DEPARTMENT OF ENERGY
FY 1990 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH

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 Plan.

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.

The BES program supports research in several ways. The BES program annually supports approximately 1400 individual research projects at over 200 separate institutions with direct support for over 4000 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 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 Los Alamos Neutron Scattering Center at Los Alamos National Laboratory).

These major facilities account for a significant amount of the increased 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, there were about 1500 users from all scientific disciplines and programs which resulted in approximately 790 publications. The activity around these facilities is growing and the number of users is estimated at about 2000 for FY 1989. Many areas of modern science require large and costly facilities; without them, the necessary advanced research could not be done. BES also is providing advanced state-of-the-art computational support for several Energy Research programs other than Magnetic Fusion Energy [which is directly supported by the National Magnetic Fusion Energy Computer Center (NMFECC)], e.g., High Energy Physics, Nuclear Physics, and Biological and Environmental Research, as well as its own program.

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 Basic Energy Sciences program takes advantage of the research capabilities available at national laboratories, government laboratories, universities, and private research laboratories in the conduct of the program. The program support can be divided into three major components: research, facility operations, and construction. The facility operations component supports the operation of major user facilities for which access by qualified users is provided to the entire scientific community. Another component of the program, which is the largest component, is research support which takes place at national laboratories, universities and other institutions. By the very nature of the national laboratories and their traditional focus, they are especially valuable in doing research which is applicable to a number of energy concepts. The interactions possible are very great because laboratory scientists are frequently involved in many aspects of the applied energy programs. In addition, the stability of the organization and specialized capabilities which exist at the laboratories in many instances are unmatched. Many of the scientists involved in BES research programs are faculty or students at universities. Their research is enhanced through access to special facilities at national laboratories. 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 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.

The U.S. has been the world leader in science and technology and has derived many economic benefits from its leadership. The Department of Energy and its multiprogram laboratories play an important role in the Nation's scientific enterprise that is essential for our preeminence. A central feature of this role has been construction and operation of large, specialized scientific facilities that are used by scientists from universities and industry as well as the national laboratories. Many of the scientific facilities in our multiprogram laboratories are old or are becoming 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 environment, health, safety, security, safeguards, multiprogram energy purpose facilities and other such areas. However, less attention has been paid to improving the essential scientific

facilities required to accomplish the main scientific mission of the laboratories, i.e., preeminence in certain key fields of research. 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 1990 request for the Basic Energy Sciences program attempts to address not only the need for these powerful new facilities but also a continuing need for research essential to meeting the long-term goals of the Department and Nation. The request can be categorized into three areas: continuation of a strong basic program, operation of major user facilities at reasonable levels, and construction of advanced facilities.

DEPARTMENT OF ENERGY
FY 1990 CONGRESSIONAL BUDGET REQUEST
OFFICE OF ENERGY RESEARCH
(dollars in thousands)

LEAD TABLE

Basic Energy Sciences

Activity	FY 1988	FY 1989	FY 1990 Base	FY 1990 Request	Program Change Request vs Base Dollar	Program Change Request vs Base Percent
Operating Expenses						
Materials Sciences	$170,336	$180,476	$180,476	$202,252	+ 21,776	+ 12
Chemical Sciences	127,226	132,903	132,903	147,917	+ 15,014	+ 11
Applied Mathematical Sciences	41,919	42,663	42,663	44,877	+ 2,214	+ 5
Engineering and Geosciences	30,968	33,174	33,174	34,093	+ 919	+ 3
Advanced Energy Projects	14,127	14,538	14,538	14,936	+ 398	+ 3
Energy Biosciences	19,997	20,632	20,632	21,200	+ 568	+ 3
Program Direction	4,500	4,900	4,900	5,450	+ 550	+ 11
Subtotal Operating Expenses	409,073	429,286	429,286	470,725	+ 41,439	+ 10
Capital Equipment	31,699	31,700	31,700	37,587	+ 5,887	+ 19
Construction	116,932	88,300	88,300	81,688	- 6,612	- 8
Total	557,704 a/	549,286	549,286	590,000	+ 40,714	+ 7
Operating Expenses	(409,073)	(429,286)	(429,286)	(470,725)	+ 41,439	+ 10
Capital Equipment	(31,699)	(31,700)	(31,700)	(37,587)	+ 5,887	+ 19
Construction	(116,932)	(88,300)	(88,300)	(81,688)	- 6,612	- 8
Staffing (FTEs)	64	63	63	63		

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

a/ Total has been reduced by $5,101,000 which has been transferred to the SBIR program.

DEPARTMENT OF ENERGY
FY 1990 CONGRESSIONAL BUDGET REQUEST
(dollars in thousands)

SUMMARY OF CHANGES

Basic Energy Sciences

FY 1989 Appropriation	$ 549,286
FY 1990 Base	$ 549,286
Operating Expenses	
- Provides for an increase in operating funds to maintain research program at constant level of effort	$ 7,327
- Provides for additional funds required in support of the advanced scientific facilities	$ 8,805
- Provides for funding of national user facilities at a level required to meet user demand	$ 18,285
- Provide for expanded research in high temperature superconductivity and molecular sciences	$ 7,022
Capital Equipment	
- Provides for equipment needs at the national user facilities and includes equipment needed for expanded research in high temperature superconductivity and molecular sciences	$ 5,887

Construction

- Provides funding for ongoing construction
  - General Plant Projects
  - Accelerator Improvement Projects
  - 1-2 GeV Synchrotron Radiation Source
  - 6-7 GeV Synchrotron Radiation Source
  - 3 GeV Spear Injector
	$ 35,988

- Provides funding for the Partial Decontamination and Medium Term Protective Storage of the ANL CP-5 Research Reactor	$ 1,000
- Funding for Nuclear Scattering Experimental Hall completed in FY 1989	$- 4,000
- Makes no provision for continuing funding for Congressionally initiated projects	$- 39,600
FY 1990 Congressional Budget Request	$ 590,000

DEPARTMENT OF ENERGY
FY 1990 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
OFFICE OF ENERGY RESEARCH
(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 properties which will contribute to meeting materials needs of present and future energy technologies. 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 74% 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 Laboratories, 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 25%. 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.

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; tailor materials properties to satisfy defined requirements; predict materials problems and service life; and improve the theoretical and experimental capability to analyze the fundamental structure 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

I. Preface: MATERIALS SCIENCES (Cont'd)

research accomplishments during the past year include: understanding the role of grain boundary segregants in determining the ductility of intermetallic compounds; significantly improved computer modeling techniques for describing structure and behavior of metallic surfaces; new methods for predicting alloy phase diagrams from basic thermodynamic parameters; demonstration that whisker reinforcement in combination with transformation toughening leads to synergistic toughening behavior; demonstration that implantation of phosphorous in an amorphous iron alloy with 10% chromium gave the corrosion resistance of conventional iron alloys with 18% chromium; design, synthesis and characterization of the first organic ferromagnets; determination of the existence of an isotope effect in the high temperature superconductors; the first application of a free electron laser to condensed matter research; demonstration that the properties of monolayer metal films (e.g., niobium) have properties dependent on the substrate and which are markedly different from the bulk. Two unscheduled redirections of effort have major impacts on research programs in Materials Sciences over the FY 1989-FY 1990 period: 1) potential large increases in costs to meet nuclear reactor safety requirements as identified by the NAS; and 2) Congressionally-directed spending to expedite the Advanced Neutron Source (ANS) design at ORNL.

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Materials Sciences Research.....	$123,636	$136,619	$140,527	+ 3
Facilities Operations.....	46,700	43,857	61,725	+ 41
Total, Materials Sciences....	$170,336	$180,476	$202,252	+ 12

II. B. Major Laboratory and Facility Funding

Argonne National Laboratory....	26,958	27,272	35,254	+ 29
Brookhaven National Laboratory.	35,376	38,689	43,244	+ 12
Lawrence Berkeley Laboratory...	15,814	16,189	21,098	+ 30
Oak Ridge National Laboratory..	26,787	30,100	28,906	- 4

III. Activity Descriptions

MATERIALS SCIENCES

Program Activity	FY 1988	FY 1989	FY 1990
Metallurgy and Ceramics Research	Research in processing and characterization of high temperature superconductors was emphasized as well as new theoretical approaches to study the structure of energy related materials. Research on high strength, high toughness ferritic steels and welds for pressure vessels supported. Expanded work on reliability and lifetime prediction. Maintained emphasis on studies of inert gases in materials which are important to understand embrittlement. Continued emphasis on compound semiconductors started in FY 1987. Properties of the artificially tailored materials were investigated. Research continued on studies of radiation induced changes in materials and fracture of energy materials under extreme conditions of temperature, stress, and hostile environment. Continued research on advanced energy materials synthesis	Increased emphasis on processing and understanding structure-property relationships of new high temperature superconductors will continue. Effort will continue on theoretical approaches to study the behavior of materials, on reliability and lifetime prediction of materials, on bonding and adhesion at interfaces, and on compound semiconductors. Continue approximately constant level of effort on properties of artificially tailored materials, radiation induced changes in materials, fracture in extreme conditions, and advanced energy materials such as high performance metallic alloys, ceramics, and magnetic materials.	Continue emphasis on processing and understanding structure-property relationships of new high-temperature superconductors. Efforts on theoretical approaches to the behavior of materials, advanced energy materials such as high-performance alloys and ceramics, bonding and adhesion of interfaces, and of compound semiconductors will continue. Significantly reduced levels of effort on the properties of artifically tailored materials, on radiation-induced changes in materials and on fracture.

III. MATERIALS SCIENCES RESEARCH (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Metallurgy and Ceramics Research (Cont'd)	and processing and magnetic materials. Continued research on nondestructive evaluation of materials failures.		
Solid State Physics Research	Continued research on new high temperature superconductors to understand structure and physical properties. Continued research with emphasis on Los Alamos neutron source and new instruments at other locations. Provided for expanded use of synchrotron radiation insertion devices. Supported new study of boron compounds with view toward utility in high temperature applications. Emphasis was on large-scale computations on energy-related materials systems with regard to materials properties and their temperature behavior. Continued research on surface modification using irradiation. Research emphasized processes and techniques important for surface characterization (e.g. photoemission	Sustained thrust via interlaboratory program and new university grants for research on solid state physics of high temperature superconductivity. Use of neutrons and synchrotron radiation for accurate studies of structure, dynamics and electronic configurations of high temperature superconductors. Research emphasizing use of synchrotron radiation, tunneling electron microscopy, ion and molecular beams and other new tools and probes for preparation, characterization and modification of thin films and surfaces. Theoretical research on new materials design will continue. Maintain strength of research effort on a priority basis.	Continue selected thrust efforts and priority research largely unique to DOE, such as in neutron scattering and synchrotron radiation. Continue augumented level of effort in the physics of high temperature superconductivity.

III. MATERIALS SCIENCES RESEARCH (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Solid State Physics Research (Cont'd)	and inverse photoemission). Research in x-ray lithography was emphasized. Research was expanded in processing of ceramic epitaxial films.		
Preconstruction R&D	Research and development continued in support of a DOE decision on a new reactor at ORNL at an accelerated rate as directed by Congress.	Expand research and development necessary to support a DOE decision to build an Advanced Neutron Source (ANS), a new research reactor to be located at ORNL.	R&D support provided for ANS conceptual design.
Materials Chemistry Research	Synthesis of new superconductors emphasized and chemical properties of these materials was measured. Emphasis was on polymer synthesis of new materials. Program in polymers and electrochemistry continued, with emphasis on electronic and magnetic properties of polymers, and on the design, synthesis, and characterization of new high strength polymers. Continued research on chemical structure, catalysis, and surface chemistry with emphasis in	Continue research on new high temperature superconductors emphasizing chemical substitution to improve critical parameters, selective constraints on other research areas. Research started on electrocatalysis using immobilized macromolecules, such as modified enzymes. Continued emphasis on the synthesis of new materials especially using modified or synthetic enzymes to make materials with tailored properties. Research will continue	Strong emphasis areas will include synthetic metals, high strength polymer systems, the materials chemistry of high Tc superconductors and enzymatic synthesis.

