BASIC ENERGY SCIENCES

PROGRAM MISSION

The mission of the Basic Energy Sciences (BES) program is to support basic research in the natural sciences leading to new and improved energy technologies and to understanding and mitigating the environmental impacts of energy technologies.

The GOAL of the BES program is:

To support a world-class, peer-reviewed fundamental research program in areas relevant to energy resources, production, conversion, and efficiency and to the mitigation of the adverse impacts of energy production and use; to operate major scientific user facilities for support of forefront research in areas important to BES activities and also in areas that extend beyond the scope of BES activities such as structural biology, medical imaging, and micromachining; to plan, design, and construct the next generation of such facilities; and to act as a steward of human resources and institutions to ensure stable, essential research communities and premier national user facilities. BES serves as the Nation's primary or sole steward of a number of essential research activities including fundamental research in heavy element chemistry, the fundamental bases of solar energy conversion, combustion related science, organometallic chemistry, catalysis, separations science, radiation chemistry, and radiation effects in materials. To accomplish these missions, BES supports basic research in materials sciences, chemical sciences, geosciences, plant and microbial biosciences, and engineering sciences. Research in advanced energy projects and applied mathematical sciences was transferred to the Computational and Technology Research Program in FY 1997.

PROGRAM MISSION - BASIC ENERGY SCIENCES (Cont'd)

The OBJECTIVES related to these goals are:

1. To OBTAIN MAJOR NEW FUNDAMENTAL KNOWLEDGE - Conduct broad-based, forward-looking fundamental research to create new scientific and engineering knowledge in support of the BES mission.

2. To CONTRIBUTE TO THE COLLECTIVE DOE MISSION - Use established management practices to link BES staff and principal investigators with their counterparts in the energy technology offices and in industry in order to contribute to DOE missions in areas of energy efficiency, renewable energy resources, improved utilization of fossil fuels, reduced environmental impacts of energy use, future fusion energy sources, and science-based stockpile stewardship. Such management practices include cofunding and collocating fundamental research programs supported by BES with applied research programs supported by the technology offices at the national laboratories.

3. To PROVIDE WORLD-CLASS SCIENTIFIC FACILITIES - Plan, construct, and operate major national user facilities to serve researchers at universities, national laboratories, and industrial laboratories. These scientific facilities - which enable advancement of basic knowledge and the development of new products, materials, and manufacturing processes - include synchrotron radiation light sources, high-flux neutron sources, electron-beam microcharacterization centers, and specialized facilities such as the Combustion Research Facility.

4. To ENSURE THAT RESEARCH RESULTS ARE OF THE HIGHEST QUALITY AND ARE WIDELY DISSEMINATED AND USED - Promote excellence in basic research through peer review. Promote open communication and the transfer of information, know-how, and technology by publication of results in the open, peer-reviewed literature and by presentation and discussion of results at workshops and conferences. Promote the use of the results of basic research by encouraging effective interactions between the basic and applied research communities.

SCIENTIFIC FACILITIES UTILIZATION:

The BES program request includes $276,846,000 to maintain support of the scientific user facilities. This funding will maintain the quality of service and availability of facility resources to users at the highest level possible consistent with overall budgetary constraints. Research communities that have benefited from the BES supported Scientific Facilities Initiative include materials sciences, chemical sciences, earth and geosciences, environmental sciences, structural biology, superconductor technology, and medical research and technology development.

PROGRAM MISSION - BASIC ENERGY SCIENCES (Cont'd)

PERFORMANCE MEASURES:

BES, like other programs that fund basic research, is working to understand the application of performance measures to its activities. During FY 1997, BES will formalize this understanding. It is anticipated that the process will involve the elements described below.

BES is a prototypical example of a large, diverse, and robust basic research program that exists within a mission agency. BES will use performance measures to evaluate four basic activities that characterize this special role. The first three correspond to the fundamental tenets or principles of BES. These are: (1) excellence in basic research, (2) relevance to the broad energy mission of the agency, and (3) stewardship of research performers, essential scientific disciplines, institutions, and scientific user facilities. Combining and sustaining these tenets is the management challenge (and vision) of BES. The fourth activity to be evaluated, therefore, is program management. These activities will be measured in a number of ways, which separate naturally into four categories: (1) peer review, (2) metrics (i.e., things that can be counted), (3) customer evaluation and stakeholder input, and (4) qualitative assessments, which might include historical retrospectives and annual program highlights.

During FY 1997, a matrix of activities to be measured versus performance measures will be constructed, and the importance of the various measurement techniques contained within the matrix will be assessed. Many standard measurement techniques are already in place. Indeed, some have been in place for many years. These include: peer review of all research programs; determination of metrics such as number of users at the facilities, number of beam hours delivered at the facilities, and number of peer reviewed publications; and customer surveys, e.g., of the scientific user facilities. During FY 1997, BES will establish baselines for selected metrics, will codify the peer review processes for national laboratory research and for facilities, and will proceed with other selected activities such as studies of the impacts of basic research on technology and the culture that promotes excellence in basic research at the national laboratories.

PROGRAM MISSION - BASIC ENERGY SCIENCES (Cont'd)

SIGNIFICANT ACCOMPLISHMENTS AND PROGRAM SHIFTS:

- Richard E. Smalley (Rice University), supported by the BES Chemical Sciences Division, shared in the 1996 Nobel Prize for Chemistry for the "collaborative discovery that carbon could occur in a uniquely beautiful and satisfying structure that engendered an entirely new branch of chemistry."

- A joint BES/Energy Efficiency research team at Oak Ridge National Laboratory developed a high-temperature superconducting tape with record current carrying capacities in high magnetic fields. The technique, dubbed RABiTS (rolling assisted, biaxially textured substrates), uses metal strips fabricated with a high degree of crystallographic alignment or "texture" that can be imparted to a superconductor deposited on the strip. The critical current density obtained, greater than 650,000 amperes per square centimeter at 77 degrees Kelvin, is the highest obtained by any process considered scaleable to production of long lengths.

- The first genome sequencing effort on a higher plant was initiated with the formation of an international, multiagency project focusing on the model plant *Arabidopsis thaliana.* The >100 megabase genome should be sequenced by 2004 by groups in Japan, France, the U.S., and a European consortium. The information will provide insight into plant growth and development with potential applications ranging from agriculture and forestry to energy production and environmental cleanup.

- Lawrence Berkeley National Laboratory researchers developed a way to enhance the sensitivity of nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI) by using hyperpolarized atomic xenon to polarize the hydrogen atoms in sample systems. Since soluble proteins and other biological structures have large numbers of protons, the enhancement of the MRI signal promises great value.

- The national scientific user facilities continued to operate more efficiently as a result of the Scientific Facilities Initiative begun in FY 1996. This initiative has provided substantial increases in operating hours, which in turn have enabled greater numbers of experiments to be performed and access to the facilities for greater numbers of users. Funds will continue to be provided for beamline fabrication and instrument development.

- Construction of the Combustion Research Facility, Phase II, continued with completion scheduled for FY 1999.

- The Advanced Photon Source became fully operational.

- Atomic and molecular level understanding of complex phenomena led to better structural materials, adhesion in composite materials, corrosion resistance, control of chemical reactions in combustion and processing, rock-fluid mechanics, and biological energy conversion.

PROGRAM MISSION - BASIC ENERGY SCIENCES (Cont'd)

- Advances in theory and modeling were applied to more complex materials and phenomena to discover new materials for improved energy technologies.

- Continuing basic research supporting: vehicles of the future, environmentally responsive technologies, and sustainable development will provide the basis for lighter, more efficient automobiles and for lower costs and environmental impacts in energy production and use.

Neutron Source Activities:

To maintain a strong U.S. position in the field of neutron science following the termination of the Advanced Neutron Source (ANS) project in FY 1995, the Department will continue to support selected enhancements of existing reactor and spallation neutron sources (as described below) and will proceed with the planning of the National Spallation Neutron Source (NSNS).

BES will initiate in FY 1998 the fabrication of instrumentation for the short-pulse spallation source at the Manuel Lujan Jr. Neutron Scattering Center at the Los Alamos Neutron Science Center (LANSCE). This instrumentation enhancement project will be undertaken concurrently with an accelerator enhancement project at LANSCE funded by the Department's Office of Defense Programs. Together, these enhancements will result in a state-of-the-art short-pulse spallation source facility for neutron scattering, radiography, and science-based stockpile stewardship.

The conceptual design of the National Spallation Neutron Source (NSNS) will be completed in FY 1997. FY 1998 funding of $23,000,000 is requested for pre-title I activities for the NSNS. The design of the NSNS will conform to the recommendations of the Basic Energy Sciences Advisory Committee (BESAC). Power from the NSNS will be in the 1 megawatt range or about six times that of the highest currently available worldwide, and NSNS's design will allow for significantly higher powers at a later stage. The design will further include moderators for neutrons with appropriate spectral and temporal characteristics in the epithermal, thermal, and cold energy ranges. This will provide expanded capabilities for research in physical, chemical, materials, biological, and medical sciences. There will be the potential for at least three target areas and for 30 to 40 instruments. It is expected that the NSNS will serve over 1,000 users per year. The conceptual design is an interlaboratory effort that involves Lawrence Berkeley National Laboratory in ion sources, Los Alamos National Laboratory and Brookhaven National Laboratory in accelerators, and Argonne National Laboratory in targets and moderators. Oak Ridge National Laboratory is responsible for project management and coordination of the technical design. Oak Ridge National Laboratory will also participate in target and moderator design and in instrumentation design and development. In addition, agreements are in place with Rutherford Appleton Laboratory (England) and the European Spallation Source project to allow joint research and development. A Working Group on Neutron Sources has been established under the Megascience Forum of the Organization for Economic Cooperation and Development.

