DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT

OVERVIEW

Basic Energy Sciences

Since the inception of the Department of Energy and its predecessor agencies, a National commitment to long-range basic research has been considered a top priority. This commitment is not only a reflection of the importance of basic research to all energy and defense technologies, but is also a realization that this type of research requires an active Federal role. The Basic Energy Sciences (BES) program is an essential component of both the Department and Federal commitment to R&D in the U.S. today and has been recently reaffirmed by the Energy Research Advisory Board (ERAB). Working with the national laboratories, universities, industry, and other government agencies, the BES program supports research which provides the foundation for new technologies and improvements to existing technologies which are crucial to achieving the goals described in the National Energy Plan.

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

The BES program supports research in several ways. The BES program annually supports approximately 1200 individual research projects at over 200 separate institutions with direct support for over 1500 researchers in the physical, biological, and mathematical sciences. These projects are selected on the basis of scientific excellence, relevance to BES' support of DOE long-term goals, and their contribution toward a responsive research program. Also, Basic Energy Sciences has a heavy involvement in major scientific user facilities (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 Transuranium Processing Plant at Oak Ridge National Laboratory, the Stanford Synchrotron Radiation Laboratory at Stanford University, the Intense Pulsed Neutron Source at Argonne National Laboratory and the Los Alamos Neutron Scattering Center at Los Alamos National Laboratory). These facilities not only account for a significant amount of the BES budget requirement but also facility costs in general have risen by an amount greater than the cost of living. These higher costs can be attributed to facilities operating at fuller capacity and by increases in power, safeguards, safety, maintenance, and equipment costs. The large, expensive, unique facilities in the BES program are made available to qualified users of the U.S. scientific community to the extent that funds permit. At the seven major user facilities funded by BES, there were about 1400 users from all scientific disciplines and programs which resulted in approximately 790 publications. The activity around these facilities is growing and the number

of users is expected to be about 2000 by FY 1988. Many areas of modern science require large and costly facilities; without them, the necessary advanced research could not be done. BES also is providing advanced state-of-the-art computational support for several Energy Research programs other than Magnetic Fusion Energy [which is directly supported by the National Magnetic Fusion Energy Computer Center (NMFECC)]: High Energy and Nuclear Physics, and Biological and Environmental Research as well as its own program.

The BES strategy continues to be:

- o Provide critical knowledge and data by supporting basic research relevant to DOE mission areas;
- o Provide and support operation of unique, specialized research facilities;
- o Exchange information with other DOE programs, Federal agencies, and the academic and industrial scientific communities;
- o 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;
- o Develop trained scientific talent through support of basic research at universities and national laboratories; and
- o Promote early applications of the results of basic research.

The Basic Energy Sciences program takes advantage of the research capabilities available at national laboratories, government laboratories, universities, both large and small, and private research laboratories in the conduct of the program. The program support can be divided into three major components: research, facility operations, and construction. One component is the operation's support of major user facilities for which access by qualified users is provided to the entire scientific community. Another and the largest component of the program is the research support which takes place at national laboratories, universities and other 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. Many of the scientists involved in BES research programs are faculty or students at universities. Their research is enhanced through access to special facilities at national laboratories. More than one-third of BES funding supports university-based research. The list of universities receiving support covers almost every state and includes participation by both large and small institutions. The third component is the construction of facilities needed by the Department and the Nation.

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

The U.S. has been the world leader in science and technology and has derived many economic benefits from its leadership. The Department of Energy and its multiprogram laboratories play an important role in the Nation's scientific enterprise that is essential for our preeminence. A central feature of this role has been 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 probably become marginal before replacements can be constructed. 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; 6-7 GeV Synchrotron Radiation Source - Argonne National Laboratory; Advanced Neutron Source - Oak Ridge National Laboratory; and Relativistic Heavy Ion Collider - Brookhaven National Laboratory. This latter facility is budgeted in the Nuclear Physics Program.

The FY 1988 request for the Basic Energy Sciences program attempts to address not only the need for these powerful new facilities but also a continuing need for research essential to meeting the long-term goals of the Department and Nation. The request can be categorized into three areas: continuation of a strong basic research program, operation of major user facilities at reasonable levels, and construction of advanced facilities.

Research

- o Conduct an aggressive program aimed at uncovering new energy-related information in materials sciences, chemical sciences, applied mathematical sciences, engineering and geosciences, energy biosciences and advanced energy projects.

Operation of Major User Facilities

- o Maintain the operational level of BES-supported major user facilities: Intense Pulsed Neutron Source (ANL), National Synchrotron Light Source (BNL), High Flux Beam Reactor (BNL), High Flux Isotope Reactor and Transuranium Processing Plant (ORNL), Combustion Research Facility (SNL), Stanford Synchrotron Radiation Laboratory (Stanford U.), and Los Alamos Neutron Scattering Center (LANL).

Facility Construction

- o Continue the R&D program in support of and in preparation for construction of the advanced scientific facilities; 6-7 GeV Synchrotron Light Source (ANL), 1-2 GeV Synchrotron Light Source (LBL) and the Advanced Neutron Source (ORNL).

- o Continue the construction of projects underway; 1-2 GeV Synchrotron Light Source (LBL), Neutron Scattering Experimental Hall (LANL), Center for Advanced Materials (LBL), and various accelerator improvements and general plant projects.

- o Start construction of the 3 GeV SPEAR Injector at Stanford University.

The detailed budget justification which follows for the Basic Energy Sciences Program has been broken down into the subprogram organization used to manage the BES program: Materials Sciences, Chemical Sciences, Applied Mathematical Sciences, Engineering and Geosciences, Advanced Energy Projects, and Energy Biosciences. Each of these subprograms has been further divided into lower levels of detail to provide further information on the nature of the research underway.

DEPARTMENT OF ENERGY
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ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

LEAD TABLE

Basic Energy Sciences

	FY 1986 Actual	FY 1987 Appropriation	FY 1988 Base	FY 1988 Request	% Change from FY 1987 Approp.
Operating Expenses					
Materials Sciences.....	$132,573	$154,991	$154,991	$169,791	+9.5%
Chemical Sciences.....	104,305	115,080	115,080	124,103	+7.8%
Applied Mathematical Sciences	37,453	38,785	38,785	40,450	+4.3%
Engineering and Geosciences..	25,261	29,412	29,412	31,350	+6.6%
Advanced Energy Projects.....	11,812	12,760	12,760	14,300	+12.1%
Energy Biosciences.....	11,811	16,500	16,500	18,550	+12.4%
Program Direction.....	3,499	4,112	4,433	4,500	+9.4%
Subtotal Operating Expenses...	326,714	371,640	371,961	403,044	+8.5%
Capital Equipment.....	25,661	31,100	31,100	31,699	+1.9%
Construction.....	67,475	122,710	122,710	44,332	-63.9%
Total.....	419,850 a/b/c/	525,450 a/d/	525,771 a/d/	479,075 a/	-8.8%
Operating Expenses.....	(326,714)	(371,640)	(371,961)	(403,044)	+8.5%
Capital Equipment.....	(25,661)	(31,100)	(31,100)	(31,699)	+1.9%
Construction.....	(67,475)	(122,710)	(122,710)	(44,332)	-63.9%
Total Program.....	($419,850)a/b/c/	($525,450)a/d/	($525,771)a/d/	($479,075)a/	-8.8%
Staffing (FTEs).....	61	63	63	63	

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

a/ Total has been reduced by $9,750,000 in FY 1986, $11,117,000 in FY 1987, and $11,698,000 in FY 1988 as a result of the transfer of the Nuclear Data activities to the Nuclear Physics Program.
b/ Total has been reduced by $4,061,000 which has been transferred to the SBIR program.
c/ Total has been reduced by $16,680,000 in accordance with P.L. 99-177, The Balanced Budget and Emergency Deficit Control Act of 1985 (Gramm/Rudman/Hollings).
d/ Total includes $61,900,000 for projects at several universities proposed for rescission by the Administration in FY 1987.

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(dollars in thousands)

SUMMARY OF CHANGES
Basic Energy Sciences

FY 1987 Appropriation enacted		$525,450
Adjustments - Increased personnel costs attributable to the 1987 pay raise, increased agency contribution to the new Federal Employees Retirement System, and one additional day.		+ 321
FY 1988 Base		$525,771
Operating Expenses		
- Provides for an increase in operating funds to cover cost of living, permit limited expansion in research, and partially cover facility requirements	+ 17,683	
- Provides for the lease of Class VII computer	+ 6,000	
- Provides for an increase in basic plant sciences research	+ 3,300	
- Provides for additional R&D associated with major new scientific facilities	+ 4,100	
Subtotal Operating Expenses		+ 31,083
Capital Equipment		
- Provides for small increase in capital equipment associated with facility and research needs in the Chemical Sciences Subprogram and small increase in equipment for the Energy Biosciences Subprogram	+ 599	
Subtotal Capital Equipment		+ 599

Construction

- Provides funding for ongoing construction	+ 12,422	
o Center for Advanced Materials		
o Neutron Scattering Experimental Hall		
o 1-2 GeV Synchrotron Radiation Source		
o General Plant Projects		
o Accelerator Improvement Projects		
- Provides for start of construction on 3 GeV SPEAR Injector	+ 3,000	
- Makes no provision for continuing funding for Congressional initiated projects	- 93,800	
Subtotal Construction		- 78,378
FY 1988 Congressional Budget Request		$479,075

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(dollars in thousands)

KEY ACTIVITY SUMMARY

BASIC ENERGY SCIENCES

I. Preface: Materials Sciences

The Materials Sciences subprogram conducts research aimed at increasing the understanding of materials related phenomena and properties which will contribute to meeting materials needs of present and future energy technologies. The subprogram supports research at DOE laboratories, universities, and to a lesser extent in industry. The laboratory component is the largest and accounts for approximately 77% of the funding. The major laboratory participants are the Ames Laboratory, Argonne National Laboratory, Brookhaven National Laboratory, Oak Ridge National Laboratory, Lawrence Berkeley Laboratory, and to a lesser extent Los Alamos, Lawrence Livermore, and Sandia Laboratories. The laboratory programs as a whole tend to contain larger groups of scientists, are multi-disciplinary, and involve longer-term research projects. The university component of the program includes top researchers from universities throughout the country. A typical project includes several graduate students in addition to the principal investigator. The projects cover all areas of materials sciences and tend to be narrower in scope and of shorter duration than projects at the laboratories. The funding associated with the university portion of the program is approximately 20%. Most of the the industry supported portion of materials research takes place at smaller businesses through the Small Business Innovation Research Program. Other industry groups are funded by their home organization and work with members of the laboratory or university research groups. Due to the unique, expensive, and specialized nature of the user facilities, the largest participation of industry researchers occur at these facilities. So long as the research conducted by industry is available to the scientific community and is of interest to DOE, there is no charge imposed on the industry groups for the use of these facilities.