III. MATERIALS SCIENCES RESEARCH (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Materials Chemistry Research (Cont'd)	fundamental research on surface wear and friction, especially in theoretical studies. Began work on modified enzymes to make materials with tailored properties.	on the electronic and magnetic properties of polymeric and organic materials and on high strength polymers. Base program in chemical structure, catalysis, and surface chemistry continues with emphasis on structural chemistry at solid-fluid interfaces.	
Subtotal Materials Science Research	$123,636	$136,619	$140,527
Facilities Operations	Provided support for operation of major DOE user facilities for the scientific community including: High Flux Beam Reactor, National Synchrotron Light Source, Intense Pulsed Neutron Source, and Stanford Synchrotron Radiation Laboratory. Development of advanced scientific facilities: 1-2 GeV and 6-7 GeV light sources.	Additional support for major DOE user facilities to meet DOE requirements and user needs at HFBR, NSLS, SSRL, and IPNS. Continued R&D on the advanced scientific facilities: 1-2 GeV and 6-7 GeV light sources.	Increased demands at the national user facilities require a higher operational level at each of the facilities. Increased funding must be provided for safety, utility costs, safeguards requirements, and increased user requirements for each of the facilities supported by the Materials Sciences subprogram. Increase for preconstruction R&D for the 1-2 GeV and the 6-7 GeV light sources possible, thus meeting the scheduled completion of these facilities.
Subtotal Facilities Operations	$ 46,700	$43,857	$61,725
Total, Materials Sciences Operating Expenses	$170,336	$180,476	$202,252

III. Material Sciences (Cont'd)

Percentage Breakdown by Performer

Laboratory	52%	54%	50%
University	20%	20%	17%
Industrial/Other	1%	2%	2%
Facility Operations	27%	24%	31%
Subtotal	100%	100%	100%
Number of Researchers Supported	1,010	1,045	1,045

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, 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 the more efficient 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. Related to those goals is the support provided to major user facilities which are available to the entire scientific community for research. The budget for the Chemical Sciences subprogram is affected in a significant way in FY 1989 and FY 1990 by the necessity to meet facility requirements above the needs of the base research program. The recent National Academy of Sciences study has recommended a number of safety improvements at the High Flux Isotope Reactor which are being assessed to determine the possible funding impact in both the FY 1989 and FY 1990 budgets.

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Chemical Sciences Research.....	$ 86,201	$ 91,785	$ 97,637	+ 6
Facilities Operations.....	41,025	41,118	50,280	+ 22
Total, Chemical Sciences.....	$127,226	$132,903	$147,917	+ 11

II. Major Laboratory and Facility Funding

Argonne National Laboratory....	16,625	16,322	16,815	+ 3
Brookhaven National Laboratory.	16,293	15,618	17,370	+ 11
Lawrence Berkeley Laboratory...	7,354	7,250	7,458	+ 3
Oak Ridge National Laboratory..	35,388	37,194	38,772	+ 4

III. Activity Descriptions

CHEMICAL SCIENCES

Program Activity	FY 1988	FY 1989	FY 1990
Chemical Sciences Research	Research was focused on design of artificial photochemical energy conversion systems. Model compounds tailored for optimum light capture and efficient conversion was studied. Research in photochemistry, as well as combustion and catalysis related research, are responsive to the Congressionally directed initiative based on the NAS/NRC report "Opportunities in Chemistry."	Theoretical and experimental examinations of the role of solvents in photochemical charge separation phenomena of model compounds designed for efficient conversion will be carried out.	The highest priority programs in chemical dynamics of combustion reaction systems and chemical catalysis would receive cost of living increases at the expense of other existing programs. Research programs at the CRF and NSLS would continue at current levels. Most other programs would remain at FY 1989 or slightly reduced dollar levels. Modest growth is planned on photocatalysis, photoselective reaction pathways, solvent effects on photo induced electron transfer, and surface chemistry at semiconductor electrodes. Research on recoil hot atom chemistry will be reduced.

III. CHEMICAL SCIENCES (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Chemical Sciences Research (Cont'd)	Combustion related research continued. A new effort on reactivity of small metal clusters provided an atom based understanding of such properties of metals as catalysis, corrosion and electronic behavior.	Emphasis will continue on the dynamics of small combustion related species central to improved models of combustion processes, and on metal cluster chemistry that may underpin an understanding of bulk properties.	New and/or increased efforts in research on the mechanisms of soot formation and the dynamics of chemical reaction related to combustion will be initiated at the expense of cost-of-living adjustments for those activities less directly related to combustion and cluster scinece related to catalysis.
	Emphasis was on studies of interactions between laser beams and accelerator produced ion beams to determine energy transfer cross sections between electrons and ions in excited states. The Kansas State University Ion Collision Physics Facility began operation.	Dynamical effects of atomic systems in intense energy fields that occur under high flux conditions of photons, electrons or ions will be studied. The Kansas State University Ion Collision Physics Facility will become completely operational.	New efforts in low temperature plasma physics research will be started at the expense of 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.
	Emphasis was on research on reactive intermediates, catalytic clusters, oxide catalysts, acid sites and new biocatalytic systems to provide insights into side reactions, catalyst deactivation and new classes of catalysts for converting fossil and biomass resources into fuels.	Research on shape selective oxide catalysts for the energy efficient conversion of paraffinic hydrocarbons to bulk chemicals will be given priority. An initiative on research related to high temperature superconductors will be started. The synthetic chemistry of novel inorganic and organometallic compounds and polymers which can serve as precursors to the new classes of perovskite ceramic superconductors will be examined.	The new program in materials precursor chemistry will be expanded 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 will be continued.

III. CHEMICAL SCIENCES (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Chemical Sciences Research (Cont'd)	Emphasis was on unified modeling of thermochemistry of turbulent combustion; macro and micro structure modeling of flow fields; ignition and extinction characteristics to increase combustion efficiencies and pollutant control.	Combustion related turbulence research and thermophysical properties of fossil derived mixtures will continue to be emphasized.	Studies of the partition function of a variety of fluid mixtures and polymers for the correlation of the thermophysical properties into the supercritical region will be pursued at the expense of research in turbulence phenomena.
	Emphasis was on the study of supercritical fluids as solvents for salts and organic compounds, novel membrane compositions for the efficient separation of gases, and mass transport-enhancing effects of electric and magnetic fields on liquid-liquid extraction systems.	Research to effect direct measurement of heteroatoms in solid matrices such as coal will be carried out. Novel analytical methods for handling polar compounds and direct chromatographic analysis of fossil derived process streams will be explored.	The study of membrane separations methods of aqueous and gaseous species will be emphasized. The analytical characterization and speciation of trace components in aqueous media will be pursued at the expense of the study of macrocycle-based complexing agents. Support will be provided for expanded research in molecular sciences.
	Emphasis in FY 1988 was on solution chemical investigations of the heaviest elements, such as lawrencium. Solid state studies were focused on the characterization of ceramic-like compounds of potential importance to the development of nuclear waste host compounds.	Further research on actinide electronic properties and bonding in high temperature solid state mixed oxides and organoactinides will be performed. Solid state actinide chemistry related to the lanthanide containing high temperature superconducting ceramic materials will be investigated.	Theoretical calculations of the electronic properties of the heaviest actinide and transactinide elements to assess relativistic effects will be emphasized. High temperature thermodynamic studies of solid compounds to determine chemical stabilities will be pursued.
Subtotal Chemical Sciences Research	$86,201	$91,785	$97,637

III. CHEMICAL SCIENCES (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Facilities Operations	Provided support for operation of major user facilities for the scientific community including: National Synchrotron Light Source, Stanford Synchrotron Radiation Laboratory, High Flux Isotope Reactor/Transuranium Processing Plant and Combustion Research Facility.	Continue support for major user facilities to meet the needs of the national user community as well as the DOE. Operational support maintained at the FY 1988 levels and permits full year of support for the High Flux Isotope Reactor which has been shutdown to correct safety problems. Redirection of funds may be required to fully address concerns raised by the NAS.	Increases support for major user facilities to a level better meeting the needs of the national community. Higher facility utilization and the higher operating costs at these facilities will be accommodated. Continues safety improvements at the HFIR. Redirection of additional funds may be required to fully address the recommendation from the NAS review.
Subtotal Facilities Operations	$41,025	$41,118	$50,280
Total, Chemical Sciences Operating Expenses	$127,226	$132,903	$147,917
Percentage Breakdown by Performer			
Laboratory	36%	36%	34%
University	30%	30%	30%
Industrial/Other	2%	3%	3%
Facility Operations	32%	31%	33%
Subtotal	100%	100%	100%
Number of Researchers Supported	877	877	877

I. Preface: Applied Mathematical Sciences

Applied Mathematical Sciences has two activities: Mathematical Sciences Research and Energy Sciences Advanced Computation. The objectives of the Mathematical Sciences Research activity are: (1) to expand the knowledge of the fundamental mathematics and computer science principles necessary to model the complex physical phenomena involved in energy production systems and basic sciences, and (2) to explore future computational algorithms and architectures necessary for investigating these mathematical models. The objective of the Energy Sciences Advanced Computation activity is to provide access to the highest quality state-of-the-art supercomputers and relevant software to researchers supported by the Office of Energy Research.

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Mathematical Sciences Research	$ 23,552	$ 24,743	$ 25,550	+ 3
Energy Sciences Advanced Computation	18,367	17,920	19,327	+ 8
Total, Applied Mathematical Sciences	$ 41,919	$ 42,663	$ 44,877	+ 5

II. B. Major Laboratory and Facility Funding

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Argonne National Laboratory....	4,325	4,510	4,400	- 2
Lawrence Berkeley Laboratory...	2,287	1,680	1,680	--
Los Alamos National Laboratory.	1,500	1,500	1,640	+ 9
Oak Ridge National Laboratory..	1,565	1,715	1,790	+ 4
Supercomputer Centers:				
(MFECC & FSU/SCRI).....	15,500	16,763	17,000	+ 1

III. Activity Descriptions

Program Activity	FY 1988	FY 1989	FY 1990
APPLIED MATHEMATICAL SCIENCES			
Mathematical Sciences Research	Emphasis was on analytical, computational, and graphical techniques by teams at universities and laboratories for designing complete computational modeling systems.	New programs in mathematics of string theories complement the classical mathematical modeling of nonlinear hyperbolic conservation laws.	Continue research program at same level as FY 1989, with minor modifications to emphasize computational aspects of analytical studies.
	Research focused on optimum analysis and display of scientific data and efficient use of new supercomputer systems.	Continued emphasis on use of geometric methods in data and display. New programs in data management on hypercube and other parallel architectures will begin.	Continue research program at same level as FY 1989. Concentrate on scientific data management and analysis on a select set of promising architectures.
	Focus of research was on high level languages for new parallel processor computer systems. These languages are used for describing the various algorithms needed to specify exactly the steps required to solve computational models. New algorithms were incorporated into large scale computational models on the parallel supercomputers.	Continue research on high level languages for parallel computer systems. Emphasis will be on incorporating new algorithms into computational programs that simulate physical processes. Evaluate five year projects started in FY 1985 on three parallel architectures.	Continue research programs at FY 1989 level. Phase out one or more of the architecture studies and concentrate effort on a subset of parallel systems showing promise of commercial development.
Subtotal Mathematical Science Research Operations	$23,552	$24,743	$25,550

III. APPLIED MATHEMATICAL SCIENCES (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Energy Sciences Advanced Computation	Permits lease of Class VI+ computer system in the last quarter of FY 1988, which allowed ER scientists to address increasingly complex problems. This new machine is located at the NMFECC at LLNL. The FSU/SCRI project continued in fourth year of the five year agreement. Preliminary steps for ESNET are underway. Funding for Mendez/JSU/LBL was included in accordance with Congressional direction.	Continues support for operations of the NMFECC center with enhanced Class VI. Continue migration to ESNET at enhanced band width and standard protocols. Funding continued for FSU/SCRI as directed by Congress.	Continues funding for supercomputer access in a manner consistent with the approach in FY 1989. Funds are included for the access capability that has been available thru FSU.
Subtotal Energy Sciences Advanced Computation Operatioations	$18,367	$17,920	$19,327
Total Applied Mathematical Sciences	$41,919	$42,663	$44,877

APPLIED MATHEMATICAL SCIENCES

Percentage Breakdown by Performer			
Laboratoratory	49%	68%	68%
Universversity	50%	30%	30%
Industrial/ Other her	1%	2%	2%
Subtotal tal	100%	100%	100%
Number of Researchers Supportedrted	160	160	160

I. Preface: ENGINEERING AND GEOSCIENCES

The subprogram supports DOE's central fundamental research activities in engineering and geosciences. The Engineering Research onjectives 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 concerned especially with analysis, control and improvement of systems for transport of heat and fluids and for materials processing. The Geosciences Research objective is to develop a quantitative, predictive understanding of the energy related aspects of geological processes. The primary focus is on the geophysics and geochemistry of rock/fluid systems, with increasing emphasis on high resolution underground imaging. Other topics emphasized include geochemical migration, basic geoscience studies of sedimentary formations where oil and gas are located, and Continental Scientific Drilling (to study underground heat and mass transport.)