BASIC ENERGY SCIENCES
PROGRAM FUNDING PROFILE
(Dollars in thousands)

	FY 1996 Enacted Appropriation	FY 1997 Original Appropriation	FY 1997 Adjustments	FY 1997 Current Appropriation	FY 1998 Budget Request
Research					
Materials Sciences	$364,036	$364,571	$0	$364,571	$392,475
Chemical Sciences	200,045	202,099	0	202,099	199,933
Engineering and Geosciences	39,592	42,920	0	42,920	41,371
Energy Biosciences	28,730	28,585	0	28,585	27,461
Advanced Energy Projects	11,700	0	0	0	0
Applied Mathematical Sciences	111,068	0	0	0	0
Program Direction	9,176	0	0	0	0
Subtotal, Research	764,347	638,175	0	638,175	661,240
Construction	9,986	11,500	0	11,500	11,000 a/
Subtotal, Basic Energy Sciences	774,333	649,675	0	649,675	
Adjustment	-17,168 b/	-9,404 b/	0	-9,404 b/	
Total, Basic Energy Sciences	$757,165 c/	$640,271	$0	$640,271	

a/ Includes $11,000,000 for fully funding completion of the Combustion Research Facility, Phase II.

b/ Share of Energy Supply, Research and Development general reduction for use of prior year balances assigned to this program. The total general reduction was applied at the appropriation level.

c/ Excludes $13,228,000 which was transferred to the SBIR program and $999,000 which was transferred to the STTR program.

Public Law Authorizations:

Public Law 95-91, DOE Organization Act

BASIC ENERGY SCIENCES
(Dollars in thousands)

PROGRAM FUNDING BY SITE

Field Offices/Sites	FY 1996 Enacted Appropriation	FY 1997 Original Appropriation	FY 1997 Adjustments	FY 1997 Current Appropriation	FY 1998 Budget Request
Albuquerque Operations Office					
Los Alamos National Laboratory	$35,005	$19,894	$0	$19,894	$23,886
National Renewable Energy Laboratory	5,431	4,270	0	4,270	4,301
Sandia National Laboratories	28,265	29,546	0	29,546	31,821
Chicago Operations Office					
Ames Laboratory	23,135	17,830	0	17,830	17,843
Argonne National Laboratory	158,579	137,098	0	137,098	143,088
Brookhaven National Laboratory	83,623	74,229	0	74,229	79,281
Idaho Operations Office					
Idaho National Engineering Laboratory	3,454	2,758	0	2,758	2,744
Oakland Operations Office					
Lawrence Berkeley National Laboratory	112,235	61,564	0	61,564	62,323
Lawrence Livermore National Laboratory	2,450	6,094	0	6,094	4,731
Stanford Linear Accelerator Center	22,083	20,537	0	20,537	21,007
Oak Ridge Operations Office					
Oak Ridge Institute for Science and Education	1,121	746	0	746	701
Oak Ridge National Laboratory	99,693	87,549	0	87,549	105,382
Thomas Jefferson National Accelerator Facility	155	0	0	0	0
Richland Operations Office					
Pacific Northwest National Laboratory	13,063	12,304	0	12,304	12,377
All Other Sites a/	186,041	175,256	0	175,256	162,755
Subtotal	774,333	649,675	0	649,675	672,240
Adjustment	-17,168 b/	-9,404 b/	0	-9,404 b/	0
TOTAL	$757,165 c/	$640,271	$0	$640,271	$672,240

a/ Funding provided to universities, industry, other Federal agencies and other miscellaneous contractors.

b/ Share of Energy Supply Research and Development general reduction for use of prior year balances assigned to this program. The total general reduction was applied at the appropriation level.

c/ Excludes $13,228,000 which was transferred to the SBIR program and $999,000 which was transferred to the STTR program.

I. **Mission Supporting Goals and Objectives**: The Materials Sciences Subprogram supports basic research in condensed matter physics, metallurgy, ceramics, and materials chemistry. This basic research seeks to understand the atomic-bases of materials properties and behavior and how to make materials perform better at acceptable cost through new methods of synthesis and processing. Basic research is supported in corrosion, metals, ceramics, alloys, semiconductors, superconductors, polymers, metallic glasses, ceramic matrix composites, non-destructive evaluation, magnetic materials, surface science, neutron and x-ray scattering, chemical and physical properties, and new instrumentation. Ultimately the research leads to the development of materials that improve the efficiency, economy, environmental acceptability, and safety in energy generation, conversion, transmission, and use. These material studies affect developments in numerous areas such as solar energy conversion, transportation, electric power production, and petroleum refining.

II. **Funding Schedule:**

Facility	FY 1996	FY 1997	FY 1998	$ Change	% Change
Materials Sciences Research	$173,307	$166,066	$192,922	$+26,856	+16.2%
Facilities Operations	190,729	182,281	190,665	+8,384	+4.6%
SBIR/STTR	0	8,800	8,888	+88	+1.0%
Congressional Direction	0	7,424	0	-7,424	-100.0%
Total, Materials Sciences	$364,036	$364,571	$392,475	$+27,904	+ 7.6%

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
Materials Sciences Research			
-Basic research is conducted on synthesis and processing; theory and modeling; structural characterization; and mechanical and physical behavior. The purpose of this research is to understand the synergistic relationship between the synthesis, processing, microscopic structure and the mechanical and physical behavior of materials. This research includes topics in lattice defects; diffusion and transport; magnetic, superconducting, semiconducting and alloy ordering behaviors; radiation damage; corrosion; deformation and fracture; and microstructural and microchemical characterizations by means of electron beams, neutron beams, and x-rays. Capital equipment is required for items such as high-temperature components for electron microscopes, atomic probes, crystals, x-ray detectors, spectrometers, tomographic instruments, and computer controls.	$67,980	$67,165	$68,829
-Basic research on the physical properties of materials, largely in the area of condensed matter physics, is conducted to determine the positions and movements of atoms in solids and liquids and the effects of these on the electronic states. This activity encompasses experiments in neutron and x-ray scattering; experiments to determine properties of solids, such as electrical and thermal conductivity, superconductivity, magnetism, and experiments on the effects of light and other radiation on materials. There are also theoretical investigations and computer simulations to gain understanding of the experiments and to model the behavior of materials. Capital equipment is required for items such as high field magnets, dilution refrigerators, neutron and x-ray spectrometers, detectors, energy filters, and magneto-optical instrumentations.	71,075	65,311	66,930

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
-Research on the chemical properties of materials is conducted to understand the effects of chemical reactivity on the behavior of materials and to synthesize new chemical compounds and structures from which better materials can be made. This activity includes research in solid state chemistry, surface chemistry, polymer chemistry, crystallography, synthetic chemistry, and colloid chemistry. Capital equipment is required for items such as spectrometers, reflectometers, computer workstations for simulations and modeling, and instrumentation to study surfaces at the atomic scale.	23,963	22,592	22,663
-The Experimental Program to Stimulate Competitive Research (EPSCoR) provides financial assistance to states that historically have received relatively less Federal research funding. BES EPSCoR funding is consolidated in the Materials Sciences subprogram in FY 1998. FY 1996 and FY 1997 EPSCoR funding is also included in all other Basic Energy Sciences subprograms. The EPSCoR program was included in the BES program at the direction of Congress in FY 1996.	2,654	3,330	7,000

BASIC ENERGY SCIENCES
MATERIALS SCIENCES

EPSCoR DISTRIBUTION OF FUNDS BY STATE
(Dollars in thousands)

	FY 1996 Actual	FY 1997 Estimate	FY 1998 Estimate
Alabama	$900	$725	$725
Kentucky	$925	$725	$725
Louisiana	$900	$725	$725
Maine	$925	$725	$725
Montana	$950	$725	$725
Nevada	$950	$725	$725
Puerto Rico	$925	$725	$725
South Carolina	----	$725	$725
Wyoming	----	$725	$725
Other*	$525	$475	$475
Totals	$7,000**	$7,000**	$7,000

* Technical support of Experimental Program to Stimulate Competitive Research (EPSCoR).

