DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT

OVERVIEW

BASIC ENERGY SCIENCES

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

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

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

BES sponsored research provides the foundation for research in each 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 ceramic material may be applied to energy systems whether they be fossil, nuclear, automotive, or may serve as the most effective way to store radioactive waste. Improved high temperature superconducting materials also hold this same potential to 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 similar research projects which

have applications across a broad range of energy technologies. Whether we are trying to burn coal cleaner, or more cheaply find ways to reduce the overall volume or hazards from wastes, whether nuclear or non-nuclear, each of these problems will ultimately depend on the results from basic research and the applications of those results in the various energy technologies. The BES program supports research in several ways.

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

Many areas of modern science require large and costly facilities; without them, the necessary advanced research could not be done. These 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, funding of about 1,500 users from all scientific disciplines and programs resulted in approximately 790 publications for FY 1988. The number of users has grown to 2,000 in FY 1989 and 2,800 for FY 1990. BES also provides 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 energy and technology in this country, one only has to look at the list of users at the facilities. For example, at the light sources, the largest U.S. companies (e.g., IBM, AT&T, Exxon, GM) have major research teams doing research in areas such as catalysis, electronics, polymers, and biomedicine. The research results are important not only to those companies, but also to the DOE. At the neutron sources, major oil companies are doing research in porosity of formations and neutron spectroscopy of hydrocarbons in cores and in coal. The Basic Energy Sciences program also supports research in radiation effects on materials important to fission, fusion, and radioactive waste technology.

The BES strategy continues to be:

- Provide critical knowledge and data by supporting basic research relevant to DOE mission areas;
- Provide and support operation of unique, specialized research facilities;
- Exchange information with other DOE programs, Federal agencies, and the academic and industrial scientific communities;
- Take full advantage of the scientific and industrial communities' identification of needs and opportunities for research in areas likely to be relevant to future energy options;
- Develop trained scientific talent through support of basic research at universities and national laboratories; and
- Promote early applications of the results of basic research.

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 three major components: research, facility operations, and construction. Research, the largest component, is supported at national laboratories, universities and other institutions. More than one-third 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 operations component supports the operations of major user facilities for which access by qualified users is provided to the scientific community. The third component is the construction of facilities needed by the Department and the Nation.

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

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

The FY 1992 request continues the strong base program which is underway in FY 1991. The program includes a provision for a cost-of-living increase for each of the BES subprograms. In addition, consistent with the schedules for the two new synchrotron construction projects, preconstruction R&D funds are increasing. The requested level also provides for limited relief in two BES subprograms, Energy Biosciences, and Engineering and Geosciences. Limited increases in these research areas are required to respond to research opportunities and to restore these research areas after several years of restricted funding. The budget request also provides funds to continue research and development for the Advanced Neutron Source at the Oak Ridge National Laboratory and will permit the completion of a conceptual design for this facility. The final provision in the budget request proposes an aggressive DOE contribution to the President's High Performance Computing and Communications Program initiative. The DOE Energy Research program has been a leader in the recognition and use of high performance computing both to solve previously intractable problems and also as an experimental tool for research. DOE, therefore, is uniquely positioned to provide a leadership role in this initiative.

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

LEAD TABLE

Basic Energy Sciences

Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Base	FY 1992 Request	Program Change Request vs Base	
					Dollar	Percent
Operating Expenses						
Materials Sciences	$196,200	$274,946	$228,127	$257,116	+ 28,989	+ 13
Chemical Sciences	138,466	157,585	157,585	158,300	+ 715	+ 1
Applied Mathematical Sciences	43,173	52,704	52,704	75,500	+ 22,796	+ 43
Engineering and Geosciences	32,801	34,299	32,310	35,800	+ 3,490	+ 11
Advanced Energy Projects	14,408	24,855	9,136	10,800	+ 1,664	+ 18
Energy Biosciences	20,389	22,075	22,075	24,700	+ 2,625	+ 12
Program Direction	5,374	6,058	7,240	7,500	+ 260	+ 4
Subtotal Operating Expenses	450,811	572,522	509,177	569,716	+ 60,539	+ 12
Capital Equipment	36,486	36,804	36,158	37,000	+ 842	+ 2
Construction	76,833	102,434	102,434	107,984	+ 5,550	+ 5
Total	$564,130 a/	$711,760 b/	$647,769 c/	$714,700	+ 66,931	+ 10

a/ Total has been reduced by $5,707,000 which has been transferred to the SBIR program.
b/ Includes $9,575,000 for education programs funded in the Atomic Energy Defense Activities account.
c/ Adjusted by $5,976,000 for transfer of Heavy Ion Fusion Research to Fusion Energy and $59,197,154 for FY 1991 Congressionally directed projects.

	FY 1990 Actual	FY 1991 Estimate	FY 1992 Base	FY 1992 Request	Program Change Request vs Base	
					Dollar	Percent
Operating Expenses	(450,811)	(572,522)	(509,177)	(569,716)	+ 60,539	+ 12
Capital Equipment	(36,486)	(36,804)	(36,158)	(37,000)	+ 842	+ 2
Construction	(76,833)	(102,434)	(102,434)	(107,984)	+ 5,550	+ 5
Staffing (FTEs)						
Headquarters	67	70	66	68	+ 2	+ 3
Field	0	0	2	3	+ 1	--
Total	67	70	68	71	+ 3	+ 4

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

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

SUMMARY OF CHANGES

Basic Energy Sciences

FY 1991 Enacted Appropriation	$ 711,760
Comparability Adjustments	
- Advanced Energy Projects - OE and CE for the Heavy Ion Fusion Research program transferred to Fusion Energy	- 5,976
- Program Direction - OE transfer of two FTEs for the Field from Departmental Administration, OE transfer of two Headquarters FTEs to Advisory and Oversight and 2 Headquarters FTEs to Superconducting Super Collider Program Direction	- 235
FY 1992 Base Adjustments	
Pay Cost Increase	+ 1,417
Congressionally Directed Projects	- 59,197
FY 1992 Major Program Changes	
Materials Sciences	+ 28,989
Provides for a cost of living increase necessary to continue support of research at the FY 1991 level; provides for continued support at each of the major BES user facilities; provides for continued research and development and funds for the completion of a conceptual design for the Advanced Neutron Source; and provides for planned increases for operations and research and development on the 1-2 GeV and 6-7 GeV Synchrotron Radiation Sources.	
Chemical Sciences	+ 715
Provides for a cost of living increase necessary to continue support of research at the FY 1991 level and provides for continued support at each of the major BES facilities.	

Applied Mathematical Sciences Provides funding for the DOE contribution to the President's High Performance Computing and Communications Program initiative.	+ 22,796
Engineering and Geosciences Provides for modest growth in research necessary to respond to promising proposals in the areas of interest to energy systems.	+ 3,490
Advanced Energy Projects Provides for a cost of living increase necessary to continue support of research at the FY 1991 level and restores the core program to permit expanded research in payoff areas.	+ 1,664
Energy Biosciences Provides for modest growth in research necessary to respond to promising proposals in the area of energy biosciences.	+ 2,625
Program Direction Provides for two additional Headquarters FTEs and one additional Field FTE.	+ 260
Capital Equipment Continues equipment levels necessary in support of each of the BES subprograms.	+ 842
Construction Continues support for ongoing construction projects: 1-2 GeV Synchrotron Radiation Source, 6-7 GeV Synchrotron Radiation Source, Accelerator Improvements Projects and General Plant Projects.	+ 5,550
FY 1992 Congressional Budget Request	$ 714,700

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Materials Sciences

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

Groups of multidisciplinary researchers work together guided by opportunities within the general goals set forth by the subprogram. Current goals include uncovering the information needed to: develop new or substitute materials that improve performance or efficiency in energy systems; tailor materials properties to satisfy defined requirements such as improved corrosion resistance in fossil plants or radiation resistance in fusion plants; predict materials problems and service life to improve safety and reliability of components in energy systems; and improve the theoretical and experimental capability to analyze the fundamental structure and behavior of materials. Related to these goals is the support provided for major user facilities which are available to the entire scientific community for research. Coordination among the various materials research efforts within DOE and with other agencies is considered essential. Within DOE this takes place primarily through the Energy Materials Coordinating Committee (EMaCC) and with other agencies through the Committee on Materials (COMAT). Within the Materials Sciences subprogram, research is undertaken in the major areas of metallurgy and ceramics, solid state physics and materials chemistry. Some examples of research accomplishments during the past year include: high critical currents at high magnetic fields were demonstrated in thin films of high-temperature superconductors, first experimental determination of the Fermi band structure of the normal state of high-temperature superconductors, synthesis of a new class of polymers from which ceramic fibers can be made, demonstrated that grazing angle neutron diffraction from near-surface atomic layers is feasible which will allow studies of magnetic thin films, achieved realistic simulation of weld melt penetration for a wide range of steel composition and process conditions, established the radiation induced segregation mechanism responsible for stress-corrosion cracking in materials for nuclear reactors, and demonstrated that a zirconium dioxide based ceramic composite could be rapidly deformed to near-net shape in a single step.

II. A. Summary Table: Materials Sciences

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Materials Sciences Research	$ 140,291	$ 150,508	$ 156,674	+ 4
Facilities Operations	55,909	77,619	100,442	+ 29
Congressionally Directed Projects	0	46,819	0	-100
Total, Materials Sciences	$ 196,200	$ 274,946	$ 257,116	- 6

II. B. Major Laboratory and Facility Funding

Ames Laboratory	$ 9,118	$ 9,138	$ 9,138	0
Argonne National Laboratory	$ 31,900	$ 37,694	$ 48,200	+ 28
Brookhaven National Laboratory	$ 40,468	$ 49,612	$ 52,794	+ 6
Idaho National Engineering Laboratory - EG&G	$ 323	$ 297	$ 297	0
Lawrence Berkeley National Laboratory	$ 21,106	$ 25,856	$ 34,888	+ 35
Lawrence Livermore National Laboratory	$ 0	$ 3,547	$ 1,811	- 49
Los Alamos National Laboratory	$ 11,052	$ 11,688	$ 12,087	+ 3
Oak Ridge National Laboratory	$ 29,713	$ 33,252	$ 45,597	+ 37
Pacific Northwest Laboratory	$ 2,493	$ 2,463	$ 2,463	0
Sandia National Laboratories	$ 7,546	$ 7,865	$ 7,676	- 2

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Materials Sciences			
Materials Sciences Research	Metallurgy and Ceramics Research - Continued emphasis on processing and understanding structure-property relationships of new high-temperature superconductors. Efforts on improved theoretical approaches to predict the behavior of advanced energy related materials such as high-performance alloys and ceramics. Research on bonding and adhesion of interfaces, and of compound semiconductors continued. Significantly reduced levels of effort on the properties of artificially tailored materials and intermetallic compounds. Some increase in radiation effects.	Metallurgy and Ceramics Research - Continuation of effort on understanding processing-structure-property relationships in ceramic superconductors and intermetallic compounds. Continue efforts on theoretical approaches to high performance metals and ceramics, structure-behavior relationships and interfacial bonding and adhesion. Continued reduction of effort on artificially tailored materials compounds. Increase in research on radiation effects on materials.	Metallurgy and Ceramics Research - Continue effort on understanding processing-structure-property relationships in ceramic superconductors. Continue efforts on theoretical approaches to high performance metals and ceramics, structure-behavior relationships and interfacial bonding and adhesion. Continued reduction of effort on artificially tailored materials, high temperature reactions and intermetallic compounds. Increase in research on radiation effects.
	Solid State Physics Research - Sustained thrust via interlaboratory program and university grants for research on solid state physics of high temperature superconductivity. Continued thrust using neutrons and synchrotron radiation for accurate studies of structure, dynamics and electronic configurations of materials. Continued research emphasizing use of synchrotron radiation, tunneling microscopy, ion and molecular beams and other new tools and probes for preparation, characterization and modification of thin films and surfaces. Maintained strength of research effort on a priority basis.	Solid State Physics Research - Continue selected efforts and priority research largely unique to DOE, such as in neutron scattering and synchrotron radiation. Continue effort on physics of high temperature superconductivity. New effort on field responsive polymeric materials. Continue efforts on solid state physics of surfaces and interfaces. Research on solid state physics of novel materials with energy-related properties and behavior. Increased effort on physics of radiation effects.	Solid State Physics Research - Reduction of selected efforts and continuation of priority research largely unique to DOE, such as in neutron scattering and synchrotron radiation. Continue effort on physics of high temperature superconductivity. Continue effort on physics of radiation effects. Continue effort on field responsive polymeric materials, solid state theory, and novel characterization methods. Continue efforts on solid state physics of surfaces and interfaces and on solid state physics of novel materials with energy-related properties and behavior.
	Preconstruction R&D - Continued R&D on ANS.	Preconstruction R&D - R&D Support for ANS.	Preconstruction R&D - R&D support for ANS continued with additional funds provided for the completion of a conceptual design for the facility.