Groups of multidisciplinary researchers work together guided by opportunities within the general goals set forth by the subprogram. Current goals include uncovering the information needed to: develop new or substitute materials; tailor materials properties to satisfy defined requirements; predict materials problems and service life; and improve the theoretical and experimental capability to analyze the fundamental structure of materials. Related to these goals is the support provided for major user facilities which are available to the entire scientific community for research. Coordination among the various materials research efforts within DOE and with other agencies is considered essential. Within DOE this takes place primarily through the Energy Materials Coordinating Committee (EMaCC) and with other agencies through the Committee on Materials (COMAT). Within the Materials Sciences subprogram, research is undertaken in the major areas of metallurgy and ceramics, solid state physics and materials chemistry. Some examples of research accomplishments during the past year include: development of ion-beam smoothing of mirror surfaces to prepare highly reflective surfaces, better, quicker and cheaper than conventional or diamond machining; discovery of an enhanced absorption of tritium in metals which results in a new form of embrittlement; successful completion of a new technique using neutrons to determine surface magnetization for the first time and which will be important for examining materials for recording devices; densified ceramic composites without processing flaws successfully using a sinter-forging method eliminating the expensive machining steps; and designed, synthesized and characterized the first organic synthetic metals containing polymeric ions.

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Materials Sciences Research....	$102,225	$118,968	$126,291	+ 6.2%
Facilities Operations.....	30,348	36,023	43,500	+ 20.8%
Total, Materials Sciences....	$132,573	$154,991	$169,791	+ 9.5%

Program Activity	FY 1986	FY 1987	FY 1988	% Change
II. B. Major Laboratory Facility Funding				
Ames Laboratory.....	$ 6,860	$ 7,430	$ 7,682	+ 3.4%
Argonne National Laboratory....	21,812	23,001	26,404	+ 14.8%
Brookhaven National Laboratory.	29,226	32,434	34,771	+ 7.2%
Lawrence Berkeley Laboratory...	12,691	14,119	15,361	+ 8.8%
Oak Ridge National Laboratory..	22,007	25,024	26,108	+ 4.3%
Total.....	$ 92,596	$102,008	$110,326	+ 8.1%

III. Activity Descriptions

MATERIALS SCIENCES RESEARCH

Program Activity	FY 1986	FY 1987	FY 1988
Metallurgy and Ceramics Research	Provides support for basic research on structure of ceramics, high temperature metallic alloys and intermetallic compounds which are important for conservation energy and amorphous materials and semiconductors which are important for solar energy. Includes support for research on the mechanical behavior of energy materials including the influence of structure and environment. Research includes deformation and fracture, hydrogen, inert gas and impurity embrittlement. Research on physical properties of energy materials includes transport phenomena, property changes brought about by ion implantation and superconductivity which is of importance in fusion energy systems. Includes research on radiation effects on materials important to energy systems. Provides for fundamental studies of processes and properties on engineering of materials.	Research will proceed on structure of surfaces using added capabilities in electron spectroscopy. Start research on reliability and lifetime of materials important to fossil energy systems. Continue research on ceramics of interest to the advanced engine program, for example the problem of brittleness. Emphasis will be on properties of compound semiconductors. New research on the preparation of novel and artificially tailored crystals important in all high speed electronic devices. Added emphasis on the cause of radiation induced phase transformations and low temperature radiation effects on fracture of energy materials. Research will emphasize the science of advanced energy materials synthesis and processing. Micromagnetic processes observed during magnetization will be studied to improve the properties of devices such as magnets for motors.	Research emphasis will be on new theoretical approaches to study the structure of energy related materials. Research on high strength, high toughness ferritic steels and welds for pressure vessels. Expand work on reliability and lifetime prediction. Maintain emphasis on studies of inert gases in materials which are important to understand embrittlement. Continue emphasis on compound semiconductors started in FY 1987. Properties of the artificially tailored materials will be investigated. Research will continue on studies of radiation induced changes in materials and fracture of energy materials under extreme conditions of temperature, stress, and hostile environment. Continue research on advanced energy materials synthesis and processing and magnetic materials. Continue research on nondestructive evaluation of materials failures.

III. Materials Sciences (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Solid State Physics Research	Provides support for neutron scattering research on structure and dynamics of condensed matter, especially in magnetic systems; fundamental studies of materials important to energy technologies at high pressures, low temperatures and high magnetic fields; and includes experimental research especially with synchrotron radiation to determine properties of materials. Provides for theoretical research using advanced computer capabilities and comparison with the results of experimental studies; research on properties of materials and their surfaces as modified by irradiation. Includes support for engineering physics research on new investigative and characterization techniques useful in study of materials for energy systems.	Expand the use of high energy neturons. Exploit new techniques employing polarized neutrons from both steady-state reactor and accelerator driven sources. Both are important for characterizing a full range of phenomena in materials. Continue emphasis on energy related research with synchrotron radiation, including new studies on magnetic surfaces and near-surface structures. Research will continue with close contact with experimental programs on materials important in energy systems. Develop new capabilities, especially in relation to new materials. Emphasis will be on improved surface properties through controlled modification of materials of promise by irradiation for energy applications. Support for measurements of physical properties and characterization of superconducting materials and optical elements.	Continue research with emphasis on Los Alamos neutron source and new instruments at other locations. Provides for expanded use of synchrotron radiation insertion devices. Supports new study of boron compounds with view toward utility in high temperature applications. Emphasis will be on large-scale computations on energy-related materials systems with regard to materials properties and their temperature behavior. Continue research on surface modification using irradiation. Research will emphasize processes and techniques important for surface characterization (e.g. photoemission and inverse photoemission).
Materials Chemistry Research	Provides support for chemical structure research on materials and synthesis of novel materials such as catalysts which are relevant to energy technologies. Includes research in engineering chemistry on non-metal conductors, electrochemistry relating to batteries and high-strength polymeric materials and supports research on high temperature and surface chemistry using highly sensitive instrumentation for analysis of liquid solid interfaces.	Continues structural chemistry research and synthesis of new materials with emphasis on the use of neutron scattering and synchrotron radiation. Emphasis will be on research in conducting polymers because of their potential for use in batteries. Program will emphasize energy-related electrical processes, and synthetic high strength materials. Continues program in surface analysis, catalysis, and surface chemistry with use of advanced techniques.	Emphasis will be on polymers and synthesis of new materials. Program in polymers and electrochemistry to continue with emphasis on conducting polymers, and on the design, synthesis, and characterization of new high strength polymers. Continues research on chemical structure, catalysis, and surface chemistry with emphasis in fundamental research on surface wear and friction.
Subtotal Materials Sciences Research	$102,225	$118,968	$126,291

III. Materials Sciences (Cont'd)

MAJOR MATERIALS SCIENCES FACILITIES OPERATIONS

The major materials facilities are used to conduct forefront research on materials using high fluxes of neutrons or photons. These facilities are unique in their ability to probe the structure and properties of important new energy related materials. In view of the expensive and unique character of these facilities, materials researchers from all parts of the Nation travel to these facilities to conduct their research, including researchers from industry and universities in addition to DOE contractors. Recommendations from national committees and DOE committees have identified needs for advanced facilities in order to continue to conduct leading edge research. The Department is continuing research and development in FY 1988 which is a necessary step toward the completion of the advanced scientific facilities. Summarized below is the operational support for major facilities provided by the Materials Sciences subprogram.

Program Activity	FY 1986	FY 1987	FY 1988
Materials Sciences Facilities Operations	High Flux Beam Reactor (HFBR) at BNL provides neutron beams for research on structural studies for all scientific fields. Operational support is provided for the full year. New requirements for safeguards and security were initiated.	Continues full year operational support with increased funds to accommodate safeguards and security requirements.	Continues full year support with more emphasis on user support.
	National Synchrotron Light Source (NSLS) at BNL consists of two storage rings which provide high intensity ultraviolet and scientific X-ray beams for experimentation by all research fields. Both vacuum-ultraviolet (VUV) and X-ray rings began to operate full time in FY 1986.	NSLS operations to continue with consideration for full year's support using both rings and increased user demand.	Together with funding in the Chemical Sciences subprogram, will continue full year operations with increase needed for user support.
	Intense Pulsed Neutron Source (IPNS) at ANL is a dedicated pulsed neutron source for multidisciplinary research.	IPNS operations will be maintained at the FY 1986 level for users. The cold neutron instrument will be emphasized.	Continue IPNS operations for users at previous year's level. The neutron flux will increase with addition of an enriched target.
	Los Alamos Neutron Scattering Center (LANSCE) at LANL is a pulsed neutron source capable of producing the world's highest flux beams of neutrons. The proton storage ring began operation and neutrons were produced late in FY 1986.	The LANSCE operations support is initiated in FY 1987 for the first year of operation.	Increased operations funding planned for LANSCE in consideration of user buildup and preparation for new experimental hall.
	Materials related operations support provided for Stanford Synchrotron Radiation Laboratory (SSRL) at Stanford U. SSRL provides synchrotron radiation over a wide range of wavelengths for all scientific disciplines. A new beam line and other materials related activities were initiated in FY 1986.	Continue the SSRL operations with the same level of support.	Materials Sciences funding to provide SSRL operations to accommodate user demand and to develop beam lines.

III. Materials Sciences (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Materials Sciences Facilities Operations (Cont'd)	R&D on the 1-2 GeV and 6-7 GeV advanced light sources begun with Congressional mandate in FY 1986. These facilities are the advanced synchrotron radiation sources which will provide unprecedented fluxes of photons in the ultraviolet and X-ray ranges for all the scientific community.	R&D on the 1-2 GeV (LBL) and the 6-7 GeV (ANL) light sources and the advanced neutron source (ORNL).	Increased R&D funding for advanced scientific facilities to meet expected construction schedule.
Subtotal Materials Sciences Facilities Operations	$30,348	$36,023	$43,500
TOTAL MATERIALS SCIENCES Operating Expenses	$132,573	$154,991	$169,791
Percentage Breakdown by Performer			
Laboratory	78%	78%	77%
University	20%	20%	21%
Industrial/ Other	02%	02%	02%
Subtotal	100%	100%	100%
Number of Researchers Supported	955	998	1,010

I. Preface: Chemical Sciences

The Chemical Sciences subprogram supports basic research across a broad front of chemistry and atomic physics necessary for the future development of energy technologies. Research includes photochemistry important to the conversion of light energy to fuels or electricity, chemical physics related to combustion processes, atomic physics important to fusion concepts, heavy element chemistry important to waste management and isotopic separation, organic chemistry as well as heterogeneous and homogeneous catalysis related to coal conversion and the more efficient production of fuels and bulk chemicals, separations and analytical science related to almost every facet of process chemistry and nuclear energy technology, and chemical thermodynamics for predicting physical properties of complex hydrocarbon mixtures. Related to those goals is the support provided to major user facilities which are available to the entire scientific community for research.

