DEPARTMENT OF ENERGY
FY 1994 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 of the Department of Energy and those described in the Energy Policy Act of 1992. In the pursuit of its research goals, BES designs, constructs, and operates large complex scientific facilities and makes them available to the scientific community at large. Thus, the two main activities in BES are to conduct energy-related research and to provide the necessary scientific facilities for this research to DOE and other users. 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 to strengthen the nation's science and engineering 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 through the transfer of information and technology, 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 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 1,400 individual research projects at over 200 separate institutions with direct support for over 4,000 investigators and 2,300 graduate students 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 the goals of the Energy Policy Act of 1992. 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 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 collaborators 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 about 4,000 from industry, academia and Federal laboratories in FY 1992. 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 long list of influential users at the facilities. For example, at the light sources, top universities and 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 institutions, but also to the DOE. At the neutron sources, major companies and universities are doing research in structural biology and superconductivity. At the neutron sources, 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 Energy Policy Act of 1992 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 2,300 graduate students and 2,000 academic professors and post-doctoral researchers.

o Promote information and 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 for FY 1994, the commissioning of a new vacuum ultraviolet radiation light source at LBL completed in FY 1993, and the continuation of construction of an advanced x-ray radiation light source at ANL. The continued design and request for construction of an advanced research reactor needed by the Department and the Nation is budgeted under a separate decision unit.

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. Two of these facilities are the Advanced Light Source located at the Lawrence Berkeley Laboratory and the 6-7 GeV Synchrotron Radiation Source located at the Argonne National Laboratory. The third facility, the Advanced Neutron Source (ANS), is budgeted for under a separate decision unit.

The following summary highlights the Basic Energy Sciences program encompassed within the requested budget:

o The research program would be held to approximately the same level of effort as in FY 1993. Within the base program request, research will continue to emphasize new areas started in FY 1993. These areas include materials synthesis and processing associated with the Advanced Materials and Processing Program, biotechnology, nonautomotive battery research, and advanced manufacturing.

o The seven major user facilities would be operated at an overall level available to users approximately equal to the FY 1993 level. The burden of increased ES&H requirements would be offset to some extent by the phase out of the MLNSC facility in FY 1994 and shutdown in FY 1995.

o The Advanced Light Source (LBL) would begin experimental operation and the 6-7 GeV Synchrotron Radiation Source (ANL) would continue to be constructed on an optimum schedule (FY 1996 completion) considering the FY 1993 reduction.

o The budgets for AIP, GPP, and Capital Equipment are proposed at approximately the FY 1993 level to address the high priority needs of the program.

o Increases support for the High Performance Computing and Communications Program by $25,000,000, which is slightly below the five year HPCC goals.

In summary, the FY 1994 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 Departmental and Energy Policy Act of 1992 goals. The research will strengthen small science at both the DOE laboratories and universities. The request contains funding to continue the construction of the 6-7 GeV Synchrotron Radiation Source, and to continue commissioning and start research for the Advanced Light Source. The Advanced Neutron Source project is budgeted under a separate decision unit.

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative in whole dollars.)

(Dollars in thousands)

LEAD TABLE

Basic Energy Sciences

Activity	FY 1992 Adjusted		FY 1993 Appropriation		FY 1993 Adjustment		FY 1994 Request
Operating Expenses							
Materials Sciences	$253,452	a/	$290,227		-$19,017		$276,985
Chemical Sciences	156,508	a/	175,400		-13,000		169,000
Applied Mathematical Sciences	80,494		91,000		-7,760		106,200
Engineering and Geosciences	35,363		39,540		-3,363		37,900
Advanced Energy Projects	54,665		11,900		-1,015		11,400
Energy Biosciences	24,391		27,600		-2,350		26,700
Program Direction	7,500		8,400		0		9,400
Subtotal Operating Expenses	612,373		644,067		-46,505		637,585
Capital Equipment	37,000		46,300		-1,370		44,880
Construction	110,984		218,333		-14,400		119,500
Subtotal	$760,357	b/	$908,700		-$62,275	d/e/f/	$801,965
Adjustment	0		-49,000	c/	49,000	c/	0
TOTAL	$760,357		$859,700		-$13,275		$801,965

a/ Reflects $1,000,000 in FY 1992 ($500,000 in Materials Sciences and $500,000 in Chemical Sciences) Internal Reprogramming from Nuclear Energy to Basic Energy Sciences for the purchase of research materials collection isotopes (92-R-33).

b/ Total has been reduced by $7,069,000 which has been transferred to the SBIR program.

c/ Program specific general reduction.

d/ Reflects $1,000,000 in FY 1993 ($500,000 in Materials Sciences and $500,000 in Chemical Sciences) Internal Reprogramming from Nuclear Energy to Basic Energy Sciences for the purchase of research materials collection isotopes (93-R-4).

e/ Program specific general reduction of $49,000,000 (Materials Sciences - $13,377,000, Chemical Sciences - $9,834,000, Applied Mathematical Sciences - $5,849,000, Engineering and Geosciences - $2,541,000, Advanced Energy Projects - $765,000, Energy Biosciences - $1,774,000, Capital Equipment - $860,000, and Construction - $14,000,000).

f/ General reduction for use of prior year balances of $14,275,000 (Materials Sciences - $6,140,000, Chemical Sciences - $3,666,000, Applied Mathematical Sciences - $1,911,000, Engineering and Geosciences - $822,000, Advanced Energy Projects - $250,000, Energy Biosciences - $576,000, Capital Equipment - $510,000, and [illegible]truction - $400,000).

	FY 1992 Adjusted	FY 19[illegible] Appropriation	FY 1993 Adjustment	FY 1994 Request
Summary				
Operating Expenses	$612,373	$609,927	-$12,365	$637,585
Capital Equipment	37,000	45,440	-510	44,880
Construction	110,984	204,333	-400	119,500
Total Program	$760,357	$859,700	-$13,275	$801,965
Staffing (FTEs)				
Headquarters	69	69	0	73
Field	3	5	0	5
Total	72	74	0	78

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

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

SUMMARY OF CHANGES

Basic Energy Sciences

FY 1993 Appropriation	$ 908,700
- Adjustment - Program specific general reduction	- 49,000
- Adjustment - General reduction for use of prior year balances	- 14,275
- Internal reprogramming from Nuclear Energy to Basic Energy Sciences for the purchase of research materials collection isotopes	+ 1,000
FY 1993 Adjusted	$ 846,425

Operating Expenses

Materials Sciences Funds provided for R&D and commissioning activities at the Advanced Light Source and the 6-7 GeV Synchrotron Radiation Source, for the operation of major user facilities and support of research for advanced materials and processing.	+ 5,775
Chemical Sciences Funds provided to support the operation of major user facilities and for research on chemical sciences aspects of advanced materials and processing.	+ 6,600
Applied Mathematical Sciences Funds are provided for the High Performance Computing and Communications Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) activities.	+22,960
Engineering and Geosciences Funds are provided for research activities associated with advanced materials and processing.	+ 1,723

Advanced Energy Projects	+ 15
Funds are provided for research activities associated with advanced materials and processing.	
Energy Biosciences	+ 1,450
Funds are provided for research activities associated with advanced materials and processing.	
Program Direction	+ 1,000
Funds provided for support of staff needed to monitor and manage program.	
Capital Equipment	- 50
Continues core equipment funding at the FY 1993 level. Increased funding provided in support of the High Performance Computing and Communications FCCSET activities. Capital equipment needs in support of the 6-7 GeV Synchrotron Radiation Source are reduced.	
Construction	-84,433
Continues support for all ongoing construction projects: 6-7 GeV Synchrotron Radiation Source ($+10,593), Accelerator Improvement Projects ($+74) and General Plant Projects ($-300). No funds provided for Congressionally Directed Projects ($-94,800).	
FY 1994 Congressional Budget.	$801,965

DEPARTMENT OF ENERGY
FY 1994 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 36% of the funding. 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 National Laboratory, Lawrence Livermore National Laboratory, Pacific Northwest Laboratory, Idaho National Engineering Laboratory, National Renewable Energy Laboratory, and Sandia National Laboratories. The laboratory programs as a whole tend to contain larger groups of scientists, are multidisciplinary, involve longer-term research projects and tend to be co-sited with DOE funded technology programs. 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 may include graduate students and post doctoral assistants 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 49%.

The Federal Coordinating Council on Science, Engineering and Technology (FCCSET) Committee on Materials coordinates materials R&D activities throughout the Federal government. Participating agencies include: Department of Energy, National Science Foundation, Department of Defense, Department of Commerce-National Institute of Standards and Technology, National Aeronautics and Space Administration, Department of Transportation, Department of Health and Human Services-National Institutes of Health, Environmental Protection Agency, Department of Agriculture, and Department of Interior-Bureau of Mines. The Materials Sciences subprogram has the lead role in coordinating and integrating the input from approximately twenty different Department of Energy program offices to FCCSET. Also, interagency coordination and planning is carried out through topical task forces under the Committee on Materials in areas such as structural ceramics, superconductivity, etc.

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; tailoring materials properties to satisfy defined requirements such as improved corrosion resistance in fossil plants or radiation resistance in fission and 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. 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 Federal Coordinating Committee on Science, Engineering, and Technology (FCCSET). 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: development of a new class of oxidation resistant silicon nitride ceramics that retains strength for longer times at elevated temperatures; predictions of systems with unusually high hydrogen storage capacity; development of a predictive capability for intelligent computer-assisted processing for alloys of aluminum; development of a new X-ray absorption method for characterizing corrosion retarding oxide layers in-situ in real corroding environments; the

I. Materials Sciences (Cont'd)

growth of synthetic diamond coatings; development of a new stress assisted reaction synthesis process for producing nickel aluminide alloys with a three to seven fold reduction in porosity; development of a high pressure gas atomization technique to produce rare-earth permanent magnet alloys; production of microcomposite superconductors from metallic precursors; development of improved method for measurement of fracture toughness of ceramics, improved catalytic decomposition of hydrogen sulfide obtained with nanophase titanium dioxide; development of a new class of magnetic materials with greatly improved properties through chemical addition of nitrogen into rare-earth iron compounds; computer simulation of thin film lubricants provides the basis for the improved design of lubricants with improved lubricating properties, with wear at contacting surfaces; development of advanced thermoacoustic concepts for non-chlorofluorocarbon refrigeration devices; development of a thin film rechargeable lithium solid state battery; the first successful effort to characterize the ordering induced in bulk polymers by the presence of a surface was achieved at the National Synchrotron Light Source by an industrial, university, and laboratory collaboration; synthesis of the first room-temperature organic-based magnet; and the development of a general biosynthetic method to insert "unnatural" amino acids and amino acid analogs into specific positions in proteins with the potential for synthesizing novel polymeric materials.

This budget includes $271,210,000 in FY 1993 and $276,985,000 in FY 1994 in support of Advanced Materials and Processing FCCSET activities. This budget also includes $2,350,000 in FY 1993 and FY 1994 in support of the Biotechnology FCCSET activity which is also included in the amounts for Advanced Materials and Processing.

II. A. Summary Table: Materials Sciences

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Materials Sciences Research	$ 132,235	$ 136,395	$ 143,085	+ 5
Facilities Operations	121,217	134,815	133,900	- 1
Total, Materials Sciences	$ 253,452	$ 271,210	$ 276,985	+ 2

II. B. Major Laboratory and Facility Funding

AMES LABORATORY	$ 9,788	$ 9,525	$ 9,775	+ 3
ARGONNE NATIONAL LABORATORY (EAST)	$ 47,609	$ 60,595	$ 80,204	+ 32
BROOKHAVEN NATIONAL LABORATORY	$ 51,855	$ 51,257	$ 53,133	+ 4
IDAHO NATIONAL ENGINEERING LABORATORY - EG&G	$ 462	$ 408	$ 340	- 17
LAWRENCE BERKELEY LABORATORY	$ 35,155	$ 37,943	$ 38,997	+ 3
LAWRENCE LIVERMORE NATIONAL LABORATORY	$ 2,350	$ 2,183	$ 2,251	+ 3
LOS ALAMOS NATIONAL LABORATORY	$ 12,536	$ 12,705	$ 9,240	- 27
OAK RIDGE NATIONAL LABORATORY	$ 46,906	$ 44,324	$ 23,575	- 47
PACIFIC NORTHWEST LABORATORY	$ 2,998	$ 2,870	$ 2,821	- 2
SANDIA NATIONAL LABORATORIES	$ 7,962	$ 7,939	$ 7,939	0

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

Program Activity	FY 1992	FY 1993	FY 1994
Materials Sciences			
Materials Sciences Research	Metallurgy and Ceramics Research - Continued effort on understanding processing-structure-property relationships in ceramic superconductors. Continued efforts on theoretical approaches to high performance metals and ceramics, structure-behavior relationships and interfacial bonding and adhesion. Reduced effort on artificially tailored materials, high temperature reactions and intermetallic compounds. Research on radiation effects was increased.	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, and structure-behavior relationships. Continue efforts in Energy Policy Act of 1992 thrusts in safety and reliable performance of materials, including corrosion resistant materials, surface modification to improve friction and wear, modeling of near-net shape fabrication processes for complex materials systems, welding and joining of materials, materials for radiation environments, synthesis of photovoltaic materials, and high temperature structural ceramics.	Metallurgy and Ceramics Research - Continue effort on understanding synthesis-processing-structure-property relationships in ceramic superconductors and structure-behavior relationships. Increased thrusts in safety and reliable performance of materials as contained in the Energy Policy Act of 1992. Continue efforts on corrosion resistant materials, surface modification to improve friction and wear, modelling of near-net shape fabrication processes for complex materials systems, welding and joining of metallic and ceramic materials, materials for radiation environments, synthesis and processing of photovoltaic materials, and high temperature structural ceramics.
	Solid State Physics Research - Reduced selected efforts and continued priority research largely unique to DOE, such as in neutron scattering and synchrotron radiation. Continued effort on physics of high temperature superconductivity. Continued effort on physics of radiation effects. Continued effort on field responsive polymeric materials, solid state theory, and novel characterization methods. Continued 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 high priority research within the DOE mission, and largely unique to DOE, such as neutron scattering and synchrotron radiation. Constant effort on the physics of high temperature superconductivity. Continue efforts on the physics of radiation effects. Continue efforts in surface and interface science, magnetic materials, theory of atomically complex materials, and characterization of complex materials. There will be new efforts to develop beamlines for the new light sources at Advanced Light Source (ALS)/(LBL) and Advanced Photon Source (APS)/(ANL). Initiate support to explore designs of a spallation neutron source.	Solid State Physics Research - Continuation of high priority research within the DOE mission especially in neutron scattering and synchrotron light sources. Continued efforts in the physics of high temperature superconductivity, radiation effects, and the development of novel characterization methods. Continued efforts on the physics of surfaces and interfaces. Enhanced emphasis on new materials with energy-related properties. Enhanced emphasis on AMPP thrusts in magnetic and photovoltaic materials. Enhanced effort to develop beamlines for ALS and APS. Support will continue at about the FY 1993 level to explore designs of a spallation neutron source. New efforts on computer simulations of photovoltaic materials and on properties of magnetic materials.