III. Materials Sciences (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Materials Sciences Research (Cont'd)	Materials Chemistry Research - Continue research on new high temperature oxide superconductors as well as organic superconductors emphasizing new synthetic routes to novel, single phase superconductors with improved critical parameters. Continued emphasis on the synthesis of new materials especially using modified or synthetic enzymes to make materials with tailored properties. Research continued on organic and polymeric materials emphasizing electronic and magnetic properties of synthetic metals, semiconductors, and insulators and also including high strength polymer synthesis. Continued base program in chemical structure, surface chemical properties and polymer research with emphasis on structural chemistry at solid-fluid interfaces.	Materials Chemistry Research - Strong emphasis on organic synthesis for synthetic metals, polymer electrolytes, high strength polymer systems, enzymatic synthesis, and the materials chemistry of high temperature superconductors. Synthesis and characterization of other novel materials of long range interest for energy systems, in cooperation with other Division programs. Increased emphasis on study of cooperative interactions of molecular species on surfaces.	Materials Chemistry Research - Continue emphasis on novel organic and inorganic materials synthesis and characterization with focus on ceramic superconductors, organic superconductors, synthetic metals, high strength polymers, polymer electrolytes, inorganic polymers, preceramic materials, and novel materials synthesized using biological processes. Increased emphasis on the materials chemistry of macromolecules at interfaces and of polymer interfaces. Continue research program in chemical structure, surface chemical properties, and polymer research.
	Implemented plans for the Energy Sciences Network (ESNET) project as identified in the Applied Mathematical Sciences subprogram. This subprogram's share for the implementation of ESNET was $236,000.	Upgrades of ESNET to conform to the National Research and Education Network standards will continue to be implemented; funding will be shared among ER programs that benefit from ESNET. This subprogram's share is $247,000.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram.
	$ 140,291	$ 150,508	$ 156,674

III. Materials Sciences (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Facilities Operations	Continued support of national user facilities. Continue preconstruction R&D for the 1-2 GeV and the 6-7 GeV light sources. Increased demands at the national user facilities required a higher operational level at each of the facilities. Increased funding was provided for safety, utility costs, safeguards requirements, and increased user requirements for each of the facilities supported by the Materials Sciences subprogram.	Increased support for major facilities in the Materials Sciences subprogram. Increased funding for uranium conversion and enrichment, heavy water costs, and safety requirements at HFBR. Increased support for R&D and commissioning of components at 1-2 GeV and 6-7 GeV light sources.	Continue support for major facilities in the Materials Sciences subprogram. Increased funding for safety requirements at HFBR. Increased support for R&D and commissioning of components at 1-2 GeV and 6-7 GeV light sources.
	$ 55,909	$ 77,619	$ 100,442
Congressionally Directed Projects	No activity.	Funding provided for Congressionally directed projects, including $2,982,600 for the Technical and Administrative Services Facility at Ames Laboratory.	Funding for the Technical and Administrative Services Facility at Ames Laboratory is budgeted for in the Multiprogram Energy Laboratories - Facilities Support program.
	$ 0	$ 46,819	$ 0
Materials Sciences	$ 196,200	$ 274,946	$ 257,116

Percentage Breakdown by Performer			
Laboratory	52%	41%	46%
University	19%	29%	13%
Industrial/Other	1%	2%	2%
Facility Operations	28%	28%	39%
Subtotal	100%	100%	100%
Number of Researchers Supported	1,045	1,065	1,035

DEPARTMENT OF ENERGY
FY 1992 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 basic research across a broad front of chemistry and atomic physics necessary for the future development of energy technologies. Research includes photochemistry important to the conversion of light energy to fuels or electricity, chemical physics related to combustion processes and more efficient utilization of fossil resources, atomic physics important to fusion concepts, heavy element chemistry important to waste management, organic chemistry as well as heterogeneous and homogeneous catalysis related to coal conversion and better processes for the production of fuels and bulk chemicals, separations and analytical science related to almost every facet of process chemistry and nuclear energy technology, and chemical thermodynamics for predicting physical properties of complex hydrocarbon mixtures such as fuels. Basic research in these areas of chemistry related to the development of environmentally safe energy technologies and innovative approaches to waste management and cleanup are also supported. Recent noteworthy examples of research results that may have important technological impact can be cited. Basic research in the chemical dynamics and kinetics of alcohol combustion has led to new insight into the mechanism of this important reaction. Studies of the lifetimes of electrons in organic liquids is providing results necessary for the development of high energy physics detectors. Research in mass spectroscopy is producing innovations that are being applied to the detection of explosives, improved sensitivity of commercial mass spectrometers and novel couplings between mass spectrometers and other analytical techniques. The synthesis and characterization of new complexing agents is pointing to many new applications including the removal of metals from waste streams and ground waters and the analysis of sodium and potassium in serum. Research on the generation and acceleration of heavy water cluster ions has even led to the observation of deuterium - deuterium fusion under unusual conditions. Support is also provided to major user facilities which are available to the entire scientific community for research. The budget for the Chemical Sciences subprogram was affected in a significant way in FY 1990 and FY 1991 by the necessity to meet facility requirements above the needs of the base research program. A number of studies, including a National Academy of Sciences study, recommended a number of safety improvements at the High Flux Isotope Reactor which are being addressed in both the FY 1990 and FY 1991 budgets. Other facility operating budgets are increasing substantially in FY 1991 to deal with maintenance problems and provide for more optimal use.

II. A. Summary Table: Chemical Sciences

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Chemical Sciences Research	$ 95,317	$ 99,525	$ 98,000	- 2
Facilities Operations	43,149	58,060	60,300	+ 4
Total, Chemical Sciences	$ 138,466	$ 157,585	$ 158,300	0

II. B. Major Laboratory and Facility Funding

	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Ames Laboratory	$ 3,595	$ 3,649	$ 3,746	+ 3
Argonne National Laboratory	$ 15,749	$ 15,917	$ 16,293	+ 2
Brookhaven National Laboratory	$ 16,513	$ 17,380	$ 17,958	+ 3
Idaho National Engineering Laboratory - EG&G	$ 279	$ 230	$ 255	+ 11
Lawrence Berkeley National Laboratory	$ 7,409	$ 7,069	$ 7,278	+ 3
Lawrence Livermore National Laboratory	$ 1,377	$ 1,776	$ 40	- 98
Los Alamos National Laboratory	$ 930	$ 947	$ 840	- 11
Oak Ridge National Laboratory	$ 35,718	$ 45,750	$ 46,495	+ 2
Pacific Northwest Laboratory	$ 4,775	$ 4,814	$ 5,133	+ 7
Sandia National Laboratories	$ 0	$ 7,194	$ 7,651	+ 6

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Chemical Sciences			
Chemical Sciences Research	Modest growth occurred on photocatalysis, photoselective reaction pathways, solvent effects on photo induced electron transfer, and surface chemistry at semiconductor electrodes. Research on recoil hot atom chemistry was reduced.	The characterization of solvent effects on photoinduced electron transfer which is critically important for solar photochemical energy conversion technologies will receive preferred emphasis, as will the related areas of photosynthesis and photoelectrochemistry. Studies on the characterization of solution properties using radiation chemistry techniques and the unique chemistry of highly energetic atoms will be maintained. Laser-based optical techniques capable of time resolution of less than a trillionth of a second allow the study of complex chemical reactions at a level of detail required to characterize processes that impact a host of energy technologies including artificial photosynthesis.	In general the requested level only covers cost of living increases for the research program and facilities operations. Program enhancements in one area will have to be offset by reductions elsewhere. A better understanding of solvent dynamics as they affect electron transfer is necessary for improvements in solar photochemical energy conversion and will receive emphasis. The related areas of photosynthesis and photoelectrochemistry will be maintained. Radiation chemistry, except as related to broader chemical questions, will be reduced.

III. Chemical Sciences (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Chemical Sciences Research (Cont'd)	The highest priority programs in chemical dynamics of combustion reaction systems and chemical catalysis received cost of living increases somewhat at the expense of existing programs. Research programs at the Combustion Research Facility (CRF) and the National Synchrotron Light Source (NSLS) continued at current levels. Most other programs remained at FY 1989 or slightly reduced dollar levels. New and/or increased efforts in research on the mechanisms of soot formation and the dynamics of chemical reactions related to combustion were initiated. Cost-of-living adjustments were deferred for those activities less directly related to combustion and cluster science related to catalysis. Support was provided for expanded experimental and theoretical basic research in molecular sciences related to environmentally safe uses of energy and waste management.	Theoretical and experimental research on the detailed dynamics of chemical reactions related to combustion remains a high priority effort and will continue unabated. Support for high priority fundamental studies of interactions of atoms and molecules with surfaces and clusters as a means for developing general theories of catalysis will continue. High priority will be given to experimental and theoretical research in molecular aspects of interfacial science to understand the reactivity and control or prevent transport of hazardous chemicals and species in the environment. The research program will emphasize both theoretical and experimental efforts to characterize extremely fast or short-lived phenomena. The CRF will contribute substantially to the combustion part of this effort.	The dynamics of chemical reactions critical to an improved understanding of combustion processes will be given priority. Studies of the electronic properties and chemical reactivity of metal clusters will be important to an improved knowledge of catalysis and will remain as a high priority area. Research in the areas of theory, dynamics and structure related to chemical aspects of environmental restoration and waste management will be enhanced. Studies of dynamical processes at extremely short times coupled with more extensive theoretical computational efforts will be performed in areas related to energy technologies including artificial photosynthesis, combustion and catalysis. The CRF will contribute substantially to the combustion part of this effort. R&D in combustion dynamics will continue with emphasis on building on capability at the Lawrence Berkeley Laboratory and Sandia National Laboratory.
	New efforts in low temperature plasma physics research were started to the degree possible. Studies designed to unravel ionic structures and the dynamics of interactions involving photons, electrons, and ions in atomic systems exposed to strong electrical and magnetic fields were maintained.	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 will continue. 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	The atomic physics research program as described in the FY 1991 budget will be continued. Every effort will be made to increase the theory component of the program and to implement recommendations of recent workshops sponsored by the Division of Chemical Sciences on "Opportunities in Atomic Physics".

III. Chemical Sciences (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Chemical Sciences Research (Cont'd)		to guide new experiments and to interpret existing data. Special attention will be given to university-based efforts in order to address a serious national shortage of high quality scientists trained in modern atomic physics theory.	
	The new program in materials precursor chemistry was expanded to include chemistry of other advanced materials in addition to high temperature superconductors at the expense of selected projects in solution chemistry and isotope effects research. Heterogeneous and homogeneous catalysis research and the studies of the chemical and physical properties, structures, and reactivity of coal macromolecules were continued.	Research programs in materials precusor chemistry, catalysis and coal chemistry will be protected. Research leading to novel organometallic polymers, layered and zeolitic structures, membranes, polyoxmetallates, and metal clusters will be supported at current levels. Their use in the preparation of advanced semiconductors, polymers, catalysts, superconductors, coated electrodes and separation membranes will be explored.	Research on materials precursors and catalysis will be maintained. Growth opportunities in this area will be realized at the expense of research in areas such as isotopes effect chemistry. Program directions established in FY 1991 will be continued.
	Emphasis was given to predictive models for fluid properties and phase equilibria of polymers, polydisperse systems and reverse micelles in supercritical fluids at the expense of lower priority research.	Continued emphasis will be given to thermodynamic properties of complex fluid mixtures involving large molecular size differences or energies of interactions as well as chain type molecules and ions. Some reductions in the thermophysical transport property research will be necessary.	In chemical engineering sciences emphasis will be given to research on solid-liquid phase equilibria that is supportive of materials sciences research efforts. Research on physically based predictive models will be protected.
	The study of membrane separations methods of aqueous and gaseous species was emphasized along with analytical characterization and speciation of trace components in aqueous media.	The chemistry of interfacial phenomena important to membrane and other separations processes will be increased. Analytical methods to determine the spatial distribution and identity of molecular species at interfaces such as a membrane liquid interface will be supported. The design and synthesis of specific molecular complexing agents and reverse micelle work at near critical conditions will be modestly enhanced.	Separations chemistry and environmentally related analytical research will be protected at current levels. To the extent possible ultrasonic studies for surface analysis and wet chemical surface analysis studies will be initiated. Research to determine the detailed role of electronic factors in membrane transport will be carried out. Studies of crown ether modifications to enhance solubilities will be explored.

III. Chemical Sciences (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Chemical Sciences Research (Cont'd)	Theoretical calculations of the electronic properties of the heaviest actinide elements to assess relativistic effects was emphasized. High temperature thermodynamic studies of solid compounds to determine chemical stabilities and the effects of high pressure on actinide metal and compound properties were pursued.	Research on highly sensitive methods for speciation of solution actinide species will be increased. The chemistry of actinides in superconducting mixed oxides will be extended. New experimental and theoretical investigations on the stabilities of high temperature molecular species will be pursued; all will be at the expense of other ongoing research.	Heavy element chemistry in the area of solid state work related to new superconducting materials will be protected. The organometallic chemistry of the actinides and lanthanides, particularly as it relates to catalysis will receive emphasis.
	Implemented plans for the Energy Sciences Network (ESNET) project as identified in the Applied Mathematical Sciences subprogram will proceed. This subprogram's share for the implementation of ESNET is $172,000.	Upgrades of ESNET to conform to the National Research and Education Network standards will continue to be implemented; funding will be shared among ER programs that benefit from ESNET. This subprogram's share is $246,000.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram.
	$ 95,317	$ 99,525	$ 98,000
Facilities Operations	Support for major user facilities at the FY 1989 level were maintained. Restart improvements at the HFIR have allowed the reactor to start operation again. Redirection of additional funds were required to meet all restart and safety requirements.	More optimal levels of support for major user facilities will be established in FY 1991. The safety, quality assurance and physical facility improvements planned for the HFIR will be carried out to the degree possible. Increases for the CRF for ultra fast dynamics and theoretical computing capability will be provided. Included for the first time in this budget are funds for the highly enriched uranium needed for the HFIR fuel.	The more optimal levels of facilities operations established in FY 1991 will be maintained. Analysis of increasing requirements for safety, quality assurance and physical facility improvements at the HFIR will continue so safe operating conditions can be maintained.
	$ 43,149	$ 58,060	$ 60,300
Chemical Sciences	$ 138,466	$ 157,585	$ 158,300

Percentage Breakdown by Performer			
Laboratory	37%	33%	32%
University	30%	27%	27%
Industrial/Other	2%	3%	3%
Facility Operations	31%	37%	38%
Subtotal	100%	100%	100%
Number of Researchers Supported	877	877	880

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Applied Mathematical Sciences

Applied Mathematical Sciences has two activities: Mathematical Sciences Research and Energy Sciences Advanced Computation. The Applied Mathematical Sciences subprogram also includes the DOE contribution to the President's High Performance Computing and Communications (HPCC) program initiative. This HPCC is included in the Applied Mathematical Sciences subprogram and builds upon the base of these two activities. The objectives of the Mathematical Sciences Research activity are: (1) to expand the knowledge of the fundamental mathematics, computational sciences and computer science principles necessary to model the complex physical phenomena involved in energy production and storage systems and basic sciences, and (2) to explore new computational algorithms and computer architectures necessary for investigating these mathematical models. Near term objectives include a rigorous mathematical investigation of current modeling activities including energy conservation and turbulent combustion, global climate modeling, structural biology, materials properties and condensed matter physics, quantum chromodynamics, and environmental modeling and remediation. Mid-term and long-range activities include investigation of the mathematical and computer science techniques to improve the utilization of these modeling activities on the parallel computer architectures of the future. The objectives of the Energy Sciences Advanced Computation activity are to provide access to the high performance computing state-of-the-art systems including the DOE participation in the HPCC National Research and Education Network, and perform research and development of advanced software required by researchers supported by the Office of Energy Research.