** FY 1996 and FY 1997 EPSCoR funding is also included in all other Basic Energy Sciences subprograms.

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
-Los Alamos Neutron Science Center (LANSCE) instrumentation enhancement. This project is a major item of equipment with a Total Estimated Cost of $20,500,000 that will provide enhanced instrumentation at the LANSCE and will be implemented concurrently with an accelerator upgrade funded by the Office of Defense Programs.	0	0	4,500
-Conceptual design of the National Spallation Neutron Source (NSNS) will be completed in FY 1997. FY 1998 funding of $23,000,000 is requested for pre-title I activities for the NSNS.	7,635	7,668	23,000
SUBTOTAL Materials Sciences Research	173,307	166,066	192,922
Facilities Operations			
-Operation of national user facilities. The facilities included in Materials Sciences are: National Synchrotron Light Source, High Flux Beam Reactor, Intense Pulsed Neutron Source, Stanford Synchrotron Radiation Laboratory, Manuel Lujan, Jr. Neutron Scattering Center, Advanced Light Source and Advanced Photon Source. The facility operations budget request, which includes operating funds, capital equipment, and AIP funding under $2,000,000, is described in a consolidated manner later in this budget. AIP funding will support additions and modifications to accelerator and reactor facilities which are supported in the Materials Sciences subprogram. Capital equipment is needed at the facilities for items such as beam monitors, interlock systems, vacuum systems, beamline front end components, monochromators, and power supplies. A summary table of the facilities included in the Materials Sciences subprogram is provided below.	190,729	182,281	190,665
SUBTOTAL Facilities Operations	$190,729	$182,281	$190,665

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
Facilities			
National Synchrotron Light Source	$22,880	$20,875	$22,487
High Flux Beam Reactor	26,339	23,955	25,383
Intense Pulsed Neutron Source	11,558	10,667	11,620
Stanford Synchrotron Radiation Laboratory	3,714	3,625	3,772
Manuel Lujan, Jr. Neutron Scattering Center	7,516	7,343	7,740
Advanced Light Source	31,888	32,868	34,971
Advanced Photon Source	83,061	81,441	84,692
Partial Offset to ESRD General Reduction Applied to BES	3,773	1,507	0
Total	$190,729	$182,281	$190,665
SBIR/STTR Funding	0	8,800	8,888
Congressional Direction	0	7,424	0
TOTAL Materials Sciences	$364,036	$364,571	$392,475

In FY 1996 $6,389,000 and $483,000 were transferred to the SBIR and STTR programs, respectively. The FY 1997 estimate is for both SBIR and STTR. The FY 1998 estimate is for SBIR only since Part D, Section 110 of P.L. 104-208, Making Omnibus Consolidated Appropriations for FY 1997 reauthorized STTR for FY 1997 only.

Funds Rose Hulman Institute of Technology; Alabama Mineral Research Center, Tuscaloosa; and University of Alabama, Birmingham in FY 1997 (per Congressional direction). No additional funds were provided for these projects by the Congress in FY 1997.

BASIC ENERGY SCIENCES
MATERIALS SCIENCES

EXPLANATION OF FUNDING CHANGES FROM FY 1997 TO FY 1998:

Increase provides capital equipment funding for the design and fabrication of instrumentation for the Short Pulse Spallation Source enhancement at LANSCE.	$+4,500,000
Restore funding in the areas of high temperature superconductivity, radiation effects, and high temperature structural ceramics.	$+3,354,000
Funding for the pre-title I design of the National Spallation Neutron Source (NSNS) is increased.	$+15,332,000
Funding for EPSCoR has been consolidated into the Materials Sciences subprogram.	$+3,670,000
Increase SBIR funding due to increase in operating expenses. No STTR funding requested in FY 1998.	$+ 88,000
Restores facility operations to the FY 1996 level. The level of funding decreased in FY 1997 as a result of Congressional direction without the additional funds.	$+8,384,000
Funding not needed in FY 1998 for FY 1997 projects included by Congress without funds.	$-7,424,000
Total Funding Change, Material Sciences	$+27,904,000

MAJOR ISSUES:

Neutron science is a critical tool in materials sciences and related disciplines that are crucial to the U.S. knowledge base for advanced technologies, particularly those related to energy technologies. The U.S. currently lags far behind both Europe and Japan in neutron science. Planned new neutron sources in Europe and Japan could increase their lead even further in materials science and related research using neutrons.

To maintain a strong U.S. position in the field of neutron science following the termination of the Advanced Neutron Source (ANS) project, the Department will support neutron source enhancements such as the Los Alamos Neutron Science Center (LANSCE) instrumentation enhancement in this request. In addition, funding for Pre-title I design efforts for the National Spallation Neutron Source is requested in FY 1998. A request for NSNS Title-I funding is anticipated in FY 1999.

BASIC ENERGY SCIENCES

CHEMICAL SCIENCES

I. **Mission Supporting Goals and Objectives**: The Chemical Sciences Subprogram has two major components. The disciplinary areas within each component are connected to and address needs of the principal DOE mission goals and objectives. One major component is comprised of atomic, molecular and optical physics; chemical physics; photochemistry; and radiation chemistry. This research provides a foundation for understanding fundamental interactions of atoms, molecules, and ions with photons and electrons. This work also underpins our fundamental understanding of chemical reactivity. This, in turn, enables the production of more efficient combustion systems with reduced emissions of pollutants. It also increases knowledge of solar photoconversion processes resulting in new, improved systems and production methods. Completely unanticipated benefits from this research often result. For example, research supported by the Chemical Science subprogram on small atomic clusters led to the discovery of the new forms of carbon named the fullerenes, typified by C_{60} (buckminsterfullerene). The 1996 Nobel Prize in chemistry was awarded to the scientists who made this discovery. The other major component of the research program is comprised of inorganic chemistry, organic chemistry, analytical chemistry, separations science, heavy element chemistry, and aspects of chemical engineering sciences. The research supported provides a better molecular level understanding of homogeneous and heterogeneous reactions occurring at surfaces, interfaces, and in bulk media. This has resulted in improvements to known heterogeneous and homogeneous catalytic systems and to new catalysts for the production of fuels and chemicals; better analytical methods with a wide variety of applications in energy processes and environmental sciences; new knowledge of actinide elements and separations important for environmental remediation and waste management; and better methods for describing turbulent combustion and predicting thermophysical properties of multicomponent systems.

II. **Funding Schedule:**

Activity	FY 1996	FY 1997	FY 1998	$ Change	% Change
Chemical Sciences Research	$130,888	$128,339	$130,308	$ +1,969	+1.5%
Facilities Operations	69,157	63,711	65,363	+1,652	+2.6%
SBIR/STTR	0	4,555	4,262	-293	-6.4%
Congressional Direction	0	5,494	0	-5,494	-100.0%
Total, Chemical Sciences	$200,045	$202,099	$199,933	$-2,166	-1.1%

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
Chemical Sciences Research			
-The program supports experimental and theoretical research devoted to study of atoms, molecules, ions and light and their interactions--areas that may have broad fundamental impact on much of chemistry. Molecular processes related to combustion of fossil fuels and catalysis as well as the conversion of solar energy to other useful energy forms are also studied. Recent accomplishments include new insights on electron transfer processes in artificial photosynthetic systems; improved theoretical understanding of simple combustion reactions; the development of several new techniques for thermochemical determinations, a new method to follow the dynamics of simple collision processes, and a new form of atomic spectroscopy. Capital equipment is required for such items as mass spectrometers, electronic waveform digitizers, oscilloscopes, detection equipment, optical spectrometers, and vacuum equipment. AIP funding is also required for additions and modifications to accelerator and reactor facilities supported by the Chemical Sciences subprogram. The total estimated cost of each AIP project will not exceed $2,000,000. The Chemical Sciences subprogram also provides General Purpose Equipment (GPE) and General Plant Projects (GPP) funds, for minor new construction, for other capital alterations and additions, and for improvements to land, buildings, and utility systems at the Ames Laboratory, Argonne National Laboratory, and Oak Ridge National Laboratory as part of Basic Energy Sciences' landlord responsibilities for these laboratories. Funding of this type is essential for maintaining the productivity and usefulness of	$69,684	$65,670	$68,931

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
Department-owned facilities and in meeting its requirement for safe and reliable facilities operation. The toal estimated cost of each GPP project will not exceed $2,000,000.			
-The program supports a broad, well-integrated continuum of effort that uses atomic and molecular level information to understand homogeneous and heterogeneous catalysis as well as separations and analysis methodologies including studies of the actinide elements. Certain engineering areas are also supported such as turbulence related to combustion and thermodynamics. Recent accomplishments include finding a safe non-incinerative technique for removal of fluorocarbons, a new catalytic route for converting small alkane molecules into high-value liquid fuels, and improved understanding of the structure and properties of supercritical water. Capital equipment is required for such items as high resolution area detectors, catalytic reactors, analytical instrumentation, lasers, and optical spectrometers.	59,354	60,359	61,377
-The Experimental Program to Stimulate Competitive Research (EPSCoR) is being consolidated in the Materials Sciences subprogram in FY 1998.	1,850	2,310	0
Total Chemical Sciences Research	$130,888	$128,339	$130,308

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
Facilities Operations			
-Operation of national user facilities. The facilities included in Chemical Sciences are: National Synchrotron Light Source, High Flux Isotope Reactor, Radiochemical Engineering Development Center, Stanford Synchrotron Radiation Laboratory, and Combustion Research Facility. The facility operations budget request, which includes operating funds, capital equipment, general plant projects, and AIP funding under $2,000,000, is described in a consolidated manner later in this budget. AIP funding will support additions and modifications to accelerator and reactor facilities which are supported in the Chemical Sciences subprogram. General Plant Project (GPP) funding is also required for minor new construction, for other capital alterations and additions, and for improvements to land, buildings, and utility systems. The total estimated cost of each GPP project will not exceed $2,000,000. Capital equipment is needed for the facilities for items such as beam monitors, interlock systems, vacuum systems, beamline front end components, monochromators, and power supplies. A summary table of the facilities included in this Chemical Sciences subprogram is provided below.	69,157	63,711	65,363
Total Facilities Operations	$69,157	$63,711	$65,363

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
Facilities			
National Synchrotron Light Source	7,853	7,429	8,113
High Flux Isotope Reactor	28,204	27,218	27,761
Radiochemical Engineering Development Center	7,078	6,705	7,127
Stanford Synchrotron Radiation Laboratory	18,169	16,902	17,228
Combustion Research Facility	5,411	4,921	5,134
Advanced Photon Source (GPP only)*	1,100	0	0
Partial Offset to ESRD General Reduction Applied to BES	1,342	536	0
Total	69,157	63,711	65,363

*Funding for General Plant Projects only; APS operations funded in Material Sciences as displayed previously.