III. Materials Sciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Materials Sciences Research (Cont'd)	Materials Chemistry Research - Continued 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. Continued research in chemical structure, surface chemical properties, and polymer research.	Materials Chemistry Research - Continued emphasis on synthesis and characterization of novel organic and inorganic materials with a focus on novel inorganic materials, organic superconductors (such as doped buckeyballs), synthetic metals, high strength polymers, polymeric electrolytes, preceramic material and novel materials synthesized using biological processes. There will be continued emphasis on the materials chemistry of macromolecules at interfaces. Continue emphasis on biomolecular materials, catalysts, organic ferromagnets and organic superconductors, materials derived from small clusters, polymers and tribology. Continue emphasis on the synthesis and processing of new materials under the AMPP initiative in order to identify new materials with new or improved properties.	Materials Chemistry Research - Continued emphasis on research in materials chemistry of high priority to the Department including synthesis and characterization of novel organic and inorganic superconductors and magnetic materials, synthetic metals, surfaces and interfaces, polymers and materials synthesized by biological processes. With continued stimulus from the AMPP initiative, new programs will be developed in the synthesis of biomolecular materials, novel ferromagnets, superconductors, and synthetic metals. There will be an enhanced effort to provide beamline support for the ALS and APS. This activity includes funding for the President's Economic Investment Package.
	Funding in the amount of $3,214,000 has been transferred to the SBIR program.	Funding in the amount of $4,068,000 has been budgeted for the SBIR program.	Funding in the amount of $4,335,000 has been budgeted for the SBIR program.
	$ 132,235	$ 136,395	$ 143,085

III. Materials Sciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Facilities Operations	Continued 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 the Advanced Light Source (LBL) and the 6-7 GeV Synchrotron Radiation Source (ANL). Preconstruction research and development support of ANS continued with additional funds provided for the completion of a conceptual design for the facility. (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 the Advanced Light Source (LBL) and R&D and commissioning of components of the 6-7 GeV Synchrotron Radiation Source (ANL). Preconstruction research and development support of ANS continues for environmental impact statement, preliminary safety analysis report, and probabilistic risk assessment for the ANS. (For more detail on Facilities Operations see the Major User Facilities section following the Construction section.)	Continues support for major facilities in the Materials Sciences Subprogram with cost-of-living increases and funds for first full year of operation for the Advanced Light Source (LBL). Provides increases needed for R&D and commissioning of components of the 6-7 GeV Synchrotron Radiation Source (ANL). Funding for ANS budgeted for in a separate decision unit. (For more detail on Facilities Operations see the Major User Facilities section following the Construction section.) **This activity includes funding for the President's Economic Investment Package.**
	$ 121,217	$ 134,815	$ 133,900
Materials Sciences	$ 253,452	$ 271,210	$ 276,985

DEPARTMENT OF ENER
FY 1994 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 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 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. Basic research in molecular sciences that will lead to innovative approaches to waste management and environmental cleanup is supported. Recent examples of research results that may have significant technological impact may be cited as follows: Recent innovations now allow surface spectroscopies to be used to structurally characterize catalysts supported on insulating materials which are typical of those used in commercial practice. A new process for safer, lower temperature processing of uranium, neptunium and plutonium metallic scrap is being developed based on oxidation of the metals using sodium hypochlorite (common bleach). A revised, higher value for a key hydrocarbon carbon-hydrogen bond energy has resulted in a new mechanism for soot formation. A novel swirl burner for premixed flames has been developed which stabilizes lean flames even at low temperatures where formation of NOx is reduced. New high yield syntheses of buckyball precursors have been achieved which should facilitate studies of these technologically promising materials. Support is also provided to major user facilities which are made available to the entire scientific community for research.

This budget includes $2,900,000 in FY 1993 and $7,500,000 in FY 1994 in support of Advanced Materials and Processing FCCSET activities. This budget includes $16,800,000 in FY 1993 and $17,000,000 in FY 1994 in support of Biotechnology FCCSET activities.

II. A. Summary Table: Chemical Sciences

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Chemical Sciences Research	$ 99,627	$ 105,805	$ 110,400	+ 4
Facilities Operations	56,881	56,595	58,600	+ 4
Total, Chemical Sciences	$ 156,508	$ 162,400	$ 169,000	+ 4

II. B. Major Laboratory and Facility Funding

	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
AMES LABORATORY	$ 3,986	$ 3,659	$ 3,759	+ 3
ARGONNE NATIONAL LABORATORY (EAST)	$ 16,395	$ 16,397	$ 16,247	- 1
BROOKHAVEN NATIONAL LABORATORY	$ 18,007	$ 17,521	$ 17,770	+ 1
IDAHO NATIONAL ENGINEERING LABORATORY - EG&G	$ 315	$ 315	$ 315	0
LAWRENCE BERKELEY LABORATORY	$ 7,932	$ 7,712	$ 7,507	- 3
LOS ALAMOS NATIONAL LABORATORY	$ 1,140	$ 761	$ 756	- 1
OAK RIDGE NATIONAL LABORATORY	$ 45,239	$ 44,996	$ 45,601	+ 1
PACIFIC NORTHWEST LABORATORY	$ 7,005	$ 6,750	$ 6,590	- 2
SANDIA NATIONAL LABORATORIES	$ 7,616	$ 7,810	$ 7,857	+ 1

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

Program Activity	FY 1992	FY 1993	FY 1994
Chemical Sciences			
Chemical Sciences Research	A better understanding of solvent dynamics as they affect electron transfer is necessary for improvements in solar photochemical energy conversion and is receiving emphasis. The related areas of photosynthesis and photoelectrochemistry were maintained. Radiation chemistry, except as related to broader chemical questions, was reduced.	The research program is aimed at understanding chemistry and reactivity at a molecular level. Work will focus upon fast or short-lived phenomena. Understanding of solvent dynamics and electron transfer are necessary for improved solar photochemical energy conversion and will be maintained as will the related area of natural photosynthesis and photoelectrochemistry. Other areas including hot atom chemistry and radiation chemistry will be given lower priority.	Increased emphasis will be placed upon understanding chemical reactivity on a molecular level in the liquid phase which will greatly enhance the utility of the existing knowledge base towards the ultimate efficient conversion of solar energy into other useful energy forms. Work will continue to focus upon solvent dynamics, electron transfer, and short-lived phenomena. These technical areas are necessary ingredients of the long-term goals of the Energy Policy Act of 1992. Also necessary to achieve these long term goals is planned research on dye-sensitized semiconductor photoelectrodes, heterogeneous photocatalysis, and new organometallic precursors for electronic materials in support of the Advanced Materials and Processing FCCSET activities.

III. Chemical Sciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Chemical Sciences Research (Cont'd)	The dynamics of chemical reactions critical to an improved understanding of combustion processes was given priority. Studies of the electronic properties and chemical reactivity of metal clusters is important to an improved knowledge of catalysis and remains a high priority area. Research in the areas of theory, dynamics and structure related to chemical aspects of environmental restoration and waste management was enhanced. Studies of dynamical processes at extremely short times coupled with more extensive theoretical computational efforts is being performed in areas related to energy technologies including artificial photosynthesis, combustion and catalysis. The CRF contributed substantially to the combustion part of this effort. R&D in combustion dynamics continued with emphasis on building on capability at the Lawrence Berkeley Laboratory and Sandia National Laboratory.	Critical to improved understanding of combustion processes is a thorough base in chemical reactivity. The dynamics and kinetics of simple combustion related reactions will be given highest priority. Modeling efforts will be continued. The CRF will continue as a major site devoted to combustion science. Research in the fundamentals related to environmental restoration and waste management will be enhanced. The areas of focus will be upon the liquid-solid interface which is important to understanding the reactivity and control or prevent transport of hazardous chemicals and species in the environment. The properties and reactivity of clusters, both metal and semiconductor, will be important in the long-term for improved catalysts and understanding materials.	Critical to the Energy Policy Act of 1992 is an understanding, on the molecular level, of combustion processes. The proposed funding levels will permit high priority programs in chemical dynamics and kinetics of simple reactions including the reaction dynamics of hot molecules and surface combustion chemistry to continue. The CRF will continue as a major site devoted to a broad program in combustion related chemical physics. Cluster research, a new area of molecular science, has potential for improved understanding of catalysis and the behavior of materials. It is an area that will contribute to the Advanced Materials and Processing FCCSET activities. Interaction with the technology programs related to combustion and environmental restoration will be continued.
	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, remains 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	The atomic physics effort will be continued with an enhanced focus upon properties of low-temperature plasmas. The recommendations of the workshops supported by the Chemical Sciences Division on "Future Research Opportunities in Atomic, Molecular, and Optical Physics" will form the long-range basis for the program.	The budget request is consistent with the report on "Future Research Opportunities in Atomic, Molecular, and Optical Physics" and the program will provide support for efforts consonant with those areas listed. Specifically, approaches to the study of high energy density systems and energy-loss processes will be emphasized. Experimental and theoretical efforts in multi-electron excitation and ionization will improve understanding of the fusion process, light-matter interactions, and collision phenomena. Programs in atomic and plasma physics for advanced energy concepts related to many industrial and consumer needs are included. The plasma physics activity is being coordinated with ER's Fusion

III. Chemical Sciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Chemical Sciences Research (Cont'd)	experiments and to interpret existing data. Every effort was made to increase the theory component of the program and to implement recommendations of recent workshops sponsored by the Division of Chemical Sciences on "Future Research Opportunities in Atomic, Molecular and Optical Physics".		Energy program. An area of emphasis will be on accurate characterization of chemical processes taking plase in plasmas including surface phenomena and interactions between complex species found in plasmas.
	Research on materials precursors and catalysis was maintained. Growth opportunities in this area were realized at the expense of research in areas such as isotopes effect chemistry. Program directions established in FY 1991 were continued.	Materials precursor chemistry based on new synthetic processes for the molecular design of advanced materials will be increased. High priority research in the heterogeneous catalysis programs and coal chemistry research will continue to be emphasized. Other efforts will be reduced. General program directions established in FY 1992 should continue.	The catalysis research will include work on oxide and photoelectric catalysis, modification of shape selective oxide catalysts, and work to extend the conversion of paraffinic hydrocarbons to chemicals with significant energy efficiency, which includes work with renewable feedstocks. This activity is coordinated with other more applied catalysis programs in DOE through ongoing discussions as part of the Advanced Materials and Processing FCCSET activities.
	In chemical engineering sciences emphasis was given to research on solid-liquid phase equilibria that is supportive of materials sciences research efforts. Research on physically based predictive models was protected.	Phase equilibria in chemical engineering sciences will emphasize simulations and theory of modeling adsorption of simple fluids in porous media. Research on physically based predictive turbulence models will be protected. A basic research program in the area of batteries for non-automotive applications will be started. Particular emphasis will be placed on improving battery size, weight, life, and recharge cycles. The initiative will involve researchers from industry, universities, and National Laboratories and emphasize consortia and technology transfer.	In chemical engineering sciences, research on combustion related turbulence and phase equilibria of complex mixtures, experimental and theoretical, and physically based predictive models will be protected. The basic research program on advanced batteries will be expanded to include research on aspects of fuel cells. This research is being coordinated with other appropriate applied program elements in DOE and is part of the Advanced Materials and Processing FCCSET activities.

III. Chemical Sciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Chemical Sciences Research (Cont'd)	Separations chemistry and environmentally related analytical research was protected at current levels. To the extent possible ultrasonic studies for surface analysis and wet chemical surface analysis studies were initiated. Research to determine the detailed role of electronic factors in membrane transport was carried out. Studies of crown ether modifications to enhance solubilities were explored.	Improvements and innovations in analytical methods will be continued and efforts to improve the understanding of separation processes will be emphasized. This will include studies of the design of ion-specific complexing agents in selective hydrometallurgical separations processes and research on the energy and process efficiencies of vapor-liquid separations.	Actinide separations research needed to underpin the development of new processes for dealing with environmental and hazardous wastes will continue. Biotechnology related analytical research on macromolecules will be protected. Program directions established in FY 1993 will be continued.
	Heavy element chemistry in the area of solid state work related to new superconducting materials was protected. The organometallic chemistry of the actinides and lanthanides, particularly as it relates to catalysis received 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 augmented.	Emphasis will be on solid state heavy element chemistry related to superconducting materials, environmental and hazardous waste related activities and lanthanide chemistry.
			This activity includes funding for the President's Economic Investment Package.
	Funding in the amount of $1,968,000 has been transferred to the SBIR program.	Funding in the amount of $2,436,000 has been budgeted for the SBIR program.	Funding in the amount of $2,535,000 has been budgeted for the SBIR program.
	$ 99,627	$ 105,805	$ 110,400

III. Chemical Sciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Facilities Operations	The more optimal levels of facilities operations established in FY 1991 were maintained. Analysis of increasing requirements for safety, quality assurance and physical facility improvements at the facilities continued 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 operate at slightly below the improved level set in FY 1991 because of inflation. Improvements in safety, management, and operations at the facilities will will be continued at the FY 1992 level. Increasing requirements in quality assurance and conduct of operations will be addressed in the context of a constrained budget. (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 level set in FY 1993 adjusted for inflation. Improvements in safety, management, and operations at the facilities will be continued. Increasing requirements in quality assurance and conduct of operations will be addressed to the extent possible. (For more detail on Facilities Operations see the Major User Facilities section following the Construction section).
	$ 56,881	$ 56,595	$ 58,600
Chemical Sciences	$ 156,508	$ 162,400	$ 169,000

DEPARTMENT OF ENERGY
FY 1994 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, Computational, and Computer Sciences Research (MCCSR) Activity supports fundamental research and educational programs in critical areas needed by all DOE program components. The AMS subprogram, through the Advanced Computation, Communications Research, and Associated Activities (ACCRA) Activity provides leading edge information technology infrastructure support for researchers funded by the Office of Energy Research, including implementation of large scale high performance computing system prototypes for computational research, supercomputer access for over 4,000 researchers nationwide, and the Energy Sciences Network (ESNet) activities. The AMS subprogram is the core DOE contribution to the Federal High Performance Computing and Communications (HPCC) which was initiated in FY 1992 and specifically authorized by the High Performance Computing Act of 1991 (P.L. 102-194). The HPCC program involves nine Federal agencies in a well coordinated and integrated approach to advance technologies which are critical to the DOE mission, U.S. economic competitiveness, and the National Security. The HPCC program has been reviewed very favorably as a national priority by many groups, including industrial groups such as the Computer Systems Policy Project (CSPP), the President's Council of Advisors for Science and Technology (PCAST), the National Academy of Sciences, and others.

The DOE program will substantially increase its participation in this interagency program, albeit at a slightly lesser level than planned in order to balance program objectives within fiscal constraints.

The objectives of the AMS subprogram activities are to advance the knowledge of mathematical, computational, and computer sciences needed to model and understand the complex physical, chemical and biological phenomena involved in energy production and storage and utilization 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 (HPCRCs), including supercomputer facilities, and the ESNet as part of the overall HPCC program. The AMS subprogram, as part of the President's Initiative in HPCC in FY 1992 and FY 1993, initiated research activities including:

o HPCRC's at Los Alamos National Laboratory (LANL) and at Oak Ridge National Laboratory (ORNL), which along with the Lawrence Livermore National Laboratory's (LLNL) National Energy Research Supercomputer Center (NERSC) also serve as collaborative consortia, involving industrial and university research partners performing computational research in global climate research, environmental groundwater transport, and materials sciences;

o Grand Challenges collaborations research projects in conjunction with other ER and DOE programs with university and industrial partners in the areas of numerical simulation of fusion energy tokamak experiments, computational chemistry, structural biology, mathematical combustion modeling, theoretical high energy physics, and flow of oil and other fluids in porous media;

o Educational programs in curricula and textbook development, teacher workshops, and computational science programs at all levels;

o Research projects in performance measurement, software environments, distributed computing, data base technologies, mass storage systems and gigabit networking with industrial and university partners;

o Installation of a class VII, Cray Research, Inc., C-90 system, in the supercomputer access program at the National Energy Research Supercomputer Center (NERSC); and

o Upgrade of the ESNet to 45 Megabits per second in a cooperative effort with the National Aeronautics and Space Administration to merge cell

I. Applied Mathematical Sciences (Cont'd)

relay telecommunications switching technology with data communications internet technologies as part of the National Research and Education Network (NREN) program of the HPCC.

This budget includes $83,240,000 in FY 1993 and $106,200,000 in FY 1994 in support of High Performance Computing and Communications FCCSET activities. This budget also includes $3,000,000 in FY 1993 and FY 1994 in support of the Math and Science Education FCCSET activities which is also included in the amounts for High Performance Computing and Communications.