II. A. Summary Table: Applied Mathematical Sciences

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Mathematical Sciences Research	$ 24,579	$ 28,632	$ 41,000	+ 43
Energy Sciences Advanced Computation	18,594	24,072	34,500	+ 43
Total, Applied Mathematical Sciences	$ 43,173	$ 52,704	$ 75,500	+ 43

II. B. Major Laboratory and Facility Funding

Ames Laboratory	$ 912	$ 1,250	$ 1,250	0
Argonne National Laboratory	$ 0	$ 4,240	$ 4,700	+ 11
Lawrence Berkeley National Laboratory	$ 1,920	$ 2,055	$ 2,100	+ 2
Lawrence Livermore National Laboratory	$ 5,870	$ 10,300	$ 20,500	+ 99
Los Alamos National Laboratory	$ 0	$ 2,100	$ 2,200	+ 5
Oak Ridge National Laboratory	$ 2,201	$ 2,200	$ 2,250	+ 2
Sandia National Laboratories	$ 1,722	$ 1,725	$ 2,240	+ 30

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Applied Mathematical Sciences			
Mathematical Sciences Research	The level of effort in analytical and numerical mathematics will be maintained.	Research in analytical and numerical mathematics will continue at the same level. A postdoctoral fellowship in computational mathematics will be continued to provide two fellowships for each major laboratory with substantial participation in the Mathematical Sciences research activity.	Research in analytical and numerical mathematics will emphasize the computational techniques applicable to the "grand challenge" problems including energy conservation and turbulent combustion, global climate modeling, structural biology, materials properties and condensed matter physics, quantum chromodynamics, and environmental modeling and remediation.
	Projects in data analysis, display and management will be curtailed somewhat as ongoing projects finish their current funding cycle in order to provide a constant level of effort in the other categories.	Projects in data analysis, display and management will receive increased attention, in order to investigate new techniques for handling large scale scientific data on new parallel architecture computing systems.	Research in data analysis, display and management will be focused on the large scale scientific data problems related to the above projects. Several special projects will be initiated including lab, university and industry researchers to attack the problems of data compression, storage, and management which are already overwhelming projects in DOE.
	Research projects in advanced computing concepts will be curtailed somewhat, particularly in terms of providing new computing resources and support staff in order to maintain a constant level of research effort.	Research projects that support investigation of scientific problems on parallel architecture computing systems will continue building up to critical mass in the major laboratories supported by the AMS program. Progress on adapting new algorithms to new architectures will focus on those techniques suitable to the "grand challenge" problems in physics, chemistry, biology, ecology, materials, and environmental studies.	High performance computing experimental research prototypes, including modern parallel computer systems, algorithm research, and visualization techniques, as described in the U.S. High Performance Computing and Communications Program Report will be emphasized at DOE laboratories and universities. Additional university based projects will be initiated to collaborate with the laboratories and provide postdoctoral fellows and graduate students to ensure future human resources in these areas.
	$ 24,579	$ 28,632	$ 41,000

III. Applied Mathematical Sciences (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Energy Sciences Advanced Computation	Continue support for operations of the National Energy Research Supercomputer Center (NERSC) (formerly the National Magnetic Fusion Energy Computer Center) at LLNL with the enhanced Class VI acquired last year. Funding continued for FSU/SCRI as directed by Congress.	Continue funding for supercomputer access to NERSC for all researchers funded by OER. Proceeds with the acquisition of a Class VII supercomputer to replace one of the older Class VI systems in use last year at NERSC. Delivery of the new Class VII is scheduled as part of a joint laboratory and industry software technology development project. A one year extension to the original five year cooperative agreement with FSU/SCRI was completed in FY 1991.	Additional support of the Advanced Software Technology and Algorithms category in the High Performance Computing Initiative will be provided for HPCC research centers. This includes support for experimental high performance computational facilities (including continued funding for the interim Cray 2, for one or more centers whose selection will be based on a competitive peer review of unsolicited proposals) and advanced software development projects in software components and tools, and computational techniques.
	Implementation plans for the Energy Sciences Network project will proceed. Total funds requested are $4.0 million, $0.5 million in the Applied Mathematical Sciences subprogram and the remainder shared among all ER research programs.	Upgrades of ESNET to conform to the National Research and Education Network standards will continue to be pursued and will be shared among ER programs that benefit from ESNET.	Initiate ESNET plan, in conjunction with the other Federal agencies as part of the High Performance Computing and Communications Program, to incorporate the DOE ESNET into the National Research and Education Network. Initiate a DOE program component for gigabit network research concentrating on distributed supercomputer applications and user interfaces projects.
	$ 18,594	$ 24,072	$ 34,500
Applied Mathematical Sciences	$ 43,173	$ 52,704	$ 75,500

Percentage Breakdown by Performer			
Laboratory	**47%**	**49%**	**63%**
University	**49%**	**46%**	**32%**
Other	**4%**	**5%**	**5%**
Subtotal	100%	100%	100%
Number of Researchers Supported	261	295	500

DEPARTMENT OF ENERGY
FY 1992 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 central fundamental research activities in the engineering and geosciences disciplines. The research serves the DOE goal of fortifying foundations; in particular, foundations for progress in the areas of respecting the environment, securing future energy supplies, and increasing energy efficiency. Principal expected payoffs of the planned activities are added domestic sources of liquid and gaseous fuels, better methods for mitigation of environment damage, reduction of capital needs for energy production and distribution, and addition of highly skilled personnel to the U.S. work force in energy-related fields.

The engineering research objectives are (1) to improve and advance our knowledge of processes underlying current engineering practice, and (2) to expand the store of fundamental concepts for solving anticipated and unforeseen engineering problems in energy technologies. Fundamental research is supported in both traditional engineering disciplines and interdisciplinary areas. The research is concerned especially with analysis, control and improvement of systems for transport of heat and fluids and for materials processing. Because of their basic nature, the results of specific engineering research projects are expected to affect more than one energy technology. Thus, for example, successful efforts in basic multiphase flow studies will impact nuclear reactor technology, waste management, rehabilitation of the environment, tertiary oil recovery methods and renewable energy technologies. Similar wide impact is expected of heat transfer research. At the same time, advances in instrumentation and systems control are leading to innovative and improved approaches in chemical and materials processing and manufacture which will save energy and extend equipment lifetimes.

The geosciences research objective is to develop a quantitative, predictive understanding of the energy-related aspects of the earth sciences. The scope of work reflects the fact that all energy resources come from the earth and the sun and all waste products are returned to the earth and its atmosphere. The primary focus of the Geosciences program is on the geophysics and geochemistry of rock/fluid systems. Topics emphasized in the program include high resolution underground imaging, geochemical migration, basic geosciences studies of sedimentary formations where oil and gas are located, continental scientific drilling and isotopic studies. This research is expected to pay off in improved approaches to the recovery of oil and natural gas, solutions to problems in the isolation of hazardous wastes and in environmental restoration, and advances in our knowledge of, and access to, the full range of the earth's energy resources. The high relevance to a secure energy supply for the nation and the special expertise of the DOE laboratories in integrating basic research with technology programs are key elements in the growing recognition of the importance of geosciences research in DOE.

II. A. Summary Table: Engineering and Geosciences

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Engineering Research	$ 15,168	$ 14,935	$ 16,370	+ 10
Geosciences Research	17,633	17,375	19,430	+ 12
Congressionally Directed Projects	0	1,989	0	-100
Total, Engineering and Geosciences	$ 32,801	$ 34,299	$ 35,800	+ 4

II. B. Major Laboratory and Facility Funding

	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Ames Laboratory	$ 254	$ 130	$ 0	-100
Argonne National Laboratory	$ 744	$ 639	$ 655	+ 3
Brookhaven National Laboratory	$ 49	$ 0	$ 100	>999
Idaho National Engineering Laboratory - EG&G	$ 1,894	$ 1,799	$ 1,684	- 6
Lawrence Berkeley National Laboratory	$ 2,690	$ 2,319	$ 2,400	+ 3
Lawrence Livermore National Laboratory	$ 2,464	$ 2,050	$ 2,151	+ 5
Los Alamos National Laboratory	$ 2,712	$ 2,594	$ 2,770	+ 7
Oak Ridge National Laboratory	$ 2,595	$ 2,182	$ 2,506	+ 15
Pacific Northwest Laboratory	$ 819	$ 810	$ 926	+ 14
Sandia National Laboratories	$ 2,233	$ 2,218	$ 2,338	+ 5

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Engineering and Geosciences			
Engineering Research	Support for basic engineering research was maintained at a level of effort slightly below that of FY 1989. Emphasis remained on the most critical aspects of two-phase flows and flows in porous media; in the latter area, for example, collaborators at MIT, Sandia National Laboratory and Los Alamos National Laboratory completed experiments suitable for testing and comparing advanced methods for analyzing such flows. Also, ongoing theoretical and experimental collaborative work at three universities cast light on the evolution of persistent organized large scale structures in turbulent flows. Several projects attacking basic engineering problems in high temperature superconducting devices were continued. Substantial progress was also made in the areas of combustion, solid mechanics, the dynamics of non-linear systems, smart controls for energy systems, welding	Support for critical long term basic engineering research in the areas of Mechanical Sciences, Control Sciences, and Engineering Data and Analysis continues at about 4% below the FY 1990 level of effort. For example, funds are provided for research by experts in theory of chaos and non-linear dynamical systems drawn from such fields as engineering, mathematics, physics, chemistry, biology, and economics. Such theory is needed to model and study the evolution of engineering, physical, biological, and economic systems. Existing, strong collaborative work among universities, industries and national laboratories continues in such diverse areas as welding automation, plasma processing, combustion, structural life prediction and intelligent machines. In the latter case, experiments have started on communication and cooperation between autonomous robots with differing operational capabilities.	Research by individual investigators will continue in carefully selected areas fundamental to creating new energy related technological opportunities, such as non-imaging optics contributing to improved efficiency in illumination; thermodynamics of engines analogous to certain highly energy efficient oscillatory biological processes, diagnostics and control of nonequilibrium plasma processing of materials for fast production of wear resistant coatings; fracture mechanics; and robot-robot interactions. Further research will be carried out towards improvement of reliability, safety and efficiency of systems based on the flow of mixtures of liquids and gases (two-phase flows); such systems range from nuclear reactors, through oil pipelines, to air-conditioning and refrigeration systems. The request provides some enhancement of the level of effort, and this will enable a

III. Engineering and Geosciences (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Engineering Research (Cont'd)	automation and plasma processing. The contributions to the last of these areas included a new process for rapid deposition of high quality diamond films on metal surfaces. In solid mechanics, research on energetics of pulverization yielded a new more efficient concept for grinding of coal, ores, and rocks. Several novel approaches to engineering problems were explored based on recent advances in the theory of dynamical systems, such as new efficient energy conversion cycles made possible by resonances between coupled oscillatory chemical reactions and mechanical process. The Engineering Research activity featured wide collaboration between national laboratories and universities.	Research in multiphase flow proceeds with emphasis on two-phase flow of liquids and gases and flow in porous media. These studies are not only important in many energy conversion devices but are also of importance to recovery of oil and gas deposits, management of nuclear waste repositories, and the Department's long-term environmental restoration program. Due to the overall decrease in the level of effort, the flow of research results for practical industrial applications will be somewhat diminished. However, results from recent engineering research continue to find their way into more applied R&D, e.g., work on multiphase flows funded by this program has been incorporated into developmental efforts funded currently by DOE's Office of Fossil Energy.	substantial start toward exploiting recent advances in biology for use in processing of fuels and energy related wastes; this long term basic research effort will rely and build on the existing base of outstanding researchers in chemical engineering. In the area of multi-phase flows important to the fulfillment of the mission of the Department, existing effort will continue in the studies of flow through porous media, e.g., rock, sand, and packed-bed reactors. Critical problems of fundamental nature need to be addressed in support of technologies ranging from oil and gas recovery to the long term stability of nuclear waste deposits. Where appropriate, efforts will be made to encourage the use of facilities at national laboratories by universities and related collaborative research.
	Implemented plans for the Energy Sciences Network (ESNET) project as identified in the Applied Mathematical Sciences subprogram. This subprogram's share for the implementation of ESNET was $18,000.	Upgrades of ESNET to conform to the National Research and Education Network Standards will continue to be implemented; funding will be shared among ER programs that benefit from ESNET. The Basic Energy Sciences' share of this funding is shown in the Materials Sciences and Chemical Sciences subprograms.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram.
	$ 15,168	$ 14,935	$ 16,370

III. Engineering and Geosciences (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Geosciences Research	Scientific accomplishments included: new insights into the structure of the volcanic vent region at Katmai (AK) using advanced and integrated geophysical research techniques; thousand-fold gain in precision of uranium-thorium dating methods; location and evaluation of wave-guide effects for seismic waves propagating in natural channels such as the fractured rocks of earthquake fault zones. The studies at Katmai, the Century's largest explosive volcanic event, help illuminate the igneous geology of the many areas impacted by older volcanism and will guide selection of drilling sites for further studies under the interagency Continental Scientific Drilling Program. Gains in uranium-thorium dating help pin down the history over the last 300 millennia of waste repository sites, oil basins and global processes. Wave-guide effects must be understood for high-resolution underground imaging and their occurrence in earthquake fault zones may be important for assessing the stability of energy facility sites. Applied researchers in DOE's Environmental Restoration Program are now using knowledge, instruments, and methods developed in the Geosciences program to address problems of site characterization and monitoring. Geophysical methods developed in this program are being used and refined in DOE laboratory (Sandia)-industry consortia. Research continued on a broad range of other geoscience topics to provide basic knowledge and a base for further achievements.	Research is being stressed in areas such as high-resolution geophysical imaging and evolution of hydrocarbon resources. Research in the latter area has led to a fully operational DOE laboratory (LLNL)-oil company consortium, illustrating effective transfer of concepts, ideas, and technology. The former has led to cooperative activities within DOE which will bring to technological fruition the results of basic research, where dramatic and unexpected improvements in spatial resolution for cross-hole electromagnetic methods were achieved. New avenues are being opened up for the evaluation of fluid transport and interaction with porous and fractured rocks of the earth's crust through use of stable and radiogenic isotopes and numerical models. These efforts, with others, will provide a base for new and improved methods for environmental mitigation and energy resource use. Fundamental studies with considerable promise continue dealing with scale-dependent bulk rock and fracture permeability in fluid bearing (gas, oil, geothermal, and waste-contaminated) reservoirs. A broad program of research on the solid earth and participation in the interagency (DOE-NSF-USGS) Continental Scientific Drilling Program will continue to provide the foundation for further achievements.	Added emphasis will be given to geophysical and geochemical processes taking place near the surface of the earth. For example, isotopic methods of sharply increased sensitivity, developed in this program, will be used for tracing fluid flow in fractured reservoirs to yield new data and concepts important for enhanced oil recovery, geothermal energy production, and waste isolation. Similarly, studies of migration and chemical change in fluids within sedimentary basins will be enhanced to strengthen our technology base for finding and using oil, gas, and geothermal resources as well as to aid in the appraisal of pollutant transport. This modified emphasis toward near surface processes will be extended to the DOE part of the interagency Continental Scientific Drilling Program, and will become a critical facet of our successful high-resolution geophysical imaging program. It will be critically important in the environmentally conscious use of the Nation's energy resources. The Environmental Impact Statement for scientific drilling at Katmai, Alaska will be completed, providing a basis for the decision on whether to fund drilling there in FY 1993. Basic research on a wide range of solid earth topics will be continued on a merit and performance basis.