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Chemical Sciences Research.....	$ 73,282	$ 81,304	$ 88,018	+ 8.3%
Facilities Operations.....	31,023	33,776	36,085	+ 6.8%
Total, Chemical Sciences.....	$104,305	$115,080	$124,103	+ 7.8%

II. B. Major Laboratory Facility Funding

Argonne National Laboratory....	$ 14,370	$ 15,580	$ 16,644	+ 6.8%
Brookhaven National Laboratory.	14,415	14,600	16,056	+ 10.0%
Lawrence Berkeley Laboratory...	6,470	6,837	7,109	+ 4.0%
Oak Ridge National Laboratory..	23,897	26,735	28,886	+ 8.0%
Sandia, Livermore.....	5,401	5,775	5,994	+ 3.8%
Total.....	$ 64,553	$ 69,527	$ 74,689	+ 7.4%

III. Activity Descriptions

CHEMICAL SCIENCES RESEARCH

Program Activity	FY 1986	FY 1987	FY 1988
Chemical Sciences Research	Provides for support of fundamental studies on photosynthesis, catalytic reactions sensitized by irradiated semiconductors, photoelectrochemistry, and homogeneous photocatalysis reactions, all important to understanding the use of solar energy for producing fuels and chemicals.	Continues research in photochemistry with emphasis on understanding initial events in green plant photosynthesis, which will be facilitated by new ultrafast spectroscopic techniques. Basic studies on photocatalytic reactions in homogeneous and heterogeneous systems will continue at current levels.	Research will focus on design of artificial photochemical energy conversion systems. Model compounds tailored for optimum light capture and efficient conversion will be studied.
	Provides support for combustion chemistry research, including spectroscopic and kinetic studies of fuel chemical reactions to permit insights into more energy efficient fuel utilization and pollutant control.	Research will focus on molecular dynamics and spectroscopy in complex fuel systems to provide better combustion diagnostics and understanding of chemical reactivity processes.	Combustion related research will continue. A new effort on reactivity of small metal clusters will provide an atom based understanding of such properties of metals as catalysis, corrosion and electronic behavior.

III. Chemical Sciences (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Chemical Sciences Research (Cont'd)	Includes research in atomic physics on merged beam experiments to yield electron transfer cross sections relevant to fusion energy technology. Supports research using laser and accelerator derived ion beams to study high temperature plasmas.	Research to continue on low energy highly charged ions seen in fusion directed plasmas. The cooling of ion beams with electron beams will be explored.	Emphasis will be on studies of interactions between laser beams and accelerator produced ion beams to determine energy transfer cross sections between electrons and ions in excited states. The Kansas State University Ion Collision Physics Facility will operate at a fairly optimal level.
	Provides support for catalysis research to provide insights into the activity and selectivity of chemical reactions for the conversion of crude resources to refined fuels and chemicals. Organic and physical chemical studies are carried out on the structure and reactivity of model compounds and coal constituents to better understand the role of chemical properties on the conversion processes.	Research to continue on catalytic studies with emphasis on oxide and new bio-catalyst substances for advancing understanding of the reactivity and specificity of catalytic processes. Early stages of oxidation on coal chemical and physical properties will be investigated.	Emphasis will be on research on reactive intermediates, catalytic clusters, oxide catalysts, acid sites and new biocatalytic systems to provide insights into side reactions, catalyst deactivation and new classes of catalysts for converting fossil and biomass resources into fuels.
	Includes research on modeling turbulence and flame propagation to help understand combustion efficiency. Thermophysical and transport properties of complex fluid mixtures including hydrocarbons in brines and supercritical mixtures are studied to better understand the behavior of liquids.	Research to continue on turbulent flame propagation studies to isolate chemically induced turbulence from physical mixing effects. Behavior of supercritical mixtures for energy efficient separations and analytical techniques of complex mixtures to be studied.	Emphasis will be on unified modeling of thermochemistry of turbulent combustion; macro and micro structure modeling of flow fields; ignition and extinction characteristics to increase combustion efficiencies and pollutant control.
	Provides support for basic chemistry underlying techniques for separation of metals and hydrocarbons, mass transport in fluids and through interfaces, and increasing the energy efficiency of separation techniques.	Continues research on the relationship of membrane composition to selectivity, solution chemistry of actinides pertinent to nuclear material processing, and extractants for strategic metals.	Emphasis will be on the study of supercritical fluids as solvents for salts and organic compounds, novel membrane compositions for the efficient separation of gases, and mass transport-enhancing effects of electric and magnetic fields on liquid-liquid extraction systems.
	Includes funding for solution chemistry studies addressing the formation of complex species in acid media important to fuel reprocessing techniques. Research also includes studies of actinides in solid compounds focused on the formation and stabilities of compounds germane to waste management.	Research continues on solution chemistry studies and high temperature, high pressure characterization of solid and gaseous actinide compounds important to the isotopic separations of nuclear materials.	Emphasis in FY 1988 will be on solution chemical investigations of the heaviest elements, such as lawrencium. Solid state studies will focus on the characterization of ceramic-like compounds of potential importance to the development of nuclear waste host compounds.
Subtotal Chemical Sciences Research	$73,282	$81,304	$88,018

MAJOR CHEMICAL FACILITIES OPERATIONS

Major chemical sciences user facilities permit forefront chemical research to be conducted in areas important to DOE by scientists from industry and universities in addition to DOE contractors. These expensive, unique DOE facilities have been opened to all qualified researchers. By providing operations support and allowing other researchers to utilize these facilities, DOE has been able to leverage additional chemical research out of the community. The five facilities operated by Chemical Sciences are: the Combustion Research Facility (CRF) at Sandia/Livermore, the National Synchrotron Light Source (NSLS) at BNL shared with Materials Sciences the High Flux Isotopes Reactor (HFIR) at ORNL, the Transuranium Processing Plant (TPP) at ORNL, and the Electromagnetic Isotopes Enrichment Facility (Calutrons) at ORNL.

Program Activity	FY 1986	FY 1987	FY 1988
Major Chemical Facilities Operations	Provides support for Chemical Sciences related operations of the National Synchrotron Light Source (NSLS), about one-third of the operations budget. NSLS provides high fluxes of ultraviolet and x-ray radiation for surface and gaseous chemical studies and for all other scientific fields also. Funding provided for full year's operation.	Continues NSLS operations at about the FY 1986 level. A wider group of chemistry users is expected in FY 1987.	Continues NSLS operations at full year level and permits increase to accommodate user demand.
	The Combustion Research Facility is a unique facility where combustion processes can be studied using advanced laser systems for diagnostics. Modeling of multicomponent reacting flows can be undertaken using advanced computers. This facility is used by scientists and engineers from all DOE programs and from industry and universities. In FY 1986, the CRF was funded for the full year of operation.	Continues CRF operations at the FY 1986 level with emphasis on making available the latest laser techniques and computational facilities for all researchers.	Continues operations and additional resources will be allocated to help satisfy the increasing demand from visiting scientists for access to advanced CRF laser systems. Emphasis will be on provision of a new laser system with better time resolution necessary for important combustion reaction kinetics studies.
	Provides funds for operation of the Calutrons 12 segment-months (one segment for 12 months) producing 23 isotopes from 9 elements for sales and loan in support of basic research and development and diagnostic medicine.	Continues operation of the Calutrons for 20 segment-months and to produce samples of approximately 26 isotopes from 14 elements. Increasing level of operations will permit the production of thallium-203 used in heart scan diagnostics.	The Calutrons will operate 22 segment-months to produce samples of approximately 28 isotopes from 14 elements.

III. Chemical Sciences (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Chemical Sciences Facilities Operations (Cont'd)	Includes funds to operate the HFIR and TPP facilities 12 months to provide heavy element research materials, neutron scattering beams, irradiation services, and Californium-252.	HFIR and TPP operation planned to continue at FY 1986 level during the second half of FY 1987 to provide neutrons for target irradiations and beams for materials studies. Studies will be completed to determine the HFIR pressure vessel life expectancy.	HFIR and TPP operations planned for 12 months.
	Includes funding for SSRL operations as a major user facility providing synchrotron radiation for research in materials, biological, chemical, medical, and engineering sciences. SSRL operated in a mode dedicated to synchrotron radiation for four months to meet fifty percent of user demand.	Continues SSRL operation at the FY 1986 level. Increased funds to cover electric power and obligations to pay a greater share of overhead. R&D to increase the utility and efficiency of synchrotron radiation by developing improved light and electron beam optics to manipulate and transport radiation will continue.	Continues SSRL operations level comparable to that in FY 1987. The use of the PEP ring will increase to take advantage of new beamlines.
Subtotal Chemical Sciences Facilities Operations	$31,023	$33,776	$36,085
TOTAL CHEMICAL SCIENCES Operating Expenses	$104,305	$115,080	$124,103
Percentage Breakdown by Performer			
Laboratory	67%	66%	66%
University	30%	31%	31%
Industrial/ Other	03%	03%	03%
Subtotal	100%	100%	100%
Number of Researchers Supported	800	847	877

I. Pref Applied Mathematical Sciences

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

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Mathematical Sciences Research.	$ 22,803	$ 22,650	$ 23,850	+ 5.3%
Energy Sciences Advanced Computation.....	14,650	16,135	16,600	+ 2.9%
Total, Applied Mathematical Sciences.....	$ 37,453	$ 38,785	$40,450	+ 4.3%

II. B. Major Laboratory Facility Funding

Argonne National Laboratory....	$ 5,530	$ 4,130	$ 4,125	- 0.1%
Lawrence Berkeley Laboratory...	1,384	1,425	1,549	+ 8.7%
Los Alamos National Laboratory.	1,115	1,440	1,300	- 9.7%
Lawrence Livermore National Laboratory.....	6,837	5,250	14,400	+174.3%
Florida State University.....	8,179	11,400	0	-
Total.....	$ 23,045	$ 23,645	$ 21,374	- 9.6%

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Mathematical Sciences Research	Provides support for both analytical and computational techniques for modeling complex interactions between material interfaces and strong shocks in detonation waves, combustion fronts, and multiphase fluid flow.	Continues research in analytical and computational methods for modeling shocks and interfaces in three spatial dimensions and more complex geometries, such as plasma confinement devices, combustion chambers, and oil reservoirs.	Emphasis will be on analytical, computational, and graphical techniques by teams at universities and laboratories for designing complete computational modeling systems.
	Includes support for design of efficient data structures and use of sophisticated computer graphics techniques such as computer generated movies and video tapes of the behavior of fluids under various flow conditions.	Research continued on new graphical diagnostic techniques for quantifying the components of computational models and comparing results with experiments.	Research will focus on optimum analysis and display of scientific data and efficient use of new supercomputer systems.

