DEPARTMENT OF ENERGY
1986 CONGRESSIONAL BUDGET REQUEST
LEAD TABLE
BASIC ENERGY SCIENCES
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(Tabular dollars in thousands. Narrative material in whole dollars.)

	1984 Appropriation	1985 Appropriation	1986 Base	1986 Request
Basic Energy Sciences				
Materials Sciences				
Operating Expenses.......	$124,560	$133,055	$133,055	$138,496
Capital Equipment........	12,780	15,450	15,450	15,450
Construction.............	16,440	43,620	43,620	28,995
Subtotal................	153,780	192,125	192,125	182,941
Chemical Sciences				
Operating Expenses.......	75,165	79,495	79,495	79,495
Capital Equipment........	6,520	8,840	8,840	8,840
Construction.............	450	6,050	6,050	5,830
Subtotal................	82,135	94,385	94,385	94,165
Nuclear Sciences				
Operating Expenses.......	37,733	40,350	40,350	43,338
Capital Equipment........	2,150	2,950	2,950	2,754
Construction.............	270	300	300	1,300
Subtotal................	40,153	43,600	43,600	47,392
Applied Mathematical Sciences				
Operating Expenses.......	14,605	35,074	35,074	28,020
Capital Equipment........	970	1,500	1,500	1,070
Subtotal................	15,575	36,574	36,574	29,090
Engineering and Geosciences				
Operating Expenses.......	18,915	26,675	26,675	26,675
Capital Equipment........	1,150	1,500	1,500	1,500
Subtotal................	20,065	28,175	28,175	28,175
Advanced Energy Projects				
Operating Expenses.......	9,060	10,602	10,602	10,602
Capital Equipment........	310	320	320	320
Subtotal................	9,370	10,922	10,922	10,922
Biological Energy Research				
Operating Expenses.......	10,534	12,455	12,455	12,455
Capital Equipment........	400	560	560	560
Subtotal................	10,934	13,015	13,015	13,015
Program Direction				
Operating Expenses.......	3,518	3,765	3,765	4,100
Subtotal................	3,518	3,765	3,765	4,100

	1984 Appropriation	1985 Appropriation	1986 Base	1986 Request
Total				
Operating Expenses.........	$294,090	$341,471	$341,471	$343,181
Capital Equipment..........	24,280	31,120	31,120	30,494
Construction...............	17,160	49,970	49,970	36,125
Basic Energy Sciences........	$335,530	$422,561 a/ b/ c/ d/	$422,561	$409,800 e/
Staffing Total FTE's.........	61	63	63	63

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

a/ FY 1985 amount does not reflect a reduction of $8,640,000 for IG audits, prior year deobligation Management Initiative Savings.

b/ FY 1985 total reflects a reduction of $3,015,000 for Management Initiative Savings, other than IG audit/deoblgiations, contained in the FY 1985 President's Request.

c/ FY 1985 total reflects a reduction of $2,940,000 for ADP general reduction.

d/ Reflects savings of $229,300 for Section 2901 of the Deficit Reduction Act of 1984 (P.L. 98-369).

e/ FY 1986 total reflects a reduction of $8,080,000 for FY 1986 Management Initiative Savings, other than IG audit/deobligations.

DEPARTMENT OF ENERGY
1986 CONGRESSIONAL BUDGET REQUEST
SUMMARY OF CHANGES
ENERGY SUPPLY RESEARCH AND DEVELOPMENT
(In thousands of dollars)

1985 Appropriation enacted	$422,561
1986 base	422,561
Program increases and decreases:	
Operating Expense Changes	
<u>Materials Sciences</u>	
o Permits selected increases required to continue major user facilities operations and will continue the core research program	+5,441
<u>Chemical Sciences</u>	
o Continues the core research program and major user facilities operations	+0
<u>Nuclear Sciences</u>	
o Permits selected increases required to continue major user facility operations and continues core research program	+2,988
<u>Applied Mathematical Sciences</u>	
o Continues support for the core research program. Funding support to the Supercomputer Center at Florida State University will be discontinued	-7,054
<u>Engineering and Geosciences</u>	
o Continues the core research program	+0
<u>Advanced Energy Projects</u>	
o Continues the core research program	+0
<u>Biological Energy Research</u>	
o Continues the core research program	+0
<u>Program Direction</u>	
o Impact of the Presidentially proposed reduction for the 5% decrease in salaries and benefits	-140
o Provides FY 1986 program support of 63 FTE's	+475
Subtotal, Operating Expense Changes	$+1,710

Capital Equipment Changes

- o Equipment funds will be restricted to meet essential replacements and upgrades required in support of the core research program .... -626

Construction Changes

- o Continues funding for General Plant Projects; Accelerator Improvement Projects; Kansas State University; National Synchrotron Light Source; Center for Advanced Materials; and Stanford Synchrotron Radiation Laboratory Enhancement. Funding for the Catholic University project has been completed. Funding support for Columbia University project will be discontinued.. -13,845

1986 budget request $409,800

Overview

The FY 1986 request for the Basic Energy Sciences (BES) program is $409,800,000. The request is composed of $343,181,000 in operating funds, $30,494,000 in equipment funds, and $33,125,000 in construction funds. In total, this budget request represents a decrease of $12,761,000 from 1985 but will continue all essential elements of the FY 1985 program. To meet this objective it proposes selected reductions to meet the budget levels of the President's Deficit Reduction Program.

In determining the appropriate Federal roles in the support of research and development, the Administration has identified support of long range basic research as the particular responsibility of Government, and further states that "mission agencies should support the foundation of basic sciences, as well as mission-oriented applied research, in appropriate disciplines." The Department request for BES is responsive to these roles.

The principal focus of the BES program is energy, but a number of other important national goals also are supported. Because of the ramifications of technical breakthroughs, national security, U.S. leadership in science and technology, and training all are served by a continuing aggressive program in basic research.

Improvements in existing technologies and the development of new technologies usually come from the application of new scientific knowledge. In FY 1984 a major new materials initiative was undertaken that not only attempted to deal with advanced materials research but also with aspects of training new researchers and interaction with industry. This initiative will continue in FY 1986. Similarly, initiatives in other areas have been started or proposed, all with substantial scientific community support.

The BES research program involves selection and continuation of projects of merit when viewed in relation to the Nation's diverse needs for energy, and selects those topics that, when taken as a whole, comprise an optimal, balanced program of mission-oriented basic research. To carry out this program, BES plans, supports and administers energy related research in the physical, biological and engineering sciences. New scientific information in these areas addresses the Administration's goals by providing the fundamental scientific and engineering base on which the Nation's future energy options depend. The strategy continues to be to:

- Provide critical knowledge and data and develop trained scientific talent through support of highly competent scientists in DOE mission areas;
- Provide for, and support operation of unique, specialized research facilities;
- Maintain liaison with other DOE programs, Federal agencies and the scientific, academic and industrial communities;
- Seek the scientific and industrial communities' assistance for the identification of needs and opportunities for research in areas likely to be relevant to future energy options; and
- Promote early applications of the results of basic research.

To continue its effectiveness, the BES program must: 1) maintain a strong core program -- this involves equipping, supporting and encouraging the scientists involved in our current program activities, and the training of new, younger scientists, to expand the forefront of knowledge in areas likely to be important to future energy technologies; 2) continue to support existing, unique facilities important to research in the U.S. while at the same time providing for needed new facilities and their operation; and 3) create opportunities for exploiting new, emerging areas that have been identified as having great potential importance to energy.

In support of basic research activities, BES funds a number of national user facilities. Four such facilities brought on line in the past several years are: the National Synchrotron Light Source at Brookhaven National Laboratory (BNL), the Intense Pulsed Neutron Source at Argonne National Laboratory (ANL), and the 1.5 Mev high voltage electron microscope at Lawrence Berkeley Laboratory (LBL), all of which became operational in FY 1983; and the Atomic Resolution Microscope at LBL, where the first full year of operation was FY 1984. Each provides new extended experimental capabilities and promises to open whole new areas of research heretofore not accessible. BES also has the responsibility for the operation of the Stanford Synchrotron Radiation Laboratory (SSRL) transferred to DOE from the National Science Foundation (NSF) in FY 1983, and the Proton Storage Ring/Spallation Neutron Research Facility at Los Alamos National Laboratory (LANL) which will begin operation in FY 1985. These new major facilities together with existing ones continue to place an added burden on BES to provide the additional funding needed for their operation at levels commensurate with the needs of the researchers.

The BES program also supports special research contracts and grants in which costs are shared by the universities. The universities' contributions are provided by a number of mechanisms, e.g., salaries to investigators, summer student assignments, provision of facilities and/or equipment, etc.

	FY 1984	FY 1985	FY 1986 Request
Materials Sciences			
Operating Expenses	$124,560	$133,055	$138,496
Capital Equipment	12,780	15,450	15,450
Construction	16,440	43,620	28,995
Subtotal	153,780	192,125	182,941

The goal of the Materials Sciences subprogram is to increase the understanding of topics related to the science of materials, which will contribute to meeting the needs of present and future energy technologies. The Energy Research Advisory Board (ERAB) placed the highest relative program priority ranking on this area of research in a review in 1981 of major energy science and technology-base programs and confirmed the high quality and importance of the Materials Sciences subprogram in last year's study of all materials research and development in the Department. This finding also was included in testimony in 1982 by the Chairman of ERAB to two House Subcommittees.

It is well known that materials technology plays a crucial role in developing new high technology industries in addition to increasing productivity of existing industries. This is because research in materials technology pushes forward the frontiers of knowledge and trains new scientists in this fundamental, highly interactive technical area, in addition to working on the long range problems of energy systems. Materials problems and limitations often restrict the performance of current energy systems and the development of future systems. A few examples of such problems and limitations include: degradation of mirror materials and low conversion efficiency of photovoltaic materials for solar energy; degradation of materials properties due to irradiation in fission and fusion energy systems; thermal and mechanical instabilities of materials for heat engines; corrosion and erosion of materials for coal conversion plants; long term environmentally compatible materials for containing nuclear waste; and light weight electrochemically stable materials for vehicular battery systems.

While each Federal agency conducts materials research to meet its own particular objectives, coordination across agencies is readily accomplished through established committees and interactions. In the area of basic materials research, the Materials Sciences subprogram coordinates its research most directly with the NSF's Materials Research Division and the more basic programs of the Department of Defense. The unique aspect of the Materials Sciences subprogram is the focus on energy related research and the use of advanced diagnostic techniques made possible by state-of-the-art research facilities supported by this subprogram. These activities complement the NSF and other agency programs. For example, there is relatively little work in the NSF program in radiation effects, corrosion-erosion related to fossil energy systems, solar photovoltaic materials, or nuclear waste isolation materials, whereas the Materials Sciences subprogram has very significant efforts in these areas.

This subprogram also has large efforts in facility-related research such as neutron scattering, synchrotron radiation research and electron microscopy, compared to the relatively small efforts in the NSF program.

The Materials Sciences subprogram has traditionally provided for the development, construction, and operation of large facilities for the total national program. Use of these major facilities is now formally open to all qualified researchers. A recent survey of 12 of the collaborative research centers under the purview of the Materials Sciences subprogram has shown that they accommodated about 900 users. The users came from DOE laboratories (21 percent), universities (48 percent), industry (14 percent), and the remainder from other organizations. The replacement cost for these facilities is estimated at $450,000,000. The Materials Sciences research funding at these facilities in FY 1984 was about $17,000,000 with another $13,000,000 being attracted from outside the Materials Sciences subprogram.