III. Engineering and Geosciences (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Geosciences Research (Cont'd)	Implementation plans for the Energy Sciences Network (ESNET) project as identified in the Applied Mathematical Sciences subprogram will proceed. This subprogram's share for the implementation of ESNET was $22,000.	Upgrades of ESNET to conform to the National Research and Education Network Standards will continue to be implemented; funding will be shared among ER programs that benefit from ESNET. The Basic Energy Sciences' share of this funding is shown in the Materials and Chemical Sciences subprograms.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram.
	$ 17,633	$ 17,375	$ 19,430
Congressionally Directed Projects	No activity.	Funding provided for Congressionally directed projects.	No activity.
	$ 0	$ 1,989	$ 0
Engineering and Geosciences	$ 32,801	$ 34,299	$ 35,800

Percentage Breakdown by Performer			
Laboratory	50%	48%	49%
University	45%	46%	45%
Industrial/Other	5%	6%	6%
Subtotal	100%	100%	100%
Number of Researchers Supported	401	392	412

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Advanced Energy Projects

The objective of the Advanced Energy Projects (AEP) subprogram is to explore the feasibility of novel, energy-related concepts, as they evolve from basic research. Such concepts are at an early stage of scientific definition and, therefore, would not qualify for support by technology programs. Because they are new and untried, those concepts invariably represent high risk. To qualify for AEP support, the concepts must also have a potential payoff of a magnitude sufficient to open new vistas for the Nation's energy posture. Projects such as the exploration of new approaches to controlled fusion and of unconventional applications for superconducting materials can lead to dramatic energy-related implementations. Major consideration is given to facilitate a transfer of successful AEP projects to the proper technology program, whether in the Government or in the private sector. Transfers are effected every year, with several leading to major development programs. The principal mode of operation for this interdisciplinary subprogram is to support individual projects for a limited time only. It differs from other subprograms in that ongoing evolutionary research is not funded. The spectrum of projects supported is very broad and encompasses the range of the Department's non-defense interests. Close contact is maintained with other DOE technology programs to ensure proper coordination. Projects are selected on the basis of unsolicited proposals received from researchers at universities, industrial laboratories (especially small R&D companies) and national laboratories.

II. A. Summary Table: Advanced Energy Projects

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Advanced Energy Projects	$ 14,408	$ 14,466	$ 10,800	- 25
Congressionally Directed Projects	0	10,389	0	-100
Total, Advanced Energy Projects	$ 14,408	$ 24,855	$ 10,800	- 57

II. B. Major Laboratory and Facility Funding

Argonne National Laboratory	$ 434	$ 1,380	$ 1,500	+ 9
Brookhaven National Laboratory	$ 93	$ 0	$ 400	>999
Lawrence Berkeley National Laboratory	$ 5,076	$ 4,850	$ 300	- 94
Lawrence Livermore National Laboratory	$ 424	$ 280	$ 0	-100
Los Alamos National Laboratory	$ 1,210	$ 660	$ 600	- 9
Oak Ridge National Laboratory	$ 310	$ 330	$ 700	+112
Pacific Northwest Laboratory	$ 145	$ 143	$ 0	-100

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Advanced Energy Projects			
Advanced Energy Projects	Funds were used to support exploratory research on innovative energy-related concepts which evolve from basic research but are in need of proving their practical feasibility. As has been the case for over a decade, all projects are supported for a limited period of time, in most cases not exceeding three years. Subjects studied by researchers at universities, national laboratories, and industrial laboratories span the full spectrum of Departmental non-defense interests and presently include areas such as unconventional approaches to superconductor development, entirely new approaches to chemical separations, new sources of coherent electromagnetic radiation, including x-ray lasers, applications of such sources to microscopic imaging of live matter at subcellular levels, muon-catalyzed fusion, and "cold-fusion"-- a hypothesized approach to fusion energy generation that does not require high temperatures.	Funds are available to continue with the mission to establish the technical feasibility of novel and highly unconventional concepts that span the Department's interests in energy technologies, as they emerge from basic studies. Projects currently underway at universities, national laboratories and industrial laboratories will be continued towards completion. These projects are in areas that include novel sources of short-wavelength radiation, unconventional approaches to chemical separations, innovative fossil fuel technology, and alternative approaches to fusion. As existing projects are completed, promising new concepts can be considered for support. Program vitality will be maintained by initiating approximately 10 new projects during the fiscal year.	Provides funds to continue to explore the technical feasibility of novel energy-related concepts that evolve from basic research. Existing projects, which include innovative techniques for cleaning oil spills, an unconventional approach to fossil fuel technology, and a novel processing technique for high-temperature superconducting materials will be continued toward completion. As projects are completed, funds would be available during the fiscal year to maintain program viability by initiating the exploration of promising new concepts.
	The Heavy Ion Fusion Accelerator Research (HIFAR) effort continued towards an understanding of key beam physics and accelerator technology issues through the comprehensive utilization of existing apparatus.	The Heavy Ion Fusion Accelerator Research (HIFAR) effort continues towards its objective with existing apparatus. Emphasis is being placed on using the ion injector system to examine beam physics issues.	TRANSFER: The Heavy Ion Fusion Accelerator Research (HIFAR) effort has been transferred to the Office of Fusion Energy. ($-6,850,000)

III. Advanced Energy Projects (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Advanced Energy Projects (Cont'd)	Implemented plans for the Energy Sciences Network (ESNET) project as identified in the Applied Mathematical Sciences subprogram. This subprogram's share for the implementation of ESNET was $20,000.	Upgrades of ESNET to conform to the National Research and Education Network Standards will continue to be implemented; funding will be shared among ER programs that benefit from ESNET. The Basic Energy Sciences' share of this funding is shown in the Materials Sciences and Chemical Sciences subprograms.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram.
	$ 14,408	$ 14,466	$ 10,800
Congressionally Directed Projects	No activity.	Funding provided for Congressionally directed projects.	No activity.
	$ 0	$ 10,389	$ 0
Advanced Energy Projects	$ 14,408	$ 24,855	$ 10,800

Percentage Breakdown by Performer			
Laboratory	60%	34%	61%
University	24%	61%	34%
Industrial/Other	16%	5%	5%
Subtotal	100%	100%	100%
Number of Researchers Supported	145	195	160

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Energy Biosciences

In the near future, biomass, a renewable resource, will assume an increasingly important role with respect to providing fuels, chemicals, and new materials as replacements for currently used fossil reserves. 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 crude, abundant biomass into other usable forms. The program provides the basic foundation for the broad exploitation of new sophisticated knowledge in molecular genetics. Currently, a major obstacle to the employment of exceedingly powerful 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. A principal thrust is to develop, in the broadest way possible, understanding at the genetic, biochemical and physiological levels of the diverse capabilities of organisms to metabolically synthesize chemical compounds. Included in this thrust is generation of a thorough understanding of the mechanisms available to organisms for the conversion of noxious or undesirable materials into less threatening species. Such information could be used in designing new clean-up biotechnologies. The EB subprogram specifically focuses on major classes of plant compounds such as carbohydrates and lignins, in terms of how they are produced, how they function in the organism, how they are degraded, and what opportunities exist for their biological modification. Applications to energy problems would be expected in the mid- to long-term time scale. The program is unique in the federal government; its major focus is on the potential biological solution of energy problems addressed at the fundamental level. These include photosynthesis, methanogenesis, fermentations, genetics of anaerobic organisms and others. The program interacts and coordinates with the Conservation and Renewable Energy program in DOE as well as USDA and NSF programs and is participating with those agencies in a three agency program to support plant science centers. Where feasible, interactions with industry are promoted.

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 energy resources by renewables (biomass) for fuels, chemicals and new materials.
2. Increasing concerns about environmental issues will enhance 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 clean-up.
4. The exploitation of biochemical transformations and other capabilities as applied to energy matters requires investment in fundamental research. The current rapid growth of biomedically oriented biotechnology represents the dividend from substantial previous basic research investments in the biomedical area.
5. The ability to genetically manipulate many organisms is growing more rapidly than our basic knowledge of the traits to be manipulated, i.e., there is a major gap in our understanding about the biochemical and physiological basis of important characteristics, e.g., yield in plants, biochemical pathways to valuable products, etc. This is a major obstacle to essentially all energy-related biotechnology applications.
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. In contrast to some other segments of U.S. industry, the biotechnology industry tracks basic research progress closely through collaborations and participation in meetings.
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).

II. A. Summary Table: Energy Biosciences

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Energy Biosciences	$ 20,389	$ 22,075	$ 24,700	+ 12
Total, Energy Biosciences	$ 20,389	$ 22,075	$ 24,700	+ 12

II. B. Major Laboratory and Facility Funding

Brookhaven National Laboratory	$ 1,000	$ 980	$ 980	0
Lawrence Berkeley National Laboratory	$ 1,131	$ 1,059	$ 1,059	0
Lawrence Livermore National Laboratory	$ 207	$ 0	$ 0	0
Los Alamos National Laboratory	$ 210	$ 130	$ 130	0
Michigan State University	$ 2,590	$ 2,709	$ 2,709	0

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Energy Biosciences	Efforts were made to focus on new projects in the areas of carbohydrate and lignin structure function synthesis and biodegradation. Ongoing research in these areas was, for the most part continued. The three agency (NSF-DOE-USDA) multidiciplinary plant science research centers begun in previous years at the University of Georgia and Arizona State University was maintained. Congressional direction to support a program at the Oregon Graduate Center continued.	This is an essentially level budget for the Energy Biosciences subprogram in the plant and microbial sciences. It allows maintenance of strong projects and initiation of a number of projects in areas of key importance for building of an information base for future energy related biotechnologies. Some of the program areas that would be affected include continuing emphasis on understanding metabolic capabilities and their regulation in plants and microbes; the basis of thermophily (life at high temperatures), genetic and physiological control of carbon partitioning mechanisms in plants, ascertaining mechanisms of genetically controlled metabolic transformation for potential new and novel materials and gaining a better understanding of the structure and function of plant photosynthetic mechanisms, the basis of renewable resource production. The Energy Biosciences program would continue a meaningful participation	With the additional capacity provided for in FY 1991 and continued in FY 1992 responsiveness to high quality research proposals will make it be possible to exploit more ideas on which to base future development of energy related biotechnologies. Some of the program areas that would be affected include continuing emphasis on understanding diverse metabolic capabilities and their regulation in plants and microbes; the basis of thermophily (life at high temperatures), genetic and physiological control of carbon partitioning mechanisms in plants, ascertaining mechanisms of genetically controlled metabolic transformation for potential new and novel materials and gaining a better understanding of the structure and function of plant photosynthetic mechanisms, the basis of renewable resource production. The Energy Biosciences program would continue a meaningful participation with USDA and NSF on plant science

III. Energy Biosciences (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Energy Biosciences (Cont'd)		with USDA NSF on plant science centers as well as aspect of plant genome studies that will lead to improved plant (biomass) productivity.	centers as well as aspects of plant genome studies that will lead to improved plant (biomass) productivity. New studies are also projected in the area of signal transduction, whereby the objective is to understand the mechanisms of how plants and microbes sense and translate outside stimuli such as light, temperature, chemicals and other ambient factors that influence growth, metabolic activity and other responses. How organisms sense and translate outside stimuli into trains of responses is poorly understood. This work will include discerning the receptor sites of outside signals, the molecular targets at those sites, and the nature of interactions between external stimuli and the organism. In addition, other new work in the area of surface biology will begin with the goal of understanding recognition events in plants that trigger whether pathogenicity, symbiosis or other key biological reactions that affect biomass productivity occur. Other very pertinent events in corrosion also occur on surfaces that involve microbes; these fundamental processes will also be studied. The basic biology of these interactions is poorly understood, thus limiting the possibilities for development of new biotechnological strategies for diminishing corrosion effects.