III. Applied Mathematical Sciences (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Mathematical Sciences Research (Cont'd)	Provides support for experimental parallel processor computer systems for speeding up computations for large scientific and engineering problems.	Continues research on the experimental parallel computers at universities as well as some commercial versions.	Focus of research will be on high level languages for new parallel processor computer systems. These languages are used for describing the various algorithms needed to specify exactly the steps required to solve computational models. New algorithms will be incorporated into large scale computational models on the parallel supercomputers.
Subtotal Mathematical Sciences Research Operations	$22,803	$22,650	$23,850
Energy Sciences Advanced Computation	Includes support for access provided for about 4,000 Office of Energy Research (OER) researchers supported by OER in HENP, BES, and BER on supercomputers via a nationwide network connected to the National Magnetic Fusion Energy Computational Center (NMFECC) at LLNL and to the Supercomputer Research Institute (SCRI) at Florida State University (FSU). This year, 24,000 hours of supercomputer time was provided. In addition, a project was begun to upgrade the file storage systems at these facilities. The network was redesigned to conform to interagency research network protocol standards and a competitive procurement was conducted to upgrade network processors for this project.	Continues supercomputer access for ER researchers at the same level as FY 1986. Support for both the NMFECC and the FSU Centers continued. Implementation of network redesign will be delayed and interagency standards and internetting will be impacted. File management upgrade will continue as scheduled.	Permits lease of Class VII computer system in the first half of FY 1988, which will allow ER scientists to address increasingly complex problems. This new machine will be located at the LLNL, and is the primary reason for the large increase in funding at this laboratory. Total supercomputer access, however, will remain approximately constant since the cooperative agreement with FSU will be discontinued. The file storage system at NMFECC will continue to be supported. The Network project will continue at a reduced level.
Subtotal Energy Sciences Advanced Computation Operations	$14,650	$16,135	$16,600

III. Applied Mathematical Sciences (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
TOTAL APPLIED MATHEMATICAL SCIENCES			
Operating Expenses	$37,453	$38,785	$40,450
Percentage Breakdown by Performer			
Laboratory	47%	66%	69%
University	52%	33%	30%
Industrial/ Other	1%	1%	1%
Subtotal	100%	100%	100%
Number of Researchers Supported	198	156	160

I. Preface: Engineering and Geosciences

This subprogram supports DOE's central fundamental research activities in engineering and geosciences. The Engineering Research objectives are (1) to improve and advance our knowledge of processes underlying current engineering practice, and (2) to expand 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 Geosciences Research objective is to develop a quantitative, predictive understanding of the energy related aspects of geological, geophysical and geochemical processes. Current emphasis includes Continental Scientific Drilling (especially thermal regimes), remote sensing of crustal structure and dynamics, geochemical migration and basic geoscience studies relating to hydrocarbon resources.

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Engineering Research	$ 12,356	$ 14,062	$ 14,845	+ 5.6%
Geosciences Research	12,905	15,350	16,505	+ 7.5%
Total, Engineering and Geosciences.....	$ 25,261	$ 29,412	$ 31,350	+ 6.6%

II. B. Major Laboratory Facility Funding

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Lawrence Berkeley Laboratory...	$ 1,930	$ 2,387	$ 2,390	---
Los Alamos National Laboratory.	2,353	2,590	$ 2,590	---
Sandia, Albuquerque.....	2,371	2,335	$ 2,335	---
Total.....	$ 6,654	$ 7,312	$ 7,315	---

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Engineering Research	In Mechanical Sciences: provides support for fluid mechanics, heat transfer, solid mechanics, fracture mechanics, and friction. Examples of supported projects include electrical and chemical corrosive actions of lubricating oils under load; fundamental aspects of heat transfer in non-steady flows; and interactions between two counter-flowing fluids (e.g., water and steam) in energy systems.	Continues research on fluid mechanics, heat transfer, solid mechanics, fracture mechanics, and friction. Research will include studies of the effects of friction on systems operating at very low temperatures and measurements of the heat released as a crack propagates in a stressed site of material (a measurement needed to test theories of fracture processes).	Emphasis will be on applications of thermodynamics to the description of plastic deformations in solids, heat and mass transfer in free convection, and continuation of basic two-phase flow studies such as dry-out and rewetting of surfaces found in energy systems.
	In System Sciences: includes support for measurements for tracking and controlling energy related processes, identification of knowledge needed to develop and operate intelligent machines in changing environments. Methods for controlling plasma processing of metals and plastics; and instrumentation for energy related hostile environments.	Continues research on measurements needed to track and control energy related processes. There will be studies of improving the way that machines can make decisions on routine questions, making more effective use of information gathered by such machines with their sensors; and studies of cost-effective ways to produce and control plasma in processing of materials.	Emphasis will be on studies of methods of controlling energy production and using modern techniques in chemical process control, programming of parallel computers to control intelligent machines, and the use of expert systems in helping such machines handle technical problems resulting from unexpected occurrences.
	In Engineering Analysis: includes support for studies of methods of dealing with complex, non-linear systems, and advancing engineering analysis methods. Of special concern are engineering systems whose underlying principles of operation are well understood and yet whose behavior from moment to moment is unpredictable.	Continues research on more energy efficient methods of mixing and stirring fluids, a joint university/industry project on a novel concept for confining chemical processing within a liquid curtain, and various engineering aspects of combustion both in quiescent and turbulent surroundings.	Emphasis will be on non-linear systems leading to methods for better analyses of engineering systems containing magnets, certain types of plastic components, and innovative computer memory systems.
Subtotal Engineering Research	$12,356	$14,062	$14,845

III. Engineering and Geosciences (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Geosciences Research	Provides support for research on large-scale earth movements, subsurface continental processes, evolution of geologic structures, properties of earth materials, rock flow, fracture and failure. Efforts have centered on modeling stress and strain changes to calculate synthetic earthquakes.	Continues research on large-scale continental processes, evolution of geologic structures, and properties of earth materials. These will continue as independent study efforts and as part of the Continental Scientific Drilling Program. Efforts will continue to relate laboratory experiments to studies conducted "in-situ," either in drill-holes or in mine shafts.	Emphasis will be on advanced seismic and other techniques useful in resource exploration, on rock mechanics and flow studies related to reservoir modeling, and on studies of the physical properties of earth materials and geologic processes.
	Provides support for research on generic properties of geothermal fluids, static rock-water interactions, geochemical transport and organic geochemistry. During the past year scientists involved in the world-wide iridium anomaly study have developed a new spectrometer which measures iridium in parts per trillion and which operates 100 to 500 times faster than is otherwise possible using current methods.	Continues research on the chemistry of geothermal fluids, rock-water interactions, geochemical transport and organic geochemistry. Special emphasis will be given in FY 1987 to the development of organic geochemistry and other aspects of the geosciences relating to fossil fuel resources and the geologic isolation of hazardous wastes.	Emphasis will be on the geochemistry of the earth's continental crust, the thermodynamics of naturally occurring underground fluids, geochemical transport, and site studies for a drilling to enhance progress in organic geochemistry. Geochemical studies will also be undertaken in the developing area of isotope geosciences.
	Includes support for studies in resource definition and utilization, reservoir dynamics and modeling, and the thermal regimes and hydrocarbon resources of the North American continent. A workshop was held in January 1986 to examine the hydrocarbon-related geoscience interest in the DOE part of Continental Scientific Drilling. Three shallow drilling projects were undertaken in FY 1986: a set of holes to measure heat flow at the lower end of the Salton Sea, a hole into a near-surface hydrothermal regime near Mammoth Lakes at Long Valley, CA, and a hole that penetrates into a vapor/hotwater-dominated hydrothermal system in the Valles Caldera, NM.	Continues research on resource definition and utilization, reservoir dynamics and modeling, and studies of the thermal regimes and hydrocarbon resources of the North American continent. Analysis of the results of the Valles Caldera drilling will continue during this year and next. Drilling is planned for the summer at a small crater formed in Long Valley, CA, about 600 years ago. Assessment will start of sites best suited for stimulation of major advances in the understanding of hydrocarbon resources.	Emphasis will be placed on hydrocarbon resource definition and utilization, and on reservoir dynamics and modeling. Additional drilling activities are planned as part of the Continental Scientific Drilling Program, both in thermal regimes and areas suited for basic studies pertaining to oil and gas resources.

III. Engineering and Geosciences (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Geosciences Research (Cont'd)	Provides support for research on solar physics, magnetospheric physics, upper atmosphere "in-situ" geochemistry and physics, solar radiation and climate-related solar terrestrial studies. These studies have focussed on aurora phenomena and the measurement of their causative processes in outer space.	Continues research on solar, solar-terrestrial and atmospheric physics and chemistry with emphasis on both direct and diffuse solar radiation. Designs will be examined for a low-cost device for energy resource assessment using radiometric techniques. Studies will be continued in 1987 as part of the International Solar-Terrestrial Physics Program (ISTP) and relating to the Geosphere-Biosphere Global Geoscience Initiative (IGBP).	Emphasis will be on the relationship between the near space environment of the earth and the upper and middle atmosphere of the earth. The interactions at this interface are poorly known yet they surely relate to the cyclic U.S. droughts and the 22-year solar cycle which has a major impact on U.S. energy concerns. About 5 projects of modest size will be funded as in previous years.
Subtotal Geosciences Research	$12,905	$15,350	$16,505
TOTAL ENGINEERING AND GEOSCIENCES Operating Expenses	$25,261	$29,412	$31,350
Percentage Breakdown by Performer			
Laboratory	53%	50%	50%
University	39%	42%	42%
Industrial/ Other	8%	8%	8%
Subtotal	100%	100%	100%
Number of Researchers Supported	237	269	284

I. Pref[redacted] Advanced Energy Projects

The objective of the Advanced Energy Projects (AEP) subprogram is to explore the feasibility of novel, energy-related concepts, as they evolve from basic research. Such concepts are at an early stage of scientific definition and, therefore, would not qualify for support by technology programs. Because they are new and untried, those concepts invariably represent a high risk; to qualify for support they must also have the potential for an eventual high pay-off of a magnitude sufficient to open new vistas in the Nation's technology posture. Muon-catalyzed fusion, an unexplored approach to controlled fusion totally different from either magnetic or inertial fusion can serve as just one of many examples. An area of major programmatic attention is the transfer of successful projects to proper technology programs; such transfers are effected every year, and several already have led to major development programs both in the Government and in private industry.