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Engineering Research.....	$ 14,669	$ 15,330	$ 15,764	+ 3
Geosciences Research.....	16,299	17,844	18,329	+ 2
Total, Engineering and Geosciences.....	$ 30,968	$ 33,174	$ 34,093	+ 3

II. B. Major Laboratory and Facility Funding

Lawrence Berkeley Laboratory...	2,410	2,782	2,888	+ 4
Los Alamos National Laboratory.	3,023	2,900	3,002	+ 4
Sandia, Albuquerque.....	2,826	2,380	2,432	+ 2

III. Activity Descriptions

Program Activity	FY 1988	FY 1989	FY 1990
ENGINEERING AND GEOSCIENCES			
Engineering Research	This activity focused on long-term research efforts cutting across energy technologies. Typical topics included thermodynamics of plastic deformations, chemical process plant control, flows of air-vapor-liquid mixtures, dynamics of non-linear systems, instrumentation for measuring properties of energy-related fluids and the like. Most of the research projects supported single investigators. However, there were several multi-investigator projects focusing on major thrust areas. Two such areas, involving collaborative efforts between a national laboratory (INEL) and several universities (MIT, Stanford University, and University of Minnesota), deal with 1) control of material processing - plasma diagnostics and welding process control, and (2) fracture mechanics. Another thrust, underway at ORNL, addressed the use of parallel computing for controlling intelligent machines in the context of energy systems. It concentrated on automating routine plant service and maintenance, as well as coping with emergency situation (accidents, natural disasters, etc.)	The appropriation provides for maintaining the same overall level of effort as in FY 1988. Basic research in energy related engineering offers ways for major improvements in energy systems design. New diagnostic and modeling methods for two-phase flows, for example, are replacing empirical correlations with vastly better models based on fundamental understanding of the underlying phenomena. This will contribute to the resolution of prime concern with reactor safety codes, namely the behavior of steam and water at high temperature and high pressure. Similar studies are extended to porous media which play a role in the recovery of oil and natural gas deposits, as well as in other energy systems. Research in solid mechanics should lead to major progress in the ability to predict life-to-crack-initiation of structural components. Research efforts will continue to address the fundamental areas of process design and control, non-destructive evaluation, instrumentation for hostile environments, and intelligent machines. With respect to the last, it is expected that experiments at	Support for basic engineering research will be maintained at a level of effort slightly below that of FY 1989. Emphasis will remain on the most critical aspects of two-phase flows and flows in porous media; in the latter case the collaboration between MIT, Sandia National Laboratory and Los Alamos National Laboratory will continue experiments aiming at the validation of advanced methods for analyzing such flows. At the same time it is expected that ongoing theoretical and experimental collaborative work at the three universities will cast light on the evolution of persistent organized large scale structures in turbulent flows. Some support for attacking basic engineering problems in high temperature superconducting devices will be provided. Research will continue in the areas of combustion, welding automation and plasma processing, as will studies in solid mechanics, and the dynamics of non-linear systems and smart controls for energy systems. Investigations of novel approaches to engineering problems based on recent advances in the theory of dynamical systems,

III. Activity Descriptions

Program Activity	FY 1988	FY 1989	FY 1990
ENGINEERING AND GEOSCIENCES			
Engineering Research (Cont'd)	Important recent accomplishments included 1) an elucidation of the mechanisms of rapid cooling by swirls injected into pipe-flow, opening the door to effective removal of high heat fluxes, such as those expected in future magnetic fusion devices; 2) utilization of instrumentation first developed for measuring thermophysical properties of mixtures of hydrocarbons to measure and standardize the properties of environmentally benign refrigerants, thus contributing to the reduction of the threat of atmospheric ozone layer depletion without compromising the energy efficiency and cost of air-conditioning and refrigeration equipment; 3) new understanding of the behavior of noise and other random processes in non-linear systems, leading to possible improvements in realistic computer simulations of nuclear reactor operation.	ORNL will demonstrate modes of operation in which two independent machines acting jointly under limited human supervision carry out a set of requested tasks. Studies carried out in the University-INEL collaborative project include developing efficient control strategies for automated welding processes, and the development of optical techniques for plasma diagnostics and process control. Further studies continue to address the fundamental engineering aspects of combustion and methods for acquisition of thermophsyical data for energy related processes. Systems using the new superconductors will be studied by, for example, use of non-destructive evaluation techniques to see changes associated with transformations to the superconducting state.	such as new efficient energy conversion cycles made possible by resonances between coupled oscillatory chemical reactions and mechanical process. Will continue the effort will continue to stimulate wide collaboration between national labs and universities in areas of interest to this program.
Subtotal Engineering Research	$14,669	$15,330	$15,764

Program Activity	FY 1988	FY 1989	FY 1990
Geosciences Research	Conducted research on physical and chemical properties of rock-water systems to aid in the interpretation of data obtained from seismic, electromagnetic and other geophysical underground imaging techniques. Rock mechanics and fluid flow studies related to reservoir modeling have contributed to a better understanding of the environment in fractured reservoirs. Measurements of the electrical properties of a black shale demonstrate that some hydrocarbon source rocks are the cause of the electrical conductivity anomalies determined by electromagnetic surveys; these results may be used in developing oil and gas exploration strategies. Laboratory studies indicate that non-linear elastic wave mixing may lead to entirely new techniques for examining underground structures. Continental scientific drilling has shown that molybdenite ore was precipitated shallowly in the Valles Caldera in New Mexico, an indication that the near surface zone was hotter in the past in this hydrothermal system. A new scientific corehole was started in the Valles with the largest core drilling rig in the United States. Isotope and rare earth elements signatures have been identified for various modes of flow and states of porosity in limestone	A major effort has been initiated to improve remote high-resolution, three-dimensional mapping capabilities using elastic waves (i.e., acoustic and shear waves) for underground imaging. Techniques for high data-rate processing and large array synthesis will be developed and applied to advance the state-of-the-art. This research seeks to provide the increased resolution necessary to define geologic discontinuities with an accuracy suitable for application to the requirements of waste isolation and hydrocarbon reservoir studies. In addition, other lines of research are in progress related to sedimentary basins which contain oil and gas resources. Rates of conversion of kerogen to petroleum, rock mechanics, fluid-rock interactions, geochemical transport, and isotopic tracer studies are major components of this effort. Thermodynamic properties of melts, brines, and other fluids will comprise an important part of geochemical research this year. Results of these studies will be applied to a better understanding of thermal regimes and the evolution of sedimentary basins. In the area of continental scientific drilling, a drill hole in the Valles Caldera, New Mexico, was completed early in FY 1989 to 1.7 km, about 200m into	Through redirection, increased funding will be provided for high resolution underground imaging of geologic media using elastic waves. New techniques for high data-rate processing, large array synthesis and the interpretation of seismic data in terms of geologic media parameters such as permeability will be part of this effort. Because of its application to DOE interests in radioactive and hazardous waste disposal, hydrocarbon reservoir studies, and geologic media in general, the underground imaging is expected to become a central effort in the Geosciences Research activity. Funding for this effort will be significantly increased in FY 1990 if the flow of excellent proposals is as strong as expected. The redirection is expected to require termination of a number of individual research projects underway in FY 1989 in areas other than high resolution underground imaging. To maintain appropriate balance in the remainder ot the program, many of the lines of research of previous years will be continued but at substantially reduced levels. Research related to sedimentary formations in which oil and gas resources are located will continue to be emphasized. Similar

II. ENGINEERING AND GEOSCIENCES (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Geosciences Research (Cont'd)	reservoirs and have proved highly valuable for improved understanding of a major class of oil fields. Research on transport in aqueous systems in underground fluids has demonstrated the importance of acetate in the fluids involved in sedimentary processes leading to the concentration of ores by organometallic complexes. Experimental studies have shown that defects in crystals produced by shock processes do not appreciably enhance the rate at which a mineral goes into solution. In studies of solar-terrestrial interactions, an absorption band of ozone was identified useful for ground based measurements of ozone column abundance.	the conductive zone of an active hydrothermal system. Geophysical surveys of the proposed drill site at Katmai in Alaska will be carried out. Solar-terrestrial physics research is concentrating on the relationship between the near-space environment of the earth and the upper and middle atmosphere.	research in other crustal rocks will aid in better understanding not only of thermal regimes and geothermal energy resources, but also of the heat sources responsible for the maturation of hydrocarbon-bearing sediments. Research topics which will continue to contribute essential basic knowledge along these lines include rock mechanics, fluid-rock interaction, sedimentary basin maturation, geochemical transport, isotopic tracer studies, and fluid flow. The research in geophysics will continue to include studies of solar-terrestrial-atmospheric interactions. Continental scientific drilling research will be maintained, particularly at Katmai.
Subtotal Geosciences Research	$16,229	$17,844	$18,329
Total Engineering and Geosciences Operating Expenses	$30,968	$33,174	$34,093
Percentage Breakdown by Performer			
Laboratory	51%	49%	49%
University	43%	42%	42%
Industrial/Other	6%	9%	9%
Subtotal	100%	100%	100%
Number of Researchers Supported	390	401	392

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 a high risk; to qualify for support they must also have the potential for an eventual high payoff of a magnitude sufficient to open new vistas in the Nation's technology posture. X-ray microscopy and holography, with a potential for imaging live biological specimens at subcellular levels, can serve as just one of many examples. An area of major programmatic attention is the transfer of successful projects to proper technology programs; such transfers are effected every year, and several already have led to major development programs both in the Government and in private industry.

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 it does not fund ongoing evolutionary research. The spectrum of projects supported is very broad, encompassing, for example, new sources of electromagnetic radiation, new methods of better fossil fuels utilization, totally new approaches to controlled fusion (including muon-catalyzed fusion) and unconventional approaches to the high temperature superconductors applications. 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.

A separate activity within AEP is the Heavy Ion Fusion Accelerator Research (HIFAR) program. HIFAR conducts research and development on the heavy-ion, induction linear accelerator method to assess its suitability as a "driver" for electric power plants based on the principle of inertial confinement fusion. In this approach to fusion, output from the driver is used to compress small pellets of fuel to the extent that energy-producing thermonuclear reactions occur. (The other driver contenders, lasers and light-ion accelerators, are being developed elsewhere within DOE.)