The field of materials sciences is timely for exploitation as a result of many new advances. We are approaching the ultimate resolution in microscopy. Significantly enhanced spectroscopic methods are now available, or will become available soon with new synchrotron radiation sources and neutron sources. Availability of high speed computers will help in understanding the theory of material science. Coupling these experimental and theoretical advances with our improved ability to prepare new materials will open up opportunities to design materials from fundamental principles and overcome or circumvent known and anticipated energy related materials problems.

Some of the needs to which the Materials Sciences research ultimately contributes include:

- Developing new or substitute materials,

- Tailoring materials to satisfy defined requirements,

- Predicting materials problems and service life,

- Improving the ability to successfully attack unforeseen materials problems in advanced energy systems, and

- Improving the theoretical and experimental capability to analyze the fundamental structure of materials.

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

In addition to maintaining an appropriate mix among long-term science, multi-technology and single energy technology oriented research, a balance must be retained between forefront large facility-related research and small individual projects. Certain types of research simply cannot be conducted without large facilities (e.g., neutron sources with significant fluxes of neutrons cannot be made in "small" sizes). Also newer instruments with significant improvement in capability (e.g., synchrotron radiation sources) are very expensive to build and operate. This subprogram, therefore, continues to review the operating cost of existing facilities relative to their research contribution and also funds a modest level of research on new capabilities which can provide advances in science and technology. The Materials Sciences subprogram currently supports research and/or operation of several major facilities which are utilized in the pursuit of its research goals, including the National Synchrotron Light source (NSLS) BNL, High Flux Beam Reactor (HFBR) BNL, High Flux Isotope Reactor (HFIR) Oak Ridge National Laboratory (ORNL), Intense Pulsed Neutron Source (IPNS) Argonne National Laboratory (ANL), Proton Storage Ring (PSR)/Spallation Neutron Research (SNR) facility LANL, Low Temperature Neutron Irradiation Facility (LTNIF) ORNL, Surface Modification and Characterization Laboratory (SMCL) ORNL, and Electron Microscopes at ORNL, ANL, LBL, and the University of Illinois. These facilities also are available to qualified users outside the national laboratory complex.

The university portion of the program will be maintained at about 20 percent. When including Ames Laboratory (Iowa State University) and Lawrence Berkeley Laboratory (University of California) the support going to universities is 37 percent. At the FY 1986 requested level, research will be strengthened or initiated in selected technical areas at the expense of other lower priority projects resulting in an overall decrease in the level of research. Areas identified for emphasis generally fall into two categories of objectives: 1) synthesis, alloying, and preparation of new materials and structures, or 2) materials characterization and property measurements using highly advanced techniques. Areas within the first category include: high field superconductors, polymeric materials for high temperature or high conductivity applications, catalysts such as those incorporating artificial enzymes, new high temperature or corrosion resistant coatings, tailored materials with layered structures, advanced systems for synthesizing multicomponent materials, advanced structural ceramics, materials with nonequilibrium structures, and materials having nonlinear behavior. In the second category, emphasis will be on the use of advanced computational capability of highspeed computers to predict materials properties, studies of surface and interfacial phenomena using theory and techniques such as synchrotron radiation, the use of high resolution and analytical electron microscopy to characterize materials, the use of cold neutrons to investigate organic materials and defects in solids, and studies relating the structure of solids to their ultimate mechanical behavior.

The Materials Sciences subprogram is the basic materials program in the agency underpinning all the energy technologies. Materials play a crucial role in the development of energy systems. Coordination among the agency's materials programs takes place primarily through the Energy Materials Coordinating Committee. Within the Federal Government, the subprogram is coordinated in part through the interagency Committee on Materials (COMAT) and the basic Interagency Materials Group. At the Federal program level, Materials Sciences continues to represent about one-third of the Federal Government support for basic materials research.

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

- The operation of a newly designed diamond anvil pressure cell to attain a static pressure of two and one-half million atmospheres. This is nearly twice the pressure heretofore attained and will permit the investigation for the first time of the theoretically predicted superconducting properties of hydrogen as well as the creation of new classes of materials.

- The synthesis of metallic glasses at low temperatures without rapid cooling from the liquid state, by directly reacting crystalline materials with certain rapidly diffusing elements. Atoms in a metallic glass do not have a regular repeating pattern as in crystalline materials. This accomplishment portends the possibility of preparing bulk (as opposed to thin ribbons) metallic glasses, thereby making metallic glasses with their enhanced properties accessible to a wider range of applications.

- The definitive delineation of a new brittle cracking mechanism in stress corrosion cracking. A new experimental observation on stress corrosion cracking in ductile alloys showed that cracking proceeds up to one thousand times more rapidly than previously predicted. Altered surface layers were found to change the fracture mode from ductile to brittle in normally ductile metals. This discovery has positive implications for understanding and controlling the stress corrosion cracking of ductile alloys such as stainless steels.

Operating and Capital Equipment Request

The FY 1986 requested level for the Materials Sciences subprogram will provide for research continuity although at a lower level than the previous year and permit a reasonable level of utilization of major facilities. Strengthening of important topical areas and initiation of some new thrust areas recommended by workshops, panels of the Council on Materials Science and materials aspects of National Academy of Sciences studies will be undertaken at the expense of other research. In general, the major user facilities such as HFBR, NSLS, IPNS, and the NCEM will operate at minimum reasonable levels in the requested budget. The requested level will permit continuation of research at the Center for Advanced Materials (LBL) and elsewhere in ceramics, polymers, electronic materials, layered compounds and materials tailored for specific property optimization. For energy systems, new advanced materials are essential to achieve the required difficult efficiency improvements.

The increase in operating funds of $5,441,000 to a total of $138,496,000 will be used to permit a reasonable level of utilization of major user facilities. The requested operating level will allow for continuation of the core program of research with some strengthening of research on advanced materials preparation and materials characterization research at the expense of other research. The capital equipment request is $15,450,000, no change from the previous year. This modest budget is needed in order to replace outmoded equipment and allow for some potential for new avenues of research in electron microscopy and neutron and photon scattering spectroscopy.

Construction

The FY 1986 request for Materials Sciences for construction will permit a continuation of projects approved in FY 1985. At the Stanford Synchrotron Radiation Laboratory (SSRL) funds of $2,560,000 are requested in FY 1986 to complete the upgrade consisting of accelerator improvements and small laboratory additions to SSRL totalling $12,930,000. At Brookhaven National Laboratory, funds of $7,200,000 are requested in FY 1986 for the National Synchrotron Light Source (NSLS) beam lines and building expansion project totalling $19,700,000. At Lawrence Berkeley Laboratory, funds are requested in FY 1986 for continuation of the Center for Advanced Materials project, consisting of two buildings--a Surface Science and Catalysis Laboratory and an Advanced Materials Laboratory. The request is for $17,440,000 out of a total project cost of $40,250,000. Accelerator and Reactor Improvements and Modifications (ARIM) funds of $1,795,000 are also requested for the existing facilities at BNL, the High Flux Beam Reactor (HFBR) and the NSLS. Further details for each of the construction projects are provided in the attached construction data sheets.

	FY 1984	FY 1985	FY 1986 Request
Chemical Sciences			
Operating Expenses	$ 75,165	$ 79,495	$ 79,495
Capital Equipment	6,520	8,840	8,840
Construction	450	6,050	5,830
Subtotal	82,135	94,385	94,165

The goal of the Chemical Sciences subprogram is to build the knowledge base needed to improve energy technologies and lead to new concepts. Chemical and physical phenomena in this framework are studied at the forefront of science, with concurrent training of future energy scientists. Two independent reviews have confirmed the quality and importance of the subprogram. The Energy Research Advisory Board placed Chemical Sciences in the highest relative priority programs needing additional funding. Futher strong evidence of the program's importance flows from a recent intensive study by a National Academy of Science Committee, which stated "Chemistry is a central science that provides fundamental understanding needed ... to tap new sources of energy..." and "Our future international competitiveness will depend upon maintaining our present leadership position in the chemical sciences."

The Chemical Sciences effort is focused on energy related science. To assure sound management the subprogram is coordinated closely with other Federal agencies which have different missions. This is accomplished by frequent individual contacts and periodic meetings of the Federal Interagency Chemistry Representatives.

Within the broad scope of this subprogram certain areas receive emphasis because they are perceived to have clear bearings on recognized or anticipated energy technologies. These are: photochemistry (including photoelectrochemistry), chemical physics (including areas related to combustion), atomic physics (especially as related to magnetic fusion), the basic chemistry of coal, catalytic phenomena, separations, analytical techniques and chemical thermodynamics.

Photochemical researchers are probing the precise molecular arrangements by which nature achieves the conversion of solar energy to chemical energy, and are also moving toward the knowledge necessary to create solar cells to produce hydrogen from water.

Researchers in chemical physics are contributing to understanding of the complex chemical sequences which determine how rapidly, completely and cleanly a flame burns and fuel is consumed. Advanced techniques are being used to answer questions about the behavior of active species which are present in many energy processes, oxygen atoms for example.

Atomic physicists (not to be confused with nuclear physicists) are achieving remarkable progress, with use of several different ion accelerators, in elucidating the properties of highly charged ions which may act as harmful traps for energy in magnetic fusion plasmas. The behavior of such ions at energies higher than those found in fusion systems is also being studied.

Two very different approaches are being taken toward obtaining the knowledge which will ultimately enable engineers to achieve the economical conversion of coals to gaseous and liquid fuels. One is to learn the molecular structures of coals in order to produce more useful products. The other is the study of catalysis to provide knowledge for technologists who need to design catalysts for selectively converting coal products into simple fuels and chemicals. A catalyst facilitates a chemical reaction but remains unaltered in the process.

Separations which use chemical as well as physical means are common in energy operations: for example, separating a valuable fuel from complex mixtures. Separation processes consume large amounts of energy which often make the difference between economical and nonviable processes. Chemical Sciences supports basic research in separations, seeking knowledge which is widely applicable. Research also is conducted on analytical techniques, since it is important to be able to identify and measure exactly the chemical species present in a fuel of unknown purity, or in other mixtures which might require purification.

The engineering design of major plants for production or handling of fuels requires reliable thermodynamic data on the behavior of the fuels in question. Such data are largely unavailable at this time for many mixtures of present or potential importance. It is thus necessary to have methods of calculating those data more reliably since measuring them for every mixture of interest would be time consuming and expensive. In fact it is unlikely that the needs could be met by experiments alone in a reasonable time. Chemical Sciences therefore supports research aimed at the ability to predict such data from known relationships using simple measurements on pure components.

A small but increasing fraction of the research is conducted at two major facilities which were constructed, and are now operated, by Basic Energy Sciences for use of both DOE-supported scientists and qualified visiting users. They are the Combustion Research Facility (CRF) and the National Synchrotron Light Source (NSLS).

At the CRF, Chemical Sciences not only provides the entire support for operation of the facility, advancing the state of the art of its unique laser systems and providing research space and assistance to visiting scientists, but also supports the major part of the Facility's internal research program. The visiting scientists come from academia and industry, especially the automobile industry. The in-house research emphasizes the development and use of advanced diagnostic techniques which probe flame temperature profiles, identifies key but short lived flame constituents and measures their quantities in different locations within flames.

At the NSLS, Chemical Sciences funds nearly 40 percent of the facility's operating costs and a large fraction of the BES supported in-house research. Among the research areas supported are: ultraviolet light photochemistry, electronic interactions between surfaces and adsorbates, and photon excitation and ionization of neutral atoms or molecules. Each of these areas is fundamental to understanding of energy processes which can be used by energy technologists in enhancing present systems or devising new ones.

The intent of the Chemical Sciences subprogram is to pursue knowledge at the cutting edge of the science. In some projects the relationship to a technology is recognizable and clear, as in the research on coal chemistry. In other projects the near term involvement with energy is less clear and the specific kind of technology cannot yet be identified because the science is too new.