The 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 (including muon-catalyzed fusion) and new approaches to solar energy 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.

A separate activity within AEP is the Heavy Ion Fusion Accelerator Research (HIFAR) program. The heavy ion fusion approach is one of three concepts for inertial fusion. This approach utilizes beams of heavy ions to drive fusion targets to produce fusion yields required to generate commercial power. (Other approaches to inertial fusion would employ either laser beams or light-ion beams to implode the targets.) HIFAR is developing the physics and technology of the heavy-ion accelerator to establish a data base that will allow this option to be considered in future decisions regarding the course of the Nation's fusion effort. The strategy to meet this objective includes a series of experiments with increasing size and sophistication to test accelerator and beam physics issues under conditions that become progressively representative of a full-scale driver.

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Advanced Energy Projects.....	$ 7,195	$ 7,500	$ 8,748	+ 16.6%
Heavy Ion Fusion Accelerator Research.....	4,617	5,260	5,552	+ 5.6%
Total, Advanced Energy Projects	$ 11,812	$ 12,760	$ 14,300	+ 12.1%

II. B. Major Laboratory Facility Funding

Lawrence Berkeley Laboratory...	$ 3,717	$ 3,976	$ 4,800	+ 20.7%
Lawrence Livermore National Laboratory.....	438	632	747	+ 18.2%
Los Alamos National Laboratory.	2,278	3,190	3,573	+ 12.0%
Total.....	$ 6,433	$ 7,798	$ 9,120	+ 16.9%

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Advanced Energy Projects	Major advancements in the AEP-supported work on a laboratory-scale x-ray laser have placed the U.S. in the forefront of this emerging technology which offers, in certain applications, significant advantages in terms of cost and performance over state-of-the-art synchrotron light sources; prospective applications range from biological cell research, x-ray lithography to fusion plasma diagnostics. In a different area, there was an important development in the field of muon-catalyzed fusion (also known as "cold fusion"): theory was offered ard experiments performed, making this intriguing approach to controlled fusion look more and more attractive. In addition, a number of projects involving concepts relevant to the DOE mission were supported. They include new ideas on how to accelerate particles, how to convert heat to electricity, and how to better exploit and utilize fossil fuels - to name a few. In all, about 40 projects were supported.	Work will continue on the exploration of novel concepts that could open new horizons in energy-related applications. It is anticipated that new records will be broken in the performance of laboratory-scale x-ray lasers. The trend is towards shorter wavelengths (needed in most of the important applications) and higher brightness. In the field of muon-catalyzed fusion, a set of crucial experiments will be performed in late summer, to elucidate the promise of this fusion method.	Continued emphasis will be on the development of very bright laser-type x-ray sources and the evaluation of their applications, with the potential for a significant amount of technology transfer. Vigorous support will be offered to muon-catalyzed fusion research which may, in this time frame, lead to answers as to the practical promise of this fusion method. Other new energy-related concepts, as they emerge, will be explored for their technical feasibility.
Subtotal Advanced Energy Projects	$7,195	$7,500	$8,748
Heavy Ion Fusion Accelerator Research	Completed the first half of the four beam accelerator experiment (MBE-4) to operate and partially characterize the accelerator's performance. Continued physics tests on single beam apparatus. Completed the system assessment. Completed design and partially fabricated a multiple-beam, high-current ion injector. Identified and proposed a 5-year R&D program to minimally meet the HIFAR objective. Initiated studies on advanced accelerator concepts such as beam merging. Results from these	Complete MBE-4 assembly. Install beam diagnostics. Operate experiment and characterize acccelerator module performance. Conduct beam amplification tests and assess results. Explore the relationship between accelerator tolerances and beam transport with single beam apparatus. Document the system assessment. Complete initial phase of advanced accelerator concept studies, incorporating results from single beam and MBE-4 tests. Update accelerator design and cost codes for sub-scale	Conduct comprehensive MBE-4 test series. Operate experiment at design specifications, document results and critically review. Complete accelerator parameter studies, review estimates and compare with experimental test results. Utilize design codes to identify and assess the accelerator concepts and techniques needed to adequately test the major beam physics and accelerator technology issues. Complete injector development. Assemble key components and operate integrated system at nominal

III. Advanced Energy Projects (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1987
	activities supplement the HIFAR data base. When completed, an evaluation can be made of induction linacs as heavy ion fusion drivers for commercial applications.	applications. Continue injector fabrication. Install electrical components needed to operate injector at one-half power. Each of these activities provides additional insight for identifying accelerator design options and concepts to optimize the performance/cost ratio for a driver.	power levels. These experiments and accelerator design studies will establish a basis for proceeding with a detailed design of an accelerator experiment to minimally meet the HIFAR program objective.
	$4,617	$5,260	$5,552
TOTAL ADVANCED ENERGY PROJECTS Operating Expenses	$11,812	$12,760	$14,300
Percentage Breakdown by Performer			
Laboratory	64%	61%	61%
University	18%	19%	19%
Industrial/ Other	18%	20%	20%
Subtotal	100%	100%	100%
Number of Researchers Supported	115	137	143

I. Preface: Energy Biosciences

The Energy Biosciences subprogram is structured to provide the basic microbiological and plant sciences information necessary for DOE's efforts in generating the technology background for enhancing the renewable resource base, for microbiological transformation of renewable organic materials such as lignocellulosics in the production of fuels and chemicals, and for other energy relevant biological systems applications. Research is undertaken to uncover basic understanding of biological mechanisms and organisms in order to implement genetic manipulation or other biotechnology operations relevant to long range DOE objectives. Some investigations are designed with the objective of wedding contemporary plant biology with state-of-the-art powerful chemical-physical techniques and thinking to achieve better understanding of mechanisms.

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Energy Biosciences.....	$ 11,811	$ 16,500	$ 18,550	+ 12.4%
Total, Energy Biosciences....	$ 11,811	$ 16,500	$ 18,550	+ 12.4%

II. B. Major Laboratory Facility Funding

Brookhaven National Laboratory.	$ 1,010	$ 1,075	$ 1,150	+ 7.0%
Lawrence Berkeley Laboratory...	1,077	1,130	1,200	+ 6.2%
Michigan State University.....	1,861	2,100	2,400	+ 14.3%
	$ 3,948	$ 4,305	$ 4,750	+ 10.3%

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Energy Biosciences	Provides support for plant sciences and microbiology principally. Some of the key activities stress fundamental investigation aimed at uncovering mechanisms of: 1) photosynthesis and other biological energy conversions, 2) synthesis and function of plant cell walls, 3) physiology, biochemistry and ecology of microbial fermentations, including methanogenesis, 4) microorganisms involved in the degradation of lignocellulosic materials, 5) genetics of neglected anaerobic and thermophilic microorganisms critical in fermentations to fuels and chemicals, 6) growth and development of plants as related to molecular and cellular events,	Continues long-term ongoing efforts on basic research with energy relevance with some changing emphases to include additional research on microbial breakdown of lignin, synthesis, structure and function of plant complex carbohydrates, data requisite to development of genetic transformation of structures involved in photosynthesis, genetics and biochemistry of fermentative orphan microbes, and other topics of high priority. Develops new methodology for mapping genetic information of plants at the molecular level which will begin at a modest level. The partial implementation of an integrated multidisciplinary effort on the biochemical structural	Emphasis will continue on the core programs of Energy Biosciences in plant and microbial sciences. This includes topics already identified in which work is already in progress. Some of these include studies on lignin and cellulose biosynthesis and microbial degradation of these biopolymers, metabolic regulation of biosynthetic pathways in plants, photosynthesis, development of genetic systems in anaerobic microorganisms, organelle genetics in plants, and others. The full implementation will be completed of a plant and microbial complex carbohydrate center, initiated earlier, dedicated to research, training and service to the research community.

III. Energy Biosciences (Cont'd)

Program Activity	FY 1986	FY 1987	FY 1988
Energy Biosciences (Cont'd)	7) perception of and adaptation to environmental factors by plants, and 8) genetic regulatory mechanisms in plants. In addition, growing emphasis is being placed on probing complex carbohydrate structures because of increasing appreciation of the roles of these molecules in cell recognition, transport and regulatory processes in the broad biological context.	characterization of plant and microbial complex carbohydrates will be accomplished. Enhanced program of basic bioconversion of woody materials will begin at Oregon Graduate Center by Congressional directive ($1.2 million). Testing and early groundwork to be done on computerized structural data base on carbohydrates.	This activity is coordinated with NSF and USDA. The effort will address those high priority needs identified in carbohydrate research. A computerized carbohydrate data base to be fully implemented. In addition, a number of new projects in protein engineering, molecular mapping of plant genetic information and biochemistry of plants and microorganisms are anticipated.
TOTAL ENERGY BIOSCIENCES Operating Expenses	$11,811	$16,500	$18,550
Percentage Breakdown by Performer			
Laboratory	20%	19%	19%
University	76%	77%	77%
Industrial/ Other	04%	04%	04%
Subtotal	100%	100%	100%
Number of Researchers Supported	159	180	200

I. Preface: Program Direction

This subprogram provides the Federal staffing resources and associated funding required to develop, direct, and administer a complex and broadly diversified program for mission-oriented research to provide the fundamental scientific and engineering base on which the Nation's future energy options depend.