SBIR/STTR Funding	0	4,555	4,262

In FY 1996 $3,421,000 and $258,000 were transferred to the SBIR and STTR programs, respectively. The FY 1997 estimate is for both SBIR and STTR. The FY 1998 estimate is for SBIR only, since Part D, Section 110 of P.L. 104-208, Making Omnibus Consolidated Appropriations for FY 1997 reauthorized STTR for FY 1997 only.

Total SBIR/STTR Funding	$0	$4,555	$4,262

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
Congressional Direction	0	5,494	0
Funds Rose-Hulman Institute of Technology; Alabama Mineral Research Center, Tuscaloosa; and University of Alabama, Birmingham in FY 1997 (per Congressional direction). No additional funds were provided for these projects by the Congress in FY 1997.			
Total Congressional Direction	$0	$5,494	$0
Total Chemical Sciences	$200.045	$202.099	$199.933

EXPLANATION OF FUNDING CHANGES FROM FY 1997 to FY 1998:

Funding for EPSCoR has been consolidated into the Materials Sciences subprogram.	$ -2,310,000
Restore funding for research in organic chemistry related to coal conversion.	$+4,279,000
SBIR/STTR funding reduced because no STTR funding is requested in FY 1998.	$ -293,000
Restores facility operations to the FY 1996 level. The level of funding decreased in FY 1997 as a result of Congressional Direction without the additional funds.	$+1,652,000
Funding not needed in FY 1998 for FY 1997 projects included by Congress without funds.	$-5,494,000
Total Funding Change, Chemical Sciences	$-2,166,000

BASIC ENERGY SCIENCES

ENGINEERING AND GEOSCIENCES

I. **Mission Supporting Goals and Objectives**: The Engineering and Geosciences Subprogram conducts research in two disciplinary areas, Engineering and Geosciences. In Engineering Research, the goals are to extend the body of knowledge underlying current engineering practice to create new options for improving energy efficiency and to broaden the technical and conceptual knowledge base for solving the engineering problems of energy technologies. In Geosciences Research, the goal is on fundamental knowledge of the processes that transport, concentrate, emplace, and modify the energy and mineral resources and the byproducts of energy production. The research supports existing energy technologies and strengthens the foundation for the development of future energy technologies. Ultimately the research impacts control of industrial processes to improve efficiency and reduce pollution, to increase energy supplies, and to lower cost and increase the effectiveness environmental remediation of polluted sites.

II. **Funding Schedule**

Activity	FY 1996	FY 1997	FY 1998	$ Change	% Change
Engineering Research	$ 18,001	$17,040	$16,889	$ -151	-0.9%
Geosciences Research	21,591	22,013	23,489	+1,476	+6.7%
SBIR/STTR	0	1,093	993	-100	-9.1%
Congressional Direction	0	2,774	0	-2,774	-100.0%
Total, Engineering and Geosciences	$39,592	$42,920	$41,371	$-1,549	-3.6%

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
Engineering Research -The Engineering Research program supports basic research in selected areas to provide the fundamental scientific base necessary for current engineering practice and to broaden the technical and conceptual base for solving future engineering problems in the energy technologies. Recent accomplishments include advancing basic knowledge of fluid flow for understanding flow in natural and manmade structures (i.e., pipelines), progress in understanding how fracture and fatigue arise in stressed energy structures for early detection and prevention of structure failure, chemical process control to improve production efficiency, instrumentation for environmental sensors, improved understanding of chaotic systems bearing on industrial scale mixing methods, principles underlying environmentally benign manufacturing methods, and continuing support for graduate training fellowships in environmentally sustainable manufacturing. Capital equipment is required for items such as instrumentation and diagnostics for experiments on: the control of plasma processing of materials and fracture and fatigue in stressed structures.	$17,711	$16,680	$16,889
-The Experimental Program to Stimulate Competitive Research (EPSCoR) is being consolidated in the Materials Sciences subprogram in FY 1998.	290	360	0
SUBTOTAL Engineering Research	$18,001	$17,040	$16,889

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
Geosciences Research			
-The Geosciences Research program supports basic research to improve the level of understanding necessary for advances in, and choices among, current and emerging energy and environmental technologies. Recent accomplishments include increasing the level of fundamental understanding of mineral-fluid interactions to provide a better foundation for oil, gas, and geothermal resource recovery and control of contaminants in groundwater flow; advances in geophysical imaging and interpretation to provide new windows on subsurface structure and properties in the context of energy and environmental technologies; new fundamental thermodynamic and physical property information on rocks, minerals, and geologic fluids for research recovery and contaminant control; and extending the applicability of isotopic tracer methods for evaluation of natural and human-perturbed processes in the geologic environment. Capital equipment is required for laboratory and in-situ studies of geologic systems, including facilities for microanalysis (e.g., synchrotron based methods) and facilities for characterizing the thermo-mechanical and transport behavior of rocks.	$21,251	$21,593	$23,489
-The Experimental Program to Stimulate Competitive Research (EPSCoR) is being consolidated in the Materials Sciences subprogram in FY 1998.	340	420	0
SUBTOTAL Geosciences Research	$21,591	$22,013	$23,489

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
SBIR/STTR Funding	$ 0	$ 1,093	$ 993
In FY 1996 $749,000 and $57,000 were transferred to the SBIR and STTR programs, respectively. The FY 1997 estimate is for both SBIR and STTR. The FY 1998 estimate is for SBIR only, since Part D, Section 110 of P.L. 104-208, Making Omnibus Consolidated Appropriations for FY 1997 reauthorized STTR for FY 1997 only.			
Congressional Direction Funds Rose-Hulman Institute of Technology; Alabama Mineral Research Center, Tuscaloosa; and University of Alabama, Birmingham in FY 1997 (per Congressional direction). No additional funds were provided for these projects by the Congress in FY 1997.	$ 0	$ 2,774	$ 0
TOTAL Engineering and Geosciences	$39,592	$42,920	$41,371

EXPLANATION OF FUNDING CHANGES FROM FY 1997 to FY 1998:

There will be a restoration in the level of effort in fluid mechanics research, chemical process control, combustion and data collection.	$+209,000
There will be restoration in support in projects related to fundamental properties of geologic materials and geophysical imaging and interpretation.	$+1,896,000
SBIR/STTR: Reduce SBIR funding due to decrease in operating expenses. No STTR funding requested in FY 1998.	$-100,000

EXPLANATION OF FUNDING CHANGES FROM FY 1997 to FY 1998: (cont'd)

EPSCoR: Funding for EPSCoR has been consolidated into the Materials Sciences subprogram.	$-780,000
Congressional Direction: Funding not needed in FY 1998 for FY 1997 projects included by Congress without funds.	$-2,774,000
Total Funding Change, Engineering and Geosciences	$-1,549,000

BASIC ENERGY SCIENCES
ADVANCED ENERGY PROJECTS

I. **Mission Supporting Goals and Objectives**: This subprogram was transferred to the Computational and Technology Research Program in FY 1997. This activity funds research to establish the feasibility of novel, energy-related concepts that span the Department's energy mission and goals. These concepts are usually derived from recent advances in basic research, but require additional research to establish their feasibility. A common theme for each concept is the initial linkage of new, or previously neglected, research results to a practical energy payoff for the Nation. Efforts are typically supported at a level of $300,000 per year for a period of 3 years. Although the funding profile can vary widely among projects in the Advanced Energy Projects (AEP) research portfolio, the 3-year budget period is considered a maximum. A measure of success is demonstrated if the project attains further funding from another source to realize its full potential. Projects are selected from proposals submitted by universities, industrial organizations, non-profit research institutions, and national laboratories. Equal consideration is given to each submission. Funding criteria include scientific merit as judged by peer review.