Important progress was made in many areas of the subprogram this past year. Some examples of recent accomplishments include:

- Identification of new catalytic steps which may lead to new ways to convert carbon monoxide into methanol and other hydrocarbons. A dissolved lead oxide catalyst has been discovered to convert carbon monoxide and water into formate ions, which interact with each other to form the methanol. Work is in progress to examine the hydrocarbon possibilities.

- A new technique was developed for nonintrusive measurement of the fraction of gas bubbles in a gas/liquid flow system. It measures the echo from a radio frequency pulse into the two phase fluid which flows through a nonuniform magnetic field. The method can measure variations of void density in both time and space with either steady or unsteady flows. One prime candidate for its use is in power plants to monitor their efficient and safe operation.

- The first measurements of the absolute value of initial energy transfer by a beam of electrons interacting with large nonspherical molecules (cesium bromide) have opened the way to understand the performance of rare gas/halogen lasers. This fills a need in laser technology which could not be met before because the transfer of energy in collisions between electrons and molecules that cannot be approximated as point shapeless particles is very difficult to measure and nearly impossible to predict theoretically.

Operating and Capital Equipment Request

The request for operating funds is $79,495,000, the same as appropriated for FY 1985. The requested funding level of the Chemical Sciences subprogram will sustain most of its projects but will require some cutbacks due to unmet inflation in the cost of performing advanced research and of operating major research facilities. Thus, some selective termination of projects will be necessary. The FY 1986 operation of the NSLS will be funded at the same amounts as in FY 1985 ($5,350,000), as will the operation of the Combustion Research Facility ($3,375,000). In the CRF case, since Chemical Sciences is the sole source of funds for operation of this facility, its ability to accommodate visiting user scientists will lose some ground.

The request of $8,840,000 in capital equipment funds is the same as in FY 1985. The request includes general purpose equipment for two laboratories: $2,000,000 for ANL and $140,000 for the Ames Laboratory. The balance of the request will go to meet the continuing need for forefront, up-to-date instrumentation for use of the scientists in the Chemical Sciences subprogram. In the competitive areas in which they operate, today's advanced chemical researchers depend on modern, sophisticated instruments, many of which range in cost into hundreds of thousands of dollars apiece. Sharing of these instruments among researchers is, thus, strongly encouraged by the BES program.

Construction

The request for construction funds is $5,830,000, which is $220,000 less than the 1985 level. There are four general plant project items representing overall landlord responsibilities: $3,000,000 for ANL, $600,000 for the Ames Laboratory, $300,000 for the Combustion Research Facility, and $30,000 for the Notre Dame Radiation Laboratory. The ANL need is especially important since it continues the recovery of plant efficiency after several years of dramatic budget stringency. Details are given in the attached construction data sheet 86-R-400.

The balance of construction funds requested, $1,900,000, is to continue construction of the Ion Collision Physics Facility at Kansas State University, the United States' first state-of-the-art accelerator based atomic physics facility. The project was initiated in FY 1985 with a total estimated cost of $3,400,000. This has been increased to $5,100,000 by including additional costs necessary to the success of this Facility. The additional costs comprise increased prices of the required components, the assembling, testing and adjusting of the new accelerator, a computer necessary for coupling the accelerators and detectors and a contingency allowance adjusted for inflation. Details of this construction project are described in the data sheet 85-ER-403.

	FY 1984	FY 1985	FY 1986 Request
Nuclear Sciences			
Operating Expenses........................	$ 37,733	$ 40,350	$ 43,338
Capital Equipment.........................	2,150	2,950	2,754
Construction..............................	270	300	1,300
Subtotal..................................	40,153	43,600	47,392

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

Nuclear Data

The goal of the Nuclear Data activity is to establish and maintain an accurate, complete, and accessible nuclear data base to meet long-term needs of the fission and fusion energy technologies and to support nuclear waste management and weapons development activities of the Department. The United States nuclear data effort is a well-integrated, time-tested activity involving data measurement, compilation, evaluation, processing, and dissemination. Measurement work is centered at the Oak Ridge Electron Linear Accelerator and the Argonne Fast Neutron Generator; the compilation and evaluation efforts are centered at the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory. The request for FY 1986 ($9,682,000 operating expenses and $600,000 capital equipment) reduces overall this subprogram's nuclear data activities by about five percent below FY 1985 levels.

The Nuclear Sciences subprogram provides for management and oversight of the national nuclear data system. In coordination with this subprogram, other nuclear-based programs (Nuclear Energy, Fusion Energy, Nuclear Regulatory Commission, and Defense Programs) participate in this activity through the Cross Section Evaluation Working Group (CSEWG) and by supporting data activities of specific, near term importance to their respective technologies. The light water reactor industry participates in CSEWG activities and provides funds for special data projects through the Electric Power Research Institute (EPRI). Nuclear data needs are documented in great detail and are regularly updated: for fission technology, as a part of the duties of the CSEWG; for fusion technology, as a part of the duties of a special working group of the United States Nuclear Data Committee. The Office of Fusion Energy provides direct input to this special working group.

Plans and tentative schedules have been drawn up for the production of the next version of the Evaluated Nuclear Data File, ENDF/B-VI. In FY 1986, work on ENDF/B-VI will include reevaluation of fissile and fertile nuclear data files in the resolved resonance region, reanalysis of Cr, Ni, and Fe (structural materials) files, and reevaluation of fission product data files. In support of fusion energy technology, ENDF computer formats will be extended to permit the inclusion of more detailed data and to make the file more useful for applications involving higher energy neutrons and low energy charged particles. An important evaluation effort is currently under way involving scientists from the National Bureau of Standards (NBS), Los Alamos National Laboratory (LANL), Oak Ridge National Laboratory (ORNL), Brookhaven National Laboratory (BNL), and Argonne National Laboratory (ANL), who are attempting for the first time a simultaneous best fit to the major "standards" cross sections used in ENDF, incorporating all available information on the covariances or correlations among measured data.

Another major data base activity, the Evaluated Nuclear Structure and Data File (ENSDF), is supported entirely by Nuclear Sciences (with the exception of non-U.S. participants) and consists of a network of evaluators of "mass-chains" in the United States and abroad. Coordination, assembly, and production of the data file and the important continuing publication of revised "Nuclear Data Sheets" is performed by the NNDC. The United States ENSDF evaluation effort includes work at BNL, Idaho National Engineering Laboratory (INEL), Lawrence Berkeley Laboratory (LBL), ORNL, and the University of Pennsylvania. A "Radioactivity Handbook" based on ENSDF is being prepared at LBL and is scheduled for publication early in 1985. This handbook has been designed to be a quick reference guide for users of nuclear data for industrial, medical, and engineering applications.

Nuclear model code work will continue in FY 1986 with the objective of developing methods for accurate estimation of needed cross sections for reactions which have not or cannot be experimentally determined. An innovative approach has been developed at ORNL for understanding uncertainties in nuclear data. This new technique utilizes group theory as the fundamental method for treating in a coherent fashion systematic and statistical uncertainties. Uncertainty analysis of experimental measurements is now being performed utilizing this new technique. Results are important for sensitivity analyses of nuclear data to determine the accuracies to which cross sections must be measured in order to meet needs of the fission and fusion energy technologies.

The Nuclear Data activity includes a nuclear data measurement effort in which the talents of experienced nuclear physicists are used at appropriate facilities to perform the difficult, painstaking measurements required to improve the data base. The major effort is carried out at the Oak Ridge Electron Linear Accelerator (ORELA) and the Argonne Fast Neutron Generator (FNG). At ORELA, neutron cross sections can be measured efficiently with great resolution and over a wide range of energies. University groups at Denison University (Ohio) and Middle Tennessee State University collaborate with ORNL staff in experimental work at the ORELA. The FNG provides unique measurement capability in the multi-MeV energy range.

Facilities at the ORELA and FNG are used to make measurements for neutron-induced reactions on materials of interest to fusion energy. Experimental apparatus and techniques used for neutron and gamma-ray emission measurements have been improved and are being used to meet fusion energy requirements for these cross sections. A new, high-resolution gamma-ray detector system for ORELA has been developed and tested and will be used in FY 1986 to further understanding of neutron inelastic scattering processes. In addition, gamma-ray measurements will provide very useful information on tertiary reactions, for example, (n,2n) and (n,xnp) reactions. Detector systems are being designed and tested to extend the capability of ORELA to measure neutron-induced charged-particle spectra over a wide range of neutron energies and outgoing angles. In FY 1986, FNG work will include activation and dosimetry cross section measurements in the 10 to 14 MeV energy range.

ORELA work also includes the measurement and analysis of neutron cross sections for materials of importance to the fast reactor program. These are primarily cross sections and related quantities for fissile and fertile reactor fuel materials, with emphasis on neutron energies below 0.3 MeV. Also, cross sections measurements in the thermal neutron energy range for the fissile and fertile nuclides are planned in FY 1986 in support of light water reactor data needs. In FY 1986, FNG work in support of fission energy technology will emphasize fast neutron radiative capture measurements on actinides (e.g., Th-232 and U-238) and on fission products.

Heavy Element Chemistry

Basic research is supported which will strengthen our understanding of the chemical, physical and nuclear properties of the actinide elements. Two purposes are served. One is to enhance knowledge of these elements to meet technological needs in connection with their industrial use as neutron sources in medicine, gauges, etc., and their behavior in spent nuclear fuels. The other is to gain insights into the chemistry and physics of elements in other parts of the periodic table through enhanced theoretical insights gained by virtue of the actinide elements' position near the limit of the periodic table.

While some of this research is conducted at universities, most of it takes place at DOE laboratories because of health and safety requirements for handling these materials. University researchers in this field typically spend much of their time at the DOE laboratories, taking advantage of their special facilities and collaborating with the laboratory scientists.

Some recent accomplishments illustrate the nature of this activity.

- o A new concept has been developed for improved cleanup of uranium hexafluoride (UF_6) process streams. Basic chemical studies found that gaseous metal fluoride impurities, such as neptunium hexafluoride, will react with solid uranium pentafluoride to form gaseous UF_6 and solid lower valence fluorides of the impurity metals. After this removal of the impurities from the gas stream, the trapped impurities can be recovered photochemically. Other streams can be similarly cleaned.

- o Thermodynamic studies have provided guidelines for handling actinide elements in candidate synthetic mineral hosts for nuclear wastes. The relative stabilities of different valence states of different actinides in these mixed-metal oxides (perovskites) have been measured with the finding that preparation methods must be adjusted so as to avoid the much more leachable hexavalent state of whatever actinide is to be contained.

The FY 1986 request for operating funds for Heavy Element Chemistry is $4,705,000. This is an increase of $390,000 above FY 1985 and is needed in order to restore this activity to the FY 1984 level. The capital equipment request of $350,000 is the same as FY 1985 and will be used for upgrading instrumentation, an especially critical aspect of this research area.

Isotope Preparations

Isotopically enriched samples of individual elements are produced in the electromagnetic isotope separation facility (Calutrons) at ORNL. They are provided by sale or loan to industrial and medical users and to research scientists, both domestic and international. Most of the samples produced at the Calutrons are nonradioactive isotopes, which are highly important to several areas of research and development including those related to fission and fusion power. They are also required as targets for manufacture of radioactive isotopes for medical diagnostics. A recent operational improvement is noteworthy:

- o Until now, separation of isotopes has been limited to only one element at a time within a single magnet segment. Modification of operating methods now permits the separation of isotopes of more than one element at a time during a run which may last many months.