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Advanced Energy Projects.....	$ 14,127	$ 14,538	$ 14,936	+ 3
Total, Advanced Energy Projects.....	$ 14,127	$ 14,538	$ 14,936	+ 3

II. B. Major Laboratory and Facility Funding

Lawrence Berkeley Laboratory...	$ 4,938	$ 4,800	$ 5,100	+ 6
Los Alamos National Laboratory.	2,836	1,466	2,170	+ 48

III. Activity Descriptions

Program Activity	FY 1988	FY 1989	FY 1990
ADVANCED ENERGY PROJECTS			
Advanced Energy Projects	Continued emphasis was on the development of very bright laser-type x-ray sources and the evaluation of their applications, with the potential for a significant amount of technology transfer. Efforts on muon-catalyzed fusion were continued. Further studies of key physics parameters were performed, building upon recent experimental results. Planned activities in Heavy Ion Fusion Accelerator Research were to conduct comprehensive MBE-4 test series; to operate experiments at design specifications, document results and critically review; to complete accelerator parameter studies, review estimates and compare with experimental test results. Design codes were used to identify and assess the accelerator concepts and techniques needed to adequately test the major beam physics and accelerator technology issues. Injector development continued. These experiments and accelerator design studies established a basis for proceeding with a detailed design of an accelerator experiment to minimally meet the HIFAR program objective.	As is the case every year, new highly nonconventional energy-related concepts, as they emerge, will be explored for their technical feasibility. Continued emphasis will be on concepts for very bright laser-type x-ray sources and their applications, especially in the area of x-ray laser holography and microscopy, for imaging of living matter at subcellular levels; the work will be coordinated with the Biological and Environmental Research program. Muon-catalyzed fusion will be further explored for its potential as an alternative to other fusion schemes. The Heavy Ion Fusion Accelerator Research program will be continued to complete and document existing major research activities within the program; emphasis will be placed on maximizing the scientific return on the sizable investment in the existing HIFAR experimental apparatus.	Funds will be used to support exploratory research on innovative energy-related concepts which evolve from basic research but are in need of proving their pratical 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, and muon-catalyzed fusion or "cold-fusion" -- an approach to fusion energy generation that does not require high temperatures. The Heavy Ion Fusion Accelerator Research (HIFAR) effort will continue towards an understanding of key beam physics and accelerator technology issues through the comprehensive utilization

II. ADVANCED ENERGY PROJECTS (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Advanced Energy Projects (Cont'd)			of existing apparatus. The injector system will be used to probe the parameter space of physics associated with transporting very high-current beams of heavy ions.
Total Advanced Energy Projects Operating Expenses	$14,127	$14,538	$14,936
Percentage Breakdown by Performer			
Laboratory	75%	75%	75%
University	10%	10%	10%
Industrial/Other	15%	15%	15%
Subtotal	100%	100%	100%
Number of Researchers Supported	145	145	145

I. Preface: ENERGY BIOSCIENCES

The Energy Biosciences (EB) subprogram is structured to provide the basic microbiological and plant sciences information necessary for DOE's efforts in generating the background for enhancing the renewable resource base, for microbiological transformation of renewable organic materials such as lignocellulosics in the production of fuels and chemicals, and for other energy relevant biological systems applications. Research is undertaken to uncover basic understanding of biological principles, mechanisms and organisms in order to implement genetic manipulation or other biotechnology operations relevant to long range DOE objectives. Some investigations are designed with the objective of wedding contemporary plant and microbial biological research with state-of-the-art powerful chemical-physical techniques and thinking to achieve better understanding of mechanisms. The program fills a significant need in the federal research network by the support of biological areas not served adequately or, in some cases, not at all, by other programs.

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Energy Biosciences.....	$ 19,997	$ 20,632	$ 21,200	+ 3
Total, Energy Biosciences....	$ 19,997	$ 20,632	$ 21,200	+ 3

II. B. Major Laboratory and Facility Funding

Brookhaven National Laboratory.	$ 1,135	$ 1,135	$ 1,200	+ 6
Lawrence Berkeley Laboratory...	1,125	1,253	1,300	+ 4
Michigan State University.....	2,400	2,450	2,500	+ 2

III. Activity Descriptions

Program Activity	FY 1988	FY 1989	FY 1990
Energy Biosciences	Emphasis was continued on the core programs of Energy Biosciences in plant and microbial sciences. This included topics already identified in which work was already in progress. Some of these included studies on lignin and cellulose biosynthesis and microbial degradation of these biopolymers, metabolic regulation of biosynthetic pathways in plants, photosynthesis, development of genetic systems in anaerobic microorganisms, organelle genetics in plants, and others. The full implementation was completed on a plant and microbial complex carbohydrate center dedicated to research, training and service to the research community. The effort addressed those high priority needs identified in carbohydrate research.	The level allows continuation of the base program in plant and microbial sciences with internal adjustments of the program based on the turnover of projects. Some additional activity in plant biochemistry related to the mechanisms and regulation of the synthesis of lignin and plant and microbial polysaccharides may be expected with funds redirected from other research areas. Research activities on the biological modification of materials sponsored jointly with the Division of Materials Science will be modestly increased. The multidisciplinary plant science center research activities initiated in FY 1987 on complex carbohydrates and in FY 1988 on the early events involved in photosynthesis will continue to be	This is a sustaining level for the Energy Biosciences subprogram in the plant and microbial sciences that allows for maintenance of strong projects and, by benefit of turnover initiation of some new projects. It is anticipated that a few new projects will be in the areas of carbohydrate and lignin structure, function, synthesis and biodegradation. Ongoing research in these areas will continue with modest enhancement. The three agency (NSF, DOE, USDA) multidisciplinary plant sciences research centers begun in previous years at the University of Georgia and Arizonia State University will be maintained. Research activities on the biological continue at a near constant level.

III. Activity Descriptions

Program Activity	FY 1988	FY 1989	FY 1990
Energy Biosciences	A computerized carbohydrate data base was fully implemented. In addition, a number of new projects in protein engineering, molecular mapping of plant genetic information and biochemistry of plants and microorganisms were anticipated. Continued program at Oregon Graduate Center in response to Congressional direction ($1.7 million).	supported. Congressional direction to support programs at the Oregon Graduate Center continues.	
Total Energy Biosciences Operating Expenses	$ 19,997	$20,632	$21,200
Percentage Breakdown by Performer			
Laboratory	25%	25%	25%
University	71%	71%	71%
Industrial/Other	4%	4%	4%
Subtotal	100%	100%	100%
Number of Researchers Supported	215	215	195

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.

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Program Direction.....	$ 4,500	$ 4,900	$ 5,450	+ 11
Total, Program Direction...	$ 4,500	$ 4,900	$ 5,450	+ 11

III. Activity Descriptions

Program Activity	FY 1988	FY 1989	FY 1990
Program Direction	Provided funds for salaries, benefits, and travel for 64 full-time equivalents (FTE's) in the Office of Basic Energy Sciences, the Scientific Computing Staff, and related program and management support staff. Ongoing activities include assessing the scientific needs and priorities of the program; planning to meet those needs; technical review of proposals from laboratories and universities; and monitoring the progress of ongoing university contracts, laboratory programs, and construction projects; as well as responding to the many day-to-day requirements involving budget, procurement and other management support activities. Provided staff support for R&D and construction activities for the next generation of scientific research facilities needed to continue U.S. leadership in key scientific areas; supported numerous university construction projects; supported the Basic Energy Sciences Advisory Committee; and provided liaison with industry in such areas as superconductivity, semiconductors,	Provide funds for salaries and benefits, including normal increased personnel costs such as within-grade and merit increases, and travel related to 63 FTE's. Additional staff effort is required to ensure compliance with environment, safety and health (ES&H) directives and regulations at numerous research facilities including two Class A reactors, the High Flux Beam Reactor at Brookhaven National Laboratory and the High Flux Isotope Reactor at Oak Ridge National Laboratory. Adequate support becomes even more critical as R&D and construction activities associated with major new scientific facilities increase. Specifically, construction will be under way in FY 1989 on the 1-2 GeV and on the 6-7 GeV Synchrotron Radiation Sources; and safety issues related to these and a new multimillion dollar research reactor still in the R&D phase will need to be resolved. ($4,485)	Provide funds for salaries, benefits, and travel related to continuation of 63 FTE's. The increased funding will provide for normal increased personnel costs resulting, for example, from within-grade and merit increases and greater employee participation in the Federal Employees Retirement System. ES&H activities in connection with facilities management activities as discussed in FY 1989 will become more critical in FY 1990 as a result of increased user facilities construction and operation. Specifically, construction on the 6-7 GeV will increase significantly. Staff will continue to manage increasing workloads in such basic research programs as hydrocarbon, plant sciences, high temperature superconductivity, combustion/chemical processes and semiconductor research. ($4,846)

III. PROGRAM DIRECTION (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Program Direction (Cont'd)	and oil and gas geosciences. Also managed the DOE-wide SBIR program and the Magnetic Fusion Energy Computer Network. ($4,182)		
	Provided a variety of program support such as electronic information and communications services, printing and binding, and contractual services for such things as the SBIR program and to assist with the environment, safety and health workload required by current regulations and directives. ($318)	Continue the variety of program support services required in FY 1988. However, the increased funding provides the entire contractual support for the SBIR program. ($415)	Continue the variety of program support required in FY 1988 and FY 1989. Increased funding will provide for support costs of Automated Office Support System workstations including hotline support, hardware modifications, upgrades, moves, and telecommunications/network support. ($604)
Total, Program Direction	$4,500	$4,900	$5,450

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 with this type of 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

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Capital Equipment.....	$ 31,699	$ 31,700	$ 37,587	+ 19

III. Activity Descriptions

Program Activity	FY 1988	FY 1989	FY 1990
Capital Equipment	Replacement and acquisition of new equipment required in each of the subprograms continued to ensure that optimum research results were obtained and properly analyzed. General purpose equipment requirements for Ames and ANL continued to be met.	Equipment needs will be accommodated at the FY 1988 level. Replacement and acquisition of new equipment required in each of the subprograms 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.	Equipment needs will be accommodated at the FY 1989 level. Replacement and acquisition of new equipment required in each of the subprograms 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. Special equipment needs in Materials Sciences in superconductivity and semiconductor research areas can receive a small but needed increase. In addition, equipment necessary to expand research in molecular sciences is provided.
Total, Capital Equipment	31,699	$31,700	$37,587

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

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Construction.....	$116,932	$ 88,300	$ 81,688	- 8

III. Activity Descriptions

Program Activity	FY 1988	FY 1989	FY 1990
Construction	Included funding for the following projects; AIP, GPP, LANSCE, 1-2 GeV, and the 3 GeV Injector. Also included was funding for Congressionally-mandated projects.	Continues all projects under way in FY 1988 and makes provision for the start of design for the 6-7 GeV Synchrotron Radiation Source at ANL. Includes funding for several Congressionally-mandated projects.	Continues funding for AIP, GPP, 1-2 GeV, the 3 GeV Injector and the 6-7 GeV projects; and permits funding for partial decontamination and decommissioning of the CP-5. The funding level in FY 1990 is less than the FY 1989 level because no provision is made for continuing funding for Congressionally-mandated university projects and funding for the LANSCE facility is completed in FY 1989.
Total Construction	$116,932	$88,300	$81,688

I. Summary of Major User Facilities

The major facilities discussed below are used to conduct forefront research in materials, chemistry, biology, medicine, semiconductors and in both the applied and basic 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 1990 for two advanced scientific facilities (1-2 GeV Synchrotron Light 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 1988, FY 1989 and FY 1990 to provide for their operation and maintenance. The budget request in FY 1990 represents a significant increase for each of the major user facilities. These increases are necessary to operate the facilities at utilization levels which satisfy user demand to meet increased safety and safeguards requirements, and to meet planned increases for the newer facilities and facilities nearing completion. Funding for these facilities is included as part of the budget request in the Materials Sciences and Chemical Sciences subprograms.

