DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
PROGRAM OVERVIEW

SUPPORTING RESEARCH AND TECHNICAL ANALYSIS

Developing new and improving the use of current energy sources continues to be of fundamental importance to the general health and welfare of the nation and its economy. The role of supporting research and technical analysis is to expand the scientific and engineering knowledge base on which the Nation's future energy options depend and to provide independent, objective analyses and assessments of research and technical needs relating to energy. The applied technology efforts of industry and government need this broad knowledge base to devise new concepts, develop new materials, and devise new and improved processes and techniques for energy production, conversion and utilization. We must continue to strengthen our understanding of the scientific basis of energy-related phenomena to overcome limitations on productivity growth, erosion of the country's competitive position with foreign nations and additional pressure on the United States balance of trade.

Seven programs comprise the Office of Energy Research's portion of the Supporting Research and Technical Analysis category of the agency's budget: (1) Basic Energy Sciences (BES); (2) Energy Research Analysis (ERA); (3) Advisory and Oversight Program Direction; (4) University Research Support (URS); (5) University Research Instrumentation (URI); (6) Multiprogram Energy Laboratories Facilities Support (MEL-FS); and (7) Policy and Management.

The mission of the Basic Energy Sciences (BES) program is to carry out long range, basic research activities needed to enhance this base. The major product of the BES program continues to be increased knowledge which becomes a part of the body of data on which applied technologies rest. In addition to a major focus on disciplinary research, there is also emphasis on innovative applications of new knowledge to energy problems, and on the early application of the results. In support of these activities, the BES program provides the major support for operating the large, unique scientific user facilities required for research in the physical and life sciences.

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 the 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 and their scientific productivity will soon become marginal. 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 general purpose facilities and other such areas. However, less attention has been paid to improving the essential scientific facilities required to accomplish the main mission of the laboratories, i.e., to be preminent in certain key fields of research. In 1987 a Scientific Facilities Upgrade, directed toward solving this problem will be initiated. It includes four facilities that have been identified by the scientific community as being the most critical to the future needs of the Department's basic research programs. The four facilities, all of which will be located at the multiprogram laboratories, are: a 1-2 GeV Synchrotron Radiation Source - Lawrence Berkeley Laboratory, a 6 GeV Synchrotron Radiation Source - Argonne National Laboratory, an Advanced Steady State Research Reactor - Oak Ridge National Laboratory; and a Relativistic Heavy Ion Collider - Brookhaven National Laboratory.

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

The University Research Support (URS) program consists of two major subprograms and a set of program activities focused on the following three primary objectives: (1) to strengthen university capability to do energy research; (2) to strengthen the quality and increase the number of students interested in pursuing energy-related professional careers; and (3) to enhance technology transfer activities through cooperative research efforts between universities, the agency's national laboratories and private industry. The first subprogram, University Laboratory Research, is directed at strengthening the capabilities of both universities and national laboratories as major energy research performers in the conduct of long range energy research. Many of the activities supported within this subprogram involve joint efforts between university and laboratory-based researchers. The second subprogram, Energy Manpower Development, includes efforts to increase the number of students pursuing energy-related engineering and science careers. This subprogram also includes the Department's statutory responsibility for assessing the supply and demand of manpower for both current and projected energy R&D programs.

The University Research Instrumentation (URI) program provides grants to major research universities to purchase state-of-the-art, scientific instrumentation used in energy-related research areas such as materials characterization, biological research, catalysis, health effects, and engineering research.

The Multiprogram Energy Laboratories-Facilities Support (MEL-FS) Program is to provide for the rehabilitation, upgrade, and replacement of general purpose facilities at the five multiprogram energy laboratories: Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Lawrence Berkeley Laboratory (LBL), Oak Ridge National Laboratory (ORNL), and Pacific Northwest Laboratory (PNL). These Government-owned sites are complete research reservations with unique research facilities including laboratories and offices and all necessary support facilities and systems such as administrative offices, craft shops, warehouses, security facilities, fire houses, cafeterias, and all required utility distribution systems plus steam generation plants, sewage and other waste treatment facilities, roads and other structures. These laboratories have performed national research programs for the Department and its predecessor agencies for nearly 40 years and continue to do so primarily in the areas of energy supply research and development and general sciences research (e.g., nuclear energy, fusion energy, basic energy sciences, nuclear physics, high energy physics, life sciences, fossil energy, solar energy and conservation.) Over 17,000 scientists, engineers and other support staff are engaged in these activities.

The MEL-FS program consists of two subprograms. The first subprogram, Multiprogram Energy Laboratories-General Purpose Facilities (MEL-GPF) originated in FY 1981 to rehabilitate, upgrade, and replace as appropriate deficient buildings, utilities, roads, railroads and other facilities at the multiprogram laboratories. This is necessary because through continuous use, aging and changing technology, facilities and related support systems deteriorate (both physically and in performance) to a point where they are no longer appropriate for their intended functions, economically justifiable to maintain, or adequate to meet security, environmental, safety, and health requirements. Thus, this program helps ensure that the capital asset base is adequate for continued effective accomplishment of the Department's R&D mission today and in the future.

The ORNL Environmental Compliance Upgrade Subprogram originated in FY 1985 to address environmental deficiencies that relate to non-defense activities at ORNL. The actions fall into two categories: those that concern the modification, replacement or upgrade of existing processes for handling wastes and those that relate to the clean-up of inactive contaminated facilities and sites. A multiyear effort will be needed to bring ORNL's active and inactive systems into compliance with existing applicable environmental regulations.

Advisory and Oversight Program Direction provides funds for the personnel resources required by the Director of Energy Research to carry out his responsibilities specifically assigned by legislation (P.L. 95-91), as well as those mandated by the Secretary of the Department of Energy, in areas beyond the scope of the Office of Energy Research programs. This staff has the responsibility to advise the Secretary with respect to the well-being and management of the multiprogram laboratories; to administer the Department's R&D Laboratory Technology Transfer Program; to supervise or support research activities carried out by any of the Assistant Secretaries; to provide for institutional planning by the Multiprogram Laboratories; and to provide for program management of the Energy Research Analysis, University Research Support, and Multiprogram Energy Laboratories-Facilities Support programs. The program provides funds only for the salaries and related personnel expenses for the personnel who carry out the studies, analyses, monitoring and coordination activities required to support the Director of the Office of Energy Research and the Secretary.

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

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
BASIC ENERGY SCIENCES
Energy Supply Research and Development - Operating Expenses
Energy Supply Research and Development - Plant and Capital Equipment
(Tabular dollars in thousands. Narrative material in whole dollars.)

	FY 1985 Appropriation	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Basic Energy Sciences					
Materials Sciences					
Operating Expenses..........	$132,227	$134,248	$134,248	$156,931	$+22,683
Capital Equipment...........	15,450	11,979	11,979	15,500	+ 3,521
Construction................	36,580	42,333	42,333	23,960	-18,373
Subtotal....................	$184,257	$188,560	$188,560	$196,391	$+ 7,831
Chemical Sciences					
Operating Expenses..........	78,592	78,123	78,123	86,419	+ 8,296
Capital Equipment...........	8,840	8,506	8,506	9,555	+ 1,049
Construction................	5,550	5,609	5,609	5,430	- 179
Subtotal....................	92,982	92,238	92,238	101,404	+ 9,166
Nuclear Sciences					
Operating Expenses..........	39,641	41,445	41,445	46,913	+ 5,468
Capital Equipment...........	2,950	2,457	2,457	2,930	+ 473
Construction................	300	1,251	1,251	150	- 1,101
Subtotal....................	42,891	45,153	45,153	49,993	+ 4,840
Applied Mathematical Sciences					
Operating Expenses..........	34,467	37,925	37,925	32,785	- 5,140
Capital Equipment...........	1,500	1,030	1,030	1,100	+ 70
Construction................	0	4,811	4,811	0	- 4,811
Subtotal....................	35,967	43,766	43,766	33,885	- 9,881
Engineering and Geosciences					
Operating Expenses..........	26,085	25,571	25,571	29,412	+ 3,841
Capital Equipment...........	1,500	1,443	1,443	1,750	+ 307
Construction................	0	7,698	7,698	0	- 7,698
Subtotal....................	27,585	34,712	34,712	31,162	- 3,550
Advanced Energy Projects					
Operating Expenses..........	10,048	7,286	7,286	8,932	+ 1,646
Capital Equipment...........	320	308	308	330	+ 22
Subtotal....................	10,368	7,594	7,594	9,262	+ 1,668
Biological Energy Research					
Operating Expenses..........	12,360	11,960	11,960	14,538	+ 2,578
Capital Equipment...........	560	515	515	610	+ 95
Construction................	0	5,773	5,773	0	- 5,773
Subtotal....................	12,920	18,248	18,248	15,148	- 3,100
Program Direction					
Operating Expenses..........	3,830	3,499	3,499	4,125	+ 626
Subtotal....................	3,830	3,499	3,499	4,125	+ 626

	FY 1985 Appropriation	FY 1986 Appropriation	FY 1987 Base	FY 1987 Request	Request vs Base
Total					
Operating Expenses.......	$337,250	$340,057	$340,057	$380,055	$+39,998
Capital Equipment........	31,120	26,238	26,238	31,775	+ 5,537
Construction.............	42,430	67,475	67,475	29,540	-37,935
Basic Energy Sciences......	$410,800 a/b/c/	$433,770 c/d/e/	$433,770 c/d/	$441,370 c/	$+ 7,600
Staffing Total FTE's.......	63	69	63	63	

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

a/ Total does not include $3,350,000 transferred to SBIR program.
b/ FY 1985 total reflects a reduction of $2,940,000 for ADP general reduction.
c/ Totals reflect a reduction of $11,655,000 in FY 1985, $10,110,000 in FY 1986, and $11,000,000 in FY 1987 for management initiative savings.
d/ Total reduced by $17,041,000 in accordance with P.L. 99-177, the Balanced Budget and Emergency Deficit Control Act of 1985 (Gramm/Rudman/Hollings).
e/ A deferral of $38,489,000 is being proposed.

Department of Energy

FY 1987 Congressional Budget Request

Adjustments to FY 1986 Appropriations

	FY 1986 Confer.	General Reduction	Management Initiatives	FTE General Reduction	Gramm-Rudman-Hollings	Subtotal	Comparability Adjustments	Adjusted Approp. Total
Basic Energy Sciences								
Material Sciences								
Operating Expenses	$140,496		$ -975		$ -5,273	$134,248		$134,248
Capital Equipment	12,450		--		-471	11,979		11,979
Construction	43,995		--		-1,662	42,333		42,333
Subtotal	196,941		-975		-7,406	188,560		188,560
Chemical Sciences								
Operating Expenses	81,495		-305		-3,067	78,123		78,123
Capital Equipment	8,840		--		-334	8,506		8,506
Construction	5,830		--		-221	5,609		5,609
Subtotal	96,165		-305		-3,622	92,238		92,238
Nuclear Sciences								
Operating Expenses	43,338		-265		-1,628	41,445		41,445
Capital Equipment	2,754		-200		-97	2,457		2,457
Construction	1,300		--		-49	1,251		1,251
Subtotal	47,392		-465		-1,774	45,153		45,153
Applied Mathematical Sciences								
Operating Expenses	39,520		-105		-1,490	37,925		37,925
Capital Equipment	1,070		--		-40	1,030		1,030
Construction....................	5,000		--		-189	4,811		4,811
Subtotal	45,590		-105		-1,719	43,766		43,766
Engineering and Geosciences								
Operating Expenses	26,675		-100		-1,004	25,571		25,571
Capital Equipment	1,500		--		-57	1,443		1,443
Construction....................	8,000		--		-302	7,698		7,698
Subtotal	36,175		-100		-1,363	34,712		34,712
Advanced Energy Projects								
Operating Expenses	7,602		-30		-286	7,286		7,286
Capital Equipment	320		--		-12	308		308
Subtotal	7,922		-30		-298	7,594		7,594
Biological Energy Research								
Operating Expenses	12,455		-25		-470	11,960		11,960
Capital Equipment	560		-25		-20	515		515
Construction....................	6,000		--		-227	5,773		5,773
Subtotal	19,015		-50		-717	18,248		18,248
Program Direction								
Operating Expenses	4,100	-335	--	-124	-142	3,499		3,499
Subtotal, Basic Energy Sciences	$453,300	$ -335	$ -2,030	$ -124	$-17,041	$433,770		$433,770

	FY 1986 Confer.	General Reduction	Management Initiatives	FTE General Reduction	Gramm-Rudman-Hollings	Subtotal	Comparability Adjustments	Adjusted Approp. Total
General Reduction:								
Operating Expenses	-335	335						
Capital Equipment	--	--						
Construction	--	--						
Total, General Reductions	-335	335						
Management Initiatives:								
Operating Expenses	-1,805		1,805					
Capital Equipment	-225		225					
Construction	--		--					
Total, Management Initiatives	-2,030		2,030					
Pay Restoration								
Total, Basic Energy Sciences..	$450,935	$ --	$ --	$ -124	$-17,041	$433,770		$433,770
Operating Expenses	353,541			-124	-13,360	340,057		340,057
Capital Equipment	27,269				1,031	26,238		26,238
Construction	70,125				-2,650	67,475		67,475

DEPARTMENT OF ENERGY
FY 1987 CONGRESSIONAL BUDGET REQUEST

SUMMARY OF CHANGES
Basic Energy Sciences
(dollars in thousands)

1986 Appropriation enacted..	$450,811
1986 Gramm-Rudman reduction..	- 17,041
1986 adjusted..	433,770
Program increases and decreases:	
- Maintains the key elements of the research efforts underway. New research must come at the expense of ongoing programs........	+25,994
- Essential facility support continued (i.e., safeguards and security, electric power, inventories, etc.); facility demand will continue to exceed capability	+ 8,504
- Research and development funding provided in support of the next generation of facilities needed to continue U.S. leadership in key scientific areas..	+ 5,500
- Permits principal capital equipment commitments for normal replacements and facility requirements...........................	+ 5,537
- Provides construction funding for ongoing projects nearing completion and for architect engineering and long-lead procurement for the 1-2 GeV Synchrotron Radiation Source....................	-37,935
1987 budget request..	$441,370

Overview

For FY 1987, the request for the Basic Energy Sciences (BES) program is $441,370,000: $380,055,000 in operating funds, $31,775,000 in equipment funds, and $29,540,000 in construction funds.

Support for long range basic research is an important responsibility of the Federal Government. The extent of private sector activity in this domain has been limited mainly to a few large corporations with sufficient breadth and ability to support the facilities and infrastructure peculiar to basic research. The private sector activity, however, has been declining while industry is, at the same time, turning more and more to Federal laboratories and universities as sources of new ideas. Thus the BES program, a primary source of Federal funding for basic research, is finding a new and dynamic role in the conduct of R&D in the U.S. today. This role includes continuing the design and construction of expensive, unique major research facilities and support of their operations. National security, U.S. leadership in science and technology, and training technical manpower all are effectively served by a continuing vigorous basic research activity.

New technologies and improvements in existing technologies result from the innovative application of new scientific knowledge and concepts. It is crucial for the U.S. to maintain its scientific base; this requires continued funding of basic research serving the different energy supply and conservation options as well as U.S. science in general. It has become increasingly important for the U.S. to disseminate research results to the private sector and to participate in the effective exploitation of these results to benefit the U.S. economy. In FY 1984, for example, a major new materials initiative was started that not only attempts to deal with advanced materials research, but also with more effective communications and interactions with U.S. industry and training new researchers.

Basic Energy Sciences has a heavy involvement in large scientific facilities (e.g., the High Flux Beam Reactor and National Synchrotron Light Source at Brookhaven National Laboratory, the Combustion Research Facility at Sandia-Livermore, the High Flux Isotope Reactor and the Oak Ridge Electron Linear Accelerator at Oak Ridge National Laboratory, and high voltage and atomic resolution microscopes at several sites). Many areas of modern science require large and costly facilities; without them, the necessary advanced research could not be done. The large, expensive, unique facilities in the BES program are made available to the entire U.S. scientific community to the extent that funds permit. 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)): High Energy and Nuclear Physics, and Biological and Environmental Research. Computational support, provided through the Applied Mathematical Sciences subprogram relies on an enhanced class VI computer system installed during FY 1985 at Lawrence Livermore National Laboratory; it is accessible through a nationwide data communications network funded jointly with Magnetic Fusion Energy.

The BES research program includes over 1200 projects; more than half of them are funded at the national laboratories. The remainder is carried out at universities and business and government laboratories. The research supported is selected on the bases of scientific merit, potential for increasing our technological base, and relevance to ultimately meeting the nation's diverse needs for energy. To carry out this program, BES plans, supports and administers energy related research in the physical, biological, mathematical and engineering sciences. New scientific information in these areas addresses the Administration's goals by providing the fundamental scientific and engineering base on which the Nation's future energy options depend. The strategy continues to be to:

Provide critical knowledge and data by supporting basic research in DOE mission areas;

Provide for, 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; and

Develop trained scientific talent through support of basic research at universities and national laboratories; and

Promote early applications of the results of basic research.

Implementation of this strategy requires:

Maintenance of a strong core program -- this calls for continuity of support for scientists involved in our current program activities, and the training of new, younger scientists;

Continued operation of existing, unique facilities important to research in the U.S. while at the same time providing for new facilities and for their operation; and

Creation of opportunities for exploiting new, emerging areas that are of potential importance to energy.