Two closely associated facilities in the Isotope Preparations activity are the High Flux Isotope Reactor (HFIR) at the Oak Ridge National Laboratory (ORNL) and the Transuranium Processing Plant (TRU) at ORNL. HFIR serves two principal missions: formation of research quantities of the higher actinide elements by neutron irradiation and provision of an exceptionally high flux of neutrons for studies of structures of matter as well as for neutron damage studies. (Other radioisotopes are also produced at HFIR, for research and other purposes.) TRU has only one purpose: the separation of radioactive elements in pure states from the media (such as HFIR targets) in which they have been formed. The HFIR/TRU combination presently is the only available source of californium-252, which is a uniquely useful portable source of neutrons, used in industrial, defense, medical and scientific applications.

The operating funds requested for Isotope Preparations are $16,957,000, an increase of $2,382,000 which is absolutely necessary if these national assets are to be kept operating to serve vital and widespread needs in the public and private sectors. Within this increase, $1,100,000 is required by the HFIR to maintain the operation costs of electricity, control plate fabrication, fuel grid procurement and chemicals, and providing the minimum professional and technical crew for safe operation. Also within the $2,382,000 increase is $700,000 for the TRU. This amount is required to minimize personnel radiation exposure in the interests of safety.

The third Isotopes Preparation facility is the Calutrons, for which an increase of $700,000 is urgently needed. This will provide the necessary core support for a very limited (6 month) operation, including minimal staff, power and utilities. Since the revenue from sales of isotopes for medical and other purposes is not predictable from year to year, such core support is required in order to maintain the facility's viability.

The request for capital equipment for Isotope Preparations is $680,000, a $30,000 increase above the amount appropriated in FY 1985. These funds are needed mainly for replacement and upgrading of the remaining old equipment at the 40 year old Calutrons, which continue to be the only source other than the U.S.S.R. of enriched isotopes in usable quantities.

Accelerator and Reactor Improvement funds of $1,200,000 are requested for safety improvements the HFIR. These funds are needed for two purposes. The first is replacing two heat exchangers which are corroding and nearing the end of their reliable lives. The second purpose is installing a remote sampling system within the reactor building, which would be needed in the event of a release of radioactivity. Although this is an unlikely event, safety considerations now dictate having such a new system.

Stanford Synchrotron Radiation Laboratory

The Stanford Synchrotron Radiation Laboratory (SSRL) is a major site of synchrotron radiation research in the U.S., particularly for the x-ray region of the spectrum. It is located at the Stanford Linear Accelerator Center (SLAC) and shares the use of the Stanford Positron-Electron Asymmetric Ring (SPEAR) storage ring with the High Energy Physics Program, the sponsor of SLAC. When SPEAR is operated solely for the production of synchrotron radiation, SLAC is reimbursed SPEAR operating costs by SSRL. The facility, sponsored prior to FY 1983 by NSF, is operated in the user mode, that is, all operating costs are provided by DOE (Nuclear Sciences subprogram). Qualified users from government, industry and university labs, whose proposals are peer reviewed, are not charged for facility use for basic research. A significant event occurred at SSRL during the past year--the installation of a 54 pole wiggler in a straight section of SPEAR which now provides the most intense x-ray beam in the world.

The request for operating funds for SSRL for FY 1986 is $7,116,000, an increase of $216,000 above the amount appropriated for FY 1985. This is an exceptionally tight funding level; it does not allow for the full inflation impact or the recently increased charges to SSRL for shared use of the Stanford Positron-Electron Asymmetric Ring which is the heart of the SSRL operation. This funding level, therefore, imposes on SSRL and its many scientific users a curtailed schedule of operation again in FY 1986. The FY 1986 capital equipment request totals $550,000, a slight reduction compared to FY 1985, the peak year of refurbishing SSRL's instrumention. general plant project funds ($100,000) are requested for necessary sewer improvements and the replacement of a high voltage power station.

Heavy Ion Fusion Accelerator Research

The goal of the Heavy Ion Fusion Accelerator Research (HIFAR) program is to develop heavy ion accelerator technology and perform appropriate ion beam experiments to the point where an adequate data base exists for evaluation of heavy ion inertial fusion drivers and their possible use in civilian power applications of inertial confinement fusion.

Transferred from the Office of Inertial Fusion within Defense Programs in FY 1984, the HIFAR program has been the subject of a number of reviews and technical workshops which have been uniformly favorable in their conclusions. In 1983 a two-stage plan was developed in connection with the transfer and was reviewed by a JASON Panel. The Panel judged the revised plan to be "---a sensible and minimal next step in Heavy Ion Fusion."

The HIFAR program is based on the need for experimental verification of the previous theoretical studies at an appropriate scale. Stage I involves the development of a "Multiple Beam Experiment" (MBE) to test the critical elements of promising accelerator technologies with particular emphasis on the use of multiple beams for cost reduction at high intensity. Stage II calls for a "High Temperature Experiment" (HTE) in which a high temperature (50-100 eV) solid-density plasma would be demonstrated. Currently planned for FY 1988-1990, the HTE would entail the construction of an accelerator suitable for verification of the design principles of a reactor-driver accelerator and for verification that target heating predictions are valid.

Demonstration of high temperature in a solid-density plasma would signify a major entry of accelerator technology into the parameter range needed for inertially confined fusion. It would settle questions relating to energy deposition and beam propagation, besides providing a crucial benchmark in the development of accelerators for fusion power. Given the established accelerator technology history that can guarantee repetition rate, efficiency, and reliability, Heavy Ion Fusion could then be evaluated as a serious candidate for a fusion power system for the next century.

In preparation for the High Temperature Experiment, it is crucial to have data from experimental tests on transport, acceleration, and the selected method for current amplification with the MBE. Issues to be addressed in Stage I include: predicted transport space-charge limits on multiple beams; stability, reproducibility, and reliability of intrapulse and pulse-to-pulse operation; accelerator cost reduction; preservation of beam quality including stability and containment of the high charge-density pulses; and designs for final compression, transport, and focusing of the beams to the target. Recent accomplishments include a major success in demonstrating single-beam high current transport with cesium ion beams.

Major FY 1986 milestones include multiple beam injector fabrication and testing, and completion of several prototype MBE accelerating and focusing cells. The principal experimental effort is conducted at the Lawrence Berkeley Laboratory, with Los Alamos National Laboratory providing multiple beam injector development.

The request for FY 1986 is $5,452,000, compared to $5,528,000 in FY 1985, and includes $4,878,000 operating expenses and $574,000 capital equipment. These funds are necessary for experimental hardware needed in Stage I of the program which, during FY 1985-1987, is dominated by purchases and fabrication of MBE hardware. The level of funds provides for completion of the MBE in FY 1988, one year later than projected in the 1983 plan (adjusted for FY 1985 funding).

	FY 1984	FY 1985	FY 1986 Request
Applied Mathematical Sciences			
Operating Expenses........................	$14,605	$35,074	$28,020
Capital Equipment.........................	970	1,500	1,070
Subtotal..............................	15,575	36,574	29,090

The Applied Mathematical Sciences subprogram will meet the immediate needs for large-scale scientific computing in the research programs supported by the Department's Office of Energy Research and the long-range needs of the Department in computational research. The program consists of two parts: Energy Science Advanced Computation and Applied Mathematical Sciences Supercomputing Research. This program will meet DOE needs and will make a substantial contribution to solving the national problems of providing access to researchers, particularly in universities, and maintaining U.S. leadership in supercomputer technology. The Energy Science Advanced Computation subprogram will provide large-scale scientific computing required by High Energy and Nuclear Physics, Basic Energy Sciences, and Biological and Environmental Research. This scientific computing will be provided through network access to supercomputers for contractors in universities, industry, and DOE national laboratories. The Supercomputing Research subprogram supports research in mathematical and computer science that is critical to the use by many DOE programs of the newly emerging multiprocessor supercomputer systems and the long-range development of future supercomputer systems.

In recent years, the modern supercomputer has changed the nature of scientific research and technology development. Computational science serves a role in research that is a hybrid between theory and experiment. In some cases, computations provide insights into experimental data, and in others, computations are used to simulate the ideal experiment to test an analytical model. The emergence of computational science as an important element in scientific research and technology development is the result of the development of our ability to do computational modeling of complex physical problems and the enormous power of the modern supercomputer. This combination allows scientists and engineers to model complex problems in a much more realistic way and to obtain much more accurate answers than was possible just 5 or 10 years ago.

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

The Department of Energy (DOE) has made a significant commitment to large-scale scientific computing in several of its research and development programs. As an agency, DOE's commitment to scientific computers is not new; it is the largest user of supercomputers in the world. Historically, the Department and its predecessor agencies (the Atomic Energy Commission and the Energy Research and Development Administration) caused many supercomputers to be developed through its nuclear weapons design work at the Lawrence Livermore National Laboratory and the Los Alamos National Laboratory. The supercomputers that were developed in response to DOE needs were delivered to the DOE laboratories nearly devoid of software, requiring our laboratories to develop the necessary software for a complete supercomputer system. Through the software development efforts and the continual interaction between DOE laboratories and the supercomputer vendors, DOE has made significant contributions to supercomputer technologies.

Great progress has been made in our ability to do computer modeling of complex scientific problems; there is, however, still a long way to go. Many of the Department's research and development programs have large, complex research and engineering problems to solve that can be only crudely approximated with today's supercomputers and mathematical techniques. There is a need to include more "physics" in the models, to use finer zoning for more accurate answers and to use more dimensions. In order to solve these complex problems to the accuracy desired in the future, computers with substantially increased computing power over those currently available will be required. Several DOE programs have estimated that they will require computers 200 times as powerful as a Cray-1 or a Cyber 205 by the end of the decade. In fact, some of the DOE programs could use that kind of computing power today, if it were available.

Applied Mathematical Sciences Supercomputing Research

The objective of the Applied Mathematical Sciences Supercomputing Research activity is to advance the understanding of the fundamental concepts of mathematics, statistics, and computer science underlying the complex mathematical models of the key physical processes in the Department's research and development programs.

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

One of the clear focuses for the Supercomputing Research activity is to develop our ability to use multiprocessor computer systems. The multiprocessor direction for supercomputers is dictated by the fact that only very limited gains can be made from increased component speeds and levels of integration in the future. This has caused computer architects to look to using more than a single processor working on a problem. The change from von Neumann (sequential) to multiprocessor machines represents an enormous change in scientific computing, greater than the challenge faced by the introduction of vector processors. The challenge with multiprocessors, is to have a large number of processors efficiently working simultaneously on the same problem. New software, languages, algorithms, and probably entirely new mathematical approaches to solving a number of scientific problems will be required. The Supercomputing Research activity has as one of its objectives, conducting the research on parallel computing necessary to ensure that the Department's programs using large-scale scientific computing will have the tools to use efficiently the new machines that will be produced commercially and to exploit their maximum capability.

The program funds basic research at many of the national laboratories, universities, and private research institutions in three major activities: Analytical and Numerical Methods, Information Analysis Techniques, and Advanced Computing Concepts. Analytical and Numerical Methods includes analytic and numerical techniques for solving systems of partial differential equations; Information Analysis Techniques includes data management and statistics; Advanced Computing Concepts includes software engineering and research on high performance systems. In addition, experimental computing capabilities are being established as research facilities to support the exploration of new concepts in large scale scientific computing. Regular meetings with program managers in other Federal agencies help coordinate these activities. Two such groups established to coordinate government sponsored research programs are the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET) panel on high performance computing research and the Interagency Committee on Extramural Mathematics Programs (ICEMAP).

