providing standard temperature and humidity conditions. Computer rooms and laboratory clean rooms have separate specialized air-handling systems. The building's fire-protection system consists of smoke-detectors, sprinkler systems, and alarm-controlled zones electronically interlocked with Argonne's site-wide fire and security system. Utility systems are conventional, interconnecting with Argonne's existing site-wide utility system.

Conventional facilities for injection consist of the linear accelerator/klystron gallery building, the synchrotron injection building, the synchrotron extraction building, and the synchrotron ring tunnel.

(1) The linear accelerator/klystron gallery building is a long, narrow structure having an outer shell similar to a prefabricated metal building and joined on one side by a reinforced concrete and earth-shielded linear accelerator tunnel. The klystron gallery is an open bay with concrete floor slab and metal panel walls.

(2) The synchrotron injection building is similar to a prefabricated metal building. Appropriate shielding is provided by concrete blocks.

(3) The storage ring extraction building is similar in construction to the synchrotron injection building. Appropriate shielding is provided by concrete blocks. The building also has a five-ton overhead hoist.

(4) The synchrotron enclosure is an approximately circular reinforced concrete structure fully covered with earth berms which provide two feet of cover over the top and having sloped sides.

1. Title and location of project: 6-7 GeV Synchrotron Radiation Source
Argonne National Laboratory
Argonne, Illinois

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

The experimental hall/storage ring tunnel building is an annular shaped, metal clad building having an average radius of 600 feet, and is approximately 28 feet high and 85 feet wide. Steel columns and 600 roof trusses provide a clear span for experimental beamline installation. A concrete "storage ring" shielding enclosure is located within the building near the inner wall. This enclosure has approximately 3-foot thick reinforced concrete walls and roof slab. The inside height is 9 feet and the width varies between about 9 and 21 feet in a sawtooth pattern.

The experimental hall building has separate air-handling units individually zoned to provide heat, air-conditioning, and humidity control. The storage ring enclosure is air-conditioned and exhausted to the extent necessary to remove equipment-generated heat only. All utilities are distributed to the building underground from the utility support building.

An emergency/service vehicle tunnel, 14 foot head clearance, is provided under the building for infield access. A pedestrian tunnel also connects the control room, the support wing, crosses under the experimental hall, and the extraction and injector buildings.

Two separate service buildings, both with infield locations, house storage-ring magnet power supplies, radio frequency (rf) equipment, and electrical substations. The four laboratory/office modules are similar metal-framed one-story buildings with insulated metal exterior panels and concrete floor slab. These buildings are spaced at intervals around the outside of the experimental hall/storage ring building and each contains offices, laboratories, conference areas, service support spaces, and truck air access to facilitate delivery of technical components.

The utility support facility houses the mechanical and electrical equipment supporting the accelerator components and conventional facilities. It is a single-story, conventional metal-framed structure similar to a prefabricated metal building, with reinforced concrete floor slab. The facility has an overhead truck access door.

1. Title and location of project: 6-7 GeV Synchrotron Radiation Source
Argonne National Laboratory
Argonne, Illinois

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

Site Improvements: The completed project will occupy approximately 80 acres of relatively level, open land on the Argonne site. A standard perimeter road encircling the entire complex will provide access to all quadrants and interconnect with Argonne's road system. The project center and the four office/laboratory modules will have paved parking facilities. Emergency and service access to the infield area of the experimental hall/storage ring will be via a 20-foot wide vehicle tunnel.

9. Purpose, Justification of Need and Scope of Project

Over the past 20 years, synchrotron radiation emitted by circulating electron or positron beams has emerged as a very powerful and versatile source of vacuum ultraviolet light and x-rays and a very powerful tool for probing the structure of matter and for studying various physical processes. Several synchrotron radiation facilities with different designs and characteristics are now in regular operation in this country, the most recent additions being the 0.8 GeV and 2.5 GeV rings of the National Synchrotron Light Source at Brookhaven National Laboratory.