III. Energy Biosciences (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Energy Biosciences (Cont'd)	Provided for the initiation of a fellowship program in Energy Biosciences to address the critical scientific needs in this area of research.	Expands the fellowship program established in FY 1990.	There is the intent to continue a limited number of fellowships in certain key, important, but underrepresented topic areas, including microbial metabolism and physiology, plant biochemistry, and other topic areas whose lack of expertise delays biotechnology development.
	Implemented plans for the Energy Sciences Network (ESNET) project as identified in the Applied Mathematical Sciences subprogram. This subprogram's share for the implementation of ESNET was $25,000.	Upgrades of ESNET to conform to the National Research and Education Network Standards will continue to be implemented; funding will be shared among ER programs that benefit from ESNET. The Basic Energy Sciences' share of this funding is shown in the Materials Sciences and Chemical Sciences subprograms.	ESNET will be fully supported in the Applied Mathematical Sciences subprogram.
	$ 20,389	$ 22,075	$ 24,700
Energy Biosciences	$ 20,389	$ 22,075	$ 24,700

Percentage Breakdown by Performer			
Laboratory	13%	12%	12%
University	83%	86%	86%
Industrial/Other	4%	2%	2%
Subtotal	100%	100%	100%
Number of Researchers Supported	195	205	215

DEPARTMENT OF ENERGY
FY 1992 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 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Program Direction	$ 5,374	$ 6,058	$ 7,500	+ 24
Total, Program Direction	$ 5,374	$ 6,058	$ 7,500	+ 24

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Program Direction	Provided funds for salaries, benefits, and travel for 67 full-time equivalents (FTEs) in the Office of Basic Energy Sciences, the Scientific Computing Staff, the Office of Assessment and Support, and related program and management support staff. ($4,757)	Provide funds for salaries, benefits, and travel related to 70 FTEs included in the FY 1991 budget. ($5,643)	Provide funds for salaries, benefits, and travel related to 71 FTEs. Provide for five additional FTEs, offset by transfer of four FTEs to other Energy Research programs. The additional FTEs include two FTEs transferred from the Departmental Administration appropriation. Also provide for normal increased personnel costs resulting, for example, from general pay raises and within-grade and merit increases. ($6,925)
	The Office of Basic Energy Sciences' activities included assessing the scientific needs and priorities of the program; planning to meet those needs; technical review of proposals from laboratories and universities; and monitoring the progress of ongoing university contracts, laboratory programs, and construction projects. Provided staff support for basic research, R&D and facilities needed to continue U.S. leadership in key scientific areas and for numerous university construction projects. Managed increased user facilities operation and construction, including the 6-7 GeV project, and increased workloads in basic research programs in such areas as hydrocarbon, plant chemical processes, and semiconductor research. Addressed escalating environment, safety and health (ES&H) issues as they pertained to current and planned program facilities. Supported the Basic Energy Sciences Advisory Committee, and managed the DOE-wide SBIR program.	Continue program management as in FY 1990. Strengthen program capability in ES&H oversight of large research facilities and construction projects; strengthen oversight of contract management activities; and maintain technical excellence in R&D in such areas as superconductivity, molecular sciences, oil and gas and coal chemistry. Continue to manage preconstruction R&D and construction of advanced scientific facilities, and support numerous current user facilities. Interact significantly with other agencies on National efforts such as superconductivity and supercomputing. Continue to support projects maintaining scientific excellence which are relevant to DOE's long-term goals and help maintain world leadership in science and technology.	Continue program management at the FY 1991 level of effort. Provide program capability to meet National research goals supporting the country's energy-related technology foundation. Oversee project management, particularly the construction of advanced scientific facilities, and support current user facilities. Continue to strengthen ES&H oversight and provide contractor management oversight. Continue to interact with other agencies and help maintain world leadership in science and technology.

III. Program Direction (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Program Direction (Cont'd)	Supported the Scientific Computing Staff, whose activities included policy and program planning, representation on interagency coordinating councils (FCCSET), management of 85 research and development projects in mathematical and computational sciences, management of ER supercomputer centers, and management of Energy Sciences Network (ESNET) development and operations. These facilities supported approximately 5,800 users.	Continue program management as in FY 1990. R&D projects will increase to 90 and network users will increase to approximately 6,300.	Continue to support the program with two additional FTEs for development and coordination of the OSTP/FCCSET high performance computing initiative for planned program growth requiring increased interaction among five Federal agencies with a major goal of transfer of technology to U.S. industry. Continue to manage R&D projects and support network users including development of an international network for the research community.
	ER established the Office of Assessment and Support to provide environment, safety and health (ES&H) oversight of ER field operations and support to line management in all areas of ES&H and in safeguards and security, emergency preparedness, and quality assurance. Provided support for a wide variety of activities in these areas to ensure compliance with ES&H directives and regulations. Designed risk acceptance, NEPA compliance, and ES&H appraisal programs, and initiated appraisals.	Continue to provide a portion of the total staffing requirement for the Office of Assessment and Support to implement oversight and support activities to ensure compliance with applicable ES&H regulations and directives.	TRANSFER: Two FTEs were transferred to the Advisory and Oversight Program Direction account within the Energy Supply, R&D appropriation.
	Provided program and management support in the areas of budget and finance, personnel administration, acquisition and assistance, policy review and coordination, and construction management support.	Continue to provide program and management support at the FY 1990 level.	TRANSFER: Continue to provide program and management support as in FY 1990 and FY 1991. However, two FTEs were transferred to the Superconducting Super Collider Program Direction account in the General Science and Research appropriation.

III. Program Direction (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Program Direction (Cont'd)			TRANSFER: Provide three FTEs to Chicago Operations Office to continue to support the 6-7 GeV project. Two of these FTEs were transferred from the Departmental Administration appropriation. The additional FTE is required to provide needed additional support for this multimillion dollar project whose obligations total $300,000 per day.
	Provided a variety of program support such as electronic information and communications services, printing and binding, and contractual services, for example, for the SBIR program and to assist with the environment, safety and health workload required by current regulations and directives. ($617)	Continue the variety of program support required in FY 1990. ($415)	Continue the variety of program support required in FY 1991. Provide support for the additional field staff and provide additional administrative and professional services. ($575)
	$ 5,374	$ 6,058	$ 7,500
Program Direction	$ 5,374	$ 6,058	$ 7,500

DEPARTMENT OF ENERGY
FY 1992 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, Argonne and Ames are funded for general purpose equipment through BES for the purpose of providing all the DOE programs at ANL and Ames with this type of equipment. Studies done both by the Department and by the laboratories continue to stress the importance of modernization in order to take advantage of technologically more efficient and safe instruments and equipment. Much of the research in the BES program involves experiments at extremes of temperature and pressure and requires unprecedented levels of resolution. Reliable, precise measurements under such conditions challenge the current state-of-the-art, and as improvements are made in instruments and equipment, it is important to benefit from them in a timely fashion. The quality of individual research projects and effective experiments at the major facilities depends on the availability of new state-of-the-art equipment and instrumentation, and on replacement of older, obsolete equipment.

II. A. Summary Table: Capital Equipment

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Capital Equipment	$ 36,486	$ 36,804	$ 37,000	+ 1
Total, Capital Equipment	$ 36,486	$ 36,804	$ 37,000	+ 1

II. B. Major Laboratory and Facility Funding

Ames Laboratory	$ 2,357	$ 1,510	$ 1,510	0
Argonne National Laboratory	$ 8,457	$ 7,852	$ 7,852	0
Brookhaven National Laboratory	$ 4,652	$ 3,710	$ 3,710	0
Idaho National Engineering Laboratory - EG&G	$ 255	$ 220	$ 220	0
Lawrence Berkeley National Laboratory	$ 5,362	$ 5,380	$ 4,734	- 12
Lawrence Livermore National Laboratory	$ 827	$ 530	$ 530	0
Los Alamos National Laboratory	$ 1,280	$ 875	$ 875	0
Oak Ridge National Laboratory	$ 6,615	$ 5,679	$ 5,679	0
Pacific Northwest Laboratory	$ 2,788	$ 2,937	$ 2,937	0
Sandia National Laboratories	$ 1,607	$ 1,625	$ 1,625	0

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Capital Equipment	Equipment needs were accommodated at the FY 1989 level. Replacement and acquisition of new equipment continued to ensure that optimum research results can be obtained and properly analyzed. General purpose equipment requirements for Ames and ANL were met. Special equipment needs in Materials Sciences in superconductivity and semiconductor research areas received a small, but needed, increase. In addition, equipment necessary to expand research in molecular sciences was provided.	Equipment needs will be accommodated at the current level, including equipment necessary to expand research in molecular sciences. Replacement and acquisition of new equipment required will continue to ensure that optimum research results can be obtained and properly analyzed. General purpose equipment requirements for Ames and ANL will continue to be met. In addition, equipment will be provided to support the research and development associated with the advanced scientific facilities.	Continues equipment funding at the current level, including equipment necessary to expand research in molecular sciences. Replacement and acquisition of new equipment required will continue to ensure that optimum research results can be obtained and properly analyzed. General purpose equipment requirements for Ames and ANL will continue to be met. Continue equipment support at the major user facilities. In addition, equipment will be provided to support the research and development associated with the advanced scientific facilities. TRANSFER: Capital equipment relating to the Heavy Ion Fusion Accelerator Research (HIFAR) effort has been transferred to the Fusion Energy ($-850,000).
	$ 36,486	$ 36,804	$ 37,000
Capital Equipment	$ 36,486	$ 36,804	$ 37,000

DEPARTMENT OF ENERGY
FY 1992 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.

II. A. Summary Table: Construction

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
Construction	$ 76,833	$ 102,434	$ 107,984	+ 5
Total, Construction	$ 76,833	$ 102,434	$ 107,984	+ 5

II. B. Major Laboratory and Facility Funding

Ames Laboratory	$ 562	$ 644	$ 600	- 7
Argonne National Laboratory	$ 40,873	$ 71,254	$ 93,910	+ 32
Brookhaven National Laboratory	$ 2,761	$ 3,012	$ 2,065	- 31
Lawrence Berkeley National Laboratory	$ 25,636	$ 22,866	$ 7,998	- 65
Oak Ridge National Laboratory	$ 1,282	$ 2,783	$ 2,061	- 26
Sandia National Laboratories	$ 395	$ 348	$ 100	- 71

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Construction	Continued funding for AIP, GPP, 1-2 GeV, the 3 GeV Injector and the 6-7 GeV projects.	Continues all projects underway in FY 1990, except for the 3 GeV which was completed.	Continues all projects underway in FY 1991.
	$ 76,833	$ 102,434	$ 107,984
Construction	$ 76,833	$ 102,434	$ 107,984

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY, RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

MAJOR USER FACILITIES

I. Preface: Major User Facilities

The major facilities discussed below are used to conduct forefront research in materials, chemistry, biology, medicine, and in the applied sciences using lasers and high fluxes of neutrons or photons. These facilities are unique in their ability to probe the structure and properties of important energy related phenomena. In view of the expensive and unique character of these facilities, researchers from all parts of the Nation travel to these facilities to conduct their research, including researchers from government laboratories, industry and universities, in addition to DOE contractors. In addition to currently operating facilities, recommendations from national committees and DOE committees have identified needs for advanced facilities in order to continue to conduct leading edge research. The Department is requesting construction and research and development in FY 1992 for two advanced scientific facilities (1-2 GeV Synchrotron Radiation Source and the 6-7 GeV Synchrotron Radiation Source). Summarized below is a list of each of these facilities, as well as a description of the activities underway in FY 1990, FY 1991 and FY 1992 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 1992, serving about 1000 users.

The High Flux Beam Reactor (HFBR) at Brookhaven National Laboratory produces high flux neutron beams used for research in a variety of fields. Neutrons are used as probes by nuclear and solid-state physicists, chemists, and biologists. This 20 year old research reactor has been a pacesetting facility and continues to be an important research tool. The scientific activity will resume in FY 1991. During FY 1990, the facility was shut down to allow for safety improvements.

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

The High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory is a multipurpose reactor which is used for the production of isotopes, and also used for materials sciences, nuclear chemistry, and radiation damage research. The isotopes are important to the research, medical, and industrial community. Many of these isotopes can only be produced at the HFIR reactor. When fully utilized, as proposed in FY 1992, about 150 users are involved with research at the facility. The reactor has recently been restarted following necessary safety improvements in plant and personnel. This includes the hiring of additional staff, modifications to the reactor, and additional training of the reactor staff. The Radiochemical Engineering Development Center, formerly the Transuranium Processing Plant, is a companion facility to the HFIR and was built to recover the transuranium elements from irradiated targets from the reactor.

The Stanford Synchrotron Radiation Laboratory (SSRL) at Stanford University is a national facility funded to permit the utilization of synchrotron radiation for basic and applied research in chemistry, physics, biology, and materials sciences. The operation of this facility has been dependent on the operation of the High Energy Physics electron injector. When fully utilized, as proposed in FY 1992, about 500 users are involved in research at the facility. With some new beamlines being commissioned, increased scientific activity is expected. The 3 GeV electron injector completed in FY 1990 will allow the SPEAR ring to operate as a dedicated synchrotron facility.

The Manuel Lujan, Jr. Neutron Scattering Center (MLNSC) (formerly LANSCE) at Los Alamos National Laboratory is a dedicated user facility for

I. Major User Facilities (Cont'd)

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

The Combustion Research Facility (CRF) at Sandia National Laboratory - Livermore provides a unique capability to outside users from industry, university, and laboratory scientists for combustion research. The focus of the laboratory is on laser diagnostics of combustion systems, but a variety of burner systems and special facilities are available, including those for research on coal combustion and internal combustion engines. About 30 experiments involving about 50 scientists were operational in FY 1990.

Funding in FY 1992 is requested to continue research and development activities associated with the two major scientific facilities proposed for construction in the program. These facilities are the 1-2 GeV Synchrotron Radiation Source (LBL) and the 6-7 GeV Synchrotron Radiation Source (ANL). Preconstruction R&D funds are requested to resolve technical uncertainties prior to and during the actual construction of the facilities. In the case of the 1-2 GeV facility, construction is underway, and the R&D funds for this project are focused on improvements to the magnet lattice, start-up and commissioning, and related activities. For the 6-7 GeV facility, significant R&D activities are necessary due to the overall size and complexity of the project. Research activities at the 6-7 GeV facility will be focused on prototypes of the dipole magnets and insertion devices. Start-up and commissioning of injector will begin in FY 1992.