Recent accomplishments of the Applied Mathematical Sciences Supercomputing Research activity include the following:

o The Cosmic Cube, a 64 processor computer, is operational at Caltech

  Researchers at Caltech have successfully built a 64 processor research computer with the equivalent computing power of one-tenth a Cray-1 at one-hundredth the price. This architecture is dramatically different from today's Class VI machines and early results indicate it may be a cost effective alternative for a variety of scientific problems. Recently a lattice gauge problem modeling the fundamental properties of matter ran for 2500 hours on the Cube providing scientists with some interesting results on the heavy quark potential with high statistics and demonstrating the reliability of the architecture. A variety of other problems have been implemented on this machine, including problems in astrophysics, molecular dynamics, geophysics, and critical phenomena in materials.

  Research in very large scale integrated (VLSI) design on this project was supported by DARPA. The problem decomposition study, algorithm implementation in software, and mathematical research was supported by DOE. Intel Corporation donated the microprocessors for the machine and DEC donated much of the cost of the front end machines. This sort of university/industry/government collaboration represents the key idea for successful supercomputing research.

o Capillarity phenomenon mathematically predictable

  Researchers at LBL and Stanford found that the solution of the equations governing liquid free surface interfaces predicts unexpected behavior if the cross-section of the tube is not circular. They concluded that the solution of the equations can behave discontinuously or even cease to exist when small changes are made in contact or capillary-tube cross-section. For example, when applied to the case of a wetting liquid in a tube of square cross-section in zero gravity, their analysis predicts that for contact angles greater than or equal to a critical value of 45 degrees the height of the free surface (portion of a sphere) is uniformly bounded, but for smaller contact angles no solution of the equation exists. This remarkable behavior was verified experimentally at the NASA-Lewis Research Center in their Zero-Gravity Drop Tower. It was observed in tests that for contact angles less than the predicted value the fluid flowed up along the corners rather than remaining simply contained in the bottom of the tube. While these findings have intrinsic mathematical importance, they may find applications in such practical areas as flow in heat pipes, growth of crystals in low gravity, behavior of petroleum in underground reservoirs, and other areas in which capillarity phenomena play a role. The effect of zero-gravity capillarity is important in space manufacturing and will be investigated further in an upcoming space shuttle flight experiment.

In FY 1985, an enhancement in the large scale scientific computing area was started, with emphasis on algorithms for large scale parallel architectures based on several experimental computer systems under study. The emphasis on new parallel multiprocessor architectures applies to all three activities of the research program: analytical and numerical methods for the solution of systems of differential equations, information analysis techniques, and advanced computing concepts.

The FY 1986 operating budget request for Applied Mathematical Sciences Supercomputing Research is $21,020,000, a slight decrease from the amount appropriated in FY 1985. This will provide a slightly reduced level of effort in research directed toward analytical, numerical, and advanced computing techniques that form the basis for maintaining DOE's lead role in the application of large scale computing for scientific research. The projects initiated in FY 1985 in universities and DOE laboratories aimed at investigating parallel architectures will be continued at a constant level of effort.

The three projects started in FY 1985 are at NYU, Cal Tech, and the University of Illinois. These three projects represent several investment strategies. The first is a collaboration with a large industrial partner providing the mathematical and computer science expertise for scientific applications with a DOE supported university (Courant Institute Mathematics and Computer Laboratory). The second represents a large DOE-supported university group providing again the mathematical and computational science expertise and a government sponsored laboratory providing the engineering design and implementation. The third represents a large, experienced university and laboratory group that is using mostly "off the shelf" components and that is at the forefront of development of software for scientific applications.

For FY 1986 $500,000 in capital equipment funds is requested, a decrease from the FY 1985 request of $600,000. These funds are used to equip the research computing facilities at the national laboratories and NYU/Courant Institute. Additional mass storage and network hardware will be acquired to ensure that wide access to the experimental and research computing facilities is available to all the universities and laboratories participating in supercomputing research.

Energy Science Advanced Computation

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

- to provide access to modern, supercomputer systems for researchers that are funded through the OER programs;
- to prepare this research community to take full advantage of new, supercomputer technologies as they become available;
- to provide more productive and effective advanced software tools for supercomputer systems; and
- to shorten the time required to implement the results of the Supercomputer Research program into existing applications and systems software.

The ER researchers served by this program are geographically dispersed throughout the United States and had little access to supercomputers prior to FY 1985. The most cost-effective and expeditious method of initiating this access program in FY 1985 was to use the existing nation-wide Magnetic Fusion Energy (MFE) computer network. The network approach allows for the matching of resources to program requirements across all ER programs rather than on an institution by institution basis.

During FY 1985, an enhanced class VI computer system, compatible with the existing system at the MFE Computer Center, was installed at the Center on an interim basis to immediately alleviate the severe capacity shortage for the new ER users. A thorough analysis of the computational needs and capability requirements of all the ER programs was also performed. This analysis verified that the most powerful and capable computer systems available are necessary to support the on-going ER research and development programs.

During FY 1985, the Energy Science Advanced Computation activity initiated a Supercomputer Computational Research Institute (SCRI) at the Florida State University (FSU) as directed by Congress in P.L. 98-360. The purpose of the SCRI is to conduct research in computational science and to provide services to support the computational needs of the SCRI, FSU, and other ER funded research projects.

For FY 1986, a total of $7,000,000 in operating funds, a decrease of $7,170,000 from the FY 1985 appropriation, is requested. These funds will be used to continue this access program at the Magnetic Fusion Energy computer network. Due to fiscal circumstances in FY 1986, support for the SCRI will be discontinued. Also identified under this activity is a Major Item of ADP Equipment, a Class V computer system, at the Argonne National Laboratory (ANL) to replace obsolete systems, to alleviate current systems saturation, and to address the local ANL scientific computing requirements through FY 1989. Funds for this computer system are not included in this activity since they will be obtained on a full cost recovery basis across the programs which utilize the scientific computational facilities within the ANL. The total costs associated with providing supercomputer access for ER scientists are as follows:

1. $4,200,000 for the lease and maintenance of a class VI computer system for one year.

2. $1,800,000 for incremental support staff, supplies, utilities, services, etc. at MFECC necessary to operate the above class VI computer system.

3. $1,000,000 for other network communications costs and access facilities.

For FY 1986, $570,000 in capital equipment funds, a decrease of $330,000 from the FY 1985 appropriation, is requested to provide replacement parts and low cost mass storage peripherials, such as disk and tape units to accomodate the increase of over 1300 new users at the MFE Computer Center through this access program.

	FY 1984	FY 1985	FY 1986 Request
Engineering and Geosciences			
Operating Expenses	$18,915	$26,675	$26,675
Capital Equipment	1,150	1,500	1,500
Subtotal	$20,065	$28,175	$28,175

This subprogram funds the Department of Energy's principal long-range research efforts in the disciplines of mechanical engineering, electrical engineering, engineering physics, geology, geophysics and geochemistry. Projects are chosen for their scientific excellence and their long-term importance to meeting the Nation's energy needs.

In addition to the requests for operating funds discussed below, $1,500,000 is requested for capital equipment (examples: microprocessors and sensors for research on intelligent control systems at the Oak Ridge National Laboratory and imaging device equipment for geophysics studies at Pacific Northwest Laboratory) Experience has shown this is the minimum for capital equipment required for effective research in the areas covered by this subprogram.

Engineering Research

The Engineering Research part of this subprogram pursues two main goals: (1) to acquire a better understanding of basic phenomena and processes underlying current energy-related engineering practices, and (2) to expand the conceptual and technical base of engineering sciences to meet the needs of future energy technologies.

Broadly useful topics are chosen in areas of traditional engineering disciplines as well as in interdisciplinary areas, addressing problems related to energy production, distribution and utilization The following examples indicate the breadth of application of the topics being supported: (1) improved basic understanding of tribology, which covers friction, wear and lubrication, is pertinent to all energy generating and consuming systems with moving components; (2) the fundamental principles underlying the flow of multiphase fluids (mixtures of gaseous and liquid fluids) must be well understood to solve problems in petroleum and chemical industrial processes as well as in specific energy systems; e.g., geothermal, chemical, and solar; and (3) advanced instrumentation and equipment for use in extreme environmental conditions of high pressures, elevated temperatures and severe toxicity are needed for many energy technologies

Engineering Research has its focus on three areas: (1) Mechanical Sciences - including tribology, heat transfer, fluid mechanics, solid mechanics and structures; (2) Systems Sciences - including process control, large scale systems, machines in unstructured environments, and instrumentation; and (3) Engineering Data and Analysis - including nonlinear dynamics, and the development of critically needed data bases for energy engineering systems.

Recent accomplishments in Engineering Research include:

- A record high in operating temperature for a key type of solid state electronic device was achieved through improved fabrication methods; this paves the way to important advances for measurement methods and process control in hostile environments

- The identification of significant electro-chemical processes which induce wear in bearings, has provided the initial knowledge for finding suitable lubricant additives for wear reduction. Successfully completed and applied, this research should contribute to increased lifetime of generators, motors and pumps.

In FY 1986 $13,044,000 is requested for operating expenses, the same level as FY 1985, and will support carefully selected, generic, high quality engineering research in the existing program categories enumerated above. The collaborative work initiated in FY 1985 among universities, industry and national laboratories (primarily the Idaho National Engineering Laboratory and Oak Ridge National Laboratory) will be pursued in focused areas of research. The specific research areas to receive continued emphasis in FY 1986 include: advanced methods and processes (mainly research underlying plasma engineering and welding automation), intelligent machines in pseudo-structured and unstructured environments, basic research on multiphase flows, and advanced instrumentation research including the development of devices and sensors operable in hostile environments.

Geosciences

The evaluation, development and utilization of energy resources and the appropriate disposition of wastes from energy production are critically dependent upon our knowledge of the earth and its atmosphere. To meet the long-term needs of the Department for such science information, the Geosciences activity supports research which is germane to the Departmert's mission in geology, geophysics, inorganic and organic geochemistry, rock mechanics, thermodynamics, tectonics of geologic systems and solar-terrestrial physics. This research is carried out principally at the DOE National Laboratories and at U.S. universities. For example, coordinated research projects in Continental Scientific Drilling address long-range national energy concerns. Studies of the thermodynamic properties of rocks and migrating ground waters and of geochemical migration in the earth's crust are providing an improved data base for the design of waste repositories. Development of new geophysical methods and computer codes for modeling of geophysical data and their use in resource exploration and evaluation are leading to improved methods of locating energy resources, modeling the earth's crust and identifying sites for waste isolation.

Areas of emphasis and specific research projects are selected to increase our fundamental knowledge of processes relevant to the origin, detection and utilization of energy resources; problems of waste isolation in geologic media; and long-term solar wind and earth-climate variability. Specific Geosciences activities are currently focused on:

(1) Seismic, acoustic, electromagnetic and other geophysical methods of remote sensing in regions of high heat flow and energy resource potential.

(2) Drilling and associated geosciences activities specifically planned to increase fundamental knowledge of crustal structure and processes, with emphasis on the thermal regimes of the continental crust consistent with the Interagency Accord on Continental Scientific Drilling signed by DOE, NSF and the U.S. Geological Survey in April 1984.

(3) Rock mechanics, element migration, and energy and mass transfer in geological systems by means of laboratory experiments, computer simulation and field studies.

(4) Thermodynamic and kinetic studies of mineral and rock systems.

(5) Organic geochemistry investigations on the nature and origin of petroleum, natural gas and coal resources.

(6) The physics of the solar-terrestrial atmospheric interactions that affect the earth's present and future energy systems.

The Continental Scientific Drilling part of DOE's Geosciences Research has attracted substantial interest nationally and internationally (where major continental scientific drilling efforts are already underway). The portions dealing with thermal regimes are especially appropriate for support by the Department of Energy. The other cooperating agencies are NSF and USGS.