II. **Funding Schedule**:

Activity	FY 1996	FY 1997	FY 1998	$ Change	% Change
Advanced Energy Projects	$ 11,700	$ 0	$ 0	$ 0	--
Total, Advanced Energy Projects	$ 11,700	$ 0	$ 0	$ 0	--

III. **Performance Summary- Accomplishments:**

	FY 1996	FY 1997	FY 1998
-Projects supported involved novel, interdisciplinary research ideas that fell outside ongoing discipline-oriented DOE subprograms, and addressed potentially significant energy or environmental benefits. Projects supported in FY 1996 included: the application of novel materials to a high efficiency, CFC-Free refrigeration technique, and exploration of the feasibility of electrically controlled thin films for windows with adjustable tint. Approximately 40 projects are supported.	11,512	0	0

BASIC ENERGY SCIENCES
ADVANCED ENERGY PROJECTS

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
-The Experimental Program to Stimulate Competitive Research (EPSCoR) is being consolidated in the Materials Sciences subprogram in FY 1998.	$188	$0	$0
SBIR/STTR Funding	0	0	0
In FY 1996 $221,000 and $17,000 were transferred to the SBIR and STTR programs, respectively.			
TOTAL Advanced Energy Projects	$11,700	$ 0	$ 0

EXPLANATION OF FUNDING CHANGES FROM FY 1997 to FY 1998:

This subprogram is funded in the Computational and Technology Research program beginning in FY 1997.

BASIC ENERGY SCIENCES

ENERGY BIOSCIENCES

I. **Mission Supporting Goals and Objectives:** The Energy Biosciences subprogram supports research to provide a basic understanding of the biological phenomena associated with the capture, transformation, storage and utilization of energy. The research on plants and non-medical microorganisms focuses on a range of biological processes including photosynthesis, bioenergetics, primary and secondary metabolism, the synthesis and degradation of biopolymers such as lignin and cellulose, anaerobic fermentations, genetic regulation of growth and development, thermophily, e.g., bacterial growth under high temperature, and other phenomena with the potential to impact biological energy production and conversion. The research supported is fundamental and is selected to broadly support Department of Energy's goals and objectives in energy production, environmental management, and energy conservation.

II. **Funding Schedule:**

Activity	FY 1996	FY 1997	FY 1998	$ Change	% Change
Energy Biosciences	$28,730	$26,980	$26,784	$ -196	-0.7%
SBIR/STTR	0	747	677	-70	-9.4%
Congressional Direction	0	858	0	-858	-100.0%
Total	$28,730	$28,585	$27,461	$-1,124	-3.9%

III. **Performance Summary- Accomplishments:**

	FY 1996	FY 1997	FY 1998
-The Energy Biosciences Program supports a broad research portfolio of molecular and mechanistic research in the microbial and plant sciences. Accomplishments include the recent initiation of the multi-agency, multinational sequencing of critical sections of the genetic material from the model plant, *Arabidopsis thaliana*. Efforts to increase the understanding of the molecular interactions between microbial systems and geologic components critical in environmental restoration and the biological modification of inorganic materials are continuing. Research efforts to determine the mechanisms of plant tissue development are being enhanced to	28,266	26,400	26,784

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
more fully understand the formation of the tissues involved in energy storage. Research efforts on the biochemistry and physiology of microbes with the potential for energy use are continuing with special emphasis on the field of microbial physiology, a subdiscipline that is critical to scaling up and deploying new biotechnologies in an industrial setting (e.g., fermentation, pharmaceutical and chemical industries). Capital equipment is required for items such as confocal microscopes, radio-high pressure liquid chromatography detectors, photon counting and imaging systems, pulsed field gel electrophoresis, and microplate readers needed in advanced molecular genetics research.			
-The Experimental Program to Stimulate Competitive Research (EPSCoR) is being consolidated in the Materials Sciences subprogram in FY 1998.	464	580	0
SBIR/STTR Funding	0	747	677

In FY 1996 $551,000 and $41,000 were transferred to the SBIR and STTR programs respectively. The FY 1997 estimate is for both SBIR only. The FY 1998 estimate is for SBIR only, since Part D, Section 110 of P.L. 104-208, Making Omnibus Consolidated Appropriations for FY 1997 reauthorized STTR for FY 1997 only.

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
Congressional Direction	$0	$858	$0
Funds Rose-Hulman Institute of Technology; Alabama Mineral Research Center, Tuscaloosa; and University of Alabama, Birmingham in FY 1997 (per Congressional direction). No additional funds were provided for these projects by the Congress in FY 1997.			
TOTAL Energy Biosciences	$28,730	$28,585	$27,461

EXPLANATION OF FUNDING CHANGES FROM FY 1997 to FY 1998:

There will be a restoration in funding of studies of the molecular mechanisms of plant and plant pathogen interactions as well as in the description of the molecular genetic regulatory strategies developed by plants.	$+384,000
Funding for EPSCoR has been consolidated into the Materials Sciences subprogram.	$-580,000
Reduce SBIR funding due to decrease in operating expenses. No STTR funding requested in FY 1998.	$-70,000
Funding not needed in FY 1998 for FY 1997 projects included by Congress without funds.	$-858,000
Total Funding Change, Energy Biosciences	$-1,124,000

BASIC ENERGY SCIENCES

APPLIED MATHEMATICAL SCIENCES (AMS)

I. **Mission Supporting Goals and Objectives**: The Applied Mathematical Sciences (AMS) subprogram is a forefront, diverse applied mathematical sciences, high performance computing, communications and information infrastructure program that spans the spectrum of activities from strategic fundamental research to technology development and demonstration. The diverse activities supported by this program are integrated to support two major strategic thrusts: National Collaboratories (NC) and Advanced Computational Testing and Simulation (ACTS). The thrust in National Collaboratories is developing a set of tools and capabilities that will permit scientists and engineers working at different DOE and other facilities to collaborate on solving problems as easily as if they were in the same location. The thrust in Advanced Computational Testing and Simulation is developing an integrated set of algorithms, software tools and infrastructure that will enable computer simulation to better complement experiment and theory or to be used in place of experiments when real experiments are too dangerous, expensive, or inaccessible. These two strategic thrusts support the underlying mathematical concepts and information technology needs of all DOE mission areas (e.g., Fundamental Research, Defense, Energy Efficiency, Environmental and Fossil programs, etc.). The efforts in these areas are closely coordinated with related activities supported by Defense Programs.

The AMS subprogram also supports and responds to the Energy Policy Act (EPACT) and to the High Performance Computing Act of 1991 and provides supercomputer access and advanced communication capabilities, through the National Energy Research Scientific Computing (NERSC) and the Energy Sciences Network (ESnet), to scientific researchers. Finally, the AMS subprogram also serves as an advocate within the Department to formulate and coordinate the Department's National Information Infrastructure (NII) initiative, especially to promote economically beneficial energy-related "National Challenges" applications such as energy demand and supply management and to develop the underlying technologies to enable these applications. This subprogram is transferred to the Computational and Technology Research program in FY 1997.

II. **Funding Schedule:**

Activity	FY 1996	FY 1997	FY 1998	$ Change	% Change
Mathematical, Computational, and Computer Sciences Research...	$ 49,431	$ 0	$ 0	$ 0	----
Advanced Computation, Communications, and Associated Activities.	61,637	0	0	0	----
Total	$ 111,068	$ 0	$ 0	$ 0	----

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
-Research supporting advanced computational testing and simulation including applied mathematics research, computer science and software tools research, grand challenge applications, and computational science education programs. Capital equipment supporting research in advanced computational testing and simulation including computers, storage devices, and other peripheral equipment.	$48,217	$ 0	$ 0
The Experimental Program to stimulate Competitive Research (EPSCoR) is being consolidated in the Materials Sciences subprogram.	1,214	0	0
SUBTOTAL Mathematical, Computational, and Computer Sciences Research	$49,431	$ 0	$ 0
Advanced Computation, Communications, and Associated Activities			
- Research in support of National Collaborators: high capability, networks information surety, underlying technologies to support national collaborators, and underlying technologies to support electricity supply and demand management.	$ 8,377	$ 0	$ 0

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
-Operations of the National Energy Research Scientific Computing (NERSC) Center, which provides high performance computing for investigators supported by the Office of Energy Research. The Center serves more than 4,000 users working on about 700 projects, of which about 35% are university based, 60% are in National Laboratories, and 5% in industry. NERSC operates a spectrum of supercomputers that provides a range of high performance computing resources that are a critical element in the success of many ER research programs. These computational resources are integrated together by a common high performance file storage system which facilitates interdisciplinary collaborations. Related capital equipment needs are also supported.	26,909	0	0
-Support for ESnet operations which provide worldwide access to Energy Research facilities, including: advanced light sources, neutron sources, particle accelerators, fusion reactors, spectrometers, high performance computing resource providers (HPCRP), and other leading-edge science instruments and facilities. Future upgrades will allow for remote experimentation and "virtual laboratory" access to these facilities, as complementary National Collaboratory technologies are developed. Related capital equipment needs are also supported.	13,965	0	0

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
-High Performance Computing Resource Providers which provide the needed leading edge computational hardware testbeds to support grand challenge and advanced computational testing and simulation research.	12,386	0	0
SUBTOTAL Advanced Computation, Communications, & Associated Activities	$61,637	$ 0	$ 0
SBIR/STTR Funding	0	0	0
In FY 1996 $1,897,000 and $143,000 were transferred to the SBIR STTR programs, respectively.			
TOTAL Applied Mathematical Sciences	$111,068	$ 0	$ 0

EXPLANATION OF FUNDING CHANGES FROM FY 1997 TO FY 1998:

This subprogram is funded in the Computational and Technology Research program beginning in FY 1997.