II. A. Summary Table: Major User Facilities

Program Activity	FY 1990 Enacted	FY 1991 Enacted	FY 1992 Request	% Change
National Synchrotron Light Source	$ 20,154	$ 22,923	$ 24,400	+ 6
High Flux Beam Reactor	15,222	22,678	24,400	+ 8
Intense Pulsed Neutron Source	5,400	6,262	6,800	+ 9
High Flux Isotope Reactor	17,692	28,150	28,500	+ 1
Radiochemical Engineering Development Center	6,850	7,610	7,800	+ 2
Stanford Synchrotron Radiation Laboratory	10,595	13,413	14,400	+ 7
Manuel Lujan, Jr. Neutron Scattering Center	4,437	5,501	5,900	+ 7
Combustion Research Facility	3,719	4,300	4,700	+ 9
Advanced Scientific Facilities	14,989	24,842	43,842	+ 76
Total, Major User Facilities	$ 99,058	$ 135,679	$ 160,742	+ 18

III. Activity Descriptions: (New BA in thousands of dollars)

Program Activity	FY 1990	FY 1991	FY 1992
Major User Facilities			
National Synchrotron Light Source	Continued full year operations with increase needed to accommodate user support.	Continue full year of operations.	Continue full year of operations with increase needed to accommodate user support and fully utilize facility.
	$ 20,154	$ 22,923	$ 24,400
High Flux Beam Reactor	Continued support to accommodate completion of safety assessments identified by the NAS. The full extent of the safety improvements identified by the NAS are currently being determined.	Restores operation and accommodates increased costs of safety and heavy water requirements at the reactor. The full extent of the safety improvements identified by the NAS will be implemented to the extent funds allow.	Full operation, safety improvements implemented. Funds are provided for uranium conversion, enrichment costs, and heavy water costs at HFBR.
	$ 15,222	$ 22,678	$ 24,400
Intense Pulsed Neutron Source	Continued at FY 1989 level of operations for users.	Provides for increased user support and operations.	Continues operation and user support.
	$ 5,400	$ 6,262	$ 6,800
High Flux Isotope Reactor	HFIR facility improvements have continued to address safety requirements which permitted the restart of the reactor.	HFIR facility improvements will proceed on a 12 month schedule. HFIR will operate to provide full services to users while safety upgrades mentioned above continue as funds allow. Funds are provided for the highly enriched uranium needed for the HFIR fuel.	HFIR will operate and provide full services to users with safety, quality assurance and physical facility improvements proceeding.
	$ 17,692	$ 28,150	$ 28,500

III. Major User Facilities (Cont'd):

Program Activity	FY 1990	FY 1991	FY 1992
Radiochemical Engineering Development Center	REDC facility improvements continued to address safety requirements which permitted the restart of HFIR.	REDC facility operations and improvements will proceed on a 12 month schedule.	REDC operations and improvements will be carried out.
	$ 6,850	$ 7,610	$ 7,800
Stanford Synchrotron Radiation Laboratory	SSRL operations continued.	Enhanced operation of SSRL. Operation with the 3 GeV injector will begin.	Full operations of SSRL as dedicated synchrotron facility with full use of the 3 GeV injector.
	$ 10,595	$ 13,413	$ 14,400
Manuel Lujan, Jr. Neutron Scattering Center	Increased operations funding for user support.	Increased operations and user support.	Continues operations and user support.
	$ 4,437	$ 5,501	$ 5,900
Combustion Research Facility	Provided for needed increase in operations and user support.	Operations will be enhanced to better serve the user community.	Continues operations and user support at the FY 1991 level.
	$ 3,719	$ 4,300	$ 4,700
Advanced Scientific Facilities	R&D funding for advanced scientific facilities continued.	Provides support for needed R&D for the 1-2 GeV and 6-7 GeV radiation sources. The increase is required to begin to hire additional staff to ready the 1-2 GeV for operation and to meet the R&D schedule for the 6-7 GeV radiation sources.	Provides for necessary increase to fully support R&D of the 1-2 GeV and 6-7 GeV radiation sources. The increase provided helps ensure that the necessary R&D is completed to maintain the schedule and cost of these projects.
	$ 14,989	$ 24,842	$ 43,842
Major User Facilities	$ 99,058	$ 135,679	$ 160,742

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

CONSTRUCTION PROJECTS

Basic Energy Sciences

IV. Construction Project Summary

Project No.	Project Title	Total Prior Year Obligations	FY 1991 Appropriated	FY 1992 Request	Unappropriated Balance	TEC
92-E-332	Accelerator Improvements Projects	$ 4,536	$ 6,924	$ 6,626	$ 0	$ 6,626
GPE-400	General Plant Projects	2,784	3,051	4,500	0	4,500
89-R-402	6-7 GeV Synchrotron Radiation Source	45,440	69,593	90,360	248,407	456,000
87-R-406	1-2 GeV Synchrotron Radiation Source	70,136	22,866	6,498	0	99,366
	Total, Basic Energy Sciences Construction	XXX	102,434	107,984	248,407	XXX

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

1. Project title and location: 92-E-332 Accelerator and reactor improvements and modifications, various locations

Project TEC: $ 6,626
Start Date: 2nd Qtr. FY 1992
Completion Date: 3rd Qtr. FY 1994

2. Financial Schedule:

Fiscal Year	Appropriated	Obligations	Costs
1992	$ 6,626	$ 6,626	$ 3,000
1993	0	0	2,500
1994	0	0	1,126

3. Narrative:

(a) This project provides for additions and modifications to accelerator and reactor facilities, which are supported by the Basic Energy Sciences program. Since program priorities and needs change, the projects described below indicate the most likely projects to be funded. A continuing evaluation, however, is necessary to ensure that those projects with the greatest productivity are funded. Two projects at the Brookhaven National Laboratory are requested to incorporate improvements at the High Flux Beam Reactor and the National Synchrotron Light Source, one project is requested for facility improvements at the Stanford Synchrotron Radiation Laboratory, one project is requested at the Oak Ridge National Laboratory for improvements to the High Flux Isotope Reactor, one project is requested for facility improvements at the University of Notre Dame Radiation Laboratory, and one project at Lawrence Berkeley Laboratory is requested for facility improvements at the 1-2 GeV Synchrotron Radiation Source.

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

National Synchrotron Light Source
Consistent with the increased user requirements at the NSLS, several additions and improvements are proposed at the facility including: replacement switch for regulating and monitoring cooling water flow, installation of additional lead shielding for both beam-line and x-ray ring vacuum chambers, upgrade beam line optics, and the installation of a hydrogen oven for brazing of high vacuum components.

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 1992, several projects are proposed including: design and installation of remote operation capability, remote capability of various plant components, improved control rod monitoring capability, improved instrumentation, and improved secondary water monitoring for tritium.

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

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

Radiation Laboratory, University of Notre Dame
Provide for improvements in the Linear Accelerator Facility by augmenting the present accelerator with a technologically superior accelerator with substantially higher beam dosage, substantially better beam stability and reproducibility, and improved time resolution.

1-2 GeV Synchrotron Radiation Source

This accelerator and reactor improvement and modification project will provide additional experimental equipment consistent with the project plan, to build on the experience gained in the development of the initial complement of beamlines for the facility. The additional beam line equipment would supplement the initial complement of experimental facilities and would permit access to the facility by a broader community of users, thus enhancing the utilization of the facility and increasing its contribution to the nation's scientific, technical and education base.

4. Total Project Funding (BA):

	FY 1992 Request
Construction	$ 6,626

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

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

Project TEC: $ 4,500
Start Date: 1st Qtr. FY 1992
Completion Date: 4th Qtr. FY 1993

2. Financial schedule:

		Costs			
Fiscal Year	Obligations	FY 1990	FY 1991	FY 1992	After FY 1992
Prior Year Projects	3,221	1,550	0	0	0
FY 1990 Projects	2,784	1,746	1,038	0	0
FY 1991 Projects	3,069	0	1,085	1,984	0
FY 1992 Projects	4,500	0	0	2,296	2,204

3. Narrative:

(a) This project is required to provide for minor new construction, other capital alterations and additions, and for buildings and utility systems. Where applicable, the request also includes the cost of installed capital equipment integral to a subproject. Funding of this type is essential for maintaining the productivity and usefulness of Department-owned facilities. Since it is difficult to detail this type of project in advance, a continuing evaluation of requirements and priorities may be expected to result in additions, deletions, and changes in the currently planned subprojects.

(b) The currently estimated distribution of FY 1990 funds by office is as follows:

Ames Laboratory	$ 600
Argonne National Laboratory	3,550
Notre Dame Radiation Laboratory	50
Sandia National Laboratories	100
Stanford Synchrotron Radiation Laboratory	200
Total project cost	$ 4,500

FY 1992 General Plant Projects (GPP) are miscellaneous minor new construction projects of a general nature. The total estimated costs of each will not exceed $1,200,000. These projects are necessary to provide for the continuing requirement to maintain the facilities in a good state of repair, to adapt the facilities to new or improved production or service techniques, to effect economics of operations and to reduce or eliminate health, fire, and security problems.

4. Total Project Funding (BA):

	Prior Years	FY 1990	FY 1991	FY 1992 Request
Construction	$ 3,221	$ 2,784	$ 3,069	$ 4,500

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

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

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

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1989	$ 6,000	$ 6,000	$ 5,633
1990	39,440	39,440	15,916
1991	69,593	69,593	50,290
1992	90,360 a/	90,360 a/	108,771
1993	110,407	110,407	117,153
1994	93,000	93,000	102,580
1995	45,000	45,000	52,290
1996	0	0	3,367

3. Narrative:

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

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

4. Total Project Funding (BA):

	Prior Years	FY 1990	FY 1991	FY 1992 Request	To Complete
Construction	$ 6,000	$39,440	$69,593	$90,360 a/	$248,407
Capital Equipment	2,800	1,000	1,500	1,500	4,500
Operating Expenses	20,822	9,441	14,332	24,300	255,727

a/ Reflects savings of $2,200,000 of B/A due to proposed Davis Bacon Amendment.

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

1. Project title and location: 87-R-406 1-2 GeV Synchrotron Radiation Source
Lawrence Berkeley Laboratory
Berkeley, California

Project TEC: $ 99,500
Start Date: 1st Qtr. FY 1987
Completion Date: 2ND Qtr. FY 1993

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1987	$ 1,500	$ 1,500	$ 985
1988	18,000	18,000	10,317
1989	25,000	25,000	21,952
1990	25,636	25,636	23,693
1991	22,866	22,866	24,500
1992	6,364	6,498	12,557
1993	0	0	5,496

3. Narrative:

(a) The 1-2 GeV Synchrotron is being built within the Lawrence Berkeley Laboratory, which is located on University of California property adjacent to the Berkeley campus. The project will include the construction of new facilities, and alterations and additions to existing plant and site facilities, especially Building 6 (the circular building that now houses the 184-Inch Cyclotron). The 1-2 GeV Synchrotron is a special facility comprised of an electron storage ring and injection system, insertion devices (undulators and wigglers) for generating synchrotron radiation and photon beamlines.

(b) The 1-2 GeV Synchrotron Facility will be a dedicated synchrotron radiation source that is optimized for generating vacuum ultraviolet (VUV) and soft x-ray (XUV) light from periodic magnetic devices. Investigators from industry, universities, and national laboratories will have access to unique capabilities--high spectral brilliance and very short pulse length (nominally tens of picoseconds). This brilliance makes possible new studies in both basic and applied science including: 1) materials and surface science; 2) atomic and molecular physics; 3) chemistry; 4) biology; 5) industrial utilization; and 6) areas of national security.

4. Total Project Funding (BA):

	Prior Years	FY 1990	FY 1991	FY 1992 Request
Construction	$44,500	$25,636	$22,866	$ 6,498
Capital Equipment	2,000	1,500	1,000	1,000
Operating Expenses	5,373	5,548	10,510	19,542

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEET
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

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

2. Project No.: 92-E-332

3. Date A-E work initiated: 2nd Qtr. FY 1992

3a. Date physical construction starts: 3rd Qtr. FY 1992

4. Date Construction ends: 3rd Qtr. FY 1994

5. Previous cost estimate: none

6. Current cost estimate: $ 6,626
Less amount for PE&D: 0
Net cost estimate: $ 6,626
Date: January 1991

7. Financial Schedule

Fiscal Year	Authorization	Appropriations	Obligations	Costs
1992	$6,626	$6,626	$6,626	$3,000
1993	0	0	0	2,500
1994	0	0	0	1,126

8. Brief Physical Description of Project

This project provides for additions and modifications to accelerator and reactor facilities, which are supported by the Basic Energy Sciences program. Since program priorities and needs change, the projects described below indicate the most likely projects to be funded. A continuing evaluation, however, is necessary to ensure that those projects with the greatest productivity are funded. Two projects at the Brookhaven National Laboratory are requested to incorporate improvements at the High Flux Beam Reactor and the National Synchrotron Light Source, one project is requested for facility improvements at the Stanford Synchrotron Radiation Laboratory, one project is requested at the Oak Ridge National Laboratory for improvements to the High Flux Isotope Reactor, one project is requested at the Lawrence Berkeley Laboratory for beam-line enhancements at the 1-2 GeV Synchrotron Radiation Laboratory, and one project is requested for facility improvements at the University of Notre Dame Radiation Laboratory.

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 92-E-332

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

Consistent with the increased user requirements at the NSLS, several additions and improvements are proposed at the facility including: replacement switch for regulating and monitoring cooling water flow, installation of additional lead shielding for both beam-line and x-ray ring vacuum chambers, upgrade beam line optics, and the installation of a hydrogen oven for brazing of high vacuum components.

b. 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 1992, several projects are proposed including: design and installation of remote operation capability, remote capability of various plant components, improved control rod monitoring capability, improved instrumentation, and improved secondary water monitoring for tritium.

c. Stanford Synchrotron Radiation Laboratory

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

d. High Flux Isotope Reactor

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.

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

2. Project No.: 92-E-332

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

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

e. University of Notre Dame Radiation Laboratory

This project will provide for the continued improvements in the Linear Accelerator Facility by augmenting the present accelerator with a technologically superior accelerator with substantially higher beam dosage, substantially better beam stability and reproducibility, and improved time resolution.

f. 1-2 GeV Synchrotron Radiation Source

The 1-2 GeV Synchrotron Radiation Source is a dedicated synchrotron radiation source that is optimized for generating vacuum ultra-violet and soft x-ray (XUV) light from periodic magnetic structures. Multiple undulators in the 1.5 GeV electron storage ring provide partially coherent radiation that is broadly tunable across the XUV region of the spectrum, permitting new studies in basic and applied sciences. Investigators from industry, universities, and national laboratories will have access to the facility's unique capabilities - high spectral brightness and very short pulse length photon beams. This facility is a much needed addition to this country's oversubscribed synchrotron radiation sources and will provide important new opportunities for student research and training in an area where the lack of qualified personnel is already being felt.

The 1-2 GeV Synchrotron Radiation Source, 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 opportunities or technical developments. This accelerator and reactor improvement and modification project will provide additional experimental equipment consistent with the project plan, to build on the experience gained in the recent development of synchrotron radiation beamlines elsewhere in addition to development of the initial complement of beamlines for the ALS facility. The additional beamline equipment would supplement the initial complement of experimental facilities and would permit access to the facility by a broader community of users, thus enhancing the utilization of the facility and increasing its contribution to the nation's scientific, technical and educational base.