The program support provided to national laboratories can be divided into two major categories. A large portion is associated with support of national user facilities for which access is provided to the entire scientific community. The national laboratory serves as the host organization and selects and arranges for visitor participation, provides necessary specialized equipment and staff, administers all activities necessary to keep the facility operating, and performs necessary facility research and improvements necessary to continue its operation at the forefront of science.

The second major component of the national laboratory program is the support of research which takes advantage of the unique environment which exists at these institutions. By the very nature of the national laboratories and their traditional focus, the national laboratories 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 all 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. As an example, the unique computer capabilities at the national laboratories are among the best in the world. The same can be said for neutron research capabilities at ORNL, ANL, and BNL. The programs supported at the laboratories are designed to exploit these unique capabilities, and programs are supported for which a long-range commitment must be made to achieve the desired results.

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 BES program supports numerous special grants and research contracts in which costs are shared by universities. Their contributions are provided through a number of mechanisms, e.g., salaries to investigators, summer student assignments, provision of facilities and/or equipment, etc. An important benefit resulting from supporting research in universities is the research training of graduate students who continue in R&D after completion of their studies.

In addition to universities and national laboratories, BES maintains ties with industry. Representatives from different industries serve on counseling committees for several of the BES subprograms; 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. Through these and other mechanisms available to, and used by, the scientific community, the results of BES supported research are available to industry and to the academic community.

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 the 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 and their scientific productivity will soon become marginal. 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 general 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. Four facilities have been identified by the scientific community as being the most critical to the future needs of the Department's basic research programs. The four facilities, all of which will be located at the Department's multiprogram laboratories, are: 1-2 GeV Synchrotron Radiation Source - Lawrence Berkeley Laboratory; 6 GeV Synchrotron Radiation Source - Argonne National Laboratory; Advanced Steady State Research Reactor - Oak Ridge National Laboratory; and Relativistic Heavy Ion Collider - Brookhaven National Laboratory. This latter facility is budgeted in the Nuclear Physics Program. The FY 1987 request includes a start toward development of these facilities for the Nation.

	FY 1985	FY 1986	FY 1987 Request
Materials Sciences			
Operating Expenses........................	$132,227	$134,248	$156,931
Capital Equipment.........................	15,450	11,979	15,500
Construction..............................	36,580	42,333	23,960
Total Materials Sciences...............	$184,257	$188,560	$196,391

The Materials Sciences subprogram has as its goal to provide the Agency and the Nation with an increased level of understanding in the science of materials, which will contribute to meeting the needs of present and future energy technologies. Knowledge or lack of knowledge in materials science and technology plays a crucial role in the development of energy systems or other high technology industries. The field of materials science is important because it pushes forward the frontiers of knowledge and trains new scientists in subjects which are highly interactive with industrial topics. Materials problems and limitations often restrict the performance of current energy systems and the development of future systems. A few examples of such problems and limitations include: degradation of mirror materials and low conversion efficiency photovoltaic materials for solar energy; degradation of materials properties due to irradiation in fission and fusion energy systems; thermal and mechanical instabilities of materials for heat engines; and corrosion and compatible materials for containing nuclear waste.

Many studies and reviews in recent years have pointed to both the importance of the field of materials science and to the opportunities and high quality of the research. Most notably these studies have been conducted by the National Academy of Sciences and the Energy Research Advisory Board. The Congress has also expressed great interest in materials research and this past year sponsored a workshop on the subject. In all of these studies and reviews, the Materials Sciences subprogram has played a key national role.

While each Federal agency conducts materials research to meet its own particular objectives, coordination across agencies is readily accomplished through established committees and interactions. In the area of basic materials research, the Materials Sciences subprogram coordinates its research most directly with the National Science Foundation's (NSF) Materials Research Division and the more basic programs of the Department of Defense. The unique aspect of the Materials Sciences subprogram is the focus on energy related research and the use of advanced diagnostic techniques made possible by state-of-the-art research facilities supported by this subprogram. These activities complement the NSF and other agency programs and are needed to carry out the mission of the DOE. As an example of how the DOE programs complement the work at other agencies, the DOE program is very significant in radiation effects, corrosion-erosion related to fossil energy systems, solar photovoltaic materials, or nuclear waste isolation materials, whereas the NSF program tends to be much more generic and tends to focus almost exclusively on small-scale science with limited involvement of major facilities. The Materials Sciences subprogram also has large efforts in facility-related research such as neutron scattering, synchrotron radiation research, and electron microscopy, compared to the relatively small efforts in the NSF program.

The Materials Sciences subprogram has traditionally provided most of the development, construction, and operational support of large facilities for the total national materials program. Use of these major facilities is open to all qualified researchers. A recent survey of these collaborative research centers under the purview of the Materials Sciences subprogram has shown that they accommodated about 1100 users. The users came from DOE laboratories (21 percent), universities (48 percent), industry (14 percent), and the remainder from other organizations. The replacement cost for these facilities is estimated at over $500,000,000. The Materials Sciences research funding at these facilities in FY 1985 was about $20,000,000 with another $14,000,000 being attracted from outside the Materials Sciences subprogram.

The FY 1987 request includes the following amounts for the Materials Sciences subprogram: $156,931,000 in operating funds which provides support for the operation of facilities and research of all types; $15,500,000 in capital equipment in support of the research objectives and $23,960,000 in construction which will permit continuation and/or completion of ongoing projects at Lawrence Berkeley Laboratory (LBL) (Center for Advanced Materials); Brookhaven National Laboratory (BNL) (National Synchrotron Light Source); and Stanford University (Stanford Synchrotron Radiation Laboratory); A-E and long lead procurement activities for the 1-2 GeV Synchrotron Radiation Source at Lawrence Berkeley Laboratory; initiation of a new construction project, the Los Alamos Neutron Scattering Experimental Hall, plus funds for Accelerator and Reactor Improvements and Modifications.

The opportunities available to the field of materials science continue to outpace the resources. New methods for characterizing materials and new materials structures are being uncovered. As a result, the time is right to exploit these opportunities and make the advances needed to solve outstanding scientific questions and technological problems. Coupling the experimental and theoretical advances with improved ability to prepare new materials will open up opportunities to design materials from fundamental principles and overcome or circumvent known and anticipated energy related materials problems.

Some of the problem areas and needs to which the Materials Science research ultimately contributes include:

- o Developing new or substitute materials
- o Tailoring materials to satisfy defined requirements
- o Predicting materials problems and service life
- o Improving the ability to successfully attack unforeseen materials problems in advanced energy systems, and
- o Improving the theoretical and experimental capability to analyze the fundamental structure of materials

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

In addition to maintaining an appropriate mix among long-term sciences, multitechnology and single energy technology oriented research, a balance must be achieved between research at forefront large facilities and research consisting of small individual projects. Certain types of research simply cannot be carried out without large facilities (e.g., neutron sources with significant fluxes of neutrons cannot be made in "small" sizes). Also newer instruments with significant improvement in capability (e.g., synchrotron radiation sources) are very expensive to build and operate. The Materials Sciences subprogram utilizes several major user facilities in the pursuit of its research goals, including the National Synchrotron Light Source (NSLS) BNL, High Flux Isotope Reactor (HFIR) Oak Ridge National Laboratory (ORNL), Intense Pulsed Neutron Source (IPNS) Argonne National Laboratory (ANL), Neutron Scattering Experimental Hall, Los Alamos Neutron Scattering Center (LANSCE), and the Stanford Synchrotron Radiation Laboratory (SSRL). Other smaller research centers include the Low Temperature Neutron Irradiation Facility (LTNIF) ORNL, Surface Modification and Characterization Laboratory (SMCL) ORNL, Electron Microscope centers at ORNL, ANL, LBL, and the University of Illinois and the Materials Preparation Center (MPC) at Ames Laboratory. These facilities are also available to qualified users outside the home institution.

The subprogram utilizes workshops and reports of its Council on Materials Science (a non-Governmental body with representatives from academia, industry, and agency laboratories) to help focus on critical issues. Panel meetings during 1984 were held on computer simulation and materials synthesis. In 1985, panel meetings were held on microfracture and surface adhesion/bonding. The reports resulting from these workshops and panels are distributed widely, including publication in the open literature. Through the auspices of the Council, a review of user facility operations has started with the electron microscope facilities in 1985.

Reviews of the neutron sources and synchrotron radiation sources will follow. Interactions and information transfer with the agency's applied materials research takes place through a number of mechanisms including a formalized Research Assistance Task Force. Examples of these latter activities include meetings on fast ion conductors and corrosion in fossil energy systems. Through these latter meetings the basic researchers learn of the problems in the applied programs and the researchers in technology oriented programs are exposed to scientists with a fundamental understanding of matter. Coordination among the Department's materials programs takes place primarily through the Energy Materials Coordinating Committee. Within the Federal Government, the subprogram is coordinated in part through the interagency Committee on Materials (COMAT) and the basic Interagency Materials Group. At the Federal program level, Materials Sciences continues to represent about one-third of the Federal government support for basic materials research.

Both directly and indirectly this subprogram supports the development of a national position on materials research. The ability to provide such support stems directly from the experience and continuity within the Materials Sciences subprogram. The fundamental understanding of materials obtained in this subprogram has led to new approaches to alloy design for critical materials substitution, new materials with superior properties and advanced characterization techniques. Materials Sciences is recognized throughout the research community for its excellence. Past technical accomplishments have moved into the technological or commercial sector (e.g., radiation resistant alloys, glassy metals, ion implantation techniques for surface modification, and superconducting wire), and it is expected that through the proven method of technology/information transfer and effective management this year's accomplishments will likewise find use either for building our fundamental base of materials understanding or in some technological application in the future. Industrial interactions with this subprogram are encouraged and indeed have been successful. The large number of patents issued under this subprogram is further evidence of the strong and appropriate technological orientation. Significant progress was made during the past year in many areas of the subprogram. Some examples of recent accomplishments include:

- For the first time, magnetic ordering (arrangement of the magnetic moments of individual items in materials) has been measured using X-rays. Magnetic ordering of the rare earth metal holmium has been measured using X-rays at the world's most intense X-ray beam line at SSRL. The magnetic scattering peak position shows an oscillation that is temperature dependent indicating an oscillation in the spiral magnetic ordering. This is the first conclusive magnetic X-ray scattering measurement made and reveals additional new capabilities for intense synchrotron radiation sources.

- The highest superconducting transition temperature (5K) has been found for an organic compound at ambient pressure. This development opens the possibility of radically new conducting organic materials which could revolutionize electrical systems.

- An automated synthesis technique has been developed that enables the preparation of low cost magnetostrictive alloys (changes in the dimensions of materials due to applied magnetic fields). The technique yields grain oriented rare earth-iron magnetostrictive (Tb-Dy-Fe) material with circular, square and hexagonal cross sections useful for transducer components and single crystals with selected axial crystallographic orientation. With this new technique, the cost of such components may be reduced by 50-75 percent. These materials will enable significant improvements to be made in the performance of transducers in jet and diesel engine fuel injection systems, submarine detection devices, and position detecting transducers in robotic systems as a consequence of the increased magnetostriction obtained in this alloy produced by this new synthesis technique.

- For the first time, a detailed characterization of cavity evolution during the compressive creep deformation of ceramic materials has been determined. Using neutron scattering measurements, it has been shown that cavity nucleation does occur, usually throughout the service lifetime prior to fracture, and that the cavity growth is transient and quickly reaches a size of about 100 nanometers. These statistical data can not be obtained by any other method and are needed in order to improve the performance and predict the service lifetimes of structural ceramic components envisaged in the next generation of energy conserving heat engines.

Within the FY 1987 request current emphases and trends in the subprogram will be continued and extended with no significant change. Because of the opportunities and increased demand to utilize major user facilities, the operations together with research at these facilities will increase. At the FY 1987 request, research will be strengthened in selected technical areas at the expense of other ongoing projects. The university portion of the program not located at DOE laboratories will be maintained at about 20 percent. When including Ames Laboratory (Iowa State University) and Lawrence Berkeley Laboratory (University of California), which are similar to other academic programs, the support going to universities is scheduled to be about 36 percent. Areas identified for emphasis generally fall into two categories of objectives: 1) synthesis, alloying, and preparation of new materials and structures; or 2) materials characterization and property measurements using highly advanced techniques. In consonance with the subprogram's long range plans published last year, the relative emphasis will be on category 1) areas where possible, recognizing of course that the two categories need to be coupled. Research areas to be emphasized include:

processing and mechanical behavior of structural ceramics; structure and properties of polymers; unique calculations, properties and measurements on surfaces, interfaces, and modified surfaces; high flux pulsed neutron scattering research; X-ray lithography, topography, and surface structural measurements using synchrotron radiation; use of high speed computers to calculate and simulate materials phenomena; and electron microscopy and property measurements on advanced materials such as high temperature, ordered, intermetallic compounds, nonequilibrium materials and atomically layered structures. As mentioned above, the limited resources available requires that most of the new emphases be undertaken at the expense of lower priority but still productive activities.

The FY 1987 request for the Materials Sciences subprogram will provide for needed continuity and permit a reasonable level of utilization of major facilities, and strengthening of important topical areas recommended by workshops, panels of the Council on Materials Science and National Academy of Sciences reports. The operating funds of $156,931,000 include part of the needed $10,000,000 for optimum facility operations. This includes added requirements at HFBR for safeguards and security, the first full year of operation of the Los Alamos Neutron Scattering Center (LANSCE) and the full operation of NSLS now that the X-ray ring is operational. Selective decreases will be made to the operating schedule of some small facilities. At the FY 1987 request all user facilities will continue to operate. About one third of the operating increase allowed will be earmarked for research and one third for facility operations and one third for research and development of advanced facilities. Selective decreases will also take place in the research programs to accommodate some specific strengthening and cost-of-living increases. This level for the capital equipment portion of the budget will be used to replace outmoded equipment and allow for some new avenues of research, new spectrometers at neutron sources and new beam lines at synchrotron radiation facilities. This capital equipment level will permit the subprogram to adequately equip the research programs moving into vitally important new areas such as semiconductor materials preparation, ceramics processing and the exploration of new high-strength or high-conductivity polymers. Funds in the amount of $300,000 are included for partial support of Atmospheric Release Advisory Capability operations managed by the Assistant Secretary for Environment, Safety, and Health.

The FY 1987 request for Materials Sciences for construction will permit completion or continuation of FY 1986 approved projects and a start on two new projects. At the Stanford Synchrotron Radiation Laboratory (SSRL), funds of $1,717,000 are requested in FY 1987 to complete the SSRL enhancement project consisting of improvements and a small laboratory addition to SSRL totaling $12,930,000. At Brookhaven National Laboratory, funds of $2,600,000 in FY 1987 are requested to complete the National Synchrotron Light Source (NSLS) beam lines and building expansion project totaling $19,700,000. At Lawrence Berkeley Laboratory, funds are requested in FY 1987 for continuation of the project, Center for Advanced Materials, consisting of two buildings--a Surface Science and Catalysis Laboratory and an Advanced Materials Laboratory. This request is for $10,560,000 of a total project cost of $40,250,000. At Los Alamos, FY 1987 funds of $5,000,000 are requested to initiate construction of the Neutron Scattering Experimental Hall, which has a TEC of $17,500,000. Accelerator and Reactor Improvements and Modifications (ARIM) funds of $2,583,000 are also requested for the existing facilities at BNL (HFBR and the NSLS) and the Ames Laboratory. Further details for each of the construction projects are provided in the attached construction data sheets.

Included in the program described above are funds for new scientific facilities research and development to better define technical parameters and define project costs. The United States has been the world leader in science and technology with the Department of Energy playing a crucial role through the innovation, development, construction, and operation of accelerator-based or reactor-based specialized scientific/engineering facilities. These unique facilities are used by scientists from universities and industry as well as the national laboratories.

The Department proposes to begin the process of providing the technical community with new more powerful facilities to advance the state of technology and the competitive position of the United States in these areas. Two of the highest priority BES-related facilities proposed are: 1-2 GeV Synchrotron Radiation Source (LBL), and continued research and development on the 6 GeV Synchrotron Radiation Source (ANL). The concept and need for these facilities have been reviewed and recommended by several committees, most notably and recently the National Research Council (NRC) study of Major Materials Facilities and the DOE Energy Research Advisory Board review of the NRC report. Since significant research has been conducted in the past, the 1-2 GeV facility is being proposed for construction by requesting architect-engineer and long-lead procurement work in FY 1987. Research and development for the 6 GeV facility will be continued to prepare for a future decision regarding construction at ANL.

The 1-2 GeV Synchrotron Radiation Source (LBL, TEC - $90-100M) consists of a storage ring with many straight sections for magnetic devices which produce high intensity vacuum ultraviolet radiation. The complement of magnetic devices will provide 30 or more experimental stations with radiation of high brilliance and very low emittance. The injection and accelerating system for the storage ring provides the circulating particles with energies in the 1-2 GeV range.