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
National Synchrotron Light Source	$ 19,625	$ 19,324	$ 22,950	+ 19
High Flux Beam Reactor	10,900	10,911	15,300	+ 40
Intense Pulsed Neutron Source	5,200	5,122	6,480	+ 26
High Flux Isotope Reactor/ Transuranium Processing Plant	23,225	23,496	28,365	+ 21
Stanford Synchrotron Radiation Laboratory	10,265	10,152	13,410	+ 32

II. A. Summary Table

Program Activity	FY 1988	FY 1989	FY 1990	% Change
Los Alamos Neutron Scattering Center.....	3,000	4,800	4,500	- 6
Combustion Research Facility...	3,510	3,475	4,500	+ 29
Advanced Scientific Facilities				
1-2 GeV.....	2,000	1,873	6,000	+ 220
6-7 GeV.....	10,000	5,822	10,500	+ 80
Total Operating Expenses.....	$ 87,725	$ 84,975	$ 112,005	+ 32

THE NATIONAL SYNCHROTRON LIGHT SOURCE (NSLS), BROOKHAVEN NATIONAL LABORATORY

The National Synchrotron Light Source 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. It is now operating at about 50 percent of its experimental capacity and is expanding rapidly.

Program Activity	FY 1988	FY 1989	FY 1990
NSLS	Continued full year operations with increase needed for user support. First full year of x-ray ring operation.	Continue full year operations with increase needed to accommodate user support.	Continue full year operations with increase needed to accommodate user support and fully utilize facility.
Subtotal NSLS Operating	$19,625	$19,324	$22,950

III. Summary of Major User Facilities (Cont'd)

THE HIGH FLUX BEAM REACTOR (HFBR), BROOKHAVEN NATIONAL LABORATORY

The High Flux Beam Reactor 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 remains fully utilized and productive. About 200 users were involved in FY 1988. The scientific activity will continue at a constant level of effort during the next 2 years.

Program Activity	FY 1988	FY 1989	FY 1990
HFBR	Continued full year support with more emphasis on user support.	Continue support with reduced number of operating cycles in order 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 full operation and accomodates increased costs of safety and heavy water requirements at the reactor. The full extent of the safety improvements identified by the NAS are currently being determined.
Subtotal HFBR Operating	$10,900	$10,911	$15,300

THE INTENSE PULSED NEUTRON SOURCE (IPNS), ARGONNE NATIONAL LABORATORY

The Intense Pulsed Neutron Source is a dedicated user facility for advanced research with pulsed neutrons serving the physics, materials, chemical, and life sciences research communities. It is fully utilized to the extent available. About 180 users were involved in FY 1988. With the planned improvements of the proton target source of neutrons and some of the spectrometers, the scientific activity at this facility will increase moderately during the next 2 years.

III. Activity Descriptions (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
IPNS	Continued operations for users is limited to 21 weeks per year. Facility fully utilized to the extent available. The neutron flux will increase with addition of an enriched target.	Continue at FY 1988 level of operations for users.	Increases level of operation and user support.
Subtotal IPNS Operating	$5,200	$5,122	$6,480

THE HIGH FLUX ISOTOPE REACTOR (HFIR) AND TRANSURANIUM PROCESSING PLANT (TPP), OAK RIDGE NATIONAL LABORATORY

The High Flux Isotope Reactor 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 about 150 users are involved with research at the facility. Currently, safety considerations have caused the reactor to remain down. The current DOE plan is to restart the reactor after it is determined that the reactor can be safely operated and necessary improvements in plant and personnel have been made. This includes the hiring of additional staff, modifications to the reactor, and additional training of the reactor staff. This is expected to begin in FY 1989 and continue in FY 1990. 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 combined operating costs of these facilities are shown below.

Program Activity	FY 1988	FY 1989	FY 1990
HFIR and TPP	TPP operations planned for 12 months in FY 1988. HFIR remained down in order to resolve outstanding safety issues.	TPP operations for 12 months will depend on procurement of some support from other programs. HFIR will restart with necessary improvements made to ensure the safe and reliable operation of the reactor The full extent of the safety improvements identified by the NAS are currently being determined.	TPP operations and facility improvements will procede on a 12 month schedule. HFIR will operate 12 months and provide full services to users with safety upgrades mentioned above continued.
Subtotal HFIR/TPP Operating	$23,225	$23,496	$28,365

III. Activity Description (Cont'd)

Summary of Major User Facilities (Cont'd)

THE STANFORD SYNCHROTRON RADIATION LABORATORY (SSRL), STANFORD UNIVERSITY

The Stanford Synchrotron Radiation Laboratory 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 is dependent on the operation of the High Energy Physics electron injector. When fully utilized about 500 users are involved in research at the facility. With some new beamlines being commissioned, increased scientific activity is expected. Construction of a separate 3 GeV electron injector for the SPEAR Ring will continue in FY 1990.

Program Activity	FY 1988	FY 1989	FY 1990
SSRL	Continued SSRL operations level comparable to that in FY 1987. The use of the PEP ring increased appropriately to take advantage of new beamlines at PEP.	SSRL will operate at approximately the same level as in FY 1988. PEP use will depend on research priorities and interactions with the high energy physics program.	Increased use of SSRL and PEP beamlines.
Subtotal SSRL Operating	$10,265	$10,152	$13,410

LOS ALAMOS NEUTRON SCATTERING CENTER (LANSCE), LOS ALAMOS NATIONAL LABORATORY

The Los Alamos Neutron Scattering Center is a dedicated user facility for advanced research with the nation's most intense pulsed neutrons serving the physics, materials, chemical, and life sciences research communities. The operation of this facility utilizes the Los Alamos proton storage ring facility and is budgeted by Defense Programs. Construction of a new experimental hall at LANSCE continued in FY 1988 and be completed in FY 1989. With the new experimental hall, the scientific program activity will involve, by FY 1990, nearly 100 materials and materials-related scientists.

Program Activity	FY 1988	FY 1989	FY 1990
LANSCE	Increased operations funding was provided for LANSCE in consideration of user buildup and preparation for new experimental hall.	Increased operations funding for user support.	Increased funding for operations and user support.
Subtotal LANSCE Operating	$3,000	$4,800	$4,500

III. Activity Descriptions

COMBUSTION RESEARCH FACILITY (CRF), SANDIA NATIONAL LABORATORY

The Combustion Research Facility 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 are operational in FY 1988. About one new experimental capability will be added each year for the next several years.

Program Activity	FY 1988	FY 1989	FY 1990
CRF	Continued operations and additional resources were allocated to help satisfy the increasing demand from visiting scientists for access to advanced CRF laser systems. Emphasis included provision of a new laser system with better time resolution necessary for important combustion reaction kinetics studies.	Provides for needed increase in operations and user support over the FY 1988 level.	Support for new improved facility lasers will be provided. The portdoctoral and visiting scientist program will be enhanced to facilitate "technology transfer."
Subtotal CRF Operating	$3,510	$3,475	$4,500

ADVANCED SCIENTIFIC FACILITIES

Funding in FY 1990 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 Light Source (LBL) and the 6-7 GeV Synchrotron Radiation Source (ANL). Preconstruction R&D funds are requested to resolve technical uncertainties prior to and early in the actual construction of the facilities. In the case of the 1-2 GeV, construction is underway and the R&D funds for this project are focused on improvements to the magnet lattice and related activities. For the 6-7 GeV Source, significant R&D activities are necessary due to the overall size and complexity of the project. Research activities at the 6-7 GeV will be focused on prototypes of the dipole magnets and insertion devices.

III. ADVANCED SCIENTIFIC FACILITIES (Cont'd)

Program Activity	FY 1988	FY 1989	FY 1990
Advanced Scientific Facilities	Increased R&D funding for advanced scientific facilities to meet the construction schedules.	R&D funding for advanced scientific facilities continues.	Provides full support for needed R&D for the 1-2 GeV and 6-7 GeV light sources. The increase in FY 1990 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 light source.
Subtotal Advanced Scientific Facilities Operating	$12,000	$7,695	$16,500

DEPARTMENT OF ENERGY
FY 1990 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 1989 Appropriated	FY 1990 Request	Remaining Balance	TEC
90-R-402	Partial Decontamination and Medium Term Protection Storage of the ANL CP-5 Research Reactor	0	0	1,000	4,400	5,400
90-R-401	Accelerator Improvement Projects	2,300	2,300	4,600	0	4,600
90-R-400	General Plant Projects	4,900	4,900	5,588	0	5,588
89-R-402	6-7 GeV Synchrotron Radiation Source	0	6,000	40,000	410,000	456,000
88-R-403	3 GeV Spear Injector	3,000	6,500	4,500	0	14,000
87-R-406	1-2 GeV Synchrotron Radiation Source	19,500	25,000	26,000	29,000	99,500
87-R-403	Neutron Scattering Experimental Hall (LANSCE)	13,500	4,000	0	0	17,500
	Prior Year Projects	0	39,600	0	0	XXX
Total, Basic Energy Sciences Construction		XXX	88,300	81,688	443,400	XXX

DEPARTMENT OF ENERGY
FY 1990 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: 90-R-402 Partial Decontamination and Medium-Term (5-25 years) Protective Storage of the ANL CP-5 Research Reactor
Argonne National Laboratory
Argonne, Illinios

Project TEC: $ 5,400
Start Date: 1st Qtr. FY 1990
Completion Date: 4th Qtr. FY 1992

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1990	$ 1,000	$ 1,000	$ 1,000
1991	4,400	4,400	2,500
1992	0	0	1,900

3. Narrative:

(a) This project will provide safe medium-term (5-25 year) protective storage of the CP-5 research reactor with minimal surveliance and maintenance cost over the period of protective storage. All radioactively contaminated or otherwise potentially hazardous material external to the reactor biological shield process system will be removed and appropriately disposed. Wall and floor surfaces will be decontaminated. Beam tubes and other penetrations into the biological shield will be sealed to preclude access to the radioactive reactor internals. The process piping and equipment on the service floor will be removed and disposed of. Intrusion alarms will be installed. The reactor containment building (roof and circular wall) will be rehabilitated to ensure structural integrity and prevent water leaks during protective storage. A number of small outbuildings and facilities, e.g., cooling towers, formerly required for reactor operation and/or experimental programs, will be demolished.

(b) The contaminated material to be removed and disposed of includes: (1) abandoned used experimenters' equipment on the experimental floor; (2) obsolete experimenter and reactor maintenance equipment in storage in the yard and out-buildings; (3) irradiated sample and obsolete in-reactor experiments' equipment shielded below-grade storage tubes (rod storage area) and in storage under water in the spent-fuel canal facility; and (4) process piping and equipment on the reactor service floor.

(c) FY 1990 funding of $1,000,000 is requested to initiate construction for the medium term protective storage of the CP-5 Research Reactor and meet completion date of 4th quarter FY 1992.

DEPARTMENT OF ENERGY
FY 1990 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: 90-R-401 Accelerator and reactor improvements and modifications, various locations

Project TEC: $ 4,600
Start Date: 2nd Qtr. FY 1990
Completion Date: 3rd Qtr. FY 1992

2. Financial Schedule:

Fiscal Year	Appropriated	Obligations	Costs
1990	$ 4,600	$ 4,600	$ 3,600
1991	0	0	800
1992	0	0	200

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 and one project is requested at the Oak Ridge National Laboratory for improvements to the High Flux Isotope Reactor.

(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 nonvGovernment owned property.

National Synchrotron Light Source
Component hardware replacements and additions to achieve improved orbit stability by elimination of noise sources and to provide active feedback systems.

High Flux Beam Reactor
New state-of-the-art instrumentation to provide improved reliability and maintainability, such as control rod position indicators, primary system instrumentation, and on-line secondary water tritium monitors.