Recent Geosciences research accomplishments include the following:

- Continental Scientific Drilling at Long Valley, California. High heat flow and geothermal energy potential are often associated with silicic magma and volcanism. The first hole ever drilled completely through a recently cooled obsidian (silica-rich volcanic glass) lava flow was completed last November at Obsidian Dome, California. Core sampling recovery was close to 100 percent and subsequent analysis of the cores has revealed the surprising result that this lava flow, in spite of the nearly total absence of bubbles and a very high viscosity, had equilibrated fully with water vapor at a pressure of one atmosphere at, or very near, the earth's surface. This finding has been interpreted to mean that the magma approached the surface as a froth, rather than a viscous liquid, and was only later reconstituted as an essentially solid mass of glass by compaction while cooling in its final position. The outgassing characteristics of silicic magma as it approaches the surface are of paramount importance in assessing the distribution of available energy in a geothermal field as well as the potential danger of explosive volcanism.

- The Kinetics of Petroleum Formation. A combined field and laboratory study of the Green River shale in Utah provides direct geological verification of the rate of petroleum formation in nature. The shale contains kerogen (an oil precursor) where it is exposed at the surface on the edge of the Uinta synclinal basin. The same rock produces oil from depths of 12,000 - 16,000 feet inside the basin. By combining laboratory measurements of the state of compaction of shale samples recovered from drilling at successive depths with data on temperature versus depth, investigators have been able to reconstruct the time-temperature history of the Green River shale formation. For the oil producing zone, the average heating rate and maximum temperature achieved are 0.6x10E-9 degrees C/hr and 155 degrees C, respectively. This geologic reconstruction of the conditions of petroleum formation is in excellent agreement with laboratory experiments on the kinetics of the conversion of kerogen to petroleum which show a very pronounced rate maximum at 150 - 160 degrees C.

The FY 1986 request for operating expenses is $13,631,000, the same level as FY 1985, and will provide continuing support for the Department's Geosciences Research activities along lines for which the scientific priority is high and which bear directly on the long-range research needs of the Department. The thermal regimes portion of the cooperative interagency Continental Scientific Drilling Program (CSDP) will be maintained, consistent with the Interagency Accord cited above.

	FY 1984	FY 1985	FY 1986 Request
Advanced Energy Projects			
Operating Expenses........................	$ 9,060	$ 10,602	$ 10,602
Capital Equipment........................	310	320	320
Subtotal................................	9,370	10,922	10,922

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

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

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

The mode of operation for this interdisciplinary subprogram is to support individual projects for a limited time only; it differs from other subprograms in that it does not fund ongoing evolutionary research. The spectrum of projects supported is very broad, encompassing, for example, the development of new sources of electromagnetic radiation, new methods of better fossil fuels utilization, totally new approaches to controlled fusion and new approaches to solar energy collection and utilization, to name a few. 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. At present, about forty projects are being supported, which allows a turnover rate of about fourteen projects a year. A recent accomplishment of Advanced Energy Projects is the demonstration, for the first time, of a new source of electromagnetic radiation known as the free electron laser (FEL) at conversion efficiencies and power levels making FEL a candidate source for numerous applications, including extremely powerful accelerators.

Last year continued to bring evidence of a wide recognition of the Advanced Energy Projects subprogram as an important vehicle in promoting science-based technical innovation:

- o The annual Energy Technology Conference and Exposition held in Washington, D.C. in February 1983, devoted a special session to the BES Advanced Energy Projects subprogram. Speakers at the session were Principal Investigators on projects supported by this subprogram.

- o An article describing the Advanced Energy Projects subprogram appeared in Spectrum, a highly regarded journal of the Institute of Electrical and Electronic Engineers.

The FY 1986 request for the Advanced Energy Projects subprogram is $10,602,000 in operating expenses and $320,000 in capital equipment funds, the same as in FY 1985. By maintaining last year's level of project support, each project currently being funded will be required to absorb cost of living increases. The budget request will, therefore, maintain the total number of projects supported at last year's level of about forty; with a typical turnover period of three years. In addition, the subprogram will continue, on a modest scale, last year's initiative in exploring novel sources of electromagnetic radiation such as x-ray and gamma-ray lasers and electron lasers. Also, modest support for the muon catalyzed fusion effort is also envisioned.

	FY 1984	FY 1985	FY 1986 Request
Biological Energy Research			
Operating Expenses........................	$ 10,534	$ 12,455	$ 12,455
Capital Equipment..........................	400	560	560
Subtotal................................	10,934	13,015	13,015

The Biological Energy Research (BER) subprogram aims at generating results and information about fundamental biological mechanisms that will serve to underpin new and improved biotechnologies relating to energy production. The program focuses on botanical and microbiological areas, each roughly funded at the same level. The research is concerned with biological energy conversion mechanisms and their regulation and also how organisms use and conserve the energy available to them. Research on: photosynthesis, the major energy supply mechanism for living organisms; growth and development as a reflection of the strategy of how plants manage to trap and store energy; stress physiology as a means of determining how plants cope with water, salt and temperature insults and manage to carry out energy trapping; genetic mechanisms which represent improved means by which one may ultimately fashion "novel" plants as more efficient producers of the energy storage materials of interest, regulatory mechanisms of metabolic and morphological processes that are to be the targets for future genetic engineering; and plant-microbial interactions that are of critical importance to plant productivity and to losses of productivity in the case of pathogen attack. Of growing importance is work on the structure and function of plant cell walls that represent the largest renewable energy storage resource.

The microbiological segment of the program consists of projects investigating how microorganisms convert various materials to fuels and chemicals of interest. The main area of research is the underlying mechanisms of a number of fermentations and other conversions. Of special interest are the pathways of degradation of the major biological polymers in which energy is stored, namely, the polysaccharides, cellulose and hemicellulose, and the aromatic polymers of lignin. Special attention is given to understanding the enzymes involved, how their synthesis and activity is controlled and what the options might be for genetically regulating them. The process of methanogenesis is being defined with respect to the organisms involved (this is a process in which several types of anaerobic microbes must interact to make the whole process go), the interactive relationships and the control mechanisms imposed and the genetics of methanogens which has been virtually totally neglected until recently. Other conversions in which one carbon compound such as carbon monoxide and formaldehyde are converted to more desirable and industrially useful products also are studied. Thermophilic organisms, or those capable of growth at high temperatures, are being investigated for their usefulness in conversions by virtue of their higher conversion rates and decreased susceptibility to contaminations. The genetics of other potentially useful microorganisms for conversions also are being studied since essentially no genetics is known for most of these. Some studies on the fundamental biochemistry and genetics of organisms that produce surfactants useful in enhanced oil recovery also are being carried out.

The majority (over 72 percent) of these research funds are expended in university laboratories with a lesser amount in national labs (22 percent). The overall program is addressing critical questions whose answers will be the foundation of an industry employing biosystems to carry out a variety of conversions for fuel and chemical production. The work in this area is moving extremely rapidly and if the U.S. is to maintain its competitive position it is essential to take advantage of the rapid unfolding of information by pursuing the extremely promising leads promptly. Of particular importance is that both the plant sciences and fermentation microbiology (pharmaceutically related are the exception) have been relatively neglected for the past few decades. Both areas are now in a renaissance with an accompanying series of new discoveries.

At the FY 1986 requested funding level, the majority of committed projects in plant and microbial sciences would be continued. There will be terminations, however, to provide for inflation for high priority projects and to permit initiation of a few exceptionally meritorious new projects.

	FY 1984	FY 1985	FY 1986 Request
Program Direction			
Operating Expenses..........................	$ 3,518	$ 3,765 [a/]	$ 4,100
Total FTE's.................................	61	63	63

a/ Reflects savings of $65,000 for Section 2901 of the Deficit Reduction Act of 1984 (P.L. 98-369).

The FY 1986 request for Basic Energy Sciences Program Direction is $4,100,000, an increase of $335,000 over the FY 1985 level. These funds are required to provide for the personnel costs associated with 63 full-time equivalents. The additional funds will provide for within-grade and merit increases, and other increased costs associated with management of this program.

Basic Energy Sciences is a broadly diversified program responsible for mission-oriented research, the chief purpose of which is to provide the fundamental scientific and engineering base on which the Nation's future energy options depend. Its staff must possess expertise covering many subfields in the areas of chemistry, physics, engineering, metallurgy, geosciences, mathematics, and biology, as well as in administration, procurement and financial management. The staff is responsible for development, direction, and management of complex technical programs, each involving one or more of the scientific areas mentioned above. Their activities include assessing scientific needs and priorities of the program, planning to meet those needs, technical review of proposals from laboratories and universities, and monitoring the progress of ongoing university contracts, laboratory programs, and construction projects, as well as responding to the many day-to-day requirements involving budget, procurement and other management activities.

The research effort involved in the Basic Energy Sciences program is extremely diverse. In FY 1985, for example, approximately 1,200 research projects will be underway either at the Department's laboratories or at more than 150 colleges and universities in 45 states. Evaluation, monitoring and management of this large number of diverse projects primarily from the Headquarters requires frequent contact with the contractors and laboratory staff and involves numerous workshops, planning meetings, and project and program reviews throughout the year.

During recent years the number of research projects at universities with industry and not-for-profits has increased from 18 to nearly 30 percent of the BES budget, and the workload per offsite project is significantly greater than that for a laboratory project. This is especially true with regard to evaluation of proposals, of which approximately 10 percent of those reviewed result in new contracts each year. The requested staffing level is required to maintain a strong core program; to evaluate research programs which have continued to grow in recent years, especially in newer emerging priority areas having great potential importance to energy; to oversee management, operation, and ongoing construction of unique research facilities; and to promote early application of the results of this basic research.

In addition to the ongoing basic research program, all three phases of the Congressionally mandated SBIR program (Public Law 97-219) will be operating concurrently in FY 1986. Phase I was implemented in FY 1983; 9,000 solicitations were mailed, resulting in 1,734 proposals spread among 25 technical topics. There were 106 contracts awarded totaling over $5,000,000. The first year of operation resulted in much heavier than anticipated workload requiring extensive use of overtime and diversion of other scientific and administrative staff from their regular duties to assist in the SBIR work. The workload in FY 1984 increased even further as 96 of the 106 initial contractors submitted proposals to enter Phase II of the program; 51 were selected. In addition, 844 proposals were received for the new Phase I awards and were reviewed and evaluated. During FY 1985 the initial FY 1983 projects will enter the second year of Phase II, FY 1984 projects will enter their first year of Phase II, and new Phase I projects will begin. FY 1986 will be the first year all three phases of the program will be in operation at the same time. This results in substantial increases in the numbers of proposals to be processed and evaluated for all phases, the procurements and projects to be monitored and evaluated, the site visits for those projects entering Phase II, and the debriefings requested by contractors not receiving awards.

This program also funds the Scientific Computing Staff which was established to manage responsibilities related to large-scale scientific computing. This staff manages two important activities related to large-scale scientific computing. They are: (1) providing access to large computers for the researchers supported by the scientific programs of the Office of Energy Research, and (2) supporting research in scientific computing necessary to meet the Department's long-range needs. Specific workload includes managing a number of research projects, including conducting peer reviews and evaluating proposals, performing economic and cost benefit studies and analyses of user needs, managing the Magnetic Fusion Energy Computer Network, and providing a single DOE focal point to maintain liaison with other Federal agencies, universities, and concerned organizations.