This facility will provide intense photon beams with the ability to undertake very short-lived timing experiments. This facility, which would have the highest brightness and lowest emittance in the world in this energy range, would be used primarily for surface investigations and spectroscopy important to physics, materials, chemistry, biology and several commercially significant technologies. The picosecond timing also makes it possible to study processes and materials that occur over periods as short as 10^{-11} seconds. The beam brilliance would allow entirely new studies of dense plasmas and absorption by highly-ionized atomic species. Microlithography techniques would be explored for the efficient production of electronic devices and soft X-ray microscopy and holographic techniques would be developed with high spatial resolution for the diagnosis of biological specimens. Other experiments important to national security needs would also be undertaken. Funding for A-E and long-lead procurement is requested ($1,500,000 construction) in FY 1987 in order to refine the costs, schedule and design in preparation for construction. FY 1987 funding ($1,500,000 operating and ($500,000 capital equipment) for research and development activities related to a final storage ring lattice design would also include investigations of RF, beam instrumentation and control and new vacuum systems that are needed for peak performance characteristics. The intense photon beams which would be employed would require radiation-hardening studies of several components of the beamline complex.

The 6 GeV Synchrotron Radiation Source (ANL) as currently envisaged would consist of a large storage ring containing as many as 30 magnetic devices to give intense hard X-rays. The injection and booster systems would be designed to inject positrons into the storage ring at the design energy of 6 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 strength 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, and inelastic X-ray scattering, an unexplored field, will be possible. Investigating time-dependent phenomena in biological membranes and in photocyclic processes will be possible as will observing the motion of atoms in proteins. Angiography of coronary and tumor diseases will be advanced through non-invasive and very fast X-ray diagnostics without the use of dyes or drugs. Topography, the study of surface imperfections, 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.

FY 1987 ($2,000,000 operating and $1,000,000 capital equipment) 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 withstand greater X-ray intensities than have been previously achieved.

	FY 1985	FY 1986	FY 1987 Request
Chemical Sciences			
Operating Expenses......................	$ 78,592	$ 78,123	$ 86,419
Capital Equipment.......................	8,840	8,506	9,555
Construction............................	5,550	5,609	5,430
Total Chemical Sciences...............	$ 92,982	$ 92,238	$101,404

The purpose of the Chemical Sciences subprogram is to expand the knowledge base of chemistry and atomic physics on which future energy technologies depend. In the foreseeable mix of energy systems, most of the technologies will depend on processes which are chemical, or based on atomic physics. Our future energy supply depends on present strong support of research seeking knowledge in fields which are basic to energy processes.

Recently a panel of the National Academy of Sciences/National Research Council, as well as the American Chemical Society, senior academic scientists, and senior industry scientists have advocated increased funding for chemical research. They have pointed to the importance of chemistry in our energy economy and to the potential losses from the current limited level of research. The Energy Research Advisory Board, in its recent appraisal of the DOE Technology Base, placed Chemical Sciences in the top grouping of subprograms recommended for increased funding.

The Chemical Sciences subprogram spans a broad front, but emphasizes eight areas because of their importance to energy technologies. The areas are: photoconversion (light energy to fuel energy or electricity), chemical physics (including basic chemistry of combustion), atomic physics (a subfield important to magnetic fusion), basics of coal chemistry, heterogeneous and homogeneous catalysis (especially that underlying coal conversion and more efficient processing of petrochemicals), separations and analytical science (underlying virtually every facet of process chemistry) and chemical thermodynamics (the chemical basis for predicting the optimal handling of hydrocarbon mixtures).

Photochemists are moving closer to a full understanding of photosynthesis, an understanding necessary if we are to imitate and improve on nature's efficiency in forming fuels from airborne gases. They are also building the knowledge base which may enable us to produce hydrogen from water at a reasonable cost.

In-depth understanding of combustion is important to the use of lower grade fuels and to continued progress in improvement of the efficiency of engines, especially automotive engines.

Researchers in atomic physics are making steady progress in enlarging our knowledge of the behavior of the highly stripped ions which can seriously lower the efficiency of fusion reactions, thereby providing guidance as to choice of materials. The behavior of ions at energies higher than fusion energies is also being examined.

Scientists supported by Chemical Sciences are studying the molecular structures of coals and the chemical reactivities of the coal constituents in order to give coal technologists better bases for improving existing coal processes and for developing new and better concepts for obtaining synfuels from coal. Premium quality samples of coals, standardized and preserved, are being provided to the research community for comparability of research done at different times and places.

Just as catalysis is used today in production of billions of dollars' worth of fuels, plastics, etc., it is reasonable to expect that, given in-depth understanding, catalysts can be designed for production of tomorrow's fuels. Those Chemical Sciences researchers engaged in catalysis research are making steady progress toward that goal of full understanding.

Many separation processes often require special extractants to remove selected constituents from process or waste streams. Such separations require both theoretical and experimental understanding to design and synthesize these extractants. Some separation processes, such as distillation of petroleum or synfuel fractions, consume large amounts of energy. New knowledge and insights can help improve existing processes, and can help create entirely new concepts which are less energy intensive. Conceptual neighbors of separations chemists are the analytical chemists who are generating basic, widely applicable approaches to analysis. It is important, in many processes which make fuels or consume energy for other purposes, to identify and quantify impurities which can spoil a product, poison a catalyst or prevent the desired chemical processes.

Chemical thermodynamic studies are being pursued in order to strengthen the knowledge needed to design major plants for producing or handling hydrocarbon fuels. Many fuel mixtures currently or potentially important are not covered by currently available data. Measuring every mixture of interest would be too costly, so thermodynamical research on a sound theoretical basis is providing the needed calculational predictive capabilities.

Two major user facilities receive support through Chemical Sciences. Both facilities were constructed by Basic Energy Sciences for use of scientists in DOE programs and qualified visiting researchers. The Combustion Research Facility (CRF) at the Sandia National Laboratories (Livermore) receives its entire facility operating support from Chemical Sciences, which also provides a major part of the user research support. The National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory receives facility operating and research support from both Chemical Sciences and Materials Sciences.

The operation of the CRF facility includes continued improvement of its unique state-of-the-art laser systems and providing laboratory space, equipment and advisory assistance to visiting users. The automobile industry is prominent among the users; its leaders have stated that CRF is the first Federal research laboratory to attract that industry. CRF research involves inventing, developing and using advanced diagnostic techniques to provide such key information as identities and quantities of very short-lived flame constituents, profiles of temperatures in flames and modeling of turbulence. These are important kinds of information needed for improvements to combustion systems.

Details on the operation of the NSLS are set forth in the Materials Sciences part of this document. The areas of research supported at NSLS by Chemical Sciences are chosen for their combination of scientific insights and importance to chemical and atomic physics problems in energy technologies. Among them: photochemistry in the ultraviolet, electronic interactions between surfaces and adsorbed molecules, and photon excitation and ionization of atoms and molecules.

The Chemical Sciences effort is coordinated with other DOE programs involving chemistry and with other Federal agencies. Periodic meetings of the Federal Interagency Chemistry Representatives and exchanges of lists of proposals and funding actions supplement frequent individual contacts between staffs. Annual and biennial topical conferences bring together the researchers in specific areas of the subprogram with industrial scientists and others.

Typical advances in energy-related chemistry and atomic physics achieved this year by Chemical Sciences are:

- Styrene-based polymers with active phosphorus-containing groups have been discovered which efficiently and economically recover major or trace amounts of toxic or precious metals, e.g., mercury or gold, from waste streams, rivers or sea water. The new extractants are synthesized from inexpensive chemicals. They contrast with present systems which generally require more expensive materials or multiple separation steps to accomplish the same degree of recovery. They were devised through a collaborative university-national laboratory effort.

- A significant advance in the quest for an artificial photosynthetic system has been achieved by chemical synthesis of a model photoreaction center. A key feature of this system is that charge separation occurs following photoinitiated multiple electron transfers. This moves us closer to the goal of improving on natural photosynthesis by positioning of electron donor and acceptor components in the optimum geometry for high efficiency solar conversion.

- o Recent results will make possible a new and detailed understanding of the effects of poisons and promoters in catalytic systems. Superior accuracy and resolution of infrared spectral bands, achieved by combining different state-of-the-art techniques for adsorbed species on single crystals in a multipurpose ultrahigh vacuum system, revealed that the frequency shifts caused by changing the amount of carbon monoxide adsorbed on a Ni(111) crystal surface are due to modification of the chemical properties of the nickel surface itself, caused by the adsorbed carbon monoxide.

- o A study on the separation of coal at ANL has resulted in the development and implementation of a method for providing very pure coal components that is now being used in several other coal research laboratories. Further, the Premium Coal Sample Program at ANL has successfully processed and sealed samples of the first premium coal, to be available to scientists world wide for comparability of basic research results obtained at different times and places for many years. The availability of premium coal samples and pure coal macerals in quantity is fostering meaningful collaborative studies between ANL and both university and industrial laboratories.

- o Laser-induced chemistry has found a new kind of molecular behavior. The absorption of light by a molecule, to introduce either large or small amounts of vibrational energy among its atoms, shows regular frequency spacings which fit quantum mechanical predictions. However, there is an intermediate, heretofore inaccessible energy region where increased vibrational energy does not follow this pattern, but may be randomly distributed. This random behavior has been observed for the first time in acetylene. One laser was used to excite the acetylene molecules to high vibrational states and a different laser then triggered energy emission to get down to the intermediate region.

The FY 1987 request for operating funds is $86,419,000. Within this, an increment will provide for operating costs of the two major user facilities (CRF wholly, NSLS partly), including assistance to visiting users, and research using their capabilities for the areas of chemistry described above.

Also included in the FY 1987 request is an increment to permit restoration in areas which have been identified as important to the knowledge base for energy technologies and which offer a high degree of scientific opportunity. One of these is chemical reactivity; this area includes study of chemical dynamics in the gas phase, which is basic to many energy systems, especially improved combustion technology. An important scientific tool, pulse radiolysis, will be brought to bear as a generator of the short-lived but important species which figure in combustion. Combined with it will be use of laser techniques such as coherent Raman spectroscopy and multiphoton ionization to characterize the species. Experts in chemical theory will provide direct and meaningful interaction with experimentalists, extending previous calculations of molecular and radical reactivities in species extending from these containing only two or three atoms to up to ten. Also studied will be reactive intermediates in condensed phases, since many chemical processes which form or convert fuels involve complex mixtures of substances undergoing chemical reactions, both desired and undesired, dispersed in solvents.

To understand the chemistry of such mixtures, effort will be directed toward understanding the individual reactions, their effects on each other and the effects of the solvent molecules. Prominent here will be study of the influence of solvent dielectrics on chemical kinetics and the relation of electronic structure to reactivity. Another aspect of the area of chemical reactivity will concern electron transfer in chemical systems. This will contribute especially to improved understanding of photosynthesis which could lead to a variety of new uses of sunlight to form fuels. Related to this will be study of the effects of the colloidal state on photoexcited electron transfer, an area likely to lead to qualitatively new knowledge.

Another area of emphasis is related to chemical catalysis. This area of the knowledge base is pervasive in energy technologies, and is at a stage likely to see scientific breakthroughs. Studies will be conducted to exploit a new and scientifically powerful technique recently pioneered in Chemical Sciences: laser-induced generation of small clusters of metal atoms of selectable size and of controllable combination with desired numbers of nonmetal atoms. The insights to be gained with this technique may lead to better understanding of various kinds of catalytic chemistry, including fuel conversions, as well as other energy-related chemical processes.

At Kansas State University the new Ion Collision Physics Facility will be nearing completion and the research activities will include stepped up preparation for its use. The cryogenic electron beam ion source (CRYEBIS), when operational, will not only strongly advance the efficiency and capabilities of scientific research on the behavior of multiply charged ions but will also greatly improve our ability to unravel the complexities of behavior of highly stripped, relatively slow moving metal ions, which must be understood in the design of magnetic fusion devices.

The remainder of the increase will allow for requirements which include the effects of inflation on research capability, and interagency activities such as panels of the National Research Council. The balance of the Chemical Sciences subprogram will continue the activities described earlier, with the evolving of scientific thrusts which has long characterized the subprogram.

The request for capital equipment funds is $9,555,000. The request includes General Purpose Equipment for ANL ($2,200,000) and the Ames Laboratory ($155,000). The principal other purpose for these capital equipment funds is to provide the advanced instruments which are revolutionizing chemical research. The measurements they allow promise to open knowledge even more meaningful than heretofore possible in areas important to energy technologies. Typical of these instruments are ultra-high field nuclear magnetic resonance spectrometers, advanced lasers, multiparameter molecular and ion beam machines, and Fourier Transform electron spin resonance spectrometers.

The request for construction funds is $5,430,000. The largest part of the need results from landlord responsibilities for sites for which BES has overall landlord responsibility: $3,000,000 for ANL, $600,000 for the Ames Laboratory, $300,000 for the Combustion Research Facility and $30,000 for the Notre Dame Radiation Laboratory. As shown above, the largest component of the request is for ANL, where there remains a heavy backlog of needs affecting plant efficiency following several years of extremely severe budget stringency. Details are shown in the attached construction data sheet (87-R-400).

Also included in the request is $1,200,000 to complete construction of the Ion Collision Physics Facility at Kansas State University. Initiated in FY 1985, this project has a total estimated cost of $5,100,000. It represents the United States' first atomic physics facility which is based on state-of-the-art ion accelerators and it will restore US competitiveness in the area of ion collision physics, an area of importance in science and energy. Details are described in the construction project data sheet 85-ER-403. The final part of the construction request is Accelerator Improvement and Modification funding of $300,000 which is needed in order to install two beam lines for atomic physics research at the Holifield Heavy Ion Research Facility, thus greatly enhancing the capability to perform research on highly charged ions.

	FY 1985	FY 1986	FY 1987 Request
Nuclear Sciences			
Operating Expenses......................	$ 39,641	$ 41,445	$ 46,913
Capital Equipment......................	2,950	2,457	2,930
Construction...........................	300	1,251	150
Total Nuclear Sciences................	$ 42,891	$ 45,153	$ 49,993

The Nuclear Sciences subprogram encompasses five principal activities: (1) advancing the knowledge and understanding of the heavy elements' chemical and physical behavior; (2) providing isotopically enriched samples of ordinary elements and samples of the man made transplutonium elements for research, medical, and industrial uses; (3) measuring, compiling, and evaluating nuclear data for both fission and fusion energy technologies; (4) operating the Stanford Synchrotron Radiation Laboratory for the broad community of synchrotron radiation researchers; and (5) conducting research on heavy ion accelerator technology and preparing for its evaluation as a driver for use in inertial confinement fusion systems.

The FY 1987 request for FY 1987 includes $46,913,000 for operating expenses, $2,930,000 for capital equipment, and $150,000 for construction.

Heavy Element Chemistry

Knowledge of the chemical, physical and nuclear properties of the manmade elements beyond plutonium is important to the management of nuclear materials, particularly in their chemical processing, and for medical, industrial or research applications. Also of importance is the information the heavy elements can provide to elucidate scientific theory on the chemical and physical properties of the natural elements. This research enhances that theoretical understanding because of the actinide elements' position near the limit of the periodic table. They are at the edge of the region where relativistic electrons may exist due to the exceedingly high electrical charges on their nuclei. The potential relevance of this phenomenon to their chemistry is completely unexplored.

Most heavy element research is conducted at DOE laboratories where adequate facilities exist to meet the requirements of health and safety in handling them. Some of the research is done through university research contracts or grants, often making use of DOE laboratory facilities and in collaboration with DOE laboratory scientists. Heavy Element Chemistry is a small but active field important as a source of expertise and trained people for future nuclear technologies in energy, medicine, the military and industry. The field's accomplishments are typified by these recent examples:

- Neptunium, a radioactive element in spent nuclear fuels, has long been considered a problem in underground storage because the chemical state preferred by neptunium when in ordinary ground water is mobile. Now it has been found that in some ground waters a different state of neptunium forms. That state much more readily binds chemically to soil constituents, immobilizing the neptunium.

- Results with unexpectedly wide impact have come from ultrahigh pressure studies of the crystal structures of transplutonium metals. Large collapses of volumes have shed new light on how certain electron states possessed only by the actinide elements bond their atoms together and bring about their physical, chemical and electronic properties. Changes will now be required in the theory of structure and bonding of many other chemical elements as well.

The FY 1987 request is $5,066,000 in operating funds. DOE provides essentially all the U.S. support for this field of science. The FY 1987 request for capital equipment is $361,000.

Isotope Preparations

U.S. capabilities for providing enriched isotopes in the quantities needed for clinical medicine, for biomedical and physical research and for industrial applications depend on three facilities at the Oak Ridge National Laboratory. These are the Electromagnetic Isotope Enrichment Facility (Calutrons), the High Flux Isotope Reactor (HFIR) and the Transuranium Processing Plant (TRU).

The Calutrons separate the various isotopes making up the naturally occurring elements. Samples are sold to researchers in biomedical, nuclear and other areas and to industrial suppliers of medical radioisotopes made by nuclear irradiation of the natural isotopes. In addition, a Research Materials Collection is maintained for use by nuclear physicists and other scientists, with the proviso that the samples are to be returned undamaged.

The HFIR has two purposes: producing research quantities of elements heavier than plutonium, and providing an exceptionally high flux of neutrons for studies of materials; it is one of the two principal U.S. facilities providing neutrons in continuous flux for such research. The research at HFIR is supported by the Materials Sciences subprogram of BES, the Magnetic Fusion Energy program, and the National Science Foundation.

The TRU chemically separates the desired higher elements produced in HFIR into pure form and returns the remaining target material for re-use. HFIR and TRU together are the only Western world source of californium-252, a widely used portable source of neutrons for medical, defense, industrial and scientific applications.