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, confinment building, and auxiliary buildings.

FY 1990 funding of $4,600,000 is requested to permit the timely improvements to these national user facilities.

DEPARTMENT OF ENERGY
FY 1990 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: 90-R-400 General plant projects

Project TEC: $ 5,588
Start Date: 1st Qtr. FY 1990
Completion Date: 4th Qtr. FY 1991

2. Financial schedule:

		Costs			
Fiscal Year	Obligations	FY 1988	FY 1989	FY 1990	After FY 1989
Prior Year Projects	3,150	731	100	0	0
FY 1987 Projects	4,900	3,265	1,635	0	0
FY 1988 Projects	4,900	0	3,500	1,400	0
FY 1989 Projects	5,588	0	0	4,188	1,400

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 subproject. At Argonne, BES is the funding program for all the laboratory's GPP.

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

Argonne National Laboratory	$ 4,218
Ames Laboratory	570
Notre Dame Radiation Laboratory	200
Sandia National Laboratories	300
Stanford Synchrotron Radiation Laboratory	300
Total project cost	$ 5,588

FY 1990 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.

(c) FY 1990 funding of $5,588,000 is requested to meet essential requirements of each of the above mentioned locations.

DEPARTMENT OF ENERGY
FY 1990 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, Illinios

Project TEC: $ 456,000
Start Date: 1st Qtr. FY 1989
Completion Date: 2nd Qtr. FY 1996

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1989	$ 6,000	$ 6,000	$ 6,000
1990	40,000	40,000	35,000
1991	75,000	75,000	48,000
1992	92,000	92,000	109,000
1993	105,000	105,000	110,000
1994	93,000	93,000	97,000
1995	45,000	45,000	49,000
1996	0	0	2,000

3. Narrative:

(a) Argonne National Laboratory has completed a conceptual design for, and plans to design, construct, and operate, a new-generation 6-7 GeV synchrotron radiation source, called the Advanced Photon Source. This facility will produce unprecedentedly brilliant soft and hard 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. Its users will include scientists, engineers, and graduate students from universities, industry, and research laboratories throughout the United States.

(b) The Advanced Photon Source as currently envisaged would 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 would 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 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 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. Observation of catalytic activity in materials with less than 1/10 of an atomic layer will be possible. 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.

(c) FY 1990 funding of $40,000,000 is requested to continue construction of the Advanced Photon Source and meet the construction completion date of 2nd Quarter FY 1996.

DEPARTMENT OF ENERGY
FY 1990 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: 88-R-403 3 GeV SPEAR Injector
Stanford Synchrotron Radiation Laboratory
Stanford, California

Project TEC: $14,000
Start Date: 1st Qtr. FY 1988
Completion Date: 4th Qtr. FY 1990

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1988	$ 3,000	$ 3,000	$ 1,695
1989	6,500	6,500	7,200
1990	4,500	4,500	5,105

3. Narrative:

(a) This project will provide a separate 3 GeV injector for the SPEAR storage ring so that synchrotron radiation experiments at the Stanford Synchrotron Radiation Laboratory (SSRL) can proceed independently instead of relying, as at present, on the availability of the linear accelerator of the Stanford Linear Accelerator Center (SLAC). In particular, this new injector will eliminate interference between SPEAR injection and functioning of the new SLAC Linear Collider (SLC), a new high priority facility in the DOE High Energy Physics program.

(b) SSRL has played a leading role in the revolution that has taken place over the past few years in synchrotron radiation research. The recent work at the Laboratory in developing a progression of increasingly effective and sophisticated insertion devices (wigglers and undulators) for the production of synchrotron radiation at both SPEAR and PEP storage rings has led to major advances in scientific and technological research. Examples of particular importance include the development of nonvinvasive angiography, the analysis of atomic arrangements the amorphous layers, and the measurement of magnet scattering. In spite of the strong capabilities offered by SPEAR for synchrotron radiation research, the effectiveness of this facility is seriously impaired by limitations on its availability for experimental work in this area. The limited

availability of SPEAR for synchrotron radiation production derives from two sources. The first is that it is also used for high energy experimentation. As a result, SPEAR is available for only half of its operating time for dedicated synchrotron radiation production. It is expected, however, that both SPEAR and PEP will become fully dedicated to synchrotron radiation production over the next few years.

(c) FY 1990 funding of $4,500,000 is requested to continue construction of the facilities and meet the construction completion date of the Fourth Quarter of FY 1990.

DEPARTMENT OF ENERGY
FY 1990 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 1992

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	22,000
1990	26,000	26,000	25,000
1991	23,000	23,000	22,600
1992	6,000	6,000	18,598

3. Narrative:

(a) The 1-2 GeV Synchrotron will be 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. The 1-2 GeV Synchrotron is a special new generation facility comprised of an electron storage ring and injection system and 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) made available from this facility. 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.

(c) FY 1990 funding of $26,000,000 is requested to permit construction and procurement activities to continue leading to construction completion in the Second Quarter of FY 1992.

* Schedule reflects Congressional reduction of $5,000,000 from the FY 1989 budget request. Restoration of the $5,000,000 is included as part of the FY 1991 total as is escalation in project cost associated with this reduction.

Department of Energy
FY 1990 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
Energy Supply Research and Development - Plant and Capital Equipment
Basic Energy Sciences
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: Partial Decontamination and Medium-Term (5-25 Years) Protective Storage of the ANL CP-5 Research Reactor Argonne National Laboratory, Argonne, IL

2. Project No.: 90-R-402

3. Date A-E work initiated: 1st Qtr. FY 1990

3a. Date physical construction starts: 2nd Qtr. FY 1990

4. Date construction ends: 4th Qtr. FY 1992

5. Previous cost estimate: None

6. Current cost estimate: $5,400
Less amount for PE&D: 0
Net cost estimate: $5,400
Date: January 1989

7. Financial Schedule:

Fiscal Year	Authorization	Appropriations	Obligations	Costs
1990	$1,000	$1,000	$1,000	$1,000
1991	4,400	4,400	4,400	2,500
1992	0	0	0	1,900

1. Title and location of project: Partial Decontamination and Medium-Term (5-25 Years) Protective Storage of the ANL CP-5 Research Reactor Argonne National Laboratory, Argonne, IL

2. Project No.: 90-R-402

8. Brief Physical Description of Project

This project will provide safe medium-term (5-25 years) protective storage of the CP-5 research reactor with minimal surveillance and maintenance cost over the period of protective storage. All radioactively contaminated or otherwise potentially hazardous material external to the reactor biological shield and process system will be removed and appropriately disposed. Wall and floor surfaces will be decontaminated. Beam tubes and other penetrations into the biological shield will be sealed to preclude access to the radioactive reactor internals. The process piping and equipment on the service floor will be removed and disposed of. Intrusion alarms will be installed. The reactor containment building (roof and circular wall) will be rehabilitated to ensure structural integrity and prevent water leaks during protective storage. A number of small outbuildings and facilities, e.g., cooling towers, formerly required for reactor operation and/or experimental programs, will be demolished.

The contaminated material to be removed and disposed of includes: (1) abandoned used experimenters' equipment on the experimental floor; (2) obsolete experimenter and reactor maintenance equipment in storage in the yard and out-buildings; (3) irradiated samples and obsolete in-reactor experimenters' equipment in shielded below-grade storage tubes (rod storage area) and in storage under water in the spent-fuel canal facility; and (4) process piping and equipment on the reactor service floor.

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

In their present state, the CP-5 facilities contain a potentially hazardous inventory of radioactive items. There is an accumulation of radioactive parts of experiments and other items on the main reactor floor around the structure. The accumulation on the main floor provides an easily accessible source for inadvertent exposure to radiation. The reactor's structure, albeit less accessible, presents a potential for exposure to extremely high levels of radiation as do the materials in storage outside of the containment building. The deteriorating condition of the containment building presents a serious risk of contamination transport due to water leaks. The risk of groundwater contamination will exist until the stored material is removed from the below-grade storage tubes. Moreover, the structural integrity of the containment building is threatened by the increasing extent of water penetration, so that rehabilitation of the building envelope is prerequisite to continued protective storage of the reactor and process piping.

1. Title and location of project: Partial Decontamination and Medium-Term (5-25 Years) Protective Storage of the ANL CP-5 Research Reactor Argonne National Laboratory, Argonne, IL

2. Project No.: 90-R-402

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

Currently, full-time surveillance and control of the facility during normal working hours is required to restrict the exposure of personnel to these sources of radiation. Off shift control is maintained by scheduled patrol by security forces. Operating costs of approximately $150,000 per year are directed to the surveillance and maintenance of the facility. The accomplishment of this project would provide an acceptable level of safety and risk control for the medium-term (5-25 years), accompanied by significant reduction in operating cost.

The ANL research reactor (CP-5) was constructed in 1951-1953 and began operation in 1954. Having outlived its usefulness, the reactor was shut down in September 1979. The spent fuel and the heavy water moderator were removed and shipped to the Savannah River Plant for reprocessing. Process systems and control instrumentation were turned off.

10. Details of Cost Estimate[a]

		Total
a. Engineering, design and inspection		$ 800
At 21% of construction cost		3,667
b. Construction Costs	$ 470	
1. Reactor Floor Cleanup	170	
2. Yard and Outbuildings Cleanup	160	
3. Cave and Canal Cleanup	235	
4. Rod Storage Area Cleanup	190	
5. Demolish Outbuildings, Facilities	1,982	
6. Reactor Process and Operational Systems Removal	260	
7. Decontamination and Secure Reactor	25	
8. Secondary Intrusion Barriers and Alarm System	80	
9. Repair Containment Building Outer Walls and Coat with Polymer Sealant	95	
10. Rehabilitate Roofs, Wings B, C, E		
Subtotal		$ 4,467

1. Title and location of project:	Partial Decontamination and Medium-Term (5-25 Years) Protective Storage of the ANL CP-5 Research Reactor Argonne National Laboratory, Argonne, IL	2. Project No.: 90-R-402

10. Details of Cost Estimate[a] (continued)

c. Contingency at 20% of Items a and b	933
Total	$ 5,400

[a]Based upon current cost data. Cost index for 1988 3.4%; 1989 4.3%, 1990 4.8%, 1991 5.0%, 1992 5.6%.

11. Method of Performance

Engineering, design, and inspection will be accomplished by Laboratory personnel. Procurement will be by fixed-price contracts awarded on the basis of competitive bids. Where practicable, construction and installation will be by outside construction contracts.

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

Not required.

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

Not required.

Department of Energy
FY 1990 CONGRESSIONAL BUDGET REQUEST
CONTSTRUCTION PROJECT DATA SHEETS
Energy Supply Research and Development - Plant and Capital Equipment
Basic Energy Sciences
(Tabular dollars in thousands. Narrative material in whole dollars.)

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

2. Project No.: 90-R-401

3. Date A-E work initiated: 2nd Qtr. FY 1990

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

4. Date Construction ends: 3rd Qtr. FY 1992

5. Previous cost estimate: none
Date:

6. Current cost estimate: $ 4,600
Less amount for PE&D: 0
Net cost estimate: $ 4,600
Date: January 1989

7. Financial Schedule

Fiscal Year	Authorization	Appropriations	Obligations	Costs
1990	$4,600	$4,600	$4,600	$3,600
1991	0	0	0	800
1992	0	0	0	200

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, and one project is requested at the Oak Ridge National Laboratory for improvements to the High Flux Isotope Reactor.

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

2. Project No.: 90-R-401

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

An upgrade of the storage rings existing horizontal trim magnets' power supplies will improve the stability of the orbit in the storage rings and thus enhance the performance of the experimental beamlines.

A monochromator and beam transport hardware is required to upgrade the beam line energy resolution for soft x-ray photoemission studies.