II. A. Summary Table: Applied Mathematical Sciences

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Mathematical, Computational, and Computer Sciences Research	$ 40,487	$ 41,191	$ 52,200	+ 27
Advanced Computation, Communications Research, and Associated Activities	40,007	42,049	54,000	+ 28
Total, Applied Mathematical Sciences	$ 80,494	$ 83,240	$ 106,200	+ 28

II. B. Major Laboratory and Facility Funding

AMES LABORATORY	$ 4,453	$ 6,385	$ 6,616	+ 4
ARGONNE NATIONAL LABORATORY (EAST)	$ 5,261	$ 4,880	$ 5,765	+ 18
LAWRENCE BERKELEY LABORATORY	$ 3,150	$ 3,300	$ 3,300	0
LAWRENCE LIVERMORE NATIONAL LABORATORY	$ 24,062	$ 25,665	$ 30,941	+ 21
LOS ALAMOS NATIONAL LABORATORY	$ 9,864	$ 9,975	$ 10,976	+ 10
OAK RIDGE NATIONAL LABORATORY	$ 7,215	$ 10,400	$ 12,129	+ 17
SANDIA NATIONAL LABORATORIES	$ 3,867	$ 2,904	$ 3,828	+ 32

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

Program Activity	FY 1992	FY 1993	FY 1994
Applied Mathematical Sciences			
Mathematical, Computational, and Computer Sciences Research	Basic Research and Human Resources (BRHR) research in analytical and numerical methods continued to pursue fundamental research in areas important for understanding the physical, chemical, and biological processes related to energy production, use, and conservation. Additional university based projects were initiated to collaborate with the laboratories and provide postdoctoral fellows and graduate students to ensure future human resources in these areas.	Basic Research and Human Resources (BRHR) 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. BRHR will also provide additional support for expanded computational science education programs.	Basic Research and Human Resources (BRHR) 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, geometry, and adaptive mesh techniques as part of the HPCC program. HPCC educational programs will continue at current levels of effort.
	High Performance Computing Systems (HPCS) experimental research prototypes, including modern parallel computer systems, algorithm research, and visualization techniques, as described in the U.S. High Performance computing and Communications Report were emphasized at DOE laboratories and universities.	High Performance Computing Systems (HPCS) research will continue in performance measurements of parallel architectures, parallel systems technology development, and prototype hardware evaluation of hig performance computing systems.	High Performance Computing Systems (HPCS) research will continue at a reduced level in performance measurements of parallel architectures, parallel systems technology development, and prototype hardware evaluation of high performance computing systems. HPCS will continue support at HPCRCs.
	Advanced Software Technology and Algorithms (ASTA) research emphasized the computational techniques applicable to the "grand challenge" problems including computational fluid and combustion dynamics, global climate modeling, structural biology, materials properties and condensed matter physics, quantum chromodynamics, numerical tokamak, enhanced oil recovery, and groundwater transport and modeling applications. Several special projects were initiated including lab, university and industry researchers to attack the problems of data	Advanced Software Technology and Algorithms (ASTA) research in applications and computational sciences will continue to emphasize the computational "grand challenge" problems, including computational fluid and combustion dynamics, global climate modeling, structural biology, materials properties and condensed matter physics, quantum chromodynamics, numerical tokamak, enhanced oil recovery, and groundwater transport modeling applications. HPCC funding support will provide for minimal growth in these existing "grand challenge"	Advanced Software Technology and Algorithms (ASTA) research will continue in computational "grand challenges," computational techniques, and software tools and components research areas. The scope of applications research support and software components research will be focused on high leverage areas such as distributed environments and software tools for parallel stystems. In addition, the "grand challenges" projects will be reviewed and evaluated for scientific progress to focus on priority energy applications to

III. Applied Mathematical Sciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Mathematical, Computational, and Computer Sciences Research (Cont'd)	compression, storage, and management which are already overwhelming problems for future large and small science projects in DOE.	collaborations. ASTA software research will also emphasize data management technologies, distributed computing environments, future generation data storage systems and visualization techniques.	accommodate planned growth in the other collaborations. This activity includes funding for the President's Economic Investment Package.
	Funding in the amount of $513,000 has been transferred to the SBIR program.	Funding in the amount of $618,000 has been budgeted for the SBIR program.	Funding in the amount of $783,000 has been budgeted for the SBIR program.
	$ 40,487	$ 41,191	$ 52,200
Advanced Computation, Communications Research, and Associated Activities	Additional support of the Advanced Software Technology and Algorithms category in the High Performance Computing Initiative provided HPCC research centers which are collaborative consortia with labs, academia and industry. This included support for experimental high performance computational facilities and advanced software development projects in software components and tools, and computational techniques. It also included acquisition of a Cray Research Inc. C90 supercomputer to replace one of the older Class VI systems at NERSC. Continued funding for the FSU/SCRI cooperative agreement.	Continue funding for Cray Research, Inc., C-90 supercomputer implementation at the National Energy Research Supercomputer Center (NERSC) and for the HPCC Research Centers initiated as part of the HPCC program. Continue funding for supercomputer software tools for improved access to HPCC systems. Continue funding for the FSU/SCRI cooperative agreement.	Continue funding for Cray Research, Inc., C-90 supercomputer supercomputer installed in FY 1992 at the National Energy Research Supercomputer Center (NERSC). Continue support for installed, full scale prototype HPCS at the HPCRCs. Continue funding for supercomputer software tools for improved access to HPCC and mass storage systems.

III. Applied Mathematical Sciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Advanced Computation, Communications Research, and Associated Activities (Cont'd)	Initiated 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. Initiated a DOE program component for gigabit network research concentrating on distributed supercomputer applications and user interfaces projects, including cofunding with DARPA and NSF for the CASA and MAGIC gigabit testbed activities.	Continue upgrade and evolution of Energy Sciences Network (ESNet) as part of the HPCC NREN project, including T3 implementation (45 megabits per second), packetized remote conferencing technology development and distributed applications network support. Maintain gigabit network research at current level.	Complete T3 (45 megabit) capability upgrades for the ESNet sites. Continue gigabit network research concentrating on multi-protocol support, interprocess communications techniques, and distributed computing technologies, e.g., those which enable telecommuting.
	No activity.	Initiate support for the FCCSET HPCC interagency management and coordination activity and for Information Resources Management (IRM) technology projects and studies in conjunction with DOE's Office of Administration and Management, and for FCCSET HPCC interagency management coordination support.	Continue support for the FCCSET HPCC interagency management and coordination support, and provide reduced support for Information Resources Management technology projects and studies being done in conjunction with DOE's Office of Administration and Management.
			This activity includes funding for the President's Economic Investment Package.
	Funding in the amount of $493,000 has been transferred to the SBIR program.	Funding in the amount of $631,000 has been budgeted for the SBIR program.	Funding in the amount of $810,000 has been budgeted for the SBIR program.
	$ 40,007	$ 42,049	$ 54,000
Applied Mathematical Sciences	$ 80,494	$ 83,240	$ 106,200

DEPARTMENT OF ENERGY
FY 1994 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 builds foundations for creation and development of environmentally appropriate technologies, contributing to 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, improved waste clean-up and management, reduction of capital needs for energy production and distribution, and addition of highly skilled personnel to the U.S. work force in energy-related specialties.

Engineering research serves as a conduit between basic science and applications-oriented research and development. Its 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 for bioprocessing of fuels and energy-related wastes), 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.

Geosciences research provides essential long-term support for the many DOE missions and programs that rest on understanding of the energy resource base, require knowledge on interactions of energy wastes with the natural host, or lead to improvements in environmental quality. Program objectives are (1) knowledge of fundamental controls on the origin, distribution, and evolution of energy resources, and (2) improved prediction of interaction of chemical and hazardous wastes with the geologic environment. The program focuses on the dynamics and interactions of geologic fluids with natural and man-made materials within a few kilometers of the earth's surface. The research is based on observation, as in geophysical imaging and scientific drilling, on experimental simulation of natural and man-perturbed processes, on comprehensive physical and chemical characterization, and on continued contribution to fundamental data on properties of rocks, minerals, and fluids at all scales important to understanding the processes. Many of the individual research activities involve collaborative efforts between various university and DOE laboratory investigators. Geosciences research bears directly on a secure energy supply for the nation as well as on developing favorable strategies to mitigate negative environmental impacts of the past and to create a better future.

This budget includes $900,000 in FY 1993 and $2,623,000 in FY 1994 in support of Advanced Materials and Processing FCCSET activities. This budget includes $4,000,000 in FY 1993 and FY 1994 in support of Biotechnology FCCSET activities. This budget includes $1,000,000 in FY 1993 and FY 1994 in support of Advanced Manufacturing FCCSET activities.

II. A. Summary Table: Engineering and Geosciences

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Engineering Research	$ 16,176	$ 16,542	$ 17,330	+ 5
Geosciences Research	19,187	19,635	20,570	+ 5
Total, Engineering and Geosciences	$ 35,363	$ 36,177	$ 37,900	+ 5

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LABORATORY (EAST)	$ 717	$ 804	$ 846	+ 5
BROOKHAVEN NATIONAL LABORATORY	$ 212	$ 324	$ 315	- 3
IDAHO NATIONAL ENGINEERING LABORATORY - EG&G	$ 2,029	$ 2,339	$ 2,369	+ 1
LAWRENCE BERKELEY LABORATORY	$ 2,357	$ 2,472	$ 2,289	- 7
LAWRENCE LIVERMORE NATIONAL LABORATORY	$ 2,288	$ 2,025	$ 1,950	- 4
LOS ALAMOS NATIONAL LABORATORY	$ 2,838	$ 2,702	$ 2,610	- 3
OAK RIDGE NATIONAL LABORATORY	$ 2,413	$ 2,350	$ 2,500	+ 6
PACIFIC NORTHWEST LABORATORY	$ 884	$ 926	$ 1,057	+ 14
SANDIA NATIONAL LABORATORIES	$ 2,460	$ 2,225	$ 2,268	+ 2

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

Program Activity	FY 1992	FY 1993	FY 1994
Engineering and Geosciences			
Engineering Research	The available funds provided some enhancement of the level of effort in the area of Engineering Data and Analysis enabling a start toward engineering research aimed at exploiting biotechnology for use in processing of fuels and energy related wastes. This long term basic research effort relies and builds on the existing base of outstanding researchers in chemical engineering. An important achievement in this area was the completion of preliminary studies of gels as absorbing agents for heavy metals. Research by individual investigators continued on topics 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, such as diamonds.	The budget provides a slightly decreased level of effort in long term basic engineering research. In the area of Engineering Data and Analysis, research in biotechnology is being given continued priority. Selected topics in bioprocessing of fuels and energy related wastes are emphasized, especially bioreactor systems, separations technology, and process monitoring and control. These bioprocessing activities are part of the Biotechnology FCCSET crosscut. Encouragement for collaborative national laboratory-university engineering research continues in this area. Efforts on energy-related non-equilibrium and non-linear processes are proceeding.	Continues support at the FY 1993 level of effort. The FCCSET initiatives in biotechnology and advanced materials processing will continue. For example, studies will proceed on possible direct communication paths among members of bacterial colonies and the resulting issues for adaptive process control. Development of methods for determining the properties of effective, environmentally benign refrigerants will continue, as well as selected topics on high critical temperature superconductors. Further emphasis will be placed on collaborative research laying the foundations for advanced plasma processing of materials.
	Research in the area of Control Systems and instrumentation by individual investigators continued in carefully selected specialties fundamental to creating new energy related technological opportunities, such as the development of process design and control strategies for energy efficiency, high product quality, and improved productivity in chemical and petroleum processing industries and robot-robot interactions. In the latter area, the first monograph on autonomous robot navigation in a	In the area of Control Systems and Instrumentation, the focus is 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 emphasizes systems useful for energy production technologies and waste management. Studies of process design and control strategies and related instrumentation	Experiments with multiple, cooperating robots at ORNL will attract visiting scholars and scientists at the CESAR project addressing the scientific basis for intelligent machines and autonomous robots for energy related applications thus creating further opportunities for collaborative research with industry and universities. As part of the increasing emphasis on advanced materials and processing, efforts on fully automating welding processes by using novel instrumentation and diagnostic methods will be sustained.

III. Engineering and Geosciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Engineering Research (Cont'd)	changing environment has been published.	are also maintained.	
	Further research in the area of Mechanical Sciences was 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 efforts continued in the studies of flow through porous media, e.g., rock, sand, and packed-bed reactors. That area is important as underpinning for energy technologies ranging from oil and gas recovery to the long term stability of nuclear waste deposits. Further research on nonlinear systems dynamics has led to the discovery of a strong ultraviolet component in extremely short light pulses driven by sound energy. Investigations in the important area of fracture mechanics, including laboratory-university collaboration continued.	The available funds provide continued support for long term basic engineering research in the area of Mechanical Sciences. Mitigating effects of aging of energy production and distribution systems are 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 draw on recent advances in solid and structural mechanics. Special attention is also 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 continues. Encouragement for collaborative national laboratory-university engineering research continues in all areas. Fellowships in integrated manufacturing are being awarded to students starting their doctoral studies.	Efforts in advanced manufacturing research including development of human resources will continue. Studies of aging and its mitigation in energy related structures will continue, with special attention being paid to the modelling of the effects of processing on the eventual properties of the materials as structural elements. These studies will include application of advances in the theories of dynamical systems - including those dealing with chaos in deterministic systems - to aging of structures. The same considerations will continue to be extended to other problems of energy engineering, such as eliciting simple, low dimensional models of seemingly complex phenomena occurring in mixing, fluid-flow driven vibrations, chemically driven patterns, self-excited dynamos, and multiphase flows. Research on foam generation and foam properties will continue because of potential insulation innovations. This activity includes funding for the President's Economic Investment Package.
	Funding in the amount of $194,000 has been transferred to the SBIR program.	Funding in the amount of $248,000 has been budgeted for the SBIR program.	Funding in the amount of $260,000 has been budgeted for the SBIR program.
	$ 16,176	$ 16,542	$ 17,330

III. Engineering and Geosciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Geosciences Research	Geophysical imaging of fluid-bearing reservoirs continued with added emphasis on high-resolution studies of near-surface features. Cooperative research between DOE National Laboratories and University researchers, with industrial participation has led to new advances in cross-hole acoustic and electromagnetic (EM) imaging. Small seismic events, accompanying fluid injection, have been used to provide improved information on path-dependent properties in fluid-bearing reservoirs. Acoustic and EM techniques were used to obtain direct information on melt extent and propagation during in situ vitrification to support evaluation of a potentially useful environmental remediation technology. Increased emphasis was placed on oil and gas reservoirs.	The request provides for continued support in geophysical imaging as it bears on selection of options for the Nation's energy future. Research will be expanded on innovative methods for obtaining and analyzing electromagnetic data to improve imaging in the earth's crust. Emphasis includes an effort to apply research to future characterization of heterogeneous and anisotropic potential oil and gas reservoirs. Multi-institutional collaborative studies on non-linear effects in acoustic wave propagation will be emphasized, with a thrust on field testing of laboratory-derived concepts. The capability of controlling the directional attributes and frequency content of man-made acoustic waves offers a great deal of potential for innovative underground imaging.	Geophysical imaging of subsurface structures and features will continue to be a key program element with an emphasis on integration of geophysical imaging with scientific drilling. This effort will continue the change in emphasis toward features to be found in the upper few kilometers of the earth's crust. Research efforts will continue on improving spatial resolution in imaging and characterizing geologic structures which may serve as hosts to oil and gas deposits. This improved spatial resolution is also directly applicable to assessment of materials in environmentally contaminated sites. Research coordination with Fossil Energy and Environmental Management will be continued and enhanced.
	Available funds provided for a slight increase in research effort on fundamental properties of earth materials. Advances were made in improved techniques for obtaining and interpreting isotopic data used in dating rocks and fluids. The change continued in programmatic emphasis as initiated the previous year, from high-temperature processes and properties to a theme emphasizing behavior near the earth's surface. Fundamental data on geologic media provide a necessary base for application in a wide range of current and future energy and environmental technologies, and are core element of the research program.	The budget provides for maintaining the program bearing on fundamental data on properties of rocks, minerals, and geologic fluids. These data are used in studies on flow, interaction, and reaction of fluids with rocks and minerals, as well as in the interpretation of geophysical data obtained in underground imaging. Increased effort has been devoted to fundamental problems related to the origin, migration and entrapment of oil and gas as well as to similar problems involved with transport of contaminated surface and ground water. Continued effort is being devoted to the origin, coalescence and propagation of rock fractures under simulated in situ stress conditions.	The request enhances support of research on fundamental properties of geologic materials, especially on fracture and failure of rocks. Research activities leading to an improved understanding of properties of rocks as they influence rock penetration and drilling will become a key thrust in the program. This research provides basic information needed for development of advanced, engineering materials. It includes activities focused on in situ measurements for scientific purposes. Geosciences research in this area will emphasize new and innovative methods for studying the micromechanics of brittle rock failure under laboratory conditions analogous to those found in deep bore holes.