The FY 1987 request for Isotope Preparations is $18,077,000 in operating funds. The requested level is needed to maintain a minimal one segment operation of the calutrons. The rest of the increase is needed for the operation of the HFIR and the TRU for two purposes: maintenancd costs of cells and apparatus which have experienced exceptionally high levels of radiation and limited replacement staff who must be trained to learn operational and safety skills before retirement of staff experienced in this unique facility.

The capital equipment request for Isotope Preparations is $524,000.

Nuclear Data

The goal of the Nuclear Data activity is to establish and maintain an accurate, complete, and accessible nuclear data base to meet the long-term needs of the fission and fusion energy technologies, to support biomedical activities using radioactive materials, and to support nuclear waste management and weapons development activities of the Department. The request for FY 1987 is $11,117,000, which includes $10,442,000 for operating expenses and $675,000 for capital equipment.

The Nuclear Data activity includes the core functions of the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory--compilation and encoding of neutron reaction data, coordination of the work of the Cross Section Evaluation Working Group, and maintenance of the Evaluated Nuclear Data File (ENDF). In FY 1987, priority will be given to efforts necessary for development of the next version of the Evaluated Nuclear Data File--Version VI (ENDF-VI). Work will include format modifications that will permit the inclusion of double differential cross-section data required for fusion reactor blanket and shielding design calculations and the reevaluation of nuclear data files for which new measurements have provided data of significantly improved quality. ENDF-VI will make use of new analysis methods that have been developed for the treatment of correlations among measured values of nuclear parameters. The second major data base activity is the continuous updating of the Evaluated Nuclear Structure and Decay File (ENSDF), from which the widely used Nuclear Data Sheets are produced. This effort includes significant contributions from international collaborators; the NNDC is responsible for overall coordination and review of ENSDF activities. The FY 1987 request budgets $2,375,000 in operating expenses and $75,000 in capital equipment for Brookhaven National Laboratory for support of NNDC activities.

The largest effort within the Nuclear Data activity is assigned to the performance of precision nuclear measurements vital to the improvement of the data base. The major United States facilities for carrying out nuclear data measurements are the Oak Ridge Electron Linear Accelerator (ORELA), the Argonne Fast Neutron Generator (FNG), and accelerators at the National Bureau of Standards. A major improvement in the short-pulse capability of ORELA, which established this machine as the premier facility for measuring neutron cross-sections by the powerful time-of-flight method, has recently been achieved. This increased capability will help greatly a new program to improve knowledge of experimental energy resolution functions to better characterize cross-sections in the region of resonance reactions. To make possible accurate measurement of neutron capture cross sections of the fissile and fertile isotopes, a large angle photon-multiplicity detector will be constructed at ORELA in FY 1986 and in FY 1987, when initial experiments are planned. With this detector, scientists will be able to distinguish with relatively high certainty between neutron capture and neutron-induced fission events. Total cost for this detector project is estimated at $480,000 in capital equipment funds--$270,000 in FY 1986 and $210,000 in FY 1987. The FY 1987 request includes $3,425,000 in operating expenses and $445,000 in capital equipment for ORELA's research and operations, including completion of the photon-multiplicity detector and participation in Cross Section Evaluation Working Group activities.

At the Argonne FNG, emphasis will be placed on cross-section measurements at higher neutron energies, up to 20 MeV, for materials of importance to the fusion energy program, including measurements of activation reactions that have been identified as high priority needs. Capital equipment funds will be provided in FY 1987 to ensure that state-of-the-art measurements can continue to be made at the FNG. The FY 1987 request includes $890,000 in operating expenses and $100,000 in capital equipment for FNG's research and operation, including participation in Cross Section Evaluation Working Group activities.

At the National Bureau of Standards, a continued effort will be applied to the measurement of neutron standard cross-sections including the fission cross-sections for U-235. In this precision effort, the development of new detectors has also been found necessary. In FY 1987, $645,000 in operating expenses is planned for work at the National Bureau of Standards. Other work planned for FY 1987 includes nuclear data measurement, compilation, and evaluation efforts at Los Alamos National Laboratory, Idaho National Engineering Laboratory, Lawrence Livermore National Laboratory, Lawrence Berkeley Laboratory, and eleven universities.

Stanford Synchrotron Radiation Laboratory

SSRL is one of the major synchrotron radiation facilities in the U.S. The BES and High Energy Physics (HEP) programs share use of the Stanford Positron-Electron Asymmetric Ring (SPEAR); SSRL, which is funded by the BES program, reimburses the Stanford Linear Accelerator Center (SLAC), which is funded by the HEP program, for SPEAR operating costs for those periods when SPEAR is operated in a mode optimized for synchrotron radiation research, approximately five months a year. Operating costs of SSRL are provided by the Nuclear Sciences subprogram, while the scientists who use SSRL's capabilities receive their research support from other sources, including the NSF. Qualified users from university, industry and government laboratories compete via proposal review for time on SSRL and the best are chosen for assignment of time without cost.

The active areas of research conducted at this facility are many, including materials, biology, physics, medicine and chemistry. Structures, surfaces, very thin layers, and interfaces between metals and semiconductors are among the materials thrusts. Microscopic structures of delicate proteins and living cells are among the innovative biological areas. The span of other areas is typified by: fragmentation of molecules by high energy photons, microminiaturization of integrated circuits and noninvasive angiography. The noninvasive angiography is especially interesting in that it should reduce the number of lives currently lost in the course of invasive angiography manipulations.

The request for operating expenses of SSRL is $8,068,000, an increase of $1,005,000 above FY 1986. There are three needs which will be only partially met by this request: (1) Charges by SLAC for operation of SPEAR were sharply increased in FY 1985, which has caused severe curtailments in SSRL's operation. Indications are that the SPEAR charges will be further increased. (2) Costs of electric power to SSRL will go up further due to a rate increase and the need for extra power from a higher priced supplier when the Stanford Linear Collider begins operation. (3) Costs are increasing for assistance to users, administrative costs, and undulators, multiundulator, wigglers and added experimental stations.

The request for capital equipment is $725,000. These funds are required for the many kinds of optical, electronic, vacuum, magnetic, computer and temperature control equipment used to maintain and improve capabilities at SSRL's nearly two dozen beam lines and experimental stations. Much of the existing equipment has become outdated and some of the beam line mirrors and other optical components have experienced measurable deterioration after 5 to 10 years of use.

Construction funds of $150,000 for general plant projects are requested for the electrical system. The electrical cabling of SSRL has become seriously overloaded with the many added beam lines and experimental stations of the past decade.

Heavy Ion Fusion Accelerator Research (HIFAR)

Heavy ion fusion, using intense beams of heavy ions from high energy accelerators, refers to one of the three major methods of inertial fusion, the others being laser fusion and light ion fusion, which use different technologies. From 1976 to 1983 a low-level program, including four national workshops, was conducted and the concept of heavy ion fusion was endorsed by several major reviews. A multi-year, two-phase program was formulated in 1983 and begun in FY 1984 to develop and evaluate the required heavy ion technology for future decision making. Phase I emphasizes construction of a multiple-beam experiment (MBE) at the Lawrence Berkeley Laboratory (LBL) to demonstrate the induction accelerator method. Accelerator innovations include beam current amplification and operation at the space charge limits in addition to the use of multiple beams. To be completed early in FY 1987, the MBE-4 is a 4-beam experimental test designed as a scaled-down model of the accelerator portion of a larger 16-beam accelerator called the High Temperature Experiment (HTE). Construction and operation of the HTE will constitute Phase II of the program and allow experimental evaluation of heavy ion drivers for inertial fusion.

The request for FY 1987 is for $5,905,000, including $5,260,000 operating expenses and $645,000 capital equipment. These funds support operation of MBE-4 at LBL, development of a 16-beam injector at the Los Alamos National Laboratory, and research on certain critical components for the 16-beam HTE. However, funds are not included for development of 16-beam prototype accelerator modules.

Recent accomplishments in the HIFAR program include: development of preliminary conceptual designs for the HTE based on the use of medium-mass ions such as sodium; confirmation of the feasibility of much higher beam currents than previously thought possible; completion of the MBE-4 engineering design; and successful operation of the MBE-4 cesium ion source.

	FY 1985	FY 1986	FY 1987 Request
Applied Mathematical Sciences			
Operating Expenses......................	$ 34,467	$ 37,925	$ 32,785
Capital Equipment.......................	1,500	1,030	1,100
Construction............................	0	4,811	0
Total Applied Mathematical Sciences...	$ 35,967	$ 43,766	$ 33,885

The Applied Mathematical Sciences subprogram will meet the immediate needs for scientific supercomputing in the research programs supported by the Department's Office of Energy Research and the long range needs of the Department in computational research. The program consists of two parts: Energy Science Advanced Computation and Applied Mathematical Sciences Supercomputing Research. The Energy Sciences Advanced Computation subprogram provides network access to supercomputers for Office of Energy Research contractors and grantees in universities, industry, and DOE national laboratories. The Supercomputing Research subprogram supports research in mathematical and computer science that is vital to understanding the newly emerging parallel processor supercomputer systems and the long range development of future supercomputer systems.

In recent years, the modern supercomputer has changed the nature of scientific research and technology development. The advancement of science used to depend upon experiments for data and theory for understanding. Today there is a third equally important ingredient to scientific research: computational science. Computational science serves a role that is a hybrid between theory and experiment. In some cases, computations provide insights into experimental data, and in others, computations are used to simulate the ideal experiment to test an analytical model. The emergence of computational science as an important element in scientific research and technology development is the result of the development of our ability to do computational modeling of complex physical problems and the enormous power of the modern supercomputer. This combination allows scientists and engineers to model complex problems in a much more realistic way and to obtain much more accurate answers than was possible just 5 years ago.

Scientific supercomputing now makes substantial contributions to many fields of research such as fluid dynamics, plasma dynamics, astrophysics, materials science, chemistry, atomic physics, etc. Similarly, large scale calculations are making significant contributions to product development in areas such as nuclear weapons, electronics, automobiles, aircraft, and chemicals. In product development, computer modeling is used to reduce the number of design/test iterations that are so time consuming and expensive.

The Department of Energy (DOE) has made a significant commitment to scientific supercomputing in several of its research and development programs. As an agency, DOE is the largest user of supercomputers in the world. In 1986 DOE laboratories will house 26 supercomputers. DOE's commitment to scientific computing is not new. Historically, the Department and its predecessor agencies (the Atomic Energy Commission and the Energy Research and Development Administration) caused many supercomputers to be developed through its nuclear weapons design work at the Lawrence Livermore National Laboratory and the Los Alamos National Laboratory.

The supercomputers that were developed in response to DOE needs were delivered to the DOE laboratories nearly devoid of software, requiring our laboratories to develop the necessary software for a complete supercomputer system. Through the software development efforts and the continual interaction between DOE laboratories and the supercomputer vendors, DOE has made significant contributions to supercomputer technologies.

Although DOE's defense efforts still represent the largest use of supercomputers, other DOE programs have become significant users and are also contributing to the further development of the technology. The Magnetic Fusion and Naval Reactors programs have been using supercomputers for many years. Other DOE programs such as Uranium Enrichment, High Energy and Nuclear Physics, Basic Energy Sciences, and Biological and Environmental Research have just begun to make significant use of supercomputers.

Great progress has been made in our ability to do computer modeling of complex scientific problems; however, there is still a long way to go. Many of the Department's research and development programs have large, complex research and engineering problems to solve that can be only crudely approximated with today's supercomputers and mathematical techniques. There is a need to include more physics in the models, to use finer zoning for more accurate answers and to attempt to model in three dimensions. In order to solve these complex problems to the accuracy desired in the future, computers with substantially increased computing power over those currently available will be required. Several DOE programs have estimated that they will require computers 200 times as powerful as a Cray XMP or a Cyber 205 by the end of the decade. In fact, some of the DOE programs could use that kind of computing power today, if it were available.

Applied Mathematical Sciences Supercomputing Research

The primary objective of the research activity is to advance the understanding of the fundamental concepts of mathematics, statistics, and computer science underlying the complex mathematical models of the key physical processes encountered in the Department's research and development programs. In addition, this activity supports investigations of new computer architectures that may lead to new approaches to supercomputers. The research activity provides the primary source of funding for applied mathematics and computer science research to meet the DOE needs in this area.

The DOE scientific research community comprises a large fraction of this country's expertise in large scale computational modeling, with applications in fusion energy, weapons design, and fundamental physical scientific research. Much of the scientific research and development effort throughout DOE programs is focused directly on analytical and numerical modeling of physical processes. An understanding of the fundamental principles upon which these models are based is important for developing energy production and distribution systems for the future. Thus, research in mathematical analysis, algorithms, and computational techniques is crucial in conducting most scientific investigations. DOE's lead role in the development and application of supercomputing techniques is based on this fundamental research.

One goal of the research activity is to develop our ability to use parallel processor computer systems to model complex physics phenomena. The parallel processor direction for supercomputers is dictated by the fact that only very limited gains can be made from increased component speeds and levels of integration in the future. This has caused computer architects to look to using more than a single processor working on a problem. In the near term, the supercomputer vendors are producing systems with 2-16 processors. In the longer term, systems with 100's to 1000's of processors are expected. The change from von Neumann (sequential) to parallel processor machines represents an enormous change in scientific computing, greater than the challenge faced by the introduction of vector processors. The challenge with parallel processors is to have a large number of processors efficiently working simultaneously on the same problem. New software, languages, algorithms, and entirely new mathematical approaches to solving scientific problems will be required.

This subprogram supports basic research at many of the DOE national laboratories, universities, and private research institutions in three major activities: Analytical and Numerical Methods, Information Analysis Techniques, and Advanced Computing Concepts. Analytical and Numerical Methods includes analytic and numerical techniques for solving systems of partial differential equations; Information Analysis Techniques includes data management and statistics; Advanced Computing Concepts includes software methodology and research on high performance systems. Regular meetings with program managers in other Federal agencies help coordinate these activities. Two such groups established to coordinate government sponsored research programs are the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) panel on high performance computing research and the Interagency Committee on Extramural Mathematics Programs (ICEMAP). DOE is one of the ICEMAP sponsors of the new Board for Mathematical Sciences in the National Research Council of the National Academy of Sciences.

Recent accomplishments of this research activity in computational science include the following:

- A fast algorithm, called "successive linkage," well suited for lattice problems involving large summations of potentials with local interactions was discovered. The key step in this algorithm is the identification of frequently appearing terms in the summation together with a method for estimating the frequency with which a given term appears. It has been tested on the exactly solvable two-dimensional Ising model which is used to describe ferromagnetic materials and yields best possible results among all exact summation algorithms for finite square lattices. Extrapolation methods were also developed which enable one to accelerate convergence to thermodynamic limits in infinite lattices.

- A new class of high resolution finite difference methods for modeling compressible fluid flow problems with discontinuities has been developed. These methods incorporate the nonlinear wave propagation properties into the algorithm, leading to methods that are stable and robust in the neighborhood of shock waves and slip surfaces and are still highly accurate in regions of smooth flow. These methods have resolution capabilities that are close to the theoretical maximum attainable and represent a major advance in the state of the art that is unlikely to be surpassed in the near future. These methods are being incorporated into large application programs used in the weapons design and laser fusion projects.

- The University of Illinois established the new Center for Supercomputing Research and Development whose goal is to demonstrate the effectiveness of their "CEDAR" design strategy for parallel architectures and associated algorithms and software. Major support for the Center is being provided by DOE; the State of Illinois is providing faculty positions and building space. Center faculty and staff consists of interdisciplinary teams with expertise in problem decomposition, parallel algorithms, architectures, and networking, including close collaboration with the Mathematics and Computer Science Division at the Argonne National Laboratory. Leaders from the supercomputer industry have applauded the formation of the Illinois Center and state that such centers are the appropriate places to carry out the research required for new generations of supercomputers.

In FY 1985, an enhancement in the research effort in large scale scientific computing was started, with emphasis on algorithms for large scale parallel architectures based on several experimental computer systems under study. The emphasis on new parallel processor architectures applies to all three activities of the research subprogram.

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

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

This subprogram supports interdisciplinary teams including analysts, applied mathematicians, computational scientists, postdoctoral fellowships and graduate students collaborating in universities and national laboratories to research parallel algorithms for mathematical software tools used in implementing these models. As documented in the David Committee's report, "Renewing U. S. Mathematics: Critical Resource for the Future," published by the National Research Council of the National Academy of Sciences, DOE's research program in applied mathematical sciences plays a lead role in support of basic research at the interface between mathematical and computational sciences. The shortage of graduate students and post doctoral support in this crucial area is becoming severe and the current demand for trained computational scientists by industry is rapidly draining the academic pool and the pool of talent available to the National Laboratories. The intent is to strengthen the ties between universities and the Laboratories and to provide salary support and computational resources in the disciplines associated with computational science. The DOE program, with its unique history of basic research in these areas, is positioned to provide strong leadership in filling the "pipeline" from graduate studies to post-graduate studies to research positions in academia and the Laboratories.

Several projects were begun in FY 1985 at the level of between $1,000,000 and $2,000,000 per year to provide for fabrication and software development of parallel architecture research machines. Each project represents a collaboration among universities, national laboratories, and private industry. Funding to support the completion and operation of these research machines is required in order to make these facilities available to researchers at other universities and laboratories via a national network.