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 92-E-332

10. Details of Cost Estimate

a.	High Flux Beam Reactor Facility	$ 565
b.	National Synchrotron Light Source	1,500
c.	Stanford Synchrotron Radiation Laboratory	400
d.	High Flux Isotope Reactor	2,061
e.	Notre Dame	600
f.	1-2 GeV Synchrotron Radiation Source	1,500
	Total Estimated Cost	$6,626

11. Method of Performance

Design, engineering and inspection will be performed by Brookhaven National Laboratory, Stanford Synchrotron Radiation Laboratory, Oak Ridge National Laboratory, Lawrence Berkeley Laboratory, and University of Notre Dame. 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 1992 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEET
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: General Plant Projects

2. Project No.: GPE-400

3. Date A-E work initiated: 1st Qtr. FY 1992

3a. Date physical construction starts: 2nd Qtr. FY 1992

4. Date construction ends: 4th Qtr. FY 1993

5. Previous cost estimate: None

6. Current cost estimate: $4,500
Date: January 1991

7. Financial Schedule:

Fiscal Year	Obligations	Costs FY 1990	FY 1991	FY 1992	FY 1993
Prior Year Projects	$ 3,221	$ 1,550	$ 0	$ 0	$ 0
FY 1990 Projects	2,784	1,746	1,038	0	0
FY 1991 Projects	3,069	0	1,085	1,984	0
FY 1992 Projects	4,500	0	0	2,296	2,204

8. Brief Physical Description of Project

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

1. Title and location of project: General Plant Projects

2. Project No.: GPE-400

8. Brief Physical Description of Project (continued)

The currently estimated distribution of FY 1991 funds by office is as follows:

Ames Laboratory	$ 600
Argonne National Laboratory	3,550
Notre Dame Radiation Laboratory	50
Sandia National Laboratories	100
Stanford Synchrotron Radiation Laboratory	200
Total project cost	$ 4,500

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..... $ 600

The major projects are the Development Building HVAC upgrade, the final phase of the Wilhelm Hall HVAC upgrade, and upgrading building security. The balance of the work involves handicapped access, energy conservations, roof replacement, and general construction items.

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

Argonne National Laboratory..... $ 3,550

The Argonne National Laboratory FY 1992 General Plant Projects (GPP) are miscellaneous minor new construction projects of a general nature. The total estimated costs of each will not exceed $1,200,000. These general plant projects are necessary to provide for the continuing requirement to maintain the facilities in a good state of repair, to adapt the facilities to new or improved production or service techniques, to effect economics of operations and to reduce or eliminate health, fire, and security problems. The highest priority projects will be selected as needs are identified in FY 1992 and will address requirements as identified in the "Tiger Team" assessment of the laboratory.

CONSTRUCTION PROJECT DATA SHEET

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

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

Of the total requested for GPP at the Argonne National Laboratory, approximately 50 percent will be used for plant rehabilitation and approximately 50 percent will be used for upgrading and programmatic projects.

Notre Dame Radiation Laboratory..... $ 50

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

Sandia National Laboratories..... $ 100

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

Stanford Synchrotron Radiation Laboratory..... $ 200

Requirements include minor modifications and additions necessary to support the optimum use of the laboratory research capabilities. 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.

CONSTRUCTION PROJECT DATA SHEET

1. Title and location of project: General Plant Projects

2. Project No.: GPE-400

11. Method of Performance

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

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEET
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

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

2. Project No.: 89-R-402

3. Date A-E work initiated: 2nd Qtr. FY 1989

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

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

5. Previous cost estimate: $456,000
Date: January 1990

6. Current cost estimate: $456,000
Date: January 1991

7. Financial Schedule:

Fiscal Year	Authorization	Appropriations	Obligations	Costs
FY 1989	$ 6,000	$ 6,000	$ 6,000	$ 5,633
FY 1990	39,440	39,440	39,440	15,916
FY 1991	69,593	69,593	69,593	50,290
FY 1992	90,360 a/	90,360 a/	90,360 a/	108,771
FY 1993	110,407	110,407	110,407	117,153
FY 1994	93,000	93,000	93,000	102,580
FY 1995	45,000	45,000	45,000	52,290
FY 1996	0	0	0	3,367

8. Brief Physical Description of Project

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

a/ Reflects savings of $2,200,000 of B/A due to proposed Davis Bacon Amendment.

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

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

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

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

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

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

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

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 92-E-332

10. Details of Cost Estimate

a.	High Flux Beam Reactor Facility	$ 565
b.	National Synchrotron Light Source	1,500
c.	Stanford Synchrotron Radiation Laboratory	400
d.	High Flux Isotope Reactor	2,061
e.	Notre Dame	600
f.	1-2 GeV Synchrotron Radiation Source	1,500
	Total Estimated Cost	$6,626

11. Method of Performance

Design, engineering and inspection will be performed by Brookhaven National Laboratory, Stanford Synchrotron Radiation Laboratory, Oak Ridge National Laboratory, Lawrence Berkeley Laboratory, and University of Notre Dame. 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 1992 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEET
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: General Plant Projects

2. Project No.: GPE-400

3. Date A-E work initiated: 1st Qtr. FY 1992

3a. Date physical construction starts: 2nd Qtr. FY 1992

4. Date construction ends: 4th Qtr. FY 1993

5. Previous cost estimate: None

6. Current cost estimate: $4,500
Date: January 1991

7. Financial Schedule:

Fiscal Year	Obligations	Costs FY 1990	FY 1991	FY 1992	FY 1993
Prior Year Projects	$ 3,221	$ 1,550	$ 0	$ 0	$ 0
FY 1990 Projects	2,784	1,746	1,038	0	0
FY 1991 Projects	3,069	0	1,085	1,984	0
FY 1992 Projects	4,500	0	0	2,296	2,204

8. Brief Physical Description of Project

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

CONSTRUCTION PROJECT DATA SHEET

1. Title and location of project: General Plant Projects

2. Project No.: GPE-400

8. Brief Physical Description of Project (continued)

The currently estimated distribution of FY 1991 funds by office is as follows:

Ames Laboratory	$ 600
Argonne National Laboratory	3,550
Notre Dame Radiation Laboratory	50
Sandia National Laboratories	100
Stanford Synchrotron Radiation Laboratory	200
Total project cost	$ 4,500

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..... $ 600

The major projects are the Development Building HVAC upgrade, the final phase of the Wilhelm Hall HVAC upgrade, and upgrading building security. The balance of the work involves handicapped access, energy conservations, roof replacement, and general construction items.

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

Argonne National Laboratory..... $ 3,550

The Argonne National Laboratory FY 1992 General Plant Projects (GPP) are miscellaneous minor new construction projects of a general nature. The total estimated costs of each will not exceed $1,200,000. These general plant projects are necessary to provide for the continuing requirement to maintain the facilities in a good state of repair, to adapt the facilities to new or improved production or service techniques, to effect economics of operations and to reduce or eliminate health, fire, and security problems. The highest priority projects will be selected as needs are identified in FY 1992 and will address requirements as identified in the "Tiger Team" assessment of the laboratory.

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

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

Of the total requested for GPP at the Argonne National Laboratory, approximately 50 percent will be used for plant rehabilitation and approximately 50 percent will be used for upgrading and programmatic projects.

Notre Dame Radiation Laboratory..... $ 50

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

Sandia National Laboratories..... $ 100

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

Stanford Synchrotron Radiation Laboratory..... $ 200

Requirements include minor modifications and additions necessary to support the optimum use of the laboratory research capabilities. 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.

CONSTRUCTION PROJECT DATA SHEET

1. Title and location of project: General Plant Projects

2. Project No.: GPE-400

11. Method of Performance

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

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEET
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

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

2. Project No.: 89-R-402

3. Date A-E work initiated: 2nd Qtr. FY 1989

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

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5. Previous cost estimate: $456,000
Date: January 1990

6. Current cost estimate: $456,000
Date: January 1991

7. Financial Schedule:

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FY 1991	69,593	69,593	69,593	50,290
FY 1992	90,360 a/	90,360 a/	90,360 a/	108,771
FY 1993	110,407	110,407	110,407	117,153
FY 1994	93,000	93,000	93,000	102,580
FY 1995	45,000	45,000	45,000	52,290
FY 1996	0	0	0	3,367

8. Brief Physical Description of Project

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

a/ Reflects savings of $2,200,000 of B/A due to proposed Davis Bacon Amendment.

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

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

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

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

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

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

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

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

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

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

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

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

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

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

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

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

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

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

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

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

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

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

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

9. Purpose, Justification of Need 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 benefited by the availability of two additional facilities in the U.S. The one with the higher priority is a high-energy storage ring capable of providing fundamental undulator radiation in the x-ray region of the spectrum up to 20 keV, with an early 1990 target date for full operation. Such a storage ring requires an electron or positron beam of energy around 6-7 GeV. Both should be insertion device (undulator and wiggler) based machines designed to accommodate a large number of such insertion devices.

CONSTRUCTION PROJECT DATA SHEET

1. Title and location of project:	6-7 GeV Synchrotron Radiation Source Argonne National Laboratory Argonne, Illinois	2. Project No.:	89-R-402

9. Purpose, Justification of Need 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. Recently, this high priority national need was reaffirmed in the National Research Council (Brinkman) report - Physics through 1990's - and by the Stehle subcommittee of the DOE Energy Research Advisory Board.

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

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

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

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

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

10. Details of Cost Estimate	Total Cost
a. Engineering, Design, and Inspection	$ 59,832
b. Construction Costs	
(1) Technical Components	189,216
(2) Conventional Facilities	132,116
c. Contingency	74,836
Total Estimated Cost	$456,000

11. Method of Performance

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

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

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

	Prior Years	FY 90	FY 91	FY 92	FY 93	FY 94	FY 95	FY 96	Total
a. Total Project Funding									
(1) Total facility costs									
(a) Construction line item	5,633	15,916	50,290	108,771	117,153	102,580	52,290	3,367	456,000
(b) Expense funded equipment	0	0	0	0	0	0	0	0	0
(c) Inventories	0	0	0	400	4,400	2,500	0	0	7,300
(2) Other project funding									
(a) R&D necessary to complete construction	20,157	10,441	15,832	17,500	19,727	12,500	7,500	0	103,657
(b) Other project related costs	0	0	0	7,900	25,500	44,600	64,600	78,900	221,500
(c) Conceptual design costs	3,465	0	0	0	0	0	0	0	3,465
Total Project Costs	29,255	26,357	66,122	134,571	166,780	162,180	124,390	82,267	791,922

b. Other Related Annual Costs (estimated costs in thousands in FY 1996 dollars)

(1) Facility Operating Cost a/	$58,100
(2) Programmatic Research	18,100
(3) Capital Equipment Related to Programmatic Research	2,500
(4) Accelerator Improvements	4,500
Total Related Annual Costs	$83,200

a/ Annual operating costs which begin in 1996 include operations effort, utility, and administrative costs.

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

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

a. Total project funding

(1) Total facility costs

(a) Construction line item - No narrative required

(b) Inventories

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

(2) Other project funding

(a) R&D necessary to complete construction.

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

(b) Other project-related costs

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

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEET
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: 1-2 GeV Synchrotron Radiation Source
Lawrence Berkeley Laboratory
Berkeley, California

2. Project No.: 87-R-406

3. Date A-E work initiated: 1st Qtr. FY 1987

3a. Date physical construction starts: 2nd Qtr. FY 1988

4. Date construction ends: 2nd Qtr. FY 1993

5. Previous cost estimate: $99,500
Date: January 1990

6. Current cost estimate: $99,500
Date: January 1991

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1987	1,500	1,500	1,500	985
1988	18,000	18,000	18,000	10,317
1989	25,000	25,000	25,000	21,952
1990	25,636	25,636	25,636	23,693
1991	22,866	22,866	22,866	24,500
1992	6,498	6,498	6,498	12,557
1993	0	0	0	5,496

8. Brief Physical Description of Project

The 1-2 GeV Synchrotron is being built within the Lawrence Berkeley Laboratory, which is located on University of California property adjacent to the Berkeley campus. The project will include the construction of new facilities, and alterations and additions to existing plant and site facilities, especially Building 6 (the circular building that now houses the 184-Inch Cyclotron). The 1-2 GeV Synchrotron is a special facility comprised of an electron storage ring and injection system, insertion devices (undulators and wigglers) for generating synchrotron radiation and photon beamlines. The facility consists of a 50-MeV injector, a full-energy booster synchrotron, an electron storage ring, which has 12 6-m-long straight sections for insertion devices (11 could support insertion devices),

CONSTRUCTION PROJECT DATA SHEET

1. Title and location of project: 1-2 GeV Synchrotron Radiation Source
Lawrence Berkeley Laboratory
Berkeley, California

2. Project No.: 87-R-406

8. Brief Physical Description of Project (continued)

initial complement of insertion devices, and photon beamlines. Development of other straight sections and bending magnet ports are not included in the scope of this project. Their development in future years however, will provide flexibility to respond to new scientific directions and to take advantage of new materials, designs, and other technological advances. When fully developed, the facility will be able to provide up to 60 user stations.

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

The 1-2 GeV Synchrotron Facility will be a dedicated synchrotron radiation source that is optimized for generating vacuum ultraviolet and soft x-ray (XUV) light from periodic magnetic devices. Investigators from industry, universities, and national laboratories will have access to unique capabilities--high spectral brilliance and very short pulse length (nominally tens of picoseconds). Multi-period undulators in the storage ring will provide spatially and longitudinally coherent radiation that is broadly tunable across the XUV region of the spectrum.

The 1-2 GeV Synchrotron will permit new studies in both basic and applied science. In **biology**, for example, the high photon flux combined with the capability for wavelength tuning, will enhance imaging and scattering techniques. Picosecond pulses and the ability to match soft x-rays to the absorption features of major structural biological elements, such as carbon, nitrogen, and oxygen, will make it possible to undertake dynamical response studies of specimens in something very close to their natural state. The coherence properties of undulator radiation will extend the use of synchrotron radiation into the phase-sensitive world of x-ray interferometry and biological microholography.