III. Engineering and Geosciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Geosciences Research (Cont'd)	The DOE facet of the Interagency Continental Scientific Drilling Program (DOE, USGS, NSF) focused on the Base Drilling Program of shallow research drilling with emphasis on organic-rich sedimentary rocks of the Cretaceous interior seaway, and on research using samples or experimental data obtained in other CSDP drilling projects.	The DOE part of the Interagency (NSF, USGS, DOE) Continental Scientific Drilling Program (CSDP) continues to emphasize collaborative efforts in shallow drilling. This component of the scientific program provides the only direct access to the third dimension of the earth's crust to obtain new observations and test hypotheses derived from surface observations.	The Interagency (NSF, USGS, DOE) Continental Scientific Drilling Program will continue to emphasize shallow drilling, with a renewed emphasis on the integration with geophysical imaging techniques. The Katmai (AK) Drilling Project NEPA Process, including the EIS, is expected to be in its concluding stages and scientific drilling may be proposed in FY 1995.
	Available funding was provided for enhanced support of research in the areas of flow and interaction of fluids with porous and fractured rock. Research activities frequently involve participants from more than one institution. They have led to a firmer foundation for analysis of seismic events associated with depletion of fluid-filled reservoirs and more detailed understanding of pore structure in reservoir rocks using computer aided tomography with advanced x-ray sources. Fundamental research on the decomposition of organic acids and the interaction of reaction products with rocks and minerals has led to improved data on origin and development of secondary porosity in reservoirs. Such research efforts illustrate the value of fundamental research in providing a base for current and emerging energy technologies. While there are important differences among geologic fluids (groundwater, gas, oil, geothermal brine, hazardous and/or radioactive waste) applications involving all of them are linked by common needs in understanding underlying principles of mineral-fluid interactions.	The budget provides for maintaining research on origin, distribution, and environmentally benign use of the Nation's energy resources. Emphasis continues on flow and interaction of fluids with porous and fractured rocks in sedimentary basins with promise for oil and gas accumulation, and on application of fundamental hydrologic approaches to oil and gas migration. Investigations continue at a reduced level on fluid flow and chemical interaction in systems with geothermal potential to understand fundamental controls on reservoir behavior. Research on development and application of new paleomagnetic methods for determining the timing of oil and gas migration and the alteration of crude oils during migration is being continued. Research on the interaction of mineral surfaces and geologic fluids at the atomistic and molecular scales has been initiated to take advantage of existing synchrotron radiation sources and to prepare for frontier research opportunities at DOE facilities.	The request provides for continuation of research on flow and interaction of fluids in fractured and porous rocks. Geologic fluids of particular interest include: geothermal fluids; oil, gas, and oilfield brines; contaminated surface and ground waters; and those of magmatic origin. Fluid interaction with porous and fractured rocks is of major importance in advanced technologies involving the use of fossil, geothermal, and nuclear resources as well in considerations of contaminant transport. Testing and refinement of models and concepts involving flow and interaction in porous and fractured rocks at in situ field sites will be deferred for an additional year, as bench-scale studies continue. Studies directed toward the macroscopic and qualitative behavior of rock-fluid interaction will decrease as new studies on the interaction of minerals and fluids focus on rate and mechanism of reaction at the atomistic or molecular scale. Limited new efforts will be devoted to studies involving use of synchrotron radiation sources and other advanced techniques at DOE's National Laboratories.
			This activity includes funding for the

III. Engineering and Geosciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Geosciences Research (Cont'd)			President's Economic Investment Package.
	Funding in the amount of $243,000 has been transferred to the SBIR program.	Funding in the amount of $295,000 has been budgeted for the SBIR program.	Funding in the amount of $310,200 has been budgeted for the SBIR program.
	$ 19,187	$ 19,635	$ 20,570
Engineering and Geosciences	$ 35,363	$ 36,177	$ 37,900

DEPARTMENT OF ENERGY
FY 1994 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 provides support to establish the feasibility of novel, energy related ideas. The ideas can be stimulated in many ways, but usually arise from advances in basic research or from innovative considerations of exploratory energy concepts that do not readily fit into an existing program area. The AEP subprogram spans the Department's energy mission. The high risk associated with an AEP project is properly balanced by a high payoff for the nation's energy posture if the project is successful. Projects are typically supported at a level of $300,000 per year for a period of three years. Although funding profiles can vary among projects in the AEP subprogram, the three year budget period is considered the maximum. Following AEP support, it is expected that each concept will be sufficiently established and, if promising, will attract further funding from other sources to realize its full potential. The AEP subprogram does not support either ongoing, evolutionary research or large scale demonstration projects. Projects are selected on the basis of unsolicited proposals submitted by universities, industrial organizations, non-profit research institutions or private individuals. The AEP subprogram also considers ideas or concepts submitted by researchers at national laboratories. Equal consideration is given to all submissions.

This budget includes $500,000 in FY 1993 and $1,015,000 in FY 1994 in support of Advanced Materials and Processing FCCSET activities. This budget includes $300,000 in FY 1993 and FY 1994 in support of Biotechnology FCCSET activities.

II. A. Summary Table: Advanced Energy Projects

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Advanced Energy Projects	$ 10,665	$ 10,885	$ 11,400	+ 5
Congressionally Directed Projects	44,000	0	0	0
Total, Advanced Energy Projects	$ 54,665	$ 10,885	$ 11,400	+ 5

II. B. Major Laboratory and Facility Funding

ARGONNE NATIONAL LABORATORY (EAST)	$ 2,420	$ 2,370	$ 1,510	- 36
BROOKHAVEN NATIONAL LABORATORY	$ 485	$ 440	$ 470	+ 7
LAWRENCE BERKELEY LABORATORY	$ 540	$ 545	$ 575	+ 6
LOS ALAMOS NATIONAL LABORATORY	$ 750	$ 900	$ 955	+ 6
OAK RIDGE NATIONAL LABORATORY	$ 833	$ 865	$ 920	+ 6

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

Program Activity	FY 1992	FY 1993	FY 1994
Advanced Energy Projects			
Advanced Energy Projects	The following projects were concluded as scheduled: an unusual method for the catalytic production of fuels and chemicals from methane, a novel approach for oil spill cleanup, a new high frequency rf source for future linear colliders, and a novel small scale extreme ultraviolet laser. The remaining projects, which address research topics in areas that include novel energy materials technology, innovative approaches to energy conservation and generation, and unusual alternative energy sources, were continued toward completion as planned.	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 are in areas that include radioactive waste treatment using an aqueous biphasic extraction method, ultrafast molecular electronic devices, solar detoxification of aquatic systems, magnet replicas using high-temperature superconductors, high band-gap photovoltaic materials for a two-step fission energy conversion, synthesis of ceramic composite powders, a biocatalytic approach to the production of alternate fuels and feedstocks, and synthesis of plastics from renewable oils. Also, increased support will be provided as part of the Materials Research FCCSET crosscut and the Biotechnology FCCSET crosscut.	Provides funds to explore the feasibility of a sufficient number of new concepts that could contribute to the nation's energy economy. Funds are also available to continue and complete existing projects as planned. These projects include the exploration of renewable polymers from plant sources of monomers, solar detoxification of aquatic systems with porous photocatalysts and ultrafast molecular electronic devices. Subprogram activities will continue to be coordinated with DOE technology development programs to identify emerging areas of mutual interest. Research will be emphasized in high-leverage areas within the Department's energy mission such as new approaches for producing alternate feedstocks and fuel and novel processing techniques of advanced materials for energy conversion, energy generation, or transportation. This activity includes funding for the President's Economic Investment Package.
	TRANSFER: The Heavy Ion Fusion Accelerator Research (HIFAR) effort has been transferred to the Office of Fusion Energy. ($-6,850)	No activity.	No activity.
	Funding in the amount of $135,000 has been transferred to the SBIR program.	Funding in the amount of $163,000 has been budgeted for the SBIR program.	Funding in the amount of $171,000 has been budgeted for the SBIR program.
	$ 10,665	$ 10,885	$ 11,400

III. Advanced Energy Projects (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Congressionally Directed Projects	Funding provided for Congressionally directed projects.	No activity.	No activity.
	$ 44,000	$ 0	$ 0
Advanced Energy Projects	$ 54,665	$ 10,885	$ 11,400

DEPARTMENT OF ENERGY
FY 1994 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 Energy Policy Act of 1992, 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 will 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. Some research is also included on other classes of compounds such as lipids. 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 one Energy Biosciences' investigator was able to show that it is possible to transfer genes from bacteria to plants that can synthesize a compound that could be used as a biodegradable plastic. This resulted in a patent. 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 Conservation and Renewable Energy program in DOE as well as USDA and NSF programs and participates with those agencies to support plant science collaborative research and training on common objectives. 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.

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 restoration.
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 deficiency of knowledge 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 and promptly exploits information that is generated 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

I. Energy Biosciences (Cont'd)

some important exceptions.

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 biosystems relating to energy matters.

This budget includes $25,250,000 in FY 1993 and $26,700,000 in FY 1994 in support of Biotechnology FCCSET activities. This budget also includes $200,000 in FY 1993 and FY 1994 in support of the Math and Science Education FCCSET activities and $500,000 in FY 1993 and $1,950,000 in FY 1994 in support of Advanced Materials and Processing FCCSET activities which are also included in the amounts for Biotechnology.

II. A. Summary Table: Energy Biosciences

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Energy Biosciences	$ 24,391	$ 25,250	$ 26,700	+ 6
Total, Energy Biosciences	$ 24,391	$ 25,250	$ 26,700	+ 6

II. B. Major Laboratory and Facility Funding

BROOKHAVEN NATIONAL LABORATORY	$ 1,125	$ 1,045	$ 1,100	+ 5
LAWRENCE BERKELEY LABORATORY	$ 1,059	$ 1,060	$ 1,060	0
LOS ALAMOS NATIONAL LABORATORY	$ 135	$ 135	$ 135	0
NATIONAL RENEWABLE ENERGY LABORATORY	$ 164	$ 150	$ 150	0

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

Program Activity	FY 1992	FY 1993	FY 1994
Energy Biosciences			
Energy Biosciences	With the additional capacity provided by the FY 1992 budget responsiveness to high quality research proposals have made it possible to exploit more ideas on which to base future energy related biotechnologies.	This 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 Energy Policy Act of 1992, 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. While the FY 1993 appropriation will allow some extension of the program into important areas, numerous high quality applications in diverse areas which have been received will not be supported with the resources available (funding of new proposals will be less than 10% of those received).	The requested budget level will sustain the existing research efforts, plus provide some flexibility: to entertain some new research projects in support of fulfilling the objectives of the Advanced Materials and Processing FCCSET activities and to continue efforts in the Biotechnology FCCSET activities. Effectively, the increase will permit technical advances to be made in underpinning the biological production of novel energy-related materials using plants.

III. Energy Biosciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Energy Biosciences (Cont'd)	In the Energy Biosciences area of Primary Biological Production, not only has it been possible to build modestly studies on photosynthetic mechanisms, the basis of renewable resource production, but also new studies 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 includes 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 Primary Biological Production will focus on these activities and the continued efforts to define the specific opportunities to enhance the photosynthetic solar conversion process, into various useful products.	The important efforts within the category of Primary Biological Production consisting of photosynthesis and other research related to plant productivity will be maintained. Some examples of specific topic areas which are being considered include pursuing the formation of lignin and its role in plant rigidity. The ability of both plants and microbes to synthesize biodegradable plastic materials will be investigated.
	Activities in the Energy Biosciences area of Conversion of Primary Biological Energy Products that have received 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 is time extended.) Some modest increase of funding of nitrogen fixation research was also added.	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 will also be	The program's activities in the metabolic diversity of microorganisms will be emphasized as well as studies on the structure of plant cell walls which form the basis for the production of novel biomolecular materials.

III. Energy Biosciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Energy Biosciences (Cont'd)		studied to provide insights to possible environmental benefits.	
	In the Energy Biosciences area of Enabling Biotechnology Research sector, new research projects in discovering how plants transfer and express genetic information were funded. Other new work in the area of surface biology were begun 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 are being 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.	The investigations falling within the category of Enabling Biotechnology Research, such as studies on the regulation of genetic expression in plants and microbes as well as other types of investigations that help to provide the basis for new biotechnologies will be sustained.
	The Energy Biosciences program has continued a meaningful participation with USDA and NSF on plant science collaborative research including setting up of new research networks in important topic areas. Also a number of interdisciplinary research training projects were jointly initiated to cover fields badly in need of more attention, e.g., root biology, field photosynthesis.	The EB subprogram, with this level of funding, will be able to continue its joint programs with other agencies, such as the plant science research and training collaboration, with USDA and NSF.	The EB subprogram, with this level of funding, will be able to continue its joint programs with other agencies, such as the plant science collaborative research, with USDA and NSF.

III. Energy Biosciences (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Energy Biosciences (Cont'd)	A limited number of fellowships in certain key, important, but underrepresented topic areas, were continued 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.	There will be continued support of a limited number of post doctoral fellowships (and potential graduate student 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 both biotechnology development and scientific advancement. This activity includes funding for the President's Economic Investment Package.
	Funding in the amount of $309,000 has been transferred to the SBIR program.	Funding in the amount of $379,000 has been budgeted for the SBIR program.	Funding in the amount of $400,500 has been budgeted for the SBIR program.
	$ 24,391	$ 25,250	$ 26,700
Energy Biosciences	$ 24,391	$ 25,250	$ 26,700

DEPARTMENT OF ENERGY
FY 1994 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 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Program Direction	$ 7,500	$ 8,400	$ 9,400	+ 12
Total, Program Direction	$ 7,500	$ 8,400	$ 9,400	+ 12

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

Program Activity	FY 1992	FY 1993	FY 1994
Program Direction	Provided funds for salaries, benefits, and travel related to 72 full-time equivalents (FTEs) in the Office of Basic Energy Sciences, the Office of Scientific Computing, and related program and management support staff in the Headquarters and field. ($5,472)	Provide funds for salaries, benefits, and travel for 74 FTEs. ($7,149)	Provide funds for salaries, benefits, and travel for 78 FTEs. ($7,665)
	Funded staff for the Office of Basic Energy Sciences activities which include 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 large advanced scientific facilities, and supported numerous current user facilities, including ES&H oversight. Maintained technical excellence in R&D in such areas as superconductivity, molecular sciences, oil and gas and coal chemistry. Provided program capability to meet National research goals supporting the country's energy-related technology foundation. Interacted with other agencies on national efforts such as superconductivity and supercomputing, and helped maintain world leadership in science and technology. Supported the Basic Energy Sciences Advisory Committee, and managed the DOE-wide SBIR program.	Continue program management as in FY 1992 to meet National research goals supporting the country's energy-related technology foundation. Provide contractor management oversight and accountability, strengthen project management, especially for the 6-7 GeV Synchrotron Radiation Source, continue research for the Advanced Neutron Source (ANS), support current user facilities, and ensure compliance with ES&H regulations. 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 Sciences Advisory Committee, and manage the DOE-wide SBIR program.	Continue to provide program direction and oversight of efforts to meet National research goals supporting the country's energy-related technology foundation at an increased FTE level. Enhance contractor oversight and accountability, and project management, especially for the 6-7 GeV Synchrotron Radiation Source. Continue interaction with other DOE organizations to oversee increased activities on the Advanced Neutron Source (ANS), support current user facilities, and ensure ES&H compliance. Manage ongoing research program activities. 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.

III. Program Direction (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Program Direction (Cont'd)	Supported the Scientific Computing Staff, whose activities included policy and program planning, representation on interagency coordinating councils (FCCSET), management of research and development projects in mathematical and computational sciences, management of ER supercomputer centers, and management of Energy Sciences Network (ESNET) development and operations. Developed and coordinated the OSTP/FCCSET high performance computing and communications (HPCC) initiative requiring increased interaction among five Federal agencies with a major goal of transfer of technology to U.S. industry. Supported and coordinated multidisciplinary research collaborations with other ER program areas. Supported network users including development of an international network for the research community.	Continue to support the OSTP/FCCSET HPCC initiative. Support increased workload involving interagency computer network research and infrastructure program management and coordination of the National Research and Education Network (NREN). Support new and important research areas in the HPCC program with an estimated 400 additional proposals and 150 research projects. Support increased and new efforts in telecommunications networking, computational science and hardware architectural research, and the FCCSET initiative.	Continue to support the OSTP/FCCSET HPCC initiative at an increased FTE level. The HPCC program will require continued interagency computer network research and infrastructure program management and coordination of NREN. Provide focused expertise and specific program management experience to manage proposals and research projects. Enhance contractor oversight and accountability, and support Energy Policy Act requirements in the area of telecommuting.
	Provided program and management support in the areas of budget and finance, personnel administration, acquisition and assistance, policy coordination, information resources management, and construction management support.	Continue to provide program and management support at the FY 1992 level.	Continue to provide program and management support as in FY 1992 and FY 1993.
	Provided contract management oversight at Chicago Field Office for construction of the 6-7 GeV Synchrotron Radiation Source, a multimillion dollar project whose obligations total $300,000 per day.	Continue to support the 6-7 GeV Synchrotron Radiation Source on site. Support the workload related to procurements, safety and environmental oversight, and project management activities during the peak construction period through FY 1994.	Continue to support the 6-7 GeV Synchrotron Radiation Source at the FTE level included in the FY 1993 budget. Handle all the procurements, safety and environmental oversight, and project management activities related to that project.