The most advanced of these is the Cal Tech Cosmic Cube project initiated by DOE in 1983. In 1984 a 64 processor version of the Cosmic Cube (6-cube) was running a variety of scientific problems, including lattice gauge calculations of the heavy quark potential, problems in astrophysics, seismic exploration, chemical dynamics, and the traveling salesman (simulated annealing) algorithm. The research team supported by DOE includes faculty and graduate students from physics, applied mathematics, computer science, chemistry, geophysics, and engineering. In addition, visitors from DOE laboratories and other universities are participating in this project under separate support. Intel and DEC donated a large amount of equipment to this project. Intel recently announced the commercial version of the 5, 6, and 7-cube based on the new Intel 80286/80287 processor set. Problem decomposition techniques and multiprocessor software is available from the Cal Tech group. Interest in acquiring the Intel cubes has been expressed by at least three DOE laboratories and several universities. In FY 1985, a 128 processor version of the Cosmic Cube (7-cube) was brought up and continues to run reliably.

Research completed to date has demonstrated the viability of this approach for the homogeneous system design. The scalability of this architecture to very large scale parallelism in a variety of problems needs to be verified experimentally. This requires continuation of the current plans to an experimental machine capable of handling problems of realistic complexity. In FY 1986, the project plans to continue the relationship with the Jet Propulsion Laboratory's engineering and fabrication resources to build a much more general purpose version of the Cube, using a modern microprocessor with vector floating point capabilities (a shortcoming of the 16-bit Intel chip in the first Cube). This experimental machine will offer modern operating system utilities that will provide a much more general environment for scientific problem solving.

These projects represent several investment strategies. The first is a collaboration with a large industrial partner providing engineering design and implementation, with a well known DOE Laboratory/university partner providing the mathematical and computer science expertise for scientific applications. The second represents a large DOE supported university group providing again the mathematical and computational science expertise and a government sponsored laboratory providing the engineering design and implementation. The third represents a large, experienced university and laboratory group using mostly "off the shelf" components and far advanced in the development of software for scientific applications.

The FY 1987 request is $22,650,000. Plans for additional facilities and capital equipment projected for the large projects will be deferred until later years, when suitable research machines can be made available. The FY 1987 capital equipment budget request is $500,000.

<u>Energy Science Advanced Computation</u>

With the advent of modern supercomputers and the maturing of computational techniques, computational science has joined experiments and analytical theory as an equal and very essential tool in the advancement of science and technology. The Energy Science Advanced Computation program provides computational support for research programs (other than Magnetic Fusion) that are supported by DOE's Office of Energy Research (OER). These OER programs include High Energy and Nuclear Physics, Basic Energy Sciences, and Biological and Environmental Research. The goals of the Energy Science Advanced Computation program are:

- to provide access to modern supercomputer systems for researchers that are funded through the OER programs;
- to build the knowledge base needed to improve computational technologies throughout the OER programs;
- to provide more effective computational tools for supercomputer systems in use by the OER programs; and
- to shorten the lead times required to implement the results of the OER Supercomputer Research program into existing OER applications and supercomputers and systems software.

The OER researchers served by this program are geographically dispersed throughout the United States and have collaborations with research communities overseas in Europe and Japan. During FY 1985, an enhanced Class VI computer system was installed at the National Magnetic Fusion Energy Computer Center (NMFECC) to provide computational support to these OER programs through the nationwide Magnetic Fusion Energy data communications network (MFENET).

This enhanced Class VI computer system has been very instrumental in the progress of the OER research programs, such as designing and modeling of the physics of high power klystrons, determining the electron energy band structures of new classes of materials, e.g., heavy fermion materials, and ecological modeling the theory for "faunal buildup of competition communities." This enhanced Class VI computer system has been operating at over 90% utilization level (24 hour/day, 7 days/week) since its second month of installation.

Recent accomplishments in the Energy Sciences Advanced Computation activity include the establishment, during FY 1985, of a Supercomputer Computations Research

Institute (SCRI) at the Florida State University, the expansion of the MFENET to include over twenty (20) new geographical sites, the addition of over 1200 supercomputer users actively engaged in OER research projects at the NMFECC, and the development of the first timesharing operating system for operation on a multiprocessor supercomputer configuration. This operating system is targeted for use at two of the new NSF supercomputer centers during FY 1986 and will be supported by the NMFECC. The SCRI was established via a cooperative agreement to conduct research in computational science related to the OER mission, to develop effective computational tools and systems software for use on supercomputer systems, and to operate a supercomputer facility. The SCRI installed a CDC Cyber 205 computer system, of which approximately 65 percent of the system capacity was used for OER related work and over 80% of this capacity had been allocated to university researchers. This operation was also incorporated as a major node on the MFENET for nationwide access.

For FY 1987, a total of $10,135,000 in operating funds is requested. Based on the need to balance the budget, funding for the Florida State Computer Center has been eliminated. These funds will be used to provide additional network capabilities for this supercomputer access program including remote user processor upgrades, replacements and installations, to provide a replacement file management/mass storage system for the obsolete CDC 7600 and 38500 cartridge devices, and to allow for increases at the NMFECC for supplies, utilities, salaries, communications lines, and hardware maintenance. The distribution of costs is: $1,600,000 for network access facilities and equipment; $500,000 for lease-to-ownership of a file management systems and mass storage; and $8,635,000 for lease and operation of the enhanced Class VI computer system. However, due to the magnitude of the increases for software, support costs and communication bandwidth upgrades, the current lease of the enhanced Class VI computer system will be converted to a lease-to-ownership arrangement.

Also, it should be noted that separately identified under this activity is a Major Item of Equipment, a Class V computer system which was initially procured in FY 1986, at the Argonne National Laboratory (ANL). This system while only partially funded in this program is essential to replace an existing outdated system at the ANL.

For FY 1987 capital equipment funds in the amount of $600,000 are requested to provide replacement parts and low cost mass storage peripherals at the NMFECC.

	FY 1985	FY 1986	FY 1987 Request
Engineering and Geosciences			
Operating Expenses....................	$ 26,085	$ 25,571	$ 29,412
Capital Equipment.....................	1,500	1,443	1,750
Construction..........................	0	7,698	0
Subtotal........................	$ 27,585	$ 34,712	$ 31,162

This subprogram provides for the principal research efforts of the Department of Energy in the various areas of engineering and the geosciences, particularly in the disciplines of mechanical engineering, electrical engineering and engineering physics, geology, geophysics and geochemistry. Research projects are selected for scientific excellence and their expected long-term impact on solutions to the Nation's energy-related problems, ultimately to meet the Nation's need for adequate energy supplies at reasonable costs.

The FY 1987 request, $29,412,000 for operating expenses and $1,750,000 for capital equipment, provides for maintaining a sound balance of activity in each of the established areas of program focus, with about the same number of engineers and geoscientists participating in these important aspects of energy research as were involved in FY 1985.

The research to be supported with the requested operating funds is discussed in some detail below. The capital equipment funds requested will be for equipment urgently needed at the national laboratories such as testing and measuring equipment needed for plasma processing research at the Idaho National Engineering Laboratory (INEL), various devices and accessories needed for research at Oak Ridge National Laboratory on intelligent machines for repair and other operations in hostile, changing environments, and for detectors and signal processing equipment needed for research on advanced seismic and electromagnetic methods in geophysics at the Lawrence Berkeley and Livermore National Laboratories.

Engineering Research

Engineering Research in this subprogram pursues two main objectives to meet the long-term basic research needs of both current and future energy technologies: (1) to improve and advance our knowledge of processes underlying current engineering practice for the purpose of enhancing energy production and savings, prolonging useful equipment life, increasing the efficiency of energy systems and reducing costs of operation while maintaining output and performance quality, and (2) to expand the technical data base and knowledge 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, addressing problems related to energy production, distribution, and utilization.

The breadth of application and the character of the research projects supported in Engineering Research are shown by the impact of the results on various energy technologies. For instance, the principles underlying the flow of multiphase fluids (i.e., mixtures of gas and liquids) must be well understood to solve many problems in the petroleum and chemical industries as well as in specific energy supply systems; for example, geothermal, nuclear and solar. Research on generic topics such as these is essential to ensure preparedness and flexibility in addressing the Nation's future energy needs, as well as competitiveness in world markets.

To optimize its impact and use of funds, Engineering Research focuses its research activities on three main categories: (1) Mechanical Sciences, (2) System Sciences and (3) Engineering Data and Analysis. Research supported under the Mechanical Sciences focus includes: fluid mechanics, heat transfer, combustion, solid mechanics and structures, damage and fracture mechanics, and tribology. Systems Sciences includes: systems analysis, synthesis and control, large scale systems, intelligent machines in changing environments, and instrumentation research. Research under the third focus, Engineering Data and

Analysis, includes: the development of important critically evaluated data for energy engineering, mathematical modeling of systems far from equilibrium, and modern engineering analysis, such as analysis needed for understanding the dynamics of nonlinear systems.

Significant accomplishments in Engineering Research have been numerous. A sampling of some of the more recent accomplishments are given below:

- o Research on the non-linear interactions between chemical reactions and transport phenomena aimed at understanding aspects of geo-engineering important for uranium mining has unexpectedly yielded new strategies for petroleum exploration. Two major oil companies (Texaco and Exxon) now fund extension and testing of the new techniques.

- o Research on the interaction between fluid flow and tube bundles in heat exchangers has led to the discovery of a key source of undesirable noise generation in these essential energy system components. This knowledge will aid the design of efficient, environmentally acceptable (low noise pollution) heat exchangers.

- o Critical laboratory experiments have revealed severe limitations on commonly used computer simulation of flow phenomena in enclosures. The results of this research are now used to improve calculation methods for complex heat transfer problems.

The FY 1987 request for this subprogram will provide $14,062,000 for Engineering Research operating expenses. The overall level of effort for Engineering Research will thus be brought back to that of FY 1985. This will provide for strengthened implementation of several efforts for which the first substantial funding was in FY 1985, including both integrated, multidisciplinary efforts (at ORNL, INEL and MIT) and complementary, single investigator-initiated research in small businesses and at universities.

Geosciences

The objective of the Geosciences research is to develop, in areas pertinent to the nation's energy needs, a quantitative and predictive understanding of crustal structure, earth processes and the solar terrestrial interface along with associated advanced techniques and instrumentation.

The earth and the sun are the sources of the world's energy supply. The earth and its atmosphere are the sinks for the wastes generated by energy-producing processes. Thus, increased knowledge in the geosciences is highly important to meeting the Nation's future energy needs. There is need for the development of more advanced methods of energy resource recognition, evaluation and utilization. There is need for an enhanced fundamental understanding of the composition, structure, dynamics and evolution of the earth's crust and how such processes affect natural phenomena such as the distribution of energy and mineral resources, earthquakes, volcanic eruptions, storage and transfer of geothermal energy, the occurrence of fossil fuels and the nature and extent of aquifers.

Geosciences research is carried out principally at the DOE National Laboratories and at universities. The program supports long range research chosen for its scientific merit as well as its special long-term relevance to energy technologies. For example, coordinated projects in geochemical migration and continental scientific drilling address directly and indirectly important long range national energy concerns. Seismic activity, tectonic uplift and increased fumarolic activity at Long Valley-Mono Craters in California have stimulated detailed studies of this area under the DOE Continental Scientific Drilling effort. These studies are part of the joint DOE-NSF-USGS program endorsed last year in a special statutory provision (P.L. 98-473, Section 323).

Geochemical studies of element migration and energy and mass transfer are providing the knowledge base needed to understand the mechanisms of energy and mass transfer in hydrothermal systems, the movement of wastes from geologic repositories, and the concentration and location of energy resources. Research in organic geochemistry is yielding an improved understanding of the origin, development and emplacement of gas, oil and coal deposits and is helping develop a cadre of organic geochemists in U.S. universities where a shortage has existed for many years. Studies of the temperature gradients and tectonic history of subsiding basins lead to a better understanding of the development of energy resources in nature and thus to their more effective exploitation. Development of new geophysical systems and their use in resource exploration are leading to improved methods of locating and defining energy resources and for modeling crustal systems. Recent Geosciences accomplishments include the following:

- Cooperative Seismic Studies at Long Valley, CA. The interagency, cooperative nature of the geophysical studies relating to DOE scientific drilling activities in the vicinity of the Long Valley Caldera is illustrated by the fact that four Federal agencies are involved, one state agency, seven universities and one industry in an effort totaling about $2.8 million with DOE providing about 20 percent of the total costs. This concerted effort is attempting to pin down the three-dimensional configuration of the Long Valley/Mono Craters area and determine the locations of magma bodies. The overall effort was initiated as a direct result of the careful, nationwide search under the auspices of the BES Geosciences activity for sites most likely to fulfill the scientific objectives for continental scientific drilling in regions of high heat flow (i.e., in thermal regimes).

- Field Tests Carried Out of Alterant Geotomography. Tomography has become familiar in medical applications, but suitable data are rarely available for imaging sections of the earth below the surface. A new technique for this purpose features use of electromagnetic waves and injection of conductive (or insulating) fluids through bore holes to alter the conductivity. The first field test was just completed. The "before," "after" and "difference" images clearly show permeable pathways through which the injected fluid moved.

The request for FY 1987 operating expenses for Geosciences is $15,350,000. The request will enable program support at about the FY 1985 level of effort and permit the strengthening of the small but profoundly influential project on worldwide effects of past asteroid impacts. To the extent possible within this framework, the Department's thermal regimes drilling activities will be maintained as a key part of the interagency Continental Scientific Drilling Program.

	FY 1985	FY 1986	FY 1987 Request
Advanced Energy Projects			
Operating Expenses....................	$ 10,048	$ 7,286	$ 8,932
Capital Equipment.....................	320	308	330
Total Advanced Energy Projects.......	$ 10,368	$ 7,594	$ 9,262

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

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

Thus, for example, several novel approaches to controlled fusion--very different from those currently pursued--have been proposed as a result of basic research. One such approach, known as "muon-catalyzed fusion," evoked considerable interest and produced unexpectedly promising results; however, this research is still at too early a stage to determine if muon-catalyzed fusion can be considered a viable process for energy generation. The concept is actively being explored under Advanced Energy Projects sponsorship.

The 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, the development of new sources of electromagnetic radiation, new methods of better fossil fuels utilization, totally new approaches to controlled fusion and new approaches to solar energy collection and utilization. Close contact is maintained with DOE technology programs to ensure proper coordination. Projects are selected on the basis of unsolicited proposals received from researchers at universities, industrial laboratories (especially small R&D companies) and national laboratories.

In FY 1985, about 40 projects are being supported, which allows a turnover rate of about 14 projects a year. A recent accomplishment of Advanced Energy Projects is the demonstration, for the first time, of a laboratory-scale x-ray laser; the range of potential applications is very broad and includes medicine, microlithography and materials research--to name a few. Also last year, a free electron laser (FEL) experiment supported by Advanced Energy Projects yielded new results of break-through proportions, making FEL a leading candidate for powering new generations of particle accelerators, as well as for other applications.

The FY 1987 request for the Advanced Energy Projects subprogram is $8,932,000 in operating expenses and $330,000 in capital equipment funds. This will maintain the total number of projects supported at about 40 and will allow continuation of the initiative in exploring new sources of electromagnetic radiation such as laboratory scale x-ray lasers. Support for the muon-catalyzed fusion effort will continue at slightly enhanced funding levels.

	FY 1985	FY 1986	FY 1987 Request
Biological Energy Research			
Operating Expenses....................	$ 12,360	$ 11,960	$ 14,538
Capital Equipment.....................	560	515	610
Construction..........................	0	5,773	0
Total Biological Energy Research....	$ 12,920	$ 18,248	$ 15,148

The Biological Energy Research (BER) subprogram supports research activities in both the plant and microbial sciences. The objective of this subprogram is to obtain the fundamental knowledge required for the future development of biological systems that produce or conserve energy resources. The research emphasis is directed towards understanding biological mechanisms. The program areas in the botanical sciences are directly related to plant productivity, including research on the main energy supply mechanism for living organisms, photosynthesis and the related fields of plant bioenergetics and metabolism. Research on the structure and function of the complex carbohydrates that make up the plant cell wall are of particular interest as these chemicals not only provide structural support for the plant, but also constitute the major renewable energy resource. Recently, the carbohydrate components of the cell wall have been implicated in having significant roles in plant regulatory processes, development and protection against pathogens. Studies are supported on the molecular mechanisms involved in the regulation of plant metabolism and development which are again directly related to plant productivity and energy conversion efficiency. The molecular events involved in the adaptation of plants to environmental stresses, as well as the molecular and cellular interaction of plants and microorganisms, both symbiotic and pathogenic, are likewise areas of interest as these interactions are often the limiting factors in plant growth. Research on the physiological genetics of plants and the associated genetic expression mechanisms can provide the information necessary to develop plant types with superior characteristics for efficient plant resource production.

The microbiological studies supported by the BER program are primarily concentrated in the areas relating to fermentation biology and to the interaction of microbes with plants. The objective of the fermentation research is to understand, at the molecular and cellular level, the microbial conversion of renewable substrates to potential fuels, chemicals or chemical feedstocks. The research emphasis is on the degradation of the major biological polymers, cellulose, hemicellulose and lignin. The degradation of these polymers frequently involves several types of microbes acting in concert. The nature of these interactions and the enzymes that are responsible for the degradation process all are active subjects of research. Methane, a common end product from the natural degradation of polysaccharides, is generated by certain anaerobic bacteria. The process of methanogenesis and the study of the organisms responsible along with the study of other neglected microorganisms with the potential for novel and valuable fermentations, have been areas of special effort by the BER subprogram. Examples of the category of plant microbial interactions include studies on symbiotic nitrogen fixing bacteria and the microbial processes that alter the properties of soils such as the bacterial process of denitrification of soils.