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Program Direction.....	$ 3,499	$ 4,112	$ 4,500	+ 9.4%
Total, Program Direction.....	$ 3,499	$ 4,112	$ 4,500	+ 9.4%

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Program Direction	Provided funds for salaries, benefits, and travel for 61 full-time equivalents (FTE's) in the Office of Basic Energy Sciences, the Scientific Computing Staff, and related program and management support staff. Ongoing activities include assessing the scientific needs and priorities of the program; planning to meet those needs; technical review of proposals from laboratories and universities; and monitoring the progress of ongoing university contracts, laboratory programs, and construction projects; as well as responding to the many day-to-day requirements involving budget, procurement and other management support activities. Also established in FY 1986 the Basic Energy Sciences Advisory Committee (BESAC). Managed the DOE-wide SBIR program and the Magnetic Fusion Energy Computer Network. ($3,317)	Provide for the normal personnel costs associated with an authorized level of 63 FTE's. Prior year unobligated funds will be used for the 1987 pay raise and for the increased agency contribution to the new Federal Employees Retirement System. Staff effort is expected to increase in support of continued growth in R&D for the next generation of facilities (1-2 GeV and 6 GeV Synchrotrons and Advanced Steady State Reactor) needed to continue U.S. leadership in key scientific areas and in support of numerous university construction projects. Staff will participate in meetings and provide administrative support for the newly established BESAC. ($4,012)	Provide funds for salaries and related costs to continue 63 FTE's. Provide for the normal increased personnel costs such as within-grade and merit increases, impact of the 1987 pay raise, and the increased agency contribution to the Federal Employees Retirement System as participation increases. Increased facilities support effort will be required as R&D increases on major new scientific facilities and construction activity increases on the 1-2 GeV Synchrotron. In addition to those facilities and activities discussed in FY 1987 are the SSRL 3 GeV SPEAR Injector, support for the new Class VII computer and associated increased network demand, and research initiatives in Energy Biosciences. ($4,400)
	Provided program support such as electronic information and communications services, printing and binding, and contractual services. Prior year unobligated carryover comprised $106 of the total expenditure. ($182)	Provide for a variety of program support services similar to those in FY 1986. Also includes contractual support for technical writing, editing, and other services and program-specific supplies and materials. ($100)	Continue the variety and level of program support services required in FY 1987. ($100)
Total, Program Direction	$3,499	$4,112	$4,500

I. Pr[redacted] Capital Equipment

Capital equipment is needed to support the basic research and facilities operations conducted by Basic Energy Sciences. In addition, Argonne is funded for general purpose equipment through BES for the purpose of providing all the DOE programs at ANL with this type of equipment. Much of the research involves experiments at extremes of temperature and pressure and requires unprecedented levels of resolution. Reliable, precise measurements under such conditions challenge the current state-of-the-art, and as improvements are made in instruments and equipment, it is important to benefit from them in a timely fashion. The quality of the research in support of the DOE mission, and the effective use of major facilities for energy related research depends on the availability of new state-of-the-art equipment and instrumentation, and on replacement of older, obsolete equipment.

II. A. Summary Table

Program Activity	FY 1986	FY 1987	FY 1988	% Change
Materials Sciences.....	$11,979	$15,500	$15,500	-
Chemical Sciences.....	9,834	11,165	11,715	+ 4.9%
Applied Mathematical Sciences.	1,030	1,100	1,100	-
Engineering and Geosciences...	1,443	1,750	1,750	-
Advanced Energy Projects.....	860	975	975	-
Energy Biosciences.....	515	610	659	+ 8.0%
Total, Capital Equipment.....	$25,661	$31,100	$31,699	+ 1.9%

II. B. Major Laboratory Facility Funding

Argonne National Laboratory....	$ 6,165	$ 7,470	$ 7,687	+ 2.9%
Brookhaven National Laboratory.	3,696	3,910	4,102	+ 4.9%
Lawrence Berkeley Laboratory...	3,336	4,315	3,870	- 10.3%
Oak Ridge National Laboratory..	4,659	4,953	4,573	- 7.7%
Total.....	$17,856	$20,648	$20,232	- 2.0%

III. Activity Descriptions

Program Activity	FY 1986	FY 1987	FY 1988
Capital Equipment for Basic Energy Sciences	Replacements and new major equipment used for energy research in the various subprograms; these include electron microscopes, neutron spectrometers, nuclear magnetic resonance spectrometers, lasers, and molecular beam equipment. General purpose equipment requirements for Ames and ANL will be met.	New equipment needs for x-ray and VUV beam lines at the NSLS and SSRL. Neutron spectrometers at the new Los Alamos Neutron Scattering Center. Computer equipment upgrading and replacement for modeling complex energy systems and supporting energy research activities will be undertaken. Replacement and new equipment acquisition will take place to the extent possible in support of BES projects. Equipment associated with the DOE advanced scientific facilities R&D activity will be initiated.	Equipment needs will be accommodated at the FY 1987 level. This will include high priority synchrotron radiation insertion devices, equipping mass spectrometry laboratories and enhancing capabilities at the Combustion Research Facility, as well as replacement and acquisition of new equipment.
Total, Capital Equipment	$25,661	$31,100	$31,699

SUMMARY OF MAJOR USER FACILITIES

As discussed in the budget narrative, the Basic Energy Sciences (BES) program plans, administers and manages the DOE basic research in energy related sciences and is responsible for building and maintaining the fundamental scientific foundation on which the nation's future energy options depend. Stable support without interruption is essential to carry out this research to provide the nation with a continuous supply of new knowledge, trained personnel and new directions for the energy well-being of the United States, and for the general technological base important to the Nation's economic future. During the last year BES funded 1100 projects at over 200 separate institutions with support for over 1500 researchers. Together with the support of research, BES undertakes a significant task for the Nation in the development, construction, and operation of major user facilities: synchrotron radiation sources, neutron sources, and other energy-related facilities such as the Combustion Research Facility. At the seven major user facilities funded by BES, there were about 1400 users of these facilities from all scientific disciplines and programs which resulted in approximately 790 publications. The activity around these facilities is growing and the number of users is expected to be about 2000 by FY 1988. These major facilities are described below with the funding levels shown for FY 1986, FY 1987 and FY 1988. Funding amounts shown are for operations costs only.

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

The National Synchrotron Light Source is a unique user oriented facility for advanced research with synchrotron radiation. At NSLS a wide range of research techniques are used by biologists, chemists, solid state physicists, metallurgist, and engineers for basic and applied studies. This is a modern dedicated facility which is rapidly being developed for vacuum ultra-violet and X-ray scattering and spectroscopy. It is now operating at about 50 percent of its experimental capacity and is expanding rapidly. About 700 users were involved in FY 1986. The scientific activity is doubling annually and the effects of saturation will be evident in FY 1988.

	FY 1986	FY 1987	FY 1988
Operating Funding			
Materials Sciences Subprogram	$11,100	$12,882	$13,700
Chemical Sciences Subprogram	5,150	5,610	6,020
Subtotal Operating Funding	$16,250	$18,492	$19,720

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

The High Flux Beam Reactor produces high-intensity neutron beams for research in a variety of fields. Neutrons are used as probes by nuclear and solid-state physicists, chemists, and biologists. This 20 year old dedicated facility has been a pacesetting facility and remains fully utilized and productive. About 200 users were involved in FY 1986. The scientific activity will remain constant during the next 2 years.

Operating Expenses			
Materials Sciences Subprogram	$ 8,276	$ 9,666	$10,400

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

The High Flux Isotope Reactor is a dual purpose reactor which is used for the production of isotopes, and also used for materials sciences, nuclear chemistry, and radiation damage research. When fully utilized: about 150 users are involved with research at the facility. Currently, safety considerations have caused the reactor to remain down after a routine refueling shut-down. Once the full extent of the problem is known and options are developed, budget adjustments may be necessary to bring the reactor back on-line. The Transuranium Processing Plant is a companion facility to the HFIR and was built to recover the transuranium elements from irradiated targets from the reactor. The combined operating costs of these facilities is shown below.

	FY 1986	FY 1987	FY 1988
Operating Expenses			
Chemical Sciences Subprogram	$13,324	$14,868	$16,200

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

The Intense Pulsed Neutron Source is a dedicated user facility for advanced research with pulsed neutrons serving the physics, materials, chemical, and life sciences research communities. The operation of this facility is limited financially to 21 weeks per year. It is fully utilized to the extent available. About 180 users were involved in FY 1986. With the planned improvements of the neutron source and some of the spectrometers, the scientific activity at this facility will increase moderately during the next 2 years.

Operating Expenses			
Materials Sciences Subprogram	$ 4,865	$ 4,875	$ 5,000

THE STANFORD SYNCHROTRON RADIATION LABORATORY (SSRL), STANFORD UNIVERSITY

The Stanford Synchrotron Radiation Laboratory is one of two national facilities funded by Basic Energy Sciences for the utilization of synchrotron radiation for basic and applied research in chemistry, physics, biology, and materials sciences. The operation of this facility is dependent on the operation of the High Energy Physics electron injector. While the schedule was reduced for FY 1986 it was fully utilized to the extent available and about 500 users were involved in research at the facility. With some new beamlines being commissioned, increased scientific activity is expected.

Operating Expenses			
Chemical Sciences Subprogram	$ 6,796	$ 8,058	$ 8,500
Materials Sciences Subprogram	1,107	1,800	1,900
Subtotal Operating Funding	$7,903	$ 9,858	$10,400

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

The Los Alamos Neutron Scattering Center is a dedicated user facility for advanced research with the nations most intense pulsed neutrons serving the physics, materials, chemical, and life sciences research communities. The operation of this facility is dependent on the Defense Program's proton storage ring facility. With the new experimental hall by FY 1988, the scientific program activity would involve nearly 100 materials and materials-related scientists by the end of that year.

	FY 1986	FY 1987	FY 1988
Operating Expenses			
Materials Sciences Subprogram	$ 0	$ 1,300	$ 3,000

COMBUSTION RESEARCH FACILITY (CRF), SANDIA NATIONAL LABORATORY

The Combustion Research Facility provides a unique capability to outside users from industry, university, and laboratory scientists for combustion research. The focus of the laboratory is on laser diagnostics of combustion systems, but a variety of burner systems and special facilities are available, including those for research on coal combustion and internal combustion engines. About 30 experiments involving about 50 scientists are operational in FY 1986. About one new experimental capability will be added each year for the next several years. The scientific activity will track these advances.