In atomic and molecular physics, very high photon fluxes are needed for spectroscopic studies of free atoms and molecules in the gas phase; with radiation from undulators and wigglers an acceptable signal-to-noise ratio can be obtained for many experiments in the x-ray region. The facility will introduce new standards for spectral resolution, and will provide access to new studies of atomic structure and dynamics, quantum interference effects, and threshold phenomena.

CONSTRUCTION PROJECT DATA SHEET

1. Title and location of project: 1-2 GeV Synchrotron Radiation Source
Lawrence Berkeley Laboratory
Berkeley, California

2. Project No.: 87-R-406

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

In chemistry, the facility will open new areas of research on chemical reactivity. High spectral brilliance and picosecond time structure of the radiation will permit high-resolution dynamical studies of reaction kinetics, intramolecular transfer processes, excited state proton and electron transfer, and molecular photodissociation and photoionization.

In materials and surface science, the capabilities of the 1-2 GeV Synchrotron will permit new investigations of bulk materials as well as surfaces and interfaces. Time-resolved studies in catalysis will be possible with XUV radiation of extremely high brilliance and picosecond time structure. For instance, it will be possible to study the dynamics of surface contamination and interface formation and to verify microscopic models for catalysis, oxidation, corrosion, and interface growth.

Industrial utilization of XUV radiation will be stimulated by the availability of this radiation source, which can become a focal point for industrial-academic collaboration. One industrial application of radiation from the 1-2 GeV Synchrotron is improved mask fabrication for the microelectronics industry. By utilizing the full potential of synchrotron radiation for x-ray lithography, it will be possible to achieve finer feature sizes at less demanding aspect ratios, while competitive writing speeds are maintained.

In the area of national security, scientists at several national defense laboratories have expressed the need for access to a modern soft x-ray synchrotron radiation facility like the 1-2 GeV Synchrotron. They have emphasized dependable access to high-flux, high-brilliance facilities for program-related research.

These scientific opportunities are only a sample, indicating the potential for state-of-the-art synchrotron radiation research with the 1-2 GeV Synchrotron. The proposed facility will provide a much-needed addition to this country's oversubscribed synchrotron radiation sources, and will provide important new opportunities for student research and training in an area in which a lack of qualified personnel is already being felt. These scientific and educational opportunities have been well documented recently by national committees studying major research facilities needed to keep the United States scientifically competitive. These committees have consistently given the 1-2 GeV Synchrotron high priority. They include the DOE's Planning Study for Advanced National Synchrotron Radiation Facilities, the NRC's Major Materials Facilities Committee, and the DOE's ERAB Materials Facilities ad hoc Review Committee which reviewed the NRC report.

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

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

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

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CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

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

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

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CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

9. Purpose, Justification of Need 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. Recently, this high priority national need was reaffirmed in the National Research Council (Brinkman) report - Physics through 1990's - and by the Stehle subcommittee of the DOE Energy Research Advisory Board.

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CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

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

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

10. Details of Cost Estimate

	Total Cost
a. Engineering, Design, and Inspection	$ 59,832
b. Construction Costs	
(1) Technical Components	189,216
(2) Conventional Facilities	132,116
c. Contingency	74,836
Total Estimated Cost	$456,000

11. Method of Performance

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

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

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

	Prior Years	FY 90	FY 91	FY 92	FY 93	FY 94	FY 95	FY 96	Total
a. Total Project Funding									
(1) Total facility costs									
(a) Construction line item	5,633	15,916	50,290	108,771	117,153	102,580	52,290	3,367	456,000
(b) Expense funded equipment	0	0	0	0	0	0	0	0	0
(c) Inventories	0	0	0	400	4,400	2,500	0	0	7,300
(2) Other project funding									
(a) R&D necessary to complete construction	20,157	10,441	15,832	17,500	19,727	12,500	7,500	0	103,657
(b) Other project related costs	0	0	0	7,900	25,500	44,600	64,600	78,900	221,500
(c) Conceptual design costs	3,465	0	0	0	0	0	0	0	3,465
Total Project Costs	29,255	26,357	66,122	134,571	166,780	162,180	124,390	82,267	791,922

b. Other Related Annual Costs (estimated costs in thousands in FY 1996 dollars)

(1) Facility Operating Cost a/	$58,100
(2) Programmatic Research	18,100
(3) Capital Equipment Related to Programmatic Research	2,500
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Total Related Annual Costs	$83,200

a/ Annual operating costs which begin in 1996 include operations effort, utility, and administrative costs.

CONSTRUCTION PROJECT DATA SHEET

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

2. Project No.: 89-R-402

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

a. Total project funding

(1) Total facility costs

(a) Construction line item - No narrative required

(b) Inventories

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

(2) Other project funding

(a) R&D necessary to complete construction.

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(b) Other project-related costs

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

DEPARTMENT OF ENERGY
FY 1992 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEET
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: 1-2 GeV Synchrotron Radiation Source
Lawrence Berkeley Laboratory
Berkeley, California

2. Project No.: 87-R-406

3. Date A-E work initiated: 1st Qtr. FY 1987

3a. Date physical construction starts: 2nd Qtr. FY 1988

4. Date construction ends: 2nd Qtr. FY 1993

5. Previous cost estimate: $99,500
Date: January 1990

6. Current cost estimate: $99,500
Date: January 1991

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1987	1,500	1,500	1,500	985
1988	18,000	18,000	18,000	10,317
1989	25,000	25,000	25,000	21,952
1990	25,636	25,636	25,636	23,693
1991	22,866	22,866	22,866	24,500
1992	6,498	6,498	6,498	12,557
1993	0	0	0	5,496

8. Brief Physical Description of Project

The 1-2 GeV Synchrotron is being built within the Lawrence Berkeley Laboratory, which is located on University of California property adjacent to the Berkeley campus. The project will include the construction of new facilities, and alterations and additions to existing plant and site facilities, especially Building 6 (the circular building that now houses the 184-Inch Cyclotron). The 1-2 GeV Synchrotron is a special facility comprised of an electron storage ring and injection system, insertion devices (undulators and wigglers) for generating synchrotron radiation and photon beamlines. The facility consists of a 50-MeV injector, a full-energy booster synchrotron, an electron storage ring, which has 12 6-m-long straight sections for insertion devices (11 could support insertion devices),

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8. Brief Physical Description of Project (continued)

initial complement of insertion devices, and photon beamlines. Development of other straight sections and bending magnet ports are not included in the scope of this project. Their development in future years however, will provide flexibility to respond to new scientific directions and to take advantage of new materials, designs, and other technological advances. When fully developed, the facility will be able to provide up to 60 user stations.

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

The 1-2 GeV Synchrotron Facility will be a dedicated synchrotron radiation source that is optimized for generating vacuum ultraviolet and soft x-ray (XUV) light from periodic magnetic devices. Investigators from industry, universities, and national laboratories will have access to unique capabilities--high spectral brilliance and very short pulse length (nominally tens of picoseconds). Multi-period undulators in the storage ring will provide spatially and longitudinally coherent radiation that is broadly tunable across the XUV region of the spectrum.

The 1-2 GeV Synchrotron will permit new studies in both basic and applied science. In biology, for example, the high photon flux combined with the capability for wavelength tuning, will enhance imaging and scattering techniques. Picosecond pulses and the ability to match soft x-rays to the absorption features of major structural biological elements, such as carbon, nitrogen, and oxygen, will make it possible to undertake dynamical response studies of specimens in something very close to their natural state. The coherence properties of undulator radiation will extend the use of synchrotron radiation into the phase-sensitive world of x-ray interferometry and biological microholography.

In atomic and molecular physics, very high photon fluxes are needed for spectroscopic studies of free atoms and molecules in the gas phase; with radiation from undulators and wigglers an acceptable signal-to-noise ratio can be obtained for many experiments in the x-ray region. The facility will introduce new standards for spectral resolution, and will provide access to new studies of atomic structure and dynamics, quantum interference effects, and threshold phenomena.

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

In chemistry, the facility will open new areas of research on chemical reactivity. High spectral brilliance and picosecond time structure of the radiation will permit high-resolution dynamical studies of reaction kinetics, intramolecular transfer processes, excited state proton and electron transfer, and molecular photodissociation and photoionization.

In materials and surface science, the capabilities of the 1-2 GeV Synchrotron will permit new investigations of bulk materials as well as surfaces and interfaces. Time-resolved studies in catalysis will be possible with XUV radiation of extremely high brilliance and picosecond time structure. For instance, it will be possible to study the dynamics of surface contamination and interface formation and to verify microscopic models for catalysis, oxidation, corrosion, and interface growth.

Industrial utilization of XUV radiation will be stimulated by the availability of this radiation source, which can become a focal point for industrial-academic collaboration. One industrial application of radiation from the 1-2 GeV Synchrotron is improved mask fabrication for the microelectronics industry. By utilizing the full potential of synchrotron radiation for x-ray lithography, it will be possible to achieve finer feature sizes at less demanding aspect ratios, while competitive writing speeds are maintained.

In the area of national security, scientists at several national defense laboratories have expressed the need for access to a modern soft x-ray synchrotron radiation facility like the 1-2 GeV Synchrotron. They have emphasized dependable access to high-flux, high-brilliance facilities for program-related research.

These scientific opportunities are only a sample, indicating the potential for state-of-the-art synchrotron radiation research with the 1-2 GeV Synchrotron. The proposed facility will provide a much-needed addition to this country's oversubscribed synchrotron radiation sources, and will provide important new opportunities for student research and training in an area in which a lack of qualified personnel is already being felt. These scientific and educational opportunities have been well documented recently by national committees studying major research facilities needed to keep the United States scientifically competitive. These committees have consistently given the 1-2 GeV Synchrotron high priority. They include the DOE's Planning Study for Advanced National Synchrotron Radiation Facilities, the NRC's Major Materials Facilities Committee, and the DOE's ERAB Materials Facilities ad hoc Review Committee which reviewed the NRC report.

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

The 1-2 GeV Synchrotron will be available to general users as well as to participating research teams (PRTs). The Laboratory is determined to construct a user-friendly facility and has arrangements for users to play a significant role in determining the specification and design of the beamlines. In addition, the 1-2 GeV Synchrotron has additional straight sections and ports on bending magnets that will be available for development by PRTs or for future facility enhancement by LBL to enable users to take advantage of new scientific opportunities or unforeseen technological developments. Realization of the full capabilities inherent in the 1-2 GeV Synchrotron configuration would result in support of up to 60 user stations.

10. Detail of Cost Estimate

	Item Cost	Total Cost
a. Engineering, design, inspection and administration (EDIA).....		$ 23,300
(1) Conventional construction at approximately 14%.....	$ 2,230	
(2) Special facilities at approximately 31%.....	13,720	
(3) Project management/administration.....	7,350	
b. Construction costs.....		58,560
(1) Conventional construction.....	14,880	
(2) Special facilities.....	43,680	
Subtotal.....		81,860
c. Contingencies at approximately 22% of (a & b).....		17,640
(1) Conventional facilities.....	2,770	
(2) Special facilities.....	14,870	
Total estimated cost.....		$ 99,500

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11. Methods of Performance

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

The 1-2 GeV Synchrotron Radiation Source special facilities engineering design will be done by LBL personnel, as will major technical component construction and assembly. Technical components and standard equipment for the facility will be procured by fixed-price subcontracts awarded on the basis of competitive bids.

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

	FY 1987	FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	Total
a. Total project costs								
1. Total facility construction costs.	$ 985	$10,317	$21,952	$23,693	$24,500	$12,557	$ 5,496	$99,500
2. Other project costs								
(a) Storage Ring, Insertion Device, and Beamline R&D a/.....	1,500	2,000	1,873	1,000	0	---	---	6,373
(b) Startup/Preoperations.....	---	---	---	4,548	10,510	19,542	---	34,600
(c) Capital Equipment Related to R&D and Facility Startup...	500	500	1,000	1,500	1,000	1,000	---	5,500
Total other project costs..	2,000	2,500	2,873	7,048	11,510	20,542	---	46,473
Total project costs (Item 1 & 2).....	$ 2,985	$12,817	$24,825	$30,741	$36,010	$33,099	$ 5,496	$145,973

a/ FY 1986 preconstruction R&D: storage ring R&D ($962).

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

b. Other related annual costs (estimated costs in thousands in FY 1993 dollars)*

1. Facility operating costs	$22,500
2. Programmatic research	1,500
3. Capital Equipment Related to programmatic research	2,000
Total related annual costs	$26,000

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

a. Total project funding

1. Site preparation and building construction for the facility is scheduled for FY 1988-1991, in order that the building be ready for installation of the injector and the storage ring. Fabrication of the beamlines and insertion devices is scheduled for FY 1990-1992.

2. Other project funding
Storage ring R&D activities include (a) accelerator physics studies of lattice design, stabilization of high-current beams; (b) development of ultra-high vacuum technology; (c) beam control and instrumentation system development; (d) radio-frequency accelerating system development; and (e) magnet system prototyping. Insertion devices and beamline R&D activities include high-fidelity magnetic structures, in-vacuum undulators, and advanced beamline components suitable for high-brilliance photon beams. Facility operations begins in FY 1993 with construction completion scheduled the second quarter of FY 1993.

Startup funding requests are for operations staff training, startup of the injector, and startup of the storage ring.

Capital Equipment related to R&D includes equipment needed for the development of the above items.

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

b. Other related funding requirements

Facility operating costs represent estimates for the personnel, supplies, utilities and maintenance funding that will be needed to effectively operate a user-friendly facility. These costs, along with supporting capital equipment estimates, are based on Laboratory experience in operating national accelerator facilities and on a survey of operating experience of existing synchrotron radiation sources. The annual costs for programmatic research will support activities associated with maintaining and developing the scientific cpabilities of the facility staff in order to assure that the support provided to facility users is of the highest quality and that the continued development of the facility reflects the needs of the scientific and tchnological community. Because the 1-2 GeV Synchrotron Radiation Source will be primarily a national user facility, research funding to support facility users will be available through related activities of this and of other agencies and researchers affiliated with universities, national laboratories, and industry.

Due to the rapid advance in the technology in synchrotron radiation, and the need for precision in the machine, the Department continues to evaluate ways to maximize facility performance. As advances are made, and to the extent that we can gain by incorporating improvements to the facility, we will continue to work with the Congress to ensure that the nation gets an optimum research facility at an affordable price.