In certain areas of biotechnology at least, it is becoming more apparent that the most serious limitation to achieving new genetically tailored products (particularly plants and certain microorganisms) is the lack of understanding of the traits to be altered ("targets"). Thus more attention is needed in understanding the fundamental genetics, physiology and biochemistry of organisms. Such studies must become more prominent to balance the very rapid progress being made in such areas as development and use of new genetic vectors for transmitting DNA, unraveling of questions of how genetic messages are read and expressed and other molecular biological areas. In fact, it might be said that the competitive U.S. position in regard to the application of genetic engineering in biotechnology could be undermined if insufficient attention is given to building the strong biological understanding needed to apply the elegant genetic techniques. Clearly, the U.S. maintains a commanding dominance in respect to the genetic aspects of biotechnology, but with respect to such areas of fermentation technology and natural products chemistry, no such lead exists.

Two representative research advances evolving from the BER program this past year include:

1. The obtaining of evidence from Raman microprobe spectrographic analyses that lignin, the noncarbohydrate portion of plant cell walls, exists in a highly ordered orientation with the aromatic subunits being arranged parallel to the plane of the cell wall. Such information could lead to the development of new strategies for performing chemical and microbial degradations.

2. The pigment, phytochrome, which controls numerous morphological developments in plants, has only recently been shown to exist as two distinct molecules, one as found in dark grown (etiolated) plants, and the other as typically found in light grown green plants. The protein characterization has been performed in association with cloning of the genes for these proteins. Such results could lead to a better understanding of light controlled development in plants and ultimately plant productivity.

The funding requested will permit the continued support of current projects at adequate funding levels, with enhanced support being allocated for several ongoing projects in the area of complex carbohydrates and several neglected areas of plant and microbial research. A recent workshop on future research directions has identified these currently funded areas and several other research opportunities as meriting a high priority for enhanced funding. An effort also will be made to respond to a few of the numerous very high quality research opportunities presently available in these areas.

	FY 1985	FY 1986	FY 1987 Request
Program Direction			
Operating Expenses.......................	$ 3,830	$ 3,499	$ 4,125
Total FTE's............................	63	63	63

The FY 1987 request for Basic Energy Sciences Program Direction is $4,125,000. These funds are required to provide for the personnel and other costs associated with 63 full-time equivalents. The additional funds will provide for within-grade and merit increases, and other increased costs associated with management of this program.

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

The research effort involved in the Basic Energy Sciences program is extremely diverse. In FY 1986, for example, over 1,200 research projects will be underway either at the Department's laboratories or at more than 150 colleges and universities in 45 states. Evaluation, monitoring and management of this large number of diverse projects are done almost entirely from the Headquarters and require frequent contact with the contractors and laboratory staff, involving numerous workshops, planning meetings, and project and program reviews throughout the year. During recent years the number of research projects at universities, with industry and not-for-profit organizations has increased from 18 to nearly 30 percent of the BES budget, and the BES staff workload per offsite project is significantly greater than that for a laboratory project. This is especially true with regard to evaluation of proposals, of which approximately 10 percent of those reviewed result in new contracts or grants each year. The requested staffing level is required to maintain a strong core program; to evaluate research programs including those in newer emerging priority areas having great potential importance to energy; to oversee management, operation, and ongoing construction of unique research facilities; and to promote early application of the results of this basic research.

In addition to the ongoing basic research program, the Congressionally mandated SBIR program (Public Law 97-219) is managed by this staff. This program has resulted in a heavy workload requiring extensive use of overtime and diversion of other scientific and administrative staff from their regular duties to assist in the SBIR work. FY 1986 is the first year all three phases of the program are in operation at the same time. This results in increases in the numbers of proposals to be processed and evaluated, procurements and projects to be monitored and evaluated, site visits for those projects entering Phase II, and debriefings requested by proposers not receiving awards. This effort will continue during FY 1987.

The BES program also funds the Scientific Computing Staff which was established to manage two important activities related to large-scale scientific computing: (1) the Applied Mathematical Sciences research subprogram, with research projects at ten national laboratories and over 30 universities, and (2) the Magnetic Fusion Energy Computer Network, which supports supercomputers for over 2,000 ER research contractors. Specific workload includes assessing scientific needs and priorities of the program; planning to meet those needs; managing a large number of research projects, including conducting peer reviews and evaluating proposals from laboratories and universities; monitoring the progress of ongoing university contracts and laboratory programs; managing the Magnetic Fusion Energy Computer Network; and providing a single DOE focal point to maintain liaison with other Federal agencies on policy matters concerning basic research and access to supercomputers.

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

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

2. Project No.: 84-ER-111

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

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

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

5. Previous cost estimate: $19,428

6. Current cost estimate: $ 19,428
Less FY 1983 PE&D: 0
$ 19,428

Date: January 1986

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1984	$ 2,500	$ 2,500	$ 2,500	$ 1,396
1985	7,400	7,400	7,400	3,290
1986	6,928	6,928	6,928	6,528
1987	2,600	2,600	2,600	8,214

8. Brief Physical Description of Project

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

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

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

2. Project No.: 84-ER-111

8. Brief Physical Description of Project (continued)

A. New Experimental Equipment

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

The new equipment will consist of a new wiggler device and the upgrading of a second wiggler, two associated beam lines and ancillary equipment; a soft X-ray undulator and associated beam line; and an infrared beam line. The exact design of this equipment will be determined as the project progresses.

B. New Building Addition

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

The expansion will add approximately 56,500 square feet of new space in a two-story addition on the north and east sides of the existing building.

The ground floor includes expanded experimental areas for X-ray and VUV storage rings, an angiography suite, laboratories, offices, technical work areas, a receiving and gas storage area, expanded lobby, mechanical equipment rooms and several public rooms. A tunnel connecting the ground floor to technical work space in an adjacent facility will be provided. First floor gross area is 28,912 square feet.

The second floor includes offices, technical work space, design and conference rooms and a mechanical equipment room. Second floor gross area is 27,569 square feet, larger than the original concept by 4,650 square feet in order to accommodate the increased need.

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-111

8. Brief Physical Description of Project (continued)

The additions will be designed to current DOE energy conservation standards and contain fire protection systems. Access by handicapped persons will be provided.

C. Existing Facility

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

The 2.5 GeV X-ray storage ring provides for the possibility of 28 primary beam ports, each of which is capable of accommodating several experimental beam lines. The VUV ring provides for 16 beam ports which are also capable of accommodating several experiments each. In sum, more than 90 experiments can be carried out at one time when the facility is fully instrumented. In addition to general users, research groups called Participating Research Teams (PRT's) from universities, industry and national and government laboratories, upon advice by a program committee, and approval by the NSLS Department Chairman provide instruments to carry out research programs at the NSLS facility. Their instruments are made available to general users for 25% of the available time. General users are able to use any of the experimental lines, PRT or community lines, upon approval of their experimental proposal. The NSLS is operated as a user facility. This means that researchers from BNL and other laboratories will be able, after review of a proposal by a committee of distinguished scientists, and acceptance by the NSLS Department Chairman to carry out an experiment using either the UV or X-ray radiation produced by the rings.

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

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

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-111

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

a) The insertion device beam lines and the infrared beam line will provide a range of wavelengths and intensities not presently available at bending magnets. These instruments will be used both by general users and by members of the Insertion Device Teams (IDT's).

b) Instruments for general users that will complement those already provided.

A. New Experimental Equipment

The original development plan provided for a small number of bending magnet beam lines. Further instrumentation, also originating in bending magnets, was to be made available by Participating Research Teams (PRT's), who installed beam lines at the rings at their expense and made 25% of the experimental time on their lines available to general users. The growth in user participation has far exceeded earlier expectations.

Developments in recent years has given a high scientific priority to insertion devices. In order to provide this important new experimental capability at the NSLS, it is proposed to accelerate beam line construction. Following the recommendations of the previously noted study committees, it is essential to provide insertion beam lines at the earliest possible date.

B. New Building

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

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

CONSTRUCTION PROJECT DATA SHEETS

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

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

X-ray experimental floor was occupied by technicians until such time that a need would arise to instrument Ports X1 through X8.

It was projected that during the early years of operations, up to approximately 50% of the 28 X-ray and 16 UV ports would be utilized. Currently, there are 18 beam lines operating at the X-ray ring, 7 more will be ready for operation this year and an additional 17 are in various stages of planning. In the VUV, there are 13 operating, 11 more that will soon be operating, and 11 in planning. The extremely enthusiastic response of the scientific community now forces us to advance the expected rate of beam line construction and building expansion. This response, coupled with the beam lines to be provided by the project, indicates that the experimental floor will be extremely crowded and additional support space would be essential.

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

In addition to the pressing need to return experimental floor space to its intended use, the expansion will provide adequate office space for the permanent staff and work areas to complement the research and development associated with the anticipated programs. The short connecting tunnel between the NSLS building and the basement of the adjacent Instrumentation building will connect the NSLS staging areas to an area where extensive vacuum, instrument, and other NSLS support activities are located.

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-111

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

Annual Costs

The estimated incremental operating costs of the proposed NSLS beam lines and support area construction are listed below. Costs are in FY 1986 dollars.

	(Dollars in Thousands)
Materials, Supplies, Support Services	$108
Electric Power	278
General and Administrative	46
Total	$432

10. Detail of Cost Estimate a/b/

	Item Cost	Total Cost
a. Engineering, design and inspection, including A-E fee	$	$ 4,080
b. Land and land rights		0
c. Construction costs		12,998
(1) Beam line construction	5,763	
(2) Sitework	105	
(3) Structures	6,730	
(4) Facility Modification	400	
d. Standard equipment		640
Subtotal		17,718
e. Contingency		1,710
Total project cost		$ 19,428

a/ Estimate is based on awarded conventional construction contract.

b/ Escalation rates conform to the guidelines prescribed in the Department of Energy Field Budget Process Chapter, August 1984, which are based on the materials and labor data contained in the Energy Supply Planning Model and escalation rates forecasted by Data Resources, Incorporated (DRI). Current costs have been escalated by 5.6%, 4.9%, 6.4% and 6.7% per year on beam line construction for FY 1984 through FY 1987, and 6.4%, 5.4% and 4.6% on conventional construction for FY 1983 through FY 1985.

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-111

11. Method of Performance

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

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

	Prior Years	FY 1984	FY 1985	FY 1986	FY 1987	Total
a. Total project costs						
1. Total facility costs						
(a) Construction line item.........	$ 0	$ 1,396	$ 3,290	$ 6,528	$ 8,214	$ 19,428
(b) CP&D.........................	0	0	0	0	0	0
(c) Expense Funded Equipment.......	0	0	0	0	0	0
(d) Inventories....................	0	0	100	100	0	200
Total facility costs...........	0	1,396	3,390	6,628	8,214	19,628
2. Other project costs						
(a) R&D necessary to complete construction of beam lines....	900	500	500	0	0	1,900
(b) Other.........................	0	0	0	0	0	0
Total other project funding....	900	500	500	0	0	1,900
Total project funding..........	$ 900	$ 1,896	$ 3,890	$ 6,628	$ 8,214	$ 21,528

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

2. Project No.: 84-ER-111

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

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

1. Operating costs	$ 432
2. Programmatic operating expenses directly related to the facility	0
3. Capital equipment not related to construction but related to the programmatic effort	0
4. GPP or other construction related to the programmatic effort	0
5. Other costs	0
Total other related annual funding requirements	$ 432

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

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

b. Total related funding requirements
   1. Operating Costs - There will be an annual requirement of additional materials, supplies, and support services associated with the new beam lines. Also, there will be a requirement for increased facility electrical power.

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

2. Project No.: 84-ER-111

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

2. Programmatic operating expenses directly related to the facility - no narrative required.
3. Capital equipment not related to construction but related to the programmatic effort - no narrative required.
4. GPP or other construction related to the programmatic effort - no narrative required.
5. Other costs - no narrative required.

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

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

2. Project No.: 84-ER-112

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

3a. Date physical construction starts: 4th Qtr. FY 1984

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

5. Previous cost estimate: $ 40,250

6. Current cost estimate: $ 40,450
Less FY 1984 PE&D: 200
$ 40,250

Date: January 1986

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1984	$ 1,760	$ 1,760	$ 1,760	$ 437
1985	9,290	9,290	9,290	1,442
1986	11,008	11,008	11,008	10,174
1987	10,560	10,560	10,560	17,522
1988	7,632	7,632	7,632	10,675

8. Brief Physical Description of Project

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

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

The CAM facilities at LBL will be located on University of California property adjacent to the Berkeley campus, within the site of the Lawrence Berkeley Laboratory. The project will include the construction of new facilities,

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-112

8. Brief Physical Description of Project (continued)

and the alteration of, and additions to, existing facilities. Plant and site facilities will consist of: a) improvements to land, including grading, drainage, paving, lighting, and walkways; b) a new Surface Science and Catalysis Laboratory (SSCL) building (approximately 47,000 GSF), located near the existing Materials and Molecular Sciences Laboratory (Building 62); c) the new approximately 80,000 GSF building, the Advanced Materials Laboratory (AML); d) the extension of existing utilities, including electrical power, water, sewage, gas, and communications; and e) standard equipment and special facilities including office and laboratory furniture and equipment, fume hoods, ventilation and temperature control equipment, laboratory diagnostics and instrumentation equipment, fire protection equipment and computation equipment.

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

The Advanced Materials Laboratory will consist of a single light-laboratory building. The proposed four-story building will occupy a hillside site providing a first floor with a main entrance at the grade level of the base of the hill. The building will consist of two rectangular wings offset in the east and the west directions around a central core with a steel frame structural system. Foundations will consist of poured-in-place reinforced concrete caissons.

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

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-112

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

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

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

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

Two research laboratories form the major components of the CAM:

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

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

Because of the pressing need to retain high-technology leadership, the proposed project schedule calls for the start of construction in FY 1984 and the completion of all facilities in FY 1988. Delays would extend the time at which research results can be generated and transferred to U.S. industry. A CAM Advisory Board composed of scientific leaders from industry, universities, and Federal laboratories will advise the LBL director on CAM scientific program

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-112

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

directions to ensure that CAM basic research addresses America's long-range high-technology needs. The CAM affiliates, consisting of major research teams from industry and universities, will participate in CAM. The following cost estimates and mix among facilities may vary depending upon the research and development progress, but does represent the current plan.

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

10. Details of Cost Estimate

	Item Cost	Total Cost
a. Engineering, design, inspection and administration....................	4,485	
b. Construction costs..	23,864	
c. Standard equipment..	6,120	
d. Removals and relocations..	600	
e. Contingencies at approximately 15% of above.........................	5,181	
Total estimated cost..		$40,250

11. Method of Performance

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

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-112

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

	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988	Total
a. Total project costs:						
1. Total facility costs a/						
(a) Construction line item						
SSCL............................	$ 437	$ 1,022	$ 6,212	$ 4,279	$ 0	$11,950
AML.............................	0	420	3,962	13,243	10,675	28,300
	437	1,442	10,174	17,522	10,675	40,250
(b) PE&D............................	8	192	0	0	0	200
Total project costs.......................	445	1,634	10,174	17,522	$10,675	$40,450

	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988	FY 1989
b. Other related funding requirements (estimated life of project: 25 years)						
1. Programmatic research.................	2,300	2,800	3,200	6,200	10,500	15,500
2. Capital equipment related to programmatic research...............	1,300	600	460	1,500	2,600	3,900
Total.......................................	$ 3,600	$ 3,400	$ 3,660	$ 7,700	$13,100	$19,400

TOO HIGH

a/ Includes escalation to midpoint of construction for all conventional facilities and compounded annually for special facilities; FY 1986 3.8%; FY 1987 $5.0%; FY 1988 5.8%.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Center for Advanced Materials Lawrence Berkeley Laboratory, Berkeley, California — 2. Project No.: 84-ER-112

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

a. Total project funding

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

(a) Construction of the Surface Science and Catalysis Laboratory began in April 1985 and will be completed in the second quarter of FY 1987.

(b) The Advanced Materials Laboratory building is scheduled for Title I review in the second quarter of FY 1986. The project will be scheduled to sequence bid packages to minimize disruption to existing programs and construction congestion and to optimize favorable bidding conditions and work leveling. Site bid packages will be let in the third quarter of FY 1986. Building construction will begin in the first quarter of FY 1987 and end in the fourth quarter of FY 1988.

b. Other related funding requirements

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

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

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

2. Project No.: 84-ER-113

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

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

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

5. Previous cost estimate: $12,833

6. Current cost estimate: $13,233
Less FY 1983/1984 PE&D: 400
$12,833
Date: January 1986

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1984	$ 1,240	$ 1,240	$ 1,240	$ 544
1985	7,413	7,413	7,413	2,661
1986	2,463	2,463	2,463	5,160
1987	1,717	1,717	1,717	4,468

8. Brief Physical Description of Project

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

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

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-113

8. Brief Physical Description of Project (continued)

The project is divided into three major portions: (a) construction of two beam lines, one on the SLAC Positron Electron Project (PEP) storage ring and an 18 degree beam line on the Spear storage ring; (b) alteration of the electron storage ring SPEAR for high flux synchrotron radiation research and (c) construction of three conventional facilities: two PEP Beam Line Facilities and a Laboratory/Office/Shop Building (LOS).

a. Beam lines

(1) PEP Beam Lines

The PEP electron-positron storage ring is operated by the Stanford Linear Accelerator Center for the study of elementary particle physics. In its present configuration it can be usefully operated from 8 GeV to 18 GeV, although the majority of the program has focussed upon research at 14 GeV. During the normal running of the machine, the electron and positron beams emit synchrotron radiation from within the bending magnets with photon energies in excess of 100 KeV.