Operating Expenses			
Chemical Sciences Subprogram	$ 3,250	$ 3,540	$ 3,565
GRAND TOTAL	$53,868	$62,599	$68,285

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY SUMMARY

CONSTRUCTION PROJECTS

Basic Energy Sciences

IV. A. Construction Project Summary

Project No.	Project Title	Total Prior Year Obligations	FY 1987 Appropriated	FY 1988 Request	Remaining Balance	TEC
88-R-403	3 GeV Spear Injector	$ 0	$ 0	$ 3,000	$ 10,500	$ 13,500
88-R-401	Accelerator Improvement Projects	XXX	2,883	2,300	0	2,300
88-R-400	General Plant Projects	XXX	3,150	4,900	0	4,900
87-R-406	1-2 GeV Synchrotron Radiation Source	0	1,500	18,000	79,200	98,700
87-R-403	Neutron Scattering Experimental Hall	0	5,000	8,500	4,000	17,500
84-ER-112	Center for Advanced Materials	22,058	10,560	7,632	0	40,250
	Prior Year Projects	XXX	99,617	0	0	XXX
Total, Basic Energy Sciences Construction		XXX	$122,710	$ 44,332	$ 93,700	XXX

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

1. Project title and location: 88-R-403 3 GeV SPEAR Injector
Stanford Synchrotron Radiation Laboratory
Stanford, California

Project TEC: $13,500
Start Date: 1st Qtr. FY 1988
Completion Date: 4th Qtr. FY 1990

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1988	$ 3,000	$ 3,000	$ 2,850
1989	7,500	7,500	7,550
1990	3,000	3,000	3,100

3. Narrative:

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

(b) SSRL has played a leading role in the revolution that has taken place over the past few years in synchrotron radiation research. The recent work at the Laboratory in developing a progression of increasingly effective and sophisticated insertion devices (wigglers and undulators) for the production of synchrotron radiation at both SPEAR and PEP storage rings has led to major advances in scientific and technological research. Examples of particular importance include the development of non-invasive angiography, the analysis of atomic arrangements in this amorphous layers, and the measurement of magnet as scattering. In spite of the strong capabilities offered by SPEAR for synchrotron radiation research, the effectiveness of this facility is seriously impaired by limitations on its availability for experimental work in this area. The limited availability of SPEAR for synchrotron radiation production derives from two sources. The first is that it is also used for high energy experimentation. As a result, SPEAR is available for only half of its operating time for dedicated synchrotron radiation production. It is expected, however, that both SPEAR and PEP will become fully dedicated to synchrotron radiation production over the coming years.

(c) FY 1988 funding of $3,000,000 is requested to continue construction of the facilities and meet the construction completion date of the Fourth Quarter of FY 1990.

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

1. Project title and location: 88-R-401 Accelerator and reactor improvements and modifications, various locations

Project TEC: $ 2,300
Start Date: 2nd Qtr. FY 1988
Completion Date: 3rd Qtr. FY 1990

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1988	$ 2,300	$ 2,300	$ 1,200
1989	0	0	1,000
1990	0	0	100

3. Narrative:

(a) This project provides for additions and modifications to accelerator and reactor facilities, which are supported by the Basic Energy Sciences program. Since program priorities and needs change, the projects described below indicate the most likely projects to be funded. A continuing evaluation, however, is necessary to ensure that those projects with the greatest productivity are funded. Two projects at the Brookhaven National Laboratory are requested to incorporate improvements at the High Flux Beam Reactor and the National Synchrotron Light Source.

(b) National Synchrotron Light Source

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

High Flux Beam Reactor

Presently, prompt local operation of certain valves on the equipment level is required for emergency cooling should all incoming electrical power be lost to the facility. In order to allow the reactor operating crew to establish emergency cooling from the control room, it is proposed that four remotely operated valves, controls, power supply, and instrumentation be installed.

(c) The funding breakdown by facility is:

High Flux Beam Reactor Facility.....	$ 340
National Synchrotron Light Source.....	1,960
Total Funding Requested.....	$ 2,300

FY 1988 funding of $2,300,000 is requested to permit the timely improvements to these national user facilities.

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

1. Project title and location: 88-R-400 General plant projects

Project TEC: $ 4,900
Start Date: 1st Qtr. FY 1988
Completion Date: 4th Qtr. FY 1989

2. Financial schedule:

		Costs			
Fiscal Year	Obligations	FY 1986	FY 1987	FY 1988	After FY 1988
Prior Year Projects	$ 3,750	$ 1,426	$ 0	$ 0	$ 0
FY 1986 Projects	3,877	1,847	1,930	100	0
FY 1987 Projects	3,150	0	1,470	1,580	100
FY 1988 Projects	4,900	0	0	2,390	2,510

3. Narrative:

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

(b) The currently estimated distribution of FY 1988 funds by office is as follows:

Argonne National Laboratory	$ 3,600
Ames Laboratory	600
Notre Dame Radiation Laboratory	30
Sandia National Laboratories	400
Stanford Synchrotron Radiation Laboratory	270
Total project cost	$ 4,900

FY 1988 General Plant Projects (GPP) are miscellaneous minor new construction projects of a general nature, the total estimated costs of each will not exceed $1,200,000. These projects are necessary to provide for the continuing requirement to maintain the facilities in a good state of repair, to adapt the facilities to new or improved production or service techniques, to effect economics of operations and to reduce or eliminate health, fire, and security problems.

(c) FY 1988 funding of $4,900,000 is requested to meet essential requirements of each of the above mentioned locations.

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

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

Project TEC: $ 98,700
Start Date: 1st Qtr. FY 1987
Completion Date: 2nd Qtr. FY 1992

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1987	$ 1,500	$ 1,500	$ 1,500
1988	18,000	18,000	16,100
1989	30,000	30,000	27,000
1990	26,000	26,000	25,000
1991	17,200	17,200	19,900
1992	6,000	6,000	9,200

3. Narrative:

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

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

(c) FY 1988 funding of $18,000,000 is requested to permit construction and procurements activities to continue leading to construction completion in the Second Quarter of FY 1992.

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

1. Project title and location: 87-R-403 Neutron scattering experimental hall
Los Alamos Neutron Scattering Center (LANSCE)
Los Alamos, New Mexico

Project TEC: $17,500
Start Date: 1st Qtr. FY 1987
Completion Date: 2nd Qtr. FY 1989

2. Financial schedule:

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

3. Narrative:

(a) 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 proposed experimental hall will provide additional space required to fully utilize this powerful source for a national neutron scattering program at LANSCE. This structure will house a minimum of nine experiments on nine flight paths. The project also includes funds for the construction of new spectrometers and data collection computers specifically designed to meet the requirements of this facility.

(b) 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 extraordinary capabilities of this facility 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. 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.

(c) FY 1988 funding of $8,500,000 is requested to continue construction of the facilities and meet the construction completion date of the Second Quarter of FY 1989.

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.

DEPARTMENT OF ENERGY
FY 1988 CONGRESSIONAL BUDGET REQUEST
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(dollars in thousands)

KEY ACTIVITY CONSTRUCTION PROJECT SUMMARY

Basic Energy Sciences

IV. B. Plant Funded Construction Project

1. Project title and location: 84-ER-112 Center for Advanced Materials
Lawrence Berkeley Laboratory
Berkeley, California

Project TEC: $40,250
Start Date: 3rd Qtr. FY 1984
Completion Date: 4th Qtr. FY 1988

2. Financial schedule:

Fiscal Year	Appropriated	Obligations	Costs
1984	$ 1,760	$ 1,760	$ 437
1985	9,290	9,290	1,968
1986	11,008	11,008	6,237
1987	10,560	10,560	12,583
1988	7,632	7,632	18,142
1989	-	-	883

3. Narrative:

(a) The Center for Advanced Materials (CAM) is comprised of two research laboratories: the Surface Science and Catalysis Laboratory, and the Advanced Materials Laboratory. 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 and the alteration of, and additions to, existing facilities.

(b) This research center was proposed and approved 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 has 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.

(c) FY 1988 funding of $7,632,000 represents the final construction funding for this project which was initiated in FY 1984.

DEPARTMENT OF ENERGY
1988 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: 3 GeV SPEAR Injector
Stanford Synchrotron Radiation Laboratory
Stanford, California

2. Project No.: 88-R-403

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

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

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

5. Previous cost estimate: none

6. Current cost estimate: $ 13,500
Less FY 1984 PE&D: 0
$ 13,500

Date: December 1986

7. Financial Schedule:

Fiscal Year	Authorization	Appropriations	Obligations	Costs
1988	$ 3,000	$ 3,000	$ 3,000	$ 2,850
1989	7,500	7,500	7,500	7,550
1990	3,000	3,000	3,000	3,100

8. Brief Physical Description of Project

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

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 88-R-403

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

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

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

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

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

2. Project No.: 88-R-403

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

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

10. Details of Cost Estimates

	Item Cost	Total Cost
a. Engineering, design, inspection and management		$ 3,420
b. Construction costs		0
c. Special facilities, Spear Injector		7,504
d. Contingency at approximately 24% of above costs		2,576
Total estimated cost		$13,500

11. Method of Performance

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

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

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 88-R-403

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

	FY 1988	FY 1989	FY 1990	TOTAL
a. Total project costs				
1. Total facility costs				
(a) SPEAR injector.....	$ 2,392	$ 6,046	$ 2,486	$10,924
Contingencies.....	458	1,504	614	2,576
TOTAL (TEC).....	2,850	7,550	3,100	13,500
2. Other project costs (Associated R&D).....	0	0	0	0
Total other project costs.....	0	0	0	0
Total project costs (Item 1 & 2)	$ 2,850	$ 7,550	$ 3,100	$13,500

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

b. Other related funding requirements (estimated life of project: 25 years)
(FY 1986 Dollars)

	FY 1991	FY 1992	FY 1993	FY 1994
1. Operations Expenses.....	$ 1,000	$ 1,000	$ 1,000	$ 1,000
2. Capital Equipment.....	200	300	300	300
Total other related funding.....	$ 1,200	$ 1,300	$ 1,300	$ 1,300

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

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

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

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1988 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: Accelerator and Reactor Improvements and Modifications, various locations

2. Project No.: 88-R-401

3. Date A-E work initiated: 2nd Qtr. FY 1988

3a. Date physical construction starts: 3rd Qtr. FY 1988

4. Date Construction ends: 3rd Qtr. FY 1990

5. Previous cost estimate: none
Date:

6. Current cost estimate: $ 2,300
Less amount for PE&D: 0
Net cost estimate: $ 2,300
Date: December 1986

7. Financial Schedule

Fiscal year	Authorizations	Appropriations	Obligations	Costs
1988	$2,300	$2,300	$2,300	$1,200
1989	0	0	0	1,000
1990	0	0	0	100

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.

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 88-R-401

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

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

a. National Synchrotron Light Source

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

A new system of optical beam position detectors will be installed on all of those beam lines which require dynamic feedback stabilization.

A system of strip-line detectors and kickers will be installed within the multipole straight sections of each of the rings. Detector electronics and power amplifier equipment will be provided to enable this system to damp all modes of transverse coherent oscillation.

A short period medium K undulator will be installed in X13 for production of x-rays optimized for the spectral range intermediate between the soft x-ray spectrum of X1 and the hard x-rays of the devices of the Phase II construction.