III. Program Direction (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Program Direction (Cont'd)	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 for Automated Office Support Systems (AOSS) workstations. ($2,028)	Continue the variety of program support required in FY 1992. ($1,251)	Continue the variety of program support required in FY 1993. Provide increased support to ensure compliance with environmental, safety and health regulations. ($1,735)
	$ 7,500	$ 8,400	$ 9,400
Program Direction	$ 7,500	$ 8,400	$ 9,400

DEPARTMENT OF ENERGY
FY 1994 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, general purpose equipment at Argonne and Ames is funded 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 temperatures 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 $650,000 in FY 1993 and FY 1994 in support of Biotechnology FCCSET activities. This budget includes $1,468,000 in FY 1993 and $3,500,000 in FY 1994 in support of High Performance Computing and Communications FCCSET activities.

II. A. Summary Table: Capital Equipment

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Capital Equipment	$ 37,000	$ 44,930	$ 44,880	0
Total, Capital Equipment	$ 37,000	$ 44,930	$ 44,880	0

II. B. Major Laboratory and Facility Funding

AMES LABORATORY	$ 1,839	$ 1,574	$ 1,574	0
ARGONNE NATIONAL LABORATORY (EAST)	$ 8,197	$ 15,595	$ 12,695	- 19
BROOKHAVEN NATIONAL LABORATORY	$ 5,428	$ 3,987	$ 3,987	0
IDAHO NATIONAL ENGINEERING LABORATORY - EG&G	$ 535	$ 245	$ 245	0
LAWRENCE BERKELEY LABORATORY	$ 5,557	$ 6,018	$ 6,035	0
LAWRENCE LIVERMORE NATIONAL LABORATORY	$ 890	$ 1,555	$ 1,955	+ 26
LOS ALAMOS NATIONAL LABORATORY	$ 1,130	$ 825	$ 1,225	+ 48
OAK RIDGE NATIONAL LABORATORY	$ 8,132	$ 7,264	$ 6,664	- 8
PACIFIC NORTHWEST LABORATORY	$ 1,232	$ 1,525	$ 1,525	0
SANDIA NATIONAL LABORATORIES	$ 2,292	$ 1,906	$ 1,906	0

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

Program Activity	FY 1992	FY 1993	FY 1994
Capital Equipment			
Capital Equipment	Continued 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 continued to be met. Continued equipment support at the major user facilities. In addition, equipment was provided to support the research and development associated with the advanced scientific facilities.	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 core equipment funding at the FY 1993 level. Emphasis will continue in areas which require ES&H attention and in areas which have high priority in the research programs. Equipment requirements at the major user facilities will continue to be met. General purpose equipment requirements for Ames and ANL will continue to be funded at the FY 1993 level. Acquisition of a field emission gun electron microscope, located at Lawrence Berkeley Laboratory, with a point-to-point resolution limit of about one Angstrom (TEC - $1.5M). Capital equipment in support of the High Performance Computing and Communications program will be increased over the FY 1993 level. These funds will be used to procure mass storage equipment, network hardware, test equipment, and workstation class computers and other equipment to support the objectives of the program.
	TRANSFER: Capital equipment relating to the Heavy Ion Fusion Accelerator Research (HIFAR) effort has been transferred to the Fusion Energy ($-850,000).	No activity.	No activity.
	$ 37,000	$ 44,930	$ 44,880
Capital Equipment	$ 37,000	$ 44,930	$ 44,880

DEPARTMENT OF ENERGY
FY 1994 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 $96,407,000 in FY 1993 and $107,000,000 in FY 1994 in support of Advanced Materials and Processing FCCSET activities.

II. A. Summary Table: Construction

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Construction	$ 110,984	$ 109,133	$ 119,500	+ 9
Congressionally Directed Projects	0	94,800	0	-100
Total, Construction	$ 110,984	$ 203,933	$ 119,500	- 41

II. B. Major Laboratory and Facility Funding

AMES LABORATORY	$ 600	$ 1,130	$ 635	- 44
ARGONNE NATIONAL LABORATORY (EAST)	$ 93,910	$ 100,007	$ 110,825	+ 11
BROOKHAVEN NATIONAL LABORATORY	$ 2,065	$ 4,153	$ 4,180	+ 1
LAWRENCE BERKELEY LABORATORY	$ 7,998	$ 1,600	$ 1,575	- 2
OAK RIDGE NATIONAL LABORATORY	$ 4,861	$ 1,033	$ 655	- 37
SANDIA NATIONAL LABORATORIES	$ 100	$ 180	$ 180	0

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

Program Activity	FY 1992	FY 1993	FY 1994
Construction			
Construction	Continued all projects underway in FY 1991. Also includes $3,000,000 for the Solid State Research Facility at ORNL.	Provides necessary funds to continue all projects underway in FY 1992, except for the 1-2 GeV and the Solid State Research Facility which were completed.	Provides necessary funds to continue at the approved schedule all projects underway in FY 1993. This activity includes funding for the President's Economic Investment Package.
	$ 110,984	$ 109,133	$ 119,500
Congressionally Directed Projects	No activity.	Funding provided for Congressionally directed projects.	No activity.
	$ 0	$ 94,800	$ 0
Construction	$ 110,984	$ 203,933	$ 119,500

DEPARTMENT OF ENERGY
FY 1994 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 conduct leading edge research. Funds have been included for those facilities requiring NRC certificates of compliance as directed by 10 CFR 170 and 171. The Department had an initiative to upgrade the major scientific facilities including two new synchrotron radiation sources and a new neutron source. This request includes construction funding in FY 1994 for the 6-7 GeV Synchrotron Radiation Source and operation of the 1-2 GeV Synchrotron Radiation Source. The new neutron source, the Advanced Neutron Source, is budgeted under a separate decision unit. Summarized below is a list of each of these facilities, as well as a description of the activities underway in FY 1992, FY 1993 and FY 1994 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 1994, serving over 2,800 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. During FY 1990, the facility was shut down to allow for safety improvements. The scientific activity resumed in FY 1991, but was shut down for a period in late 1992 for additional safety improvements. The facility will be fully utilized in FY 1994, serving about 270 users.

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 200 users are involved.

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 1994, about 200 users are involved with research at the facility. The Radiochemical Engineering Development Center 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 1994, about 500 users are involved in research at the facility. With some new beamlines being commissioned, increased scientific activity is expected.

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

I. Major User Facilities (Cont'd)

communities. The operation of this facility utilizes the Los Alamos proton storage ring facility which is budgeted by Defense Programs and the LAMPF facility which is budgeted by the Office of Energy Research, Office of Nuclear Physics. The scientific program activity will involve more than 100 materials and materials-related scientists. FY 1994 funding is for shutdown of this facility. The facility will shut down because LAMPF operations are being terminated.

The Combustion Research Facility (CRF) at Sandia National Laboratories, 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 60 scientists are expected to be operational in FY 1994.

The Advanced Light Source (ALS) at Lawrence Berkeley Laboratory, which was previously called the 1-2 GeV Synchrotron Radiation Source, is a third generation synchrotron radiation facility for intense beams of light in the UV and soft x-ray regions of the spectrum. FY 1994 will be the first full year of operation of this facility. Research will include atomic and molecular structure, corrosion, surface phenomena, chemical dynamics, imaging of biological structures, x-ray lithography, and catalysis.

Funding in FY 1994 is requested to continue research and development activities associated with the 6-7 GeV Synchrotron Radiation Source (ANL). For the 6-7 GeV facility, funds provided are for R&D commissioning and testing of components with increases to support construction of the 6-7 GeV Synchrotron.

Funding for the Advanced Neutron Source is budgeted for in a separate decision unit.

II. A. Summary Table: Major User Facilities

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
National Synchrotron Light Source	$ 23,445	$ 23,401	$ 25,200	+ 8
High Flux Beam Reactor	23,941	23,888	24,400	+ 2
Intense Pulsed Neutron Source	6,654	6,644	7,300	+ 10
High Flux Isotope Reactor	26,331	26,259	27,100	+ 3
Radiochemical Engineering Development Center	7,800	7,636	7,900	+ 3
Stanford Synchrotron Radiation Laboratory	13,764	13,736	14,300	+ 4
Manuel Lujan, Jr. Neutron Scattering Center	5,774	5,765	2,300	- 60
Combustion Research Facility	4,390	4,379	4,600	+ 5
Advanced Light Source	19,124	22,496	23,700	+ 5
6-7 GeV Synchrotron Radiation Source	23,780	36,647	55,700	+ 52
Advanced Neutron Source	23,095	20,559	0	-100
Total, Major User Facilities	$ 178,098	$ 191,410	$ 192,500	+ 1

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

Program Activity	FY 1992	FY 1993	FY 1994
Major User Facilities			
National Synchrotron Light Source	Continued full year of operations with increase needed to accommodate user support and fully utilize facility.	Continues operations at a slightly lower level than FY 1992. Reduction in operations and user support necessary to absorb the full effect of any cost of living increases.	Continue operations with an increase to support a larger number of users. Provide upgrades in experimental systems.
	$ 23,445	$ 23,401	$ 25,200
High Flux Beam Reactor	Full operation, safety improvements implemented.	Continues operations at a slightly lower level than FY 1992. Reduction in operations and user support necessary to absorb the full effect of any cost of living increases.	Continue operations with an increase to support a larger number of users.
	$ 23,941	$ 23,888	$ 24,400
Intense Pulsed Neutron Source	Continued operation and user support.	Continues operations at a slightly lower level than FY 1992. Reduction in operations and user support necessary to absorb the full effect of any cost of living increases.	Enhance operations (5 additional weeks) with an increase to support a larger number of users.
	$ 6,654	$ 6,644	$ 7,300
High Flux Isotope Reactor	HFIR operated at a slightly reduced level and provided services to users with safety, quality assurance and physical facility improvements proceeding.	Continues operations at a slightly lower level than FY 1992. Reduction in operations and user support relative to the optimal level realized in FY 1991.	Continues operations at FY 1993 level with full attention given to ES&H upgrades.
	$ 26,331	$ 26,259	$ 27,100
Radiochemical Engineering Development Center	REDC operations and improvements were carried out.	Continues operations at a slightly lower level than FY 1992. Reduction in operations and user support necessary to absorb the effect of any cost of living increases.	Continues operations at FY 1993 level with full attention given to ES&H upgrades.

III. Major User Facilities (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
Radiochemical Engineering Development Center (Cont'd)	$ 7,800	$ 7,636	$ 7,900
Stanford Synchrotron Radiation Laboratory	Full operations of SSRL as dedicated synchrotron facility with full use of the 3 GeV injector.	Continues operations at a slightly lower level than FY 1992. Reduction in operations and user support necessary to absorb the full effect of any cost of living increases.	Continues operations at FY 1993 level. Improvements to the SPEAR ring will be initiated.
	$ 13,764	$ 13,736	$ 14,300
Manuel Lujan, Jr. Neutron Scattering Center	Continued operations and user support.	Continues operations at a slightly lower level than 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.	Provides for shutdown of facility
	$ 5,774	$ 5,765	$ 2,300
Combustion Research Facility	Continued operations and user support at the FY 1991 level.	Continues operations at a slightly lower level than FY 1992. Reduction in operations and user support necessary to absorb the full effect of any cost of living increases.	Continues operations at the FY 1993 level. Strengthened programs in chemical kinetics and dynamics will accommodate more users.
	$ 4,390	$ 4,379	$ 4,600
Advanced Light Source	Provided for commissioning and testing and research and development for the Advanced Light Source.	Increases support for commissioning and starts operation of the Advanced Light Source.	Provides support for first full year of operation of the Advanced Light Source.
	$ 19,124	$ 22,496	$ 23,700

III. Major User Facilities (Cont'd):

Program Activity	FY 1992	FY 1993	FY 1994
6-7 GeV Synchrotron Radiation Source	Provided for research and development to support the construction of the 6-7 GeV Synchrotron Radiation Source.	Increases support for commissioning and testing and research and development to support construction of 6-7 GeV synchrotron Radiation Source.	Continues research and development, commissioning and testing of components with increases to accelerate R&D needed to support construction of the 6-7 GeV Synchrotron Radiation Source.
	$ 23,780	$ 36,647	$ 55,700
Advanced Neutron Source	Preconstruction research and development support of ANS continued with additional funds provided for the completion of a conceptual design for the facility.	Preconstruction research and development support of ANS continues with additional funds for environmental impact statement, preliminary safety analysis report, and probabilistic risk assessment for the ANS.	Funding for the ANS is budgeted for in a separate decision unit.
	$ 23,095	$ 20,559	$ 0
Major User Facilities	$ 178,098	$ 191,410	$ 192,500

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

IV. A. Construction Project Summary

Project No.	Project Title	Previous Obligations	FY 1993 Appropriated	FY 1994 Request	Unappropriated Balance	TEC
GPE-400	General Plant Projects	XXX	5,300 a/	5,000	0	5,000
94-E-305	Accelerator and Reactor Improvements and Modifications, various locations	XXX	7,426 b/	7,500	0	7,500
89-R-402	6-7 GeV Synchrotron Radiation Source Argonne National Laboratory Argonne, Illinois	205,392	96,407	107,000	58,379	467,178
	Congressionally Directed Projects	XXX	94,800	0	0	0
	Total, Basic Energy Sciences	XXX	$203,933	$119,500	$ 58,379	XXX

a/ Reflects general reduction for use of prior year balances of $200,000.
b/ Reflects general reduction for use of prior year balances of $200,000.

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: GPE-400 General Plant Projects, Various Locations — TEC: $ 5,000, TPC: $ 5,000

Start Date: 1st Qtr. FY 1994 — Completion Date: 4th Qtr. FY 1995

2. Financial Schedule (Federal Funds):

		Costs				
Fiscal Year	Obligations	FY 1992 --	FY 1993	FY 1994	FY 1995	FY 1996
Prior Year Projects	3,051	2,610	1,220	0	0	0
1992 Projects	4,500	900	1,800	1,800	0	0
1993 Projects	5,300 a/	0	1,060	2,120	2,120	0
1994 Projects	5,000	0	0	1,000	2,000	2,000

3. Narrative: 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.

The currently estimated distribution of FY 1994 funds by office is as follows:

Ames Laboratory	$ 635
Argonne National Laboratory	3,825
Notre Dame Radiation Laboratory	90
Sandia National Laboratories	180
Stanford Synchrotron Radiation Laboratory	270
Total project cost	$ 5,000

FY 1994 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. Funding of this type is essential for maintaining the productivity and usefulness of Department-owned facilities and in meeting its requirement for safe and reliable facilities operation.

4. Total Project Funding (BA):

	Prior Years	FY 1992	FY 1993	FY 1994 Request
Construction	$ 3,051	$ 4,500	$ 5,300 a/	$ 5,000

a/ Reflects general reduction for use prior year balances of $200,000.

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 94-E-305 Accelerator and Reactor Improvements and Modifications, Various Locations

TEC: $ 7,500
TPC: $ 7,500

Start Date: 1st Qtr. FY 1994 Completion Date: 3rd Qtr. FY 1996

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Obligations	Costs
1994	$ 7,500	$ 7,500	$ 1,500
1995	0	0	3,000
1996	0	0	3,000

3. Narrative: 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 Kansas State University, Ion Collision Physics Facility, and one project at Lawrence Berkeley Laboratory is requested for beam-line enhancements at the Advanced Light Source.

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. Projects include beam position monitor, beamline optics, and beamline exit chambers.

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 1994, several projects are proposed including: to upgrade the 440 volt electrical system; 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.

Stanford Synchrotron Radiation Laboratory
Provide for improvements to 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. SPEAR power supplies, isolation valves, and a positron kicker 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.

Kansas State University, Ion Collision Physics Facility
The cryogenic refrigeration system feeding liquid helium to the high voltage rf linac cavities and the CRYEBIS solenoid will be relocated remotely and thereby decouple its sound and vibration from the laboratory building housing the accelerators. A second screw compressor will be added in parallel to the existing compressor, the CRYEBIS will be modified, and metal seals will be installed in the CRYEBIS beamlines.

Advanced Light Source

The Advanced Light Source, which begins operation in FY 1993, as originally configured, provided for straight sections and ports on bending magnets that were not initially instrumented in order to provide opportunities for further development to take advantage of new scientific or technical developments. This accelerator and reactor improvement and modification project will provide additional experimental equipment, including general purpose end stations, undulator front end systems, or advanced beam stabilization.

4. Total Project Funding (BA):

	FY 1994 Request
Construction	$ 7,500

IV. Construction Funded Project Descriptive Summary

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

TEC: $467,178
TPC: $811,922

Start Date: 3rd Qtr. FY 1990 Completion Date: 1st Qtr. FY 1997

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriated	Adjustments	Obligations	Costs
1989	$ 6,000	$ 0	$ 6,000	$ 5,633
1990	40,000	- 560 a/	39,440	15,916
1991	70,000	- 408 b/	69,592	37,347
1992	90,360	0	90,360	88,044
1993	110,407	-14,000 c/	96,407	102,298
1994	107,000	0	107,000	120,914
1995	58,379	0	58,379	88,143
1996	0	0	0	8,883

3. Narrative: Argonne National Laboratory 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.

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.