This project also includes funding for installation of two 26-period, 2-meter rare earth cobalt undulator magnets on a symmetry straight section of the PEP storage ring, resulting in the emission of photon beams peaked at 13 KeV when the machine is running at 14 GeV. Mossbauer diffraction and ultra-high energy resolution x-ray scattering research will be performed on these beam lines.

(2) Eighteen Degree Beam Line

To complement the high x-ray energy program on the PEP storage ring, SSRL proposes to construct a low-energy photon beam on the SPEAR storage ring, on the reinforced mezzanine in Bldg. 131. SSRL would relocate the existing Seya-Namioka monochromator from Beam Line I, and construct a new beam line transport system, consisting of two successive focussing mirrors.

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

2. Project No.: 84-ER-113

8. Brief Physical Description of Project (continued)

b. Machine Improvements

(1) Reduction of SPEAR Emittance and Vertical Aperture Requirements

To obtain approximately an order of magnitude increase in spectral brilliance from all beam lines and to more effectively utilize insertion devices, the injection system and the electron optics of the storage ring will be modified. This will achieve a factor of approximately 3.5 reduction in horizontal emittance and a factor of approximately two reduction in vertical aperture requirements at wiggler and undulator locations.

To accomplish the proposed reduction in emittance, SSRL has initiated the design and fabrication of a current shunt for the four focussing magnets located between the injection kicker magnets, using FY 1983 R&D operations funds. SSRL will also complete the shunt and injector modifications, and modify the SPEAR sextupole powering system. At present, the SPEAR sextupole magnets are divided into two families, each of which is powered independently. To properly correct for chromaticity effects in low emittance configurations, the SPEAR sextupole magnets need to be divided into four independently powered families. This requires two additional power supplies and additional cabling.

Realization of the full benefits of the reduced emittance and reduced vertical aperture requirement requires an improved beam position monitoring system for the storage ring. Improved monitoring and control over the orbit will result in reduced cross-coupling and better steering of the SSRL synchrotron radiation beams.

In addition, modifications and additions will be made to the SPEAR lattice to facilitate compensation for the increased number of wiggler/undulator magnets that will be implemented in the future.

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

2. Project No.: 84-ER-113

8. Brief Physical Description of Project (continued)

(2) Beam Stabilization

At present the stored beam in SPEAR is perturbed by ground vibrations which couple into the SPEAR magnet supports, causing small amplitude, low frequency (4-12 Hz) oscillations of the electron beam. The effect of this is to cause vertical bouncing of the synchrotron radiation beams and intensity modulation of the flux transmitted through narrow slits at the experimental stations.

The present level of "beam bounce" will be reduced by making use of electronic feedback systems to detect and reduce the amplitude of the beam bounce by applying magnetic corrections to the orbit at each beam line source point.

(3) New Linac Electron Injection System

The American University proposal to construct a new electron gun and injection system will be funded in FY 1984. This gun is designed to produce high current, long pulse length (approximately 1 microsecond) beams of low energy electrons suitable for use in a nuclear physics research program.

SSRL funded the addition of a "chopper" to the gun in order for the injection system to have the capability for producing short pulses (of about 1 nanosecond in duration). This addition will allow the gun to provide low current beams, up to about 4 GeV, suitable for electron injection into SPEAR. A gun with this capability will be advantageous for use during SSRL dedicated operation of SPEAR since it can provide more reliable injection into SPEAR at somewhat lower operations costs It will also allow dedicated operation of SPEAR during parts of SLAC's summer shutdowns.

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-113

8. Brief Physical Description of Project (continued)

c. Conventional Construction

(1) PEP Beam Line Facility 5B (PBF 5B)

The site at PEP has been chosen for the first PEP Beam Line and the associated facility. The site is just within the existing SLAC lease boundary and it will not be necessary to acquire more land from the University for the facility. The site requires a retaining wall for the access road, service yard and PBF building which will be half buried into the PEP ring earth shielding mount.

The PBF 5B will be an experimental hall with three adjoining rooms and a partial mezzanine. The hall and room areas will be 2,900 square feet; the mezzanine will be 600 square feet, for a total of 3,500 square feet.

(2) PEP Beam Line Facility 1B (PBF 1B)

The site at PEP has been chosen for the second PEP Beam Line and the associated facility. The site also requires a retaining wall for the access road, service yard and PBF building which will be three-fourths buried into the PEP ring earth shielding mount.

(3) Laboratory/Office/Shop Building (LOS)

The Laboratory/Office/Shop Building (LOS) will be a three-story, 31,500 gross square feet building designed to accommodate activities displaced by beam lines in the existing SSRL buildings, as well as laboratory growth associated with SEP and other SSRL construction programs.

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

2. Project No.: 84-ER-113

8. Brief Physical Description of Project (continued)

The first floor will consist of a Vacuum Clean Room, a Beam Line Component Assembly Shop, a Machine and Welding Shop, and machine shop offices and storage facilities.

The second floor will consist of six light laboratories, each 1800 gsf in size, with the following functions, respectively: 1) electronics, 2) computation, 3) biotechnology, 4) vacuum-ultraviolet research, 5) metrology and 6) x-ray research. Provision will be made for later addition of two chemical fume hoods and two toxic/acid waste disposal systems.

The third floor will provide up to 43 offices, a library, a conference room, a drafting room, a lounge-lecture area, and seven work rooms.

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

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

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

As a result, new storage rings are presently being planned which are optimized for high spectral brilliance and photon flux through utilization of insertion devices, rather than bending magnets, for the production of radiation

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-113

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

and through the achievement of extremely low emittances and high currents. These rings are also optimized for specific spectral regions through choice of stored electron energies. Generally, stored electron energies at 1.0 to 1.5 GeV are utilized for ultra-high brilliance soft x-ray and vacuum ultraviolet (VUV) generation whereas rings of greater than 3.0 GeV are used for ultra-high brilliance x-ray generation.

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

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

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

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-113

10. Details of Cost Estimate

	Item Cost	Total Cost
(a) Engineering, design, and inspection..................	1,899	
(b) Construction costs..................................	8,367	
(c) Standard equipment..................................	308	
(d) Removals and relocations............................	100	
(e) Contingencies at approximately 19% of above..........	2,159	
Total estimated costs...		$ 12,833

11. Method of Performance

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

Conventional facilities engineering design will be performed partially under a negotiated Architect/Engineer subcontract, but primarily by the SLAC Plant Engineering Dept. on a "best efforts" basis. Inspection and some engineering will be done by Laboratory personnel. Construction and procurement will be accomplished by fixed-price subcontracts awarded on the basis of competitive bids.

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-113

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

	FY 1984	FY 1985	FY 1986	FY 1987	Total
a. Total facility construction costs: a/					
SSRL Enhancement	$ 544	$ 2,661	$ 5,160	$ 4,468	$ 12,833
Total facility construction cost..........	544	2,661	5,160	4,468	12,833
b. Other project funding:					
SSRL R&D................................	800	800	0	300	1,900
Total R&D/Startup........................	800	800	0	300	1,900
Total Project Funding........................	$ 1,344	$ 3,461	$ 5,160	$ 4,468	$ 14,733

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

Related Funding Requirements

a. Total Project Funding

(1) The major elements of the SSRL Enhancement Project have been described in item 8.

a/ Includes escalation to midpoint of construction for all conventional facilities and compounded annually for special facilities; FY 1984 N/A; FY 1985 6.2%; and FY 1986 $6.5%.

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-113

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

The funding profiles were determined as follows:

(a) At SSRL the PEP Beam Line will be accomplished during the first two years. Improvements to SPEAR are scheduled for the second year and the Laboratory/Office/Shop Building is scheduled for the second and third year. Completion of the PEP Beam Line Facility 1B will occur in the third year, and completion of the PEP Beam Line 1B will occur in the fourth year.

(2) Other project funding

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

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

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

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

2. Project No.: 85-ER-403

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

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

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

5. Previous cost estimate: $3,400

6. Current cost estimate: $5,028

Date: January 1986

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1985	$ 2,000	$ 2,000	$ 2,000	$ 100
1986	1,828	1,828	1,828	928
1987	1,200	1,200	1,200	2,100
1988	0	0	0	1,900

Financial schedule is based on the net Government funding associated with this project. In May 1985, the State of Kansas Legislature appropriated $1,100,000 for the conventional construction necessary to house the new capabilities.

8. Brief Physical Description of Project

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

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 85-ER-403

8. Brief Physical Description of Project (continued)

New equipment to be installed in new basement addition includes:

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

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

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

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

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

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 85-ER-403

10. Details of Cost Estimate

	Item Cost	Total Cost
a. Engineering, design and installation		$ 980
b. Land and level rights		0
c. Construction costs		330
1) beam line construction	$ 315	
2) utilities	15	
3) buildings	a/	
d. Equipment		2,900
e. Contingency		818
Total Project Cost		$ 5,028 a/

11. Method of Performance

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

a/ Kansas State University has provided additional funding to construct the building. Estimate is based on completed conceptual design.

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 85-ER-403

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

	FY 1985	FY 1986	FY 1987	FY 1988	Total
a. Total project funding					
(1) Total facility costs					
(a) Construction line item	$ 100	$ 928	$ 2,100	$ 1,900	$ 5,028 a/
(b) CP&D	0	0	0	0	0
(c) Expense funded equipment	0	0	0	0	0
(d) Inventories	0	0	0	0	0
Total facility costs	$ 100	$ 928	$ 2,100	$ 1,900	$ 5,028 a/
(2) Other project funding					
(a) R&D necessary to complete construction	$ 180	$ 180	$ 50	$ 0	$ 410
(b) Other	0	0	0	0	0
Total other project funding	180	180	50	0	410
Total project funding	$ 280	$ 1,108	$ 2,150	$ 1,900	$ 5,438 b/

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

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

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

No narrative required.

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a/ Kansas State University has provided additional funding to construct the building. Estimate is based on completed conceptual design.

b/ As noted above, the State of Kansas has provided an additional $1,100,000 for conventional construction of housing.

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

1. Title and location of project: General plant projects

2. Project No.: 87-R-400

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

3a. Date physical construction starts: 2nd Qtr. FY 1987

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

5. Previous cost estimate: None
Date:

6. Current cost estimate: $4,080
Date: January 1986

7. Financial Schedule:

Fiscal Year	Obligations	Costs FY 1985	FY 1986	FY 1987	After FY 1987
Prior Year Projects	$ 400	$ 167	$ 0	$ 0	$ 0
FY 1985 Projects	3,750	2,015	1,735	0	0
FY 1986 Projects	3,877	0	847	3,030	0
FY 1987 Projects	4,080	0	0	470	3,610

8. Brief Physical Description of Project

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

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: General plant projects 2. Project No.: 87-R-400

8. Brief Physical Description of Project (continued)

The currently estimated distribution of FY 1986 funds by office is as follows:

Argonne National Laboratory	$ 3,000
Ames Laboratory	600
Notre Dame Radiation Laboratory	30
Sandia National Laboratories	300
Stanford Synchrotron Radiation Laboratory	150
Total project cost	$ 4,080

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 .... $ 3,000

1. Materials Handling Receiving/Shipping Building
2. Replace Post Indicator Valves
3. Install Standby Power Feed, ZPPR to Bldg. 752
4. RSWF Road Rebuilding
5. Rigging Test Facility Addition
6. Security System Upgrading
7. Upgrade Animal Facility Cooling E and Q Wings, Bldg. 202
8. Chiller and Unit Substation Replacement, Bldg. 205
9. 15kV Undergound Valut Switch Replacement, Bldg. 211
10. Transformer and Power Center Replacement, Bldg. 203
11. Replace Economizer Tubes of Boiler No. 5
12. Building 201 Improvements
13. Emergency Generator Replacement, Bldg. 350

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: General plant projects — 2. Project No.: 87-R-400

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

14. Replace Air Compressors, Bldg. 211
15. Rehabilitate Washrooms and Locker Roomms, Bldgs. 301, 308 and 310
16. 15kV Underground Vault Switch Replacements, Bldg. 205
17. Upgrade of Electrical Service Laboratories, Bldg. 223
18. Cooling System Upgrade, Bldg. 203
19. Air Condition Hot Shop, Building 212
20. Lecture Room Improvement, Bldg. 221
21. Test Instrument Room for EBR-II Sodium Boiler Bldg.
22. Laboratory Renovation Lab, J-102, Bldg. 205
23. Upgrading of the Tandem-Linac Area, Phase IV, Bldg. 300
24. HFEF/S Backup Emergency Power Supply
25. Expansion of Instrument Test Facility (ITF) Bldg. 772

Of the total request of $3,000,000 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.

At present, a total documented GPP backlog of approximately $20,000,000 exists at ANL for required upgrading and programmatic projects at both sites. This backlog is not static and is constantly under review by ANL management so that the most critical requirements are taken care of as promptly as possible with available GPP funding. These requirements may come about as the result of the unscheduled failure of major plant components or the need to satisfy scientific program requirements.

The backlog of GPP projects has tended to increase steadily in recent years due to the shortfall in funding line item requests for plant rehabilitation at ANL-East and ANL-West, and because of programmatic shifts at ANL which have required modifications to the existing plant. When it is considered that total GPP funds available to ANL in FY 1983 and FY 1984 total only $2,100,000, it is readily apparent that while funding was increased ANL needs still far outpace the availability of funds with which to satisfy them.

1. Title and location of project: General plant projects   2. Project No.: 87-R-400

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

Ames Laboratory.. $ 600

Requirements include for example: development building second floor addition, campus warehouse roof replacement, metallurgy building electrical system upgrade, water system upgrade and miscellaneous proejcts. The projects described will be constructed on the Ames Laboratory, non-Government owned property.

Notre Dame Radiation Laboratory.. $ 30

Requirements include minor building modifications to properly house staff members and to make optimum use of laboratory research space. The projects described will be constructed on the Notre Dame Radiation Laboratory, non-Government owned property.

Sandia National Laboratories... $ 300

The Combusion 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.

Many experiments, both active and proposed, at the CRF have greatly impacted the available laboratory space and facilities. Some experiments 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.

Stanford Synchrotron Radiation Laboratory.............................. $ 150

Requirements include minor modifications and additions necessary to support the optimum use of the laboratory research space. Examples include cable trays, terminal racks, status panels, and similar improvements.

10. Details of Cost Estimate

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

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: General plant projects   2. Project No.: 87-R-400

11. Method of Performance

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

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

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

2. Project No.: 87-R-401

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

3a. Date physical construction starts: 1st Qtr. FY 1987

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

5. Previous cost estimate: None
Less amount for CP&D: None
Net cost estimate: None
Date: January 1986

6. Current cost estimate: $2,883
Less amount for CP&D: 0
Net cost estimate: $2,883

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1987	$ 2,883	$ 2,883	$ 2,883	$ 1,000
1988	0	0	0	1,333
1989	0	0	0	550

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; two projects are requested at the Oak Ridge National Laboratory for improvements at the High Flux Isotope Reactor and the Holifield Ion Research Facility, and one project is requested for an enhanced injection system at the Stanford Synchrotron Radiation Laboratory.

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 87-R-401

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

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

Brookhaven National Laboratory

High Flux Beam Reactor Facility (HFBR).. $ 940

The control room recorders are becoming obsolete. Increased maintenance and unavailability of spare parts for the present system are two factors which contribute to the need for updated recorders. The control room recorders will be replaced with modern recorders which will reduce maintenance requirements, provide better timing accuracy and have capability for both analog and digital output.

The existing fuel element cutting system requires continual maintenance which results in unnecessary radiation exposure, inefficient use of maintenance personnel, and a system of less than desirable operating efficiency. A new system will be designed to eliminate the deficiencies of the present system and provide a simple and effective method of cutting spent fuel elements in the fuel storage canal.

An automated method of treatment will be installed for controlling biological fouling in the secondary system for the HFBR reactor.

The present HFBR turbines are not optimized to the existing workload conditions of helium pressure and mass flow. New turbines of appropriate design will improve the efficiency of the refrigerator, reduce power consumption and lengthen the expected life of the system components.

There is a need for a second compressor at the Cold Neutron Facility (CNF) in order to provide redundancy and assure continuity of operation. If the present compressor has to be removed from service for any reason, the

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 87-R-401

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

facility must be shut down, with the attendant loss to the solid state physics and biology programs. The new compressor would not need to be as large as the old compressor (400 hp instead of 600 hp) since the loads are not as great as originally expected; this would result in some savings in electrical power consumption. A small building with a concrete mounting pad is included to house the new compressor.

Human error has been a factor in venting and purging of the CNF causing down time and programmatic delays. Improvements to the CNF console would include changing the layouts, making displays more compact and legible, and adding a computer to log operating procedures, thereby reducing downtime.

Instrumentation, equipment, and other reactor modifications are required for safeguards and security directly related to HFBR for protection against theft, radiation leakage, or sabotage of nuclear fuel storage and transfer.

National Synchrotron Light Source (NSLS).. $ 1,515

The linear accelerator preinjector will be replaced by a new state-of-the-art injector of higher performance, higher energy, and better reliability and maintainability.