In October of 1983, an ad hoc committee was convened by the Department of Energy, Office of Basic Energy Sciences, with the charter to "solicit and evaluate ideas from synchrotron-radiation providers and users as to the future opportunities and technical needs for synchrotron-radiation based research." The committee had a membership of 17 scientists actively pursuing research using synchrotron radiation. The finding of the committee, briefly stated, is that the present research and development programs in materials science, physics, biology, and chemistry using synchrotron radiation can be greatly benefited by the availability of two additional facilities in the U.S. The one with the higher priority is a high-energy storage ring capable of providing fundamental undulator radiation in the x-ray region of the spectrum up to 20 keV, with an early 1990 target date for full operation. Such a storage ring requires an electron or positron beam of energy around 6-7 GeV. Both should be insertion device (undulator and wiggler) based machines designed to accommodate a large number of such insertion devices.

1. Title and location of project: 6-7 GeV Synchrotron Radiation Source
Argonne National Laboratory
Argonne, Illinois

2. Project No.: 89-R-402

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

The recommendation by the Committee was later studied and endorsed by the Major Materials Facilities Committee of the National Academy of Sciences and the top priority for the 6 GeV facility was strongly reaffirmed. Recently, this high priority national need was reaffirmed in the National Research Council (Brinkman) report - Physics through 1990's - and by the Stehle subcommittee of the DOE Energy Research Advisory Board.

During 1986 a National Task Group recommended that the synchrotron energy should be increased from the previously specified value of 6 GeV in order to provide wider tunability ranges of x-rays from undulator sources. Based on the report of that Task Group, 7 GeV has been chosen as the standard operating energy of the synchrotron. This document addresses the proposed construction of this new synchrotron radiation facility. This new facility would consist of a large storage ring containing as many as 34 insertion devices to give intense beams of hard x-rays. The injection and booster systems will be designed to inject positrons into the storage ring at the design energy of 7 GeV. Beam currents as high as 100 milliamperes and lifetimes of at least 10 hours are anticipated. Most importantly, the lowest possible beam emittance would be sought to give the highest brilliance x-ray source by a factor of 10,000 over any in existence. This facility would impact heavily on the field of physics, materials, chemistry, biology and medicine, and many technologies. Determination of bulk and surface structure will be performed with greater resolution and accuracy. Microprobe characterization will allow impurity detection in the parts per billion range. The high brilliance will make possible inelastic x-ray scattering which is an essentially unexplored field. Investigating time-dependent phenomena in biological membranes and in photosynthetic processes will be possible, as will observing the motion of atoms in protein systems. Angiography and analysis of tumor diseases will be advanced through non-invasive and very fast x-ray diagnostics without, or with the minimal use of, dyes or drugs. Topography will be extended to time-resolved studies of plastic deformation and fracture. All of these investigations are made possible by the photon energy, time-structure, intensity, and unusual brilliance of the radiation source.

Other experiments important to national security needs can also be undertaken. Research and development funding will be used to refine the lattice design of the storage ring, design and test new radio-frequency cavity systems, advance vacuum technology and surface cleaning techniques, develop insertion devices, and investigate beamline components that must handle greater x-ray intensities than at existing sources.

1. Title and location of project: 6-7 GeV Synchrotron Radiation Source
Argonne National Laboratory
Argonne, Illinois

2. Project No.: 89-R-402

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

Reliability, stability, and flexibility are emphasized in the accelerator, storage ring, and beamline designs. Specifically, the storage ring can accommodate all types of insertion devices with all tuning conditions desired by the users.

10. Details of Cost Estimate

| | Total Cost |
|---|---|
| a. Engineering, design, and inspection | $ 59,832 |
| b. Construction costs | |
| (1) Technical components | 189,216 |
| (2) Conventional facilities | 132,116 |
| Subtotal | 381,164 |
| c. Contingency | 74,836 |
| Total Estimated Construction Cost (TECC) | $456,000 |

11. Method of Performance

Customary accepted practice will be followed. Design of the conventional facilities will be performed under a CPFF architect/engineer contract awarded in accordance with established, DOE approved, procedures. Design of technical components will be performed by the Laboratory. To the extent feasible, construction and other procurements will be by means of fixed price contracts awarded on the basis of competitive bidding.