1. Title and location of project: General plant projects

2. Project No.: 86-R-400

3. Date A-E work initiated: 1st Qtr. FY 1986

3a. Date physical construction starts: 2nd Qtr. FY 1986

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

5. Previous cost estimate: None
Date:

6. Current cost estimate: $4,030
Date: 8/84

7. Financial Schedule:

		Costs			
Fiscal Year	Obligations	FY 1984	FY 1985	FY 1986	After FY 1986
Prior Year Projects	$ 300	$ 226	$ 0	$ 0	$ 0
FY 1984 Projects	400	150	250	0	0
FY 1985 Projects	3,750	0	1,350	2,400	0
FY 1986 Projects	4,030	0	0	1,000	3,030

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.: 86-R-400

8. Brief Physical Description of Project (continued)

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

Argonne National Laboratory	$ 3,000
Ames Laboratory	600
Notre Dame Radiation Laboratory	30
Sandia National Laboratory	300
Stanford Synchrotron Radiation Laboratory	100
Total project cost	$ 4,030

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

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

Argonne National Laboratory .... $ 3,000

Group I - Plant Rehabilitation and Upgrade Projects - ANL-West

*1. Replacement Condensate Piping from SM-2 to Bldg. 774
2. Roof Reconstruction, Bldgs. T-6, T-12, and T-13
3. Rehabilitate Industrial Waste and Drainage Ditches
*4. Replace Indicator Valves
5. Rigging Test Addition, Bldg. 752, ANL-West

*General Site-Wide Support Facility. All others are programmatic support.

Group II - Plant Rehabilitation and Upgrade Projects - ANL-East

1. Cooling Tower Rehabilitation, Bldgs. 200, 203
*2. Replace Underground Vault Switches, Bldg. 211
3. Replace Exhaust System, Wing A, Bldg. 203
4. Modify Chilled Water Piping, Bldg. 203
*5. Rehabilitate Canal Water Pump Station Bldg. 582

*General Site-Wide Support Facility. All others are programmatic support.

1. Title and location of project: General plant projects 2. Project No.: 86-R-400

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

Group III - Programmatic Projects

1. Thermochemical Properties Laboratory, Bldg. 205
2. Fast Neutron Generator Target Area Expansion, Bldg. 314
3. AGHCF Shield Window Refurbishment, Bldg. 212
4. Helium Gas Recovery and Storage System, Bldg. 203
5. HFEF/S Fixed Air Sampling System, ANL-West

Of the total request of $3,000,000 for GPP at the Argonne National Laboratory approximately 50 percent will be used for plant rehabilitation and approximately 50 percent will be used for upgrading and programmatic projects. By group of project the split for FY 1986 will be about $500,000 for Group I projects, $2,000,000 for Group II, and $500,000 for Group III.

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

The backlog of GPP projects has tended to increase steadily in recent years due to the shortfall in funding line item requests for plant rehabilitation at ANL-East and ANL-West, and because of programmatic shifts at ANL which have required modifications to the existing plant. When it is considered that total GPP funds available to ANL in FY 1983 and FY 1984 total only $2,100,000, it is readily apparent that while FY 1985 funding was increased ANL needs still far outpace the availability of funds with which to satisfy them.

Ames Laboratory.. $ 600

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

Notre Dame Radiation Laboratory.. $ 30

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

1. Title and location of project: General plant projects 2. Project No.: 86-R-400

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

Sandia National Laboratory.. $ 300

Requirements include minor laboratory modifications required in support of the Combustion Research Facility. The conversion of light duty laboratory space to heavy duty laboratory space is an example of the type of project to be supported.

Stanford Synchrotron Radiation Laboratory.. $ 100

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

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
1986 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

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

2. Project No.: 86-R-401

3. Date A-E work initiated: 1st Qtr. FY 1986

3a. Date physical construction starts: 1st Qtr. FY 1986

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

5. Previous cost estimate: None
Less amount for CP&D: None
Net cost estimate: None
Date: 8/84

6. Current cost estimate: $2,995
Less amount for CP&D: 0
Net cost estimate: $2,995

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1986	$ 2,995	$ 2,995	$ 2,995	$ 1,500
1987	0	0	0	1,495

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 and two projects are requested at the Oak Ridge National Laboratory for improvements at the High Flux Isotope Reactor.

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

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

1. Title and location of project: Accelerator improvements and modifications, various locations — 2. Project No.: 86-R-401

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

Brookhaven National Laboratory

High Flux Beam Reactor Facility (HFBR) .... $ 180

Funds are requested for seismic instrumentation, fuel element cutting systems and fuel handling blower system improvements.

National Synchrotron Light Source (NSLS) .... $ 1,615

Funds requested for the NSLS facility which consists of two electron storage rings, and electron linac and booster and which all require some annual improvements and modifications. Included in the request are: x-ray ring high density magnetic quadrupole coils, improvements to the VUV and x-ray ring radiofrequency systems, a 50 MHz booster folded cavity for 800 MeV operation, and improvements for increased energy capability of the linac injector.

Oak Ridge National Laboratory

High Flux Isotope Reactor (HFIR) .... $ 1,200

These funds requested for the HFIR are needed for two purposes. The first is replacement of two heating exchangers which are corroding and nearing the end of their reliable lives; they are, of course, absolutely necessary to the operation of HFIR in a safe and efficient manner, since they provide for cooling of the water in the primary loop of the reactor. Two of the total four of HFIR's heat exchangers are being replaced in FY 1985, and with the other two in FY 1986 many more years of safe operation are assured. The second purpose is installing a remote sampling system within the reactor building, which would be needed in the event of a release of radioactivity. Although this is an unlikely event, safety considerations now dictate having such sampling available.

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

2. Project No.: 86-R-401

10. Details of Cost Estimate

a.	High Flux Beam Reactor Facility................................	$ 180
b.	National Synchrotron Light Source..............................	1,615
c.	High Flux Isotope Reactor......................................	1,200
	Total Project Cost...	$ 2,995

11. Method of Performance

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

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1986 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

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

2. Project No.: 85-ER-403

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

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

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

5. Previous cost estimate: $3,400

6. Current cost estimate: $5,100

Date: 8/84

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1985	$ 2,000	$ 2,000	$ 2,000	$ 1,500
1986	1,900	1,900	1,900	1,000
1987	1,200	1,200	1,200	2,100
1988	0	0	0	500

Financial schedule is based on the net Government funding associated with this project. The State of Kansas will provide an additional $1,000,000 for the conventional construction necessary to house the new capabilities.

8. Brief Physical Description of Project

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

1. Title and location of project: Kansas State University, Ion Collision Physics Facility, Manhattan, Kansas — 2. Project No.: 85-ER-403

8. Brief Physical Description of Project (continued)

New equipment to be installed in new basement addition includes:

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

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

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

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

The total estimated cost for the project has been revised upward from the amount in the FY 1985 budget. The reestimate results from a more complete design, firm data on outside procurements, and a complete review of all components necessary for the scope of the project.

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

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

2. Project No.: 85-ER-403

10. Details of Cost Estimate

	Item Cost	Total Cost
a. Engineering, design and installation		$ 980
b. Land and level rights		0
c. Construction costs		330
1) beam line construction	$ 315	
2) utilities	15	
3) buildings	a/	
d. Equipment		2,900
e. Contingency		890
Total Project Cost		$ 5,100 a/

11. Method of Performance

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

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a/ Kansas State University will provide additional funding to construct the building. a) Estimate is based on completed conceptual design; b) Escalation is based on annual 8% to the mid-point of construction

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 85-ER-403

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

	FY 1985	FY 1986	FY 1987	FY 1988	Total
a. Total project funding					
(1) Total facility costs					
(a) Construction line item	$ 1,500	$ 1,000	$ 2,100	$ 500	$ 5,100 a/
(b) CP&D	0	0	0	0	0
(c) Expense funded equipment	0	0	0	0	0
(d) Inventories	0	0	0	0	0
Total facility costs	$ 1,500	$ 1,000	$ 2,100	$ 500	$ 5,100 a/
(2) Other project funding					
(a) R&D necessary to complete construction	$ 180	$ 180	$ 50	$ 0	$ 410
(b) Other	0	0	0	0	0
Total other project funding	180	180	50	0	410
Total project funding	$ 1,680	$ 1,180	$ 2,150	$ 500	$ 5,510 b/

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

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

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

No narrative required.

a/ Kansas State University will provide additional funding to construct the building. a) Estimate is based on completed conceptual design; b) Escalation is based on annual 8% to the mid-point of construction

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

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CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

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

2. Project No.: 84-ER-111

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

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

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

5. Previous cost estimate: $19,700

6. Current cost estimate: $ 19,700
Less FY 1983 PE&D: 0
$ 19,700

Date: 8/84

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1984	$ 2,500	$ 2,500	$ 2,500	$ 1,396
1985	10,000	10,000	10,000	10,254
1986	7,200	7,200	7,200	6,800
1987	0	0	0	1,250

Work included for accomplishment with the first year's appropriation of $2,500,000 will include but not be limited to the design and engineering of beam line components and preliminary and detail design of the support area construction.

8. Brief Physical Description of Project

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

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

2. Project No.: 84-ER-111

8. Brief Physical Description of Project (continued)

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

A. New Experimental Equipment

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

The new equipment to be provided will take maximum advantage of the properties of the NSLS source. As noted above the exact design of this equipment will be determined as the project progresses to maintain the flexibility necessary to develop state of the art facilities which will ensure high quality research capabilities. Four beam lines and associated insertion devices have been designated. Up to two additional beam lines may be constructed as dictated by science and permitted by available resources.

B. New Building Addition

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

The proposed building expansion will add approximately 52,000 square feet of new space in a two-story addition to the north and east sides of the existing building.

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

The second floor includes offices, technical work space, a large design room, a conference room and a mechanical room. Second floor gross area is 22,919 square feet.

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

2. Project No.: 84-ER-111

8. Brief Physical Description of Project (continued)

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

C. Existing Facility

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

The high energy x-ray storage ring provides for the possibility of 28 primary beam ports, each of which is capable of accommodating several experimental beam lines. The VUV ring provides for 16 beam ports which are also capable of accommodating several experiments each. In sum, more than 90 experiments can be carried out at one time when the facility is fully instrumented. In addition to general users, research groups called Participating Research Teams (PRT's) from universities, industry and national and government laboratories, upon advice by a program committee, and approval by the NSLS Department Chairman provide instruments to carry out research programs at the NSLS facility. Their instruments are made available to general users for 25% of the available time. At present such groups provide an additional 20 experiments at the facility. General users are able to use any of the experimental lines, PRT or community lines, upon approval of their experimental proposal.

The NSLS is operated as a user facility. This means that researchers from BNL and other laboratories will be able, after review of a proposal by a committee of distinguished scientists, and acceptance by the NSLS Department Chairman to carry out an experiment using either the UV or X-ray radiation produced by the rings.

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

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

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

2. Project No.: 84-ER-111

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

a) A group of instruments that will be available to general users that will complement in capability those already provided, and;

b) Several instruments (wiggler magnets and an undulator) which will provide a range of wavelength and intensity not available at the bending magnets. These instruments will be used both by general users and by members of the Participating Research Teams who will require such capabilities for their experiments.

A. New Experimental Equipment

In the original development plan, provision was made for a total of eight beam lines to be available to general users. Additional beam lines were to be provided at the rate of about two a year out of capital funds. Further instrumentation was to be made available by Participating Research Teams (PRT's), who would install beam lines at the rings at their expense and who would make 25% of the experimental time on those lines available to general users. However, the growth in user participation has far exceeded earlier expectations.

In order to provide experimental capabilities required both by PRT's and by general users, it is proposed to accelerate beam line construction. It is particularly important that the capabilities provided for in this project, such as wiggler magnets, be made available at the earliest possible date.