Due to budgetary constraints, this project has been stretched out from the 3rd Quarter of FY 1996 to the 1st Quarter of FY 1997 resulting in an attendant increase in TEC and TPC. The TEC has been increased from $456,000,000 to $467,178,000. The TPC has been increased from $791,922,000 to $811,922,000.

4. Total Project Funding (BA):

	Prior Years	FY 1992	FY 1993	FY 1994 Request	To Complete
Construction	$115,032	$90,360	$ 96,407	$107,000	$ 58,379
Capital Equipment	5,300	1,500	9,000	6,100	6,900
Operating Expenses	44,595	23,780	36,647	55,700	155,222

a/ Reflects sequestration of funds for FY 1990.
b/ Application of a portion of the FY 1991 general reduction of $4,111,000.
c/ Application of a portion of the FY 1993 programmatic general reduction of $49,000,000.

(Tabular dollars in thousands. Narrative dollars in whole dollars.)

IV. A. Construction Project Summary

Project No.	Project Title	Previous Obligations	FY 1993 Appropriated	FY 1994 Request	Unappropriated Balance	TEC
GPE-400	General Plant Projects	XXX	5,300 a/	5,000	0	5,000
94-E-305	Accelerator and Reactor Improvements and Modifications, various locations	XXX	7,426 b/	7,500	0	7,500
89-R-402	6-7 GeV Synchrotron Radiation Source Argonne National Laboratory Argonne, Illinois	205,392	96,407	107,000	58,379	467,178
	Congressionally Directed Projects	XXX	94,800	0	0	0
	Total, Basic Energy Sciences	XXX	$203,933	$119,500	$ 58,379	XXX

a/ Reflects general reduction for use of prior year balances of $200,000.
b/ Reflects general reduction for use of prior year balances of $200,000.

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: GPE-400 General Plant Projects, Various Locations — TEC: $ 5,000, TPC: $ 5,000

Start Date: 1st Qtr. FY 1994 Completion Date: 4th Qtr. FY 1995

2. Financial Schedule (Federal Funds):

		Costs				
Fiscal Year	Obligations	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996
Prior Year Projects	3,051	2,610	1,220	0	0	0
1992 Projects	4,500	900	1,800	1,800	0	0
1993 Projects	5,300 a/	0	1,060	2,120	2,120	0
1994 Projects	5,000	0	0	1,000	2,000	2,000

3. Narrative: 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.

The currently estimated distribution of FY 1994 funds by office is as follows:

Ames Laboratory	$ 635
Argonne National Laboratory	3,825
Notre Dame Radiation Laboratory	90
Sandia National Laboratories	180
Stanford Synchrotron Radiation Laboratory	270
Total project cost	$ 5,000

FY 1994 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. Funding of this type is essential for maintaining the productivity and usefulness of Department-owned facilities and in meeting its requirement for safe and reliable facilities operation.

4. Total Project Funding (BA):

	Prior Years	FY 1992	FY 1993	FY 1994 Request
Construction	$ 3,051	$ 4,500	$ 5,300 a/	$ 5,000

a/ Reflects general reduction for use prior year balances of $200,000.

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 94-E-305 Accelerator and Reactor Improvements and Modifications, Various Locations — TEC: $ 7,500 TPC: $ 7,500

Start Date: 1st Qtr. FY 1994 Completion Date: 3rd Qtr. FY 1996

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Obligations	Costs
1994	$ 7,500	$ 7,500	$ 1,500
1995	0	0	3,000
1996	0	0	3,000

3. Narrative: 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 Kansas State University, Ion Collision Physics Facility, and one project at Lawrence Berkeley Laboratory is requested for beam-line enhancements at the Advanced Light Source.

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. Projects include beam position monitor, beamline optics, and beamline exit chambers.

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 1994, several projects are proposed including: to upgrade the 440 volt electrical system; 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.

Stanford Synchrotron Radiation Laboratory
Provide for improvements to 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. SPEAR power supplies, isolation valves, and a positron kicker 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.

Kansas State University, Ion Collision Physics Facility
The cryogenic refrigeration system feeding liquid helium to the high voltage rf linac cavities and the CRYEBIS solenoid will be relocated remotely and thereby decouple its sound and vibration from the laboratory building housing the accelerators. A second screw compressor will be added in parallel to the existing compressor, the CRYEBIS will be modified, and metal seals will be installed in the CRYEBIS beamlines.

Advanced Light Source

The Advanced Light Source, which begins operation in FY 1993, as originally configured, provided for straight sections and ports on bending magnets that were not initially instrumented in order to provide opportunities for further development to take advantage of new scientific or technical developments. This accelerator and reactor improvement and modification project will provide additional experimental equipment, including general purpose end stations, undulator front end systems, or advanced beam stabilization.

4. Total Project Funding (BA):

	FY 1994 Request
Construction	$ 7,500

IV. B. Construction Funded Project Descriptive Summary

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

TEC: $467,178
TPC: $811,922

Start Date: 3rd Qtr. FY 1990 Completion Date: 1st Qtr. FY 1997

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriated	Adjustments	Obligations	Costs
1989	$ 6,000	$ 0	$ 6,000	$ 5,633
1990	40,000	- 560 a/	39,440	15,916
1991	70,000	- 408 b/	69,592	37,347
1992	90,360	0	90,360	88,044
1993	110,407	-14,000 c/	96,407	102,298
1994	107,000	0	107,000	120,914
1995	58,379	0	58,379	88,143
1996	0	0	0	8,883

3. Narrative: Argonne National Laboratory 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.

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.

Due to budgetary constraints, this project has been stretched out from the 3rd Quarter of FY 1996 to the 1st Quarter of FY 1997 resulting in an attendant increase in TEC and TPC. The TEC has been increased from $456,000,000 to $467,178,000. The TPC has been increased from $791,922,000 to $811,922,000.

4. Total Project Funding (BA):

	Prior Years	FY 1992	FY 1993	FY 1994 Request	To Complete
Construction	$115,032	$90,360	$ 96,407	$107,000	$ 58,379
Capital Equipment	5,300	1,500	9,000	6,100	6,900
Operating Expenses	44,595	23,780	36,647	55,700	155,222

a/ Reflects sequestration of funds for FY 1990.
b/ Application of a portion of the FY 1991 general reduction of $4,111,000.
c/ Application of a portion of the FY 1993 programmatic general reduction of $49,000,000.

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST

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

Basic Energy Sciences

1. Title and Location of Project: General Plant Projects

2a. Project No. GPE-400
2b. Construction Funded

3a. Date A-E Work Initiated, (Title I Design Start Scheduled): 1st Qtr. FY 1994

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

4a. Date Physical Construction Starts: 2nd Qtr. FY 1994

4b. Date construction ends: 4th Qtr. FY 1995

5. Previous Cost Estimate: None

6. Current Cost Estimate: $5,000
TEC -- $5,000
TPC -- $5,000

7. Financial Schedule (Federal Funds):

		Costs				
Fiscal Year	Obligations	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996
Prior Year Projects	$ 3,051	$ 2,610	$ 1,220	$ 0	$ 0	$ 0
1992 Projects	4,500	900	1,800	1,800	0	0
1993 Projects	5,300 a/	0	1,060	2,120	2,120	0
1994 Projects	5,000	0	0	1,000	2,000	2,000

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

a/ Reflects general reduction for use of prior year balances of $200,000.

1. Title and Location of Project: General Plant Projects	2a. Project No. GPE-400 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

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.

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

Ames Laboratory	$ 635
Argonne National Laboratory	3,825
Notre Dame Radiation Laboratory	90
Sandia National Laboratories	180
Stanford Linear Accelerator Center (SSRL)	270
Total project cost	$ 5,000

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

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

Ames Laboratory ..... $ 635

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 major projects are the conversion of 15,000 square feet of administrative space in Spedding Hall to laboratories, the upgrade of the fire panel detector system, the upgrade of the electrical service, and the upgrade of the demineralized water system piping. The highest priorities 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.

1. Title and Location of Project: General Plant Projects	2a. Project No. GPE-400 2b. Construction Funded

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

Argonne National Laboratory..... $ 3,825

The Argonne National Laboratory FY 1994 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 required to provide for minor new construction and additions, and upgrades 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 and in meeting its requirements for safe and reliable facilities operation. 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 modifications to the currently planned subprojects. No significant R&D program is anticipated as a prerequisite for design and construction of the subprojects under construction. The highest priority projects will be selected as needs are identified in FY 1994.

Notre Dame Radiation Laboratory..... $ 90

Requirements include: 1) conversion of old LINAC vault to laser spectroscopy laboratory; and 2) conversion of general usage laboratory to organic preparation laboratory, which is a Government-owned facility located on non-Government owned property.

Sandia National Laboratories..... $ 180

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 continuously changing programmatic goals and to meet identified environmental, health, and safety requirements. This project will provide funding to modify laboratory space and facilities in the CRF Laboratory Complex. Modifications will be needed to accommodate the many active and proposed combustion research experiments whose needs continuously change and have become increasingly complex because of the technological advances in combustion research. Additional modifications are mandated for environmental, safety and health needs that have evolved since the original facility was designed in 1977.

1. Title and Location of Project: General Plant Projects	2a. Project No. GPE-400 2b. Construction Funded

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

Stanford Linear Accelerator Center (SSRL)..... $ 270

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.

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 1994 CONGRESSIONAL BUDGET REQUEST

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

Basic Energy Sciences

1. Title and Location of Project: Accelerator and Reactor Improvements and Modifications, various locations

2a. Project No. 94-E-305
2b. Construction Funded

3a. Date A-E Work Initiated, (Title I Design Start Scheduled): 1st Qtr. FY 1994

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

4a. Date Physical Construction Starts: 3rd Qtr. FY 1994

4b. Date Construction Ends: 3rd Qtr. FY 1996

5. Previous Cost Estimate: None

6. Current Cost Estimate: $7,500
TEC -- $7,500
TPC -- $7,500

7. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Obligations	Costs
1994	$7,500	$7,500	$1,500
1995	0	0	3,000
1996	0	0	3,000

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 at the Stanford Linear Accelerator 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 Kansas State University, Ion Collision Physics Facility, and one project is requested at the Lawrence Berkeley Laboratory for beam-line enhancements at the Advanced Light Source.

1. Title and Location of Project: Accelerator and Reactor Improvements and Modifications, various locations	2a. Project No. 94-E-305 2b. Construction Funded

9. Purpose, Justification of Need For, 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)..... $ 1,580

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. Projects include beam position monitor, beamline optics, and beamline exit chambers.

b. High Flux Beam Reactor (BNL)..... $ 2,600

Several reactor additions and improvements are necessary to ensure the continued safe and reliable operation of this facility. Specifically in FY 1994, several projects are proposed: to upgrade the 440 volt electrical system; 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.

c. Stanford Synchrotron Radiation Laboratory (SLAC)..... $ 450

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. SPEAR power supplies, isolation valves, and a positron kicker are among the types of improvements necessary at this laboratory.

1. Title and Location of Project:	Accelerator and Reactor Improvements and Modifications, various locations	2a. Project No. 94-E-305 2b. Construction Funded

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

d. High Flux Isotope Reactor (ORNL)..... $ 655

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. Current instrumentation used in three systems for monitoring and controlling reactor power level is "original HFIR" and is far out of date. Due to their age, these instrumentation systems are difficult to maintain because of the non-availability of spare parts and services, and calibration is inaccurate and subject to excessive drifting. Funding is being provided to replace them.

e. Kansas State University, Ion Collision Physics Facility..... $ 640

The cryogenic refrigeration system feeding liquid helium to the high voltage rf linac cavities and the CRYEBIS solenoid will be relocated remotely and thereby decouple its sound and vibration from the laboratory building housing the accelerators. A second screw compressor will be added in parallel to the existing compressor to allow for continuous operation and thus avoid deleterious effects due to full temperature recycling of the rf cavities and to provide backup helium recovery capability to prevent loss of gas inventory. The CRYEBIS accelerator will be modified to take advantage of the full 200 keV accelerating capability now limited to 100 keV by the existing accelerator tubes. Metal seals will be installed in the CRYEBIS beamlines to assure ultrahigh vacuum integrity.

f. Advanced Light Source (LBL)..... $ 1,575

The Advanced Light Source, which begins operation in FY 1993, as originally configured, provided for straight sections and ports on bending magnets that were not initially instrumented in order to provide opportunities for further development to take advantage of new scientific or technical developments. This accelerator and reactor improvement and modification project will provide additional experimental equipment, including general purpose end stations, undulator front end system, or advanced beam stabilization.

1. Title and Location of Project:	Accelerator and Reactor Improvements and Modifications, various locations	2a. Project No. 94-E-305 2b. Construction Funded

10. Details of Cost Estimate

a. Engineering, design, and inspection and component assembly and installation	$ 7,500
Total line item cost	$ 7,500

11. Method of Performance

Design, engineering and inspection will be performed by Brookhaven National Laboratory, Stanford Synchrotron Radiation Laboratory, Kansas State University, 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 1994 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1993 Congressional Budget Request are denoted with a vertical line in left margin.)

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

Basic Energy Sciences

1. Title and Location of Project:	6-7 GeV Synchrotron Radiation Source Argonne National Laboratory Argonne, Illinois	2a. Project No. 89-R-402 2b. Construction Funded

SIGNIFICANT CHANGES

- TEC increased from $456,000,000 to $467,178,000 because of inefficiencies created by funding shortfalls. In addition to the effects of escalation, the delay in project completion requires maintaining the construction and project management staff beyond the originally planned date.

- TPC increased from $791,922,000 to $811,922,000. The delayed completion of the project forced by construction funding shortfalls requires the extension of commissioning and start-up activities in FY 1997.

- Completion date of 3rd Quarter FY 1996 changed to 1st Quarter of FY 1997 because of a 4-month slippage in schedule caused by procurement delays forced by cuts in B/A levels in Fiscal Years 1990 through 1993.

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1993 Congressional Budget Request are denoted with a vertical line in left margin.)

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

Basic Energy Sciences

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

2a. Project No. 89-R-402
2b. Construction Funded

3a. Date A-E Work Initiated (Title I Design Start Scheduled): 2nd Qtr. FY 1989

3b. A-E Work (Titles I & II) Duration: 48 months

5. Previous Cost Estimate:
Total Estimated Cost (TEC) -- $456,000
Total Project Cost (TPC) -- $791,922

4a. Date Physical Construction Starts: 3rd Qtr. FY 1990

4b. Date Construction Ends: 1st Qtr. FY 1997

6. Current Cost Estimate: $467,178
TEC -- $467,178
TPC -- $811,922

7. Financial Schedule (Federal Funds):

Fiscal Year	Appropriation	Adjustments	Obligations	Costs
1989	$ 6,000	$ 0	$ 6,000	$ 5,633
1990	40,000	- 560 a/	39,440	15,916
1991	70,000	- 408 b/	69,592	37,347
1992	90,360	0	90,360	88,044
1993	110,407	-14,000 c/	96,407	102,298
1994	107,000	0	107,000	120,914
1995	58,379	0	58,379	88,143
1996	0		0	8,883

a/ Reflects sequestration of funds for FY 1990.
b/ Application of a portion of the FY 1991 general reduction of $4,111,000.
c/ Application of a portion of the FY 1993 programmatic general reduction of $49,000,000.

1. Title and Location of Project:	6-7 GeV Synchrotron Radiation Source Argonne National Laboratory Argonne, Illinois	2a. Project No. 89-R-402 2b. Construction Funded

8. Brief Physical Description of Project

Due to budgetary constraints, this project has been stretched out from the 3rd Quarter of FY 1996 to the 1st Quarter of FY 1997 resulting in an attendant increase in TEC and TPC. The TEC has been increased from $456,000,000 to $467,178,000. The TPC has been increased from $791,922,000 to $811,922,000.

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, 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~~ 69 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.

1. Title and Location of Project:	6-7 GeV Synchrotron Radiation Source Argonne National Laboratory Argonne, Illinois	2a. Project No. 89-R-402 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

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.

CONVENTIONAL FACILITIES: The central laboratory/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~~ composed of two connected four story buildings 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 accelerator control center is located in a two story building attached to the experimental hall building near the central laboratory/office building.

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 buildings for injection consist of the linear accelerator/klystron gallery wing, the synchrotron injection wing, the synchrotron extraction wing, 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, steel frame, and metal panel walls.