1. Title and location of project: 6-7 GeV Synchrotron Radiation Source
Argonne National Laboratory
Argonne, Illinois

2. Project No.: 89-R-402

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

| | Prior Years | FY 90 | FY 91 | FY 92 | FY 93 | FY 94 | FY 95 | FY 96 | Total |
|---|---|---|---|---|---|---|---|---|---|
| a. Total project funding costs (TPC) | | | | | | | | | |
| (1) Total facility costs | | | | | | | | | |
| (a) Construction line item | 5,633 | 15,916 | 37,347 | 112,771 | 117,153 | 107,523 | 56,290 | 3,367 | 456,000 |
| (b) Expense funded equipment | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| (c) Inventories | 0 | 0 | 0 | 400 | 4,400 | 2,500 | 0 | 0 | 7,300 |
| Total direct costs | 5,633 | 15,916 | 37,347 | 113,171 | 121,553 | 110,023 | 56,290 | 3,367 | 463,300 |
| (2) Other project costs | | | | | | | | | |
| (a) R&D necessary to complete construction | 17,357 | 9,441 | 14,332 | 17,500 | 19,727 | 12,500 | 7,500 | 0 | 98,357 |
| (b) Other project related costs | 0 | 0 | 0 | 5,880 | 16,500 | 38,600 | 61,120 | 75,900 | 198,000 |
| (c) Capital equipment | 2,800 | 1,000 | 1,500 | 1,500 | 8,000 | 6,500 | 4,500 | 3,000 | 28,800 |
| (d) Conceptual design costs | 3,465 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,465 |
| Total other project related costs | 23,622 | 10,441 | 15,832 | 24,880 | 44,227 | 57,600 | 73,120 | 78,900 | 328,622 |
| Total project costs (Items 1 & 2) | 29,255 | 26,357 | 53,179 | 138,051 | 165,780 | 167,623 | 129,410 | 82,267 | 791,922 |

b. Other related annual costs a/ (estimated live of project: 20 years)

| | |
|---|---|
| (1) Facility operating costs b/ | $58,100 |
| (2) Programmatic research | 18,100 |
| (3) Capital equipment related to programmatic research | 2,500 |
| (4) Accelerator improvements | 4,500 |
| Total related annual costs | $83,200 |

a/ Estimated costs in thousands escalated to 1997-year dollars.
b/ Annual operating costs which begin in 1997 include operations effort, utility, and administrative costs.

1. Title and location of project: 6-7 GeV Synchrotron Radiation Source
Argonne National Laboratory
Argonne, Illinois

2. Project No.: 89-R-402

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

a. Total project funding

(1) Total facility costs

(a) Construction line item - No narrative required

(b) Inventories

The spare parts inventory consists of specialized technical components which are not readily available "off the shelf" and have long lead times for procurement. These components include items such as rf accelerating cavities, klystrons, magnets, and beam diagnostic apparatus.

(2) Other project funding

(a) R&D necessary to complete construction.

These costs represent the R&D necessary to assure the best possible performance of the facility, to optimize conceptual engineering designs, and to develop the quality assurance plans for the testing of all hardware. The R&D plan includes: accelerator physics, including optimization of the current lattice and studies of alternative lattices, tracking with component errors and misalignments, nonlinear effects of the lattice and insertion devices, and vacuum chamber impedances; component prototyping and testing; designs for insertion devices and beamline components; detector development; and reexamination of the designs for the conventional facilities.

(b) Other project-related costs

These costs provide support for staff, utilities, management, start-up, commissioning, operations and operations-related R&D for the APS. This support starts in FY 1992 with the commissioning of the linac and continues in FY 1993 through FY 1996, to include the Positron Accumulator Ring, the Booster Synchrotron, the Storage Ring and beamlines. In late FY 1996, the monthly cost profile for the APS should be the same as for a fully operational APS.