In addition to satisfying the requirements of the users, the accelerated design and construction of these beam lines will provide a cost saving because of efficiencies in planning, design, and construction.

B. New Building

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

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

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

2. Project No.: 84-ER-111

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

It was projected that during the early years of operations, up to approximately 50% of the 28 X-ray and 16 UV ports would be utilized. The extremely enthusiastic response of the scientific community now forces us to advance the expected rate of beam line construction and building expansion. More than 20 experiments have been proposed by PRT's, which are expected to be constructed at an early date. This response, coupled with the beam lines to provide by the project, indicate that the experimental floor would be extremely crowded beyond October 1983 and additional support space would be essential.

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

In addition to the pressing need to return experimental floor space to its intended use, the expansion will provide adequate office space for the permanent staff and work areas to complement the research and development associated with the anticipated experimental and machine improvement programs. The short connecting tunnel between the NSLS building and the basement of the adjacent Instrumentation building will connect the NSLS staging areas to an area where now extensive NSLS vacuum, instrument, and diagnostic work is in progress and where UV and X-ray test sources are located.

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

2. Project No.: 84-ER-111

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

Annual Costs

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

	(Dollars in Thousands)
Materials, Supplies, Support Services	$108
Electric Power	181
General and Administrative	46
Total	$335

10. Detail of Cost Estimate a/ b/

	Item Cost	Total Cost
a. Engineering, design and inspection, including A-E fee (approx. 25% of item c)..	$	$ 3,305
b. Land and land rights..........		0
c. Construction costs..........		13,465
(1) Beam line construction..........	6,430	
(2) Sitework..........	85	
(3) Structures..........	6,455	
(4) Facility Modification..........	495	
d. Standard equipment..........		770
Subtotal..........		17,540
e. Contingency..........		2,160
Total project cost..........		$ 19,700

a/ Estimate is based on a 90% Title II design.

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

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

2. Project No.: 84-ER-111

11. Method of Performance

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

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

	Prior Years	FY 1984	FY 1985	FY 1986	FY 1987	Total
a. Total project costs						
1. Total facility costs						
(a) Construction line item.........	$ 0	$ 1,396	$ 10,254	$ 6,800	$ 1,250	$ 19,700
(b) CP&D.........................	0	0	0	0	0	0
(c) Expense Funded Equipment.......	0	0	0	0	0	0
(d) Inventories....................	0	0	100	100	0	200
Total facility costs...........	0	1,396	10,354	6,900	1,250	19,900
2. Other project costs						
(a) R&D necessary to complete construction of beam lines....	900	500	500	0	0	1,900
(b) Other..........................	0	0	0	0	0	0
Total other project funding....	900	500	500	0	0	1,900
Total project funding..........	$ 900	$ 1,896	$ 10,854	$ 6,900	$ 1,250	$ 21,800

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

2. Project No.: 84-ER-111

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

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

1. Operating costs	$ 355
2. Programmatic operating expenses directly related to the facility	0
3. Capital equipment not related to construction but related to the programmatic effort	0
4. GPP or other construction related to the programmatic effort	0
5. Other costs	0
Total other related annual funding requirements	$ 355

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

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

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

2. Project No.: 84-ER-111

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

b. Total related funding requirements
   1. Operating Costs - There will be an annual requirement of additional materials, supplies, and support services associated with the new beam lines. Also, there will be a requirement for increased facility electrical power.
   2. Programmatic operating expenses directly related to the facility - no narrative required.
   3. Capital equipment not related to construction but related to the programmatic effort - no narrative required.
   4. GPP or other construction related to the programmatic effort - no narrative required.
   5. Other costs - no narrative required.

DEPARTMENT OF ENERGY
1986 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

1. Title and location of project: 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: 8/84

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1984	$ 1,760	$ 1,760	$ 1,760	$ 437
1985	10,790	10,790	10,790	5,423
1986	17,440	17,440	17,440	10,875
1987	9,060	9,060	9,060	12,840
1988	1,200	1,200	1,200	10,675

8. Brief Physical Description of Project

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

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

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

2. Project No.: 84-ER-112

8. Brief Physical Description of Project (continued)

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 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 full floor-plan will be L-shaped, about 192 feet long in one direction and 173 feet in the other; the longer element will be 63 feet wide and the other, 96 feet wide. The building structure will consist of a reinforced concrete frame with shear walls. Roof and floors above the base level will be of waffle-slab construction. Foundations will consist of poured-in-place reinforced concrete caissons.

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

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-112

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

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

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

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

Two research laboratories form the major components of the CAM:

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

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

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

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

2. Project No.: 84-ER-112

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

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

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

10. Details of Cost Estimate

	Item Cost	Total Cost
a. Engineering, design, inspection and administration	4,840	
b. Construction costs	22,930	
c. Standard equipment	5,850	
d. Removals and relocations	260	
e. Contingencies at approximately 19% of above	6,370	
Total estimated cost		$40,250

11. Method of Performance

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

CONSTRUCTION PROJECT DATA SHEETS

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

2. Project No.: 84-ER-112

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

	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988	Total
a. Total facility construction costs: a/						
SSCL	$ 437	$ 4,483	$ 6,745	$ 285	$ 0	$11,950
AML	0	940	4,130	12,555	10,675	28,300
Total facility construction cost	437	5,423	10,875	12,840	10,675	40,250
Total Project Funding	$ 437	$ 5,423	$10,875	$12,840	$10,675	$40,250

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

	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988	FY 1989
1. Programmatic research	$ 2,300	$ 2,900	$ 3,700	$ 6,200	$10,500	$15,500
2. Capital equipment related to programmatic research	1,300	600	1,200	2,000	2,200	2,400
Total	$ 3,600	$ 3,500	$ 4,900	$ 8,200	$12,700	$17,900

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a/ Includes escalation to midpoint of construction for all conventional facilities and compounded annually for special facilities; FY 1985 6.2%; FY 1986 6.5%; FY 1987 $6.3%; FY 1988 6.6%; FY 1989 6.8%.

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

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

a. Total project funding

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

(a) The Surface Science and Catalysis Laboratory has a completed Title II design. Construction will be packaged with site preparation planned in FY 1984 so that building construction can be completed in the second quarter of FY 1987.

(b) The Advanced Materials Laboratory building is scheduled for Title I review in the fourth quarter of FY 1985. 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 second quarter of FY 1986. Building construction will begin in the first quarter of FY 1987 and end in the fourth quarter of FY 1988.

b. Other related funding requirements

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

DEPARTMENT OF ENERGY
1986 CONGRESSIONAL BUDGET REQUEST
CONSTRUCTION PROJECT DATA SHEETS
ENERGY SUPPLY RESEARCH AND DEVELOPMENT - PLANT AND CAPITAL EQUIPMENT
BASIC ENERGY SCIENCES
(Tabular dollars in thousands. Narrative material in whole dollars.)

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

2. Project No.: 84-ER-113

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

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

4. Date construction ends: 4th Qtr. FY 1986

5. Previous cost estimate: $12,930

6. Current cost estimate: $13,330
Less FY 1983/1984 PE&D: 400
$12,930

Date: 8/84

7. Financial Schedule:

Fiscal Year	Authorizations	Appropriations	Obligations	Costs
1984	$ 1,240	$ 1,240	$ 1,240	$ 544
1985	9,130	9,130	9,130	6,261
1986	2,560	2,560	2,560	6,125

8. Brief Physical Description of Project

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

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

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

2. Project No.: 84-ER-113

8. Brief Physical Description of Project (continued)

The project is divided into three major portions: (a) construction of two beam lines, one on the SLAC Positron Electron Project (PEP) storage ring and one on the SLAC SPEAR storage ring; (b) alteration of the electron storage ring SPEAR for high flux synchrotron radiation research and (c) construction of three conventional facilities: a PEP Beam Line Facility (PBF) (3,100 GSF), a Light Assembly Shop (LAS) (8,600 GSF), and a Laboratory/Office Building (LOB) (26,200 GSF).

SSRL Conventional Construction

The site at PEP chosen for the PEP Beam Line and the associated facility -- (PBF) is just within the existing SLAC lease boundary and it will not be necessary to acquire more land from the University for the facility. The site requires a retaining wall for the access road, service yard, and PBF building which will be half buried into the PEP ring earth shielding mount. The PBF will be an experimental hall with three adjoining rooms and partial mezzanine. The Light Assembly Shop (LAS) will consist of a Vacuum Clean Room, and Vacuum Shop Office, a Beam Line Component Assembly Shop, a small Machine and Welding Shop, a Machine Shop Office, a Beam Line Component Storage Deck, and support rooms. The Laboratory/Office Building (LOB) will be a two story building. The upper floor will provide up to 43 offices, a library, a conference room, a drafting room, a lounge-kitchen area; seven work rooms and two HVAC equipment rooms. The ground floor will provide a receptionist area, two large work rooms, up to 24 offices, an x-ray lab, a metrology lab, a VUV lab, an electronics lab and four lab storerooms.

The optimum location for the LOB is presently occupied by an existing SLAC liquid hydrogen storage facility which SSRL will relocate to a new site selected by SLAC.

Special Facilities

A 26-period, 2-meter rare-earth cobalt undulator magnet will be installed on the PEP storage ring to produce photon beams peaked at 13 KeV. A scattering beam line will originate with a 54-pole rare-earth cobalt wiggler magnet on the spear storage ring. Machine improvements will include reduction of SPEAR emittance and vertical aperture, beam stabilization, and a new LINAC electron injection system.

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

Over the past decade, the development of synchrotron radiation has led to major advances in a number of different scientific and technological fields, but particularly materials science, condensed matter physics and chemistry, as

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

2. Project No.: 84-ER-113

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

well as the biological sciences. Each order of magnitude increase in photon flux or spectral brilliance achieved during this period has resulted in qualitatively new experiments which provide previously unobtained information and yield new understandings.

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

As a result, new storage rings are presently being planned which are optimized for high spectral brilliance and photon flux through utilization of insertion devices, rather than bending magnets, for the production of radiation and through the achievement of extremely low emittances and high currents. These rings are also optimized for specific spectral regions through choice of stored electron energies. Generally, stored electron energies at 1.0 to 1.5 GeV are utilized for ultra-high brilliance soft x-ray and vacuum ultraviolet (VUV) generation whereas rings of greater than 3.0 GeV are used for ultra-high brilliance x-ray generation.

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

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

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

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

2. Project No.: 84-ER-113

10. Details of Cost Estimate

	Item Cost	Total Cost
(a) Engineering, design, and inspection	1,630	
(b) Construction costs	8,070	
(c) Standard equipment	520	
(d) Removals and relocations	100	
(e) Contingencies at approximately 19% of above	2,610	
Total estimated costs		$ 12,930

11. Method of Performance

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

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

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

2. Project No.: 84-ER-113

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

	FY 1984	FY 1985	FY 1986	Total
a. Total facility construction costs: a/				
SSRL Enhancement	$ 544	$ 6,261	$ 6,125	$ 12,930
Total facility construction cost..........	544	6,261	6,125	12,930
b. Other project funding:				
SSRL R&D.................................	800	700	0	1,500
Total R&D/Startup........................	800	700	0	1,500
Total Project Funding........................	$ 1,344	$ 6,961	$ 6,125	$ 14,430

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

a. Total project funding

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

(a) At SSRL the PEP Beam Line will be accomplished during the first two years. Improvements to SPEAR are scheduled for the second year and the Laboratory Office Building is scheduled for the second and third

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

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

2. Project No.: 84-ER-113

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

years. Completion of the SPEAR scattering Beam Line and the Laboratory-Office Building will occur during the third year.

(2) Other project funding

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

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