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

1. Title and Location of Project:	6-7 GeV Synchrotron Radiation Source Argonne National Laboratory Argonne, Illinois	2a. Project No. 89-R-402 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

(3) The synchrotron extraction ~~building is similar in construction to the synchrotron injection building~~. tunnel is located below the rf/extraction ring. Appropriate shielding is provided by concrete walls and roof. ~~The building also has a five ton overhead hoist~~.

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

The experimental hall/storage ring 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~~ 120 roof beams 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~~ and air-distribution units creating multiple zones to provide heat and 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 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 central laboratory/office building to the control room, crosses the experimental hall, and connects the rf/extraction and injector buildings.

~~Two separate service buildings, both with infield locations~~ An rf/extraction building, located above the synchrotron extraction tunnel, will house storage-ring magnet power supplies and radio frequency (rf) equipment ~~and electrical substations~~ for the synchrotron and the storage ring. The four laboratory/office modules are similar metal-framed one-story buildings with insulated metal exterior panels and concrete floor slabs. 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-lock access to facilitate delivery of technical components.

1. Title and Location of Project:	6-7 GeV Synchrotron Radiation Source Argonne National Laboratory Argonne, Illinois	2a. Project No. 89-R-402 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

The utility support facility houses central 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.

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~~ 16-foot wide vehicle tunnel.

9. Purpose, Justification of Need For, 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 benefitted 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	2a. Project No. 89-R-402 2b. Construction Funded

9. Purpose, Justification of Need For, 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. 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 Council 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 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.

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.

1. Title and Location of Project:	2a. Project No. 89-R-402
6-7 GeV Synchrotron Radiation Source Argonne National Laboratory Argonne, Illinois	2b. Construction Funded

10. Details of Cost Estimate

	Total Cost
a. 1. Engineering, design, and inspection	$ 61,735
2. Construction management costs	11,910
b. Construction costs	
1. Technical components	209,571
2. Conventional facilities	136,632
Subtotal	419,848
c. Contingency	47,330
Total line item cost	$467,178

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. The 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

2a. Project No. 89-R-402
2b. Construction Funded

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

	Prior Years	FY 91	FY 92	FY 93	FY 94	FY 95	FY 96	FY 97	Total
a. Total project funding									
1. Total facility costs									
(a) Line item (Sec. 10).....	21,549	37,347	88,044	102,298	120,914	88,143	8,883	0	467,178
(b) Expense funded equipment.	0	0	0	0	0	0	0	0	0
(c) Inventories.....	0	0	400	4,000	2,900	0	0	0	7,300
Total direct cost.....	21,549	37,347	88,444	106,298	123,814	88,143	8,883	0	474,478
2. Other project costs									
(a) R&D necessary to complete construction...	26,798	14,332	17,265	21,626	12,500	7,500	0	0	100,001
(b) Other project related costs.....	0	0	6,115	11,021	40,300	59,500	80,900	7,322	205,178
(c) Capital equipment.....	3,800	1,500	1,500	9,000	6,100	3,900	3,000	0	28,800
(d) Conceptual design costs..	3,465	0	0	0	0	0	0	0	3,465
Total other project costs.....	34,063	15,832	24,880	41,647	58,900	70,900	83,900	7,322	337,444
Total project cost (TPC) (Items 1 & 2).....	55,612	53,179	113,324	147,945	182,714	159,043	92,783	7,322	811,922

b. Related annual funding a/ (estimated live of project: 20 years)

1. Facility operating costs b/	$61,000
2. Programmatic research	19,000
3. ES&H Costs	6,100
4. Maintenance Costs c/	2,000
5. Capital equipment related to programmatic research	2,625
6. Accelerator improvements	4,725
Total related annual funding	$95,450

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.
c/ Maintenance cost estimated at 2.5% of annual operating cost in FY 1997, building to 7% by FY 2000.

1. Title and Location of Project:	6-7 GeV Synchrotron Radiation Source Argonne National Laboratory Argonne, Illinois	2a. Project No. 89-R-402 2b. Construction Funded

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 costs

(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) Related annual funding

These costs provide support for staff, utilities, management, start-up, commissioning, and pre-operations 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.

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT

OVERVIEW

ADVANCED NEUTRON SOURCE (ANS)

Neutrons are extremely useful to study the structure and dynamics of materials, to produce certain isotopes, to understand radiation effects, and for other research. Because they are uncharged, neutrons can penetrate deeply into materials, and interact with the nuclei of atoms; thus, they afford a unique capability to study materials. From neutron scattering experiments, it is possible to obtain detailed information on a microscopic scale of the position of atoms in a material, and the manner in which these atoms move as the result of thermal excitations. Because the neutron possesses a magnetic moment, the location of atomic-scale magnetic moments can be obtained. The structural and magnetic information thus obtained by neutron experiments is essential to the understanding of materials and has been instrumental in the creation of new materials. Of particular importance is the impact made by neutron research on polymers and biological materials. The use of neutron scattering to investigate the microscopic characteristics and structures of polymers has increased exponentially in the past decade, and this trend continues at the present time. Neutrons, by virtue of their capability to determine accurately the position of hydrogen in macromolecular structures, provide unique methods to study the structure and function of, for example, receptor molecules in biological systems. These latter studies are, in turn, vital to the understanding of disease and human genetics. Neutrons are also needed to make transuranic and other isotopes which find important uses in such diverse areas as medical applications, aircraft radiography, residual stress analysis, the study of impurities and dopants in semiconductors, and the inspection of a variety of components of industrial equipment. Neutrons are also used for irradiation studies of materials for fusion and fission reactors, materials analysis, and nondestructive evaluation of materials.

Over the past two decades, a considerable erosion in the strength of the U.S. neutron capability has occurred relative to other industrialized countries. The two major U.S. high-flux reactors, the High Flux Beam Reactor at Brookhaven National Laboratory and the High Flux Isotope Reactor at Oak Ridge National Laboratory, were both constructed in the 1960's. The High Flux Beam Reactor was optimized for neutron scattering. The High Flux Isotope Reactor was optimized for isotope production; however, it also provides several scattering beam lines and facilities for materials irradiation. Since the 1960's, no new high-flux beam research reactor has been constructed in the U.S. In Europe, the situation is different. Major reactor facilities were constructed in 1971 and 1980 in France, and in 1982 and 1991 in Germany.

The strategy for the development of new, advanced research reactor facilities which serve a broad scientific community in the investigation of the structure of matter resulted from an evaluation by the National Research Council's Major Materials Facilities Committee. In 1984, this Committee recommended an advanced steady-state neutron facility. This recommendation was reaffirmed in 1985 by the Energy Research Advisory Board; in 1987 by the National Research Council's Physics Review Panel, the Energy Research Advisory Board's Physics Review Panel, and the Basic Energy Sciences Advisory Committee; in 1989 by the National Research Council's Materials Science and Engineering Committee; and in 1990 again by the Basic Energy Sciences Advisory Committee. More recently in 1993, the Basic Energy Sciences Advisory Committee's Panel on Neutron Sources provided the following recommendation:

"Recommendation 1: Complete the design and construction of the Advanced Neutron Source according to the schedule proposed by the project."

The Office of Energy Research currently supports a number of major user facilities, including the High Flux Isotope Reactor and the High Flux Beam Reactor, which provide neutrons for research. Both of these reactors were built in the 1960's and will approach the end of their useful lifetimes probably in the next decade. The Advanced Neutron Source would replace both reactors, provide increased research capability, and provide increased assurance of worker and public safety. The Advanced Neutron Source is an experimental facility designed to meet the Nation's need for an intense steady-state source of neutrons, as described above. The facility will be based on a new research reactor that will have the

most intense neutron beams in the world, exceeding its closest competitor by a factor of 5 to 10. The Advanced Neutron Source will be designed to meet the programmatic needs of the Department of Energy in condensed matter physics, chemistry, the biological sciences, materials science, polymer science, isotope production, and materials irradiation. In addition, it will function as a national facility open to researchers from universities, national laboratories, and industry. Based on the experience in Europe, it is anticipated that the Advanced Neutron Source will serve over 1,000 researchers per year.

The requested construction funds for ANS, $26,000,000 in FY 1994 and $1,242,865 over the next 5 years, are part of the President's Investment proposal.

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative in whole dollars).

LEAD TABLE

Advanced Neutron Source

Activity	FY 1992 Adjusted a/	FY 1993 Appropriation a/	FY 1993 Adjustment	FY 1994 Request
Operating Expenses	$0	$0	$0	$12,000
Capital Equipment	0	0	0	1000
Construction	0	0	0	26,000
Total	$0	$0	$0	$39,000
Summary				
Operating Expenses	0	0	0	12,000
Capital Equipment	0	0	0	1,000
Construction	0	0	0	26,000
Total Program	$0	$0	$0	$39,000
Staffing (FTE's)	(Included in Basic Energy Sciences Program Direction)			

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

a/ ANS is budgeted as part of the Basic Energy Sciences program in FY 1992 and FY 1993 ($24,095,000 in FY 1992 and $21,419,000 in FY 1993).

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

SUMMARY OF CHANGES

Advanced Neutron Source

FY 1993 Appropriation	$ 0
- Adjustments	0
FY 1993 Adjusted	0
Operating Expenses	+ 12,000

Provides research and development to further develop the design and provide the technical foundation for the Advanced Neutron Source.

Capital Equipment	+ 1,000

Provides funds for equipment associated with the Reactor Component Test Facility and the Safety Test Facility.

Construction	+ 26,000

Provides funds to begin Title I design of the Advanced Neutron Source.

FY 1994 Congressional Budget Request	$ 39,000

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

ADVANCED NEUTRON SOURCE (ANS)

I. Preface: Advanced Neutron Source, Research, Development and Operations

The Advanced Neutron Source Research and Development (R&D) Program provides support for research and development to further the design and provide the technical foundation for the ANS and its technical systems. The program currently has a strong focus on the design, fabrication, and testing of the fuel elements for the reactor. Also included are corrosion testing and analyses of potential fuel elements, the neutronic and thermal hydraulic design of the reactor core, and reactor kinetics studies. Specific experiments will be carried out such as the irradiation of aluminum in the High Flux Isotope Reactor and the development of a materials data base for reactor system components. Continued modelling and testing of components and concepts for sources of cold (long wavelength) neutron beams will be undertaken. Efforts to refine designs and concepts for scientific instruments and beam guides will be continued. Shielding calculations, design of reactor protection systems and sensor development will be carried out. Various activities such as thermal hydraulics testing, material certification, and flow blockage to support the safety analysis will be carried out.

This budget includes $12,000,000 in FY 1994 in support of Advanced Materials and Processing FCCSET activities.

II. A. Summary Table: Advanced Neutron Source, Research, Development and Operations

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Advanced Neutron Source, Research, Development and Operations	$ 0	$ 0	$ 12,000	>999
Total, Advanced Neutron Source, Research, Development and Operations	$ 0	$ 0	$ 12,000	>999

II. B. Major Laboratory and Facility Funding

OAK RIDGE NATIONAL LABORATORY	$ 0	$ 0	$ 12,000	>999

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

Program Activity	FY 1992	FY 1993	FY 1994
Advanced Neutron Source, Research, Development and Operations	This activity was funded in the Basic Energy Sciences program.	This activity is funded in the Basic Energy Sciences program.	The FY 1994 Research and Development (R&D) Program will be a continuation of designs, tests and modelling of ANS components in order to provide further results before the ANS goes into physical construction. Activities in FY 1994 will include fuel element R&D such as the irradiation of the second miniplate in the reflector region of the High Flux Isotope Reactor facility. Upper and lower fuel elements without uranium in fuel plates will be fabricated for use in core flow tests. The fabrication of fuel elements for use in ANS critical experiments will begin. Cold source tests will be performed. Dynamic tests of some reactor core elements, the control rods, and the reflector shutdown rods will be carried out. A study will be undertaken to examine the impact on the ANS performance goals if low or medium-enriched fuel is used rather than the highly enriched fuel used for the design. The study will build on existing information using currently developed fuels and focus on low (20%) and medium (35%) enriched fuel. Continue work on Environmental Impact Statement.
	$ 0	$ 0	$ 12,000
Advanced Neutron Source, Research, Development and Operations	$ 0	$ 0	$ 12,000

note!

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

ADVANCED NEUTRON SOURCE (ANS)

I. Preface: Capital Equipment

The ANS has specific capital equipment requirements in support of the research and development efforts on the many technical system components and for the engineering design of scientific instruments and systems which will exploit these neutron beams. Included are equipment to support control rod element testing and evaluation, the design and cold source component and loop tests, natural circulation test, transient low flow testing, and reactor component tests.

II. A. Summary Table: Capital Equipment

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Capital Equipment.....	$ 0	$ 0	$ 1,000	>999
Total, Capital Equipment	$ 0	$ 0	$ 1,000	>999

II. B. Major Laboratory and Facility Funding

OAK RIDGE NATIONAL LABORATORY	$ 0	$ 0	$ 1,000	>999

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

Program Activity	FY 1992	FY 1993	FY 1994
Capital Equipment	This activity was funded in the Basic Energy Sciences program.	This activity is funded in the Basic Energy Sciences program.	Funds are being provided for equipment associated with the Reactor Component Test Facility and the Safety Test Facility.
	$ 0	$ 0	$ 1,000
Capital Equipment	$ 0	$ 0	$ 1,000

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

ADVANCED NEUTRON SOURCE (ANS)

I. Preface: Construction

The Advanced Neutron Source will be a new reactor facility planned to meet national experimental needs for an intense, steady-state source of neutrons. It will be open for use by scientists from universities, industry, and other Federal laboratories. The Advanced Neutron Source research complex will be built around a new reactor with a fission power of approximately 330 megawatt.

A heavy-water cooled and moderated system using highly enriched uranium fuel is required to maximize performance. Alternative cores with enrichment levels of 20% and 35% will be examined for their impact on performance levels. The core is comprised of two right circular cylindrical elements which are coaxially aligned, separated on the vertical axis, and offset in radius such that unheated coolant enters each element. The core volume is approximately 67 liters. The core is positioned in a replaceable core pressure boundary tube which constitutes a section of the primary coolant loop piping. Surrounding the core pressure boundary tube is a reflector tank of heavy water, approximately 3 meters in diameter, which serves as a neutron reflector and moderator for the reactor and experimental systems. Materials irradiation and transuranic production targets are located inside the core pressure boundary tube near the core while beam tubes and other irradiation facilities are located in the reflector tank. For further moderation of neutrons to very low energies, the reflector tank will also contain two "cold sources." Each cold source is a helium-cooled cryostat containing a liquid deuterium moderator and serves as a source of cold neutrons.

There are four major buildings planned for the Advanced Neutron Source complex. The central structure is an approximately 60-meter-diameter cylindrical, domed reactor containment building. This building houses the reactor itself, with the first floor dedicated to beam and irradiation experiments, the second floor divided between experimental facilities and reactor operations, and a high bay floor dedicated to reactor operations. Adjacent to the reactor building is a reactor support building. This structure houses other large reactor equipment and the general support equipment which need not be located in the reactor building. Also connected to the reactor building is the guide hall. This structure, outside of reactor containment, is dedicated to beam experiments and will be equipped with an initial complement of advanced instruments for neutron scattering. The fourth building in the complex is an office building, serving both the extensive user community and the reactor operations staff. A number of state-of-the-art experimental systems will be provided to make use of the intense neutron beams from the Advanced Neutron Source. These would include beam transport systems, monochrometers, sample chambers, detectors, and the necessary electronics.

This budget includes $26,000,000 in FY 1994 in support of Advanced Materials and Processing FCCSET activities.

II. A. Summary Table: Construction

Program Activity	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
Construction	$ 0	$ 0	$ 26,000	>999
Total, Construction	$ 0	$ 0	$ 26,000	>999

II. B. Major Laboratory and Facility Funding

	FY 1992 Enacted	FY 1993 Enacted	FY 1994 Request	% Change
OAK RIDGE NATIONAL LABORATORY	$ 0	$ 0	$ 26,000	>999

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

Program Activity	FY 1992	FY 1993	FY 1994
Construction	No activity.	No activity.	Provides necessary funds to begin Title I design of the Advanced Neutron Source (ANS). Funding for this project is part of the President's Investment proposal.
	$ 0	$ 0	$ 26,000
Construction	$ 0	$ 0	$ 26,000

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

IV. A. Construction Project Summary

Project No.	Project Title	Previous Obligations	FY 1993 Appropriated	FY 1994 Request	Unappropriated Balance	TEC
94-E-308	Advanced Neutron Source	$ 0	$ 0	$ 26,000	$ 2,113,329	$ 2,139,329
	Total, Advanced Neutron Source	$ 0	$ 0	$ 26,000	$ 2,113,329	XXX

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 94-E-308 Advanced Neutron Source
Oak Ridge National Laboratory
Oak Ridge, Tennessee

TEC: $2,139,329
TPC: $2,748,900

Start Date: 1st Qtr. FY 1996 Completion Date: 4th Qtr. FY 2002

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriated	Obligations	Costs
1994	$ 26,000	$ 26,000	$ 26,000
1995	88,616	88,616	67,415
1996	168,532	168,532	124,829
1997	359,473	359,473	249,945
1998	600,244	600,244	507,683
1999	472,757	472,757	555,762
2000	257,174	257,174	387,407
2001	146,130	146,130	189,087
2002	20,403	20,403	31,201

3. Narrative: The Advanced Neutron Source will be a new reactor facility planned to meet national experimental needs for an intense, steady-state source of neutrons. It will be open for use by scientists from universities, industry, and other Federal laboratories. The Advanced Neutron Source research complex will be built around a new reactor with a fission power of approximately 330 megawatt.