BASIC ENERGY SCIENCES

PROGRAM DIRECTION

I. **Mission Supporting Goals/Ongoing Objectives:** This subprogram was transferred to the new Energy Research Energy Supply Research and Development Program Direction decision unit in FY 1997 at the direction of Congress. Program Direction provides the Federal staffing resources and associated funding required to develop, direct, and administer a complex and broadly diversified program of mission-oriented research, including the construction and operation of scientific user facilities, for the scientific and engineering community. The Nation's future energy, defense, and technology options depend on long-range research supported by this program. This staff administers a basic research program which helps us attain our national goals, i.e., better health and quality of life, economic competitiveness, energy self-sufficiency, and national security. The staff annually monitors and evaluates approximately 1,400 individual research projects at over 200 separate institutions.

Staff include scientific and technical personnel and program management support in the areas of budget and finance, personnel administration, grants and contracts, information resource management, policy review and coordination, and construction management.

II. **Funding Schedule:**

Activity	FY 1996 Current Appropriation	FY 1997 Original Appropriation	FY 1997 Adjustment	FY 1997 Current Appropriation	FY 1998 Budget Request
Salaries and Benefits	$ 7,893	$ 0	$ 0	$ 0	$ 0
Travel	300	0	0	0	0
Support Services	782	0	0	0	0
Other Related Expenses	201	0	0	0	0
Total	$ 9,176	$ 0	$ 0	$ 0	$ 0
Full-time Equivalents	85	0	0	0	0

III. Performance Summary	FY 1996	FY 1997	FY 1998
Salaries and Benefits: Funded staff managing and supporting the Basic Energy Sciences program with reduced staffing levels as a result of streamlining efforts.	$7,893	$0	$0
Travel: Provided on-site contractor and facility oversight and participated in major scientific conferences to maintain state-of-the-art scientific expertise.	$300	$0	$0
Support Services: Provided computer system development, environment, health, and safety, and administrative support for the Basic Energy Sciences program.	$782	$0	$0
Other Related Expenses: Provided hardware and software for information technology improvements and other miscellaneous costs of supporting the program.	$201	$0	$0
Total	$9,176	$0	$0

EXPLANATION OF FUNDING CHANGES FROM FY 1997 TO FY 1998

This program was transferred to the new Energy Supply Research and Development Program Direction account in FY 1997 at the direction of Congress.

Support Services	FY 1996 ($000)	FY 1997 ($000)	FY 1998 ($000)	FY 1998/ FY 1997 Change ($000)
Technical Support Service				
Feasibility of Design Considerations				
Economic and Environmental Analysis	270			
Test and Evaluation Studies				
Subtotal	270			
Management Support Services				
Management Studies				
Training and Education	30			
ADP Support	392			
Administrative Support Services	90			
Subtotal	512			
Total Support Services	782			
Use of Prior Year Balances				

Other Related Expenses	FY 1996 ($000)	FY 1997 ($000)	FY 1998 ($000)	FY 1998/ FY 1997 Change ($000)
Training				
Working Capital Fund				
Printing and Reproduction				
Rental Space				
Software Procurement/Maintenance Activities/Capital Acquisitions	150			
Other	50			
Total Obligational Authority	201			
Use of Prior-Year Balances				
Total Budget Authority	201			

BASIC ENERGY SCIENCES

CONSTRUCTION

I. **Mission Supporting Goals and Objectives**: Construction is needed to support the research in each of the subprograms in the Basic Energy Sciences program. Experiments necessary in support of basic research require that state-of-the-art facilities be built or existing facilities modified to meet unique research requirements. Reactors, radiation sources, and neutron sources are among the expensive, but necessary, facilities required. The budget for the BES program includes funding for the construction and modification of these facilities.

II. **Funding Schedule:**

Activity	FY 1996	FY 1997	FY 1998	$ Change	% Change
Construction	$ 9,986	$ 11,500	$ 11,000	$ -500	- 4.4%
Total	$ 9,986	$ 11,500	$ 11,000	$ -500	- 4.4%

III. **Performance Summary- Accomplishments:**

	FY 1996	FY 1997	FY 1998
-Completed the Advanced Photon Source consistent with the approved schedule.	$ 3,186	$ 0	$ 0
-Provide the full funding to complete the Combustion Research Facility, Phase II project.	2,000	9,000	11,000
-Funding for Accelerator and Reactor Improvements and Modifications in excess of $2,000,000 is provided for a liquid hydrogen cold source at the High Flux Isotope Reactor ($2,500,000) and an insertion device at the Advanced Light Source ($2,300,000) in FY 1996, and for construction of the Accelerator and Reactor Improvement (AIP) liquid hydrogen cold source project at the High Flux Isotope Reactor ($2,500,000) in FY 1997.	4,800	2,500	0
TOTAL Construction	$ 9,986	$11,500	$ 11,000

BASIC ENERGY SCIENCES
CONSTRUCTION

EXPLANATION OF FUNDING CHANGES FROM FY 1997 to FY 1998:

Increase to provide full funding for construction of CRF, Phase II.	$+2,000,000
Completion of AIP project at ORNL.	$-2,500,000
Total Funding Change, Construction	$ -500,000

BASIC ENERGY SCIENCES

MAJOR USER FACILITIES

I. **Mission Supporting Goals and Objectives**: The BES scientific user facilities provide experimental capabilities that are beyond the scope of those found in laboratories of individual investigators. Synchrotron radiation light sources, high-flux neutron sources, electron beam microcharacterization centers, and other specialized facilities enable scientists to carry out experiments that could not be done elsewhere. These seventeen facilities are part of the Department's system of scientific user facilities, the largest of its kind in the world.

The facilities are planned in collaboration with the scientific community and are constructed and operated by BES for support of forefront research in areas important to BES activities and also in areas that extend beyond the scope of BES activities such as structural biology, medical imaging, and micro machining. These facilities are used by researchers in materials sciences, chemical sciences, earth and geosciences, environmental sciences, structural biology, superconductor technology, and medical research and technology development. The facilities are open to all qualified scientists from academia, industry, and the federal laboratory system whose intention is to publish in the open literature.

II. **Funding Schedule:**

Funding for operation of these facilities is provided in the Materials Sciences and Chemical Sciences subprograms.

Facilities	FY 1996	FY 1997	FY 1998	$ Change	% Change
National Synchrotron Light Source	$30,733	$28,304	$30,600	$ +2,296	+8.1%
High Flux Beam Reactor	26,339	23,955	25,383	+1,428	+6.0%
Intense Pulsed Neutron Source	11,558	10,667	11,620	+953	+8.9%
High Flux Isotope Reactor	28,204	27,218	27,761	+543	+2.0%
Radiochemical Engineering Development Center	7,078	6,705	7,127	+422	+6.3%
Stanford Synchrotron Radiation Laboratory	21,883	20,527	21,000	+473	+2.3%
Manuel Lujan, Jr. Neutron Scattering Center	7,516	7,343	7,740	+397	+5.4%
Combustion Research Facility	5,411	4,921	5,134	+213	+4.3%
Advanced Light Source	31,888	32,868	34,971	+2,103	+6.4%
Advanced Photon Source	84,161	81,441	84,692	+3,251	+4.0%
Partial Offset to ESRD General Reduction Applied To BES	5,115	2,043	0	-2,043	-100.0%
Total	$259,886	$245,992	$256,028	$ +10,036	+4.1%

III. Performance Summary- Accomplishments:

	FY 1996	FY 1997	FY 1998
It will be noted that the requested funding for each facility in FY 1998 is, in general, at or below the level of the FY 1996 funding. Therefore, it can be expected that there will be some attenuation of operating time and user support due to the increase in the cost of living from FY 1996 to FY 1998. The level of funding decreased in FY 1997 for almost all the facilities as a result of Congressional Direction in the BES program without the addition of funds. These reductions are restored in FY 1998.			
-National Synchrotron Light Source at Brookhaven National Laboratory: This synchrotron provides 79 experimental stations for research using visible, ultraviolet light, and x-rays.	$30,733	$28,304	$30,600
-High Flux Beam Reactor at Brookhaven National Laboratory: This high-flux reactor operates at 30 megawatts to provide neutrons for 9 beam tubes and 16 instruments.	26,339	23,955	25,383
-Intense Pulsed Neutron Source at Argonne National Laboratory: This pulsed spallation neutron source operates at 6.7 kilowatts with 12 instruments.	11,558	10,667	11,620
-High Flux Isotope Reactor at Oak Ridge National Laboratory: This high-flux reactor operates at 85 megawatts primarily to provide isotopes and also has 4 beam tubes with 9 instruments for neutron scattering. There will be increased operating support to take advantage of the new cold source with 3 new experimental stations.	28,204	27,218	27,761
-Radiochemical Engineering Development Center at Oak Ridge National Laboratory: This facility is used to process the isotopes produced in the High Flux Isotope Reactor.	7,078	6,705	7,127