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.: 88-R-401

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

b. High Flux Beam Reactor

Presently, prompt local operation of certain valves on the equipment level is required for emergency cooling should all incoming electrical power be lost to the facility. In order to allow the reactor operating crew to establish emergency cooling from the control room, it is proposed that four remotely operated valves, controls, power supply, and instrumentation be installed.

Currently, the several maintenance functions such as the resin bed regeneration and filter cleaning operation generates large quantities of liquid radioactive waste which must be treated and disposed of by the BNL waste concentration facility. This project will replace the current light water purification system with a powdered filter in the fuel pool system. This will result in the elimination of all regeneration water as liquid radioactive waste leaving only powdered resin water which will be reclaimed as solid waste. This solid waste is less expensive to process and environmentally safer that the current liquid waste.

The shutdown cooling water pumps are important components of the emergency core cooling systems. To insure a constant power supply, a redundant power supply system is used. This project will replace the current transfer switches with state of the art transfer switches, thereby eliminating the increasing maintenance requirements.

The present safety relief valve system for the poison water tank is a single valve which requires replacement. This project will provide for the replacement with a two valve connection. This will eliminate the problem of loss of programmatic time due to unscheduled maintenance on the single valve.

The wiring to the control rod drive units are located within a high radiation field. Within this area insulation often becomes brittle, thereby hampering the maintenance operation and frequently results in secondary maintenance projects following control rod drive maintenance. This project would replace the present direct wiring system with a terminal board/quick disconnect system. As a result of this project, maintenance time in this high radioactive area will be reduced.

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 88-R-401

10. Details of Cost Estimate

a. High Flux Beam Reactor Facility	$ 340
b. National Synchrotron Light Source	1,960
Total Project Cost	$2,300

11. Method of Performance

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

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1988 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: 2nd Qtr. FY 1988

4. Date construction ends: 2nd Qtr. FY 1992

5. Previous cost estimate: None
Date: None
Current cost estimate: $ 98,700
Date: December 1986

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1987	1,500	1,500	1,500	1,500
1988	18,000	18,000	18,000	16,100
1989	30,000	30,000	30,000	27,000
1990	26,000	26,000	26,000	25,000
1991	17,200	17,200	17,200	19,000
1992	6,000	6,000	6,000	9,200

8. Brief Physical Description of Project

The 1-2 GeV Synchrotron will be built within the Lawrence Berkeley Laboratory, which is located on University of California property adjacent to the Berkeley campus. The project will include the construction of new facilities, and alterations and additions to existing plant and site facilities, especially Building 6 (the circular building that now houses the 184-Inch Cyclotron). The 1-2 GeV Synchrotron is a special 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

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

2. Project No.: 87-R-406

8. Brief Physical Description of Project (continued)

devices (eleven could support insertion devices), an initial complement of 5 insertion devices, and photon beamlines extending from the insertion devices and two beamlines from bend magnets. Development of other straight sections and bending magnet ports are not included in the scope of this project. Their development in future years however, will provide flexibility to respond to new scientific directions and to take advantage of new materials, designs, and other technological advances. When fully developed, the facility will be able to provide up to 60 user stations.

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

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

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

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

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

2. Project No.: 87-R-406

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

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

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

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

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

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

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)

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.

10. Detail of Cost Estimate

	Item Cost	Total Cost
a. Engineering, design, inspection and administration (EDIA).....		$ 23,300
(1) Conventional construction at approximately 14%.....	$ 2,230	
(2) Special facilities at approximately 31%.....	13,720	
(3) Project management/administration.....	7,350	
b. Construction costs.....		57,760
(1) Conventional construction.....	14,880	
(2) Special facilities.....	42,880	
Subtotal.....		81,060
c. Contingencies at approximately 23% of (a & b).....		17,640
(1) Conventional facilities.....	2,770	
(2) Special facilities.....	14,870	
~~Total Project Cost~~.....		$ 98,700

TEC

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

2. Project No.: 87-R-406

11. Methods of Performance

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

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

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

	FY 1987	FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	Total
a. Total project costs							
1. Total facility construction costs.	$ 1,500	$16,100	$27,000	$25,000	$19,900	$ 9,200	$ 98,700
2. Other project costs							
(a) Storage Ring, Insertion Device, and Beamline R&D[a/]	1,500	2,000	2,000	1,000	--	--	6,500
(b) Startup.....	--	--	--	5,000	11,000	18,600	34,600
(c) Capital Equipment Related to R&D and Facility Startup...	500	500	1,000	1,500	1,000	1,000	5,500
Total other project costs..	2,000	2,500	3,000	7,500	12,000	19,600	46,600
Total project costs (Item 1 & 2).....	$ 3,500	$18,600	$30,000	$32,500	$31,900	$28,800	$145,300

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

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

2. Project No.: 87-R-406

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

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

1. Facility operating costs	$18,600
2. Programmatic research	3,000
3. Capital Equipment Related to programmatic research	600
Total related annual costs	$22,200

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

a. Total project funding

1. Site preparation and building construction for the facility is scheduled for FY 1988-1991, in order that the building be ready for installation of the injector and the storage ring. Fabrication of the beamlines and insertion devices is scheduled for FY 1990-1993.

2. Other project funding

Storage ring R&D activities include (a) accelerator physics studies of lattice design, stabilization of high-current beams; (b) development of ultra-high vacuum technology; (c) beam control and instrumentation system development; (d) radio-frequency accelerating system development; and (e) magnet system prototyping. Insertion devices and beamline R&D activities include high-fidelity magnetic structures, in-vacuum undulators, and advanced beamline components suitable for high-brilliance photon beams.

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

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

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

2. Project No.: 87-R-406

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

b. Other related funding requirements

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

DEPARTMENT OF ENERGY
1988 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: General Plant Projects

2. Project No.: 88-R-400

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

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

4. Date construction ends: 4th Qtr. FY 1989

5. Previous cost estimate: None
Date:

6. Current cost estimate: $4,900
Date: December 1986

7. Financial Schedule:

Fiscal Year	Obligations	Costs FY 1986	Costs FY 1987	Costs FY 1988	Costs After FY 1988
Prior Year Projects	$ 3,750	$ 1,426	$ 0	$ 0	$ 0
FY 1986 Projects	3,877	1,847	1,930	100	0
FY 1987 Projects	3,150	0	1,470	1,580	100
FY 1988 Projects	4,900	0	0	2,390	2,510

8. Brief Physical Description of Project

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

1. Title and location of project: General Plant Projects — 2. Project No.: 88-R-400

8. Brief Physical Description of Project (continued)

The currently estimated distribution of FY 1988 funds by office is as follows:

Argonne National Laboratory	$ 3,600
Ames Laboratory	600
Notre Dame Radiation Laboratory	30
Sandia National Laboratories	400
Stanford Synchrotron Radiation Laboratory	270
Total project cost	$ 4,900

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..... $ 3,600

The Argonne National Laboratory FY 1988 General Plant Projects (GPP) are miscellaneous minor new construction projects of a general nature, the total estimated costs of each will not exceed $1,200,000. These general plant projects are necessary to provide for the continuing requirement to maintain the facilities in a good state of repair, to adapt the facilities to new or improved production or service techniques, to effect economics of operations and to reduce or eliminate health, fire, and security problems.

1. Clean Room Laboratory, Building 205
2. Instrument Laboratory, Building 205
3. Rehabilitation of Guard Posts and Security Fence
4. Rehabilitate Site-Wide Emergency Paging System, ANL-E
5. Helium Gas Recovery System
6. Bridge, Culvert and Sidewalk Repair
7. Correction of Safety Related Deficiency, Bldg. 316, Equipment Room
8. Rehabilitation of Cafeteria, Building 213
9. Rehabilitation of Building 208, Phase III
10. Replace Compressors, Building 364

1. Title and location of project: General Plant Projects 2. Project No.: 88-R-400

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

Of the total request of $3,600,000 for GPP at the Argonne National Laboratory, approximately 50 percent will be used for plant rehabilitation and approximately 50 percent will be used for upgrading and programmatic projects.

Ames Laboratory..... $ 600

The projects involve the renovation of existing space and adding new space for equipment and personnel associated with administrative data processing. Other projects include replacement of the existing freight elevator in the Metallurgy Building, converting a portion of a production area into research space, replacing the existing EMCS controller, and miscellaneous small projects. 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..... $ 400

The Combustion Research Facility (CRF) at Sandia National Laboratories, Livermore (SNLL) has a continuing need for General Plant Project (GPP) funds for upgrading or the construction of facilities as required to meet expanding or changing programmatic goals. 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.

1. Title and location of project: General Plant Projects

2. Project No.: 88-R-400

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

Stanford Synchrotron Radiation Laboratory..... $ 270

Requirements include minor modifications and additions necessary to support the optimum use of the laboratory research capabilities. These improvements are necessary to maintain the capital investment at the site and to accommodate the continuous changes to the physical site necessitated by the evolving SSRL research program. Examples include replacement of telephone system, installation of data control system, construction of parking facilities, and installation of liquid nitrogen facility. The projects described will be constructed at the Stanford University, non-Government owned property.

10. Details of Cost Estimate

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

11. Method of Performance

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

DEPARTMENT OF ENERGY
1988 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: 4th Qtr. FY 1989

5. Previous cost estimate: None
Date: None

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

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
	a/	a/	a/	a/
1986				
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^{0} 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.

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 new spectrometers specially designed to make optimum use of the intense pulsed neutron beam. These will be in addition to 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 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

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)

includes research into improved 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.

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.

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

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

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 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
1988 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: December 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	1,968
1986	11,008	11,008	11,008	6,237
1987	10,560	10,560	10,560	12,583
1988	7,632	7,632	7,632	18,142
1989	-	-	-	883

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, 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

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8. Brief Physical Description of Project (continued)

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.

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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

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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.

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

	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988	FY 1989	Total
a. Total project costs:							
1. Total facility costs							
(a) Construction line item							
SSCL	$ 437	$ 1,755	$ 3,746	$ 5,767	$ 0	$ 0	$11,705
AML	0	213	2,491	6,816	18,142	883	28,545
	437	1,968	6,237	12,583	18,142	883	40,250
(b) PE&D	8	192	0	0	0	0	200
Total project costs	445	2,160	6,237	12,583	18,142	883	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	2,900	2,885	3,200	3,500	5,000
2. Capital equipment related to programmatic research	1,300	600	454	1,500	1,500	2,000
Total	$ 3,600	$ 3,500	$ 3,339	$ 4,700	$ 5,000	$ 7,000

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.

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

(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.