A hydrogen oven for the brazing of high vacuum components will insure the integrity and cleanliness of the storage rings' vacuum system.

An additional undulator which will be part of the storage ring vacuum environment will allow very small gap and periodicity and a large number of periods within the limited maximum allowable length of an X-ray storage ring straight section. An extremely bright, coherent source can be realized.

A special high power exit chamber will be fabricated for the above mentioned special source. This chamber will be capable of taking the power density of this source at full X-ray ring current.

Replacement of two of the existing RF cavities will increase the reliability and performance of the systems, resulting in improved beam stability and lifetime. Higher beam intensities will be possible at higher energies in the X-Ray ring.

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

2. Project No.: 90-R-401

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

b. High Flux Beam Reactor

The present viewing system for conducting fuel discharging operations utilizes periscopes, which must be manually assembled and disassembled before and after fuel discharging procedures. This is a cumbersome and strenuous task which has a history of nuisance problems. Closed Circuit TV (CCTV) systems to replace these periscopes are now available which can tolerate the high radiation environments to which they would be subjected in this type of application. This proposal is to purchase the CCTV equipment, and design and install the hardware necessary to convert from periscopes to a CCTV system.

The existing HFBR annunciator system is over 20 years old. Sections of the system are filled to capacity and spare parts are difficult to obtain. A new state-of-the-art system would consume much less electrical power and provide additional and useful information such as a sequence of events. Also, low power consumption would permit an alternate standby power system which would allow the annunciator to function during electrical power outages.

The HFBR has a radiation monitoring system which is approximately 25 years old. Its specialized ion chamber detectors are obsolete and are no longer manufactured. In addition, this existing system has poor stability and calibration is difficult due to the interaction of adjustments. Newer equipment with improved response and testability is commercially available. Installation will require rewiring and redesign of existing control room instrument panels.

Sealing of the HFBR building air inlets for establishing building confinement is accomplished by two 30" automatically operated butterfly valves in each inlet duct. One of the valves in each inlet is a more recent addition (1980), but the original valves, which have been in use for over 20 years, are deteriorating and no longer seal tightly. Additionally, an original 30" butterfly valve used to seal an exhaust duct for testing purposes is no longer effective. This proposal will replace the two old inlet valves with new valves of improved design, similar to those installed more recently, which have proven reliable. Similarly, the valve used to seal the exhaust duct will be replaced with a manually operated valve of improved design.

1. Title and location of project: Accelerator and Reactor Improvements and Modifications, various locations	2. Project No.: 90-R-401

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

Assessments of accident scenarios and post-accident monitoring requirements have identified a need to improve the ability to remotely sample both the HFBR building air in various areas and the reactor primary cooling water. Sampling systems would include sampling lines to the remote area, automatic valves and manifolding as necessary, remotely controlled grab sampler for primary water, sampling pumps and collection devices, electrical control systems, and necessary shielding.

Aging of the mechanical equipment and instrumentation is becoming increasingly evident, as maintenance problems develop which require continual attention. Maintaining an inventory of spare parts for this equipment and instrumentation is burdensome due to obsolescence and unavailability. Recent plant life extension studies have determined a need for continual upgrading and replacement of reactor instruments and mechanical equipment. This item is intended to provide funding for anticipated reactor improvement projects.

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

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

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

2. Project No.: 90-R-401

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

In addition a new centralized maintenance facility will be built to minimize the location of maintenance areas in the HFIR reactor building. In addition it will provide for a better controlled and safer environment for performing maintenance on contaminated tooling and hardware, and for better controlled storage of process spare parts and maintenance spare parts. A new flammable and/or hazardous material storage building isolated from other areas will be provided. An addition on the south side of the reactor building will be built to safely store and maintain experimenter and neutron scattering group test instrumentation and apparatus, relieving the congestion in the experiment areas of the reactor building. Limited office areas and laboratory space will be added. Renovation of the existing maintenance and operations building will provide for storage of safety related documentation. The renovation will also provide for storage of certified materials and reactor component spare parts. A quality assurance laboratory will be provided for use in the procurement, maintenance, and fabrication activities. Modifications to chemical handling systems to meet federal, state, and internal environmental regulations will be defined and will be accomplished under this project.

10. Details of Cost Estimate

a.	High Flux Beam Reactor Facility	$ 500
b.	National Synchrotron Light Source	2,300
c.	Stanford Synchrotron Radiation Laboratory	500
d.	High Flux Isotope Reactor	1,300
	Total Project Cost	$4,600

11. Method of Performance

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

Department of Energy
FY 1990 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
Energy Supply Research and Development - Plant and Capital Equipment
Basic Energy Sciences
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: General Plant Projects

2. Project No.: 90-R-400

3. Date A-E work initiated: 1st Qtr. FY 1990

3a. Date physical construction starts: 2nd Qtr. FY 1990

4. Date construction ends: 4th Qtr. FY 1991

5. Previous cost estimate: None

6. Current cost estimate: $5,588
Date: January 1989

7. Financial Schedule:

Fiscal Year	Obligations	Costs FY 1988	Costs FY 1989	Costs FY 1990	Costs FY 1991
Prior Year Projects	$ 3,150	$ 731	$ 100	$ 0	$ 0
FY 1988 Projects	4,900	3,265	1,635	0	0
FY 1989 Projects	4,900	0	3,500	1,400	0
FY 1990 Projects	5,588	0	0	4,188	1,400

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.: 90-R-400

8. Brief Physical Description of Project (continued)

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

Argonne National Laboratory	$ 4,218
Ames Laboratory	570
Notre Dame Radiation Laboratory	200
Sandia National Laboratories	300
Stanford Synchrotron Radiation Laboratory	300
Total project cost	$ 5,588

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

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

Argonne National Laboratory..... $ 4,218

The Argonne National Laboratory FY 1990 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.

1. Upgrade Computer Facility HVAC, Building 202
2. Extend Chilled Water Piping, Wing QA, Building 202
3. Replace Heating System, Building 951
4. Replace Hot Water Heaters, Buildings 205, 206, 208
5. Instrument Lab for Analytical Chemistry, Bldg. 205
6. Replace AC Units, Building 202
7. Replace Cooling Tower, Building 203
8. Increase Reliability of Substation 545, Building 108
9. Replace Cooling Systems, Wings E, L, & Q, Bldg. 202

1. Title and location of project: General Plant Projects — 2. Project No.: 90-R-400

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

10. Replace Cooling Towers, Wings G & H, Building 212
11. Replace Exhaust Systems, Wings A & B, Building 202
12. Replace Fan Coil Units and Pumps, Building 213
13. Klystron Staging Area, Building 211
14. Convert CHW System to Glycol System, Building 213
15. Rehab Gantry Hoist Controls, Building 317
16. Repipe Fan Coil Units, Wings A & B, Building 202
17. Rehab HVAC, Wing F, Building 308
18. Upgrade Animal Fac. Cooling, Wings E & Q, Bldg. 202
19. Rehab HVAC, Wing A, Building 330
20. Laboratory Scale Electromagnetic Caster, Bldg. 370
21. Repair Air Handling Units, Buildings 360 and 361
22. Upgrade ELFRAT Cooling System, Building 202
23. Replace 60 Ton Chiller, Building 211
24. Increase Electric Power Center, Building 221
25. Add Chiller for Computer Building, Building 221
26. Recirculating Cooling Water System, Building 205
27. Power Center Replacement (203A), Building 203

Of the total request of $4,218,000 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.

Ames Laboratory..... $ 570

The projects involve the following:

1. Replace Roof, Spedding Hall
2. Electric Distribution, Spedding Hall
3. Upgrade Development Building Laboratory Area HVAC System

1. Title and location of project: General Plant Projects — 2. Project No.: 90-R-400

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

4. Equipment Cooling System, Development Building
5. Wilhelm Hall HVAC System Upgrade
6. Handicapped Access
7. Miscellaneous Programmatic Projects

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

Notre Dame Radiation Laboratory..... $ 200

Requirements include the upgrade of the accelerator; planned addition of personnel and programmatic changes will increase the requirement for properly ventilated areas. This requires two hood additions and one replacement on an inadequate unit. The glass shop's present saw is deteriorating, and is not repairable due to its age (no longer manufactured). The new saw will restore capabilities which the glass shop will otherwise lose. Due to lack of sufficient storage space in the original design of the building, several laboratories are presently used for storage purposes. Construction of a storage area in room 003, which formerly housed cobalt irradiation sources, will enable us to use those laboratories to good advantage. The ceiling in the Laboratory lobby is beginning to deteriorate and buckle in places. While patchwork repairs will extend its life to FY 1990, a replacement dropped ceiling should be installed at that time.

Sandia National Laboratories..... $ 300

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 additional laboratory space with appropriate modifications to suit individual experimental situations.

1. Title and location of project: General Plant Projects 2. Project No.: 90-R-400

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

Stanford Synchrotron Radiation Laboratory..... $ 300

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.

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 1990 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
Energy Supply Research and Development - Plant and Capital Equipment
Basic Energy Sciences
(Tabular dollars in thousands. Narrative material in whole dollars.)

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

2. Project No.: 89-R-402

3. Date A-E work initiated: 1st Qtr. FY 1989

3a. Date physical construction starts: 4th Qtr. FY 1989

4. Date construction ends: 2nd Qtr. FY 1996

5. Previous cost estimate: none
Date: None

6. Current cost estimate: $456,000
Date: January 1989

7. Financial Schedule:

Fiscal Year	Authorization	Appropriations	Obligations	Costs
FY 1989	$ 6,000	$ 6,000	$ 6,000	$ 6,000
FY 1990	40,000	40,000	40,000	35,000
FY 1991	75,000	75,000	75,000	48,000
FY 1992	92,000	92,000	92,000	109,000
FY 1993	105,000	105,000	105,000	110,000
FY 1994	93,000	93,000	93,000	97,000
FY 1995	45,000	45,000	45,000	49,000
FY 1996	0	0	0	2,000

8. Brief Physical Description of Project

The DOE has selected the Argonne National Laboratory to conduct research and complete a conceptual design of 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 disciplines and

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

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

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

The accelerator complex will consist of a 200 MeV electron accelerator, a positron production target, a positron linac, 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 adjacent auditorium.

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 a 1060-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 compliment of beamlines included directly in the project are based on three different types of radiation sources. Additional beamlines, as provided through Participating Research Teams (PRTs), are also expected to be ready at commissioning.

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

2. Project No.: 89-R-402

8. Brief Physical Description of Project (continued)

CONVENTIONAL FACILITIES: The central laboratory and office building is a conventionally designed building with structural steel framing, concrete floor slabs, and an architectural metal exterior curtain wall with insulated glass windows. The office/laboratory section is three stories high, while the adjoining support wing areas are one story high which forms a "Y" shaped building footprint. An adjacent building houses a auditorium 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 ring tunnel is an approximately circular reinforced concrete structure fully covered with earth berms which provide two feet of cover over the top and have a side-slope of 34 degrees.

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 exterior radius of 628 feet, an inner radius of approximately 540 feet and is approximately 32 feet high. Steel columns and roof trusses provide a clear span approximately 88 feet wide for experimental beamline installation. A concrete "storage ring" tunnel having an 1060-meter circumference is located within the building near the inner wall. This tunnel has 2.6-foot reinforced concrete walls and 3.2-foot roof slab. The inside height is 9 feet and the width varies between 11.3 and 21.4 feet in a sawtooth pattern.

The experimental hall building has separate air-handling units located between the roof trusses and is individually zoned to provide heat, air-conditioning, and humidity control. The storage ring tunnel 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, 20 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 but identical service buildings, both with infield locations, houses 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 uniform intervals around the outside of the experimental hall/storage ring tunnel building and each contains offices, laboratories, conference areas, service support spaces, and truck air lock to facilitate delivery of technical components.