The system of hardware which connects the control compiler system to hardware devices such as power supplies, beam diagnostic equipment, and safety interlocks, will be replaced with up-to-date equipment.

In addition to the 50 MHz rf system, the VUV ring rf system will be complimented with a 500 MHz rf system for making fractional nanosecond duration bunch lengths such as are desired in various experiments.

The pulsing power supplies of the booster synchrotron will be replaced with new units of improved stability and capable of operating at higher repetition rates.

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

2. Project No.: 87-R-401

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

Oak Ridge National Laboratory

Holifield Heavy Ion Research Facility (HHIRF).. $ 300

The atomic physics program at ORNL supports the national effort in basic atomic collisions research and its application to energy technology. This project is designed to increase the utility of the Holifield Heavy Ion Research Facility (HHIRF) for atomic physics and is part of a continuing program to provide for those improvement which have been identified as having the highest priority.

Experiments conducted in the ORNL EN-tandem require extension to the higher energies available from the HHIRF facility. The wide energy overlap available between these two accelerators, plus the fact that the EN accelerator reaches to energies much lower than those attainable with the HHIRF accelerators, provide a highly flexible accelerator complex. The experimental apparatus proposed here will enable us to exploit the unique capabilities of this accelerator complex. The experimental apparatus proposed here will enable us to exploit the unique capabilities of this accelerator complex.

Ames Laboratory

Ames Research Reactor.. $ 128

Provides funds for modifications to the Ames Research Reactor, which will make this space usable for laboratory research.

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 87-R-401

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

10. Details of Cost Estimate

a. High Flux Beam Reactor Facility	$ 940
b. National Synchrotron Light Source	1,515
c. Holifield Heavy Ion Research Facility	300
d. Ames Research Reactor	128
Total Project Cost	$ 2,883

11. Method of Performance

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

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: Neutron scattering experimental hall, Los Alamos Neutron Scattering Center (LANSCE) Los Alamos, New Mexico

2. Project No.: 87-R-403

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

3a. Date physical construction starts: 1st Qtr. FY 1987

4. Date construction ends: 2nd Qtr. FY 1989

5. Previous cost estimate: None
Date: None

6. Current cost estimate: $ 17,500
Date: January 1986

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1986	a/	a/	a/	a/
1987	$ 5,000	$ 5,000	$ 5,000	$ 4,600
1988	8,500	8,500	8,500	7,900
1989	4,000	4,000	4,000	5,000

8. Brief Physical Description of Project

This project provides for the addition of an experimental hall, support space, and associated facilities to the Los Alamos Neutron Scattering Center (LANSCE) to allow full use of what will be the nation's most intense pulsed neutron source with the completion of the Proton Storage Ring (PSR). The unique vertical orientation of the proton beam as it strikes the neutron-generating target allows neutron drift tubes to be arranged in a full 360^{o} circle permitting experiments to be arranged in all directions around the source. The proposed experimental hall will provide the additional space required to fully utilize this powerful source for a national neutron scattering program at LANSCE.

a/ Funding in the amount of $1,000,000 was appropriated by the Congress in FY 1986 in the Atomic Energy Defense Appropriation with instructions that future Appropriations were to be requested in the Energy Supply Appropriations.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Neutron scattering experimental hall, Los Alamos Neutron Scattering Center (LANSCE) Los Alamos, New Mexico

2. Project No.: 87-R-403

8. Brief Physical Description of Project (continued)

The experimental hall will be an 18,000 square foot pre-engineered high-bay structure on a concrete slab attached to the east side of the LANSCE facility. This structure will house a minimum of nine experiments on nine flight paths. Two of the flight paths can be extended as far as 300 meters outside the hall for ultra-high resolution experiments. An overhead crane with a 20 foot hook height will provide access to both the experiments and the service area. The hall will be equipped with a full complement of services required for multiuse experiments, including special grounds, extension signal cable, easy access to several power distribution systems, process cooling water, compressed air, and inert gas distribution systems. An access channel into the existing LANSCE experimental area suitable for forklift trucks will be provided.

Ventilation and heating for the experimental hall will be a recirculating forced-air system with heat provided by the existing hot water service. Plumbing and piping system will consist of gas, potable hot and cold water, industrial water, sanitary sewer, contaminated liquid waste drain, cooling tower water, and compressed air. Fire protection will be provided through a wet-pipe sprinkler system and alarms. Existing site utility systems, except for the sewage system, have adequate capacity.

An approximate 22,800 square foot three-story building directly attached to the hall will also be constructed. This building will house the new data acquisition system, mechanical and electronic shops, sample preparation laboratories, cryogenic laboratories, and offices for users and personnel directly associated with the operation of the user program at the LANSCE.

Only minimal site preparation will be required for the experimental hall after an existing detector building is relocated. The site will be essentially clear and at the same elevation as the existing LANSCE experimental area. A new 1500-kVA substation and an increase in sewage treatment capacity at the existing lagoons will be required. The present hall will be renovated by adding two new access doors, by installing a catwalk system, and by drilling five new shielding penetrations for new neutron beamlines. Special facilities for nuclear physics studies will be removed from the existing experimental hall and reestablished elsewhere to provide more space and independent operation for the neutron scattering programs.

1. Title and location of project: Neutron scattering experimental hall, Los Alamos Neutron Scattering Center (LANSCE) Los Alamos, New Mexico

2. Project No.: 87-R-403

8. Brief Physical Description of Project (continued)

The project includes funding for construction of four new spectrometers specially designed to make optimum use of the intense pulsed neutron beam. These will be in addition to six world class spectrometers, built and tested at LANSCE prior to construction of this experimental hall, that will be installed in the new experimental hall. Present plans include one spectrometer for each beam hole, although as many as two per beam hole are often feasible. In addition to the ten spectrometers discussed above, new spectrometer development and other experiments will be conducted on five other beam lines. Altogether, the neutron scattering program will have fifteen beam lines available when full facility operation is reached - ten operating world class spectrometers along with five other beam lines for future spectrometer locations.

The project also includes funding for six data collection computers of advanced design and a hub computer for data reduction, storage and manipulation. Time-of-flight experiments with the PSR are expected to collect an enormous amount of data (approximately 1 million resolution elements per instrument) at very high instantaneous data rates (up to 20 MHz expected). On-line data reduction will be essential so that raw data can be transformed into physical terms, displayed with high-quality graphics, thereby allowing on-line decisions on the progress of the experiments. Peak data rates with the PSR will be 400 times current levels and time average data rates will be 40 times current levels. We will continue to use four of the computers now in service so that ten experiments can run simultaneously with independent data collection systems when the facility is complete. These four existing computers will be replaced gradually after FY 1986 with advanced systems incorporating the latest in computer improvements. Funds for these four replacement computers be provided in later years.

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

The LANSCE facility, which is now in operation, is a neutron time-of-flight laboratory devoted to neutron scattering research in materials science and neutron nuclear science research. The research is applied to problems of significance to the nation's energy and defense programs and also contributes to the pool of basic knowledge underlying materials and nuclear science. The experimental program, which is well underway using the existing LANSCE spallation source, covers a wide variety of condensed matter research. The program also includes research into improved

1. Title and location of project: Neutron scattering experimental hall, Los Alamos Neutron Scattering Center (LANSCE) Los Alamos, New Mexico

2. Project No.: 87-R-403

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

spectrometers and neutron source design that will allow the optimum use of pulsed neutrons. This research program has been planned so that it can continue and can grow throughout the period of construction of the PSR and the proposed experimental hall. The original plan for the existing experimental hall did not contemplate the 100 fold increase in neutron source capability to be made available by the PSR. This greater intensity and optimized pulse structure from the PSR transformed the source into clearly the best spallation neutron source in the nation and perhaps in the world. The extraordinary capabilities have proved attractive not only to the Los Alamos National Laboratory staff, but to a large contingent of the nation's best researchers from universities and from industry. The increasing flow of visiting experimenters is being organized into a user group that began operation formally in May 1983. Proposals for experiments at Los Alamos from this user group are submitted to an external panel of reviewers. These external reviewers will plan the use of 2/3 of the beam time available on the established spectrometers. Presently, the reviewers receive requests for three times as much experimental time as the facility can provide. Soon after the PSR becomes operational, the Laboratory expects to host approximately 100 visitors each year.

The requested experimental hall will provide adequate experimental areas to accommodate the user community and will permit the full use of the neutron source for material science research. Space is included ultimately for as many as 15 spectrometers with enough room between so that neighboring experiments do not interfere with each other. It includes space located at longer distances from the source that permits full exploitation of advances in resolution made possible by the source. Room for staging of experiments and for preparation of samples in special environments is included within the experimental hall. Also, the hall is provided with an overhead crane that allows equipment to be transported over all of the experimental and staging areas. Sound conditioned or "quiet" rooms are located adjacent to the experimental floor for the use of experimenters in evaluating and planning the next step in an active experiment.

1. Title and location of project: Neutron scattering experimental hall, Los Alamos Neutron Scattering Center (LANSCE) Los Alamos, New Mexico

2. Project No.: 87-R-403

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

Since data collection rates for many experiments at LANSCE will be orders of magnitude greater than encountered at present facilities, it is necessary that at least half of our spectrometers have forefront computerized data collection and analysis systems when the PSR becomes operational. This system will make possible the operation of experiments at full performance levels and also will greatly speed the interpretation of the results of the experiments. State-of-the-art data collection and handling facilities are of great importance to visiting scientists who must complete experiments and interpret them during very short visits probably lasting on the average of about one week. These computers will therefore ensure that the LANSCE facility will have its greatest impact in strengthening the national position in materials science through the visitor program. Data acquisition for other spectrometers designed for slower data rates (small samples, ultra-high resolution) will use computers now in service at the LANSCE and will be replaced out of the annual Laboratory equipment budget allocation in accordance with the needs and funding level of the developing LANSCE program.

In summary, the combined floor space of the existing and proposed experimental hall of 22,500 square feet will more than quadruple the space available for spectrometers and staging of experiments thus assuring full use of the source intensity for the national neutron scattering program. The support area will provide space for data collection, light technician service, and for visiting users and facility support staff. The six data collection systems will assure that adequate computer facilities will be available to service at least five spectrometers simultaneously at the extraordinarily high data rates needed for the higher intensity neutron scattering measurements. This additional experimental and support space is essential in order for the nation's materials science research community to take full advantage of the major advance in pulsed neutron intensity provided by the PSR.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Neutron scattering experimental hall, Los Alamos Neutron Scattering Center (LANSCE) Los Alamos, New Mexico

2. Project No.: 87-R-403

10. Details of Cost Estimate*

	Item Cost	Total Cost
a. Engineering, design, inspection** and project management.......		$ 1,450
1. Facility @ 11% of construction costs less Item B.3.........	$ 1,200	
2. Special equipment design at about 5% of Item B.3...........	250	
b. Construction costs...		12,950
1. Improvements to land..		
a. Site work including sand and filters......................	640	
2. Buildings		
a. East side laboratory and support offices, 22,800 sq. ft. @ $105/sq. ft............................	2,400	
b. East experimental hall, 18,000 sq. ft. @ $168/sq. ft...	3,020	
c. Modify existing LANSCE experimental areas..............	2,080	
d. Relocate existing detector building....................	80	
3. Special equipment		
a. Computers..	1,750	
b. Spectrometers..	2,210	
4. Utilities including new substation.........................	770	
c. Standard equipment including overhead cranes...................		500
Subtotal..............................		14,900
d. Contingency @ 18%..		2,600
Total estimated costs..................		$ 17,500

*The above cost estimate is based on a conceptual design that is complete. The Laboratory is using escalation rates of 4.9% for CY 1985, 6.4% for CY 1986, 6.7% for CY 1987 and 6.5% for 1988. These rates were provided by the "Data Resources Incorporated," under contract to the DOE.

**Engineering, design and inspection are projected from historical records and experience, then applied based on the complexity of the project.

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Neutron scattering experimental hall, Los Alamos Neutron Scattering Center (LANSCE) Los Alamos, New Mexico

2. Project No.: 87-R-403

11. Method of Performance

Design and inspection of the facility additions will be accomplished by a negotiated architect-engineer contract. Special facility equipment design and procurement will be performed by the operating contractor. To the extent feasible, construction and procurement will be accomplished by fixed-price contracts and contracts awarded on the basis of competitive bidding.

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

	Prior Years	FY 1987	FY 1988	FY 1989	Total
a. Total project funding					
1. Total facility costs					
a. Construction line item	$ 0	$ 4,600	$ 7,900	$ 5,000	$ 17,500
b. PE&D	0	0	0	0	0
c. Expense funded equipment	0	0	0	0	0
d. Inventories	0	0	0	0	0
Total facility costs	0	4,600	7,900	5,000	17,500
2. Other project funding					
a. Conceptual design	180	0	0	0	180
b. Other project-related costs	2,420	0	0	0	2,420
Total other project funding	2,600	0	0	0	2,600
Total project funding (Items 1 and 2)	$ 2,600	$ 4,600	$ 7,900	$ 5,000	$ 20,100

b. Related annual funding requirements (estimated life of project: 25 years)

1. Experimental hall operating costs	$ 600
2. Programmatic research expenses directly related to the DOE/BES neutron scattering program	5,400
3. Capital equipment not related to construction but related to the programmatic effort in the facility	500
4. GPP or other construction related to programmatic effort in the facility	0
5. Other Los Alamos program costs	4,100
Total	$ 10,600

CONSTRUCTION PROJECT DATA SHEETS

1. Title and location of project: Neutron scattering experimental hall, Los Alamos Neutron Scattering Center (LANSCE) Los Alamos, New Mexico

2. Project No.: 87-R-403

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

a. Total project funding
   1. Total facility
      a. Construction line item. No narrative required.
      b. No PE&D is anticipated.
      c. No expense-funded equipment is anticipated.
      d. No inventories are anticipated.
   2. Other project funding
      a. The amount shown is for conceptual design. No research and development is necessary for this project.
      b. Other projected-related costs. Six world class spectrometers will be built and tested prior to experimental halls construction and will become part of the facility upon completion of construction.

b. Total related funding requirements
   1. Experimental hall operating costs
      This category includes maintenance, janitorial, and utilities calculated from FY 1984 costs on a per square foot basis throughout the Laboratory and projected to FY 1989. Approximately $600,000 per year is anticipated.
   2. Programmatic operating and research expenses directly related to the BES neutron scattering program is anticipated to be approximately $5,400,000 per year.
   3. Capital equipment not related to construction but related to the programmatic effort in the facility approximately $500,000 per year is anticipated.
   4. No GPP or other construction related to programmatic effort is anticipated.
   5. Other Los Alamos programs
      The Los Alamos National Laboratory will conduct internally-supported programs in neutron scattering and other research at an annual cost of $4,100,000.

DEPARTMENT OF ENERGY
1987 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: 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: a/

4. Date construction ends: a/

5. Previous cost estimate: None

6. Current cost estimate: $ 1,500 a/

Date: January 1986

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1987	1,500	1,500	1,500	1,500

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 FY 1987 request is for A-E and long lead procurement to better define the cost, schedule and design prior to construction. (The estimated construction costs of the facility are projected at 90-100 million dollars with total R&D and startup costs of $25-30M.) The project will include the construction of new facilities, and alterations and additions to existing plant and site facilities, especially Building 6 (the circular building that now houses the 184-Inch Cyclotron). The 1-2 GeV Synchrotron is a special facility comprised of an electron storage ring and injection system, insertion devices (undulators and wigglers) for generating synchrotron radiation and photon beamlines. The facility consists of a 50-MeV injector, a full-energy booster synchrotron, an electron storage ring, which has 12 6-m-long straight sections for insertion devices, an initial complement of 5 insertion devices, and photon beamlines extending from the insertion devices. Development of 7 straight sections and 24 bending magnet ports are not included in the scope of this project. Their development in future years, however, will provide flexibility to respond to new scientific directions and to take advantage of new materials, designs, and other technological advances. When fully developed, the facility will be able to provide up to 60 user stations.

a/ The FY 1987 request provides for architect-engineering work and long lead procurement. The total estimated cost and exact construction dates of this project are currently under review.

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 for, and Scope of Project

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

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

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

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

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

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 for, and Scope of Project (continued)

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, 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.

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

2. Project No.: 87-R-406

10. Detail of Cost Estimate

The project provides funds for an Architect-Engineer to accomplish design sufficient to define the cost, schedule, and scope of the proposed facility. Also included are funds necessary for long lead procurement for those components which would limit the timely completion of the project. Early studies have been completed and it is anticipated that the TEC will be $90,000,000 to $100,000,000.

11. Methods of Performance

Conventional facilities engineering design will be performed under a negotiated Architect/Engineer subcontract.

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

	FY 1987	Total
a. Total project costs		
1. A-E costs	$ 1,500	$ 1,500
Total facility costs	1,500	1,500
2. Other project costs		
(a) Storage Ring R&D	1,000	1,000
(b) Insertion Device and Beamline R&D	500	500
(c) Startup	0	0
(d) Capital Equipment Related to R&D	500	500
Total other project funding	2,000	2,000
Total project funding	$ 3,500	$ 3,500

CONSTRUCTION PROJECT DATA SHEETS

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

The FY 1987 funding request for the project is for A-E design and long lead procurement necessary to fully define the cost, schedule, and cost of the proposed facility.

Site preparation and building construction for the 1-2 GeV Synchrotron Facility is scheduled for FY 1988-1989, 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 1988-1991.