There are four major buildings for the Advanced Neutron Source complex. The central structure is an approximately 60-meter-diameter cylindrical, domed reactor containment building. This building houses the reactor itself, with the first floor dedicated to beam and irradiation experiments, the second floor divided between experimental facilities and reactor operations, and a high bay floor dedicated to reactor operations. Adjacent to the reactor building is a reactor support building. This structure houses other large reactor equipment and the general support equipment which need not be located in the reactor building. Also connected to the reactor building is the guide hall. This structure, outside of reactor containment, is dedicated to beam experiments and will be equipped with an initial complement of advanced instruments for neutron scattering. The fourth building in the complex is an office building, serving both the extensive user community and the reactor operations staff. A number of state-of-the-art experimental systems will be provided to make use of the intense neutron beams from the Advanced Neutron Source. These would include beam transport systems, monochrometers, sample chambers, detectors, and the necessary electronics.

4. Total Project Funding (BA):

	Prior Years	FY 1992	FY 1993	FY 1994 Request	To Complete
Construction	$ 0	$ 0	$ 0	$ 26,000	$ 2,113,329
Capital Equipment	3,500	1,000	860	1,000	22,589
Operating Expenses	37,281	23,095	20,559	12,000	487,687

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1993 Congressional Budget Request are denoted with a vertical line in left margin.)

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

IV. A. Construction Project Summary

Project No.	Project Title	Previous Obligations	FY 1993 Appropriated	FY 1994 Request	Unappropriated Balance	TEC
94-E-308	Advanced Neutron Source	$ 0	$ 0	$ 26,000	$ 2,113,329	$ 2,139,329
	Total, Advanced Neutron Source	$ 0	$ 0	$ 26,000	$ 2,113,329	XXX

IV. B. Construction Funded Project Descriptive Summary

1. Project Title and Location: Project 94-E-308 Advanced Neutron Source
Oak Ridge National Laboratory
Oak Ridge, Tennessee

TEC: $2,139,329
TPC: $2,748,900

Start Date: 1st Qtr. FY 1996 Completion Date: 4th Qtr. FY 2002

2. Financial Schedule (Federal Funds):

Fiscal Year	Appropriated	Obligations	Costs
1994	$ 26,000	$ 26,000	$ 26,000
1995	88,616	88,616	67,415
1996	168,532	168,532	124,829
1997	359,473	359,473	249,945
1998	600,244	600,244	507,683
1999	472,757	472,757	555,762
2000	257,174	257,174	387,407
2001	146,130	146,130	189,087
2002	20,403	20,403	31,201

3. Narrative: The Advanced Neutron Source will be a new reactor facility planned to meet national experimental needs for an intense, steady-state source of neutrons. It will be open for use by scientists from universities, industry, and other Federal laboratories. The Advanced Neutron Source research complex will be built around a new reactor with a fission power of approximately 330 megawatt.

There are four major buildings for the Advanced Neutron Source complex. The central structure is an approximately 60-meter-diameter cylindrical, domed reactor containment building. This building houses the reactor itself, with the first floor dedicated to beam and irradiation experiments, the second floor divided between experimental facilities and reactor operations, and a high bay floor dedicated to reactor operations. Adjacent to the reactor building is a reactor support building. This structure houses other large reactor equipment and the general support equipment which need not be located in the reactor building. Also connected to the reactor building is the guide hall. This structure, outside of reactor containment, is dedicated to beam experiments and will be equipped with an initial complement of advanced instruments for neutron scattering. The fourth building in the complex is an office building, serving both the extensive user community and the reactor operations staff. A number of state-of-the-art experimental systems will be provided to make use of the intense neutron beams from the Advanced Neutron Source. These would include beam transport systems, monochrometers, sample chambers, detectors, and the necessary electronics.

4. Total Project Funding (BA):

	Prior Years	FY 1992	FY 1993	FY 1994 Request	To Complete
Construction	$ 0	$ 0	$ 0	$ 26,000	$ 2,113,329
Capital Equipment	3,500	1,000	860	1,000	22,589 — 23,589
Operating Expenses	37,281	23,095	20,559	12,000	487,687
					12
					499,687

2258

DEPARTMENT OF ENERGY
FY 1994 CONGRESSIONAL BUDGET REQUEST

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

Basic Energy Sciences 1/

1. Title and Location of Project: Advanced Neutron Source (ANS)
Oak Ridge National Laboratory (ORNL)
Oak Ridge, Tennessee

2a. Project No. 94-E-308
2b. Construction Funded

3a. Date A-E Work Initiated, (Title I Design Start Scheduled): 1st Qtr. FY 1994

3b. A-E Work (Title I, II, III) Duration: 108 months

4a. Date Physical Construction Starts: 1st Qtr. FY 1996

4b. Date Construction Ends. 4th Qtr. FY 2002

5. Previous Cost Estimate: None

6. Current Cost Estimates:
TEC: $2,139,329
TPC: $2,748,900

7. Financial Schedule (Federal Funds):

Fiscal Year	Appropriations	Obligations	Costs
1994	26,000	26,000	26,000
1995	88,616	88,616	67,415
1996	168,532	168,532	124,829
1997	359,473	359,473	249,945
1998	600,244	600,244	507,683
1999	472,757	472,757	555,762
2000	257,174	257,174	387,407
2001	146,130	146,130	189,087
2002	20,403	20,403	31,201

1/ The Office of Energy Research is the sponsoring (funding) office while the Assistant Secretary for Nuclear Energy will be responsible for project management and execution.

1. Title and Location of Project:	Advanced Neutron Source (ANS) Oak Ridge National Laboratory (ORNL) Oak Ridge, Tennessee	2a. Project No. 94-E-308 2b. Construction Funded

8. Brief Physical Description of Project

The Advanced Neutron Source (ANS) is a new experimental facility planned to meet the national need for an intense, steady-state source of neutrons. It will be open to use by scientists from universities, from industry, and from other federal laboratories. The ANS will be equipped with an initial complement of instruments for neutron scattering and nuclear physics research, isotope production, and materials irradiation.

The facility will be built around a new research reactor of unprecedented flux that will have the most intense beams of steady-state neutrons in the world--a minimum of five to ten times higher than the current world leader at the Institute Laue-Langevin (ILL) in Grenoble, France. The higher source flux and improved instruments and detectors will create a useful neutron flux that is at least ten times and, for certain experiments, more than one hundred times, higher than is now available in the United States. When fully instrumented, there will be three times as many scattering instruments as there are at either of the present high-flux reactors so that the scientific output can be much more than 10 times greater than that at the High Flux Isotope Reactor (HFIR) at Oak Ridge and the High Flux Beam Reactor (HFBR) at Brookhaven together. The potential also exists for the development of entirely new lines of scientific research based on the advanced capabilities that will be available in the ANS.

In addition to meeting the DOE programmatic needs, this will be a national facility with an open user policy attractive to scientists from universities, other national laboratories, and industry. It is anticipated that the ANS would be used by approximately 1000 different individuals each year for neutron scattering experiments in solid state physics, chemistry, metallurgy, ceramics, polymers, colloids, biology, and nuclear physics. In addition, a wide community of isotope and materials irradiation users will also be supported both on-site and throughout the world.

The primary objectives in the design of the site and buildings for the ANS are to provide a protective containment structure for the reactor, to provide the optimal instruments for utilization of neutron beams and irradiation studies, and to address the mix of needs associated with the user community, the operations staff, security, contamination control, noise, etc.

1. Title and Location of Project:	Advanced Neutron Source (ANS) Oak Ridge National Laboratory (ORNL) Oak Ridge, Tennessee	2a. Project No. 94-E-308 2b. Construction Funded

8. Brief Physical Description of Project (Continued)

The objectives stated above are being met with a four major building concept. The central structure is an approximately 60 m (200 ft.) diameter cylindrical, domed, reactor containment building. This building houses the reactor itself, with lower floors dedicated to beam and irradiation experiments, and a high bay floor dedicated to reactor operations. The entire primary cooling circuits are located in cell banks in reactor containment. Adjacent to the containment building is a reactor support building. This structure houses other large reactor and general support equipment which need not be located in containment.

Also connected to the reactor dome is the guide hall. This structure, outside of reactor containment, is dedicated to cold neutron beam experiment use. The fourth building in this complex is an office building, serving both the extensive user community and the permanent staff. Other ancillary structures associated with facility operations will be located in proximity to the basic four building complex.

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

All studies of U. S. facilities used for conducting research in neutron scattering and other fields of materials science have shown the facilities do not have state-of-the-art capabilities. The most significant studies supporting this finding were the Seitz/Eastman committee of the National Academy on Major Materials Facilities (1984) and the DOE Energy Research Advisory Board (1985). Both recommended an immediate start on development and design work for a new advanced steady state neutron source. More recently the Basic Energy Sciences Advisory Commission (BESAC) Panel on Neutron Sources concluded the ANS was the Panel's highest priority for rapid construction.

The purpose of the ANS project is to provide a research reactor with unsurpassed capability for scientific experiments. The ANS will provide for very greatly enhanced neutron scattering research in condensed matter physics, chemistry, biology, materials science, and polymer science. It will also replace and enhance the High Flux Isotope Reactor's capabilities for production of transuranium elements, for irradiation test facilities and abundant fast neutrons required for fusion reactor materials research and development.

If the ANS is not supported, the United States will not be capable of performing state-of-the-art research and will fall further behind the Europeans, whose existing reactors are superior to those in the U.S. Further, existing major U.S. reactors (HFIR, HBFR) are expected to be retired in the next decade. The specific impact for

1. Title and Location of Project:	Advanced Neutron Source (ANS) Oak Ridge National Laboratory (ORNL) Oak Ridge, Tennessee	2a. Project No. 94-E-308 2b. Construction Funded

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

not supporting this request is an increase in the likelihood that the U.S. will be without any of these research capabilities and will not be able to preserve a minimum level of U.S. competitiveness in the areas based on this important area of research.

The scope of this project is defined by the requirements for neutron flux and materials irradiation consistent with the recommendations contained in the studies mentioned earlier. This requires the design and construction of a new research reactor to meet the defined national need for an intense, steady-state source of neutrons.

10. Details of Cost Estimate

			Total Cost
a.	1. Engineering, design, and inspection at approx. 16.8% of construction costs, Item b.....		$223,578
	2. Construction management costs.....		205,676
b.	Construction costs:.....		1,327,670
	1. Land improvements.....	45,568	
	2. Building costs.....	43,739	
	3. Other structures.....	18,745	
	4. Special facilities.....	1,195,035	
	5. Outside utilities.....	24,583	
c.	Standard equipment.....		15,844
	Subtotal.....		1,772,768
d.	Contingency at approximately 20.7% of above costs.....		366,561
	Total line item cost.....		$2,139,329

1. Title and Location of Project:	Advanced Neutron Source (ANS) Oak Ridge National Laboratory (ORNL) Oak Ridge, Tennessee	2a. Project No. 94-E-308 2b. Construction Funded

11. Method of Performance

The ORNL Management and Operating Contractor will subcontract for the services of a Prime Contractor, teamed with an Architect-Engineer for the balance-of-plant, a Reactor Manufacturer for reactor systems, and a Construction Manager. To the extent feasible, construction and procurement will be accomplished by fixed-priced subcontracts awarded on the basis of competitive bidding.

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

	Prior Years	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	TOTAL
a. Total project funding											
1. Total facility costs											
(a) Line item (Sec. 10).	0	26,000	67,415	124,829	249,945	507,683	555,762	387,407	189,087	31,201	2,139,329
(b) Expense funded equipment											
(c) Inventories.....								a/			
Total direct cost...	0	26,000	67,415	124,829	249,945	507,683	555,762	387,407	189,087	31,201	2,139,329
2. Other project costs											
(a) R&D necessary to complete construction.....	36,200	12,000	26,056	27,725	27,402	16,825	8,766	5,511	2,040	200	162,725
(b) Conceptual design costs.....	44,673										44,673
(c) Other project related costs.....				3,613	12,327	21,381	29,563	58,845	100,651	146,782	373,162
(d) DOE site office support subcontracts.....	62										62
(e) Capital equipment not related to construction	5,360	1,000	5,572	4,016	3,849	3,397	2,734	1,971	426	624	28,949
Total other project Costs.....	$86,295	13,000	31,628	35,354	43,578	41,603	41,063	66,327	103,117	147,606	609,571
Total project cost (TPC)...	$86,295	39,000	99,043	160,183	293,523	549,286	596,825	453,734	292,204	178,807	2,748,900

a/ Value of Heavy Water (D_2O) (assumed to be supplied in this year from existing government stocks) not included.

1. Title and Location of Project:	Advanced Neutron Source (ANS) Oak Ridge National Laboratory (ORNL) Oak Ridge, Tennessee	2a. Project No. 94-E-308 2b. Construction Funded

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

	TOTAL
b. Related annual funding (Estimated Life: 40 Years) a/	
1. Facility operating costs	$119,687
2. Programmatic operating expenses directly related to the facility	57,937
3. Capital equipment not related to construction but related to the programmatic effort in the facility	848
4. GPP or other construction related to the programmatic effort in the facility	0
5. Accelerator reactor improvement modifications (ARIM)	2,448
6. Other costs	0
Total related annual funding	$180,920 b/

a/ Estimated costs in thousands escalated to 2003-year dollars.

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

a. Total project funding

1. Total facility costs

(a) Line item

The estimated costs for this data sheet are for providing Title I and II design, inspection and construction of the ANS facility.

(b) Expense funded equipment

No narrative required

b/ These costs will be offset by savings from closing down HFIR and HFBR. The annual operating costs of these facilities escalated to 2003 dollars is $72,500,000.

1. Title and Location of Project:	Advanced Neutron Source (ANS) Oak Ridge National Laboratory (ORNL) Oak Ridge, Tennessee	2a. Project No. 94-E-308 2b. Construction Funded

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

(c) Inventories

No narrative required

2. Other Project Costs

(a) R&D necessary to complete construction

A research and development program is needed to confirm several design bases related primarily to the reactor core performance, system control concepts, cold source designs, and neutron guides, beam tubes, and instruments. Several of these development tasks require long time durations to resolve detailed life cycle characteristics and the timely coupling of development results into the design is a major factor in detailed task planning. A detailed R&D plan has been prepared which defines each specific task and the interface requirements and timing relationships to the ANS project.

(b) Conceptual design costs

Costs are included for preparation of the conceptual design documentation and for one year of advanced conceptual design prior to the start of Title I design in FY 1994.

(c) Other project related costs

Costs in this category include one-third of the full complement of instruments which were not included in the line item and for buildup of the operations staff participation in the design, construction, and test and checkout phases of the project.

(d) DOE site office support

Subcontractor support costs for the DOE-OR project office are included in this item.

1. Title and Location of Project:	Advanced Neutron Source (ANS) Oak Ridge National Laboratory (ORNL) Oak Ridge, Tennessee	2a. Project No. 94-E-308 2b. Construction Funded

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

(e) Capital equipment not related to construction but related to the programmatic effort in the facility. Estimated costs are to provide test facilities for use in development of cold sources, evaluation of core flow blockage, natural convection cooling and flow induced vibration of components. In addition, equipment and facilities supporting structural testing of the fuel elements as well as reactor control components evaluation and major equipment items evaluation is required.

b. Related annual funding:

1. Facility operating costs

The annual facility operating costs expressed in FY 2003 dollars include all operations, Quality Assurance and support staff and the annual utility costs.

2. Programmatic operating expenses directly related to the facility

The costs included in this category are those related to support for the users of the ANS facility.

3. Capital equipment not related to construction but related to the programmatic effort in the facility. Costs included are intended to reflect probable replacement parts for capital equipment with moving parts.

4. GPP or other construction related to the programmatic effort in the facility

No narrative required

5. Other costs

No narrative required