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 utility support facility houses the mechanical and electrical equipment supporting the accelerator complex conventional facilities. It is a single-story, conventional metal-framed structure similar to a prefabricated metal building, with an 8-inch reinforced concrete floor slab. The facility has a 14-foot overhead truck access door and is located at a distance from the experimental hall to avoid transmitting equipment vibrations.

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. A separate tunnel will accommodate personnel movement. A third tunnel will house all utility service lines entering the complex.

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 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

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)

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.

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 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 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.

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)

In 1988, 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, and investigate beamline components that must handle greater x-ray intensities than at existing sources.

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

10. Details of Cost Estimate

	($000)	($000)
a. Engineering, Design, and Inspection		$ 51,200
b. Construction Costs		
(1) Technical Components		191,285
(2) Conventional Facilities		130,820
c. Contingency		82,695
Total Construction Costs		$456,000

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

2. Project No.: 89-R-402

11. Method of Performance

Customary accepted practice will be followed. It is expected that design and inspection will be performed under a fixed price architect/engineer contract awarded in accordance with established, DOE approved, procedures. To the extent feasible, construction and other procurements will be by means of fixed price contracts awarded on the basis of competitive bidding.

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

	Prior Years	FY 89	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	0	6,000	35,000	48,000	109,000	110,000	97,000	49,000	2,000	456,000
(b) Expense funded equipment	0	0	0	0	0	0	0	0	0	0
(c) Inventories	0	0	0	0	1,300	3,500	2,500	0	0	7,300
(2) Other project funding										
(a) R&D necessary to complete construction	13,835	6,660	11,500	16,500	18,500	16,500	12,500	7,500	0	103,495
(b) Other project related costs	0	0	0	0	0	6,000	12,000	17,000	32,000	67,000
(c) Conceptual design costs	3,465[a/]	0	0	0	0	0	0	0	0	3,465
Total Project Costs	17,300	12,660	46,500	64,500	128,800	136,000	124,000	73,500	34,000	637,260

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 (continued)

b. Other Related Annual Costs (estimated life of project: 20 years)

(1) Facility Operating Cost	$34,000
(2) Programmatic Research	10,600
(3) Capital Equipment Related to Programmatic Research	1,300
Total Related Annual Costs	$45,900

a/ Includes an allocation of required R&D costs.

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.

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 (continued)

(b) Other project-related costs
These costs include startup, commissioning, and operating costs. Startup activity for the linac is scheduled for FY 1992.

DEPARTMENT OF ENERGY
FY 1990 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: 3 GeV SPEAR Injector
Stanford Synchrotron Radiation Laboratory
Stanford, California

2. Project No.: 88-R-403

3. Date A-E work initiated: 1st Qtr. FY 1988

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

4. Date construction ends: 4th Qtr. FY 1990

5. Previous cost estimate: $ 13,500

6. Current cost estimate: $ 14,000
Less FY 1984 PE&D: 0
$ 14,000
Date: January 1989

7. Financial Schedule:

Fiscal Year	Authorization	Appropriations	Obligations	Costs
1988	$ 3,000	$ 3,000	$ 3,000	$ 1,695
1989	6,500	6,500	6,500	7,200
1990	4,500	4,500	4,500	5,105

8. Brief Physical Description of Project

This project will provide a separate 3 GeV injector for the SPEAR storage ring so that synchrotron radiation experiments at the Stanford Synchrotron Radiation Laboratory (SSRL) can proceed independently instead of relying, as at present, on the availability of the linear accelerator of the Stanford Linear Accelerator Center (SLAC). This new injector, in particular, will eliminate interference between SPEAR injection and functioning of the new SLAC Linear Collider (SLC), a new high priority facility in the DOE High Energy Physics program. The separate injector will consist of a short 150 MeV electron linac to be followed by a slow cycling (less than 10 Hz) booster synchrotron that will accelerate the electrons to 3 GeV and then inject into SPEAR. The electron beam from the 3 GeV booster synchrotron will be directed into the existing "downstream" portion of the SPEAR electron injection line. To make full use of the booster energy for full energy injection, it is planned to upgrade the components of the injection line to 3 GeV. Finally, a third kicker magnet will be implemented to achieve operationally reliable injection into a low emittance, high brilliance configuration of SPEAR.

1. Title and location of project: 3 GeV SPEAR Injector
Stanford Synchrotron Radiation Laboratory
Stanford, California

2. Project No.: 88-R-403

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

SSRL has played a leading role in the revolution that has taken place over the past few years in synchrotron radiation research. The recent work at the Laboratory in developing a progression of increasingly effective and sophisticated insertion devices (wigglers and undulators) for the production of synchrotron radiation at both SPEAR and PEP storage rings has led to major advances in scientific and technological research. Examples of particular importance include the development of non-invasive angiography, the analysis of atomic arrangements in thin amorphous layers, and the measurement of magnetic scattering.

In spite of the strong capabilities offered by SPEAR for synchrotron radiation research, the effectiveness of this facility is seriously impaired by limitations on its availability for experimental work in this area. The limited availability of SPEAR for synchrotron radiation production derives from two sources. The first is that it is also used for high energy experimentation. As a result, SPEAR is available for only half of its operating time for dedicated synchrotron radiation production. It is expected, however, that both SPEAR and PEP will become fully dedicated to synchrotron radiation production over the coming years.

In addition, SPEAR presently receives electrons from the main SLAC linear accelerator. This linac is being converted to run at a much higher energy, 50 GeV for the Stanford Linear Collider (SLC) program and is scheduled to begin operation at 50 GeV beam energy by Fall 1986. This high energy operation will make the linear accelera-tor considerably less effective as a SPEAR injector. Moreover, significant changeover time is expected to be required to set up the accelerator for SPEAR injection at 2 to 2.5 GeV and then return it to 50 GeV operation. This changeover will interrupt the high energy physics program because of the difficulty of running the accelera-tor in the SLC mode as well as keeping two beams colliding with a beam diameter of only 3 micrometers. To make SLC effective as a high energy tool, the number of fillings of SPEAR must be kept at a minimum. This, however, will greatly limit the operating performance of SPEAR and any accidental loss of beam will mean a SPEAR/SSRL down time until the next scheduled filling time for SPEAR comes up again. There may also be extended periods in which linear accelerator development and improvement for the SLC makes it unavailable for SPEAR injection.

1. Title and location of project: 3 GeV SPEAR Injector
Stanford Synchrotron Radiation Laboratory
Stanford, California

2. Project No.: 88-R-403

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

Given the importance of SLC for the high energy physics program and the importance of SPEAR for research with synchrotron radiation, it is vital to achieve a situation in which these operations do not interfere with each other. This is the major reason that a separate SPEAR injector is being proposed. This injector will increase markedly the availability and effectiveness of SPEAR for synchrotron radiation production. It will allow SPEAR to function at full effectiveness during all dedicated time periods. It will, in addition, allow SPEAR to function when the linear accelerator is shut down for modification.

10. Details of Cost Estimates

	Item Cost	Total Cost
a. Engineering, design, inspection and management		$ 3,637
b. Construction costs		0
c. Special facilities, Spear Injector		7,981
d. Contingency at approximately 21% of above costs		2,382
Total estimated cost		$14,000

11. Method of Performance

Design of technical components will be accomplished primarily by SSRL scientists and engineers. Some support from SLAC will be required for storage ring vacuum chamber modifications.

Technical component construction and fabrication will be done by a combination of SLAC shops and by subcontracts awarded on the basis of competitive bidding and managed by SSRL and SLAC personnel.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: 3 GeV SPEAR Injector
Stanford Synchrotron Radiation Laboratory
Stanford, California

2. Project No.: 88-R-403

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

	FY 1988	FY 1989	FY 1990	TOTAL
a. Total project costs				
1. Total facility costs				
(a) SPEAR injector.....	$ 1,425	$ 6,048	$ 4,285	$11,758
Contingencies.....	270	1,152	820	2,242
TOTAL (TEC).....	1,695	7,200	5,105	14,000
2. Other project costs (Associated R&D).....	400	250	150	800
Pre-operations run-in.....	0	0	350	350
Total other project costs.....	400	250	500	1,150
Total project costs (Item 1 & 2)	$ 2,095	$ 7,450	$ 5,605	$15,150

b. Other related annual costs (estimated life of project: 25 years)

1. Operations Expenses.....	
2. Capital Equipment.....	$ 1,000
Total related annual costs.....	300
	$ 1,300

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

a. Total project funding
Only construction funding is required for the project.

b. Other related funding requirements
Estimated costs of operating and maintaining the injector (excluding power costs).

Department of Energy
FY 1990 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
Energy Supply Research and Development - Plant and Capital Equipment
Basic Energy Sciences
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: 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 1992

5. Previous cost estimate: 98,700
Date: September 1988
Current cost estimate: $99,500[a/]
Date: January 1989

7. Financial Schedule:

Fiscal Year	Authorization	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	22,000
1990	26,000	26,000	26,000	25,000
1991[a/]	23,000	23,000	23,000	22,600
1992	6,000	6,000	6,000	18,598

8. Brief Physical Description of Project

The 1-2 GeV Synchrotron will be 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 new generation facility comprised of an electron storage ring and injection system and 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), an initial complement of 5 insertion devices, and photon beamlines extending from the insertion devices and 2 beamlines from bend magnets. Development of other straight sections and bending magnet ports are not included in the scope of this project.

[a/] Schedule reflects Congressional reduction of $5,000,000 from the FY 1989 budget request. Restoration of the $5,000,000 is included as part of the FY 1991 total as is escalation in project cost associated with this reduction.

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)

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.

This brilliance makes possible 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.

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.

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 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.

The 1-2 GeV Synchrotron will be available to general users as well as to participating research teams (PRT's). 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. Before commencing construction,

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)

LBL will conduct one more Users' Workshop to finalize operational parameters and organize beamline user teams. In addition, the 1-2 GeV Synchrotron has 7 additional straight sections and 24 ports on bending magnets that will be available for development by PRT's 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 Project Cost.....		$ 99,500

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.

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

2. Project No.: 87-R-406

11. Methods of Performance (continued)

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	Total
a. Total project costs							
1. Total facility construction costs.	$ 985	$10,317	$22,000	$25,000	$22,600	$18,598	$ 99,500
2. Other project costs							
(a) Storage Ring, Insertion Device, and Beamline R&D[a/]	1.500	2,000	2,000	1,000	--	--	6,500
(b) Startup.....	--	--	--	5,000	11,000	18,600	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	3,000	7,500	12,000	19,600	46,600
Total project costs (Item 1 & 2).....	$ 2,985	$12,817	$25,000	$32,500	$34,600	$38,198	$146,100

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

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

2. Project No.: 87-R-406

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

b. Other related annual costs (estimated life of project: 25 years)

1. Facility operating costs	$18,000
2. Programmatic research	3,000
3. Capital Equipment Related to programmatic research	600
Total related annual costs	$21,600

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 1990-1993.

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.

Startup funding requests are for operations staff training beginning in FY 1991, startup of the injector in FY 1991, and startup of the storage ring in FY 1992.

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

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

2. Project No.: 87-R-406

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

b. Other related funding requirements

Facility operating costs represent the personnel (approximately 100 FTE), supplies and equipment, utilities, and maintenance funding that will be needed to operate a user-friendly facility. These cost estimates are based on Laboratory experience in operating national accelerator facilities and on a survey of operating experience of existing light sources. The annual costs of the scientific program will fund approximately three high quality research groups at LBL when the facility becomes fully operational. Prior-year funding is necessary to enhance existing groups and to redirect operations from other light sources. The capital equipment needs related to this research staff buildup reflect Laboratory experience that numerous laboratory equipment items will be needed at the level of approximately 20% of the operating program budget. Because the 1-2 GeV Synchrotron Radiation Source will primarily be a national user facility, additional research funding will be available through related activities of other agencies and researchers affiliated with universities, other 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.