BASIC ENERGY SCIENCES
MAJOR USER FACILITIES

III. Performance Summary- Accomplishments:	FY 1996	FY 1997	FY 1998
-Stanford Synchrotron Radiation Laboratory at Stanford University: This synchrotron provides 22 experimental stations for x-ray scattering research with an additional 4 stations under construction.	21,883	20,527	21,000
-Manuel Lujan, Jr. Neutron Scattering Center at Los Alamos National Laboratory: This pulsed spallation neutron source operates at 60 kilowatts with 7 instruments for neutron scattering and is part of the Los Alamos Neutron Science Center, a facility supported jointly by the Office of Basic Energy Sciences and the Office of Defense programs. Beginning in FY 1998, an additional 7 neutron scattering instruments will be added to accommodate more users with new capabilities.	7,516	7,343	7,740
-Combustion Research Facility at Sandia National Laboratories/ California: This facility provides lasers for research in chemical dynamics and spectroscopy.	5,411	4,921	5,134
-Advanced Light Source at Lawrence Berkeley National Laboratory: This new, third-generation synchrotron light source provides high-brilliance visible and ultra-violet light and low energy x-rays to 22 experimental stations including 4 that are under construction.	31,888	32,868	34,971
-Advanced Photon Source: This new, third-generation synchrotron light source provides high-energy x-rays to at least 20 experimental stations with more under construction.	84,161	81,441	84,692
-Partial Offset to ESRD General Reduction Applied to BES	5,115	2,043	0
TOTAL Major User Facilities	$259,886	$245,992	$256,028

BASIC ENERGY SCIENCES
CAPITAL OPERATING EXPENSES AND CONSTRUCTION SUMMARY
(Dollars in thousands)

Capital Operating Expenses	FY 1996	FY 1997	FY 1998	$ Change	% Change
General Plant Projects (total)	$9,089	$9,275	$9,275	$0	--
AIP under $2 million (total)	7,220	9,840	9,840	0	--
Capital Equipment (total)	77,682	45,695	49,372	3,677	+8.0%

Construction Project Summary (both Operating and Construction Funded)

Project No.	Project Title	TEC	Previous Appropriated	FY 1996 Appropriated	FY 1997 Request	FY 1998 Congressional Request
96-E-305	Accelerator and Reactor Improvements & Modifications, Various Locations	$4,800	$0	$4,800	$0	$0
97-E-305	Accelerator and Reactor Improvements & Modifications, Various Locations	2,500	0	0	2,500	0
96-E-300	Combustion Research Facility, Phase II, SNL	26,800	4,800	2,000	9,000	11,000
89-R-402	6-7 GeV Synchrotron Radiation Source, ANL	467,178	463,992	3,186	0	0
Total Basic Energy Sciences		XXXXXXX	$468,792	$9,986	$11,500	$11,000

Detailed Breakouts	Total CDR Cost	Previous Appropriated	FY 1996 Appropriated	FY 1997 Request	FY 1998 Congressional Request
CDR's - Exceeding $3 million					
1. National Spallation Neutron Source	$15,303	$0	$7,635	$7,668	$0
Bridge Costs - Exceeding $3 million					
1. National Spallation Neutron Source		$0	$0	$0	$23,000

Major Items of Equipment (CE $2 million and above)	TEC	Previous Appropriated	FY 1996 Appropriated	FY 1997 Request	FY 1998 Congressional Request	Acceptance Date
1. Machine Room Aux. Services & Network, LBNL	$2,000	$0	$2,000	$0	$0	Apr-1996
2. Data Storage Systems at NERSC - LBNL	2,000	0	2,000	0	0	Mar-1996
3. Short Pulse Spallation Upgrade at LANSCE - LANL	20,500	0	0	0	4,500	Sept-2001

DEPARTMENT OF ENERGY
FY 1998 CONGRESSIONAL BUDGET REQUEST
(Changes from FY 1997 Congressional Budget Requested are denoted with a vertical line in left margin)

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

Basic Energy Sciences

1.	Title and Location of Project:	Combustion Research Facility, Phase II Sandia National Laboratories Livermore, California	2a. 2b.	Project No. 96-E-300 Construction Funded
3a.	Date A-E Work Initiated, (Title I Design Start Scheduled): 1st Qtr., FY 1988		5.	Previous Cost Estimate: Total Estimated Cost (TEC) -- None
3b.	A-E Work (Titles I & II) Duration : 12 months			Total Project Cost (TPC) -- None
4a.	Date Physical Construction Starts: 4th Qtr., FY 1988		6.	Current Cost Estimate: TEC -- $26,800
4b.	Date Construction Ends: 4th Qtr., FY 1999			TPC -- $30,020

7. Financial Schedule: (Federal Funds)

Fiscal Year	Appropriation	Obligations	Costs
Prior Years a/	$ 4,800	$ 4,800	$ 4,205
1995	0	0	4
1996	2,000	2,000	685
1997	9,000	9,000	6,740
1998	11,000	7,000	8,476
1999	0	4,000	6,690

a/ Prior year funds transferred from 87-R-405.

1.	Title and Location of Project:	Combustion Research Facility, Phase II Sandia National Laboratories Livermore, California	2a. 2b.	Project No. 96-E-300 Construction Funded

8. Project Description, Justification and Scope

Phase II of the Combustion Research Facility (CRF) will add approximately 32,300 gross square feet to the existing 51,100 square-foot multibuilding CRF facility (Project No. 78-13-B, TEC $9,400,000) at Sandia National Laboratories, Livermore (SNL/L). Phase II will add 21,200 square feet to the existing 16,400 square-foot laboratory building and 11,100 square feet to the existing 25,000 square-foot office building. The project will include such site modifications and improvements as yard paving, walkways, landscaping, fencing, signage, and east entrance road relocation.

The project has been delayed due to budget constraints from FY 1989 through FY 1995. The appropriations totaling $4,800,000 in FY 1987 and FY 1988 were used for site preparation and design and construction of the shell of the laboratory building addition. The appropriations in FY 1996-FY 1998 will complete the balance of the project.

The laboratory building addition will be an L-shaped extension to the south and east of the existing building. Construction of the addition will match the existing building in architectural style, materials, and finishes, color, and floor-to-floor heights. The laboratory building addition will provide sixteen new laboratory spaces and two facility laser laboratories. The new facility laser rooms will be connected to serve any Lab in the facility, via the Laser Duct and Periscope System.

Once-through conditioned ventilation will be provided from existing building fans for existing and new laboratory spaces to carry off fuel gases or vapors and products of combustion, with systems included to minimize the discharge of contaminants to the atmosphere. An electronic safety monitoring and control system will provide back-up to the ventilation system.

The existing system of ducts used for diagnostic laser beam transmission from the central laser rooms will be extended to all new laboratories. Other existing building systems such as power distribution, lighting, communications, security alarms, fire and evacuation alarms, automatic fire sprinkler, and piping and plumbing will also be extended to the addition.

The office building addition will provide space for thirty-four new offices, an open office secretarial and file area, computer terminal rooms, and conference rooms. The addition will be a two-story wing added to the north of the existing office building and will match it in architectural style, materials and finishes, color, and floor-to-floor height.

1.	Title and Location of Project:	Combustion Research Facility, Phase II Sandia National Laboratories Livermore, California	2a. 2b.	Project No. 96-E-300 Construction Funded

8. Project Description, Justification and Scope (Continued)

Design of the existing mechanical building allowed space for the expansion of some services. Included in this project will be an additional chiller, pumps, and heat exchangers. Additional fan equipment providing recirculated conditioned air for the laboratory building and its addition will be in the loft space above the laboratory buildings. An additional electrical substation and process-cooling water system will also be provided.

Existing site utilities such as domestic and fire protection water, sanitary sewer, natural gas, site lighting, and electrical power and special systems will be modified and extended to service the additional facilities.

A key feature of the Combustion Research Facility is the availability of specially designed lasers for optical diagnostics. The Facility lasers developed in Phase I will continue to be used, and will be supplemented by two new Facility lasers: a high-power pulsed, high-repetition rate tunable ultraviolet laser (UV) and a subpicosecond laser. The laser beam directing system will be extended so that the existing and new laboratories have the capability of receiving the beam from any of the Facility lasers.

Other equipment includes a gas-chromatograph-mass spectrometer, infrared, visible, and ultraviolet spectrometers, elemental analyzers, optical signal processing equipment, and fast laser image processing devices.

Existing equipment from current facilities at SNL/L will be relocated to eleven of the new labs, although some of these experiments will be modified and some equipment will be upgraded. Two labs will be furnished with new equipment within the project TEC, and three labs will be furnished with new equipment by future users of the facilities.

This project will add vitally needed capacity and important new capabilities to the Combustion Research Facility at SNL, Livermore. The principal objective of this construction is to provide combustion research resources that can adequately deal with the critical needs of the 1990s and beyond. To accomplish this goal requires the addition of a new laboratory wing that emphasizes centralized next-generation laser diagnostic facilities and specially designed laboratories not available in CRF Phase I.

1.	Title and Location of Project:	Combustion Research Facility, Phase II Sandia National Laboratories Livermore, California	2a. 2b.	Project No. 96-E-300 Construction Funded

8. Project Description, Justification and Scope (Continued)

The overall scope of this project is the doubling of space available for experiments. Equipment funds are required for a new central laser system and special purpose laboratory equipment. A modest enlargement of the office building is included to house the rapidly increasing population of visiting scientists. These enhancements will consolidate the combustion-related resources at a single site readily accessible to visiting scientists.

There is a continuing need for the CRF to advance combustion-related science and technology to a higher level. The improvements included in the Phase II project will address this need. For example, special lasers and equipment will be developed to provide the ability to measure quantitatively entire two- and three-dimensional images of a system's physical and chemical properties with better resolution, and far greater speed than is now possible. It is this type of advance in the science of combustion that will allow the pursuit of the increasingly more difficult and complex problems that face our country.

CRF Phase II will enable attacking many complex problems directly associated with combustion. An important example is the need for improved combustion processes that incorporate high efficiency together with minimum production of pollutants such as NO_x and air toxics. Rapid progress on these problems both in engines and in furnaces requires Phase II's next-generation diagnostic capabilities. Completion of Phase II will also enable using the tools and expertise developed in Phase I to address broader challenges facing the country. CRF basic research in laser diagnostics, for example, will underpin remote sensing applications that contribute to global-change research and to nonproliferation of weapons. Basic research in chemically reacting flows will continue to support improved U.S. competitiveness in semiconductor processing and will support the development of new industrial materials. Basic research in chemistry will address new processes, such as supercritical water oxidation, for destroying hazardous wastes with minimal environmental impact.

The implementation of Phase II will develop and make available a new class of lasers. Phase II will include a specially designed high repetition rate laser system. This laser will be optimized for laser photochemistry combustion research and for high speed planar imaging of transient combustion phenomena. A second laser system will be designed to study combustion phenomena occurring on extremely short time scales (subpicosecond time scales). The new laser systems will enable significant extension of our knowledge in a broad range of topics in fundamental combustion science.

1.	Title and Location of Project:	Combustion Research Facility, Phase II Sandia National Laboratories Livermore, California	2a. 2b.	Project No. 96-E-300 Construction Funded

8. Project Description, Justification and Scope (Continued)

The normal increase in both the quantity and sophistication of combustion research by Sandia staff, together with the heightened requirements of visiting scientists, have completely saturated the facilities provided under CRF Phase I. During the past ten years the number of scientists who visit the CRF long enough to participate in research has almost tripled. In fiscal year 1993 forty professional staff hosted eighty nine such visits. Many important experiments cannot be carried out in the existing facilities because of a lack of space. Access to the unique capabilities of the CRF (such as the Facility lasers and computer resources) is essential for studying trade-offs between combustion efficiency and the pollution that results from existing and alternative fuels. However, much of the combustion research and diagnostics development work at Sandia is currently being done in facilities that are widely scattered throughout Sandia/CA where the researchers do not have access to these unique capabilities. Additional laboratories will permit the consolidation of these experiments at the CRF, thus providing the necessary access to the unique capabilities at the Facility. It will also provide adequate space and ready access to visiting scientists.

The number of offices required to support visiting researchers and staff must also be increased as each year of operation brings a large number of requests from qualified researchers to do work here who stay longer.

This addition is crucial to continuation of the lead role the CRF now plays in developing, improving, and applying advanced research methods for combustion science. As a result of successful technology transfer from the CRF to visiting scientists, there has been a significant advance in the research methods practiced by the combustion community. Given the increasingly difficult challenges faced in the use of fuel resources, the CRF mission must continue to emphasize advancing the frontiers of combustion science.

Without Phase II the technology at the CRF will stagnate, and opportunities for important new scientific research will be missed. The major advances in lasers and computers will not be brought to bear on pressing problems, nor made available to combustion researchers and designers in this country. CRF Phase II is also crucial to the success of programs in combustion research and diagnostics development. Currently, progress is hampered by the fractionation of the research effort. A significant amount of the experimental activities are housed in other buildings without direct access to the Facility lasers and other resources. Some of the activities are in security areas where it is difficult or impossible for uncleared visiting researchers to work. Moreover, the major portion of the diagnostics research is housed in a converted warehouse. It is essential that this activity be moved to an area that provides cleaner air, better temperature control, improved safety, access to the facility lasers, and unrestricted availability to users.

1.	Title and Location of Project:	Combustion Research Facility, Phase II Sandia National Laboratories Livermore, California	2a. 2b.	Project No. 96-E-300 Construction Funded

Finally, without the Phase II addition to the Facility, the size of the visiting scientist (user) program will have to be curtailed, due to the saturation of laboratory and office space. As a result, the ability for the combustion community to move on to more complex, yet realistically important research topics, will be constrained.

9. Details of Cost Estimate	Unit Cost	Item Cost	Total Cost
a. Engineering, design, and inspection (ED&I)			$4,200
1. Engineering, design, and inspection at approximately 22 percent of construction		3,000	
2. Construction management costs		900	
3. Project management		300	
b. Construction costs			13,800
1. Improvements to land		1,000	
Paving, walkways, landscaping, fencing, signage, road relocation parking lot rearrangement			
2. Buildings		12,000	
(a) Office Building (11,100 SF $193/SF)	2,100		
(b) Laboratory Building (21,200 SF $432/SF)	9,200		
(c) Mechanical Building (Existing)	700		
3. Utilities		800	
Water, sanitary sewer, natural gas, site lighting, electrical power, signal systems			
c. Standard equipment			6,800
Lasers, spectrometers, analyzers, processing equipment			
Subtotal			24,800
d. Contingency at approximately 8 percent of above costs			2,000
Total line item cost			$26,800

1.	Title and Location of Project:	Combustion Research Facility, Phase II Sandia National Laboratories Livermore, California	2a. 2b.	Project No. 96-E-300 Construction Funded

9. Details of Cost Estimate: (Continued)

ED&I costs for Title I and II reflect negotiated contract fees. ED&I for Title III is based on a negotiated fee plus an allowance for an extended period of construction, and for escalation. Construction costs and equipment costs have been escalated to mid points of construction and equipment procurement and installation. Escalation rates are in agreement with the DOE Price Change Index dated August 1993 for DOE construction projects, published by the DOE Independent Cost Estimating Staff.

Contingency is judged to be adequate for the remainder of the project. Construction of the laboratory shell was completed in FY 1990. Design was completed for the balance of the construction work in FY 1989. As a result of zero appropriations in FY 1989 through FY 1995 and the consequential schedule extension, some remaining ED&I and Project Management funds will be expended on obsolete Title II design elements prior to going to bid for remaining construction.

10. Method of Performance

Engineering, design, and inspection will be performed under negotiated architect and engineer contracts. Construction, procurement of equipment, and occupancy will be accomplished by fixed price contracts awarded on the basis of competitive bidding.

1. Title and Location of Project:	Combustion Research Facility, Phase II Sandia National Laboratories Livermore, California	2a. Project No. 96-E-300 2b. Construction Funded

11. Schedule of Project Funding and Other Related Funding Requirements

	Prior Years	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	Total
a. Total project funding							
1. Total facility costs							
(a) Line item	$4,205	$ 4	$ 685	$ 6,740	$ 8,476	$6,690	$26,800
Total direct cost	4,205	4	685	6,740	8,476	6,690	26,800
2. Other project costs							
(a) Other project costs	220	0	0	500	750	750	2,220
(b) Capital equipment	0	0	0	500	250	250	1,000
Total other project costs	220	0	0	1,000	1,000	1,000	3,220
Total project cost (TPC)	$4,425	$ 4	$ 685	$7,740	$ 9,476	$7,690	$30,020

b. Related annual costs a/ (estimated life of building: 50 years)

1. Facility operating costs	$ 300
2. Programmatic operating expenses directly related the facility	2,400
3. Capital equipment not related to construction but related to the programmatic effort in the facility	400
4. GPP or other construction related to programmatic effort in the facility	200
5. Other costs	0
Total related annual costs	$ 3,300[a/]

a/ Estimated costs in thousands escalated to 1999-year dollars. The related annual funding displayed is related to CRF, Phase II project only. These amounts are in addition to annual funding for the existing CRF operations ($4,739,000 in the FY 1997 OMB Budget Request).

1. Title and Location of Project:	Combustion Research Facility, Phase II Sandia National Laboratories Livermore, California	2a. Project No. 96-E-300 2b. Construction Funded

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

a. Total project costs:
   1. Total facility costs
      (a) Construction Line Item as described in previous items.
   2. Other project costs
      (a) Other project costs
      $220,000 of operating funds have been paid to architect engineering firms for preparation of conceptual designs/conceptual design reports and supplemental information for this project. $500,000 in FY 1997, $750,000 in FY 1998, and $750,000 in FY 1999, are operating costs associated with the new facility.
      (b) $500,000 in FY 1997, $250,000 in FY 1998, and $250,000 in FY 1999 is for capital equipment associated with the new facility.

b. Related annual costs:
   1. Facility operating costs
      This cost represents the annual operating expenses for utilities, maintenance, and janitorial service incurred due to the increase of 32,300 gross square feet in laboratory and office space.
   2. Programmatic operating expenses
      Staff increase resulting from this project is estimated to be six people. Costs also include acquisition of computer resources that will serve both resident staff and visiting scientists.
   3. Capital equipment not related to construction
      The increase in annual capital equipment is estimated at $400,000. This is in addition to capital equipment funds currently allocated to the CRF.
   4. Maintenance, repair, GPP or other construction related to programmatic effort
      The annual GPP needs for Phase II are expected to be approximately $200,000. This is in addition to GPP funds presently allocated to the CRF.
   5. Other costs - No other costs are anticipated.